Trapped particles around Jupiter detected by Advanced Stellar Compass

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Introduction

- The Advanced Stellar Compass (ASC), attitude reference for the MAG investigation on board Juno, continuously monitors high energy particles fluxes in Jupiter's magnetosphere
- The instrument performs this function by tracking the effects of radiation with sufficient energy to transit the instrument's radiation shielding.
  - >15MeV for electrons, >80MeV for protons, and >~GeV for heavier elements.

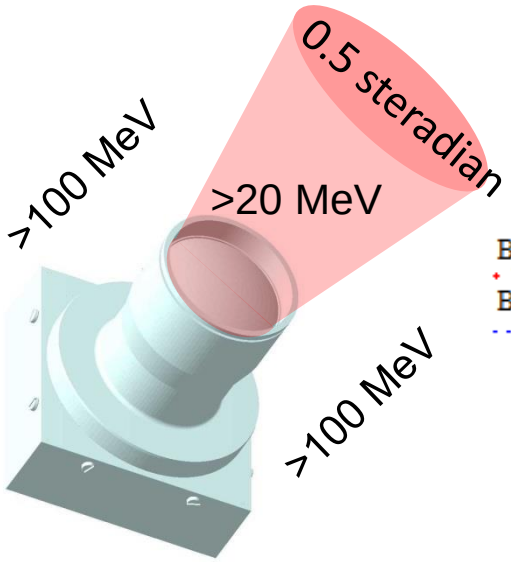
- The measured particle signature changes substantially, whenever one of the Galilean moons happens to be on or near the same field line as Juno.

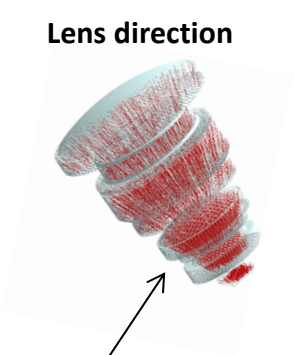
- We measure that each of the Galilean moons has unique impact on the particles trapped in the drift shell around Jupiter, which depends on the moon size, composition and presence of magnetic field.

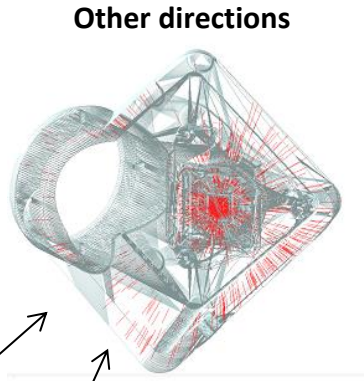
- Surprisingly the Galilean moons impact on the high energy particle motion in their associated L-shells may be either a sink, source or both.

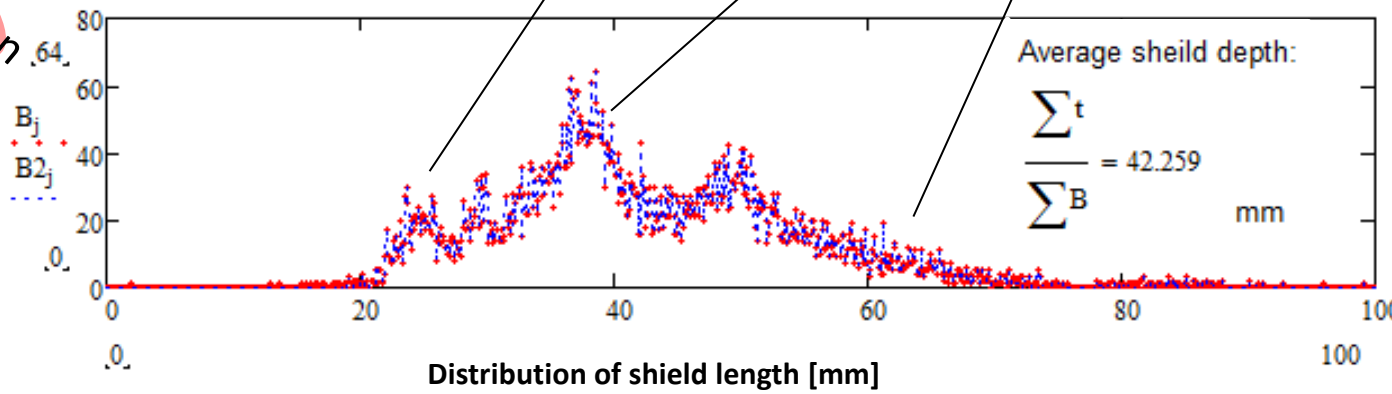
CHU shield structure

- Silicon carbide structure and metal CHU housing provides shield length of >>35mm Al eq. in all directions except through the lens
- Lens shield length is 23-35mm Al eq.
- 100MeV protons are stopped by >40mm Al.
  - that is practically everything even under peak flux conditions



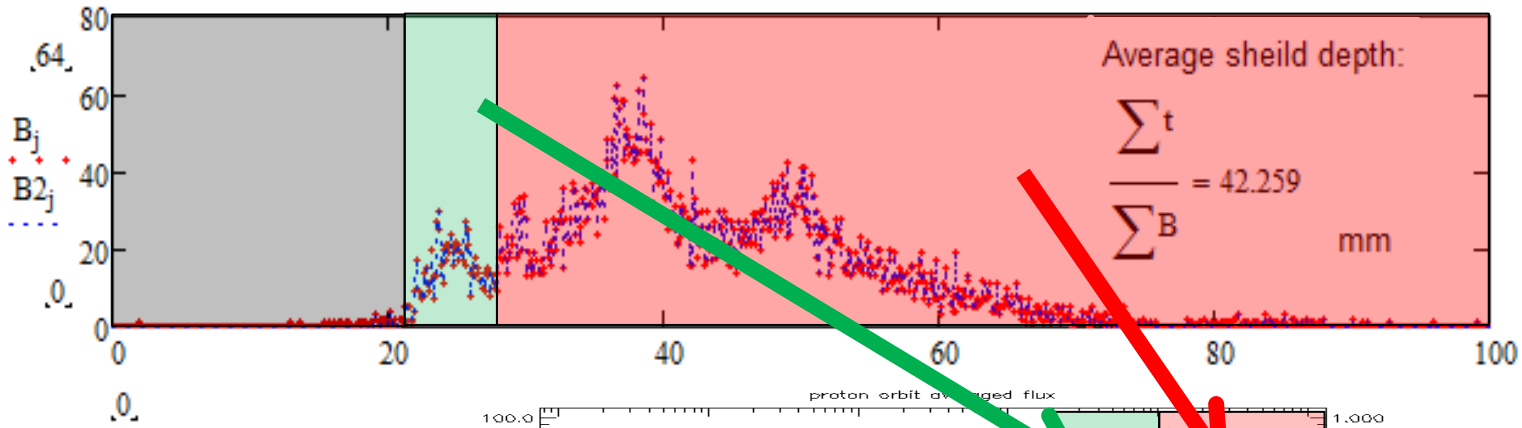






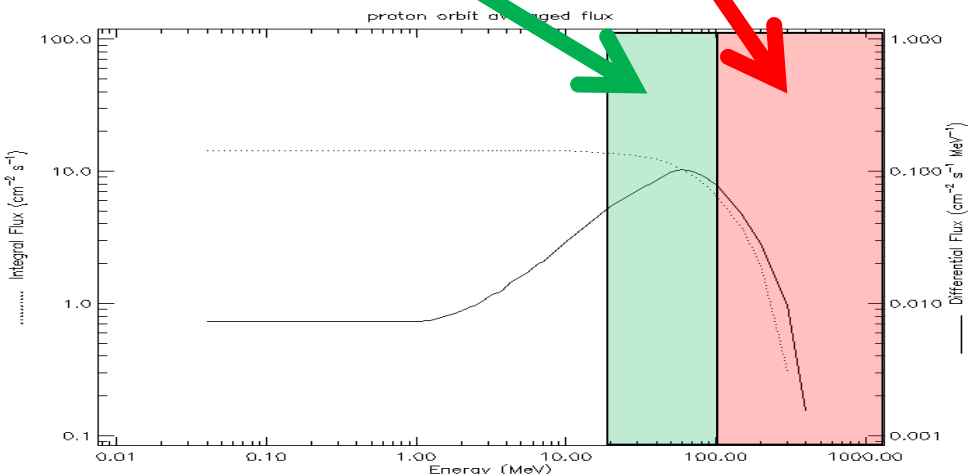
µASC as particle telescope

- Shield depth, the quartz only (lenses and CCD quarts), 19-32 mm eq. Al
  - blocks electrons with E< 20 MeV

