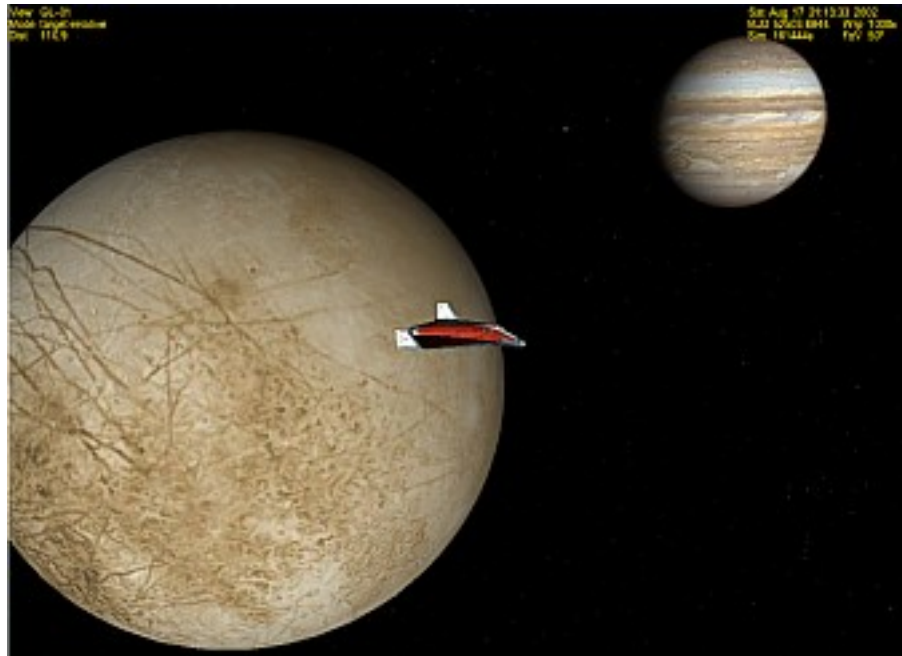# INTERPLANETARY MFD TUTO
REVISED EXAMPLES FOR ORBITER 2016 & IMFD 5.7

Interplanetary MFD is an Orbiter add-on created by Jarmo Nikkanen. It facilitates the travel throughout the solar system by calculating and displaying the vessel's predicted trajectories

Credits: Dr. Martin Schweiger   creator of the amazing Orbiter virtual world of planets, moon, spacecrafts and space stations
Jarmo Nikkanen   author of the Interplanetary MFD
Mark Lieberbaum IMFD Full Manual
Papyref Pappy's Hangar - IMFD

REQUIRED
IMFD 5.7
http://users.kymp.net/p501474a/Orbiter/Orbiter.html

REFERENCES
IMFD Full Manual by Mark Lieberbaum
https://www.orbiterwiki.org/wiki/IMFD_Manual
Pappy's Hangar - IMFD
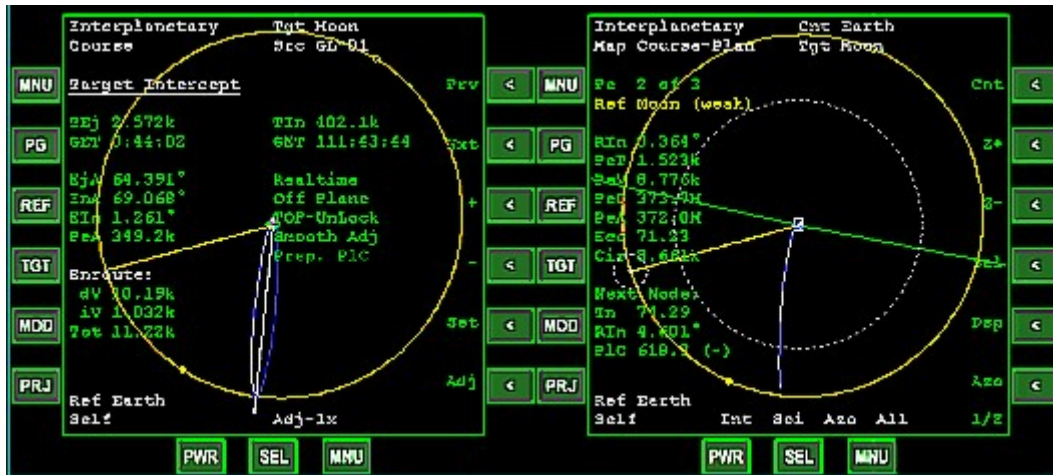http://francophone.dansteph.com/?page=search
IMFDTuto
https://www.orbithangar.com/search_quick.php?text=imfdtuto&submit.x=0&submit.y=0

