Compared Air Combat Performances analysis
MiG-23ML versus F-4E Phantom II

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Table of Contents

A. Introduction

The purpose of this document is to compare the performances of the MiG-23ML and F-4E in the context of close (within visual range) air combat.

The MiG-23ML has been opposed to the F-4E in two main conflicts: the first Persian Gulf War (1981-1988, also called IPGW) where Iraqi MiG-23MLA faced Iranian F-4E, and the 1982 Bekaa Valley War where Syrian Air Forces MiG-23ML faced Israeli IDF/AF F-4E.

In both case, the F-4E to be considered are variants with leading edge slats: Blk.50 used by the IDF/AF (Israeli Air Force), and Blk.54 or Blk.57 used by then IRIAF (Iranian Air Force).

The MiG-23ML variants to be considered are the ones provided to Syrian, Iraqi, Egyptian or even Algerian Air Forces: MiG-23ML, MLA or MLD (Izdeliye.23-12A, Izdeliye.23-19B and Izdeliye.23-22B).

Aircrafts will be compared in their most probable configurations during an air/air combat: external tanks dropped, close to 50% of internal fuel, full load of gun rounds and the most common missiles configuration.

This document also contains a short comparison of the MiG-23 ML iz-23.12 with non-slated F-4E (Blk.41) even if the two planes never were direct opponents in real combat.

B. Methodology description

Critical performances

For each altitude, we will compare stall speed, turning, climbing and acceleration capabilities.

Stall speed

Stall speed will be computed for the identified configurations (gross weight and external stores), flaps and slats up (or at least set to 'combat position' if relevant) with a load factor of 1G (constant speed, no bank, and a horizontal plane trajectory) with engines at full dry power (also called MILITARY power), and with full reheat engaged (also called FULL A/B for After Burner).

These performances are representative of the plane's capacities when very low speed maneuvers are performed, such as rolling scissors (slow yo-yo), combined with Minimum Sustained turn radius, It gives an idea of the plane's performance level when engaged in a low speed combat. The performance indicator is the Full A/B stall speed.

The 1G stall speed is not the minimum speed the plane can reach in a slow yo-yo, most of the time, the load factor is less the 1G (nose up, with a climb angle of 60°, load factor is only 0.5G), but the relative stall speed position of 2 planes are very similar for load factors of around 1G (0.5-1.5), so 1G stall speed is a good enough performance indicator.

Turning

Turning capabilities will be measured by the following performances:

Quickest half turn: Minimum time required to perform a 180° horizontal turn with maximum G-Load (structural or maximum lift limits), each aircraft starting its turn at the speed that results in the best time.
This is typically what can happen "at the merge", when the decision is to go for a short range (within visual range, aka WVR) fight and that no one is in a position to open fire, the target being outside of the weapon employment domain for angles problem (offset or aspect) more than a range one. In this situation, energy (speed or altitude) is traded for angle. If the pilot decides to do this and keeping his altitude (staying in the horizontal plane), he will pull all the available G load to reduce his target's aspect and offset angles and bleed his speed to do that in the shortest time possible. If both pilots do the same manoeuver, the pilot flying the plane with the highest average turn rate will reach a firing solution first.

Average turn radius during the quickest half turn measures the capacity to win the fight immediatly after entering it.

Maximum Sustained Turn Rate: maximum deviation the pilot can impose to the direction of his plane in one second, keeping his speed and altitude constant (as speed and altitude are constant, this deviation is the same if measured between plane/gun axis or between speed vector).
When both planes fail to reach a firing solution just after the merge (aspect of offset angle too large) and decide to stay in the horizontal plane, they will enter a sustained turn fight, the one that will be able to reduce his target aspect and offset angle is the one that can sustain the best turn rate. Maximizing turn rate is the most common offensive maneuver in a turn fight.

Maximum Sustained Turn Rate measures the offensive capacities in a stabilized turn fight.

Minimum Sustained Turn Radius: Smallest turn radius of a constant speed 360° turn.
Once engaged in a sustained turn fight in a defensive posture (the opposing fighter is behind you), you may be able to deny him any firing solution if you can turn in a circle which radius is significantly smaller than his own, you will turn inside him and he will not be able to reduce the offset angle with which he is seeing you.

Minimum Sustained Turn Radius measures the defensive capacities in a turn fight.

Climbing

Non turning climb: both aircrafts fly at their maximum constant speed climb rate with 1G load factor, starting from same point, first aircraft gaining 2000 feet, and measuring altitude advantage on the other fighter at that new position.

Turning climb: both aircrafts engaged in a constant speed, constant G-load (2G at 30,000ft, 3G at 15,000ft, 4G at 5,000ft) turn, measuring altitude gain after a 90 degrees turn.

Acceleration

Distance covered in 3 minutes, starting from M0.5 and M0.9

Both aircrafts perform a level flight, starting at same speed (Mach 0.5 and Mach 0.9), the measured performance is the horizontal distance covered after a three minutes full power sprint.

Also measures the time and distance for the fastest to catch his target (for a total time less than 3 minutes).

The one able to cover the greatest distance is able to force his opponent to enter the fight or to deny it, the slower one being forced to follow his opponent's decision.

When the run starts at high speed (M0.9), this covered distance is a measure of the offensive capacity to engage, or to deny his opponent this capacity at the beginning of the fight.

When run starts at low speed (M0.5), this covered distance is a measure of the capacity to disengage, near to its end, by getting out of the engagement zone of the enemy's weapons.

Aircraft configuration definition

Mig-23ML combat configuration

The referenced MiG-23ML is the iz.23-12A powered by the Turmanski R35-F-300 turbojet engine that entered production in 1978 and is considered as a "second generation" of MiG-23.

In terms of performances, all second generation variants of MiG-23: iz.23-12A, iz.23-19B, iz.23-22B (called MiG-23ML, MLA or MLD depending on equipment and operating air forces) are equivalent, with a noticeable exception of the iz.23-18.

Aircraft loaded with 50% of internal fuel (-256lbs to fit a gross weight of 13t), two R-60M or MK missiles (fox-2), two R-24R missiles (fox-1) and their respective pylons and racks (BD3-60-23 pylon and APU-60IM rack for R-60 under fuselage and APU-23IM rack for R-24R under wings). There is a possibility to load 4 R-60 using special launching rails, but we keep the configuration with only 2 as it has been the most commonly used by both Syrian and Iraqi MiG-23ML.

zero fuel clean weight	10,470 Kg
internal fuel	1,734 Kg
2 x BD3-60-23	50 Kg
2 x APU-60IM	70 Kg
2 x R-60M/MK	90 Kg
2 x APU-23IM	106 Kg
2 x R-24R	480 Kg
Gross Weight	13,000 Kg

<u>Speed limitations:</u>

For all configurations with wing sweep angles of 45 or 72 degrees, the speed is limited to 1,400 Km/h – 756 Kts CAS/IAS or Mach 2.35, whichever is the lowest.

For all configurations with wing sweep angle of 16 degrees, the speed is limited to Mach 0.80.

<u>Load Factor limitations:</u>

Maximum allowed load factor (Ngz) depends on Mach number and wing sweep angle as follows:

Wing sweep	M<=0.85	M>0.85
16 deg	Ngz < 5.5	Ngz < 5.0
45 deg	Ngz < 7.5	Ngz < 7.0
72 deg	Ngz < 8.5	Ngz < 7.5

<u>Angle of Attack (AoA) limitations:</u>

As a general rule, we will consider the angle of attack limiter (the SOUA system) as activated. For more details on how this device limits the angle of attack, please refer to the "Flight Model Identification" document mentioned in the bibliography section.

<u>Sweep wings angle (sometimes noted X)</u>

MiG-23ML performances are documented for 2 values of the wings sweep angle: fully forward (16°) recommended for take-off, landing (the only angle allowing trailing edge flaps and leading edge slats to be deployed) and low speed flight (ground target attack), medium (45°) recommended for air combat and fully backward (72°) for supersonic flight.

It is possible to fly with other angle values (pilot can select any wing position and lock wings), but they are not documented (at least not in any document of my knowledge).

All have their own "preferred" domain (mainly Mach number driven), but it must be understood that it is not possible to 'adapt' wing position to the combat situation (unlike the F-14A, which adapts automatically the wing position to the situation). This limitation is not due to the load factor (MiG-23 pilots usually move their wings from 45° to 16° under 3-5G during the break performed before going to base leg and land), but because of the time it takes (around 18s).

This means that, once you have chosen, you have it set until the end of the fight.

F-4E Blk.50 combat configuration.

The concerned F-4E Blk.50 is one of the first variant of the F-4 produced with leading edge slats. This improvement is included in most (if not all) later blocks of the F-4E and in the F-4F and F-4G. It can also be applied as a retrofit (T.O. 566) to earlier blocks of the F-4E.

This particular variant is representative of the F-4E Blk.50 used by IDF/AF (Israeli Air Force), but also very close to the F-4E Blk.54 and Blk.57 used by IRIAF (Iranian Air Force).

When used by IDF/AF in 1982 Bekaa Valley war, Israeli F-4E main task was not any more Air Superiority. This has been the case during attrition war, and even during 1973 Kippur, but in 1982, F-4E was mainly used as a deep striker. The weapons configurations that are relevant for air combat is this kind of missions are the one obtained after air-ground ordonnances and external fuel tanks have been released.
Air-Air missiles purpose were mainly self-defense and fox-2: AIM-9G or Python 3 under front fuselage points with a dedicated adapter (it is admitted that the AIM-9L, even if available for IDF/AF fighters were used only by F-15 and F-16). AIM-7 fox-1 were not always mounted on rear fuselage points.
As wing pylons were used for air-to-ground weapons and so unable to be fitted with AIM-9 launchers, nor air-to-air missile neither ECM pods were mounted under them, the latter being sometime loaded on one of the front fuselage point (where an AIM-7 is usually mounted).

F-4E used by Iranian Air Force during the first Persian Gulf War (1981-1988) were often tasked for air-air mission, even if the most famous air superiority assets of the IRIAF were the F-14A Tomcat, in many cases F-4E were used in combination with F-14, the latter playing the role if a kind of mini-AWACS.

In that cases, F-4E weapon configurations were the very classical one: 4 AIM-7E on fuselages points, 4 AIM-9J under internal wing pylon (and 2 external tanks under external wing pylons, dropped before engaging close air combat).

In order to take into account the multiple possible weapons configurations, and because there are not that different in term of drag and weight we decide to keep the already documented one.

The F-4E close air combat configuration we will use in all this document is the following: aircraft loaded with 50% of internal fuel, four AIM-7 (whatever sub-type) under fuselage, two AIM-9 (whatever sub-type) and launchers under a LAU-7/A pylon on station 2, an ALQ-71/QRC-160-1 ECM pod on station 9 with its outboard pylon.

Zero fuel weight, including oil, two equipped crew members (440 lbs) and internal gun munitions (639 rds for 373 lbs) : 33,373 lbs

Fuel weight with JP-4 fuel at 6.5 lbs per gallon (60 F)
- Not Usable : 370 lbs
- 50% internal fuel : 6,214 lbs
- Usable (with 50%) : 5,844 lbs

Weapons:
- 4 x AIM-7E : 1,820 lbs
- LAU-7/A + 2xAIM-9D : 828 lbs
- Outter Pylon + ALQ-71/QRC-160-1 : 393 lbs
- Total : 3,041 lbs

This leads to a Gross Weight of 42,628 lbs (19.3t).

Speed limitations:

- Due to the ALQ-71/QRC-160-1 pod's RAT limitation, 750Kts up to 25,000ft, 650Kts at 40,000ft (with linear variation in between).
- Mach number below 2.4 (and below 2.0 for normal usage)

Load factor limitations:
- Due to AIM-9D under LAU-7/A pylon and launchers on station 2, subsonic and supersonic limitations are the same depending only on gross weight, resulting in a maximum value of 5.47g.

F-4E Blk.41 combat configuration.

The F4-E Blk41 is not the most obvious opponent to the MiG-23ML, these non-slated F-4E variants having been provided to IDF/AF in 1969 through Peace Echo I, and certainly retrofitted to slated Blk.50 before the MiG-23ML is operational in the war zone.

Other operators of non-slated F-4E in the late 70s (Japan Defense Air Force with its F-4EJ as an example) are not known to have faced the MiG-23ML.

In fact, there is very few chance that any non-slated F-4E has ever been opposed to a MiG-23ML.

But the non-slated F-4E is known as the best (understand faster) western interceptor before the availability of the F-15A. Not too different of the F-4E Blk41, the US NAVY F-4J is assumed to be on par with the F-14A in terms of instantaneous subsonic climb rate.

So the F4-E Blk41 is here to represent the supposed "best" western fighter in vertical maneuvers in the 70s. (We will also see that it is the western fighter whose the performances are the closest to the MiG-23ML)

Aircraft loaded with 50% of internal fuel, four AIM-7Es under fuselage, two AIM-9D and launchers under a LAU-7/A pylon on station 2, an ALQ-71/QRC-160-1 ECM pod on station 9 with its outboard pylon.

Zero fuel weight, including oil, two equipped crew members (440lbs) and internal gun munitions (639rds for 373lbs): 32,303lbs

Fuel weight with JP-4 fuel at 6.5 lbs per gallon (60 F)
- Not Usable : 370 lbs
- 50% internal fuel : 6,214 lbs
- Usable (with 50%) : 5,844 lbs

Weapons:
- 4 x AIM-7E : 1,820 lbs
- LAU-7/A + 2xAIM-9D : 828 lbs
- Outter Pylon + ALQ-71/QRC-160-1 : 393 lbs
- Total : 3,041 lbs

This leads to a Gross Weight of 41,558 lbs (18.8t).

Drag Index:
- 4 x AIM-7E : 5.2
- LAU-7/A + 2xAIM-9D : 6.0
- Outter Pylon + ALQ-71/QRC-160-1 : 4.1
- Total : 15.3

Speed limitations:
- Due to the ALQ-71/QRC-160-1 pod's RAT limitation, 750Kts up to 25,000ft, 650Kts at 40,000ft (with linear variation in between).
- Mach number below 2.4 (and below 2.0 for normal usage)

Load factor limitations:
Due to AIM-9D under LAU-7/A pylon and launchers on station 2, subsonic and supersonic limitations are the same depending only on gross weight, resulting in a maximum value of 5.58g.

C. MiG-23ML & F-4E Blk50 at 15,000ft

Stall speed

At this altitude, the stall speed of the F-4E and the MIG-23ML in its difference wing sweep configurations (with SOOUA device activated) can be found in the table below:

	A/B power	MIL power
F-4E Blk.50	125.94	132.66
MiG-23ML X=16	132.14	136.66
MiG-23ML X=45	171.38	175.94
MiG-23ML X=72	194.28	199.35

We can see that the F-4E can fly slower than the MiG, whatever wing sweep angle is chosen.

With wings fully forward (16°) the difference is very low (around 5Kts or 4% depending on engine power), but with the 'regular' wing angle for air combat (45°), the F-4E can fly 40-50Kts (26%) slower than the MiG's minimum speed (allowed by SOUA system).

The engine capabilities at low speed must also be taken into account. While the J-79 after-burner is not known to be very sensitive to high AoA or low speed (unlike the TF-30 can be), the R-35 of the MiG-23ML is not well documented in that aspect. The few low speed combat testimonies of MiG-23 pilots lead to think they do not engage afterburner in such situations. So, we may have to compare the MiG MIL stall speed to the F-4E max A/B one.

It is well known that the F-4E, even with leading edge slats is really hard to maneuver at such low speed: few if no stick roll authority, needing large rudder input to turn the nose. But even then, it is hard to believe a MiG-23ML being able to take advantage over an F-4E in a rolling scissors / slow yo-yo exercise if both pilots fly their plane to the very limit of the flight domain.

Turning performances

Quickest half turn

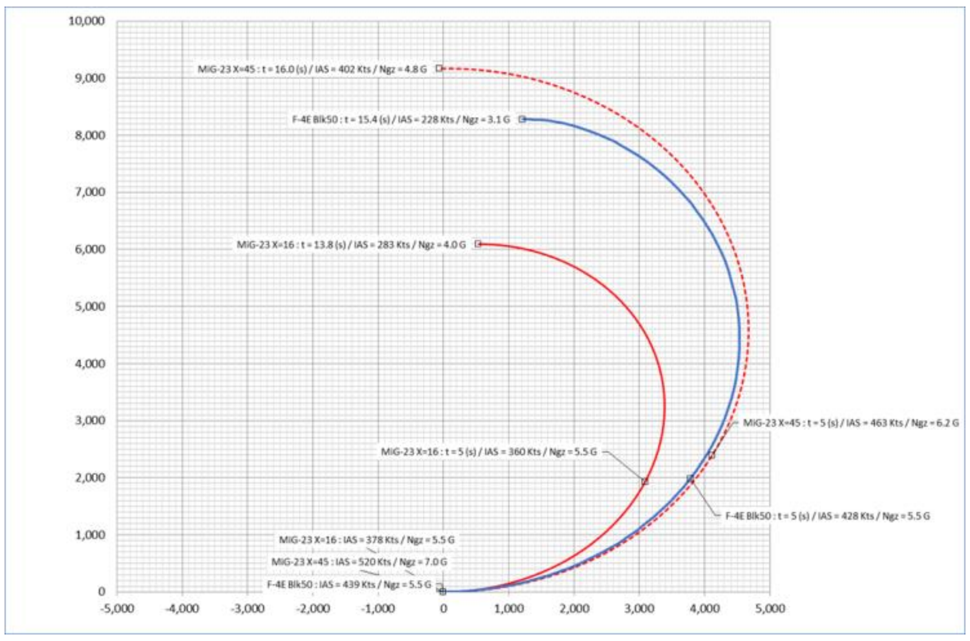
The quickest half turn is supposed to be representative of what can happen at the "merge" when the two opponents decide to enter the fight in the horizontal plane and to find a (head on) firing solution as soon as possible.

Both aircrafts pull their maximum allowed load factor, bleeding their speed down to a point where the maximum angle of attack does not even provide the maximum allowed load factor. As high G turns will never be performed in transonic regime, it is assumed that the half turn is started at a speed under Mach 1.0. For each configuration, the initial speed is the speed minimizing the time it takes to perform a 180 degrees turn.

The large scale graphic description of the quickest half turn for each plane can be found in fig 1.1 and fig 1.2 of section K. Appendix and Figures.

The graphic comparison does not include the half turn performed by a MiG-23ML with wings sweep angle of 72° as this configuration will not be used for a subsonic maneuver.

As the angle of attack limiter system (SOUA) does not reduce maximum lift available when wings are fully forward (sweep angle of 16°) we have three configurations for the MiG-23ML: Sweep angles of 16° and 45° with SOUA system engaged (fig 1.1) and sweep angle of 45° with SOUA system disengaged (fig 1.2)



The results can be summarized with the following values:

	Time (s)	Radius (ft)	average turn rate (°/s)
F-4E Blk.50	15.40	4,140	11.7
MiG-23ML X=16 SOUA ON	13.80	3,046	13.0
MiG-23ML X=45 SOUA ON	16.00	4,582	11.3
MiG-23ML X=72 SOUA ON	19.00	5,286	9.5
MiG-23ML X=45 SOUA OFF	14.40	3,884	12.5

As expected, MiG-23ML turns faster when wings are swept forward, and also when the angle of attack limiter system (SOUA) is not engaged, allowing the pilot to fly at the edge of the maximum lift (just before stall).

This last option is not representative of what can be done, but more of what cannot be exceeded in any case.

The MiG-23ML pilot can decide to take a significant advantage (1s faster, around 3,000 ft of offset inside the circle) at the merge in sweeping his wings fully forward and merging at a low speed (380 Kts indicated). If the F-4E decides to follow, the R-60M/MK will provide a head-on firing solution before the F-4E can reach a gun shoot opportunity.

IRIAF has never received any all-aspect variants of the AIM-9, so their F-4E never had any head-on fire capacities but their gun.

IDF/AF received AIM-9L (first AIM-9 with all sector IR seeker) and used then in 1982, at least with their F-15 and F-16. Python 3 used under their F-4E are also supposed to have an all-aspect IR seeker.

So, the decision to go for the sharpest turn at the merge may be a good option for an Iraqi MiG-23ML with R-60M/MK facing an Iranian F-4E, but is more risky for a Syrian MiG-23ML pilot facing an IDF/AF F-4E.

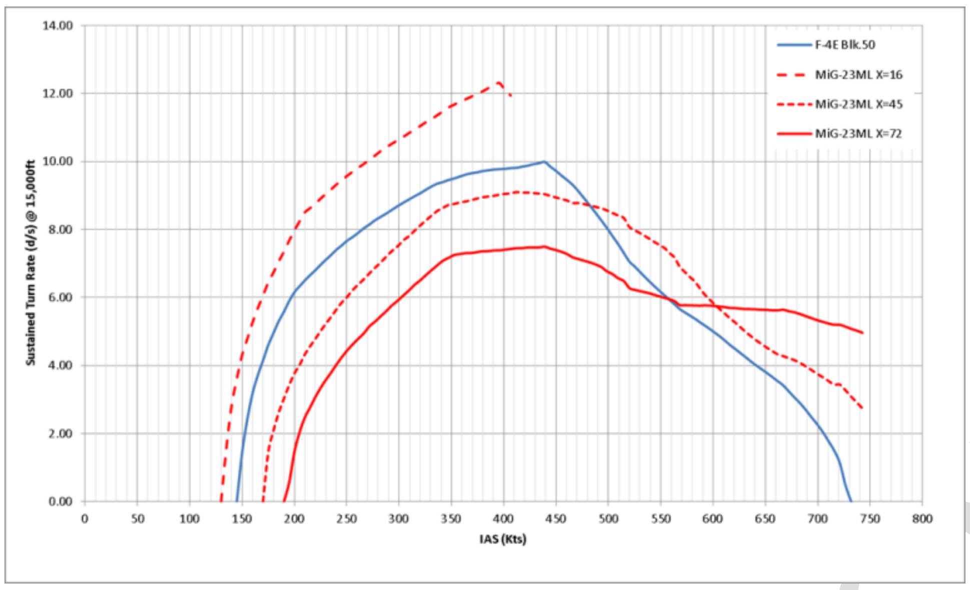
But this is a very risky decision: The opponent will be able to see the wing's sweep angle and conclude a M0.8 speed limit for the MiG, who will be engaging in a low speed / small radius combat as a consequence. The F-4E pilot can then decide to not merge directly but force the combat to a high speed and re-engage later a target that have spent all its energy and is not any more able to accelerate to break the fight and so becomes an easy non maneuvering target (sitting duck).

This is why I foresee the MiG pilot following the manual's advice and choose a sweep angle of 45°. In this situation, we can see that none of the two can get a significant advantage over the other. Both perform in a similar way even if the F-4E needs to start slower due to its load factor limit (5.5G imposed by its AIM-9 racks) and consequently ends also slower.

Maximum Sustained Turn Rate

Once the merge ends on a status quo and the two pilots decide to stay in the horizontal plane, they can choose to go for an angle fight (offensive turn fight) to reach a position behind the target where IR missiles and gun can be used at short range. In such a case, the sustained turn rate is decisive.

As maximum sustained turn rate is highly dependent on aircraft speed, their values must be compared as seen in the following figure (to be found in larger scale as fig 1.3 in section K):



First case: the MiG-23 has its wings fully swept forward. At any indicated speed below 370Kts, the MiG-23ML will gain around 2°/s on the F-4E, so the F-4E pilot will need to break immediately the angle fight, we will see later that a radius fight (defensive turn fight) is not an option, the best and unique solution being to dive and accelerate (as the MiG-23ML cannot follow with such a wing sweep angle). If not, the F-4E will be shot by the MiG-23ML R-60M/MK.

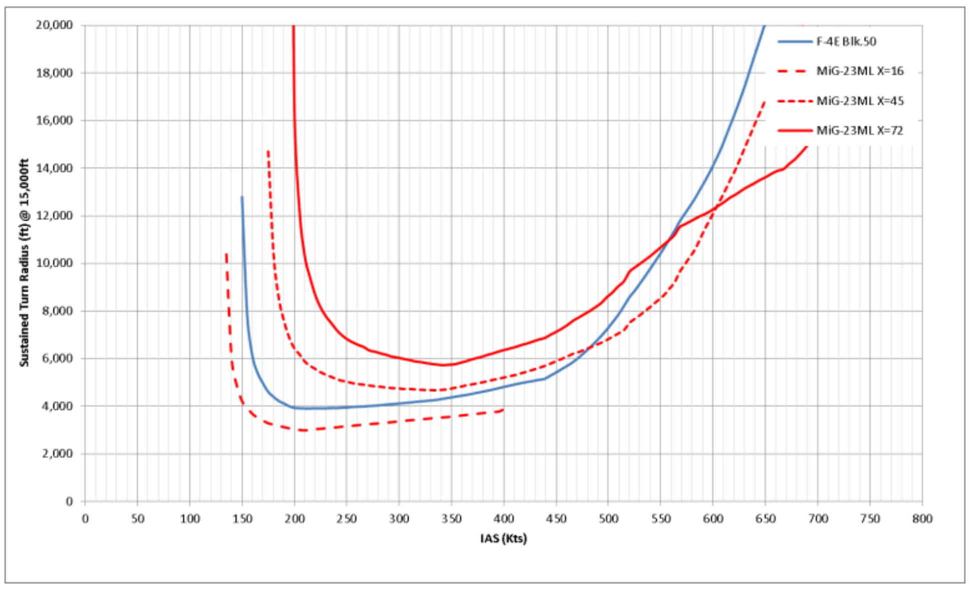
Second case: the MiG-23 has its wings swept at 45° (most probable situation). The situation is quite the opposite: at any speed below 480Kts/M0.92 the F-4E turn rate is between 1 and 2°/s superior to the one of the MiG-23ML and thus will find a firing solution for its AIM-9.

Minimum Sustained Turn Radius

Minimum radius turn is the defensive option if you want to stay in the horizontal plane and your opponent has the turn rate (angle) advantage.

Usually highest sustained turn rate is achieved at much higher speed than the lowest sustained turn radius; this explains why the aircraft having the highest sustained turn rate may not have the lowest sustained turn radius (the one behaving the best at high speed may not be the same at low speed)

In our case, the one having the highest turn rate also has the lowest sustained turn radius as shown in the graphic below (to be found in larger scale as fig 1.4 in section K):



If the MiG-23ML has its wings fully swept forward, it has the advantage on both domains, and even if the F-4E increases its speed above what the MiG can do, both turn rate and turn radius fight will remain at the MiG advantage.

On the other hand if the MiG-23ML has its wings sweep angle set to 45°, the F-4E will have the advantage over the MiG in both turn rate and radius.

Climbing performances

Instantaneous climb rate at constant speed (also known as Excess Specific Power or Ps) is not related to the time required to climb to a given altitude (a key performance indicator for an interceptor, but having a lower importance in a dogfight), but rather explains how the plane will keep or bleed its speed (or energy) during vertical maneuvers such as vertical scissors, yo-yo… in such configurations the one that can keep its energy will eventually take the advantage.

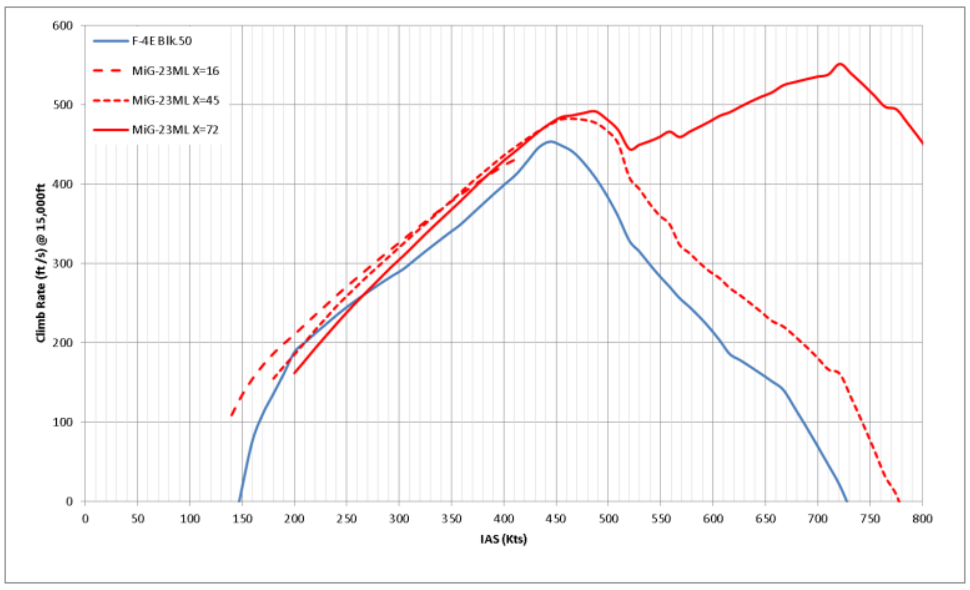
Climbing maneuvers can be performed at low (close to 1G or below) load factor (pure vertical) or combined with turning at medium G load (in oblique plane), in both cases, the pilot adapts his climb angle in order to keep its speed constant.

Non turning climb

In a pure vertical configuration, we can see that:

- Sweep angle has little influence on the climb rate of the MiG-23, especially in the speed range of a regular dogfight (between 250 and 450Kts at this altitude).
- Only the MiG-23ML with wings fully swept back can go vertical in supersonic, in such a configuration (600Kts+ merge) going vertical will keep the MiG-23ML out of F-4E weapon range with a large security margin.
- The F-4E with leading edge slats will bleed its speed or energy faster than any MiG-23ML in most of the regular dogfight speed range.

The difference is around 8-10% between 280 Kts and 400 Kts (compared to a wings configuration with sweep angle of 45°)



The figure above can be found in larger scale as fig 1.5 in section K Appendix.

If we assume both planes climbing at their optimum subsonic speed (445 Kts for the F-4E, 490Kts for the MIG with wings at 45°, 490Kts with wings swept at 72° and M0.8/412Kts with wings swept at 16°), we can see that when the F-4E gains 2,000ft in 4.4s, the MiG-23ML will be 127 or 168ft higher. The MiG-23ML climbs slower only when its wings are swept fully forward.

	Ps (ft/s)	(s) 2,000ft	Z (ft)	dZ (ft)
F-4E Blk.50	454	4.4	2,000	
MiG-23ML X=16	432	4.6	1,904	-96
MiG-23ML X=45	482	4.1	2,127	127
MiG-23ML X=72	492	4.1	2,168	168

If both fly at low speed (M0.5), we obtains:

F-4E Blk.50	245	8.2	2,000	
MiG-23ML X=16	271	7.4	2,211	211
MiG-23ML X=45	259	7.7	2,113	113
MiG-23ML X=72	238	8.4	1,945	-55

After the 8.2s required for the F-4E to climb of 2,000ft, the MiG-23ML will be 113 or 211ft above.

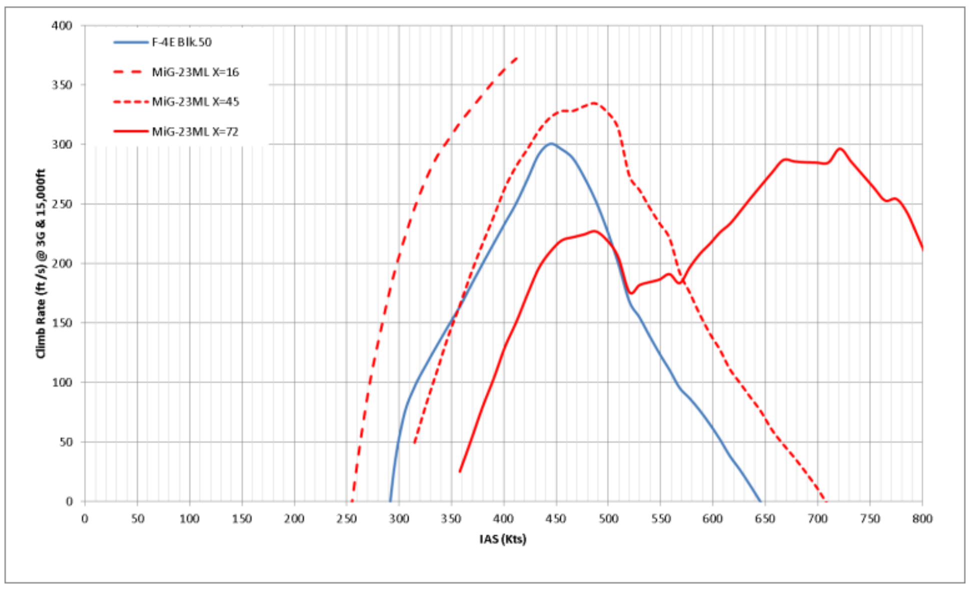
Even if the difference is not really significant (less than 10%), that means that the F-4E pilot should avoid to go vertical in front of a MiG-23ML when it is one of its best option for most of its usual opponents.

On the other hand, going vertical is a better option for the MiG-23ML (than a turning fight), even at low speed (when wings are swept forward).

Turning Climb

This 3G constant speed climb rate describes what happen when planes engage a moderate (3G) turn and keep their speed constant by adjusting their climb angle. It is a current defensive maneuver (sometime called screw pull), in such case the plane that gains an altitude advantage will take the upper hand.

As we can see below, this is not a good option for a MiG-23ML with wings swept back.



The figure above can be found in larger scale as fig 1.6 in Appendix section K.

But in any other case, the MiG will end a 2,000ft "climbing screw pull" with 226 or even 477ft height advantage.

	Ps (ft/s)	(s) 2,000ft	Z (ft)	dZ (ft)
F-4E Blk.50	301	6.7	2,000	
MiG-23ML X=16	372	5.4	2,477	477
MiG-23ML X=45	335	6.0	2,226	226
MiG-23ML X=72	227	8.8	1,511	-489

Once again, if both planes fly slowly (below M0.8) and the MIG's wings are swept forward, as soon as they turn, the MIG will perform better. But we know this is a very marginal case, as it is very easy for the F-4E to accelerate and disengage in this scenario, the MiG not being able to follow.

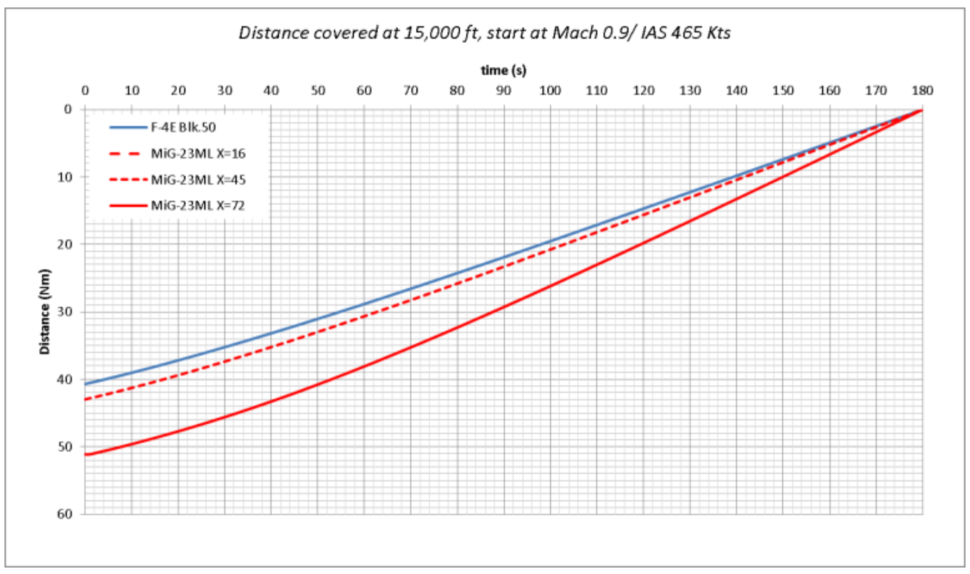
In the most common case (wing sweep angle at 45°, high subsonic) the MiG has just a 10% advantage over the Phantom.

Acceleration performances

Here we calculate the distance covered in 3 minutes with maximum available thrust and keeping a constant altitude, from two different initial speeds: M0.9 and M0.5

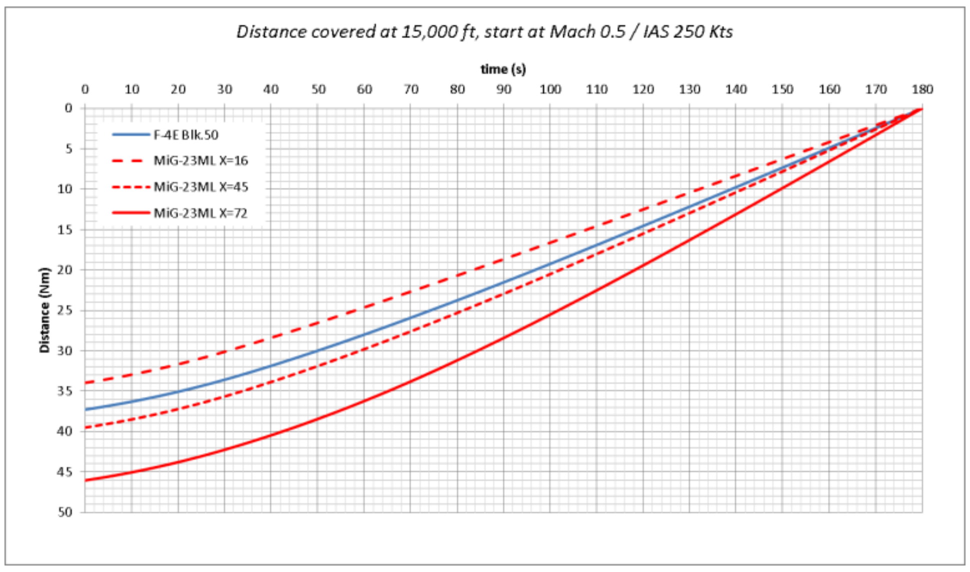
The first measures the capability to catch the target when it has been detected (or to avoid being caught) and to exit the fight at its beginning, the latter only measures the capacity to break the fight after having bled all its energy (as M0.5 is the speed one should have when looking for a target).