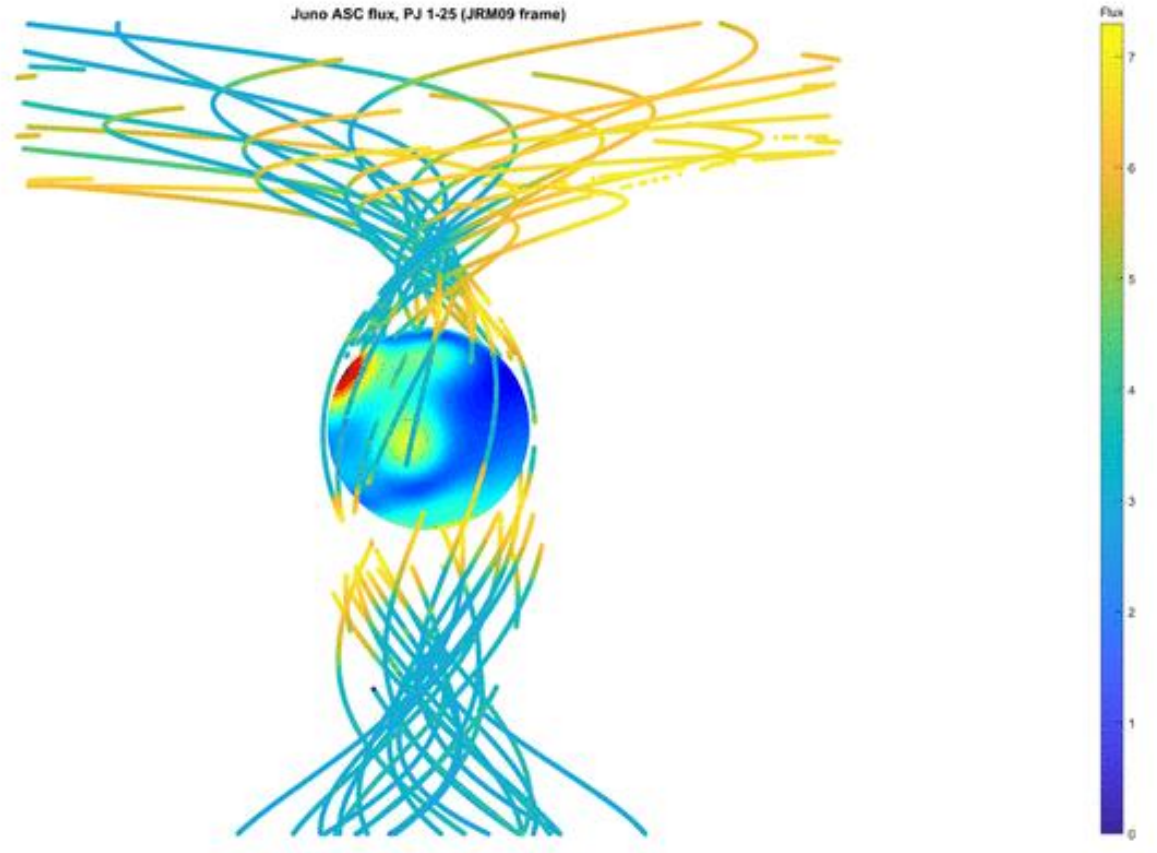


>20MeV may pass through the lens

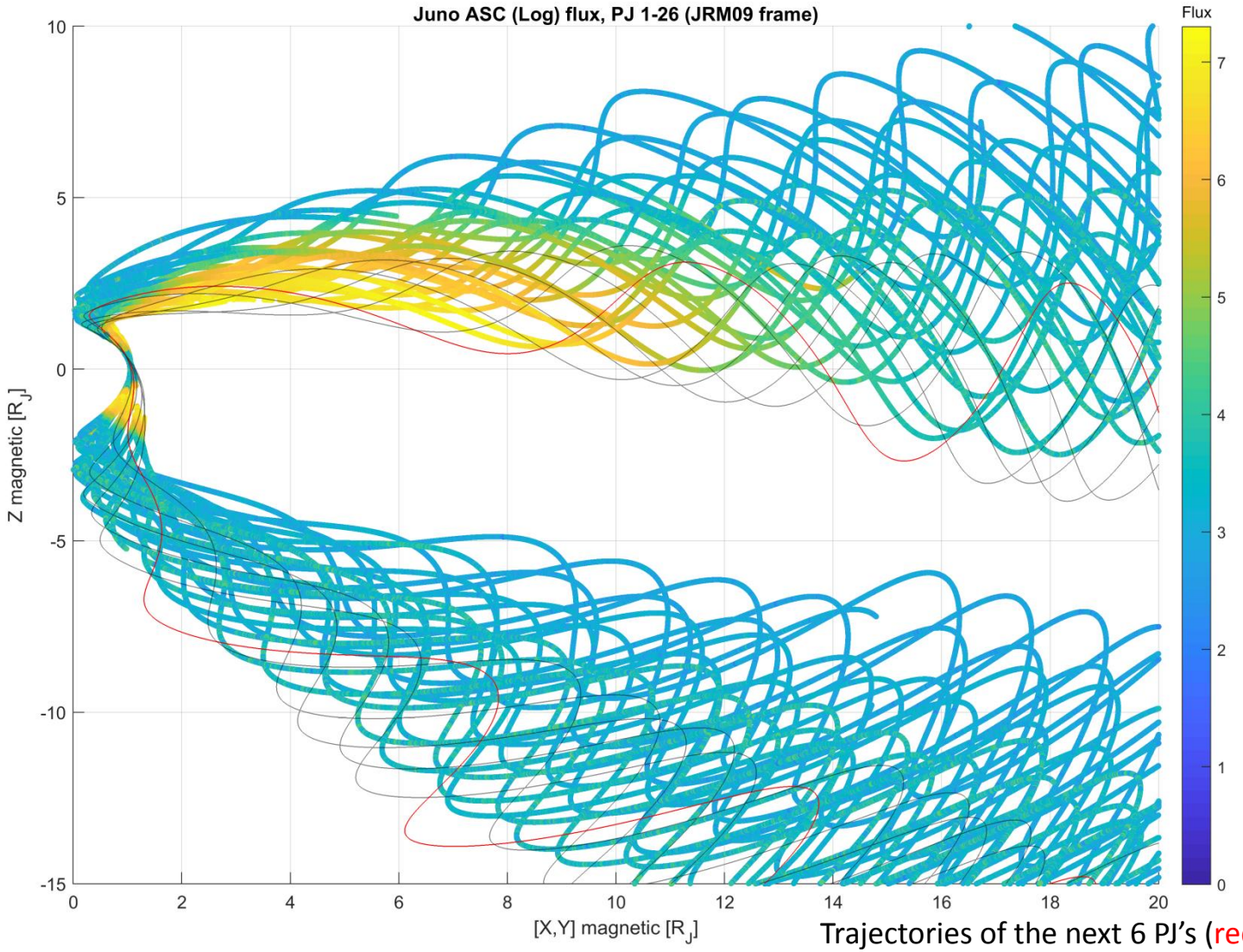
>100MeV passes through from all directions



