EJSM Synergistic Magnetospheric Science (SN)O(W)PAG Meeting Washington DC, Feb 8/9 2010

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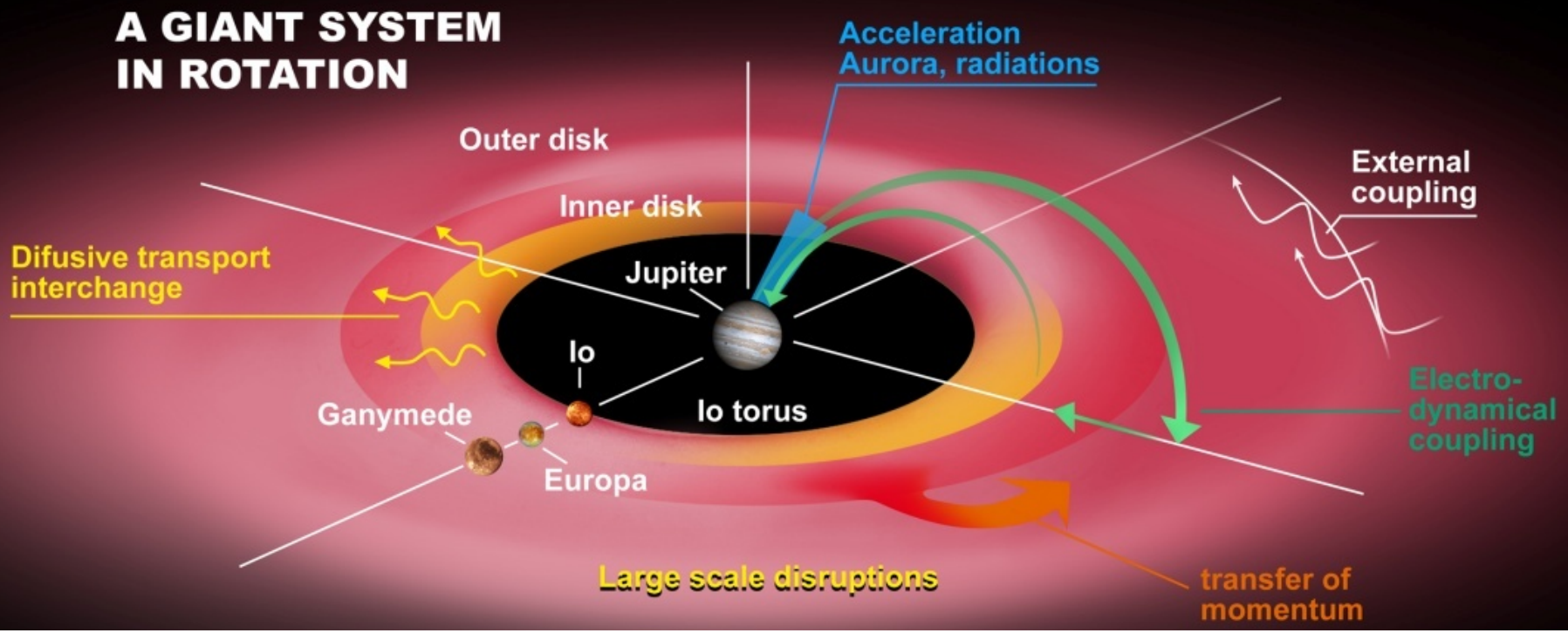