In both cases, the flight conditions allows the MIG pilot to choose the best wing position (72°) before or at the beginning of the acceleration.



As we can see above, from M0.9, in 3 minutes a MiG-23ML with wings fully swept back is 10Nm ahead of an F-4E Blk50… said the other way, the MiG can circle more than 55s (more than 3 times what is required to do an half turn) and rejoin the Phantom in less than 2'10''.

So no doubt that the MiG pilot has the possibility to force his opponent to the fight and to break it quickly if in a bad posture with very few risks to being engaged.



The figure above can be found in larger scale as fig 1.7 and 1.8 in section K Appendix

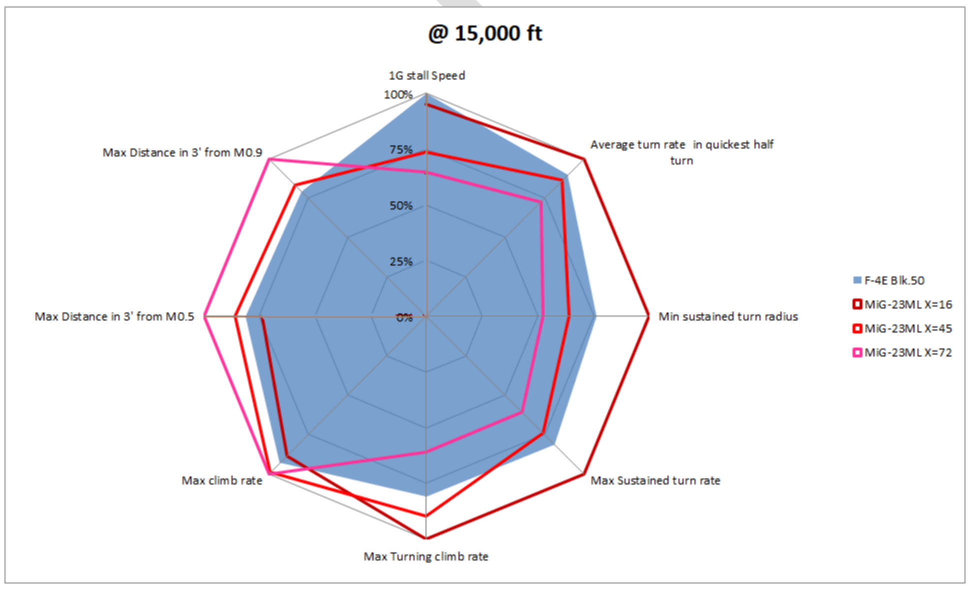
From a low speed (M0.5), the result is very similar: 8.75Nm ahead, corresponding to 50s. If, at any point in time, the MiG is in a bad posture, he can decide to break the fight in just sweeping back its wings and accelerate.

Conclusion

If we try to graphically represent the eight main values (keeping "more-is-better" convention) we can compare:

- Stall speed
- Average turn rate during quickest half turn
- Maximum Sustained Turn rate
- 1000ft / Minimum Sustained Turn Radius
- Maximum Level flight Climb Rate (Mach < 0.9)
- Maximum Turning Climb Rate (Mach < 0.9)
- Distance Covered in 3' from Mach 0.5
- Distance Covered in 3' from Mach 0.9

In normalizing them (in percentage of the best value), we get the following diagram:



In the picture above, we have the 3 wing positions of the MiG compared with the F-4E and 100% is always the best of the 4. This would have been representative if the MiG's pilot could always choose his wing sweep angle depending on the action he wants to perform.

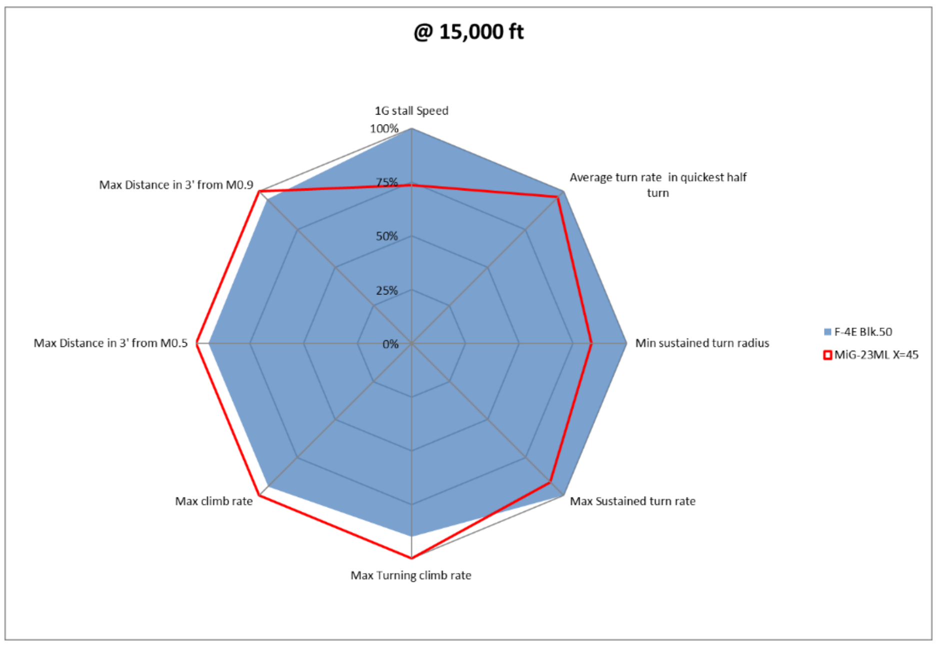
But we know that it is not this way the MiG can be flown, wing sweep angle need too much time to be changed (up to 18s), thus this cannot be done in the middle of a dogfight.

Now, let's try to summarize what can happen at medium altitude:

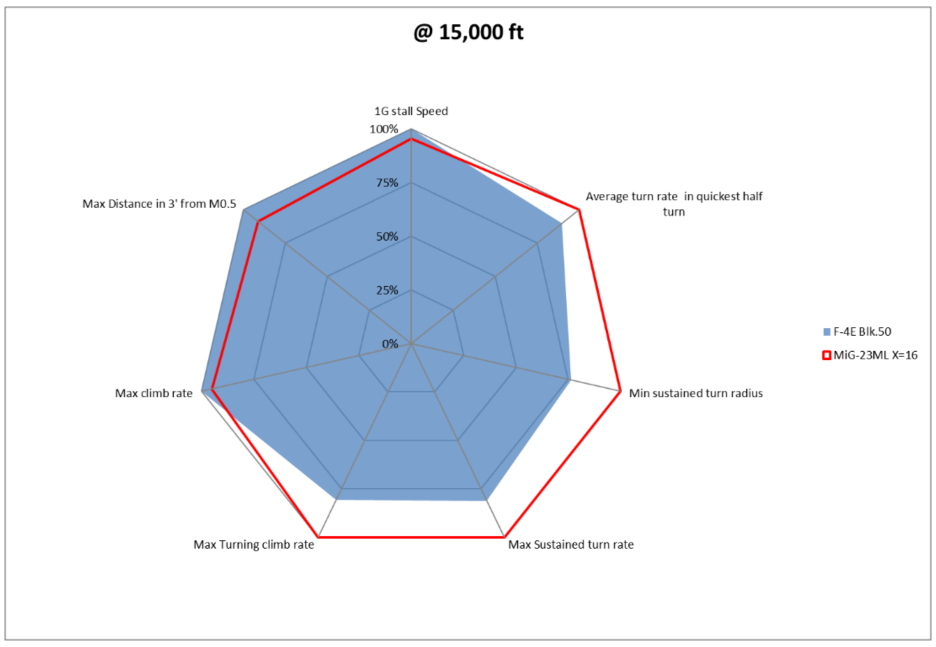
If the MiG-23 has its wings swept back (72°) when both planes enter the WVR arena, the MiG pilot can try a pure boom & zoom tactic: head on (or at least high aspect) attack using radar guided missile (R-23 or 24R) even at short range, stay in the vertical plane to perform offensive and defensive maneuvers (as soon as load factor exceeds 3G, the F-4E will take the advantage). Based on the perception of the R-23R or R-24R efficiency against maneuvering targets, I would not say this choice have a high probability of success for the MiG. On the other hand, the F-4E has no other choice that turning, as he will not be able to really break the fight, but he is able to deny to his opponent any efficient firing solution in keeping load factor at least medium (3G or more) and keeping his speed high enough to not bleed its energy.

If both planes get to within visual range at high subsonic speed, the MiG will have its wing swept at 45° (as recommended) and performances of the two planes are close enough to have a well-balanced dogfight. The MiG will keep the advantage in vertical maneuvers, and more generally when speed is high and load factor is low. On the other hand, the slated F-4E will take the advantage if he can drag the MiG below 500Kts and stay in the horizontal or oblique plane, situations where the MiG will have difficulties to find a firing solution and the Phantom will increase its advantage turn after turn. The main opportunity for the MiG (and risk for the F-4) would be that the Phantom pilot does not adopt a horizontal turning tactic, as it is exactly what he must not do in front of any other of its usual opponent. It must also be noticed that only the MiG always has the capacity to disengage by sweeping back its wings and accelerate (it will take a long time, but will be valuable as soon as the acceleration is performed during more than 20s), the F-4E will have to wait that the MiG has burnt most of its fuel and not be able to engage his after burner any more.

In such a situation, we have the figure below:



The third case is the one involving a MiG at low speed with its wing fully swept forward, in such a configuration, the MiG-23ML dominates the slated F-4E in all areas but stall speed, acceleration and pure climb rate.



But we have to remember that keeping the MiG inside its flight envelope (not exceeding M0.8/410Kts IAS) with after burner engaged is a full time challenge. It is also obvious that in such a situation, the Phantom pilot has an obvious solution: just dive to raise the speed above 500 IAS where the MiG can't follow (time required to sweep back his wings is much longer that the time required by the F-4E to disengage), and then re-engage in a pure boom & zoom style. With its wings swept forward, the MiG-23ML is kind of a sitting duck in the middle of the combat arena. So even if such a configuration gives the MiG some significant advantages in terms of performances, I do see this choice as a dead end, especially in a many vs many air combat.

In any case, the F-4E remains superior to the MiG-23ML at a medium altitude horizontal turn fight, the MiG on the other hand being superior in the vertical plane and having the capacity to engage or leave the fight at will.

D.MiG-23ML & F-4E Blk50 at 5,000ft

Stall speed

At low altitude, the slated F-4E stalls at lower speed than the MiG-23ML in any case but the difference is very low when the MiG wings are swept forward (3-7 Kts / 2-6%).

On the other hand, in its regular air combat configuration (45°), the MiG can't fly slower than 42-46Kts (24-28%) more than the slated F-4E stall speed.

Obviously the situation is even worse with wings swept back.

	A/B power	MIL power
F-4E Blk.50	119.38	130.19
MiG-23ML X=16	126.33	133.03
MiG-23ML X=45	165.57	172.05
MiG-23ML X=72	189.00	196.26

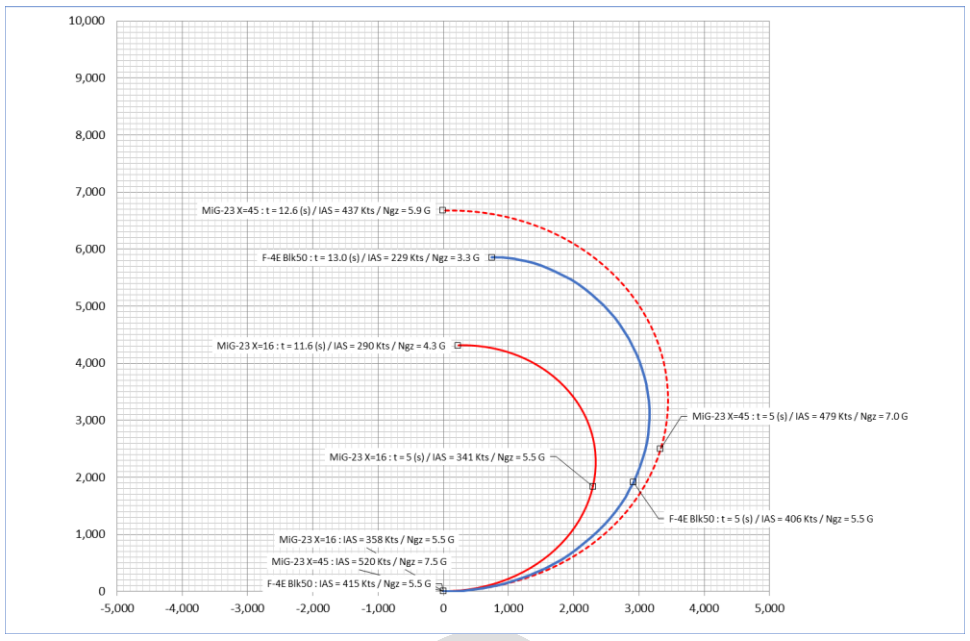
Even if the F-4E is really hard to fly at low speed and high AoA, figures such as slow yo-yo or any low speed maneuvers are not good options for the MiG-23ML.

Turning performances

Quickest half turn

Like in previous section, the large scale graphic description of the quickest half turn that both planes can perform can be found in fig 2.1 and fig 2.2 of section K. Appendix and Figures.

The graphic comparison does not include the half turn performed by a MiG-23ML with wings sweep angle of 72° as this configuration will not be chosen for a subsonic maneuver.



The results can be summarize in the following table:

	Time (s)	Radius (ft)	average turn rate
F-4E Blk.50	13.00	2,926	13.8 °/s
MiG-23ML X=45 SOUA OFF	11.60	2,859	15.5 °/s
MiG-23ML X=16 SOUA ON	11.60	2,156	15.5 °/s
MiG-23ML X=45 SOUA ON	12.60	3,338	14.3 °/s
MiG-23ML X=72 SOUA ON	13.80	3,937	13.0 °/s

The MiG turns faster than the F-4E when its wings are fully swept forward (-1.5s), it will also end its turn with more energy (speed), and last, he will end inside his opponent's circle. This kind of merge is clearly the winning one, according to all criteria. It is clear that the F-4 pilot must identify this situation from the beginning and must never accept to enter the fight with his tightest turn.

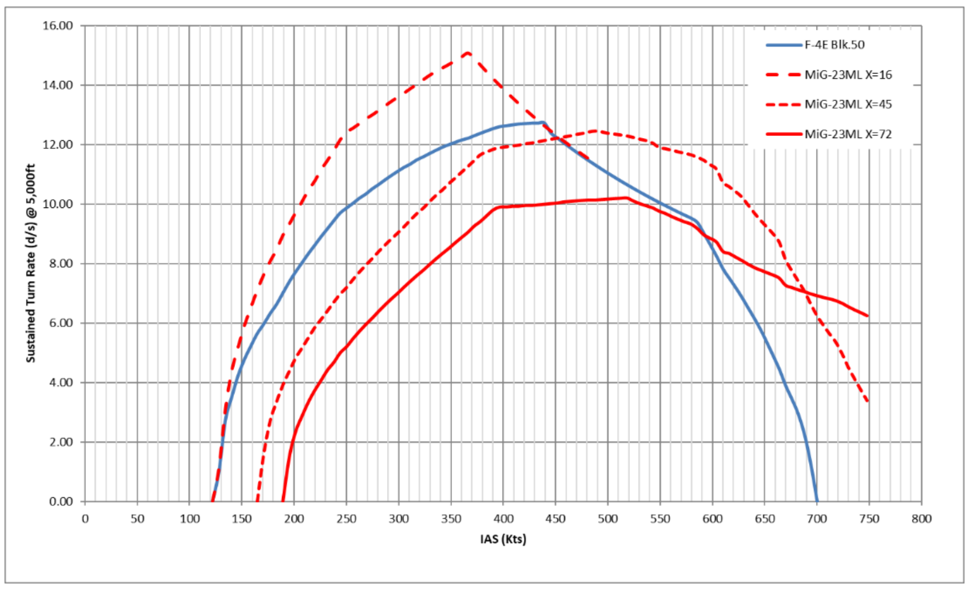
The MiG turns also faster than the F-4 with wings at 45° with SOUA off, but keeping AoA so close to the stall speed without SOUA help is really risky (the SOUA system has been installed just because the MiG-23 is subject to pitch up is such configurations), so the most probable case is that the MiG-23 will have its wings at 45° and SOUA engaged, in which case the slated F-4E turns faster and with a smaller radius.

Down to the deck and facing a regular pilot (not one that shuts the SOUA off like Hoser would do), the F-4E can engage the fight in the horizontal plane with its tightest turn, and this will allow him to exchange energy for angle.

If both do the same, the MiG will end up around 440Kts and the F-4E close to 230Kts, the latter then having a significantly smaller sustained turn radius than the MiG, but also a lower sustained turn rate.

Maximum Sustained Turn Rate

The figure below can be found in larger scale as fig 2.3 in section K Appendix



Once merged, and if both decide to stay in a horizontal fight, they will have to choose their respective combat speeds.

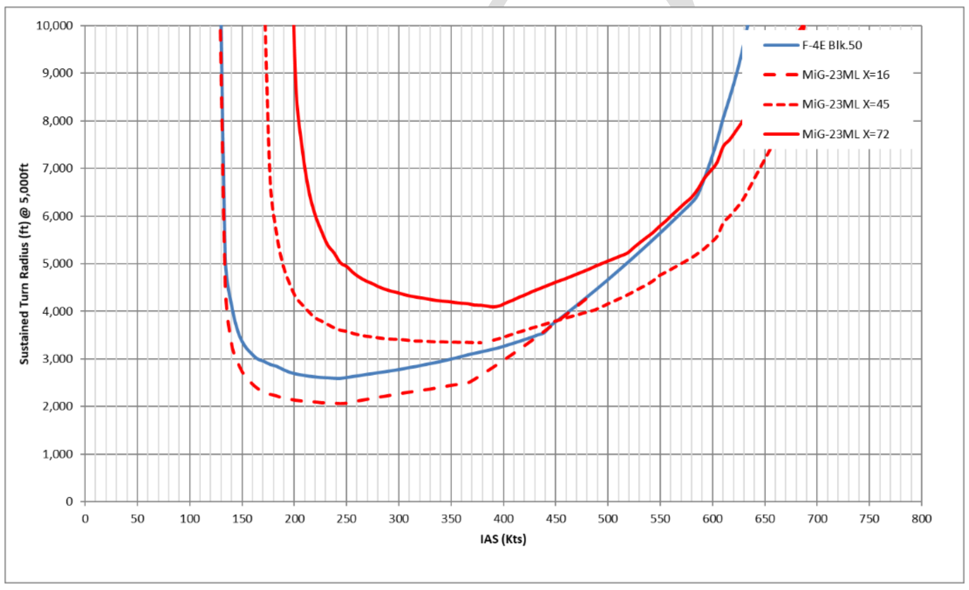
Under 450Kts, the F-4E turns faster (sustained turn rate) and tighter (sustained turn radius) than the MiG with its wings at 45°. In the same conditions, the MiG can have a better turn rate at higher speed, but only because its load factor limit is higher, so if the MiG chooses an angle fight it will have to keep its speed around 500Kts and its load factor close to 7G. This can be done for some seconds, but even then, the best MiGs turn rate (12.44°/s @488Kts) will not be higher than the one of the F-4E (12.73°/s @440Kts). Angle fight is not a winning option for the MiG with wings at 45°.

On the other hand, the advantage of the F-4E below 450Kts is around 0.5-1.0°/s, not enough to offer an easy win, but enough to stay offensive and to gradually gain advantage.

The situation is clearly different if the MiG has entered the fight with wings fully forward and the F-4 has tried to follow, in that case, with a speed between 250 and 350Kts the MiG will gain 2°/s and will find a firing solution for its R-60 sooner or later. By such a case, the F-4 pilot must evade in taking benefit of the very low speed limit of the MiG (M0.8/488Kts), and try to re-engage later with speed advantage.

Minimum Sustained Turn Radius

The figure below can be found in larger scale as fig 2.4 in section K Appendix.



We have seen that angles fight is not the winning option for the MiG with wings swept, the figure above shows it is the same way in the case of a radius fight: the F-4E is able to turn inside the MiG at any speed below 450Kts (up to 1,000ft , on top of which the F-4E is able to decrease its speed under 200Kts when the MiG can't (remember the MiG cannot even expand its flaps when wings are not at 16°, so slowing down is really not an option).

On the other hand, we can see that with its wings fully forward, the MiG can turn inside the F-4, but with only with an advantage of 500ft. Meaning that in such a case, the MiG has a greater advantage in turn rate than in turn radius (we do not have any data on performances of the 2 planes using their flaps, but as this could only be possible at very low speed due to structural speed limitations of the flaps, this is not to be taken into consideration in a close air combat situation).

To summarize what can happen if both decide to go in the horizontal plane:

Horizontal fight with wings fully swept back (72°) is not to be considered at all for the MiG.

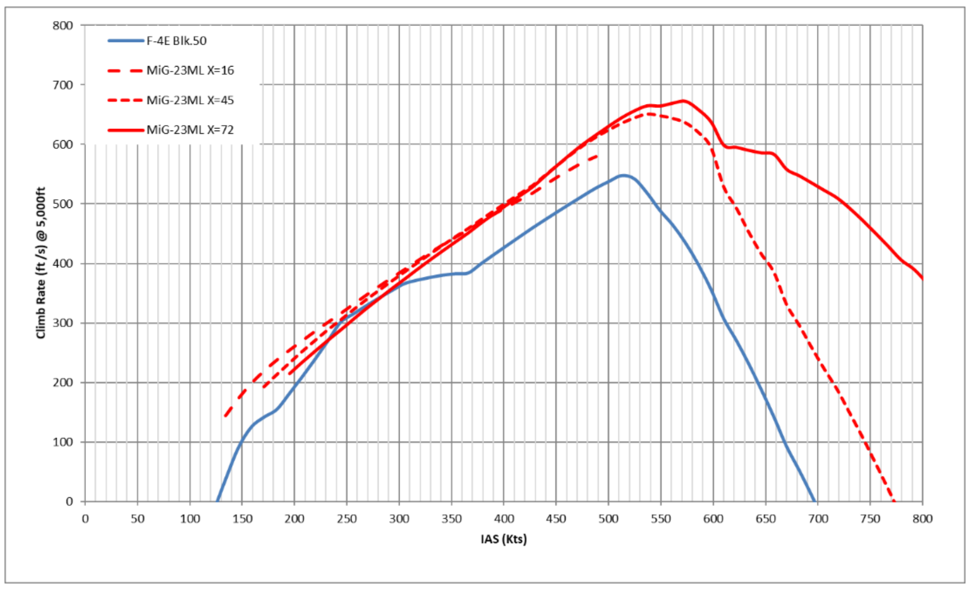
With wings swept at 45° (as recommended), the F-4E will have the ability to reach an initial favorable position with its quicker first half turn. Then he will be able to increase its offensive advantage using its better sustained turn rate and to stay in a good situation if he goes defensive in using its smaller sustained turn radius.

In the last case where the MiG goes to the merge with wings swept forward (16°), the situation is the opposite: better merge (faster, sharper and higher end speed), offensive advantage allowing to reduce aspect angle (better turn rate) and in case of problem, keep the defensive advantage with lower sustained turn radius.

Climbing performances

Non turning climb

The figure below can be found in larger scale as fig 2.5 in section K Appendix



The figure above shows that the climbing performances of the MiG-23ML are not significantly impacted by the wing sweep angle in the subsonic domain, the 3 curves being very close to one another, and this is still true at low altitude.

The difference with the situation at 15,000ft is that, whatever the wing sweep angle is, the MiG climbs faster than the F-4E from 5,000ft.

The time needed to gain 2,000ft with each aircraft is described in the following table:

Best subsonic Climb rate				
	Ps (ft/s)	time(s) for 2,000ft	Z	dZ
F-4E Blk.50	547	3.7	2,000	-
MiG-23ML X=16	579	3.5	2,116	116
MiG-23ML X=45	651	3.1	2,379	379
MiG-23ML X=72	672	3.0	2,456	456

When the F-4E has climbed 2,000ft (@ M0.84/512Kts) in 3.7 seconds, the MiG-23 with wings swept at 45° ends 379ft higher (+19%), and even with wings full forward, the MiG ends 116ft higher (+6%).

This means that, in any case, going vertical is a dead end for the F-4E that will bleed its energy faster than the MiG. This is not surprising with wings swept back at 72°, or even at 45°, but was not expected in the "low speed configuration" with wings fully swept forward.

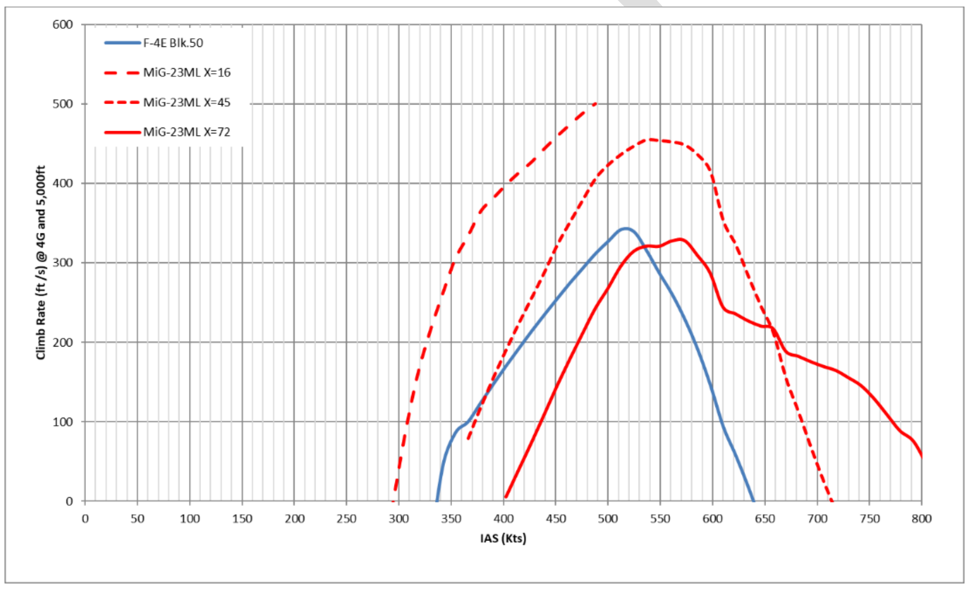
If the decision to go in the vertical plane is taken when both planes are slow (M0.5/305Kts), the situation is not that different:

M0.5 Climb rate				
	Ps (ft/s)	time(s) for 2,000ft	Z	dZ
F-4E Blk.50	366	5.5	2,000	-
MiG-23ML X=16	389	5.1	2,129	129
MiG-23ML X=45	386	5.2	2,109	109
MiG-23ML X=72	373	5.4	2,041	41

Even if the value concerning the 72° sweep angle is meaningless (such a configuration will never be flown at such low speeds), the 2 others show that the MiG bleeds its energy slower than the F-4 in the climb, even at low speed.

Turning Climb

The figure below can be found in larger scale as fig 2.6 in section K Appendix



At low altitude (5,000ft), the documented turning climb is performed at 4G.

Like at 15,000ft and 3G, the MiG-23ML with wings at 72° would end lower than the F-4E in this figure. In any other case, it will end significantly higher, as we can see in the following table:

Best subsonic Climb rate from 5,000ft @4G				
	Ps (ft/s)	(s) / 2,000ft	Z	dZ
F-4E Blk.50	342	5.8	2,000	-
MiG-23ML X=16	500	4.0	2,925	925
MiG-23ML X=45	455	4.4	2,658	658
MiG-23ML X=72	328	6.1	1,920	-80

It is clear that if both planes enter a high G screw pull from low altitude, the F-4E will be in a very bad situation in less than 6 seconds…

Acceleration performances

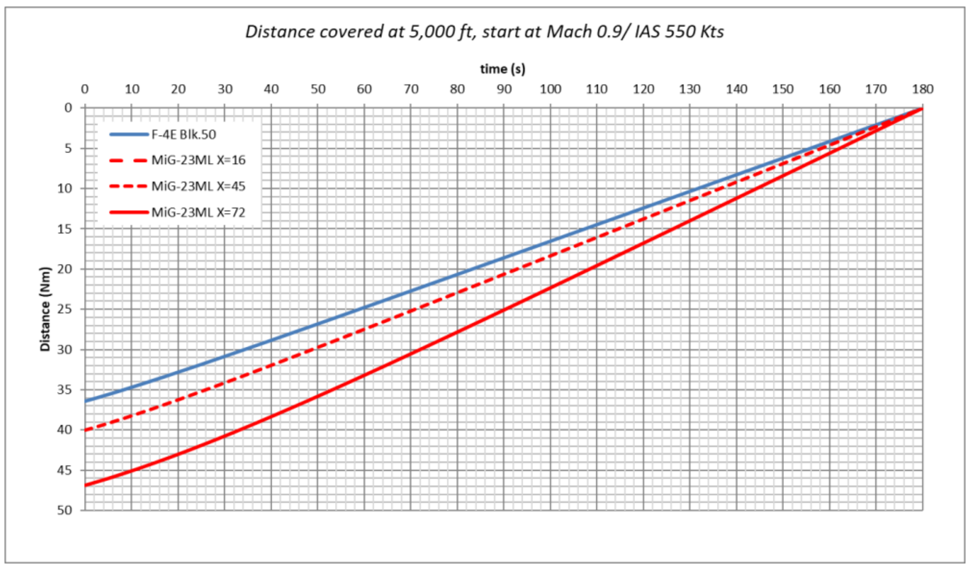
When it comes to acceleration, the performances does not really describe the comparative behavior of the two planes during a close air combat, but much more the capacity to force the opponent to the fight and / or to break it (or to deny it).

Under such conditions, the impossibility to move its wings quickly is no more a significant drawback for the MiG as it can be done gradually at the beginning of the acceleration. So even if the curves have been computed and displayed for the 3 wing angles, the only one to be of importance is the one with wings swept back at 72°.

In a scenario where both planes fly around M0.9 (typically before really engaging the fight), the MiG-23ML flies a distance 10.41Nm greater than the F-4E, corresponding to 47s, in 3 minutes.

It means that even being 10Nm behind or 47s late on the F-4, the MiG23 can clearly force it to the fight without this one having a chance to evade.

The figure below can be found in larger scale as fig 2.7 in section K Appendix

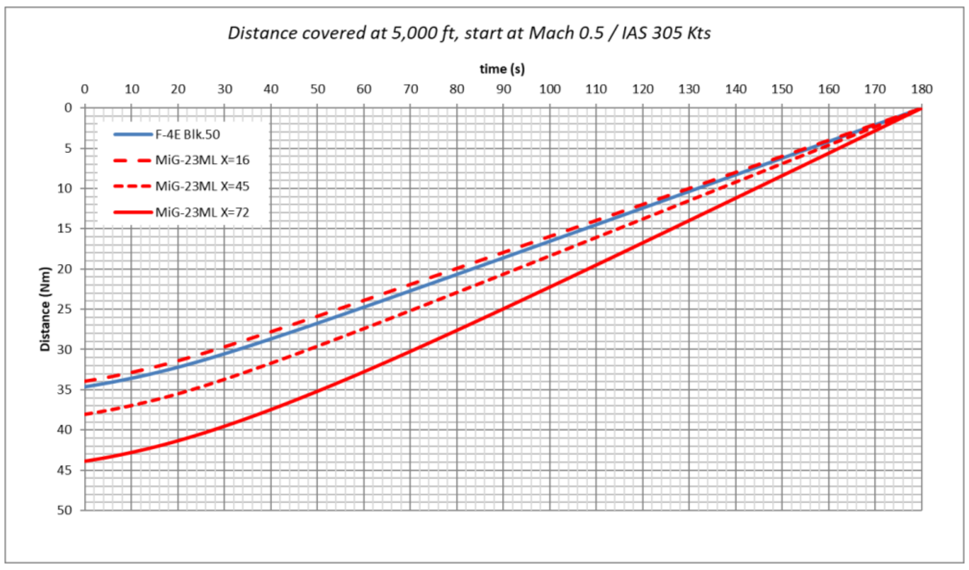


In a scenario where both planes fly around M0.5 (typically at the end of the fight when one may want to exit), the MiG-23ML can run a distance 9.27Nm greater than the F-4E, corresponding to 52s, in 3 minutes.

It means that the F-4E can leave the fight (without being rejoined in less than 3 minutes) only if it is 9 Nm ahead of the MiG, or if this one detects the F-4's maneuver 52s late.

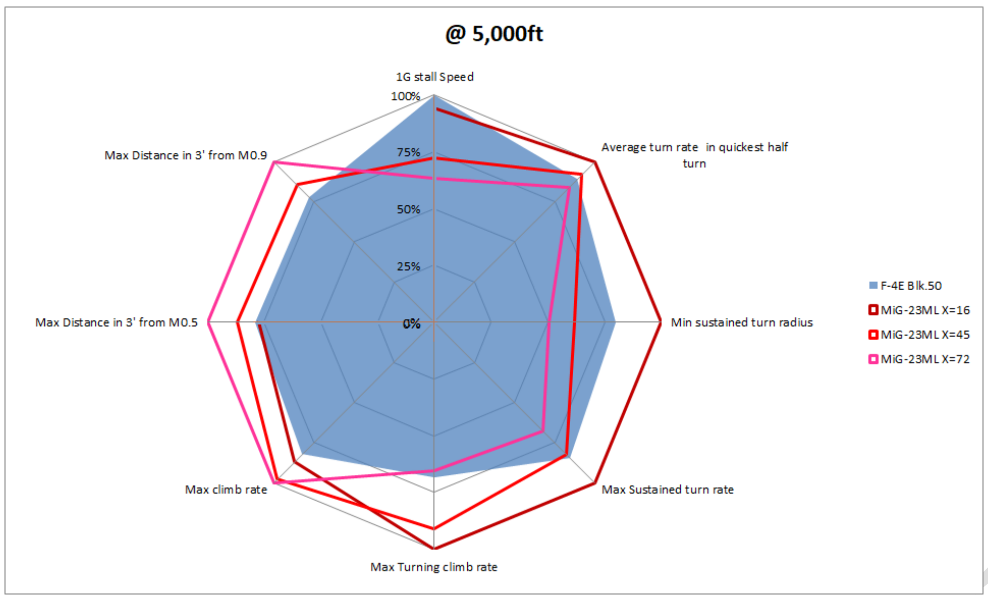
On the other hand, the MiG can decide to leave the fight at any moment, and will never be rejoined.

The figure below can be found in larger scale as fig 2.8 in section K Appendix



Conclusion

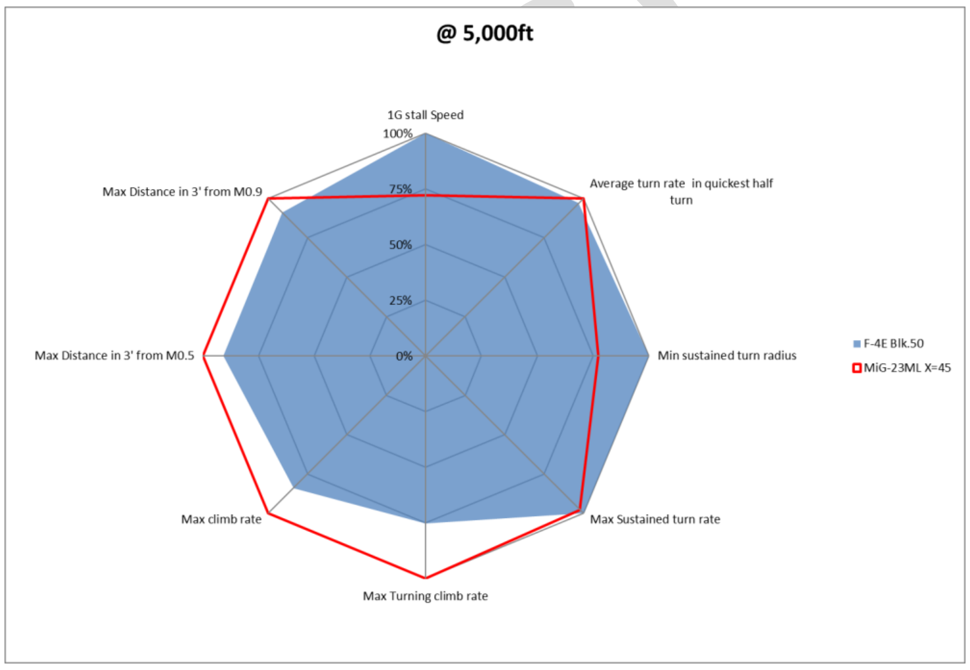
With the same normalized graphical convention as the one used for 15,000ft, we get the following diagram:



The complete figure (with the 3 MiG-23ML wing configurations) suggests clearly that the MiG has a clear advantage in almost all the domains (short of the stall speed) against the F-4E at low altitude.