Animation of Juno μASC high energy electron flux observations

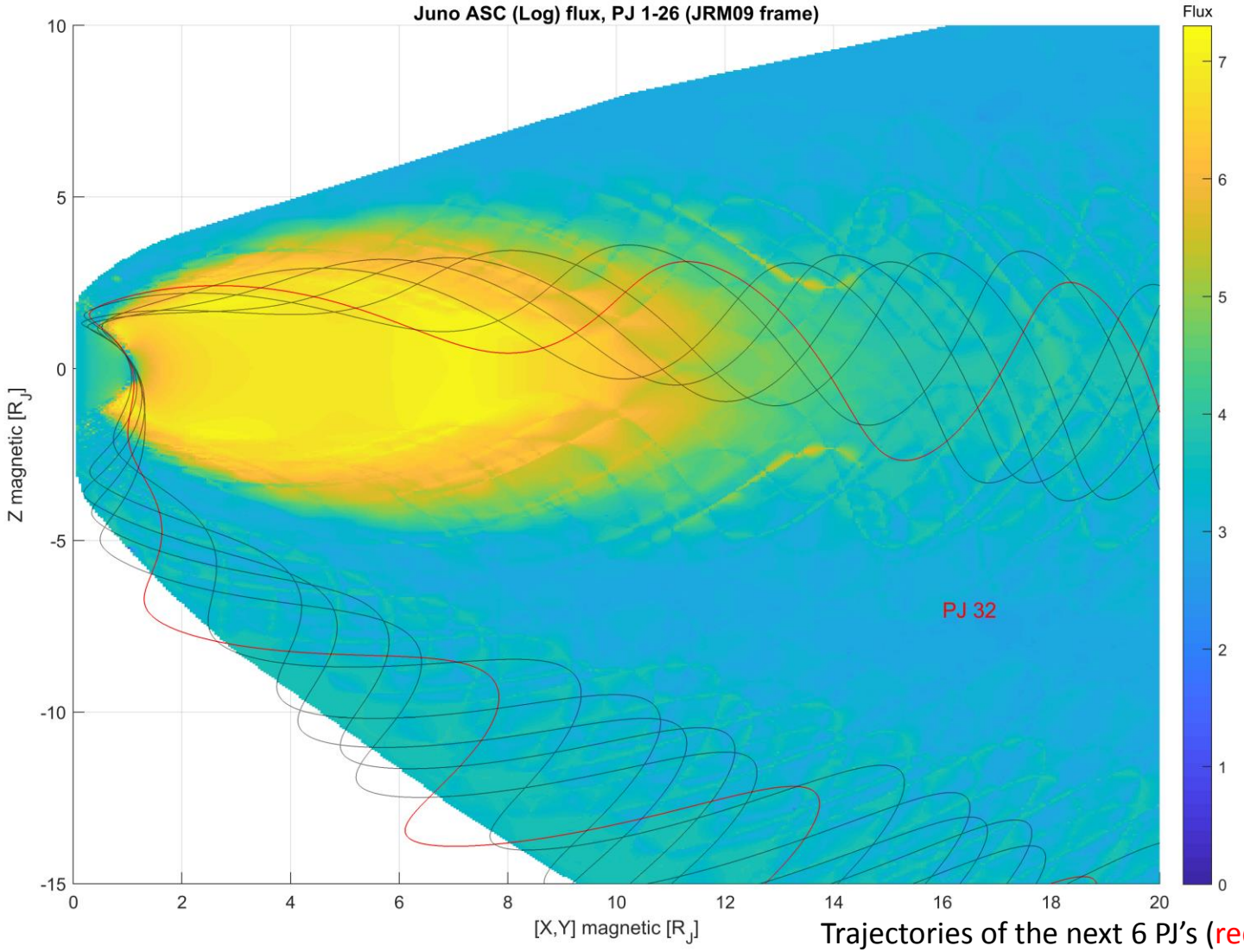


Juno μASC observations of the electron flux in JRM09 frame



Trajectories of the next 6 PJ's (red is PJ32)

High energy electron density orbit 1-27

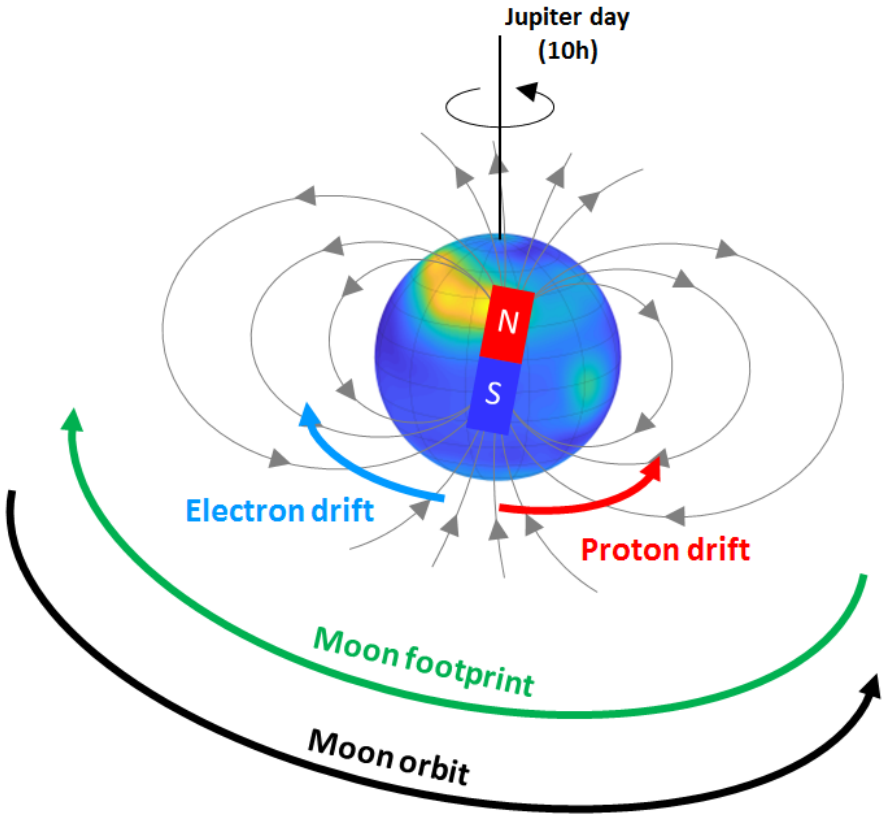


Trajectories of the next 6 PJ's (red is PJ32)

Jupiter's moons footprint detection

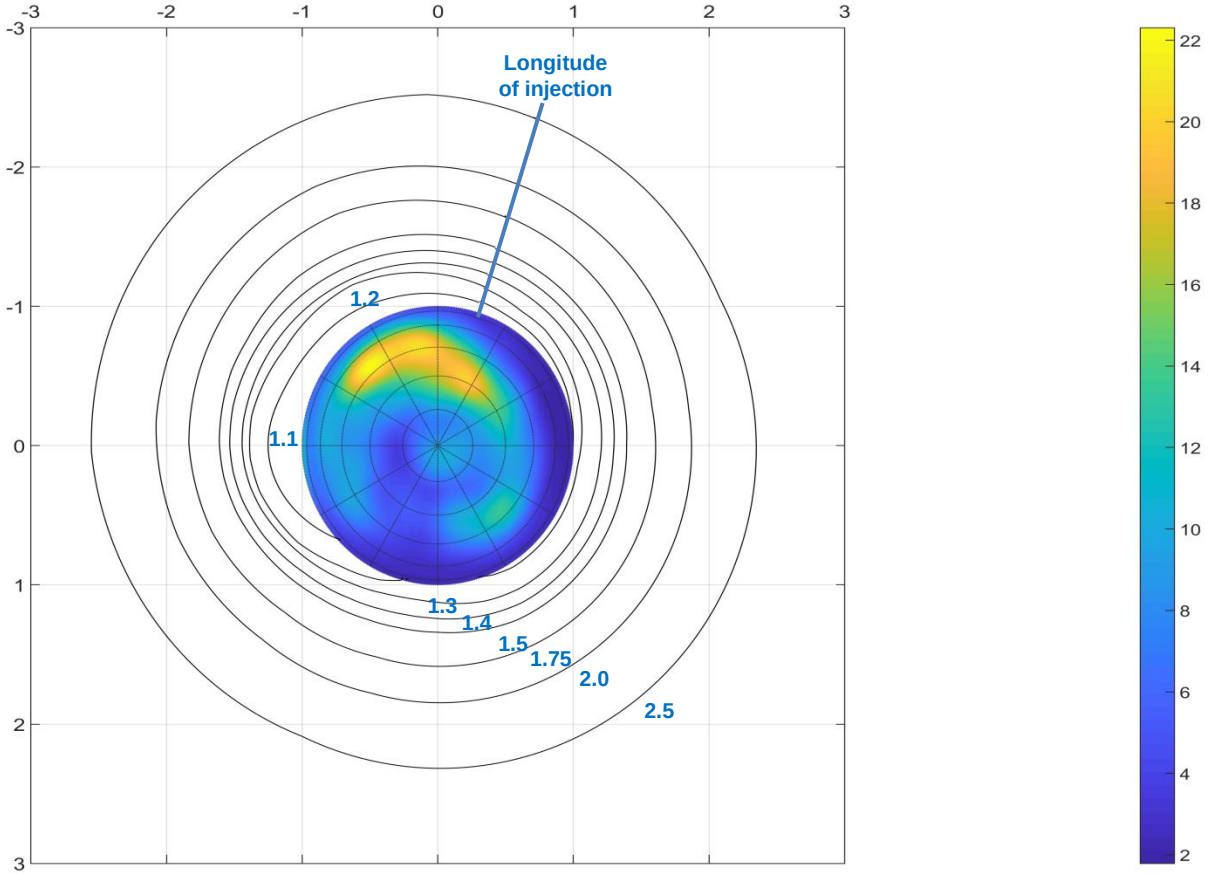
- Signatures of all of the Jupiters moons on the particle detection have beeen observed
- For the current mission period of 26 periJoves:
  - 62 for Io
  - 93 for Europa
  - 103 for Ganymede
  - 74 for Callisto