NOTE: In order to save fuel, try to have your vessel parking and target orbits as aligned as possible

1 – EARTH TO MOON

Step 1 . Target Intercept
1. **Left MFD** →Open **Course** →**Target Intercept** →TGT →enter **Moon** →Realtime → Offplane →**PRJ** → Self →**Z+** several times
2. **Right MFD** →**MNU** → Opmode →enter **0**
3. **Right MFD** →**Map** → TGT → enter **Moon** →Dsp → PG → Soi → Int → Plan → PG → Cnt → Sel →**PRJ** → Self
4. Open **external MFD** →**REF** enter the **Moon** →**FRM** →Equ → **PRJ**→Shp →**DST**
5. Modify **Tin** in Target intercept to get rhe min **dv** (= BT)
6. Modify **TEj** to get the blue line as close as possible to the periapsis blue dot Warp 100X
7. →PG→BV→**AB** autoburn
8. →Warp 1000X until the vessel (white point in Map) reaches the Moon Soi and appears the message **"Invalid Source of Reference"** Warp 0.1X

Step 2 Planer Approach
9. Select Target Intercept →**Menu** (*top right*) →select **Planet Approach** → enter **Eqi** and **PeA**
10. Close External MFD and,Open as **Orbit** in Right MFD
11. Planet Approach →PG→BV→**AB** autoburn......**wait end of burn**
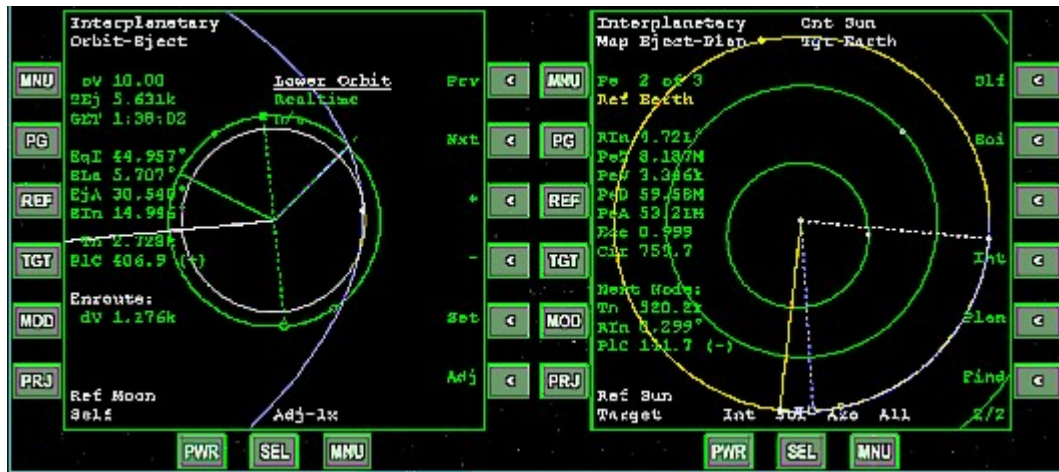
Step 3 Orbit Insert
12. In Planet Approach →Next →select **Otbit Insert** → REF=**Moon** → select **Apoapsis** →Next → aelect **Alt** enter desired altitude (Km) →PG→BV→**AB** autoburn (you may warp 1000X until end of burn)

The message "Invalid Source or Reference" will appear when overlaping the Moon Soi and Vessel