In order to have a more accurate understanding, let's focus on two possible combat configurations: the first is the one where the MiG pilot, as soon as the decision is taken to engage a close air combat, set his wings to 45° as advised in the manual.

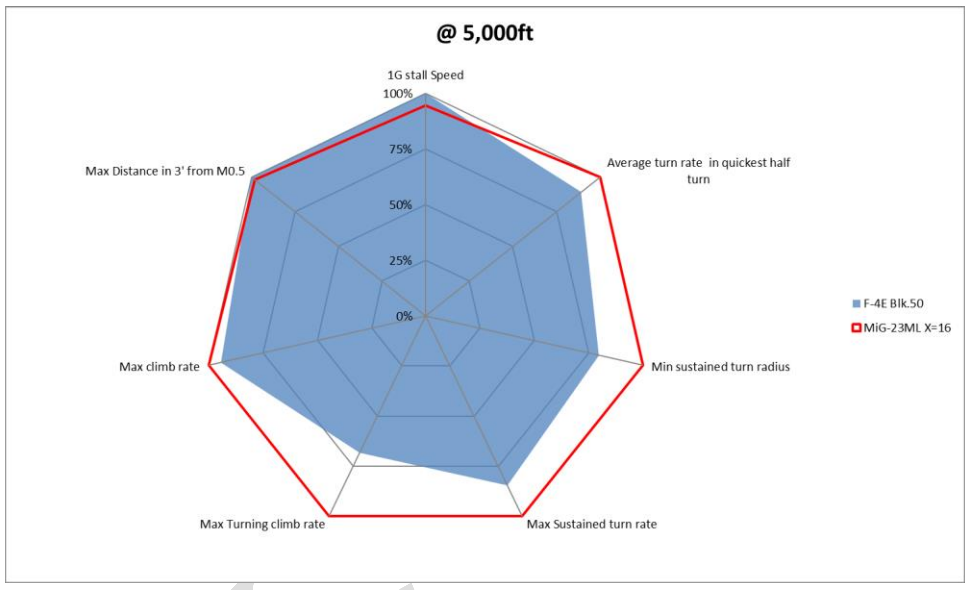
The result is described in the figure below:



The only two situations where the MiG can find itself in an uncomfortable position would be a low speed radius combat in the horizontal plane or nose high, but even then, as it accelerates faster, it can regain energy (speed) faster, resulting in having the upper hand again.

Nevertheless, it can be observed that the MiG is far superior in the vertical or oblique maneuvers, but only on par in the strictly horizontal fight (as soon as it keeps speeds above 400Kts). It is ironic to see that a MiG-23ML with wings at 45° opposed to a slated F-4E at low altitude is in a position very similar to the one of an non slated F-4E pilot opposed to a MiG-21.

The second situation is when the MiG enters the fight with wings swept fully forward (16°)



In such a case, it can be seen that the MiG-23ML performs way better than the F-4E except for stall speed and acceleration where it the MiG is roughly on par with the F-4E.

But the situation is the same as at medium altitude, with such a wing angle, the F-4E pilot can always choose to disengage and come back at a speed the MiG is not able to keep up with.

Based on the fact that the MiG is already superior to the slated F-4E at this altitude, sweeping its wings at 16° does not seem a good choice.

At low altitude, the MiG-23ML seems dynamically superior to the slated F-4E.

E. MiG-23ML & F-4E Blk50 at 30,000ft

Stall speed

At high altitude the MiG-23ML stall speed with wings swept fully forward is very close to the one of the F-4E (3-4Kts / 2-3%).

But in combat configuration (wings at 45°), the minimum speed allowed by the SOUA system is 43-45Kts (24-25%) higher than the F-4E's stall speed.

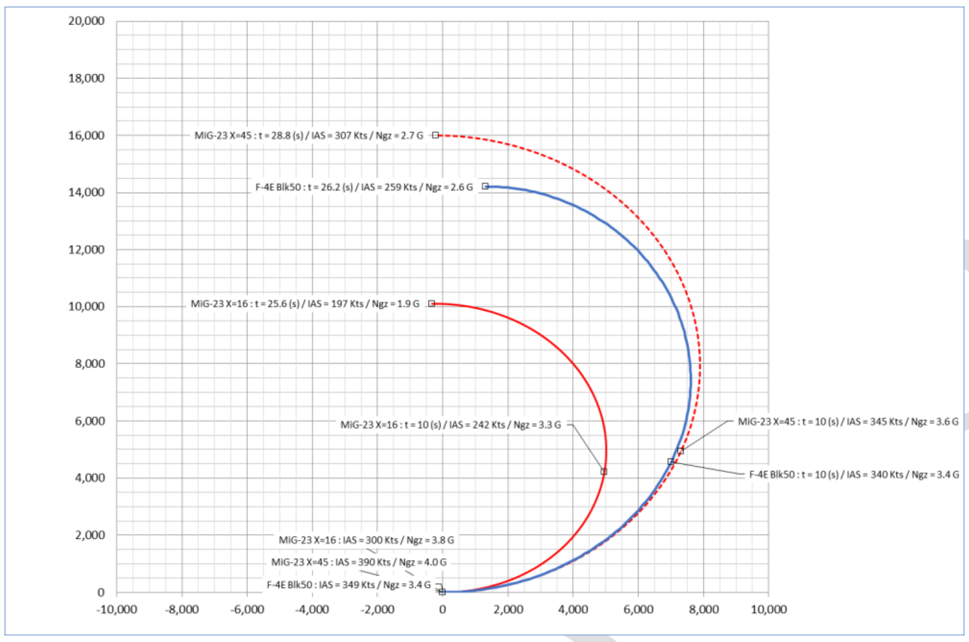
	A/B power	MIL power
F-4E Blk.50	134.36	138.48
MiG-23ML X=16	138.70	141.25
MiG-23ML X=45	178.91	181.56
MiG-23ML X=72	200.44	205.53

Even if low speed maneuvers are not common at such a high flight level, it is obvious that they would not be a good option for the MiG.

Turning performances

Quickest half turn

The figure below can be found in larger scale as fig 3.1 in section K Appendix



Summary of all possible configurations are in the table below.

	Time (s)	Radius (ft)	average turn rate (°/s)
F-4E Blk.50	26.20	7,102	6.9
MiG-23ML X=16 SOUA ON	25.60	5,052	7.0
MiG-23ML X=45 SOUA OFF	26.20	6,545	6.9
MiG-23ML X=45 SOUA ON	28.80	8,001	6.3
MiG-23ML X=72 SOUA ON	35.40	9,427	5.1

Taking 25/30s to make a half turn in a radius of 7,000ft, it is clear that, as such a high flight level, even the tighest turn is not a very aggressive one.

The MiG-23ML, wings set at 45° sweep, takes 2'' longer than the F-4E and makes a 1000ft wider turn, albeit 50kts faster thus ending with more energy, so, I would say that the F-4E can end this first turn with a small advantage.

On the other hand, if the MiG decides to go for the merge with wings at 16°, it will turn a bit faster than the F-4E (0.6s), needing much less room (radius is 2,000ft smaller, 25-30%) but ending with even less speed and energy than the F-4E.

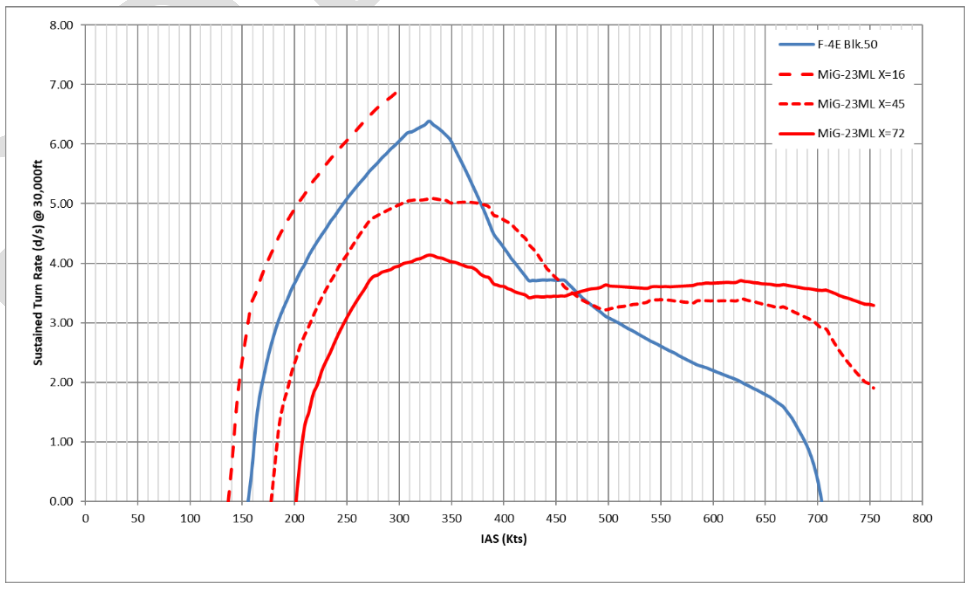
At this altitude, the limitation to 5.5G with wings fully forward is not a real problem (for most planes, it is not even possible to reach 5G while flying subsonic at such height), but the maximum Mach number of 0.8 (300 Kts indicated) is more problematic.

From this altitude, the most obvious defensive maneuver is to dive and accelerate at full power, and this would be absolutely successful against a MiG-23 with wings at 16° because it would not be able to follow before a very long time.

This is something we have to keep in mind all along the analysis of flight characteristics at that altitude: even if wings fully forward is the only configuration that gives the MiG an advantage over the F-4E, it becomes quickly a dead end as the F-4E can react in a way that denies the MiG pilot any possibility to keep this offensive position until reaching a shooting solution.

Maximum Sustained Turn Rate

The figure below can be found in larger scale as fig 3.3 in section K Appendix



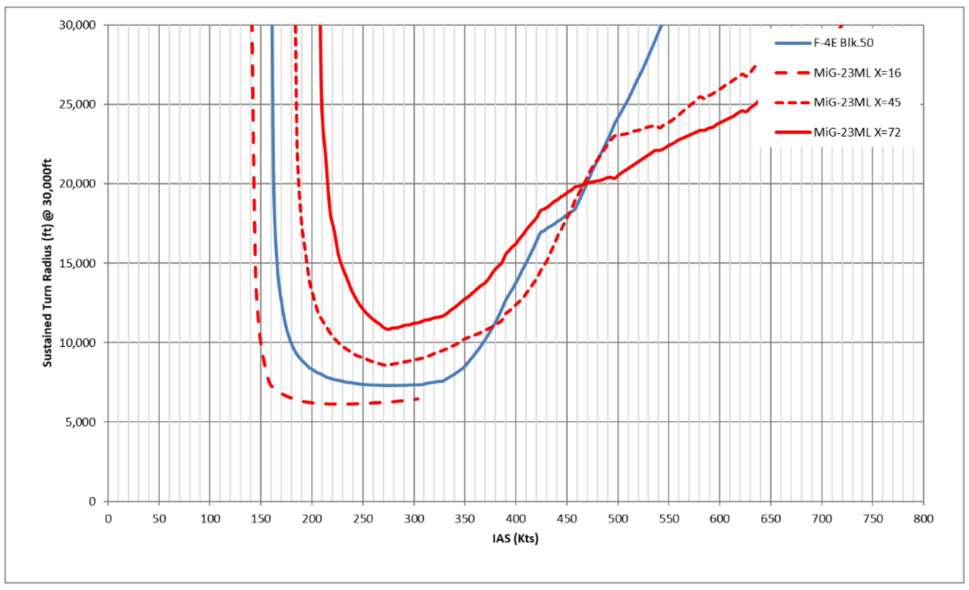
The MiG-23ML in combat configuration (wings at 45°) turns 1-1.5°/s slower than the slated F-4E up to 350Kts (M0.9) at constant speed. Even if the difference is small (more than 30'' needed to close a 45° aspect angle gap), this clearly indicates the MiG will never succeed in reaching its target's 6 o'clock in a classic horizontal turn fight at 30,000ft.

If both planes stay supersonic (M1.25 and more), the MiG will take the advantage, this advantage increasing with speed. But, as far as I know, supersonic fighter-to-fighter air combat never occurred between the MiG-23 and the F-4.

With wings at 16°, the MiG turns 1°/s faster than the F-4E, but the latter has just to stop turning and accelerate to outrun the MiG (limited to 300Kts).

Minimum Sustained Turn Radius

The figure below can be found in larger scale as fig 3.4 in section K Appendix



The slated F-4E can turn and stay inside the smallest turn the MiG-23ML can perform with wings at 45° (1,000-2,000ft).

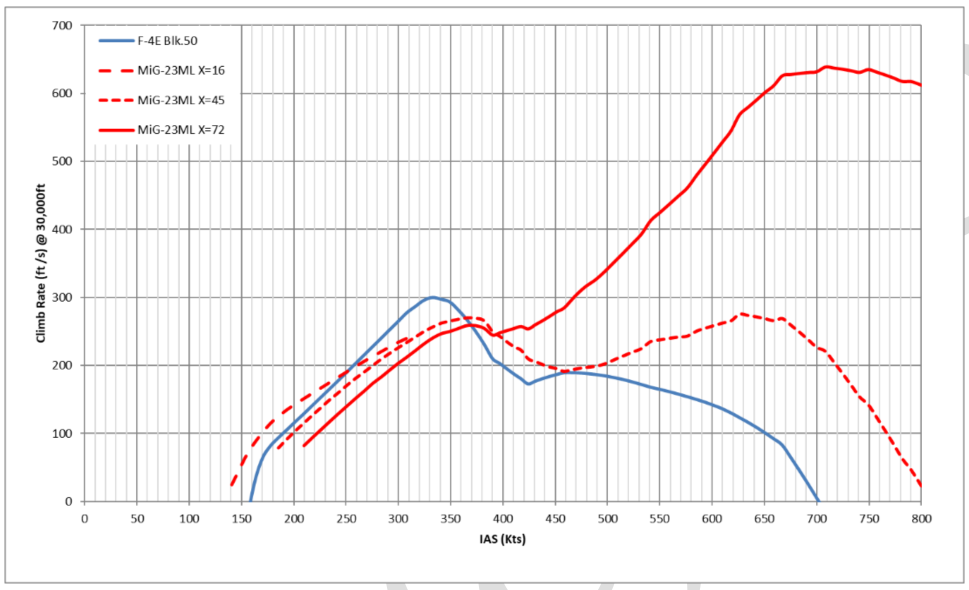
So, neither angle nor radius fights are a winning tactic for a MiG-23ML at such a flight level in regular combat configuration (wings at 45°), in fact staying in the horizontal plane is not an option.

As always, with its wings at 16°, the MiG would have been able to turn and stay inside the F-4E's turn, but the latter can outrun the MiG at any moment in this scenario, so it's not really an option for the fight.

Climbing performances

Non turning climb

The figure below can be found in larger scale as fig 3.5 in section K Appendix



If we take into account only the subsonic domain, in an attempt to gain 2,000ft, the situation can be described in the following table:

Best subsonic Climb rate				
	Ps (ft/s)	time(s) for 2,000ft	Z	dZ
F-4E Blk.50	300	6.67	2,000	
MiG-23ML X=16	240	8.35	1,598	402
MiG-23ML X=45	270	7.41	1,800	200
MiG-23ML X=72	259	7.73	1,727	273

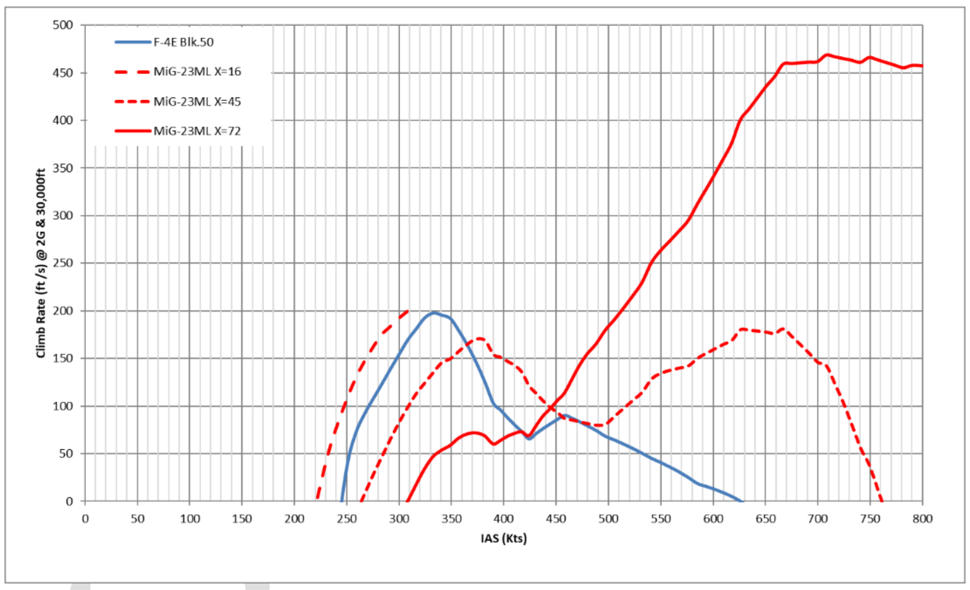
As expected, the best performance is reached with wings set at 45°, but even in that case, the MiG-23ML lacks 10% of the climb speed of its opponent, so going in the vertical plane is not an option for the MiG, at least at subsonic speeds.

But if we look at what can happen before or at the end of an engagement at visual range, we can see that at high supersonic speed the MiG is far superior to the Phantom.

When the F-4E climb rate decreases slowly with speed, the one of the MiG-23 is at its maximum around M1.8/700Kts. This clearly provides the MiG-23ML the capacity to intercept high altitude – high speed targets much more efficiently than the F-4E can do (excluding weapons or weapon system performances).

Turning Climb

The figure below can be found in larger scale as fig 3.6 in section K Appendix



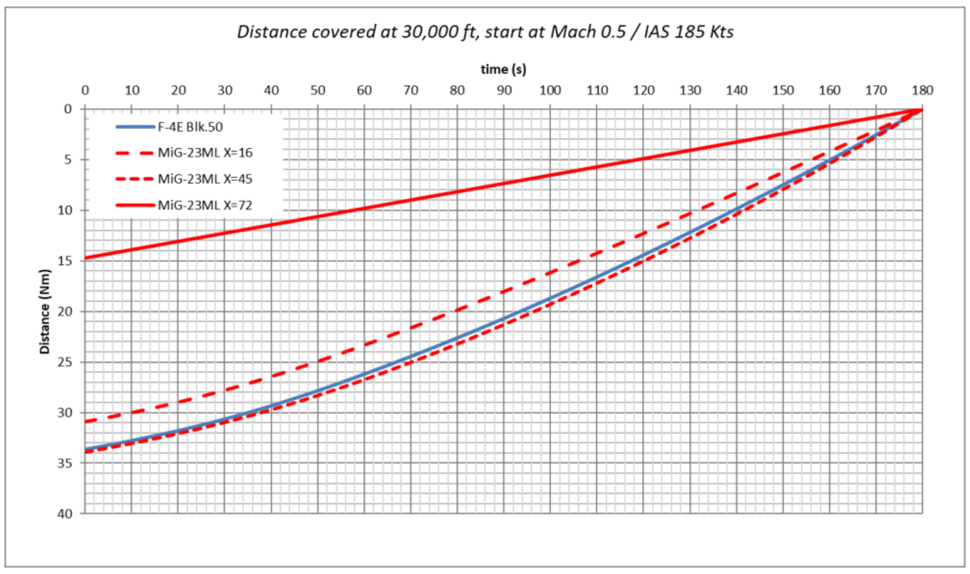
At 30,000ft the climb rate is computed simulating a 2G turn (not really a hard turn), but in this kind of gentle screw-pull maneuver, the slated F-4E easily outperformes the MiG in combat configuration (wings at 45°).

At M0.9/350Kts, both plane take 25'' to do a 90° turn at 2G, if the 2 planes keep the speed constant, the F-4E climbs 5,000ft (best climb rate of 200ft/s), the MiG-23ML will end 1,200ft lower (average climb speed of 150ft/s with wings at 45°).

We have seen that the vertical plane was not an option when opposed to the F-4E, the oblique one is not better (in subsonic).

Acceleration performances

The figure below can be found in larger scale as fig 3.8 in section K Appendix

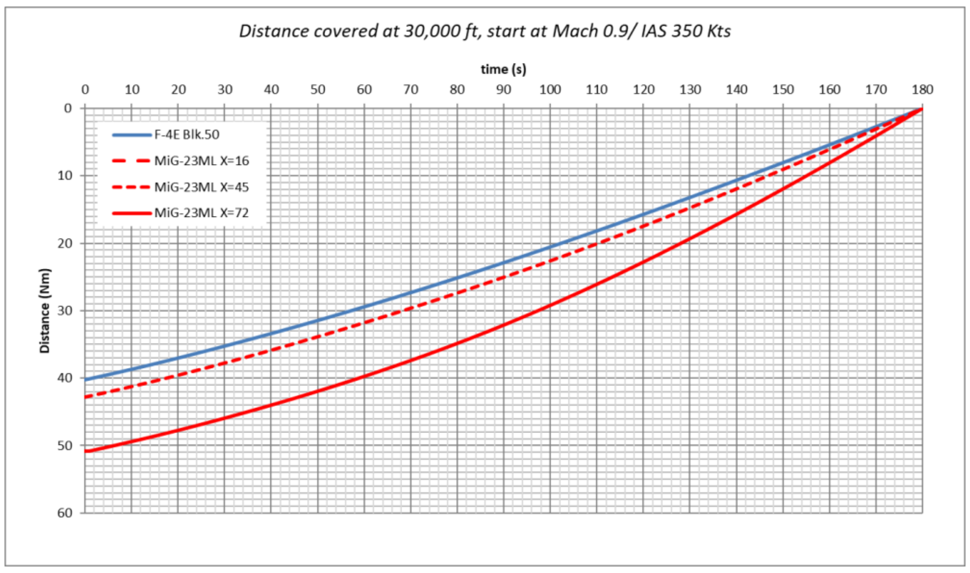


We can see that the MiG-23ML is close to the F-4E when it comes to acceleration capabilities from low speed (M0.5/185Kts), at least in combat configuration (wings at 45°), a bit slower with wings at 16° (but in such a configuration, with speed limited to M0.8 the MiG would be severely damaged by such an high speed flight) and is not even able to accelerate (and in fact, not able to fly at such a low speed) with wings at 72°.

In fact the level acceleration capabilities from M0.5 at 30,000ft are not really significant, as soon as you want to accelerate after having reached such a low speed, the pilot would exchange altitude for speed.

The next indicator (acceleration from M0.9) is much more important as it is the best one describing the high-speed / high-altitude performances. Even if these are not the most critical ones for a close air combat, it measures the capacity to intercept and shoot high-speed / high-altitude targets.

The figure below can be found in larger scale as fig 3.7 in section K Appendix

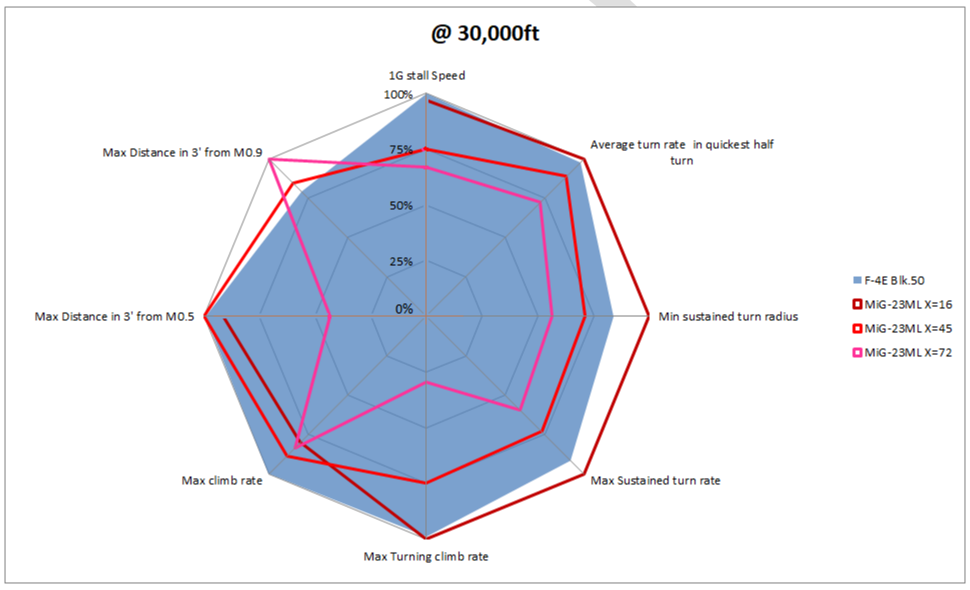


The MiG-23ML with wings set at 72° just outruns the Phantom by more than 10Nm in 3 minutes.

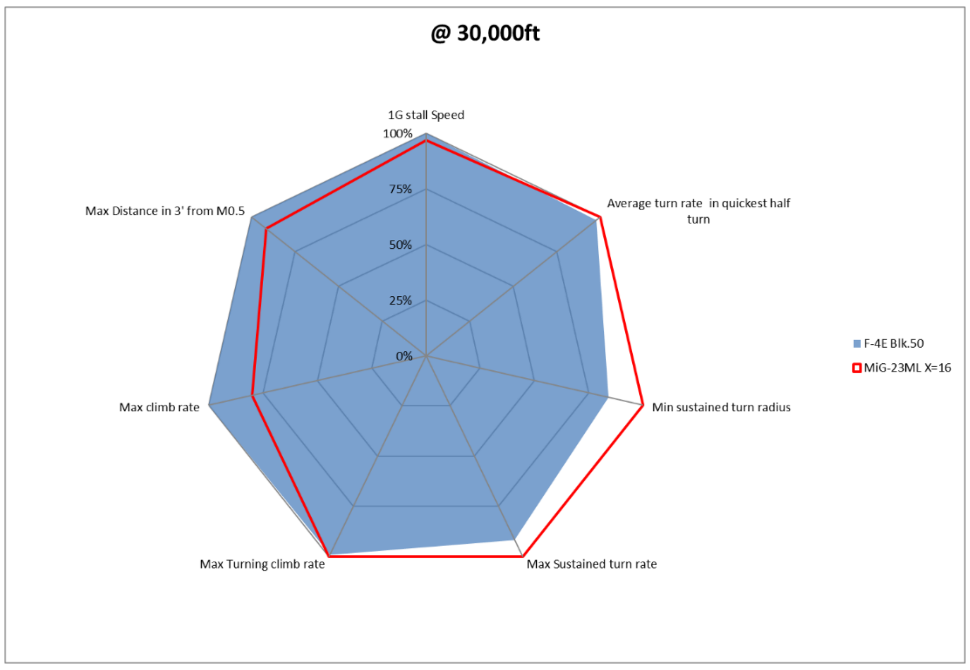
Combined with its far better climbing capabilities in high supersonic, its better sustained turning performances between 500 and 700Kts (the MiG is able to turn continuously at more than 3°/s), this makes the MiG-23ML a far more potent interceptor than the slated F-4E, especially opposed to high speed bombers flying at speeds of M1.8/M2.0 and between 30,000 and 45,000ft.

Conclusion

With the same normalized graphical convention than the one used for 15,000ft, we get the following diagram:

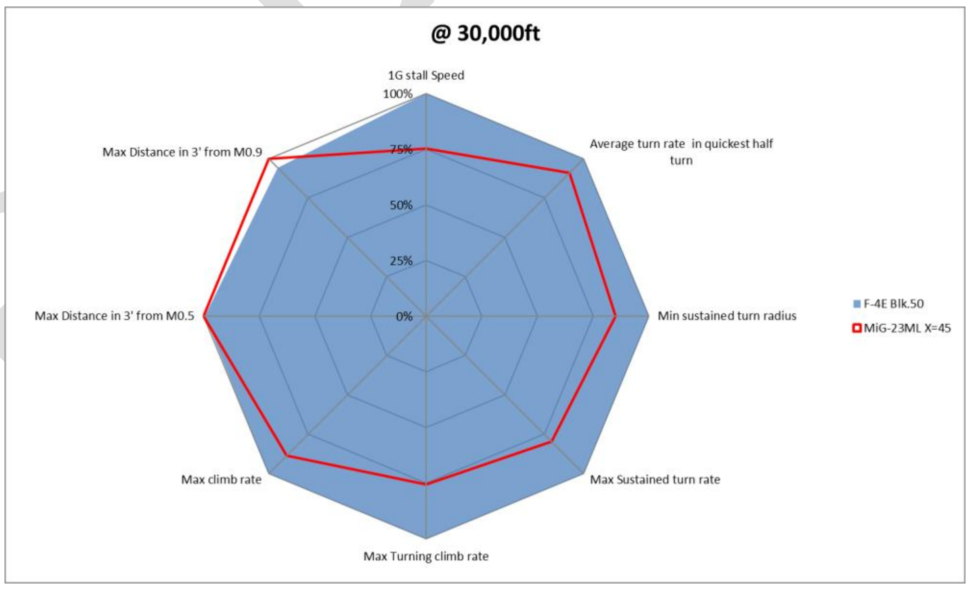


The only case where the MiG can have an advantage upon its opponent in a classical air combat is a horizontal turn fight: hard turn at the merge, constant speed turn to reduce aspect angle gap and then slow down to turn inside the target. For these 3 things, the MiG performs better than the Phantom as we can see in the figure above. But the problem (for the MiG) is that the Phantom can keep its speed above what the MiG can reach, and thus, the latter will never be able to reduce the distance to its target inside its weapons firing envelope.



If we assume that the MiG cannot fight with wings fully forward (16°) at this altitude, it is clear that it is outperformed by the salted F-4E in the entire subsonic flight domain: higher stall speed, bigger turn radius, slower turn rate and lower climb rate turning or not.

With wings at 45°, like shown by the figure below, only its supersonic acceleration is superior to the one of the Phantom.



But, we must keep in mind that, outside the strict close air-to-air combat, the supersonic capacities of the MiG are far above those of the F-4E.

That means that the MiG pilot can always deny its opponent the capacity to engage the fight, he just has to sweep his wings and accelerate straight forward, turning, or climbing, as soon as he is supersonic (more than 500Kts IAS at 30,000ft) the F-4E has no chance to rejoin.

The supersonic acceleration of the MiG-23ML with swept wings may also give him the capacity to outrun any AA missile (if not shot from close range or head on).

F. MiG-23ML & F-4E Blk50 Conclusion

There are two pitfalls, in my opinion, in which one should not fall when comparing the MiG-23 and the F-4. The first is to see only the MiG with its wings swept at 45° because it is the recommended configuration for air combat. The second is to see, at every moment, the MiG able to fly with the wing position that gives it the best performance.

The first denies any advantage to the wing sweeping capacity of the MiG when it gives it a significant advantages in any supersonic conditions, a situation that often occurs before and after the restricted "close air combat" and defines the capacity to engage or exit the fight.

The second sees the MiG-23ML for what it is not: a soviet F-14, the only fighter up to now able to continuously and automatically adapt its wing geometry: sweep angle, slats and flaps position to its flight condition in order to provide the best performance at every moment of the fight.

This is why, understanding the very strict limitations of the MiG-23ML with its wing at 16°, we have to consider this configuration of a very marginal importance in air combat, not because it is useless, but because it is a dead-end needing about 20s to get out…

All that taken into account, we can see that:

- At medium altitude (where most of air combats start), the MiG is better in the vertical and the slated F-4E is better in the horizontal plane (which globally means it turns better), but decision to engage or exit is on the MiG's side.
- At low level (where air combats end if not concluded in the very first minutes) the MiG globally dominates the slated F-4E, and also keeps the decision to engage or disengage.
- At high altitude, the MiG is significantly dominated by the Phantom as soon as the fight is turning into a true dogfight, a situation the MiG has always the choice to deny due to its superiority as soon as supersonic.

But, we also need to keep in mind that this comparison is done by taking into account only the dynamic capacities of the airframes and their respective engines, and without any consideration of weapon efficiency or even cockpit ergonomy (both already identified as major weaknesses of the MiG-21 when facing its western counterparts).

G. Special comments on the non-slated F-4E

One can read sometimes that the MiG-23 is very similar to the Phantom, and this is not exactly the conclusion I've obtained.

But, in fact, such statements must be taken in a particular context: they are often (even indirectly) issued by USAF pilots that have flown the MiG-23 in the 4477th Test and Evaluation Squadron.

That means they refer to earlier versions of the MiG-23 (YF-113B / MiG-23BN or YF-113E / MiG-23MS with R-29 engine).

That also means that aircrafts have been compared in conditions permitted by peace-time BFM exercises, in particular when it comes to low altitude fights, as usual peace-time deck for BFM training is about 10,000ft, so evaluation of performances is mainly done around 15,000ft (that is also the most common altitude where air combats start).

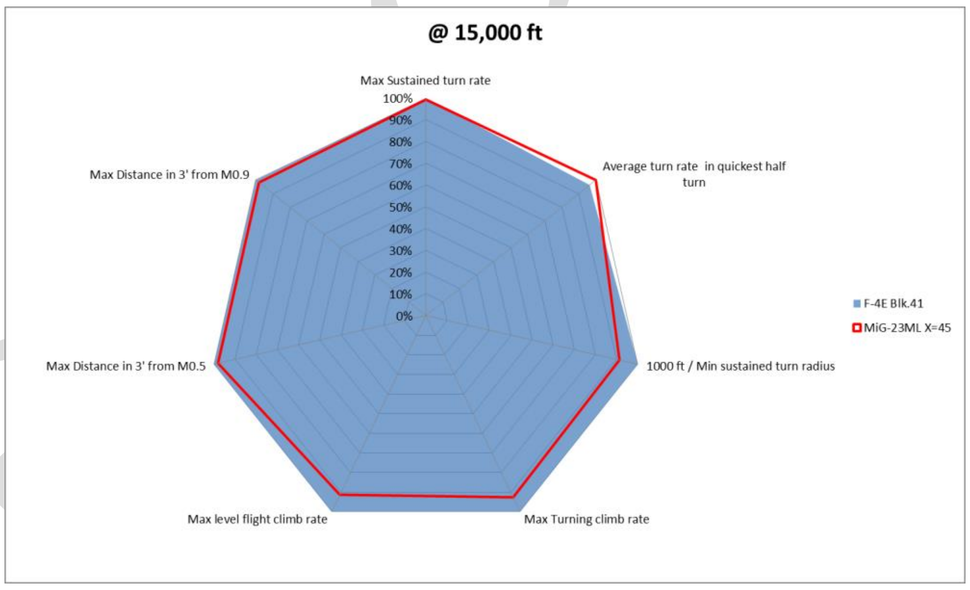
As the 4477th Test and Evaluation Squadron's purpose was also to mimic red-side doctrine (or at least what was supposed to be the doctrine of all users of soviet aircraft, usually assumed to be an exact copy of soviet doctrine, even if this should be debated), they focus on MiG-23 combat performances when wings are set at 45°.

And last, the Phantom to be compared to the MiG-23 may not be the late slated export version of the F-4E (Blk-50 and later), but the regular (non-slated) one.

And if we compare performances of the MiG-23ML to the one of a F-4E Blk41 at 15,000ft (as you can see in the appendix of this document with figure 4.1 to figure 4.8) we can see that they are very close to each other.

At 15,000ft, where the slated F-4E turns better but climbs slower than the MiG with wings at 45°, the un-slated version closes both gaps (doesn't turn better, but climbs as fast as the MiG).

This can be summarized using the regular comparison diagram:



The difference is always lower the 10%.

In these conditions, both planes can be assumed having the same performances.

H.Appendix and Figures.