Jupiter's moons footprint detection

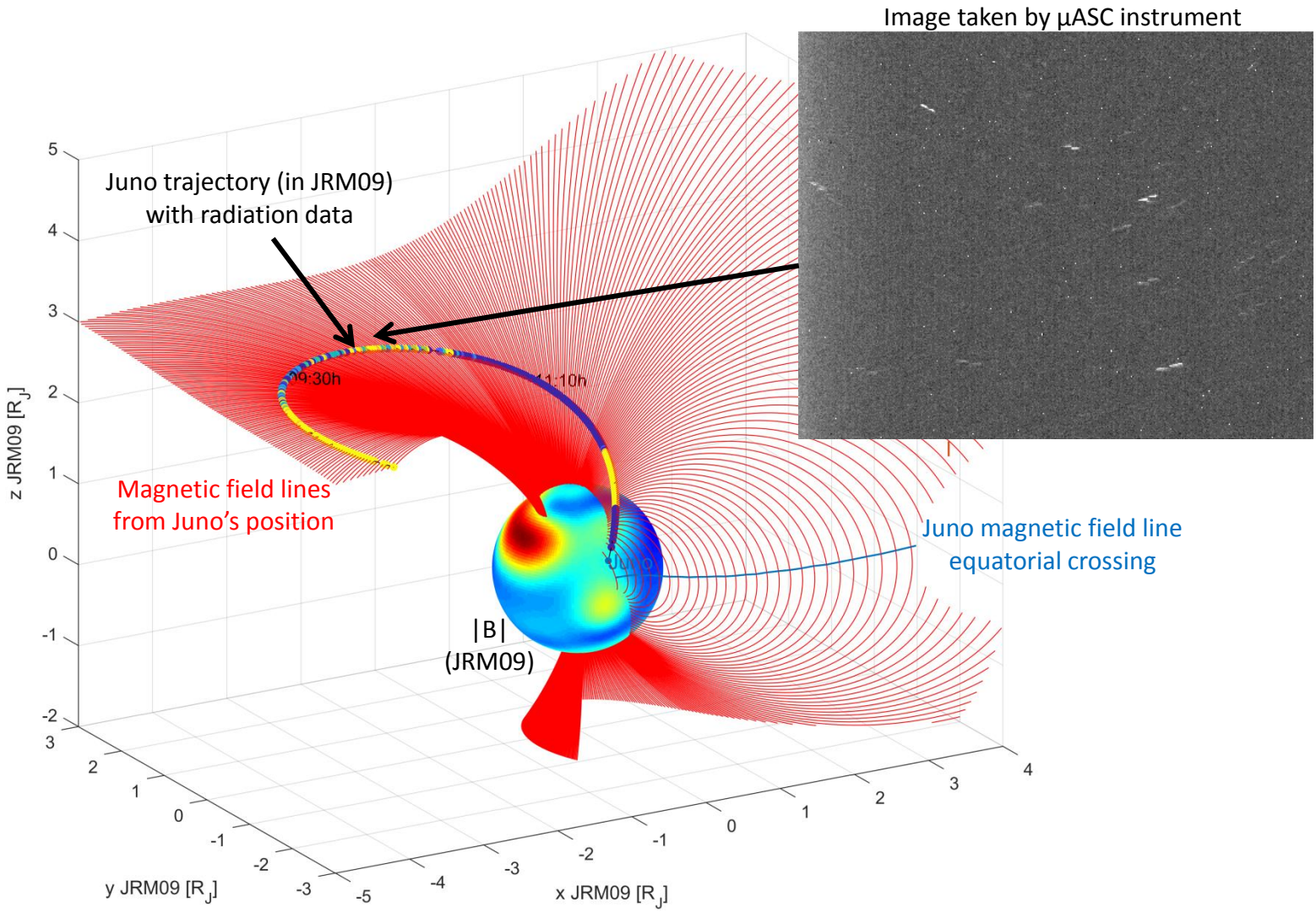


Moon	Orbital radius [R_J]	Orbital period
Metis	1.8	7:10h
Adrastea	1.8	7:15h
Amalthea	2.5	12:01h
Thebe	3.1	16:16h
Io	5.9	1.77d
Europa	9.4	3.55d
Ganymede	15.0	7.15d
Callisto	26.3	16.68d

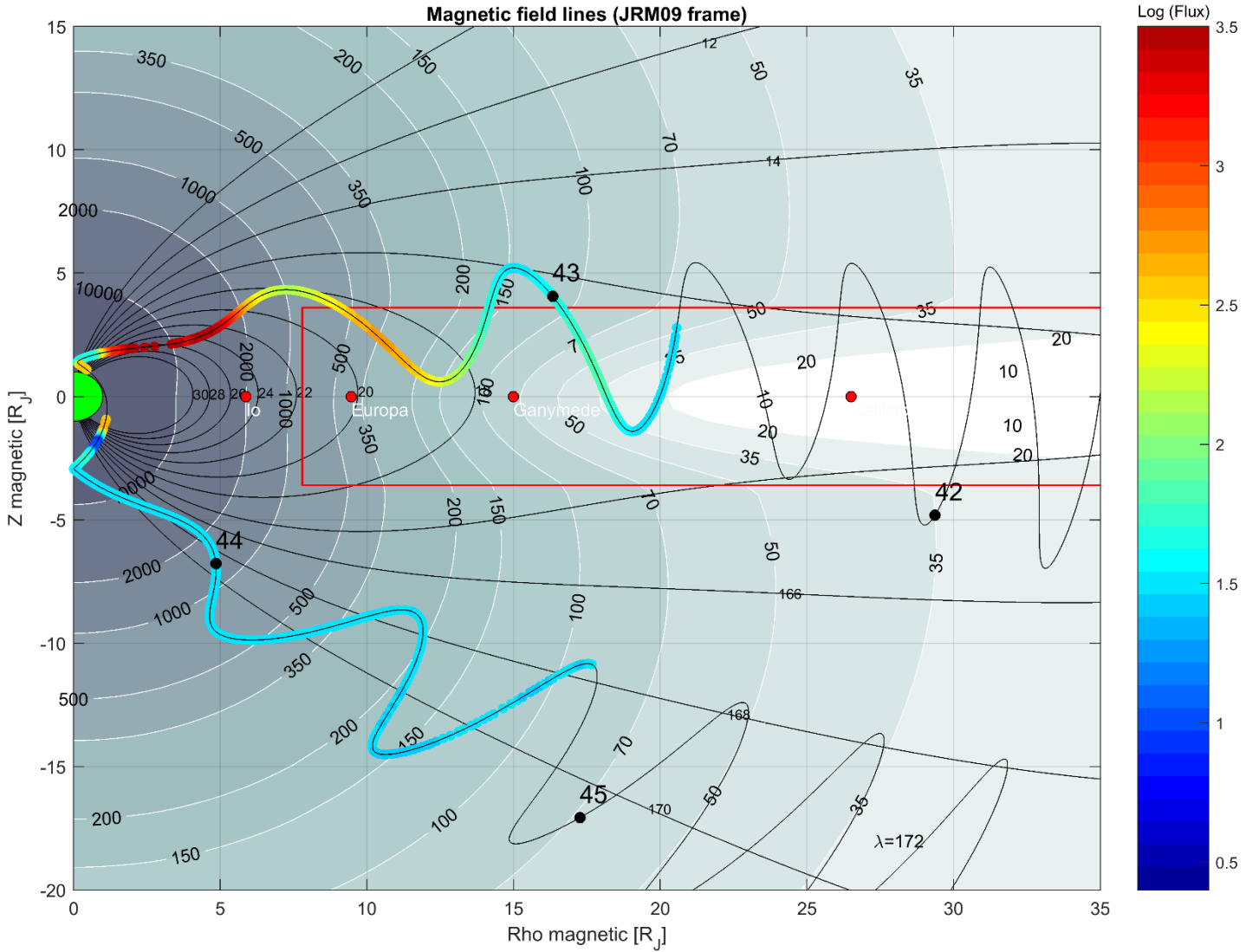
Jupiter drift inner shells according to JRM09