EJSM Syn Science

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A GIANT SYS
IN ROTATION

Difusive transport interchange

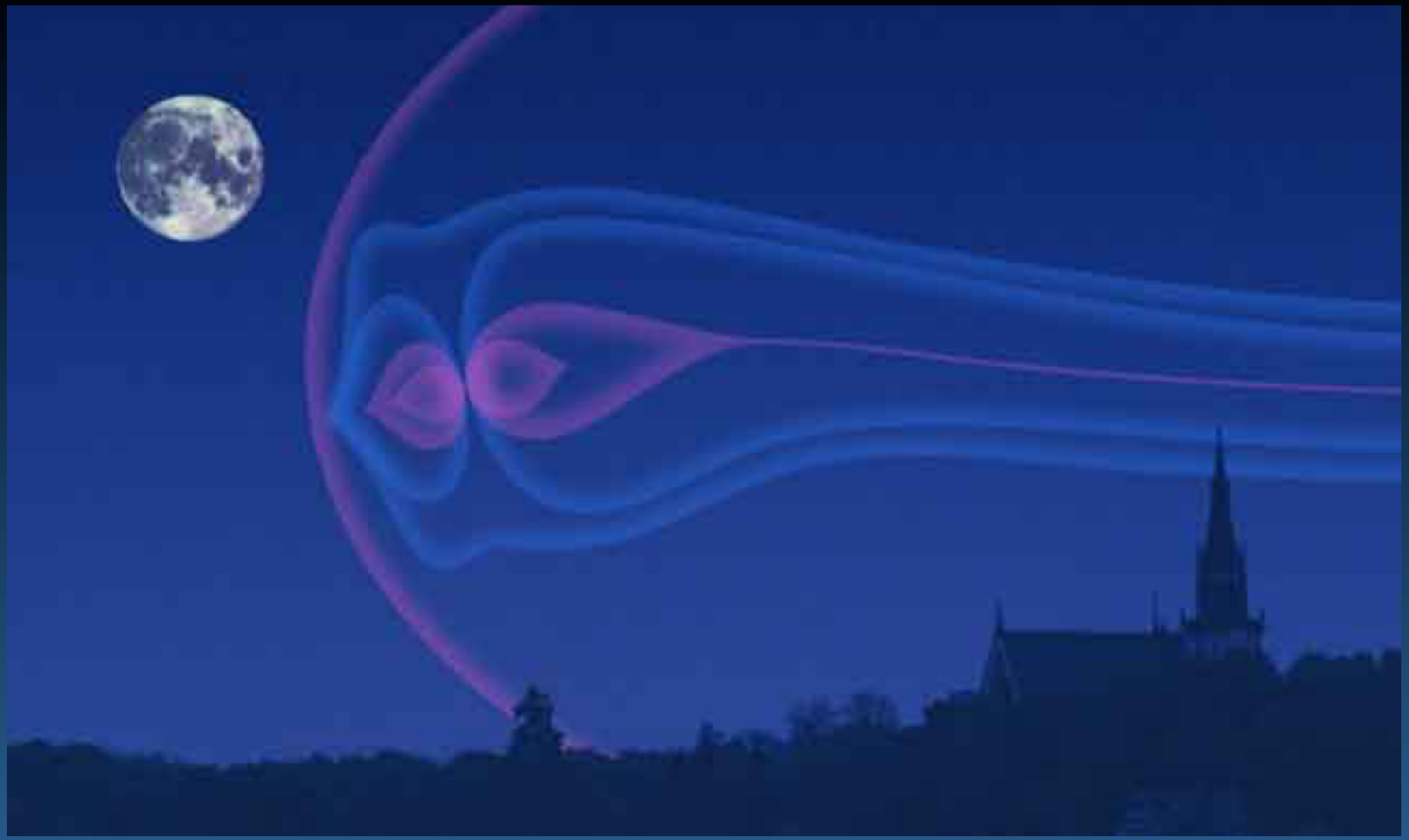
Ganyr

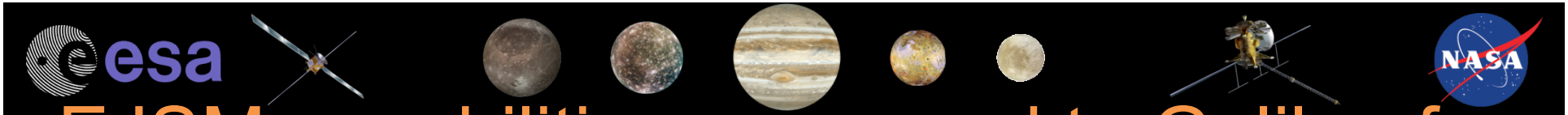
External coupling

Electro-dynamical coupling

transfer of momentum

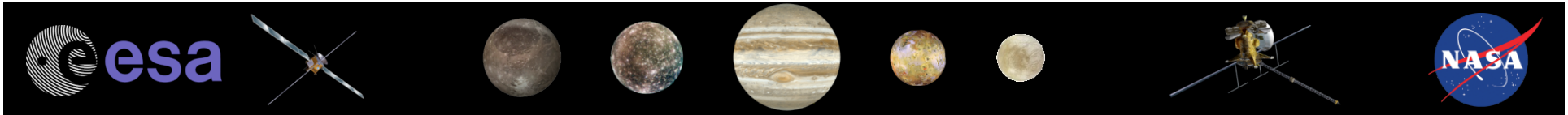
The size of the Jovian magnetosphere





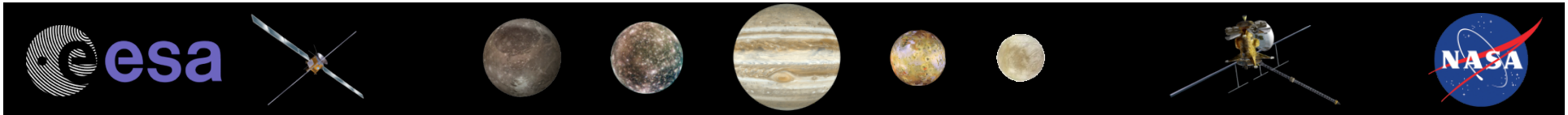
EJSM capabilities compared to Galileo for magnetospheric science