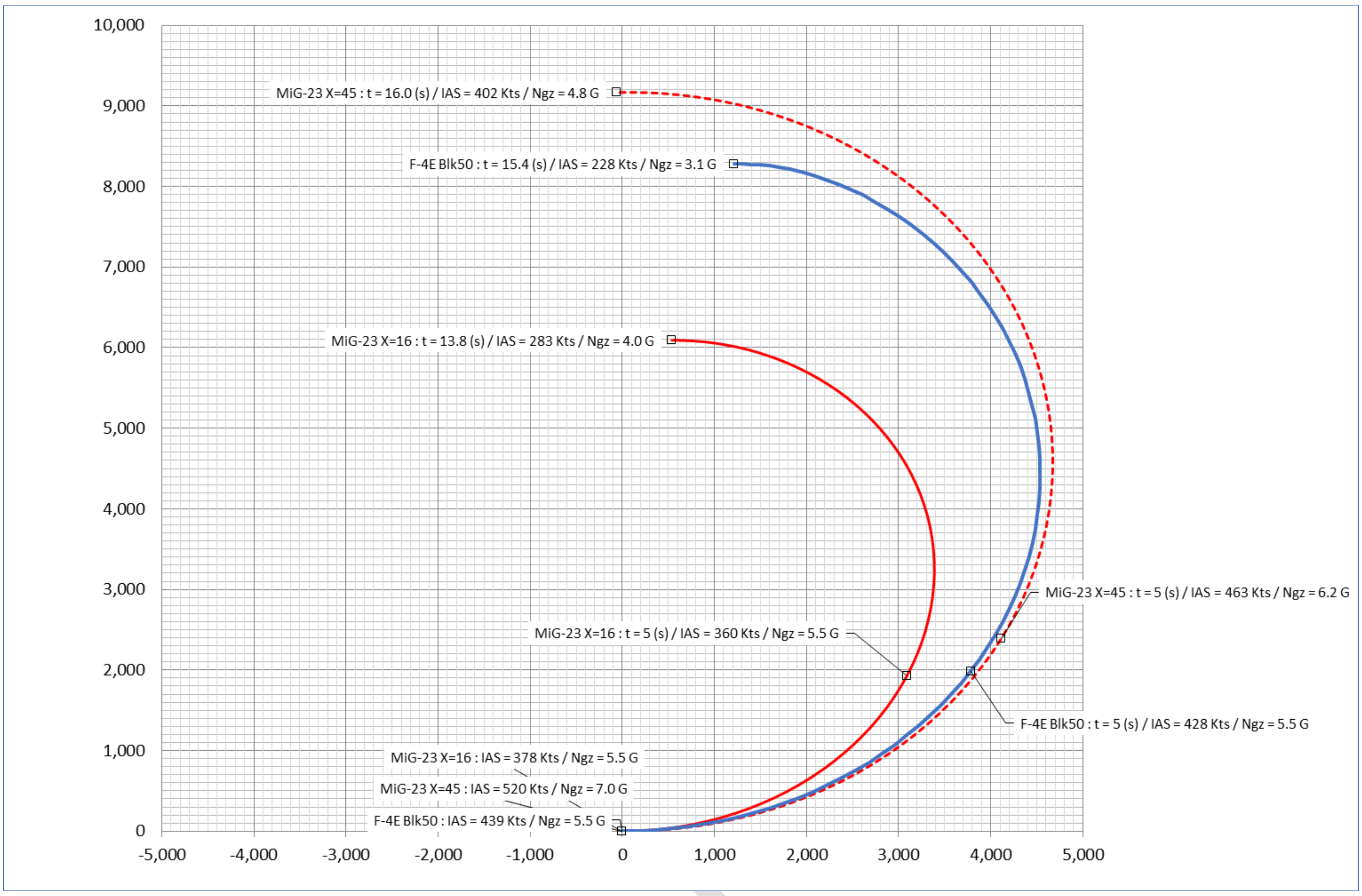


Fig 1.1 F-4E Blk.50 and Mig-23ML (SOUA ON) quickest half turn at 15,000ft

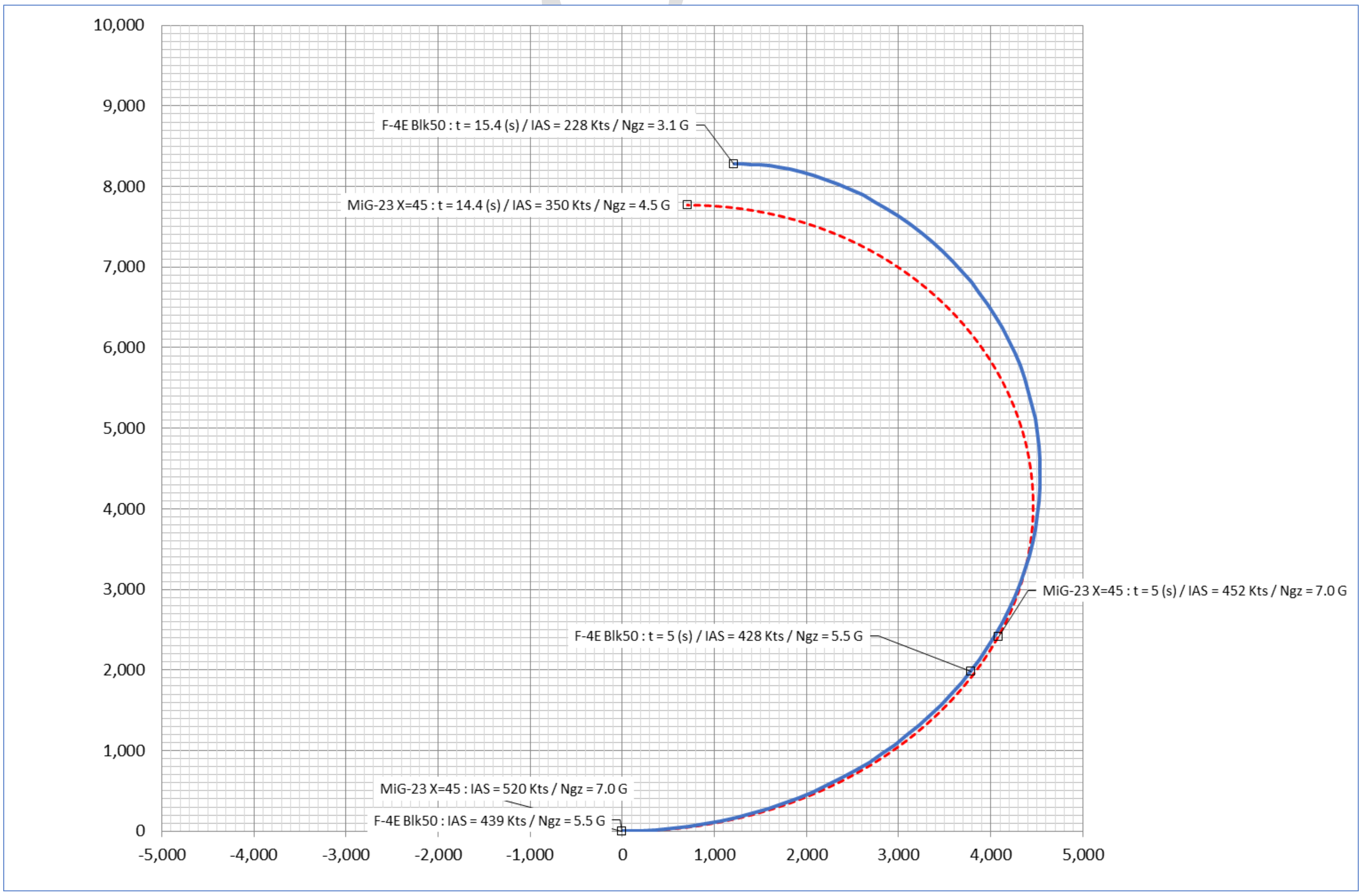


Fig 1.2 F-4E Blk.50 and Mig-23ML (X=45 SOUA OFF) quickest half turn at 15,000ft

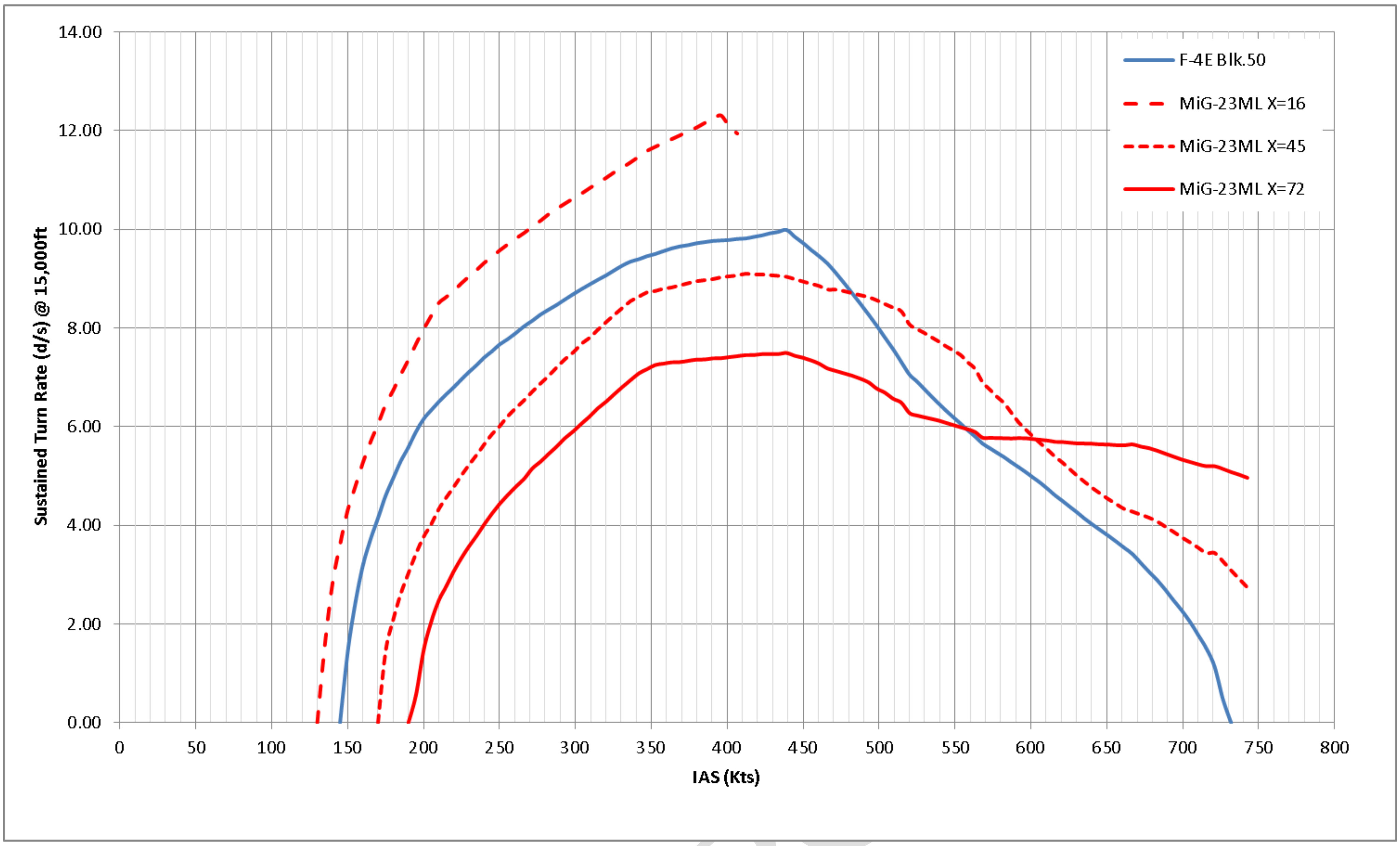


Fig 1.3. F-4E Blk.50 and Mig-23ML Sustained Turn Rate at 15,000ft

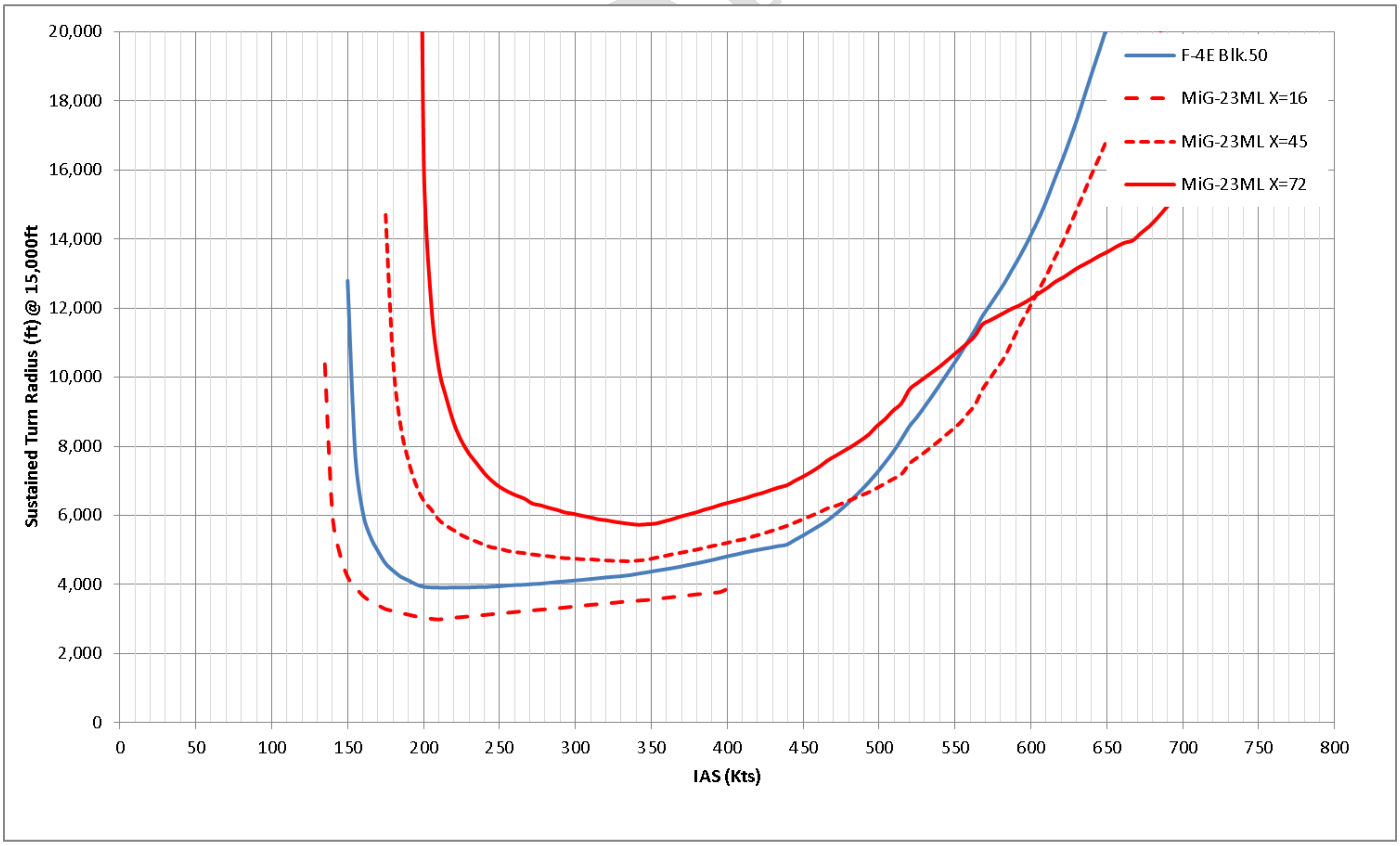


Fig 1.4. F-4E Blk.50 and Mig-23ML Sustained Turn Radius at 15,000ft

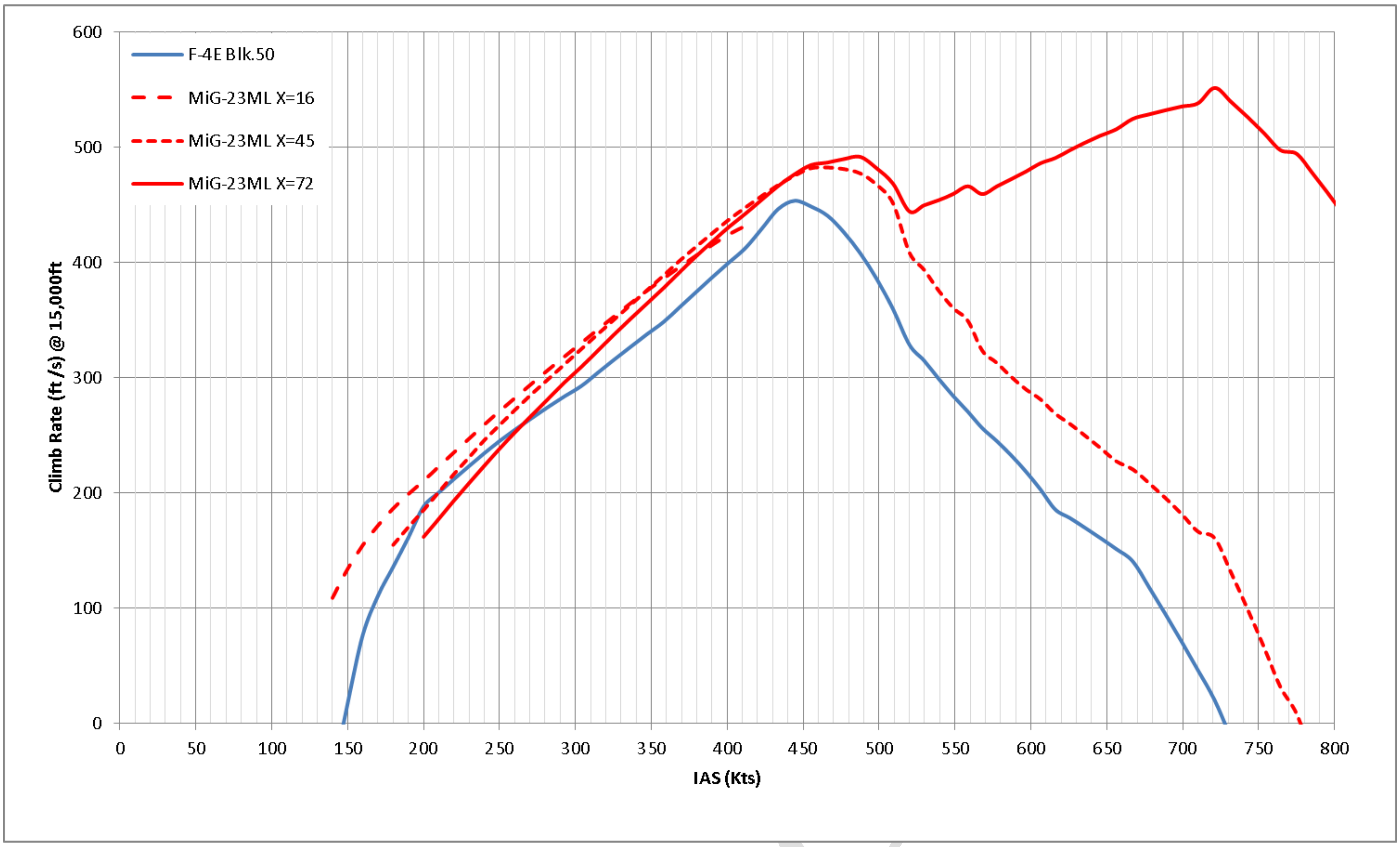


Fig 1.5. F-4E Blk.50 and Mig-23ML Constant Speed Climb Rate at 15,000ft

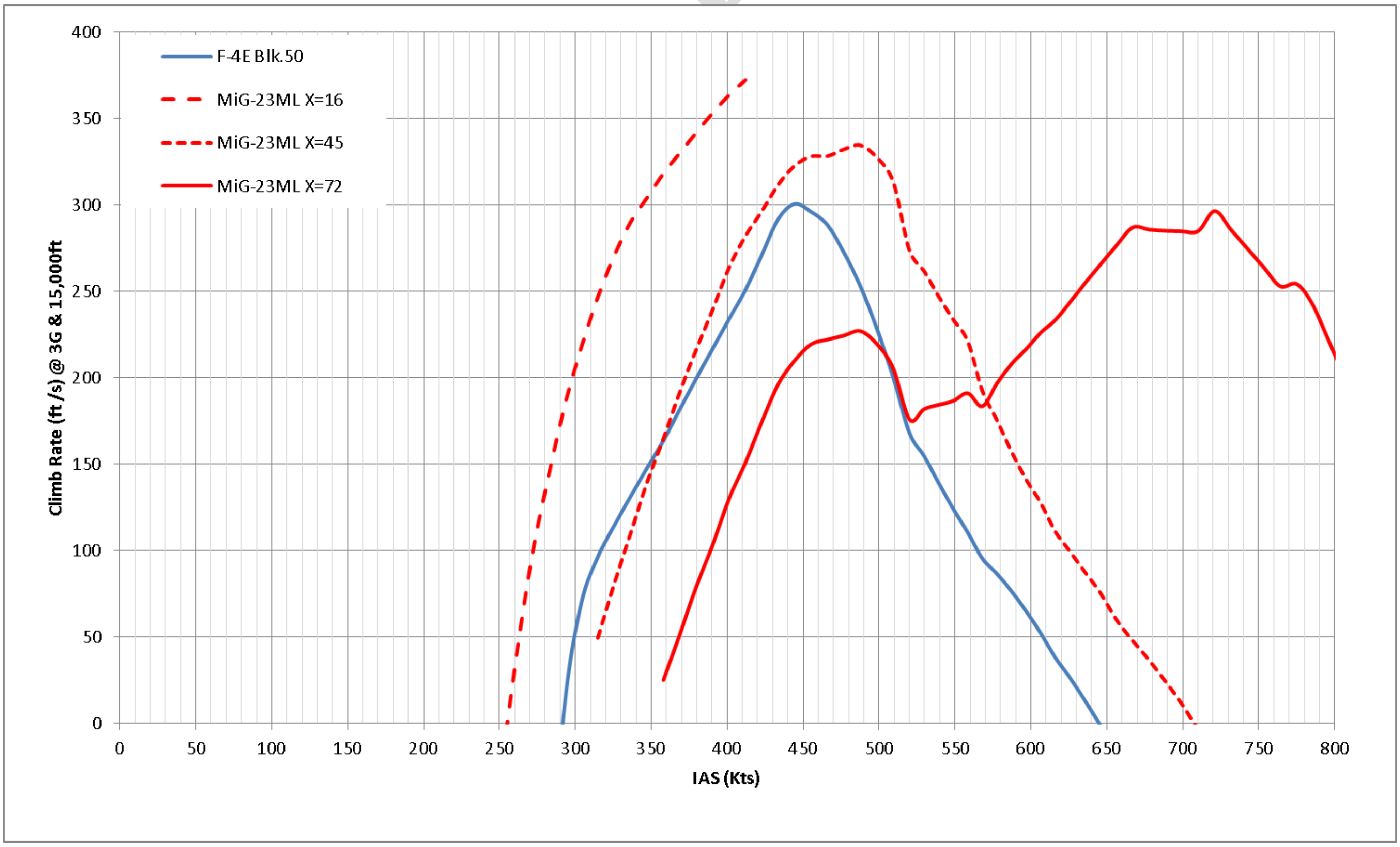


Fig 1.6. F-4E Blk.50 and Mig-23ML Constant Speed and 3G Load turn Climb, Rate at 15,000ft

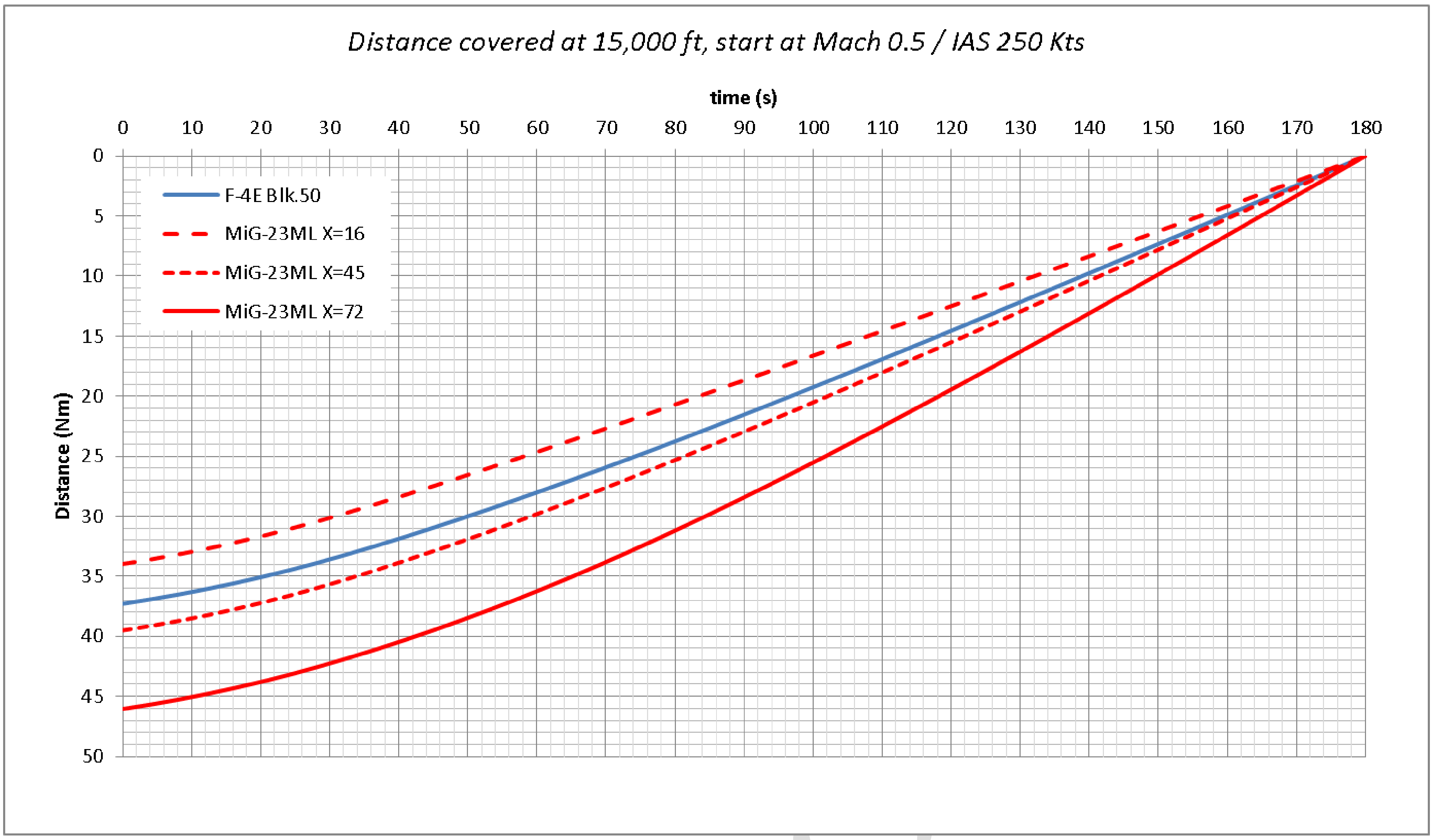


Fig 1.7. F-4E Blk.50 and Mig-23ML Distance covered in 3', from mach 0.5 at 15,000ft

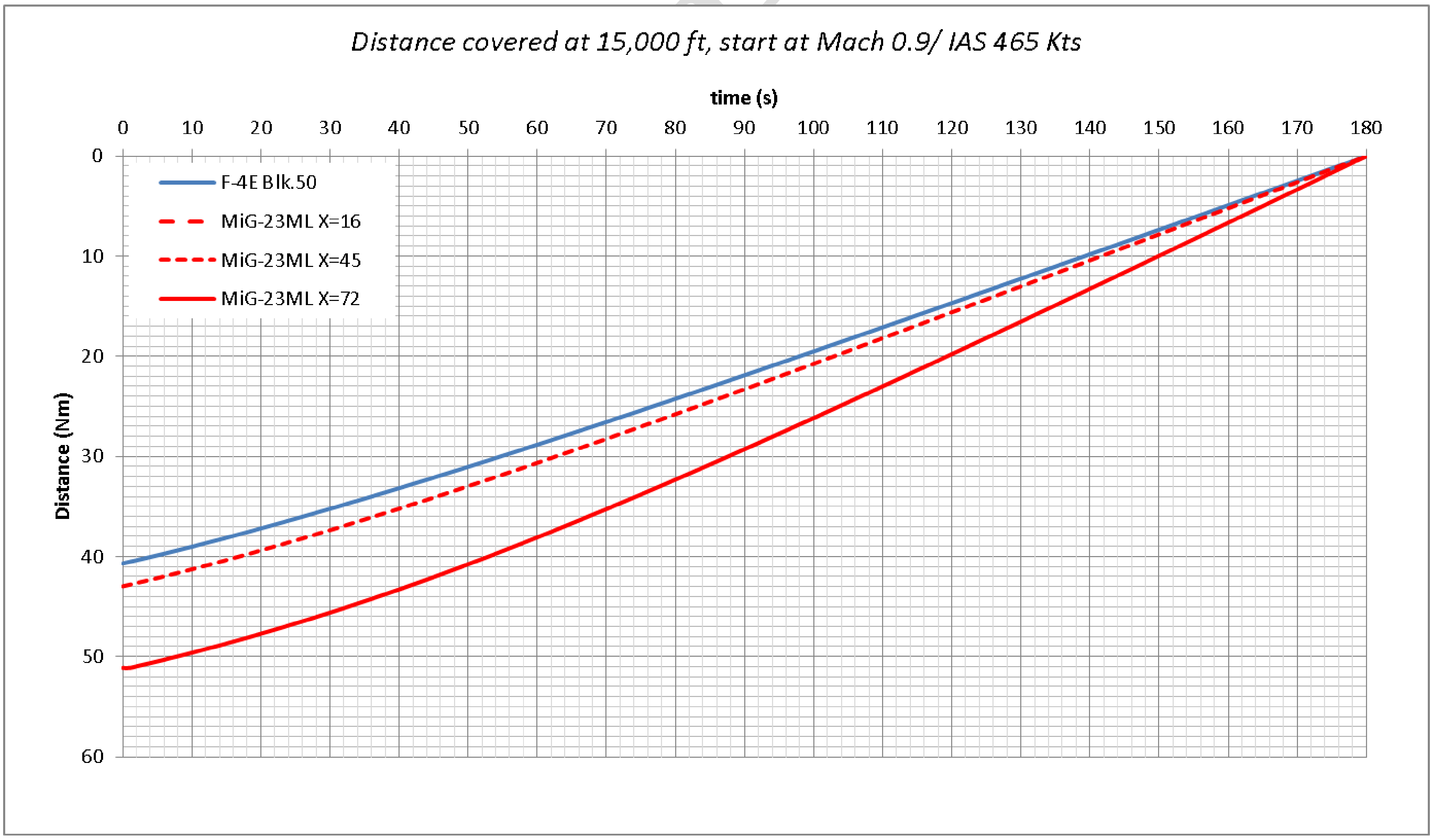


Fig 1.8. F-4E Blk.50 and Mig-23ML Distance covered in 3', from mach 0.9 at 15,000ft