2 - MOON TO EARTH

Step 1 Orbit Eject

1. **Left MFD** →Interplanetary →Menu →**Orbit Eject** → select **Lower Orbit** →**PRJ** → Self
2. **Right MFD** →**MNU** → **Opmode** →enter **0**
3. **Right MFD** →**Map** → TGT enter **Earth**→Dsp →PG →Soi →Int →Plan →PG →Cnt →Sel →**PRJ** → Self
4. Open **external MFD** →**REF** enter **Earth**→FRM →Equ → PRJ→Shp →DST
5. **Orbit Eject** →Modify **Tej** to get the blue line over the green doted line
6. Modify **oV** to set **PeA** in Map as close as possible to desired Pea (***Note**; try to set warp 10X and change oV …..pay attention because it takes time to change PeA in Map*)
7. →PG →BV →**AB** autoburn
8. **Warp** 1000X until the vessel reaches the Moon Soi and appears ·the message **""Have a nice voyage"**

Step 2 Planer Approach

9. Left MFD →Select **Course** → **Planet Approach** → enter **Eqi** and **PeA**
10. Close External MFD and,Open as **Orbit** in right MFD
11. Planet Approach →PG→BV→**AB** autoburn......**wait end of burn**

Step 3 Orbit Insert

12. Planet Approach →Next →select **Otbit Insert** → REF=**Planet** → select **Apoapsis** →Next → aelect **Alt** enter desired altitude (Km) →PG→BV→**AB** autoburn (you may warp 1000X until end of burn)

3. EARTH TO MARS

Step 1 . Orbit Eject
1.   **Left MFD** →Interplanetary→Menu →Course →Target Intercept →TGT → enter **Mars** →PRJ →Self
2.   **Right MFD** →MNU → Opmode →enter **0**→Orbit Eject → Select **Course** →PRJ →Self
3.   Open **external MFD** →REF enter the **Earth**→FRM →Equ → PRJ→Shp →DST
4.   Target Intercept → Modify **Tin** and **TEj** to minimize **dV** (BT**)** in Orbit Eject
5.   Orbit Eject → Modify **Tej** to get the blue line over the green doted line (min EjA / dV)
6.   →PG → BV → **AB**
7.   **Warp** 1000X until appears ·the message ""**Have a nice voyage**"

Step 2 . Mid Course Correction
8.   Target Intercept →PG   →**Src** enter **X** to get the vessel as source
9.   **Right MFD** →MNU → Map →TGT enter **Mars**→Dsp → PG → Soi → Int → Plan → PG → Cnt → Sel
10.   Read **PeT** and warp 1000X **Wait** until Pet about=1/2 of initial PeT and warp 1X
11.   →PG→BV→**AB autoburn**
12.   **Warp** 100000X and wait until the Target Intercept shows the message "**Invalid Source or Reference**"
13.   **Note**: This step may take some time

Step 3 . Planet Approach Correction
14.   **Close** External MFD and,Open as **Orbit** in right MFD → Ref →**Mars** →PRJ to get Shp →DST
15.   Target Intercept → **Menu** (*top right*) → select **Planet Approach** and enter desired *Eqi* and *PeA*
16.   PG→BV→**AB** autoburn......**wait end of burn**