- EJSM can for the first time tackle the global picture of the largest object of the solar system by using global imaging together with multi-point measurements
- Increased time resolution to look for anything of short duration
  - looking for ion pickup (ion cyclotron waves), short-lived interchanging flux tubes
  - resolving the boundary layers of the Ganymede magnetosphere.
- Solar wind monitoring capability with either spacecraft
  - to be able to see the response to change of sector orientation and to crossing of sector boundaries
  - to study the solar wind influence
- Enhanced time resolution coverage beyond 50 RJ
- Magnetospheric coverage capability away from the equatorial plane and beyond 150 RJ in the magnetotail
- Combined plasma data set/magnetometer measurements on both S/C
  - (to better understand the global and temporal variability of the magnetosphere)
- INMS instrument on JEO and JGO, ENA camera on JGO
  - to study the global magnetospheric dynamcis, Europa torus, and sputtered /backscattered neutral particles from the moon surfaces
- Multipoint- and combined remote-sensing/in–situ measurements



Magnetospheric instrumentation on EJSM

spacecraft	instrumentation	Short cut
JEO	Magnetometer	MAG
JEO	Plasma/Energetic particle package	PPI
JEO	UV spectrometer	UVS
JEO	Ion Neutral Mass spectrometer	INMS
JGO	Magnetometer	MAG
JGO	Plasma/Energetic particle package	**PLP**/INMS
JGO	Plasma wave instrument	RPWI/LP
JGO	Ion Neutral Mass spectrometer	PLP/**INMS**
JGO	UV spectrometer	UVIS