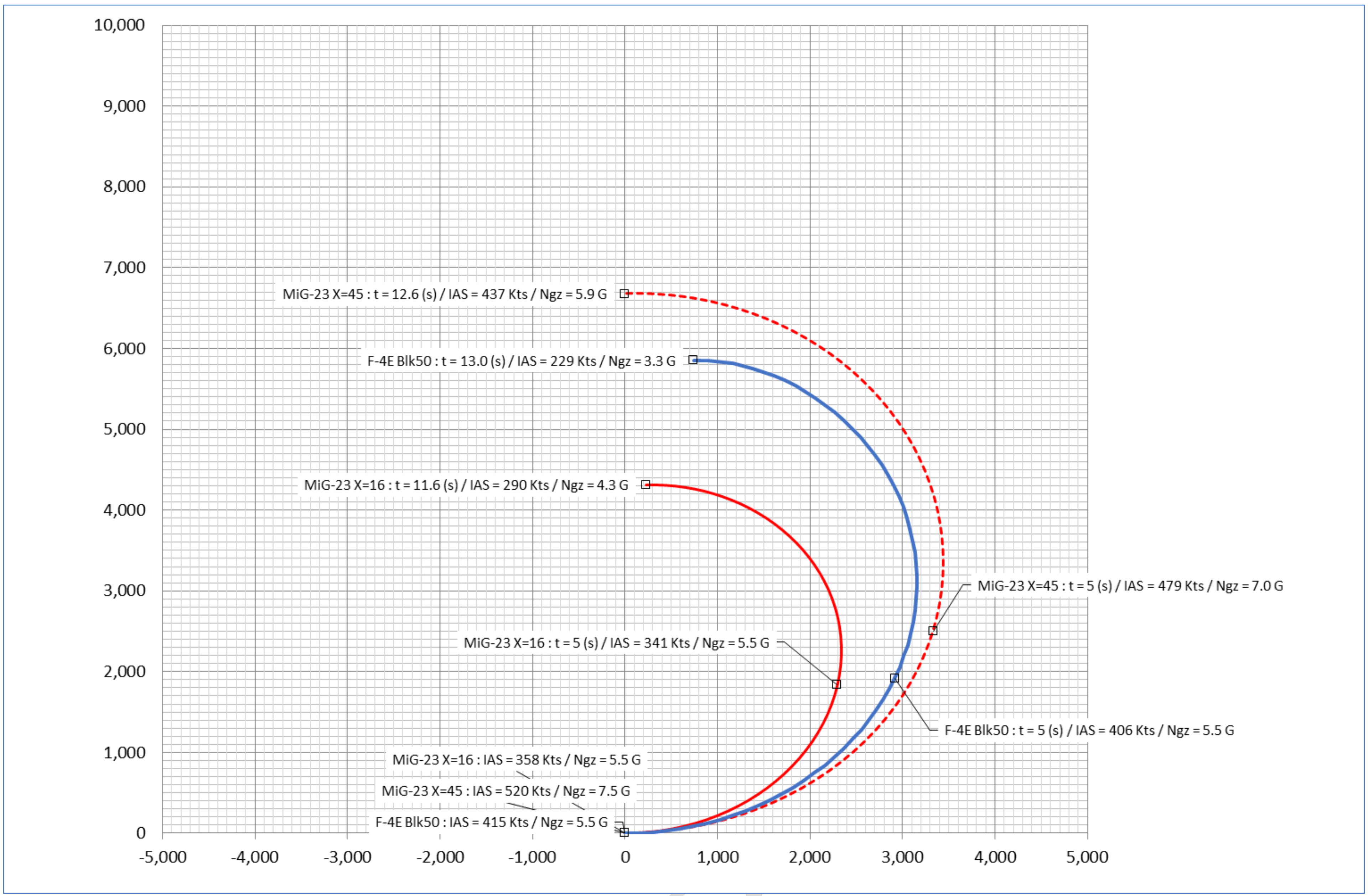


Fig 2.1 F-4E Blk.50 and Mig-23ML (SOUA ON) quickest half turn at 5,000ft

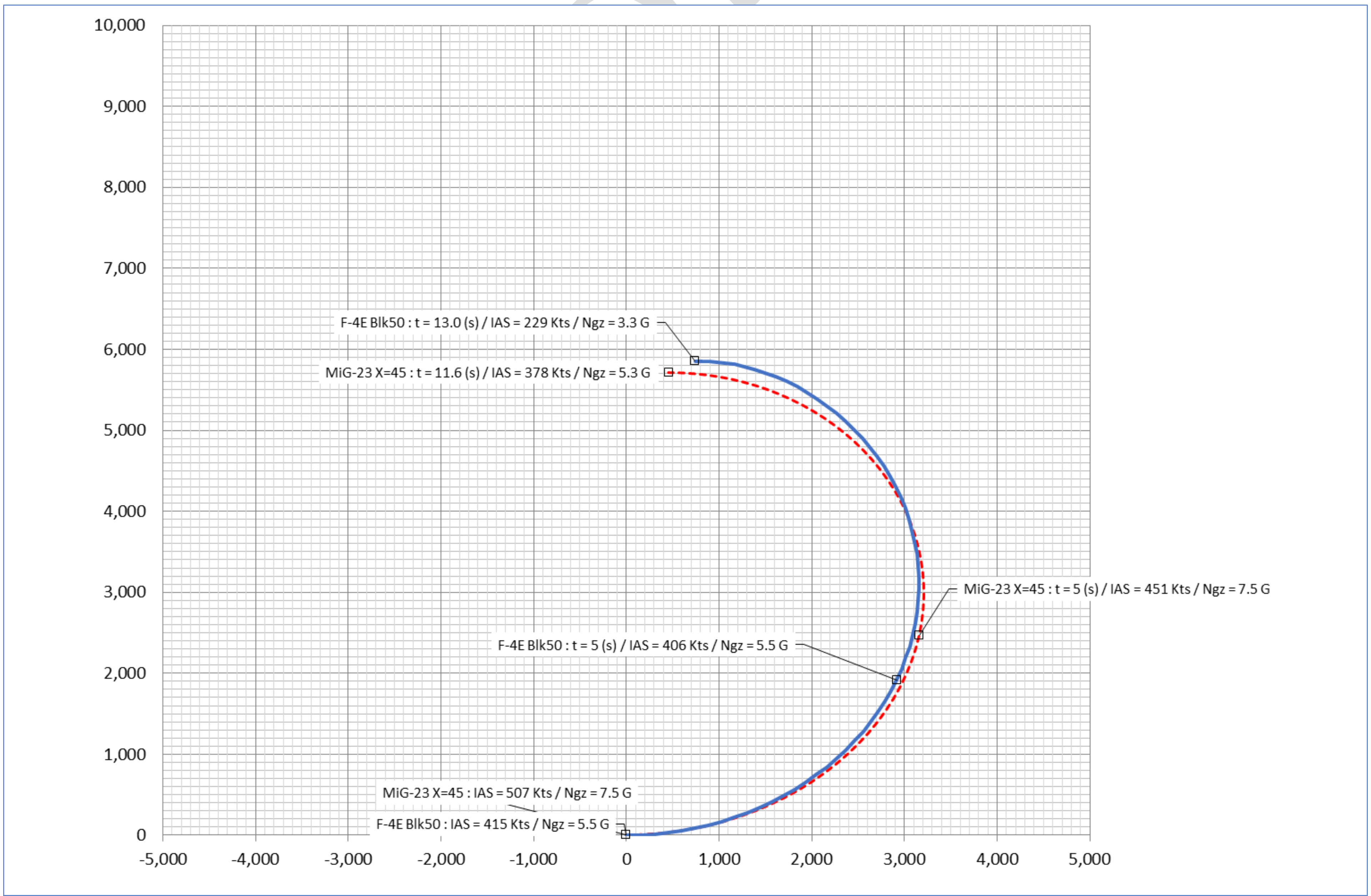


Fig 2.2 F-4E Blk.50 and Mig-23ML (X=45 SOUA OFF) quickest half turn at 5,000ft

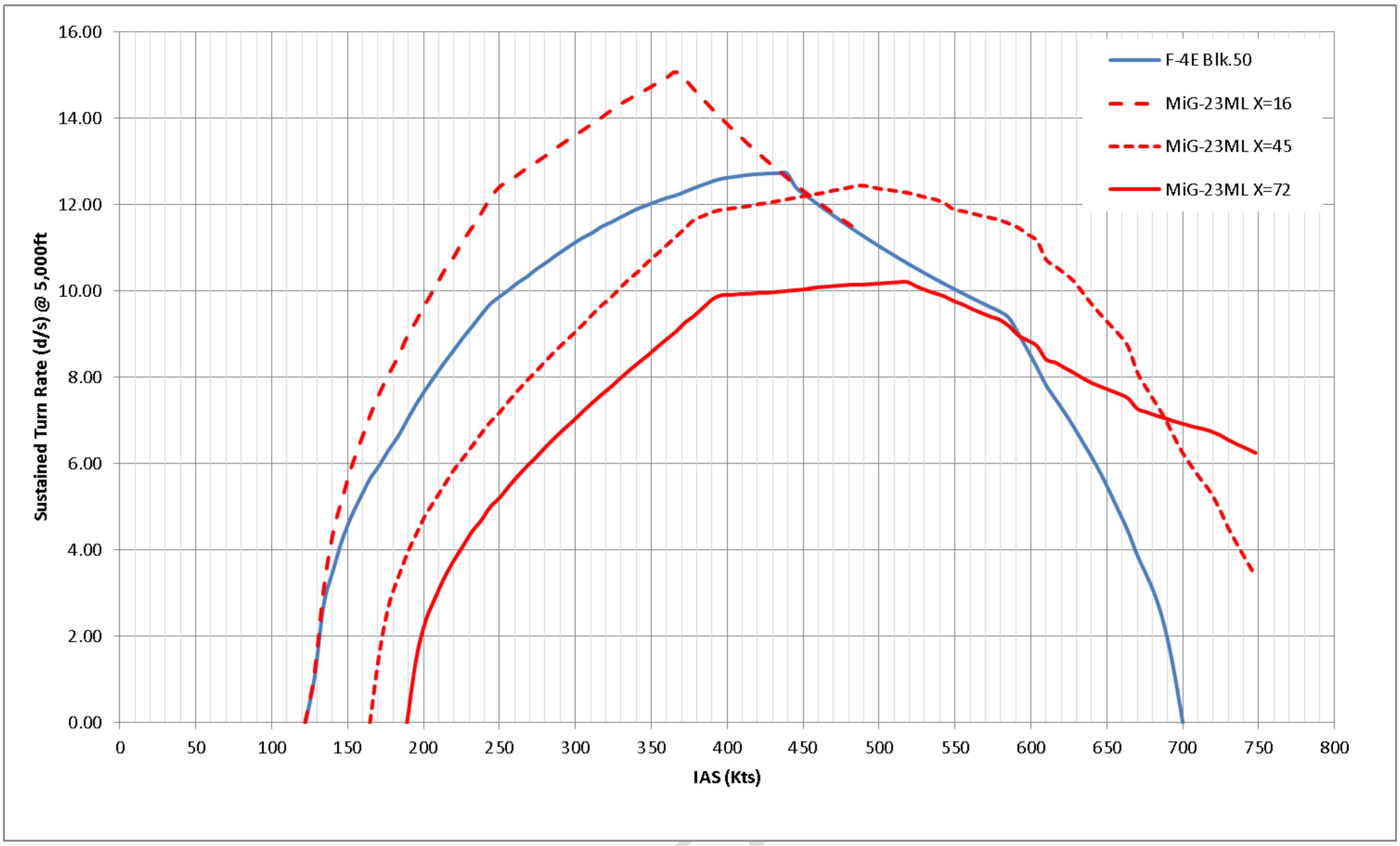


Fig 2.3. F-4E Blk.50 and Mig-23ML Sustained Turn Rate at 5,000ft

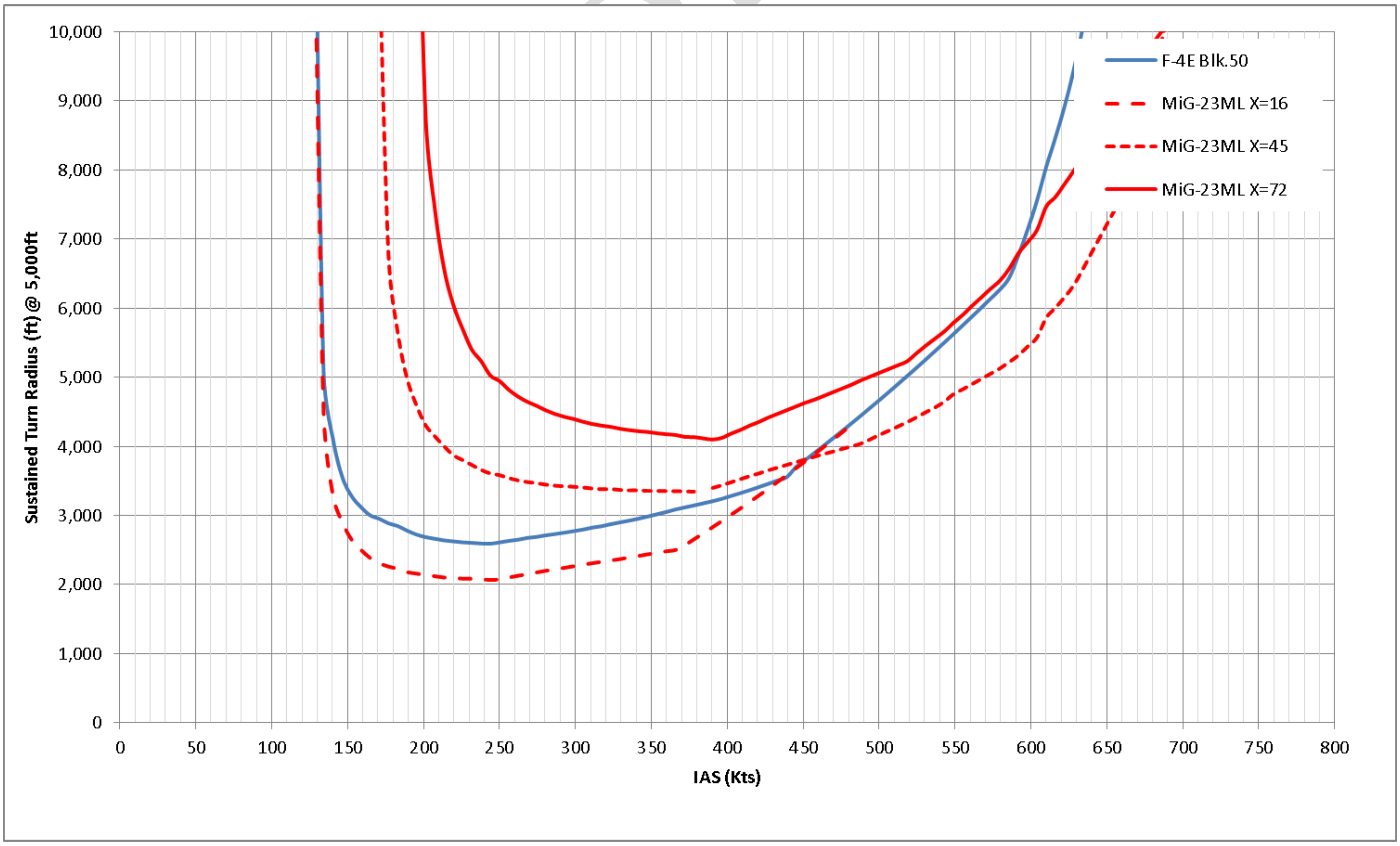


Fig 2.4. F-4E Blk.50 and Mig-23ML Sustained Turn Radius at 5,000ft

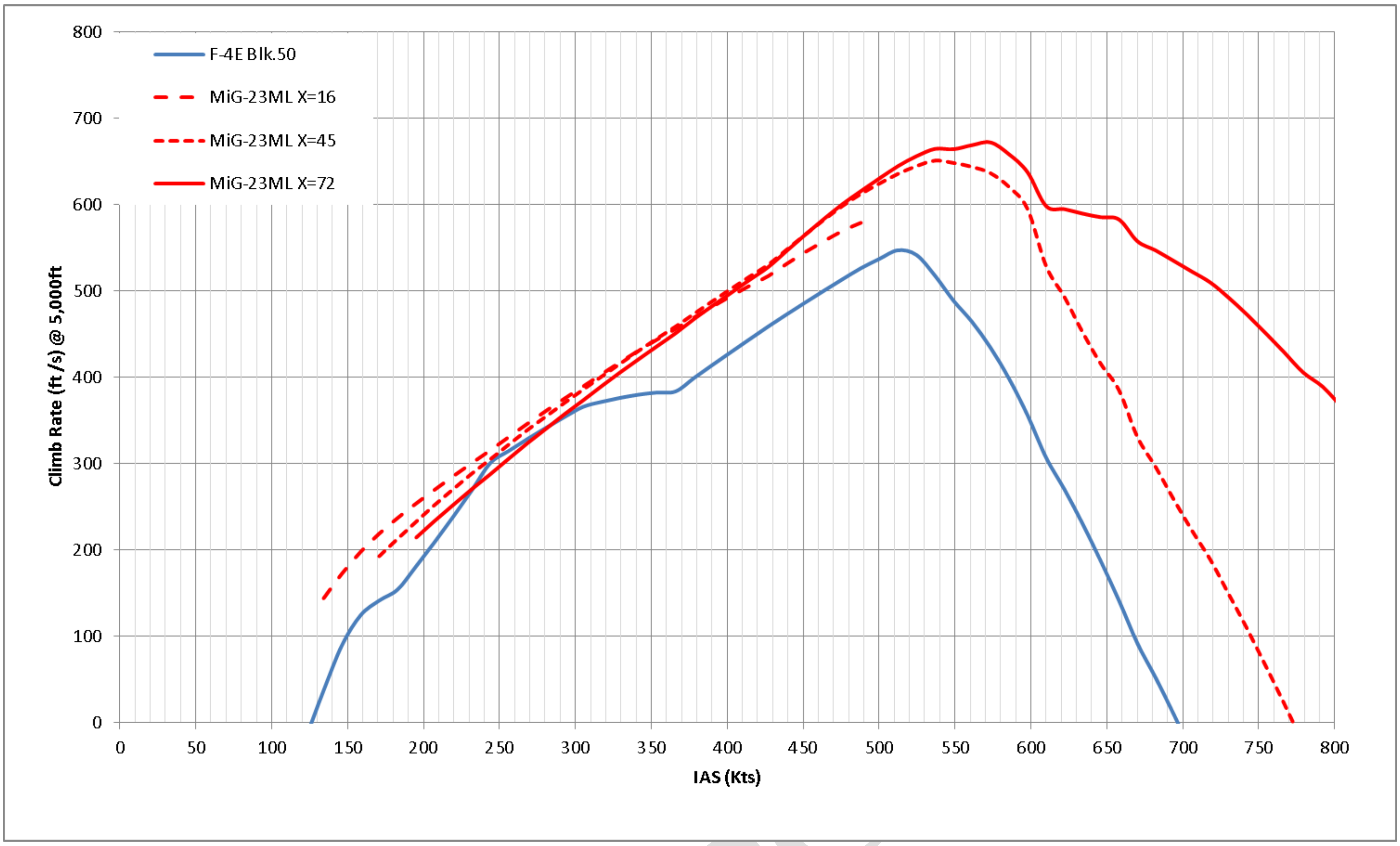


Fig 2.5. F-4E Blk.50 and Mig-23ML Constant Speed Climb Rate at 5,000ft

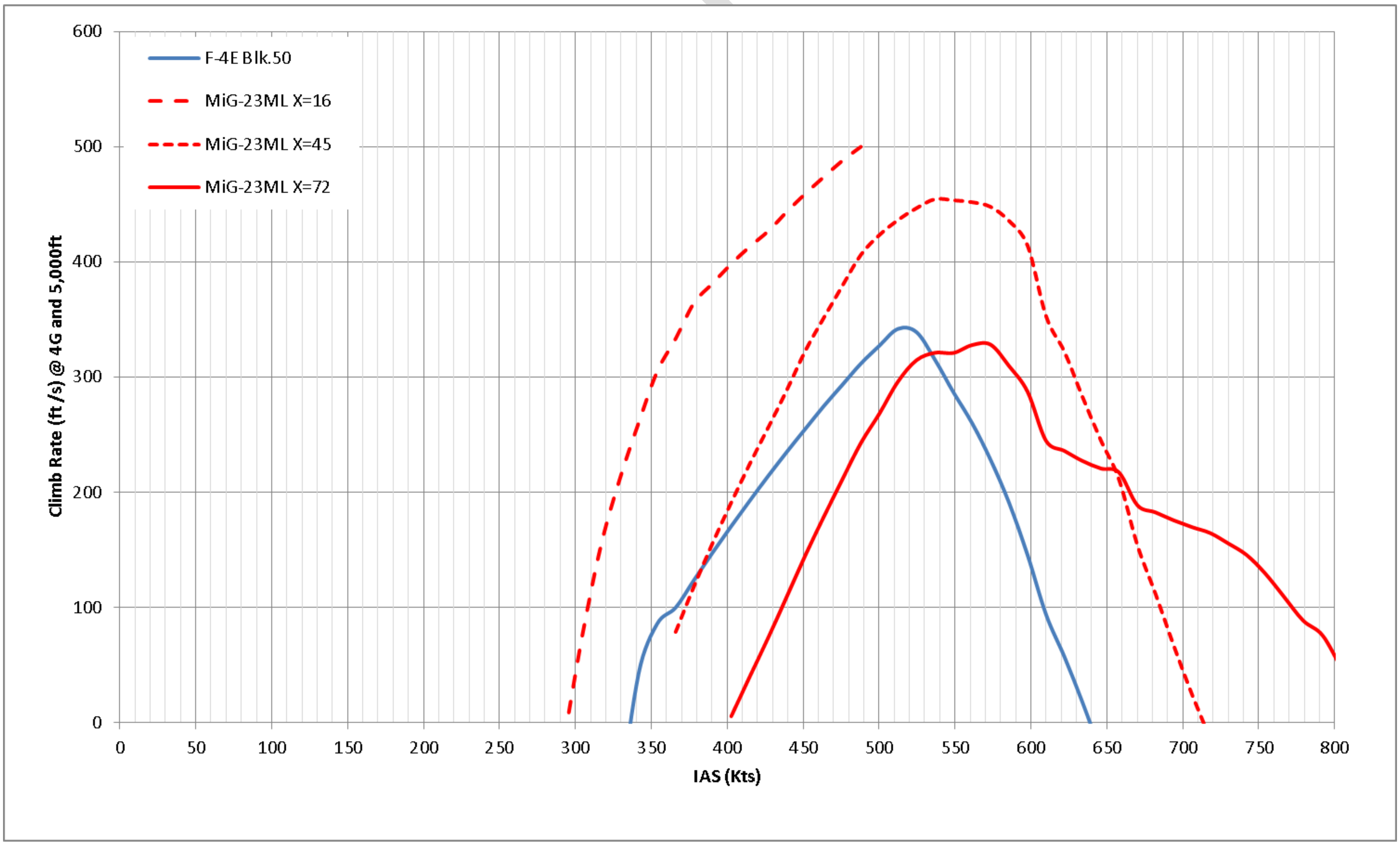


Fig 2.6. F-4E Blk.50 and Mig-23ML Constant Speed and 4G Load turn Climb, Rate at 5,000ft

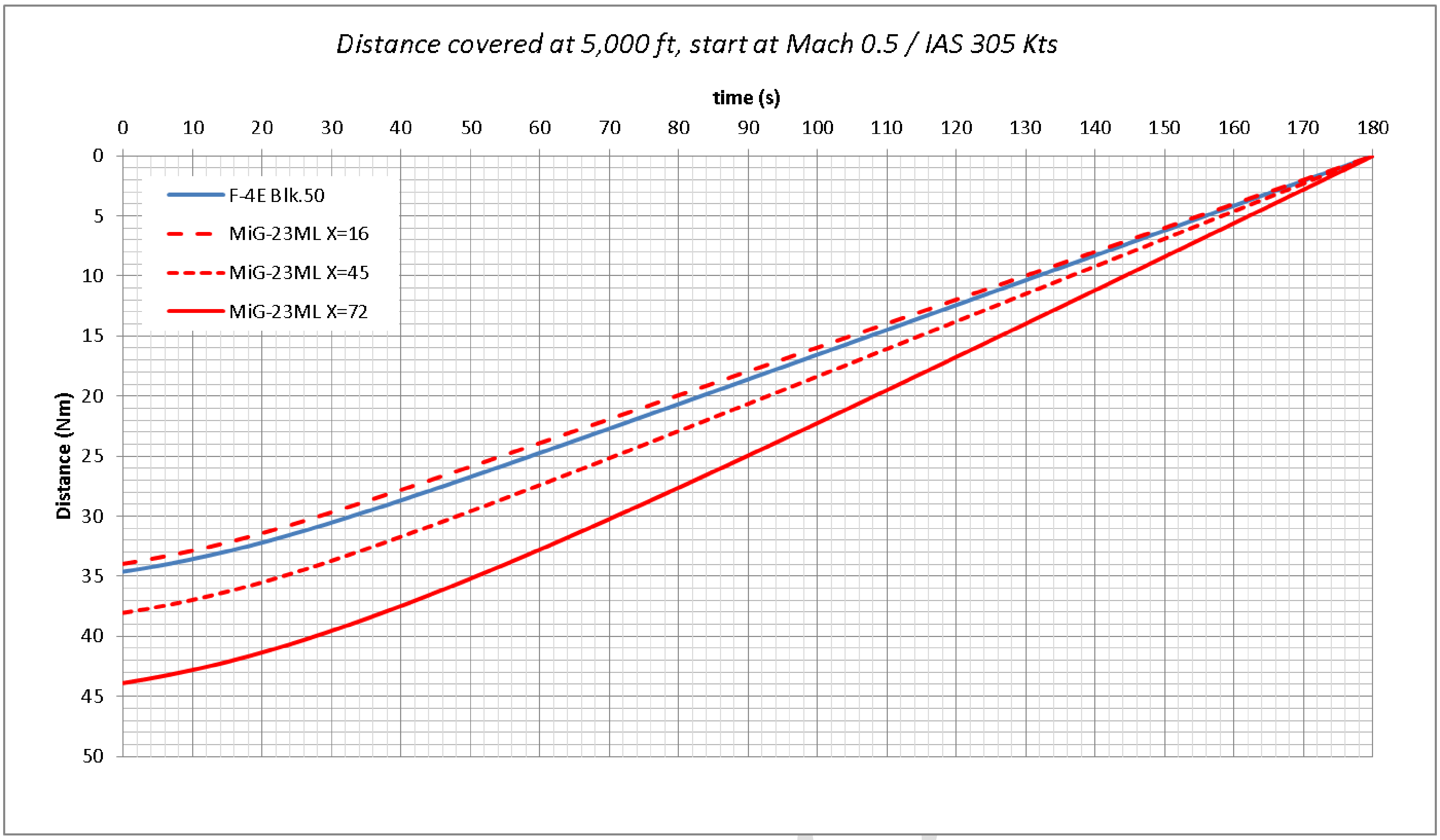


Fig 2.7. F-4E Blk.50 and Mig-23ML Distance covered in 3', from mach 0.5 at 5,000ft

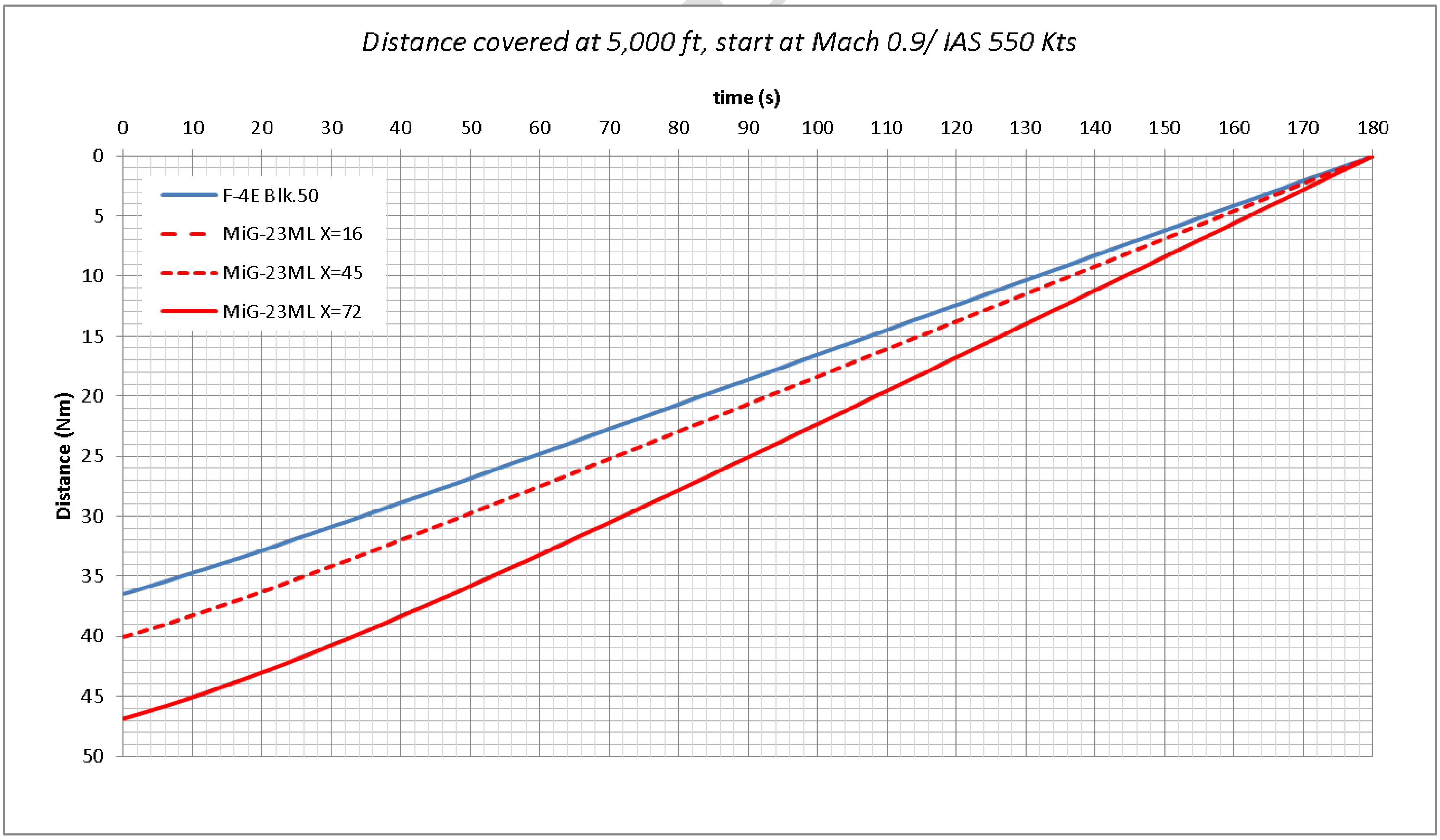


Fig 2.8. F-4E Blk.50 and Mig-23ML Distance covered in 3', from mach 0.9 at 5,000ft