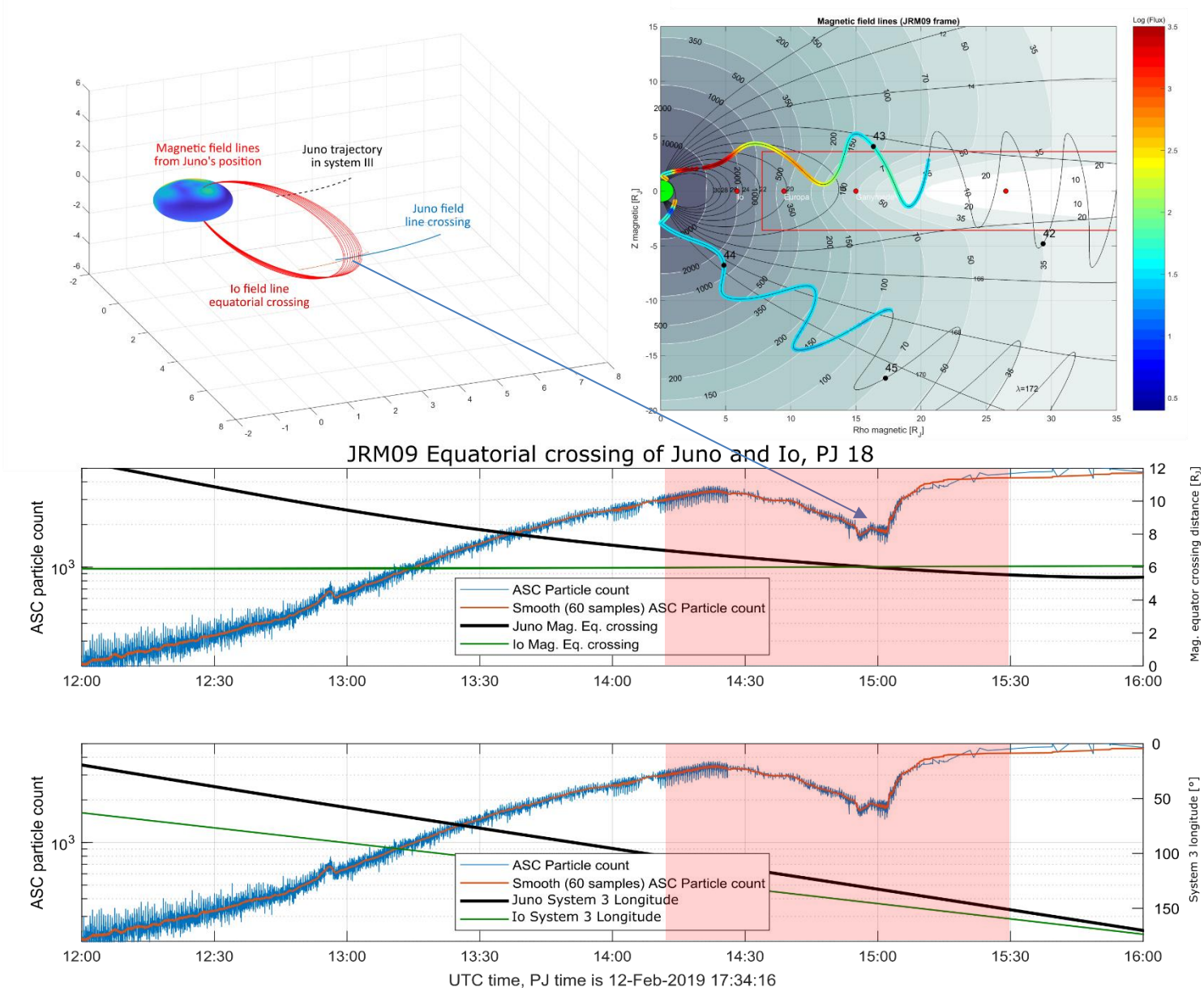
The ASC basic observable



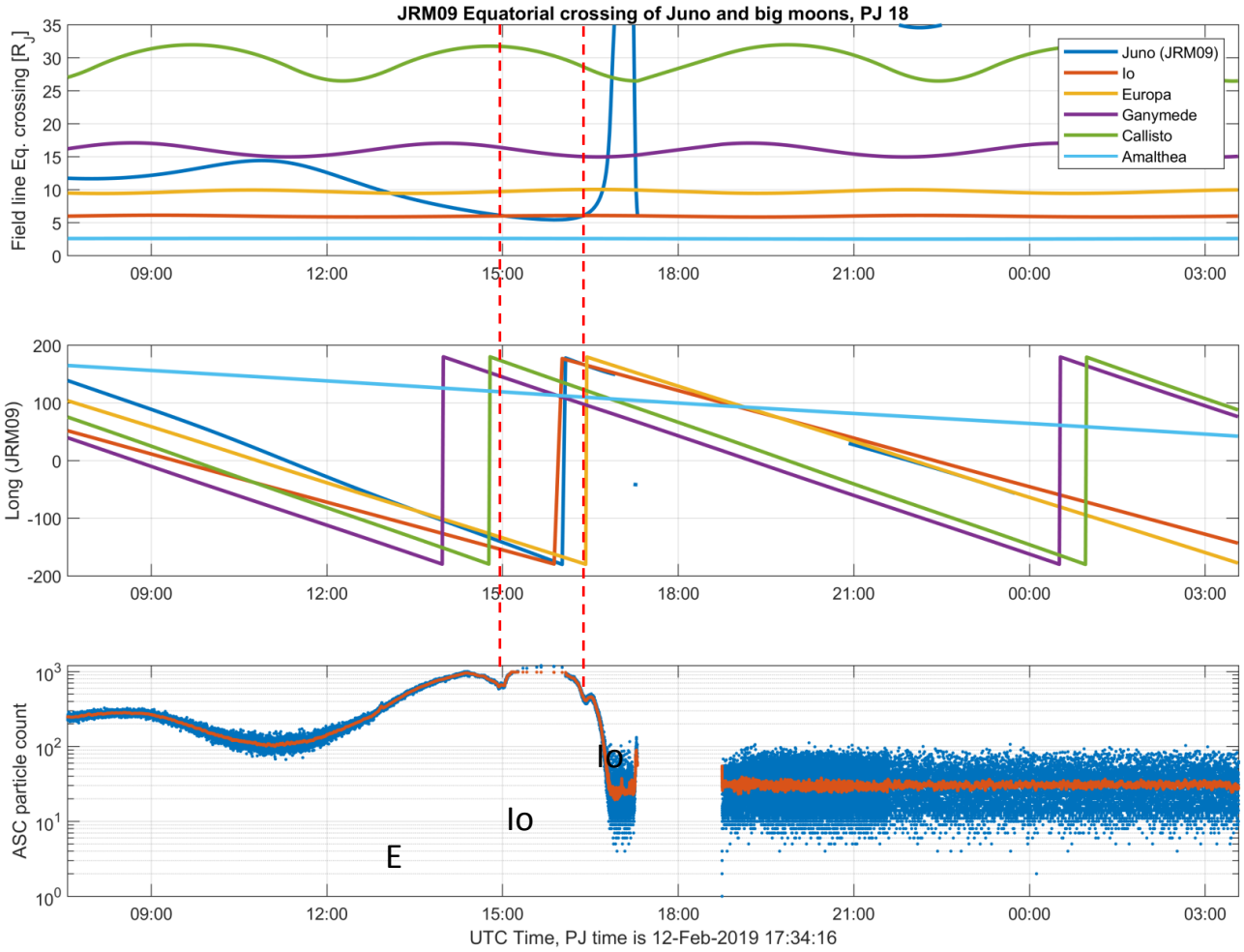
Example of observed drift shell particle flux disturbance from Io