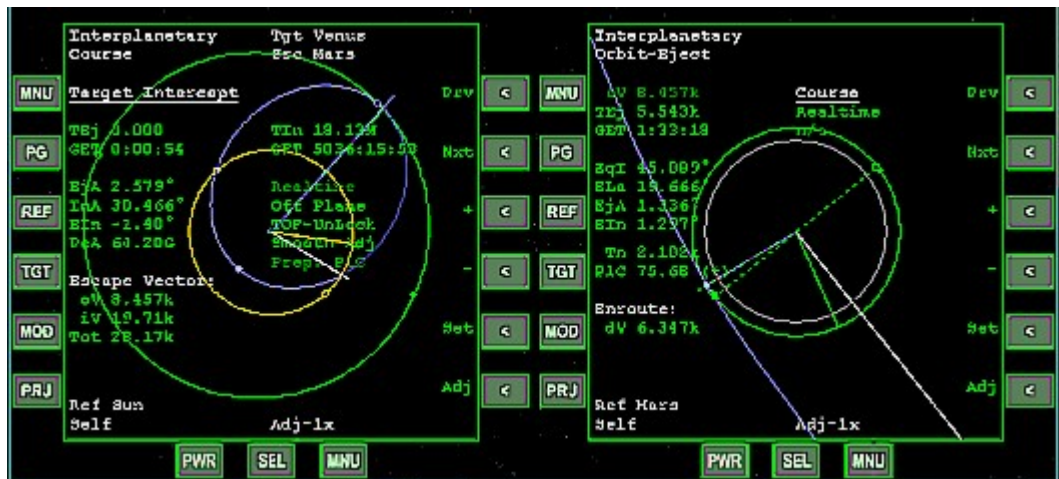### Step 4 . Orbit Insert
17.   Planet Approach →Next →select **Otbit Insert** → select **Apoapsis** →Next → aelect **Alt** enter desired
    altitude (Km) →PG→BV→**AB** autoburn (you may warp 1000X until end of burn)

The message "**Invalid Source or Reference**" will appear when overlaping the three points

4. MARS TO VENUS

Step 1 . Orbit Eject
18. **Left MFD** →Interplanetary→Menu →Course →Target Intercept →TGT → enter **Venus** →PRJ →Self
19. **Right MFD** →MNU → Opmode →enter **0**→Orbit Eject → Select **Course** →PRJ →Self
20. Open **external MFD** →REF enter the **Earth**→FRM →Equ → PRJ→Shp →DST
21. Target Intercept → Modify **Tin** and **TEj** to minimize **dV** (BT**)** in Orbit Eject
22. Orbit Eject → Modify **Tej** to get the blue line over the green doted line (min EjA / dV)
23. →PG → BV → **AB**
24. **Warp** 1000X until appears ·the message ""**Have a nice voyage**"

Step 2 . Mid Course Correction
25. Target Intercept →PG →**Src** enter **X** to get the vessel as source
26. **Right MFD** →**MNU** → **Map** →**TGT** enter **Venus**→Dsp → PG → Soi → Int → Plan → PG → Cnt → Sel
27. Read **PeT** and warp 1000X **Wait** until Pet about=1/2 of initial PeT and warp 1X
28. →PG→BV→**AB autoburn**
29. **Warp** 100000X and wait until the Target Intercept shows the message "**Invalid Source or Reference**"
30. **Note**: This step may take some time

Step 3 . Planet Approach Correction
31. **Close** External MFD and,Open as **Orbit** in right MFD → Ref →**Venus** →PRJ to get Shp →DST
32. Target Intercept → **Menu** (*top right*) → select **Planet Approach** and enter desired *Eqi* and **PeA**
33. PG→BV→**AB** autoburn......**wait end of burn**

Step 4 . Orbit Insert
34. Planet Approach →Next →select **Otbit Insert** → select **Apoapsis** →Next → aelect **Alt** enter desired
altitude (Km) →PG→BV→**AB** autoburn (you may warp 1000X until end of burn)

5. IO TO EUROPA

Step 1 . Target In tercept
1. **Left MFD**→**Interplanetary** →**Menu** →**Course** → **Target Intercept** → **TGT** → enter **Europa** →**PRJ** = self
2. **Right MFD** →MNU → Opmode →**enter 0** →**Orbit Eject** → Select **Course** → **PRJ** = self
3. Open **external MFD** →**REF** enter the **Io**→FRM →Equ → PRJ→Shp →DST
4. **Target Intercept** →**Z+** several times → TOF Locked Modify →**Tej** to minimize **dV** (BT**)** in Orbit Eject
5. TOF unLocked →Modify **Tin** to further modtfy dv in orbit Eject
6. **Orbit Eject** → Modify **Tej** to get the blue line over the green doted line (min EjA / dV) →PG → BV → **AB**
7. **......wait end of burn**