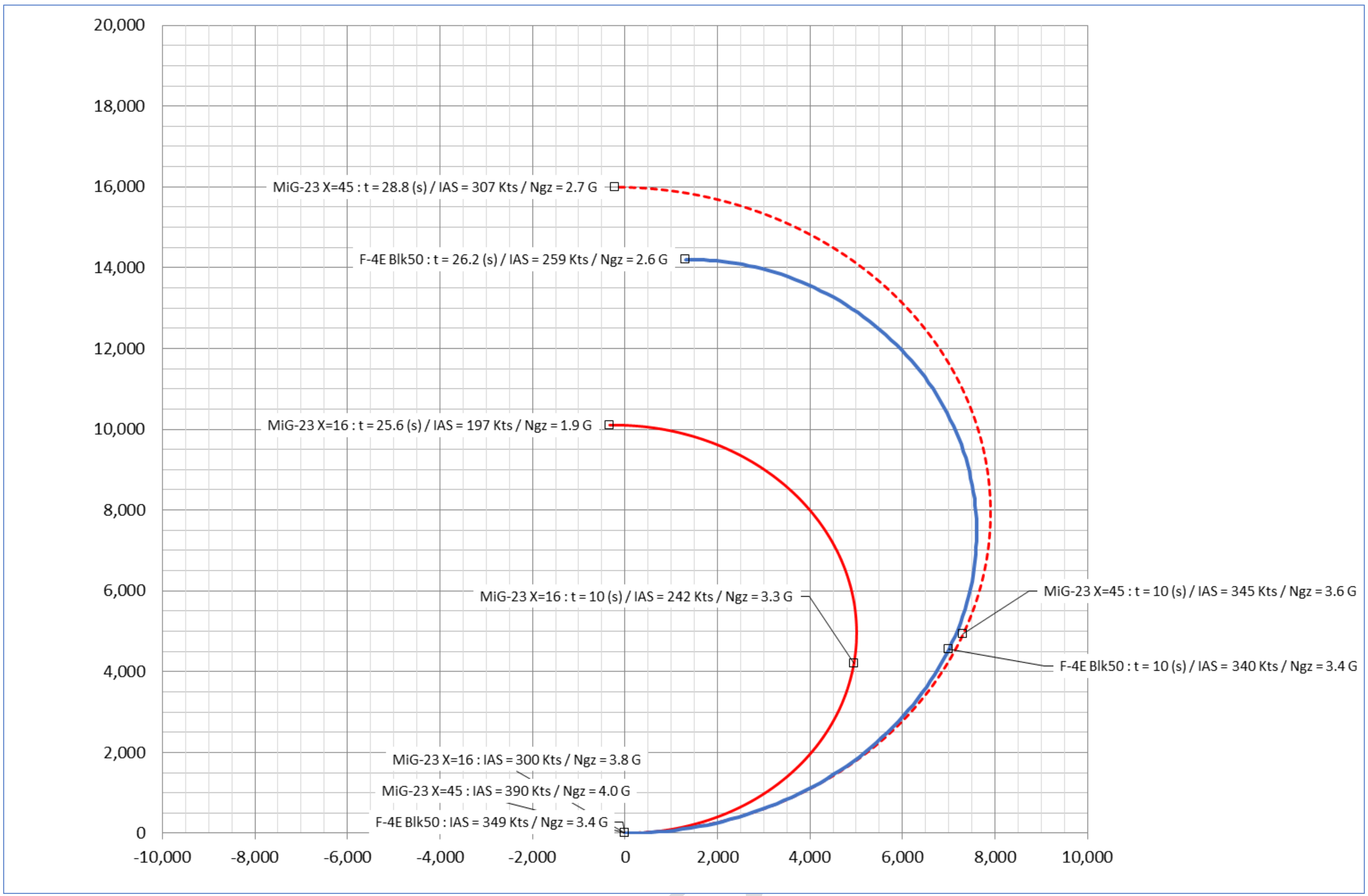


Fig 3.1 F-4E Blk.50 and Mig-23ML (SOUA ON) quickest half turn at 30,000ft

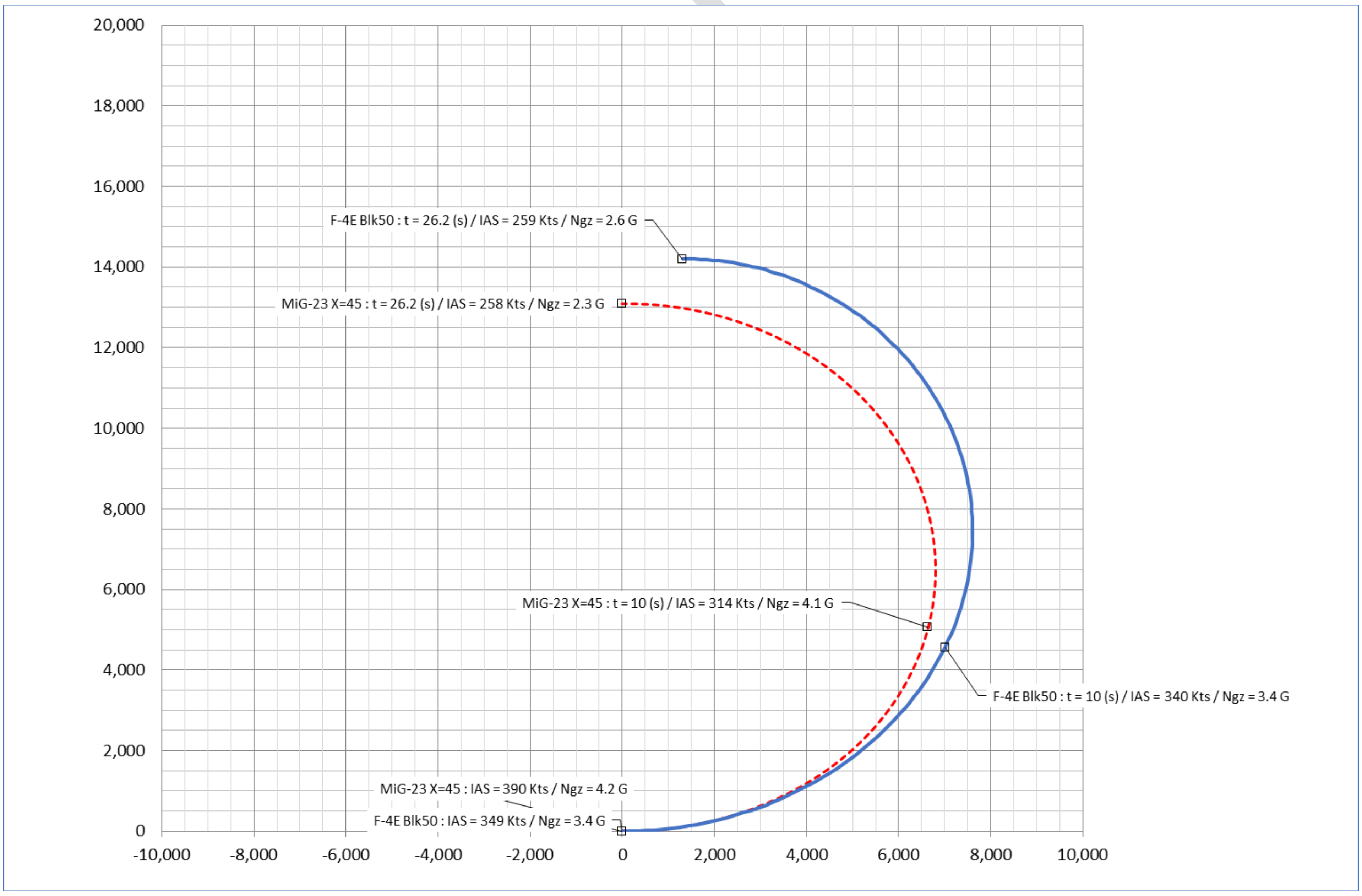


Fig 3.2 F-4E Blk.50 and Mig-23ML (X=45 SOUA OFF) quickest half turn at 30,000ft

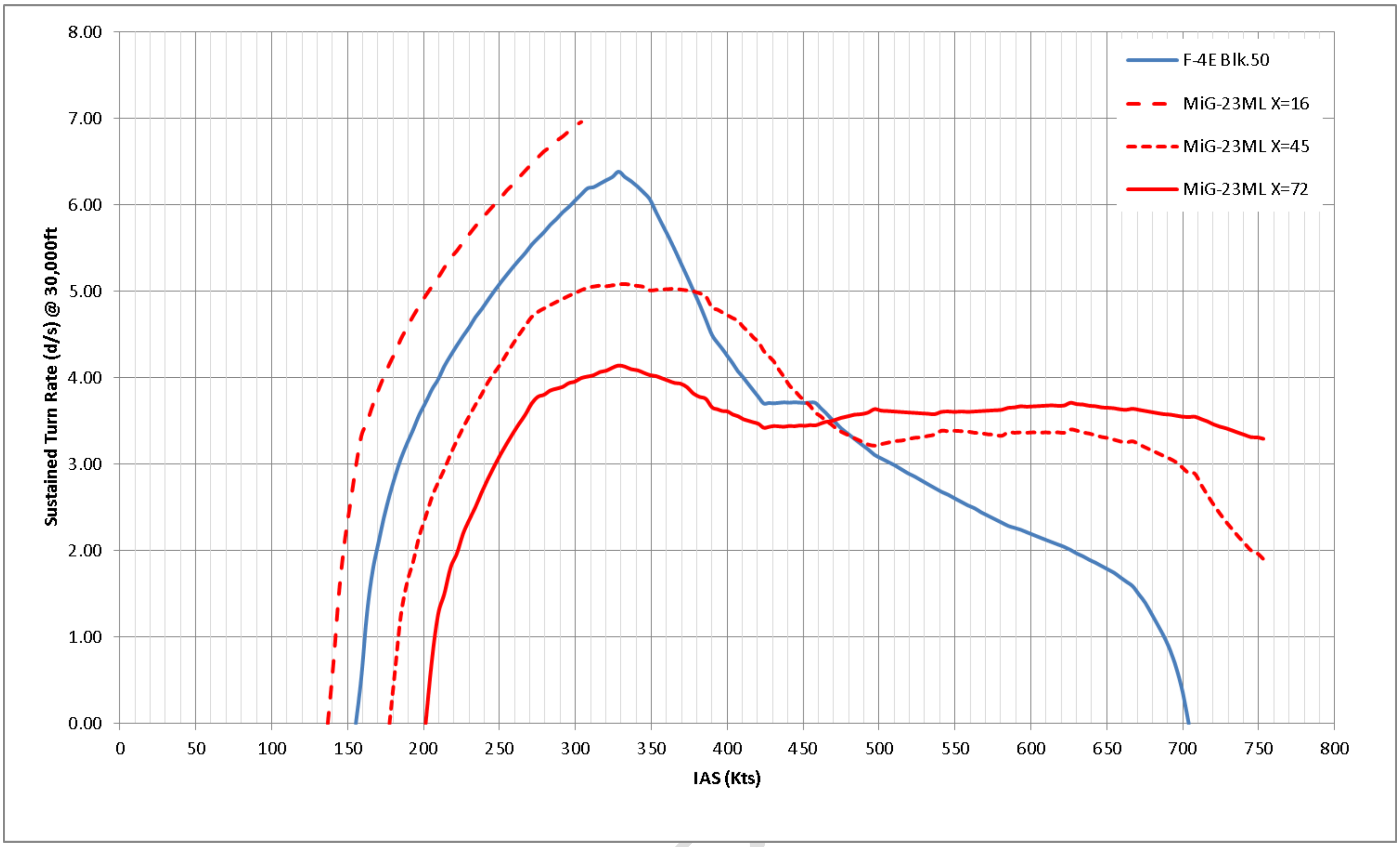


Fig 3.3. F-4E Blk.50 and Mig-23ML Sustained Turn Rate at 30,000ft

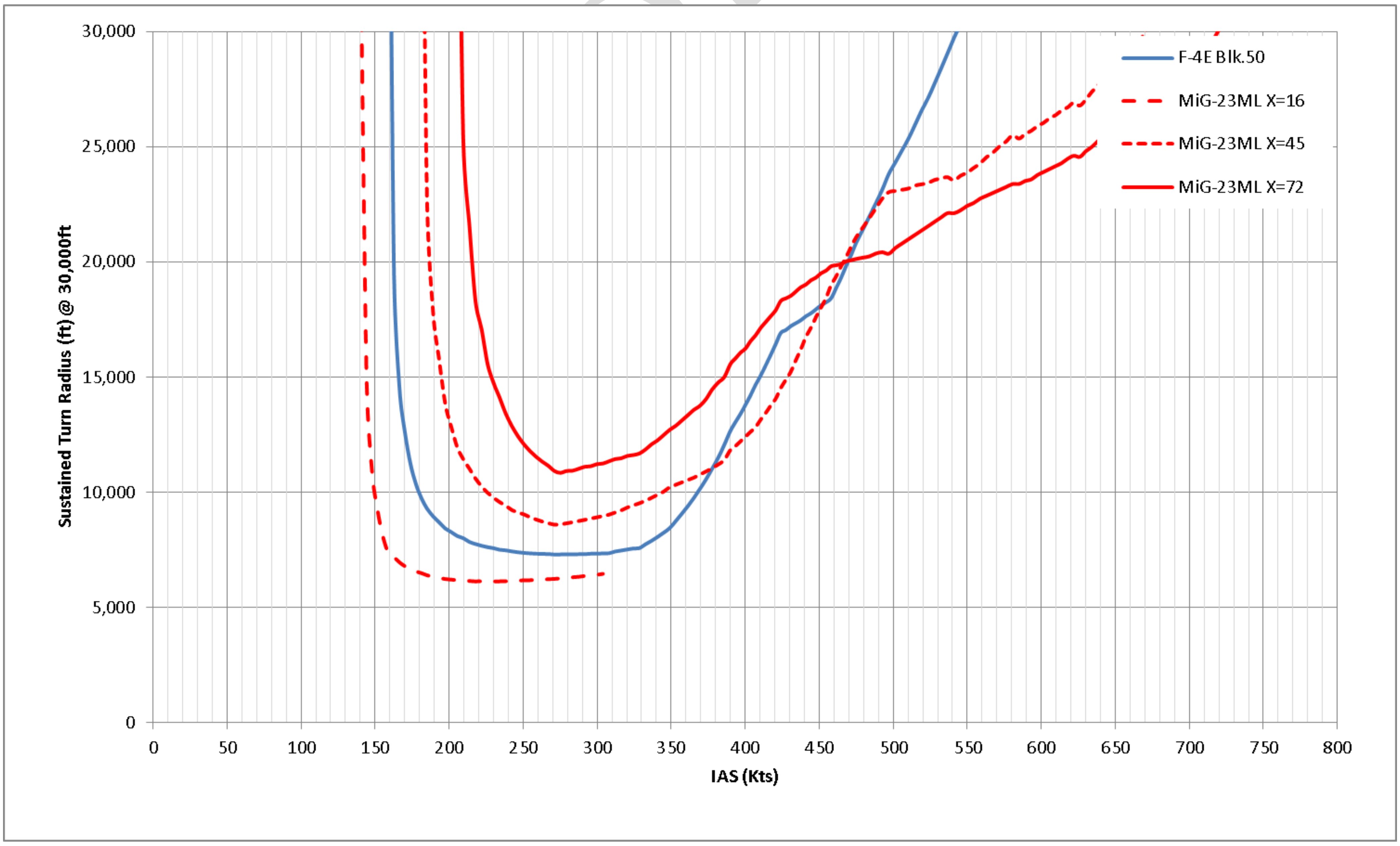


Fig 3.4. F-4E Blk.50 and Mig-23ML Sustained Turn Radius at 30,000ft

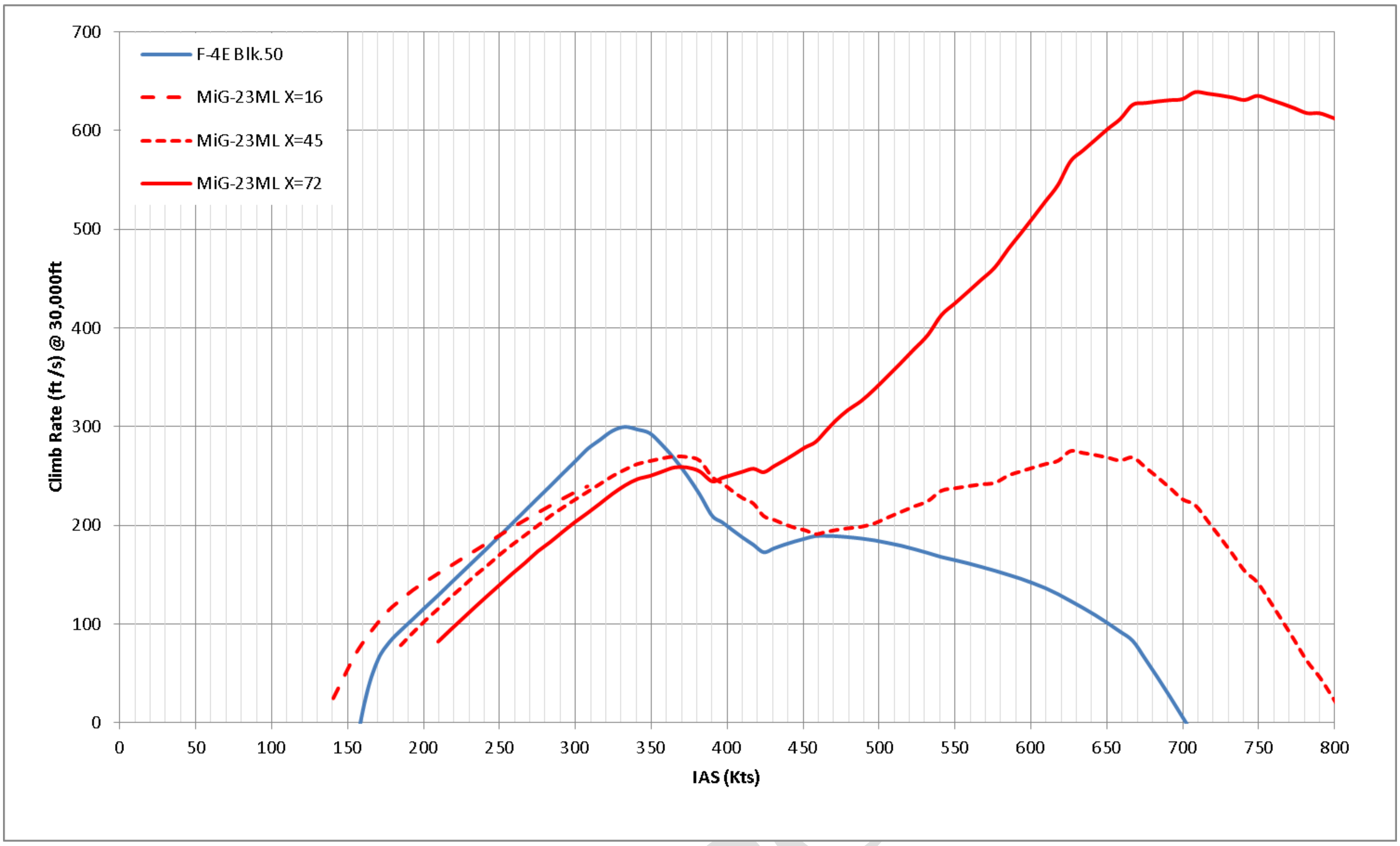


Fig 3.5. F-4E Blk.50 and Mig-23ML Constant Speed Climb Rate at 30,000ft

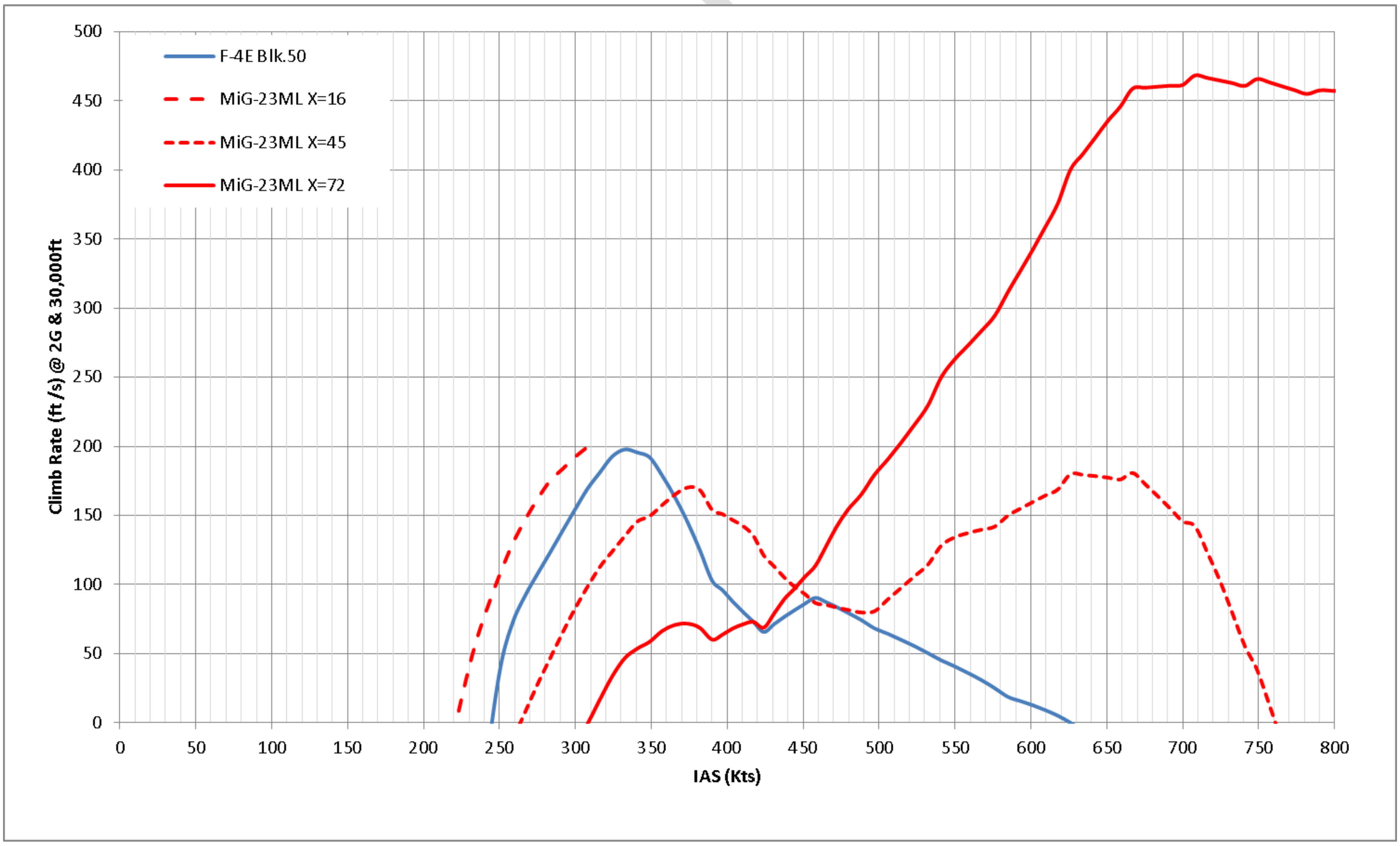


Fig 3.6. F-4E Blk.50 and Mig-23ML Constant Speed and 2G Load turn Climb, Rate at 30,000ft

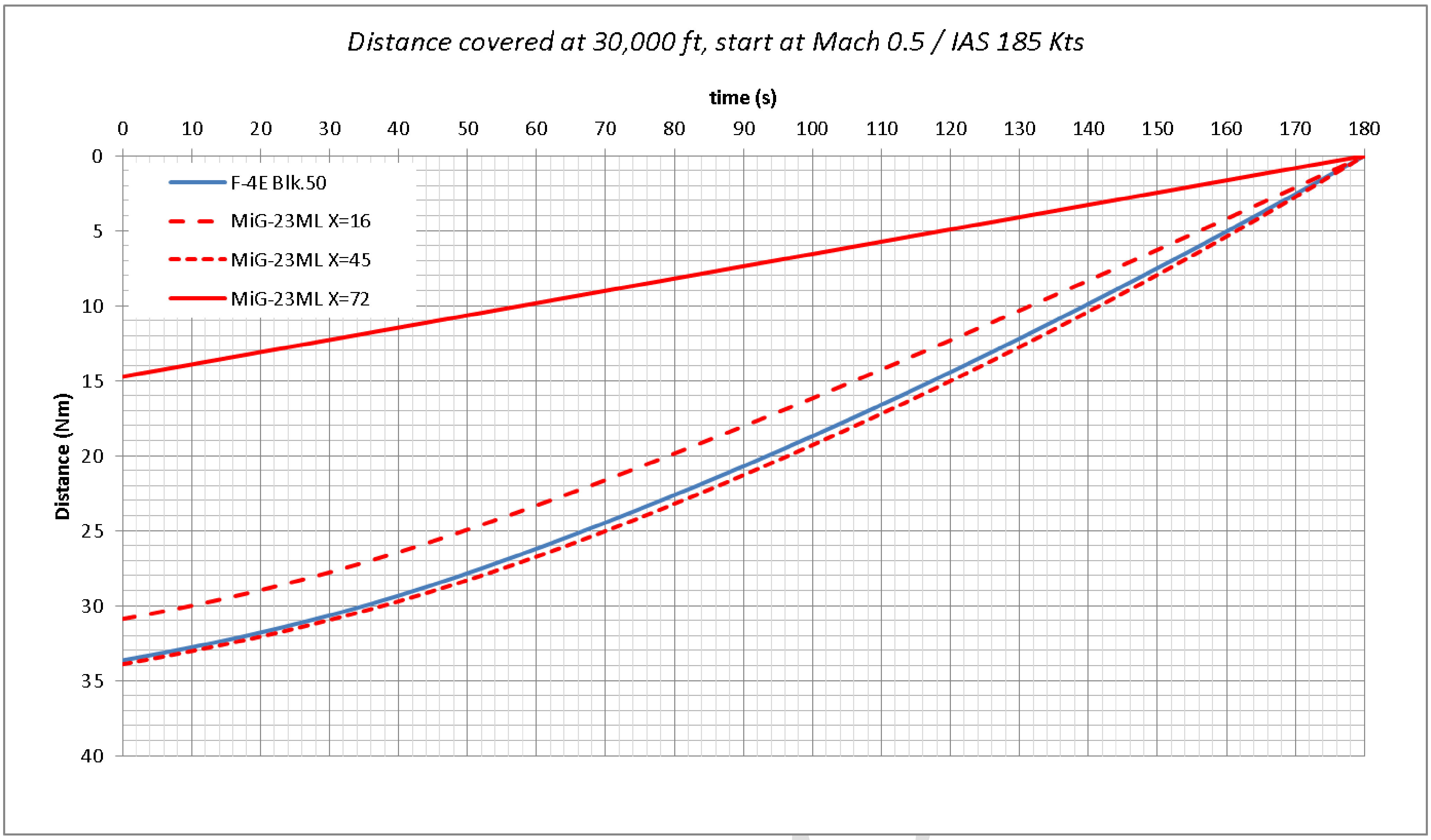


Fig 3.7. F-4E Blk.50 and Mig-23ML Distance covered in 3', from mach 0.5 at 30,000ft

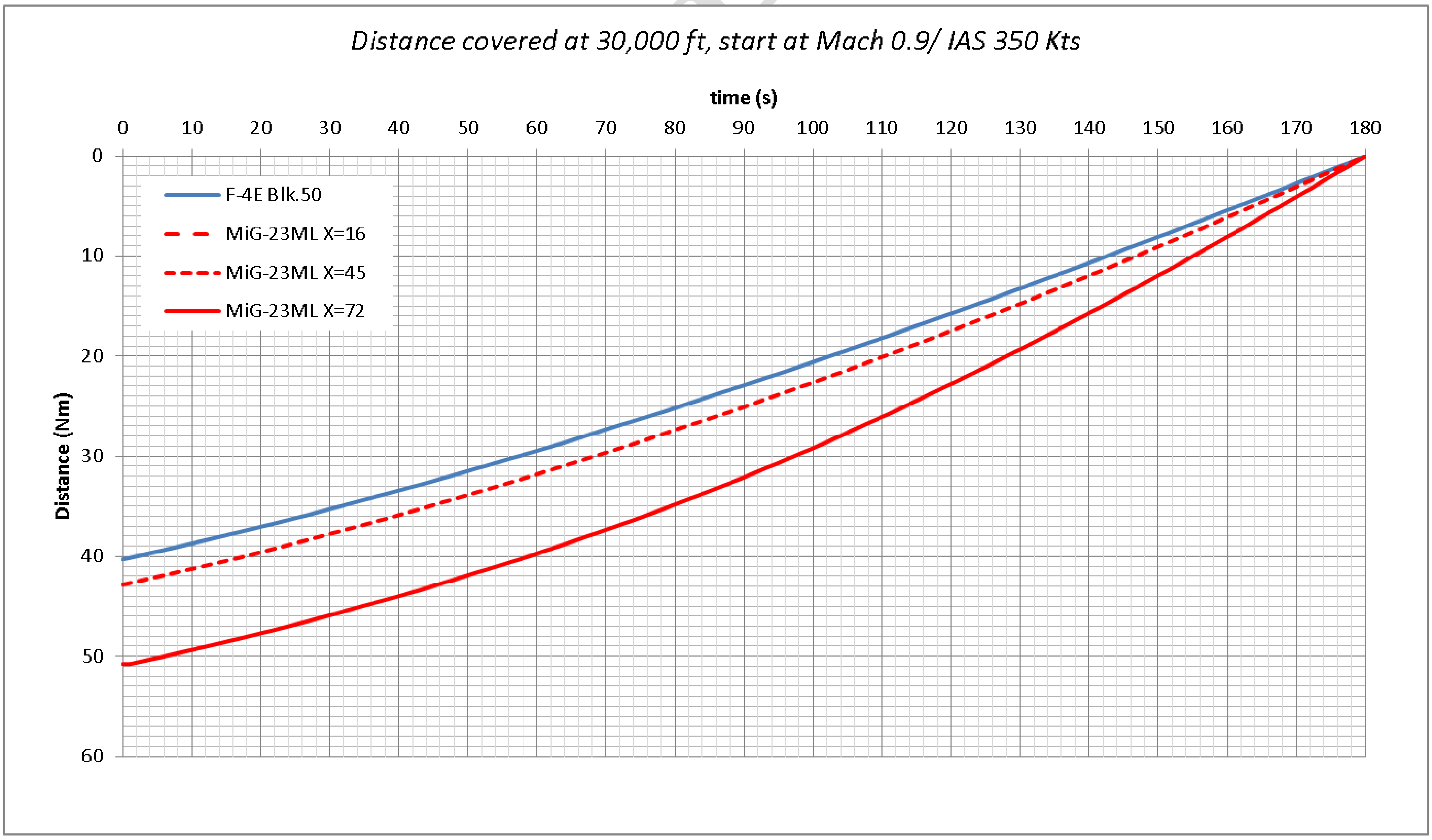


Fig 3.8. F-4E Blk.50 and Mig-23ML Distance covered in 3', from mach 0.9 at 30,000ft

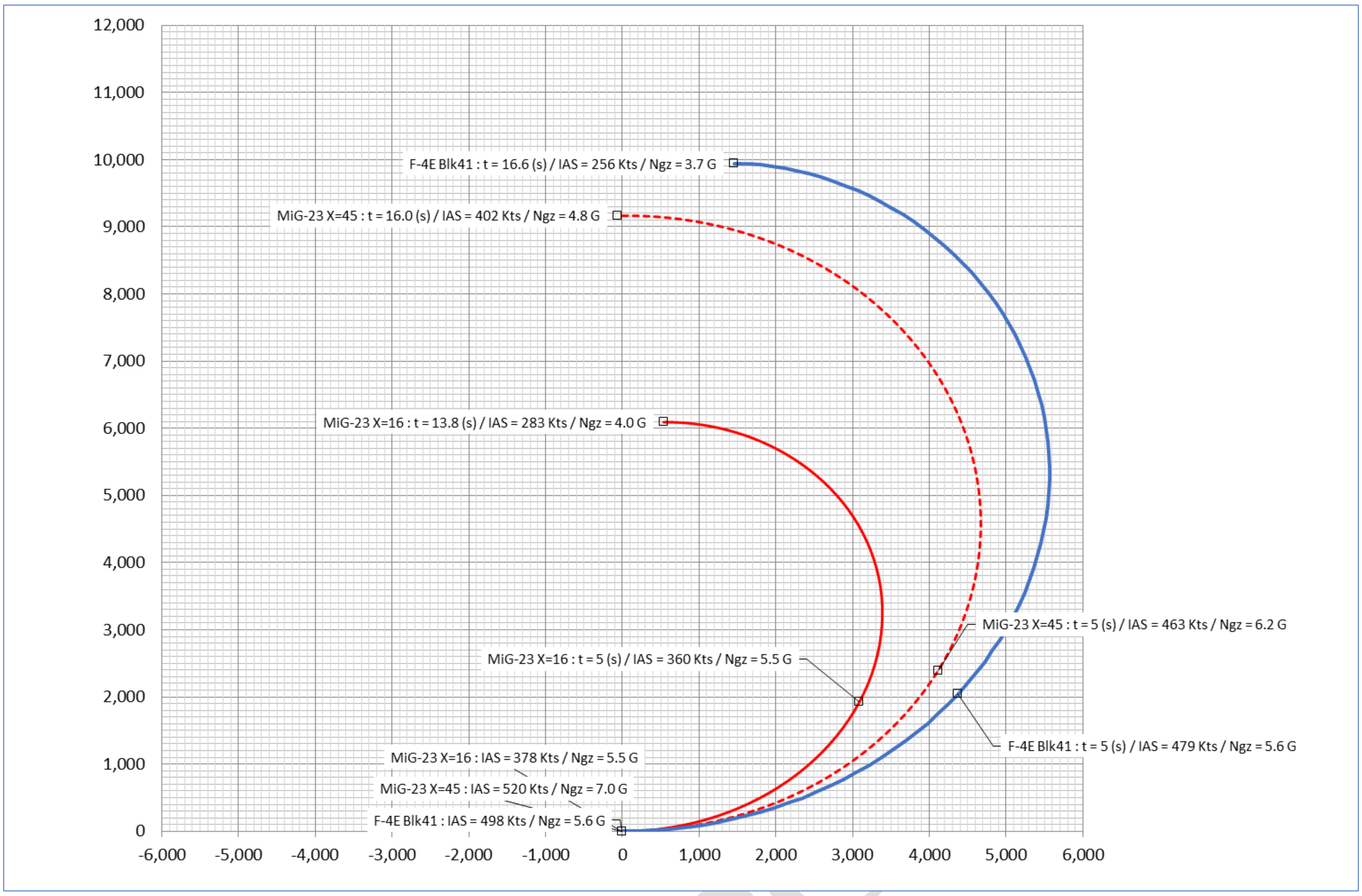


Fig 4.1 F-4E Blk.41 and Mig-23ML (SOUA ON) quickest half turn at 15,000ft

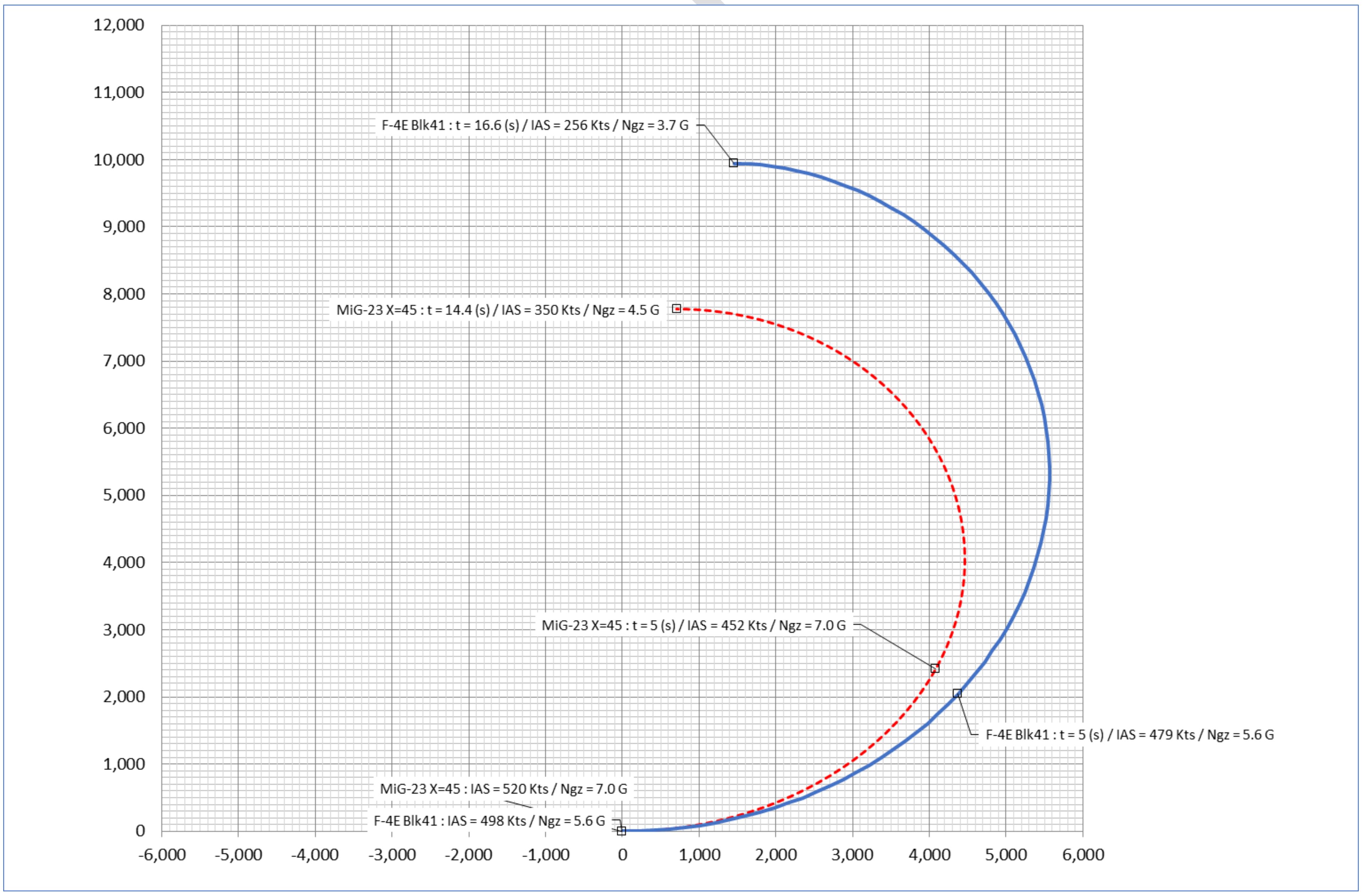


Fig 4.2 F-4E Blk.41 and Mig-23ML (X=45 SOUA OFF) quickest half turn at 15,000ft

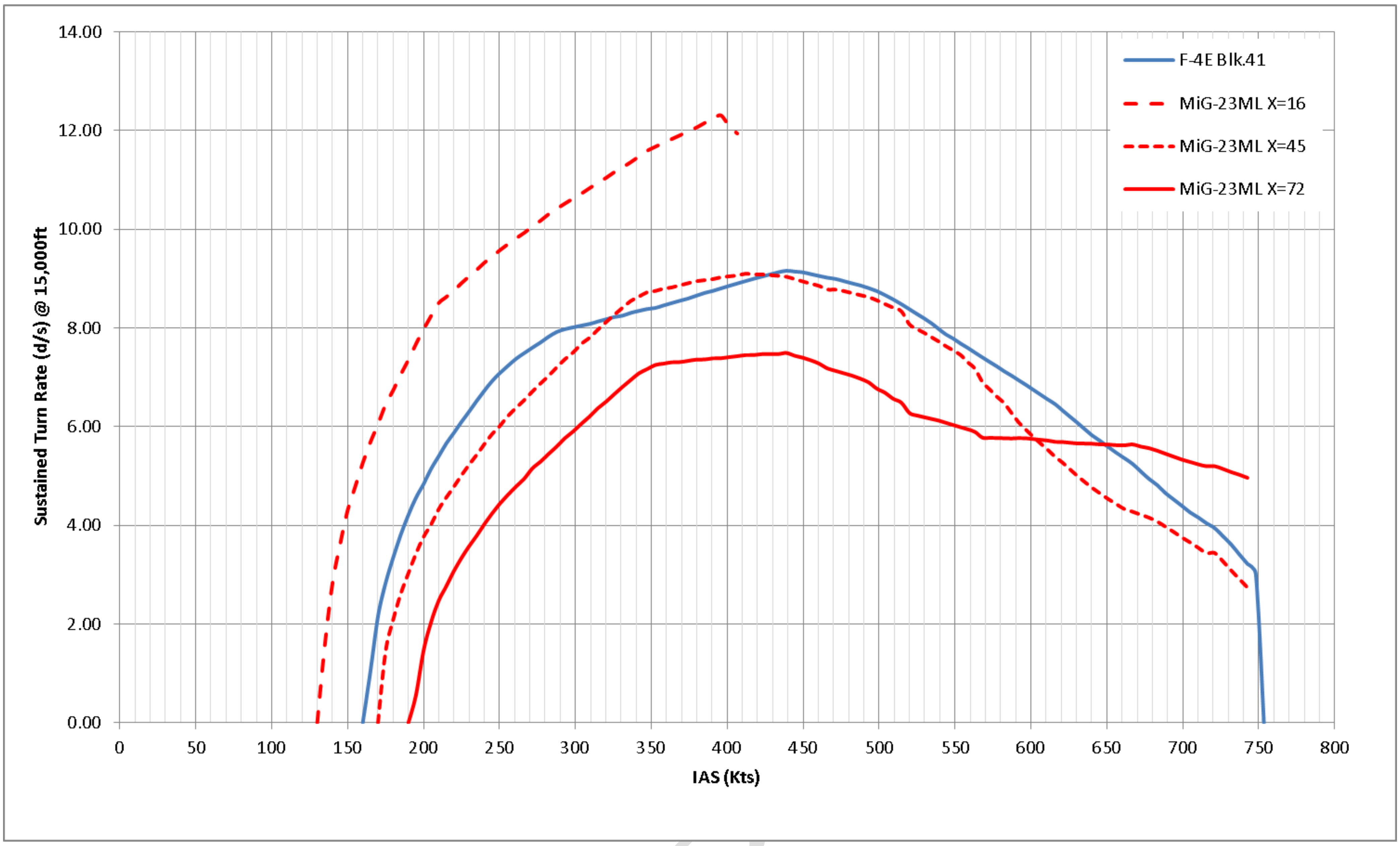


Fig 4.3. F-4E Blk.41 and Mig-23ML Sustained Turn Rate at 15,000ft

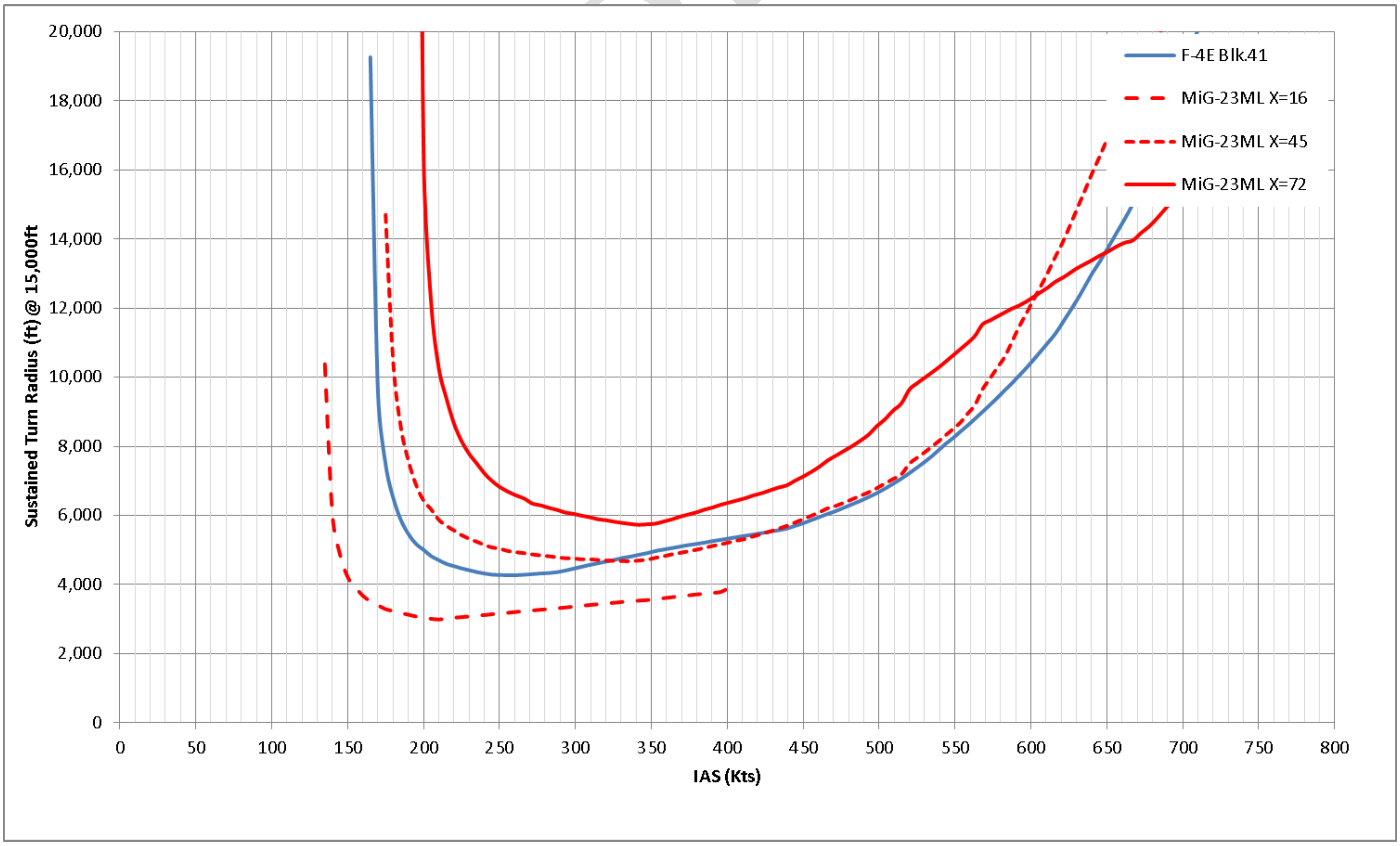


Fig 4.4. F-4E Blk.41 and Mig-23ML Sustained Turn Radius at 15,000ft

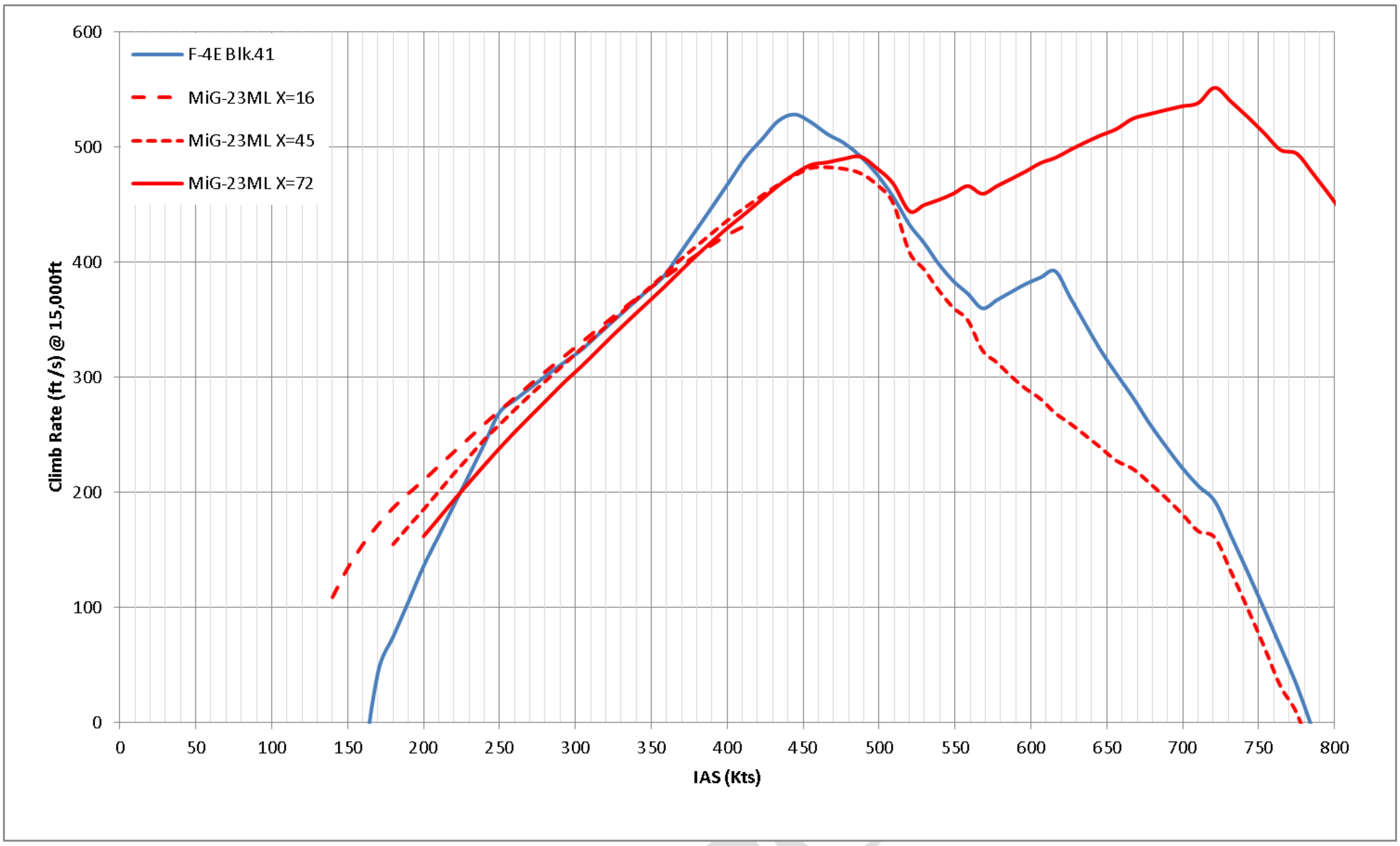


Fig 4.5. F-4E Blk.41 and Mig-23ML Constant Speed Climb Rate at 15,000ft

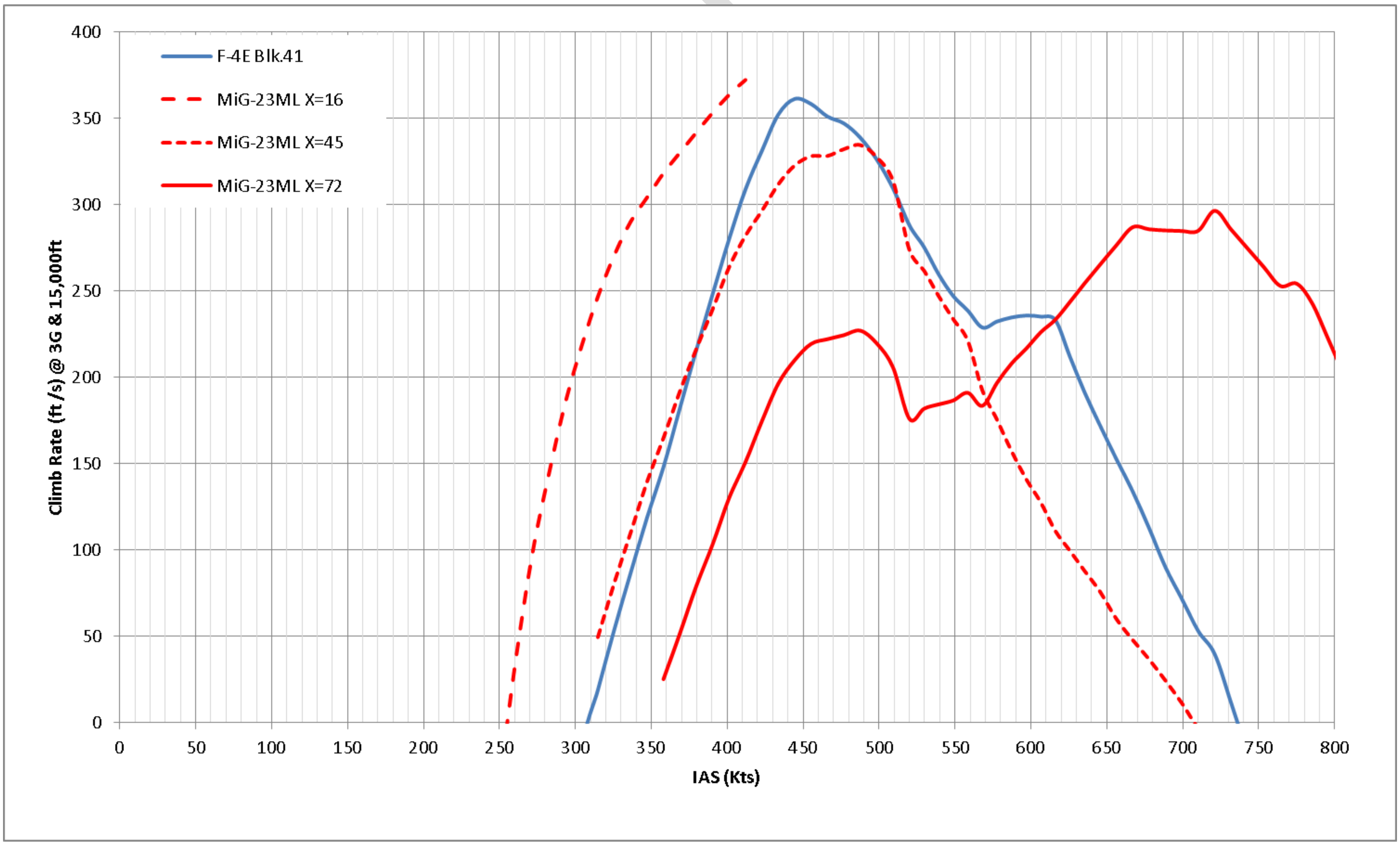


Fig 4.6. F-4E Blk.41 and Mig-23ML Constant Speed and 3G Load turn Climb, Rate at 15,000ft