PJ 22 – radiation

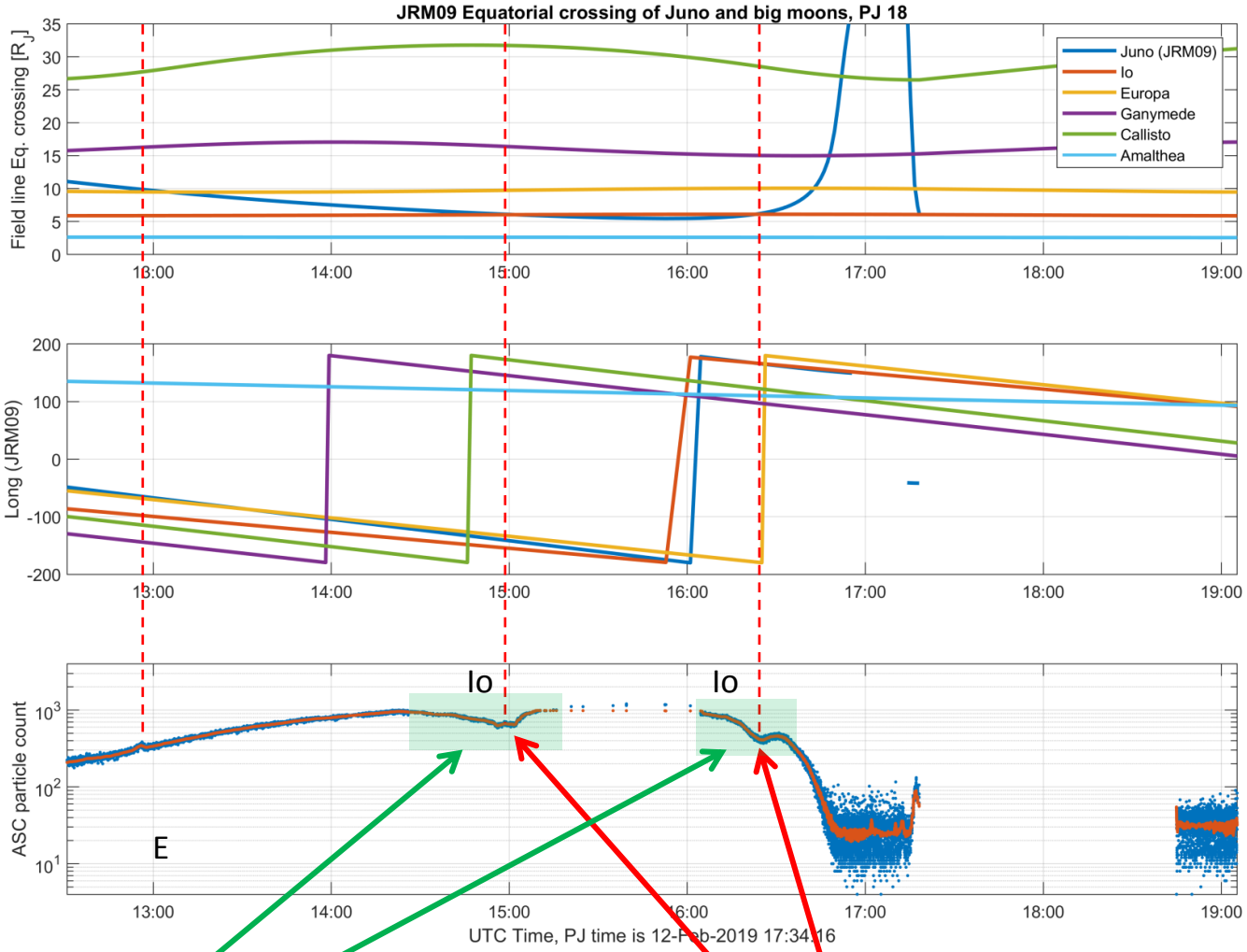


PJ 18 – Io crossing



- Strong sigunatures in the particle counts are always observed when Juno is passing through the magnetic field lines that intersect Io.
- Relative longitudinal position of Io and magnetic file line crossing is not as significant as with Ganymede

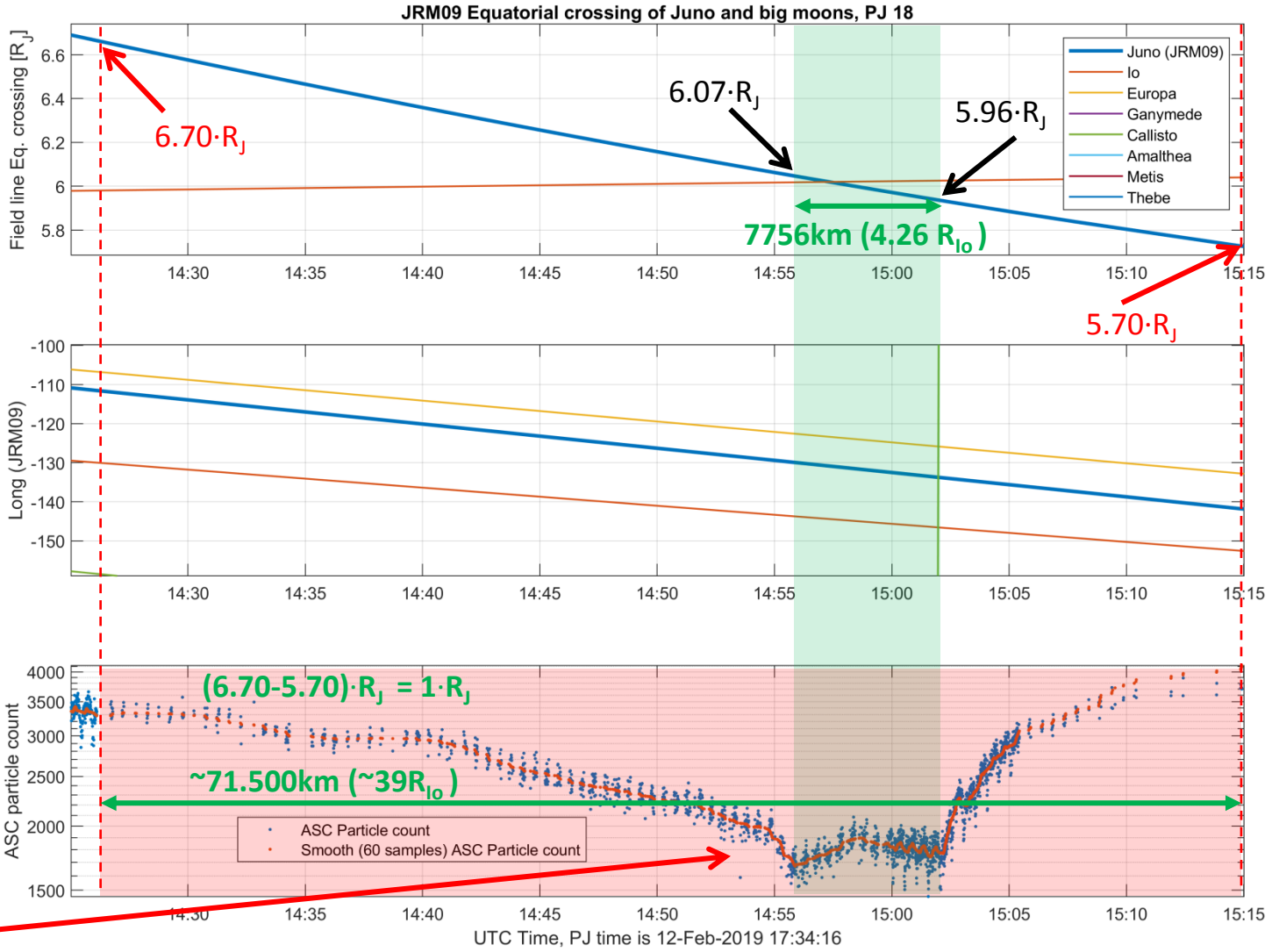
PJ 18 – Io crossing (zoom)