Step 2 . Mid course correction
8. **Map** →TGT= **Moon** →Sel→Dsp→PG→Soi →Int→Plan →PG→Sel to get Pe Ref Moon in top left corner →**MOD** 3 times to set **Accurracy = 1** →MOD to return Ref Moon
9. The white dot is our vessel
10. Warp 10000X and when leaving the **Io** Soi → warp 0.01X → **Scr** enter **X** to get the vessel as source
11. **Read PeT** and warp 1000X Wait until **Pet=1/2** initial PeT and warp 1X →PG →BV →**AB autoburn**
12. **Warp** 1000K until appears ·the message "**Invalid Source of Reference"**

Step 3 . Planet Approach
13. **Close** External MFD and,Open as **Orbit** in right MFD → Ref →**target Europa** →PRJ to get Shp →DST
14. Target Intercept → **Menu** (*top right*) → select **Planet Approach** and enter desired *Eqi* and **PeA**
15. PG→BV→**AB** autoburn......**wait end of burn**

Step 4 . Orbit Insert
16. Planet Approach →Next →select **Otbit Insert** → REF=**Planet** → select **Apoapsis** →Next → aelect **Alt** enter desired altitude (Km) →PG→BV→**AB** autoburn (you may warp 1000X until end of burn)

APPENDIX – GLOSSARY OF IMFD ABBREVIATIONS
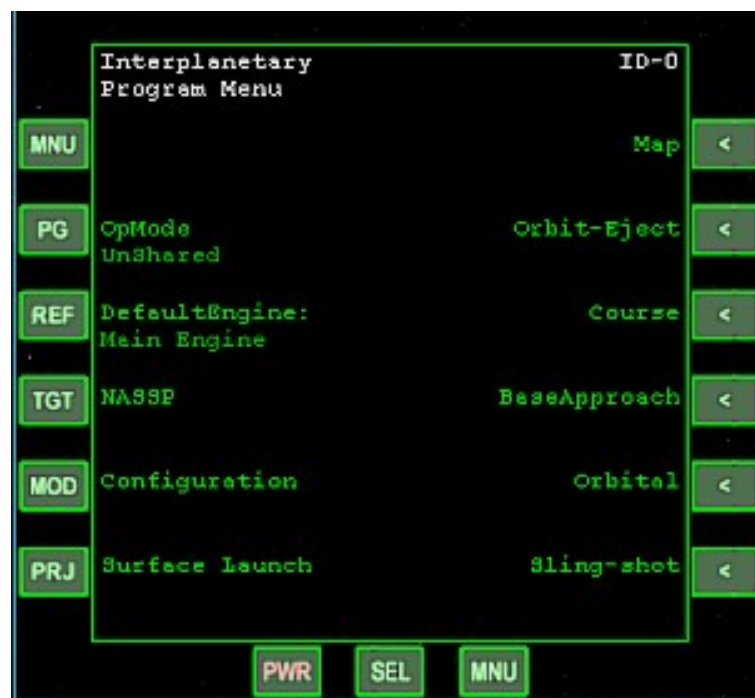
Map program can be used to display entire solar system and predict the actual course of the vessel with numerical trajectory calculator. The predictor can be also used to predict a hypothetical scenarios as well.

Orbit Eject program is required when starting interplanetary missions from the orbit. This program is used in a combination with the other programs to convert the Escape information into burn guidance data.

Course program is a collection of minor navigation programs those will let you to navigate through the solar system to other planets, moons and comets. Primary programs are based on the Lambert solver. In the most simplest case only a date of ejection and the date of arrival are required as an user input.

o   **Target Intercept** Set the course to intercept the target at the specified time or date
o   **Tangential Transfer** Similarly to the Target Intercept Program, but will take only one input parameter expressed in a two forms a time to ejection (TEj) or a MJD of ejection.
o   **Planet Approach** Used to change the orbit altitude and/or the equatorial inclination assuming that you are close to or inside the sphere of influence of the approaching body
o   **Orbit Insert** Used to make an orbit insertion from hyperbolic approach orbit to a low orbit around the reference planet
o   **Delta Velocity** Manual Delta Velocity tool

BaseApproach The program will allow to establish an orbit right over a specific base on a planet so that it is possible to continue the descent on the base..