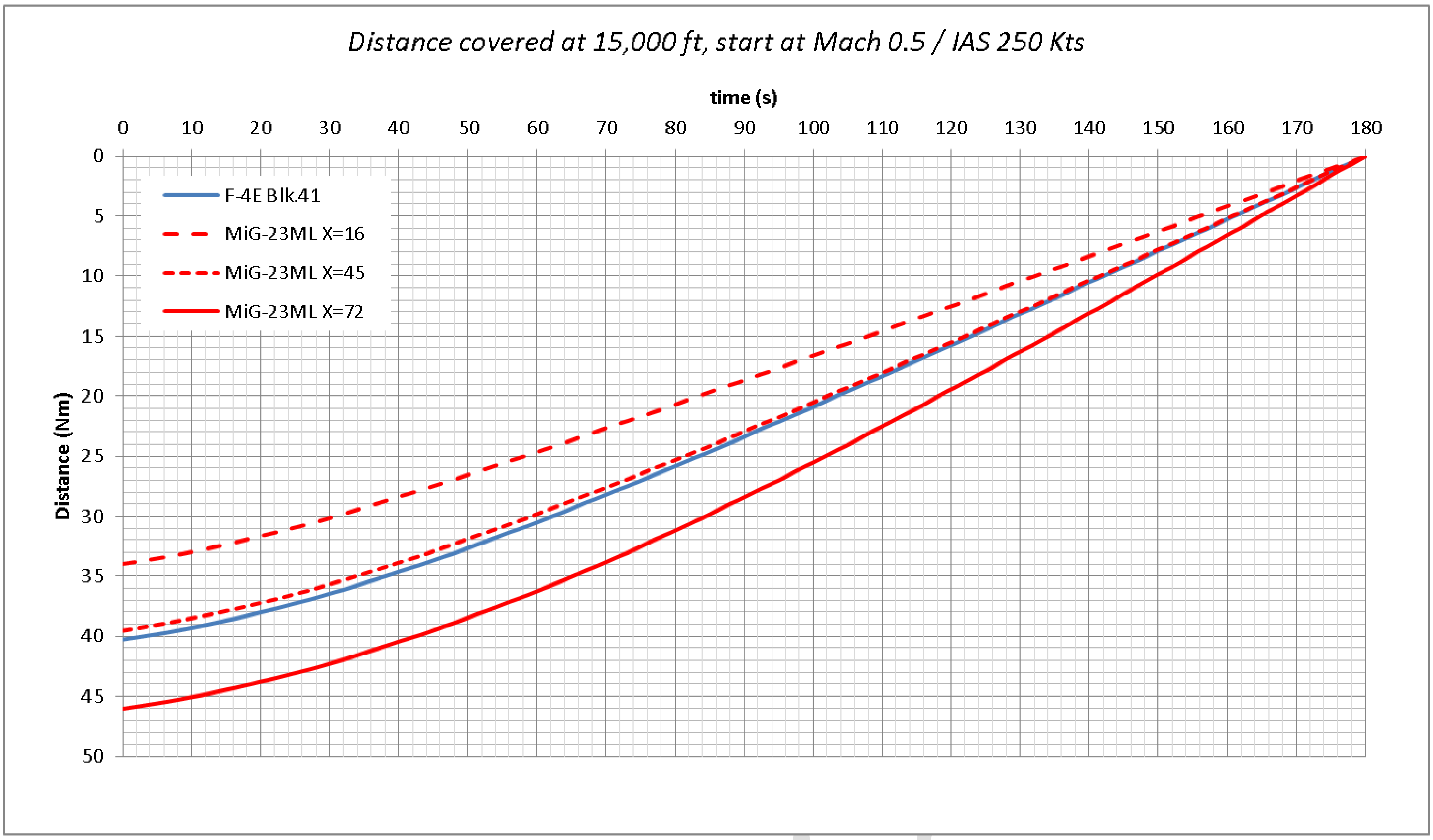


Fig 4.7. F-4E Blk.41 and Mig-23ML Distance covered in 3', from mach 0.5 at 15,000ft

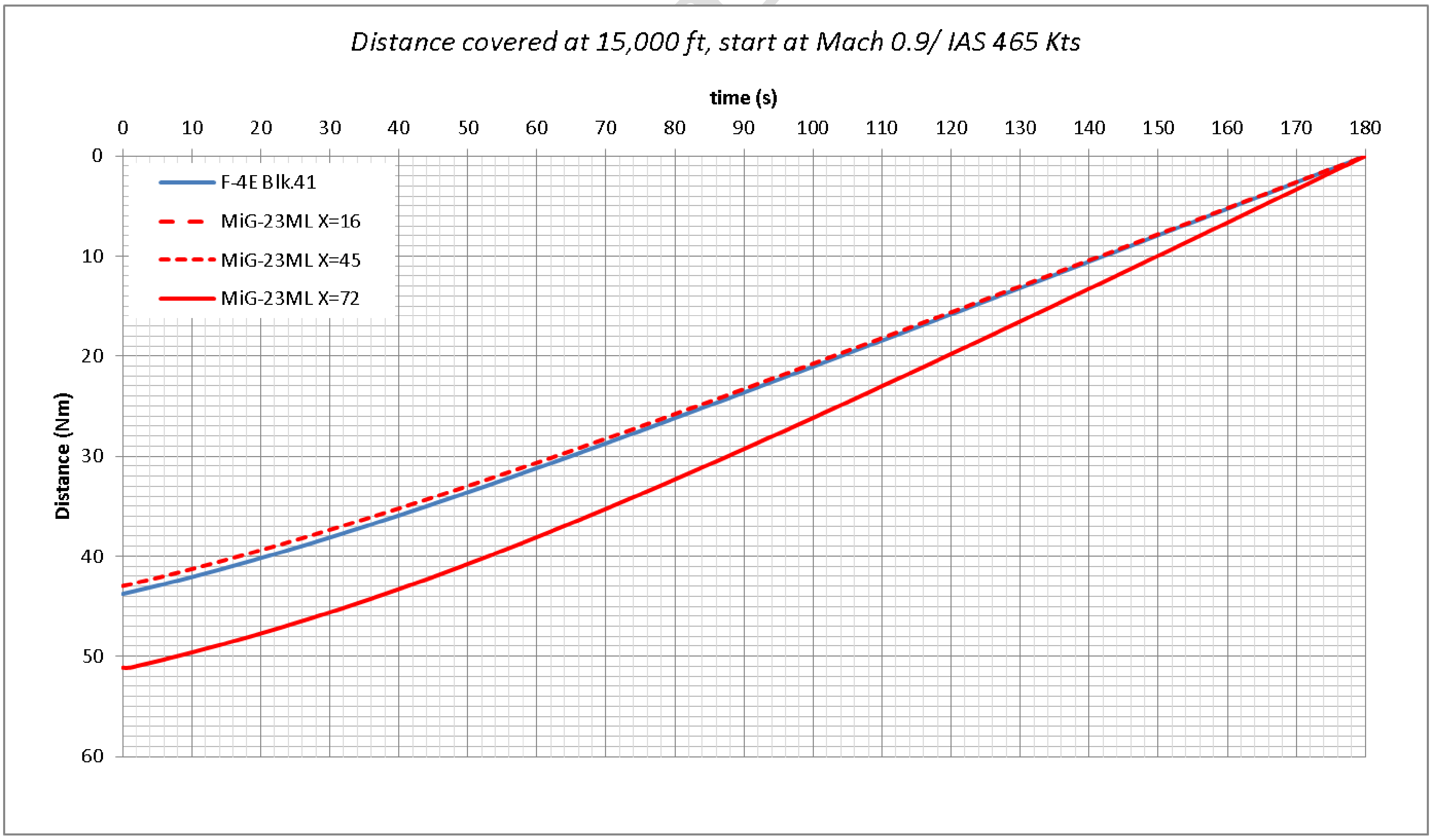


Fig 4.8. F-4E Blk.41 and Mig-23ML Distance covered in 3', from mach 0.9 at 15,000ft

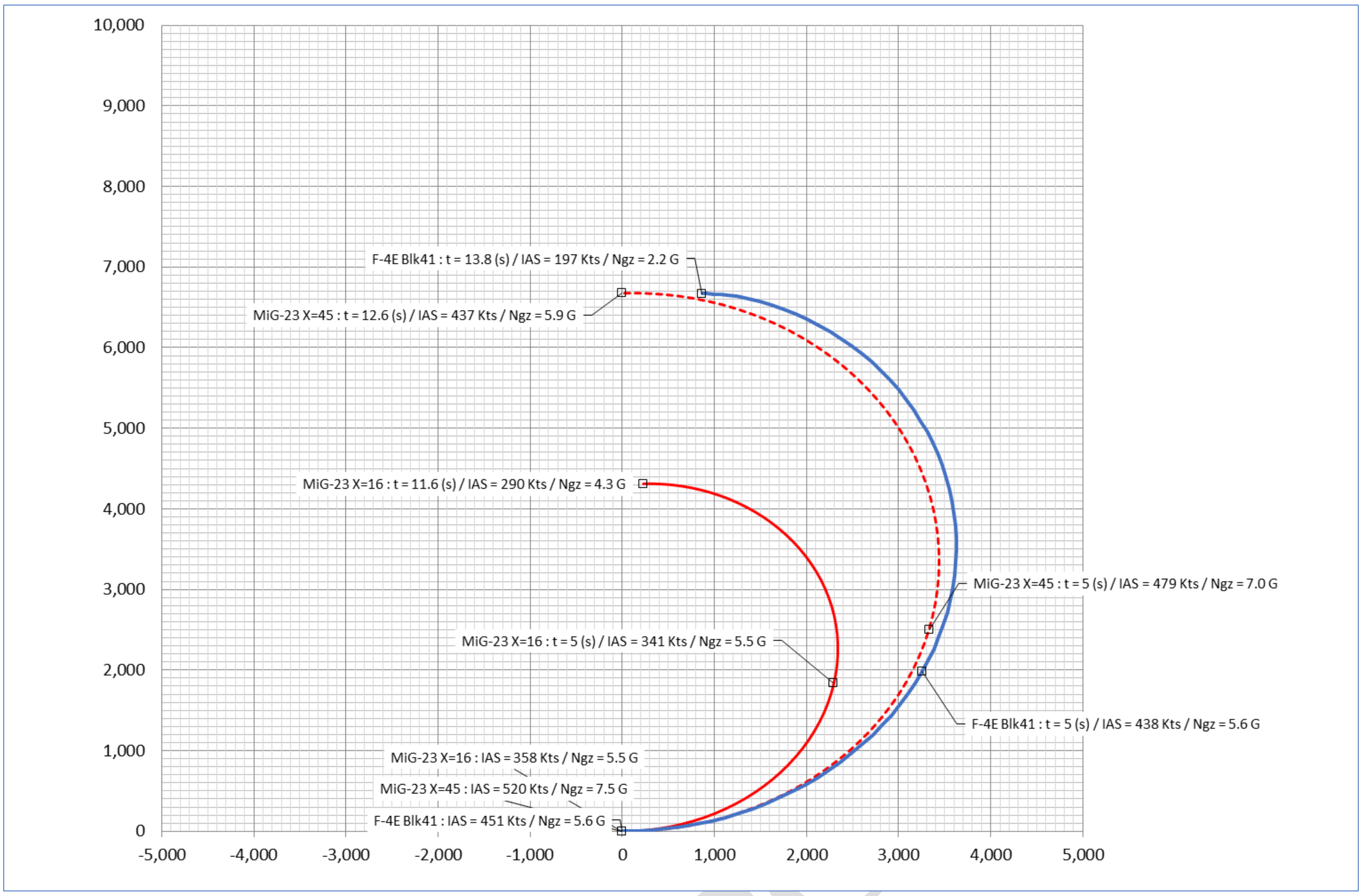


Fig 5.1 F-4E Blk.41 and Mig-23ML (SOUA ON) quickest half turn at 5,000ft

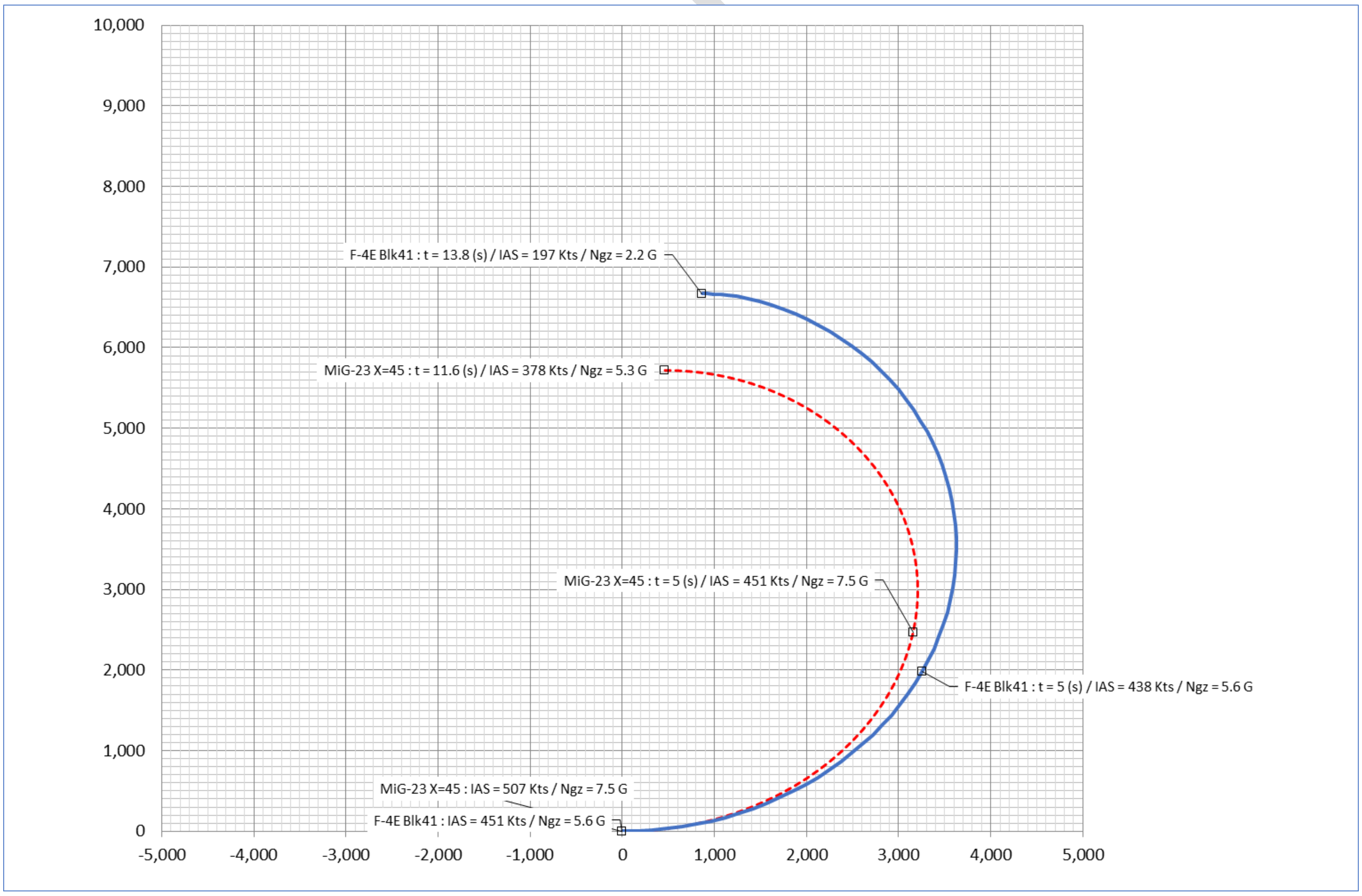


Fig 5.2 F-4E Blk.41 and Mig-23ML (X=45 SOUA OFF) quickest half turn at 5,000ft

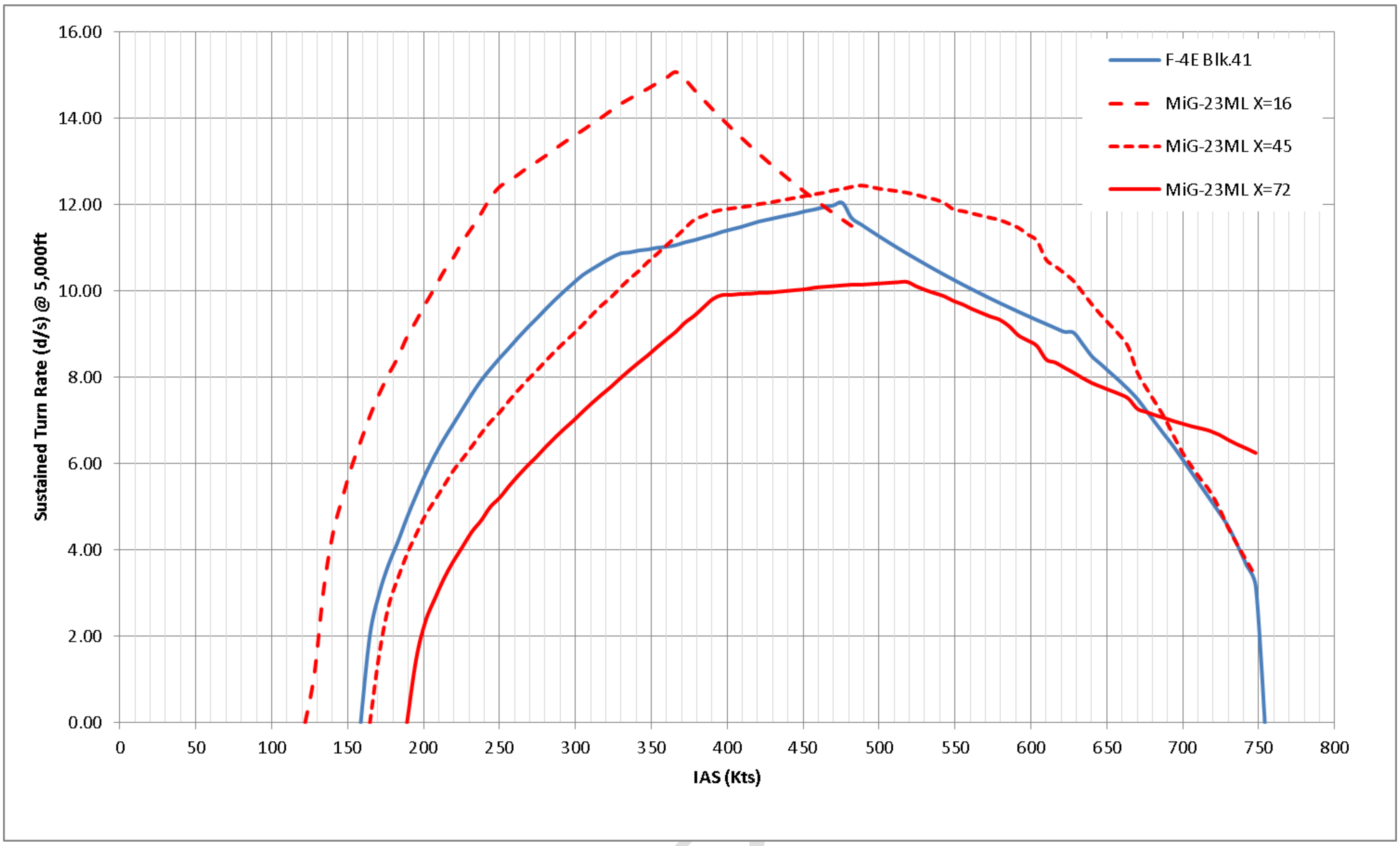


Fig 5.3. F-4E Blk.41 and Mig-23ML Sustained Turn Rate at 5,000ft

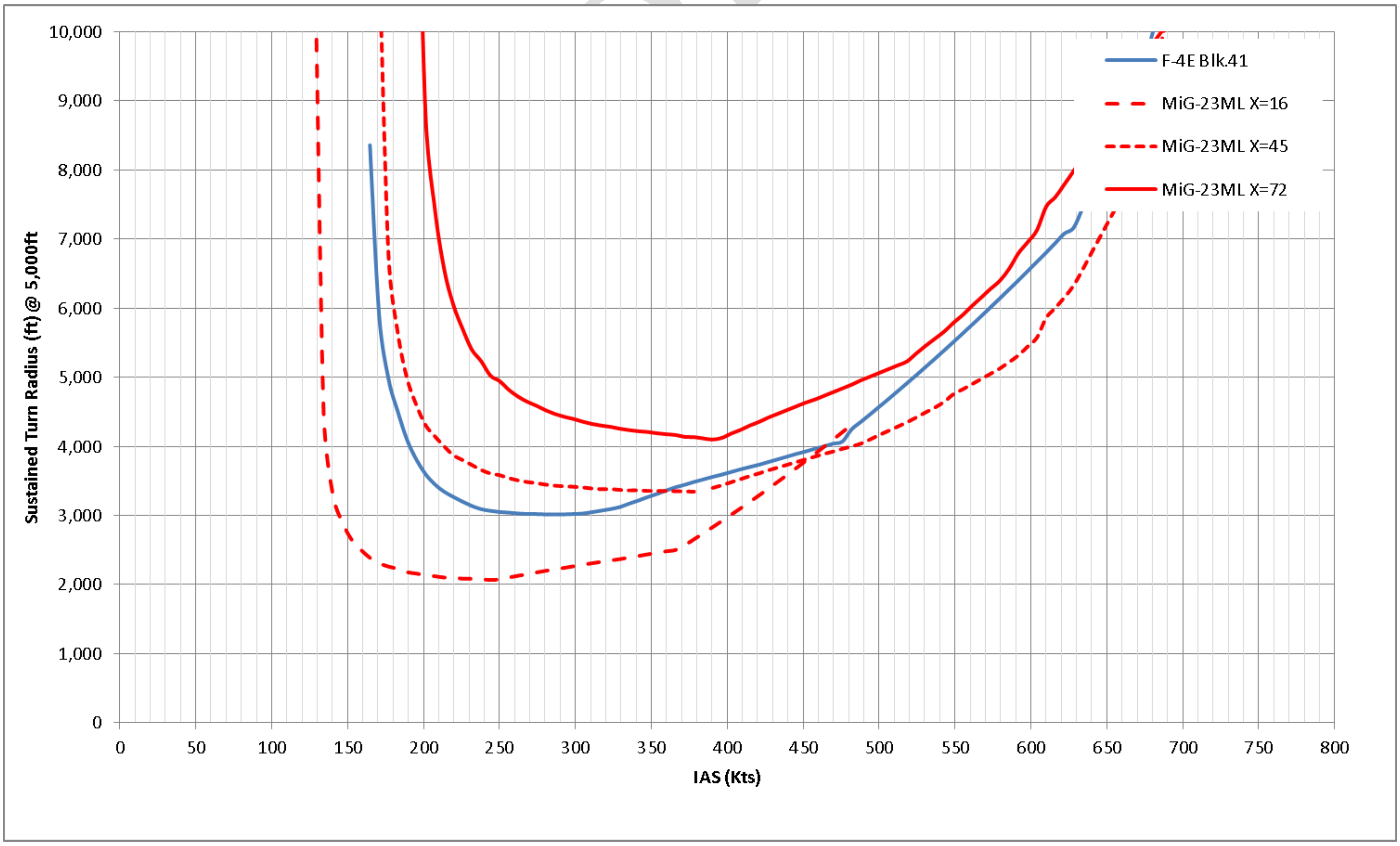


Fig 5.4. F-4E Blk.41 and Mig-23ML Sustained Turn Radius at 5,000ft

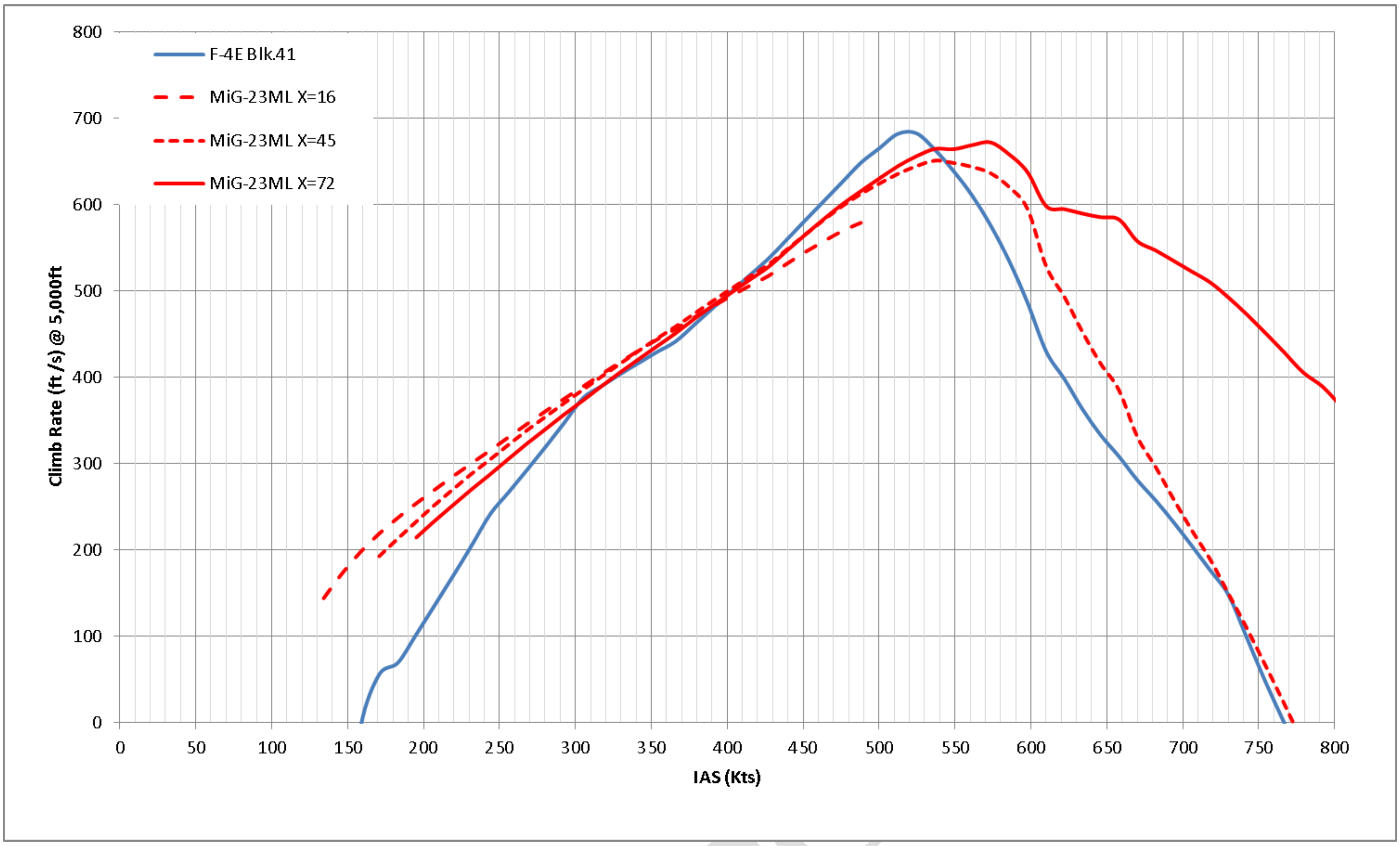


Fig 5.5. F-4E Blk.41 and Mig-23ML Constant Speed Climb Rate at 5,000ft

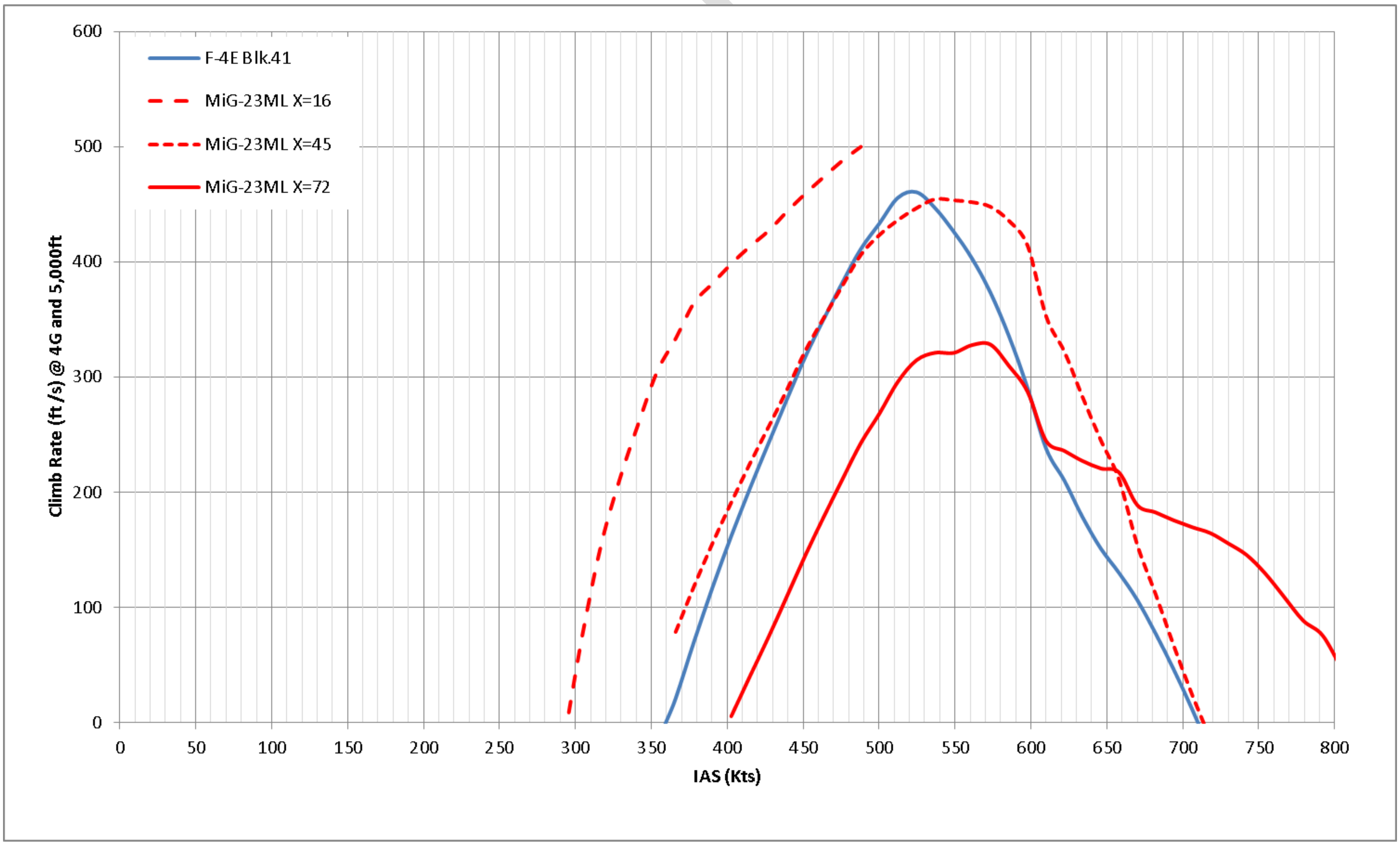


Fig 5.6. F-4E Blk.41 and Mig-23ML Constant Speed and 4G Load turn Climb, Rate at 5,000ft