Width of the Io disturbance on the radiation belt

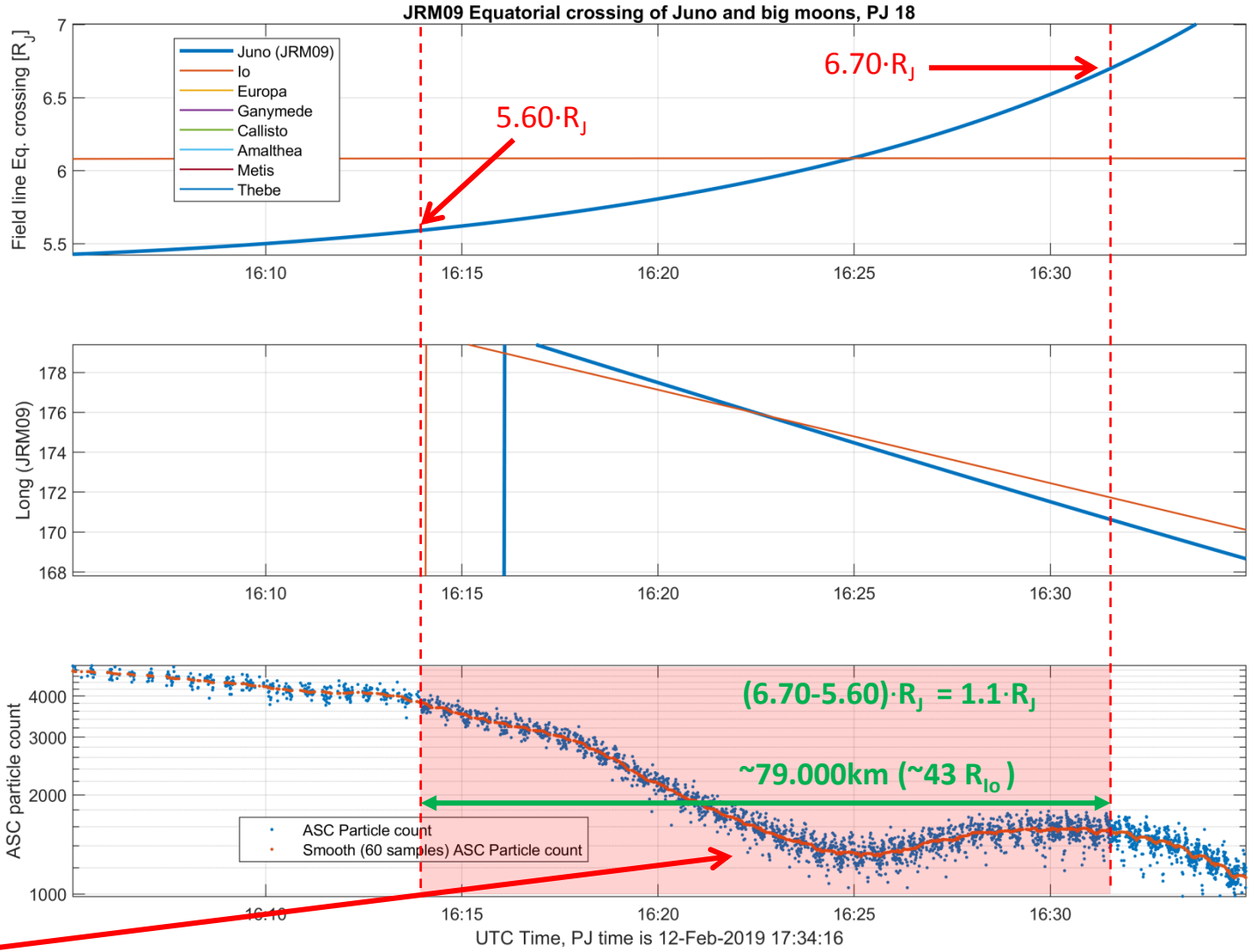
Juno is passing through the magnetic field lines that intersect Io.

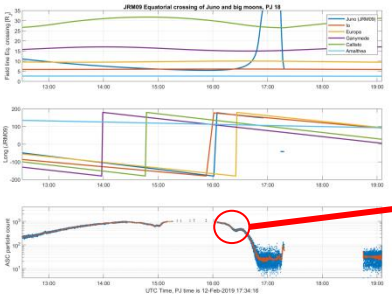
Zoom of Juno passing through the magnetic field line that intersect Io (1)



- **Width of the Io ”well” is 7756km (4.26 R_{Io})**
- **Width of the Io disturbance on the radiation belt is ~71.500km (~39R_{Io})**

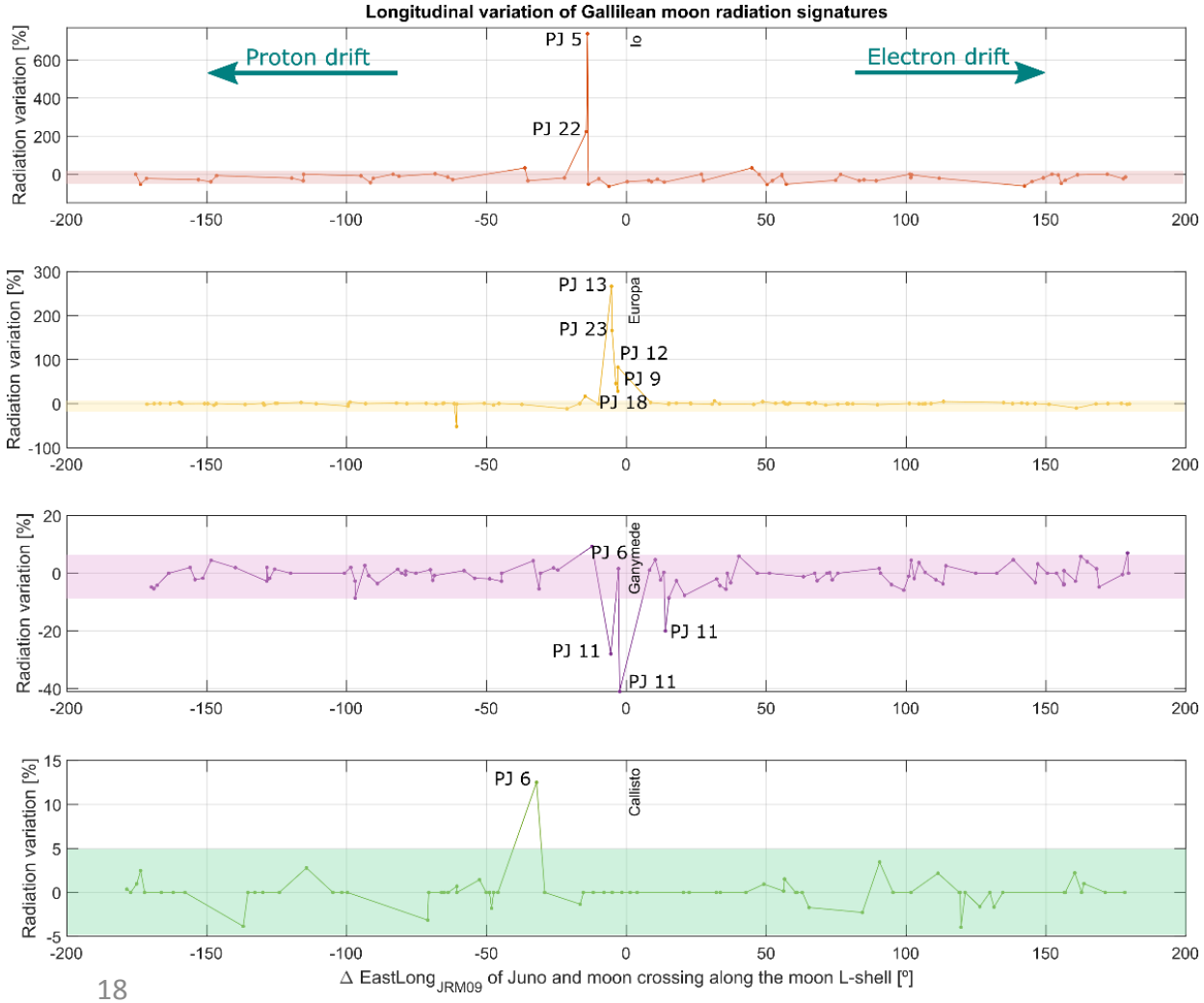
Zoom of Juno passing through the magnetic field line that intersect Io (2)