Orbital can change your orbit It has three modes: Circularise, Velocity Match, Find Target and Orbital Vel. Match.

Sling-shot or planetary gravity assists, involves exchanging energy or momentum with a planet as a spacecraft flies past it. Gravity assistance can be used to accelerate, decelerate and/or re-direct the path of a spacecraft

Surface Launch program is usefull when starting interplanetary or lunar missions from the planet surface. The program will compute the time to launch window and required launch heading. This program is the only one that doesn't compute any burn guidance data. A vessel specific ascent profile should be used to reach a low orbit

LEFT BUTTON DESCRIPTIONS

MNU	Brings up the main menu screen of IM
PG	Cycle through pages
REF	Cycle through pages
TGT	Allows the user to set up the target body
MOD	Cycle through text modes
PRJ	Cycle through projections - Self, Ecliptic, Target, Periapsis and Equator

KEY COMMANDS FOR PROGRAMS OTHER THAN MAP

Prv	Select previous variable
Nxt	Select next variable
+,-	Adjust variable
Set	Set variable manually
Adj	Change adjustment speed
BV	Open/Close burn vector display
Z+ -	Change a zoom factor
Src	Set-up source object
Cnt	Center the display in other position
AB	Enable/Disable autoburn

KEY COMMANDS FOR MAP PROGRAM

Cnt	Allows the user to set up the object that the Map Program displays at the center
Z + -	Zoom in / out on the object that is currently centered
Sel	Cycles through Periapsises or Apoapsises
Dsp	All bodies above the mass limit designated in the Map Configuration Page are displayed
Azo	Auto Zoom
Slf	Display or Hide ship's trajectory
Soi	Display the sphere of influence
Int	Turn Intercept Mode on or off
Plan	Switch flight planning mode on and off
Find	Cycles through all bodies in the star system displayed

LINES AND COLORS

Green orbit	Current orbit of the source object
Orange orbit	Current target orbit.
Blue orbit	Transfer orbit
White line	Intersection / interception positions and in the orbit-eject program it will show the escape direction
Orange dashed line	Target position at the time of intersection
Orange dashed line	Target position at the time of intersection
Blue dashed line	Ship position at a time of interception
Green dashed line	Position for the burn.

INFORMATION ITEMS

AgP	Angle between your periapsis and your ascending node
ApA	Altitude of the Apoapsis of the target orbit
ApD	Radial Distance of Apoapsis
ApT	Time to Apoapsis
ApV	Velocity at Apoapsis
BLL	The optimum Latitude that you should launch at
BT	Burn time
C3	Orbital energy of scape asymptote
Cir	Delta Velocity required to circularize orbit
Dis	Radial Distance from the Reference body minus initial Radial Distance from the Reference Body
dV	Delta Velocity required for your current orbit to match the target orbit
Ecc	Eccentricity of the target orbit.
Ein	Relative inclination

EjA	Ejection angle
ELa	Longitude of ascending node relative to the equator
Eql	Equatorial Inclination
Gap	Argument of Periapsist. This is the angle between your periapsis and your ascending node
GET	The GET at the time which you intercept your target
Hed	The heading you should fly when you launch for orbit
InA	Intercept angle
iV	Inward Delta Velocity
LAN	Longitude of Ascending Node of your target orbit
Lat	Current latitude on surface of celestial body
Lon	Current longitude on surface of celestial body
Max Eql	Maximum Equatorial Inclination possible given all of your current parameters
Min Eql	Minimum Equatorial Inclination possible given all of your current parameters.
Ope	Orbital period
oV	Outward delta velocity, that's the velocity added in a velocity of the planet
PeA	Altitude of Periapsis
PeD	Radial Distance of Periapsis
PeT	Time to Periapsis
PeV	Velocity at Periapsis
PIC	Delta Velocity required for the Plane Change
PIC	Delta Velocity required for the Plane Change
PIC	Delta Velocity required for the Plane Change
Time	Time in seconds until the optimum launch time
in	Time to intercepting your target.
Tn	Time to next node. When negative it is presenting the time after the node.
Tot	Total delta velocity