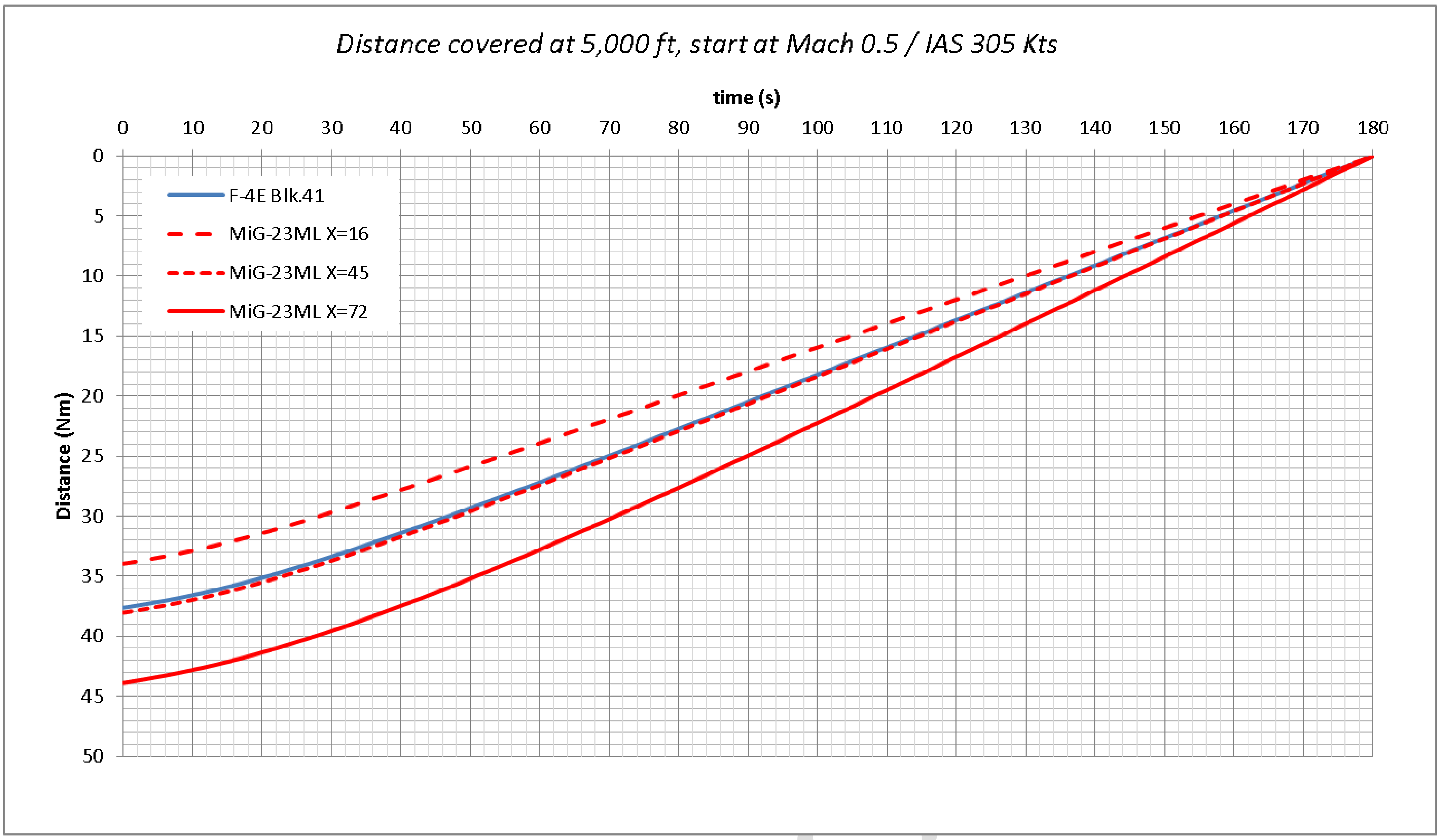


Fig 5.7. F-4E Blk.41 and Mig-23ML Distance covered in 3', from mach 0.5 at 5,000ft

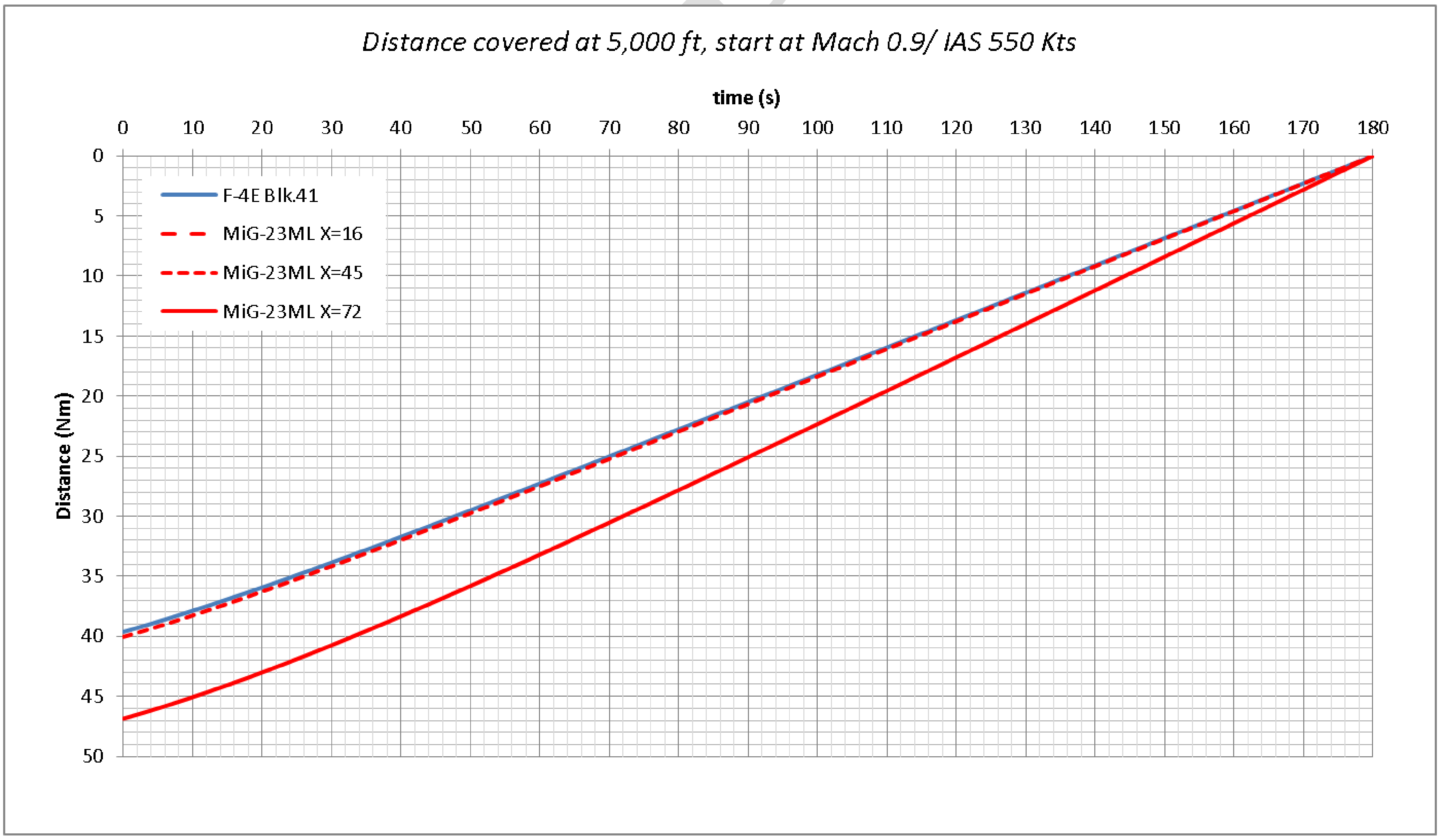


Fig 5.8. F-4E Blk.41 and Mig-23ML Distance covered in 3', from mach 0.9 at 5,000ft

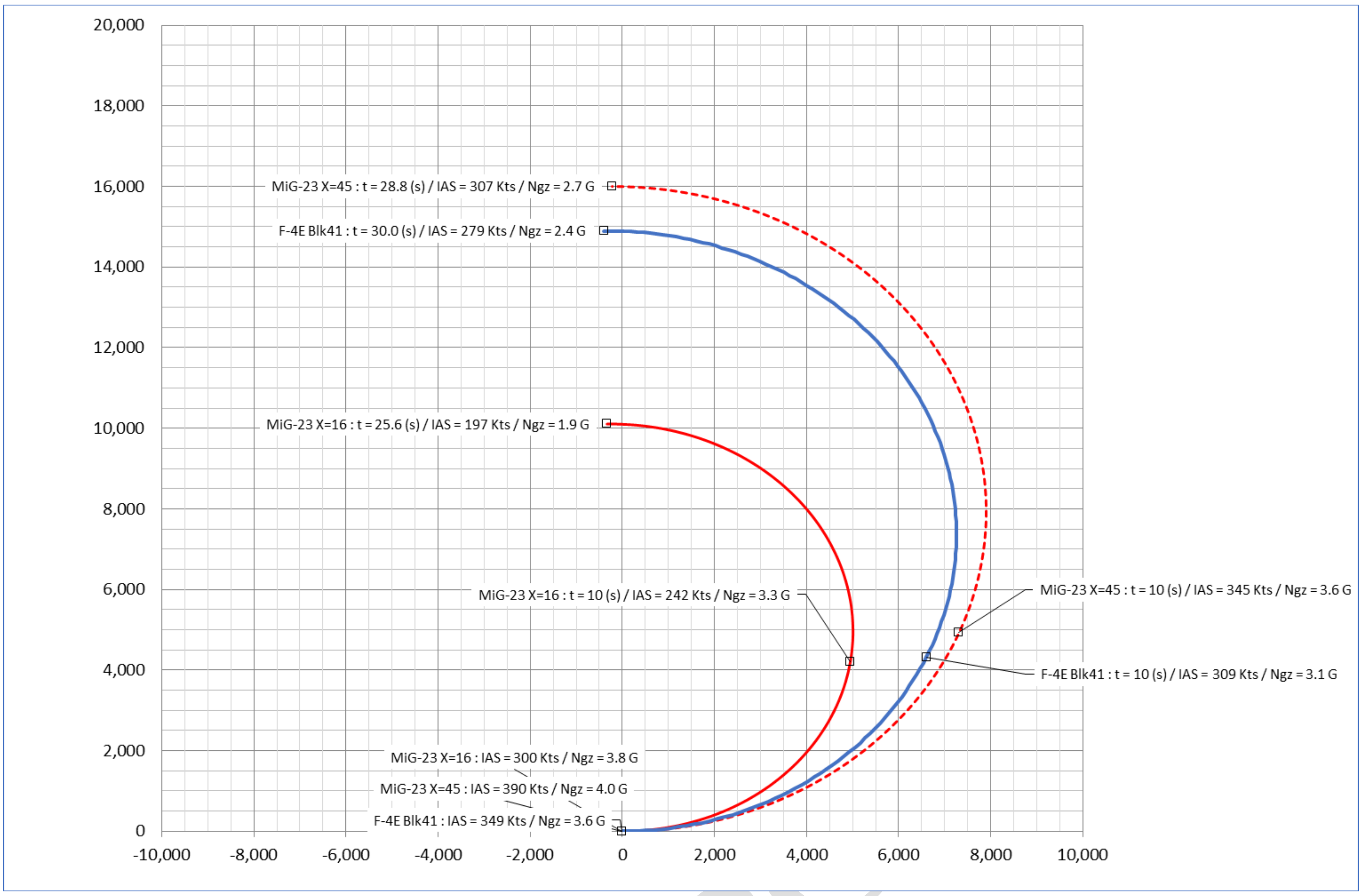


Fig 6.1 F-4E Blk.41 and Mig-23ML (SOUA ON) quickest half turn at 30,000ft

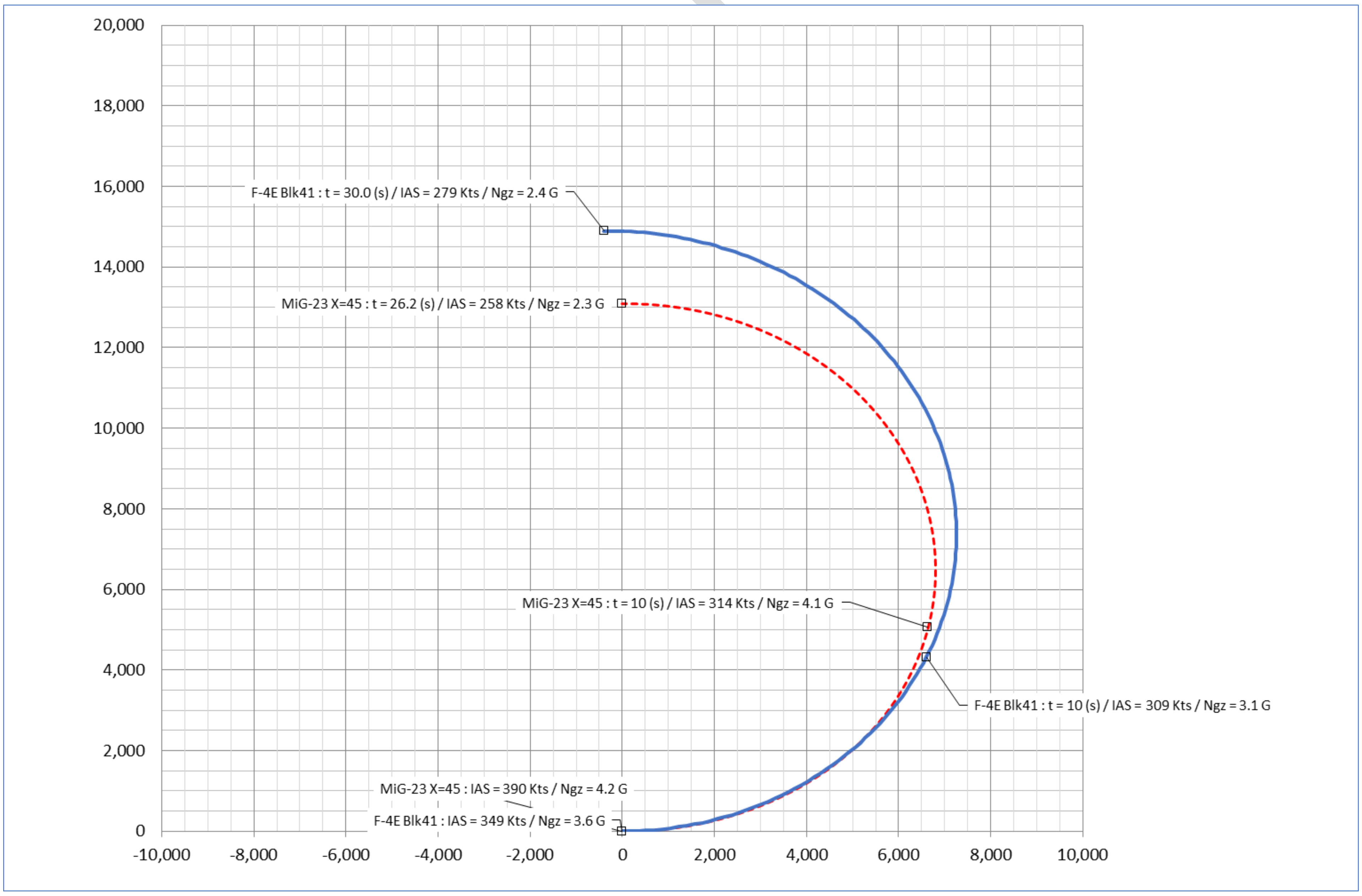


Fig 6.2 F-4E Blk.41 and Mig-23ML (X=45 SOUA OFF) quickest half turn at 30,000ft

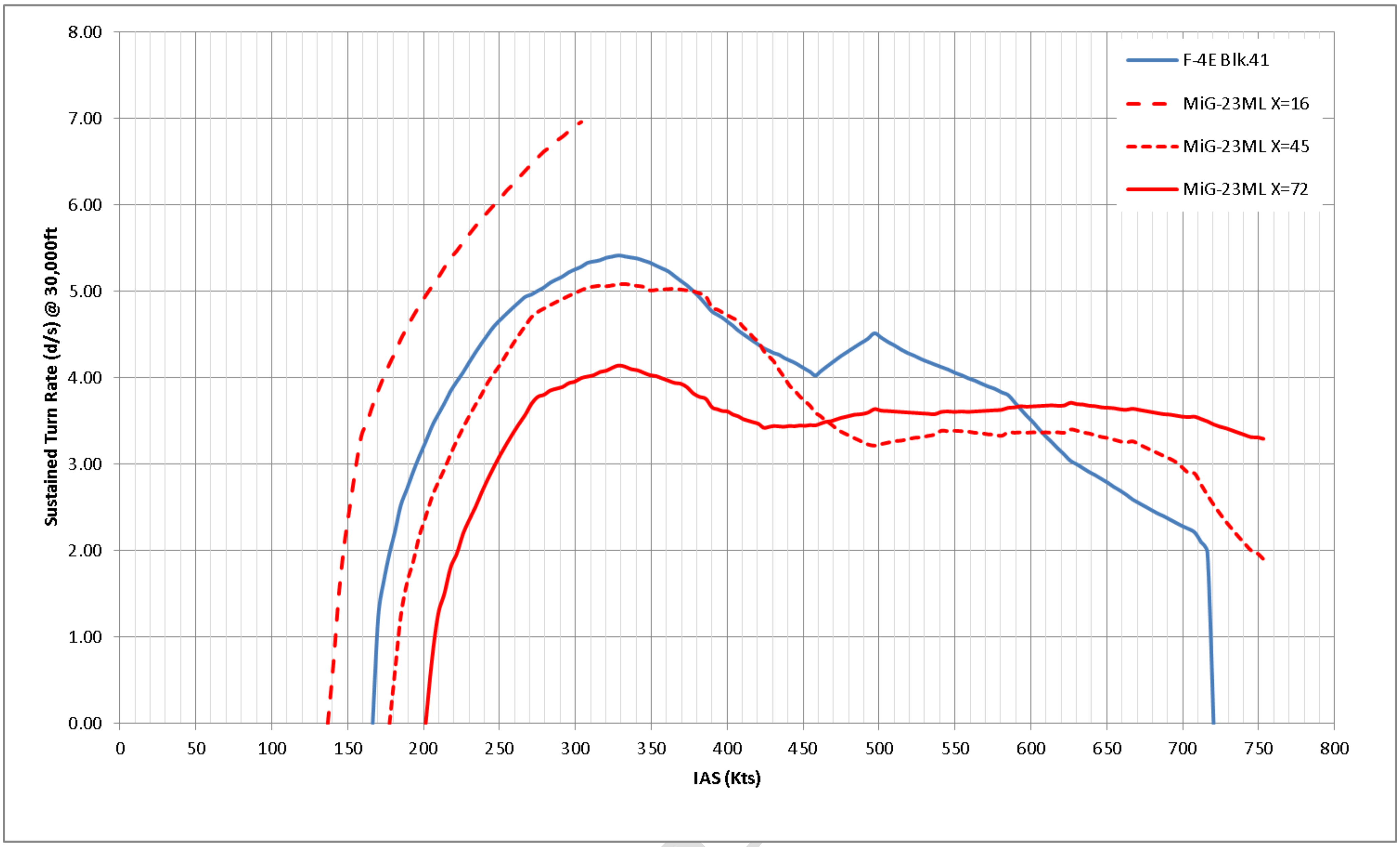


Fig 6.3. F-4E Blk.41 and Mig-23ML Sustained Turn Rate at 30,000ft

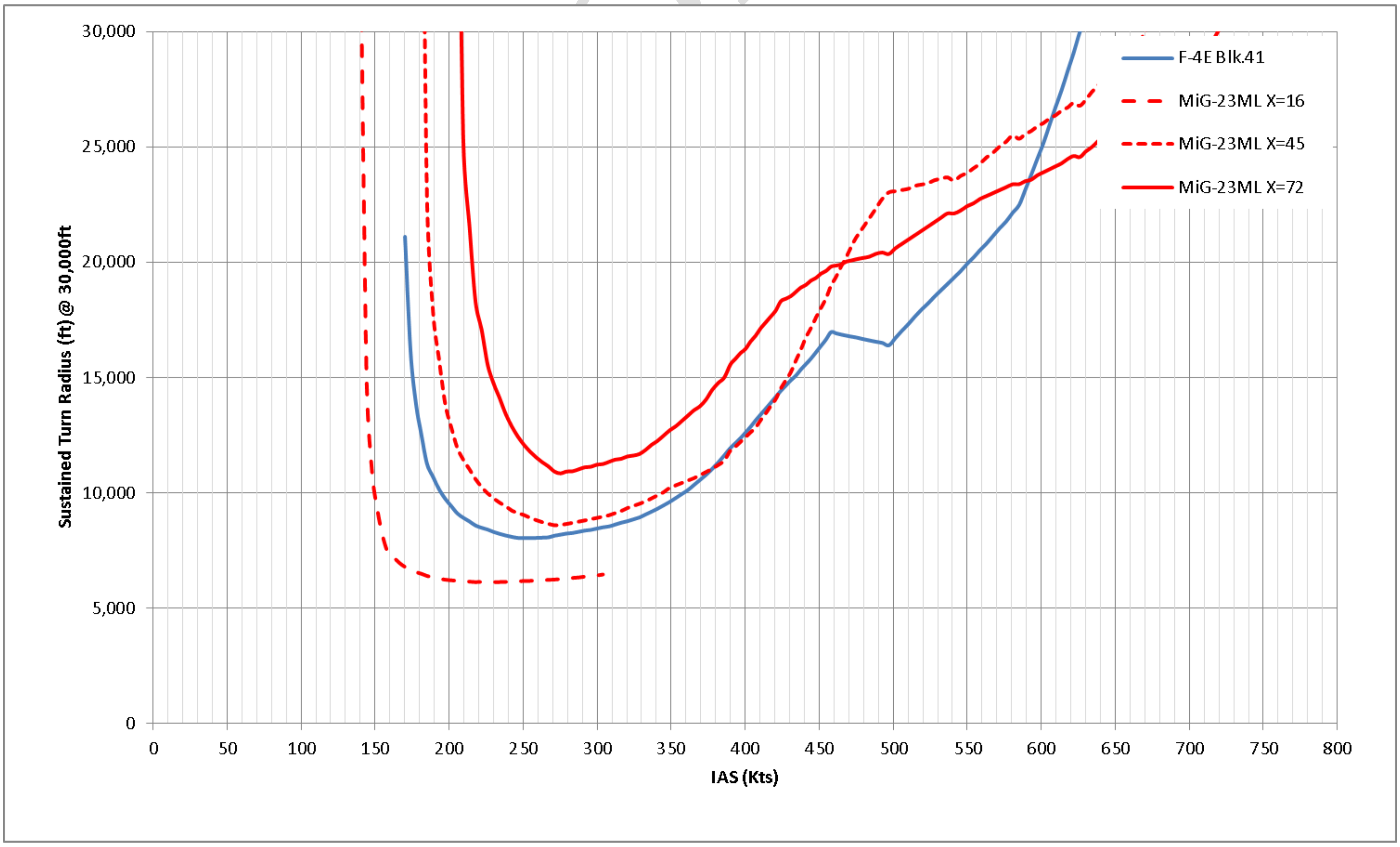


Fig 6.4. F-4E Blk.41 and Mig-23ML Sustained Turn Radius at 30,000ft

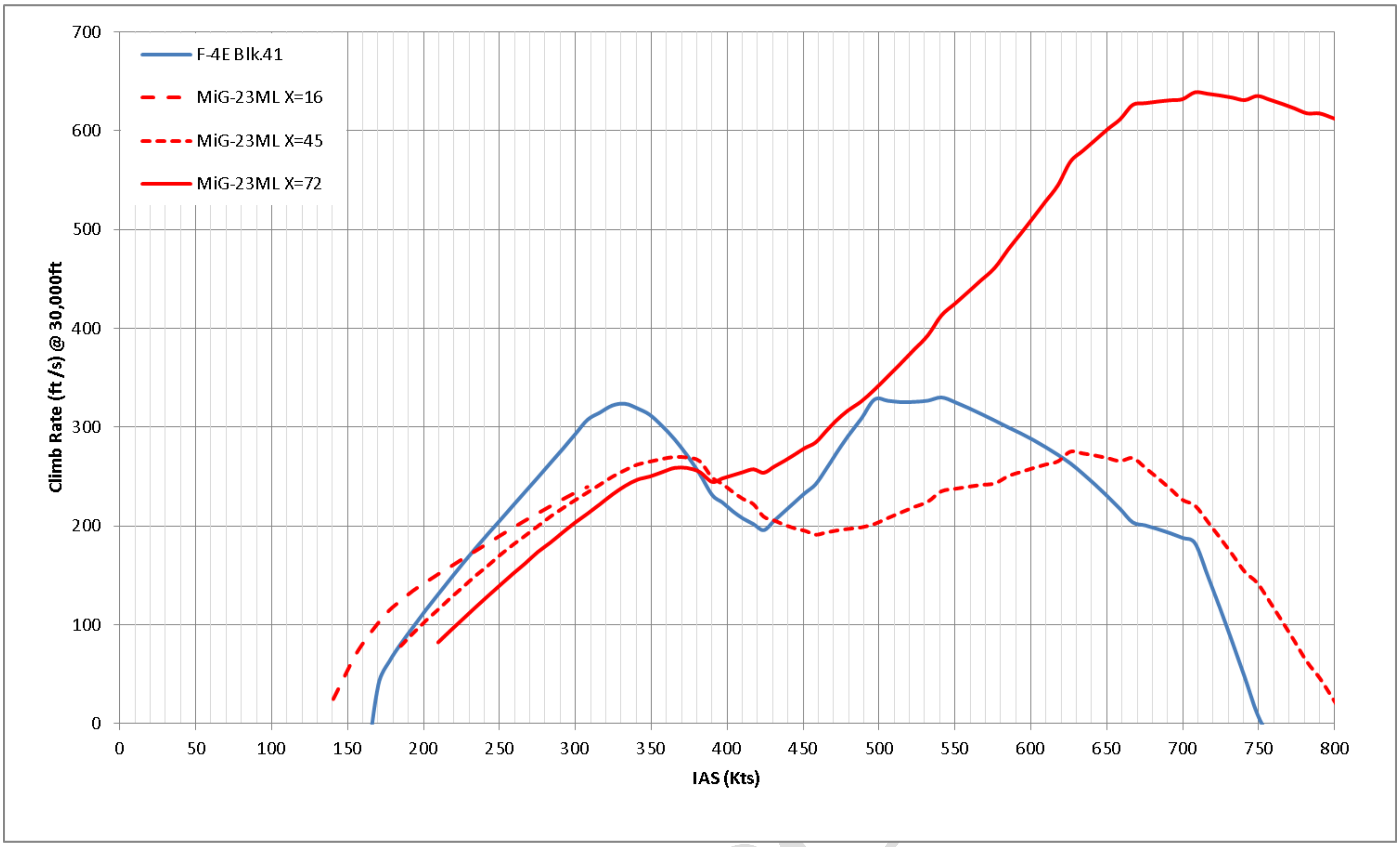


Fig 6.5. F-4E Blk.41 and Mig-23ML Constant Speed Climb Rate at 30,000ft

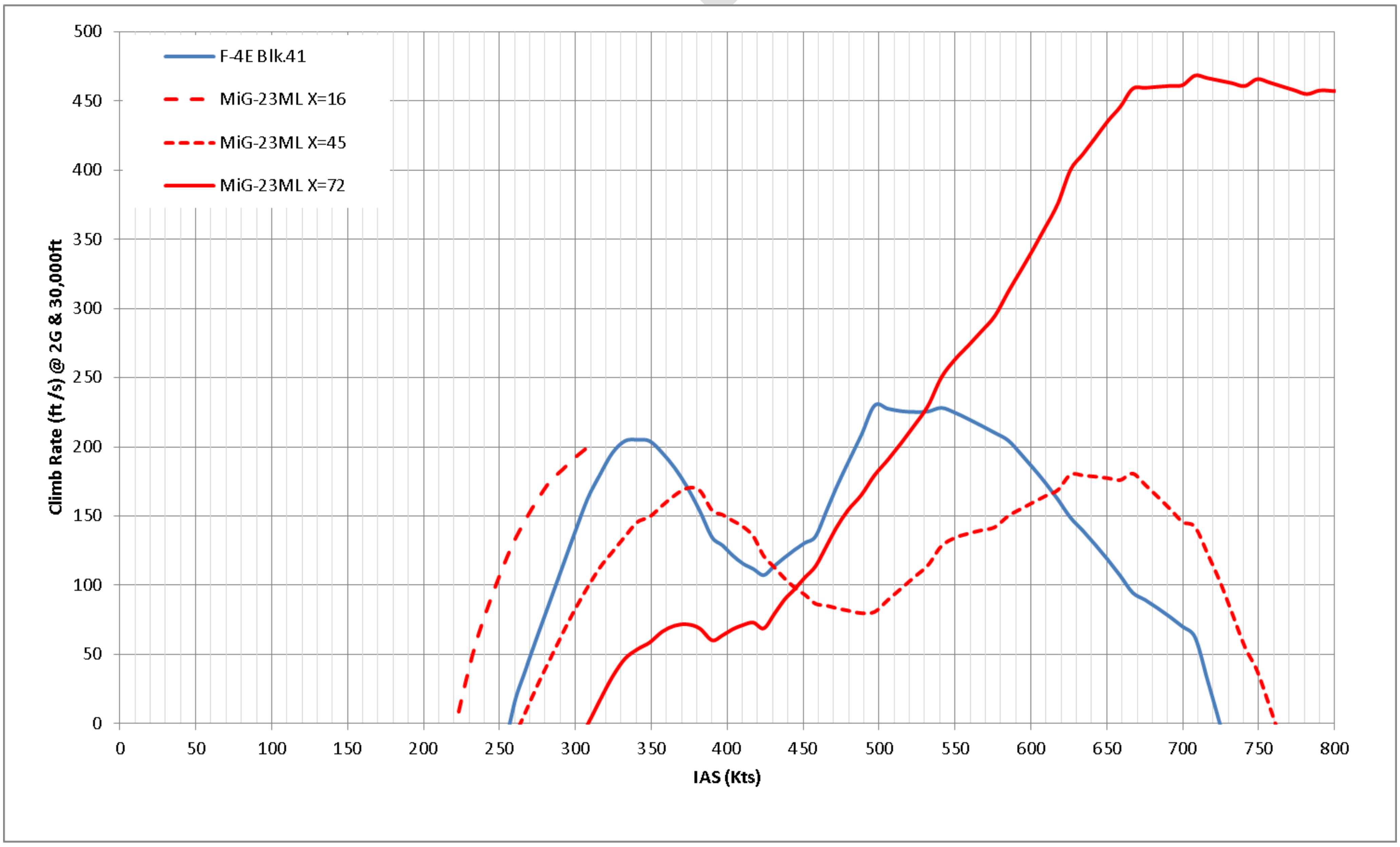


Fig 6.6. F-4E Blk.41 and Mig-23ML Constant Speed and 2G Load turn Climb, Rate at 30,000ft

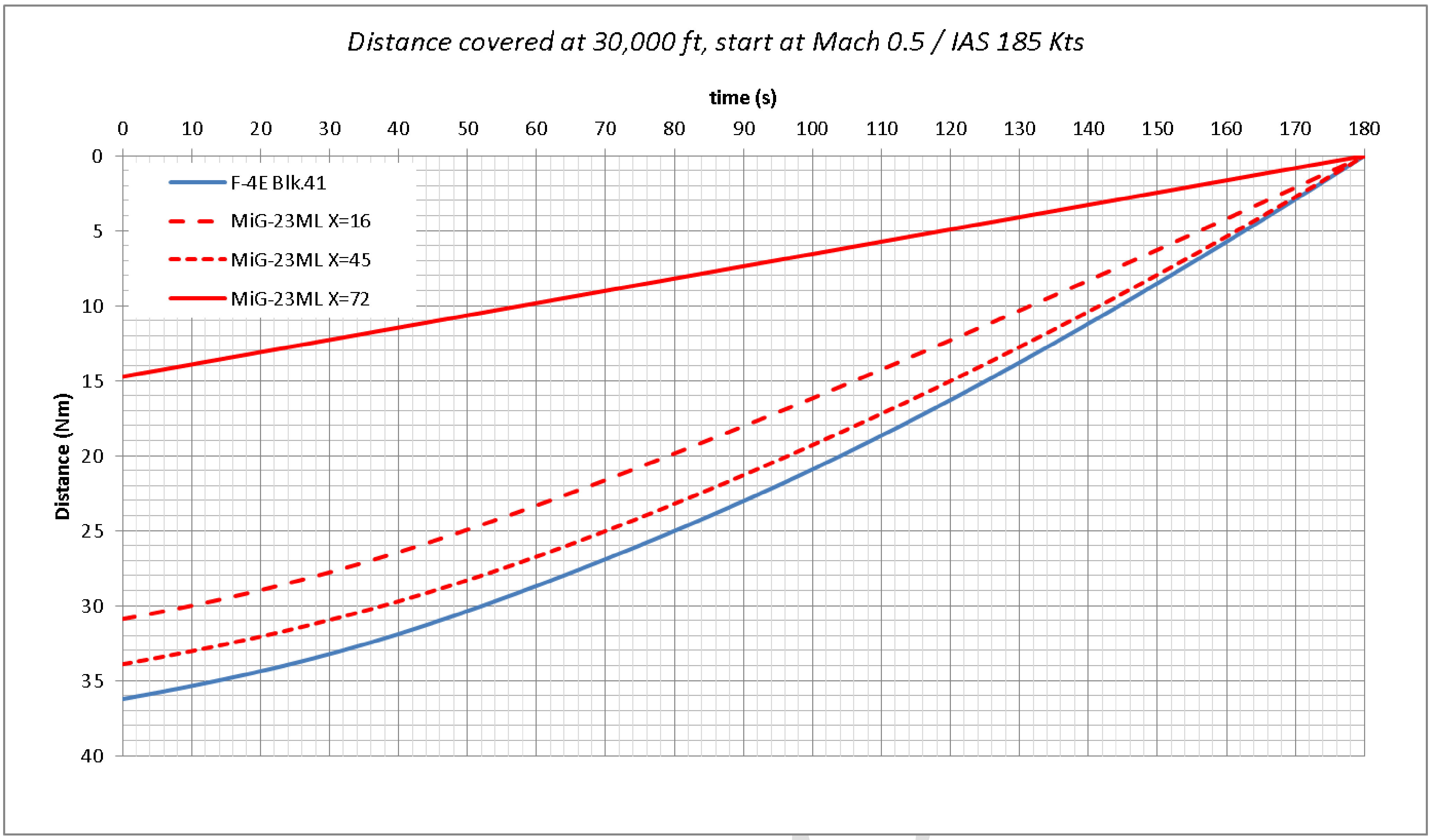


Fig 6.7. F-4E Blk.41 and Mig-23ML Distance covered in 3’, from mach 0.5 at 30,000ft

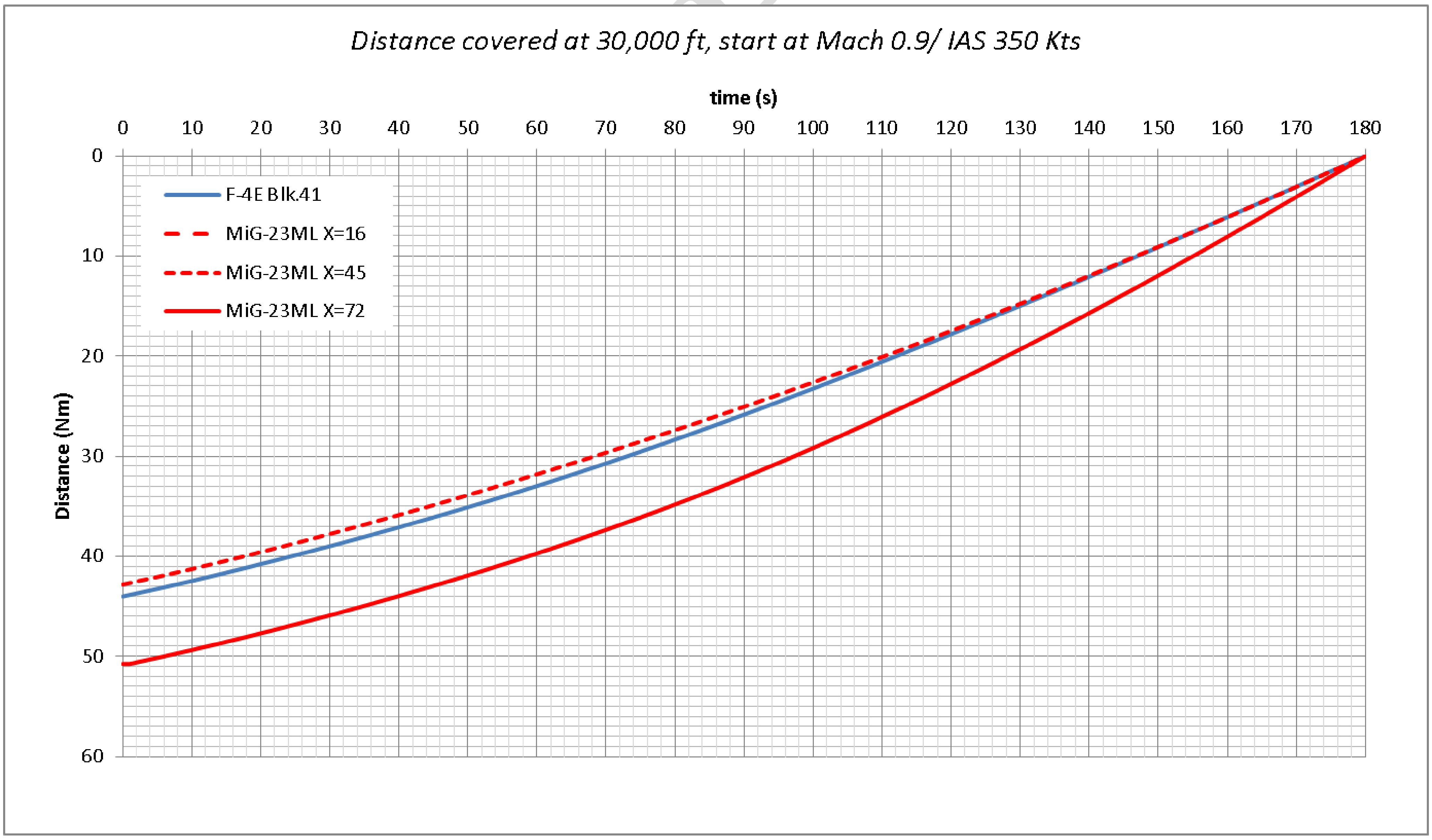


Fig 6.8. F-4E Blk.41 and Mig-23ML Distance covered in 3’, from mach 0.9 at 30,000ft

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