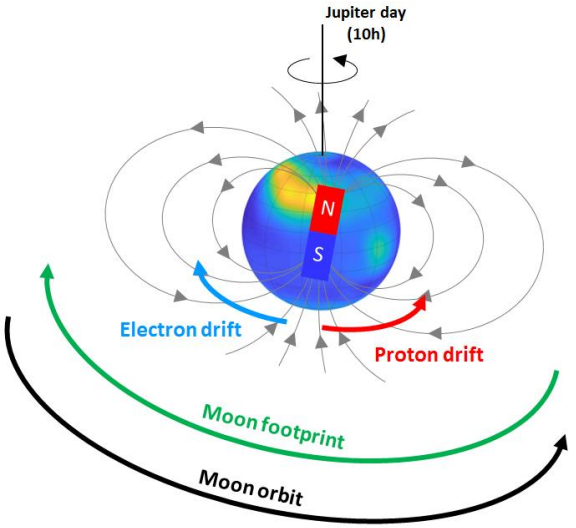




- **Width of the Io disturbance on the radiation belt is ~79.000km (~43R_{Io})**

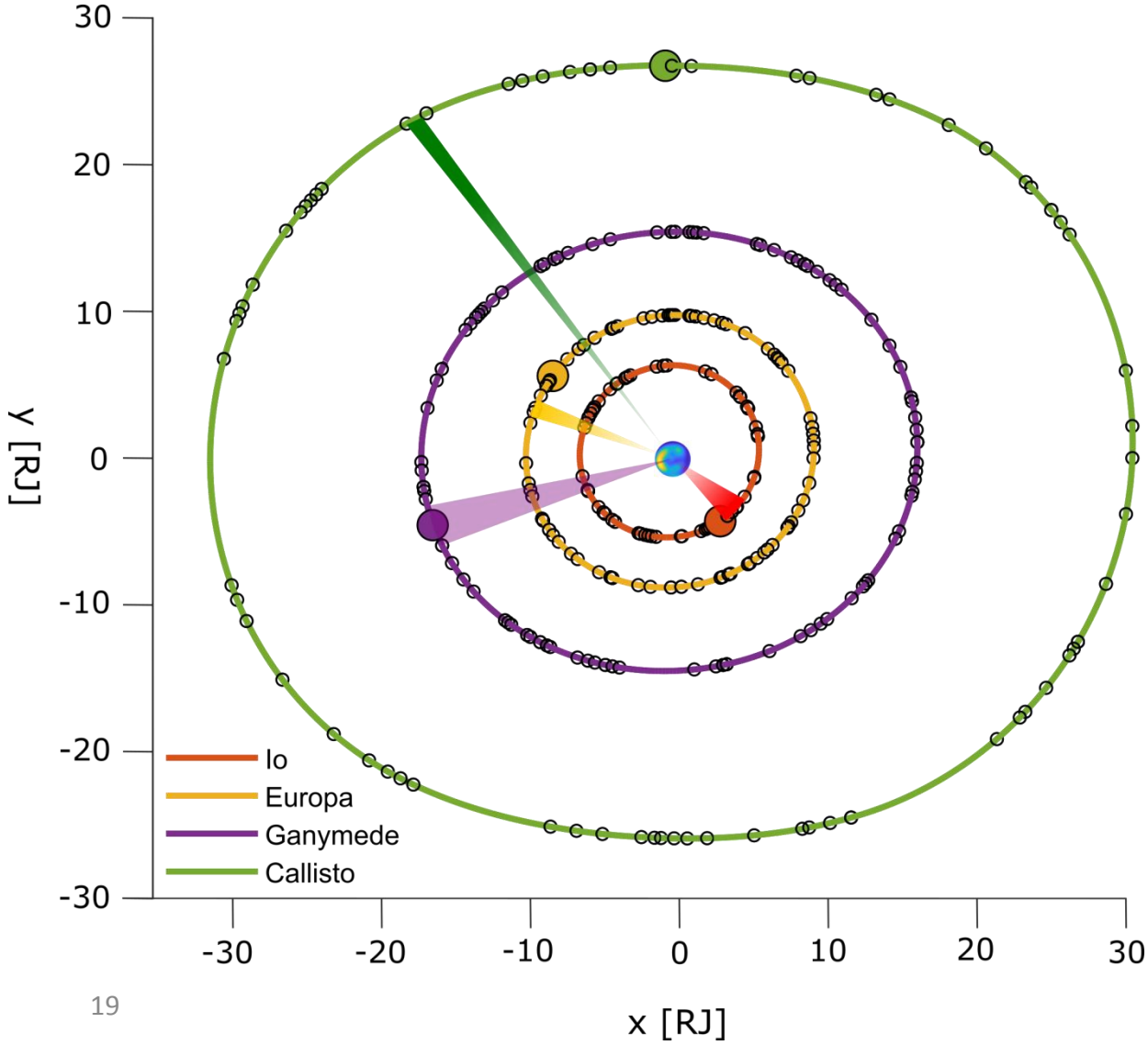
Jupiter's moons footprint signature





System 3 longitudinal difference of the intersected magnetic equator by magnetic field lines through Juno and moon. When longitude difference is positive, Juno magnetic field line is crossing in front of the Galilean moon (leading), while negative difference indicates crossing behind the moon (tailing).

Jupiter's moons footprint signature



Footprint of the Galilean moons in the magnetic (JRM09) equator on the high energy particle population. Dots show the observations of the particle flux disturbance when Juno transverses the magnetic field line that connects the moon L-shell. Signature observed in the radiation data are marked with colored slices.

Conclusion

- During 25 Juno science orbits, the μASC on board Juno spacecraft has observed global particle flux distribution around Jupiter
- μASC has observed 332 signatures of the Galilean moon's disturbance on the Jupiter L-shells.
- Io has the strongest signature
  - at the tail of Io, tailing by 20 degrees
  - in all other parts of Io flux tube where constant depletion of high energy particle flux is observed.
- Europa signature is highest at the Europa's 10-degree tail
- Ganymede exhibits signature which is central and symmetrical (supported by the analysis of Ganymede magnetic lensing effect with a width of 29.000km or 11 RG).
- Callisto has a tailing signature, weak compared to the three inner Galilean moons.