EJSM will provide

enhanced Particle Energy Coverage

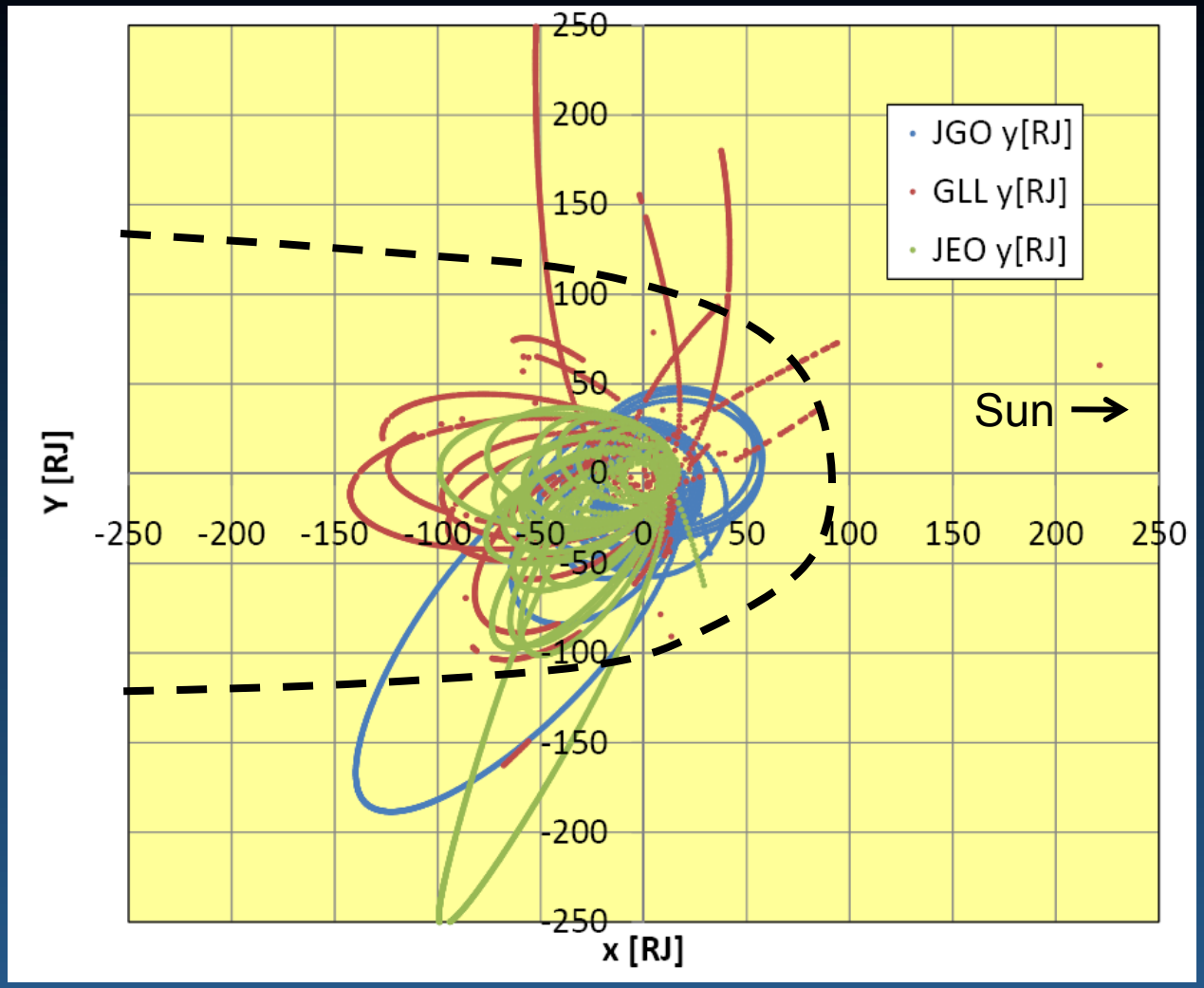
+

INMS and ENA instruments

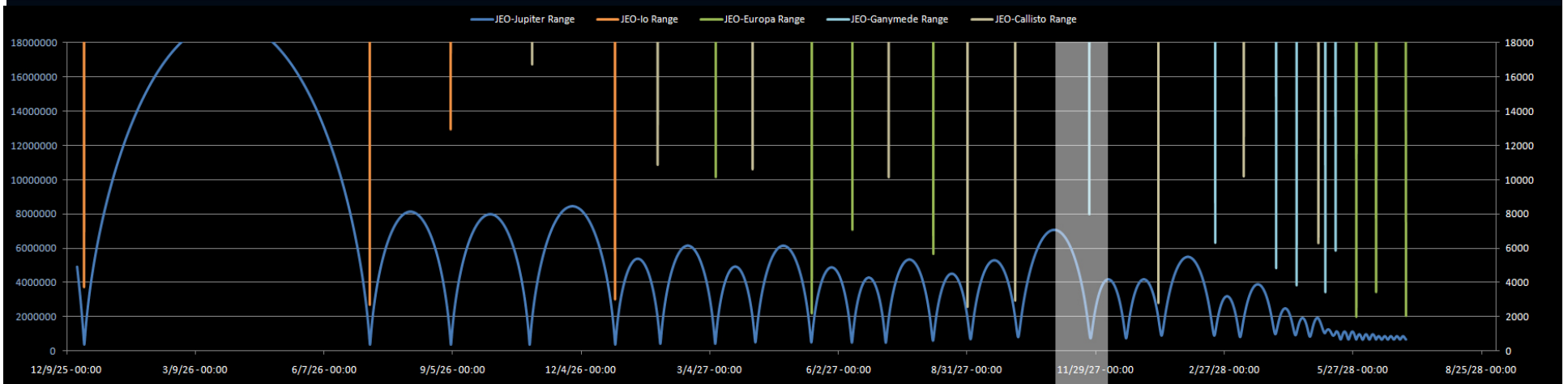
	JEO	JGO	GLL
INMS	Energy Resolution: 10% Reflectron Time-of-Flight Mass Spectrometer Mass Range: 1 to > 300 Daltons Mass Resolution: > 500	Thermal neutrals Mass range: 1-300	
Plasma/ energetic particle instrument	Plasma: Top Hat Analyzer 10 eV to 30 KeV electrons 10 eV to 30 KeV ions with composition Particles: Puck Analyzer 30 KeV to 1 MeV electrons 30 KeV to 10s of MeV ions High Energy Electrons: : >2 MeV, >4 MeV, >8 MeV, >16 MeV	PP: 1-20 keV electrons 1-30 keV ions (mass resolution 1-60, high time resolution) 1-10 keV ions with mass resolution 1-60 3-5000 keV ions with mass resolution 15-1000 keV electrons 10-10000 eV neutrals	PLS: 0.9 eV/q - 52 keV/q EPD: Ions > 20 keV Electrons 15-884 keV; > 2 MeV; > 11 MeV Ions (p, He, O, S and heavies 10 keV/nuc-15 MeV/nuc)

EJSM will provide

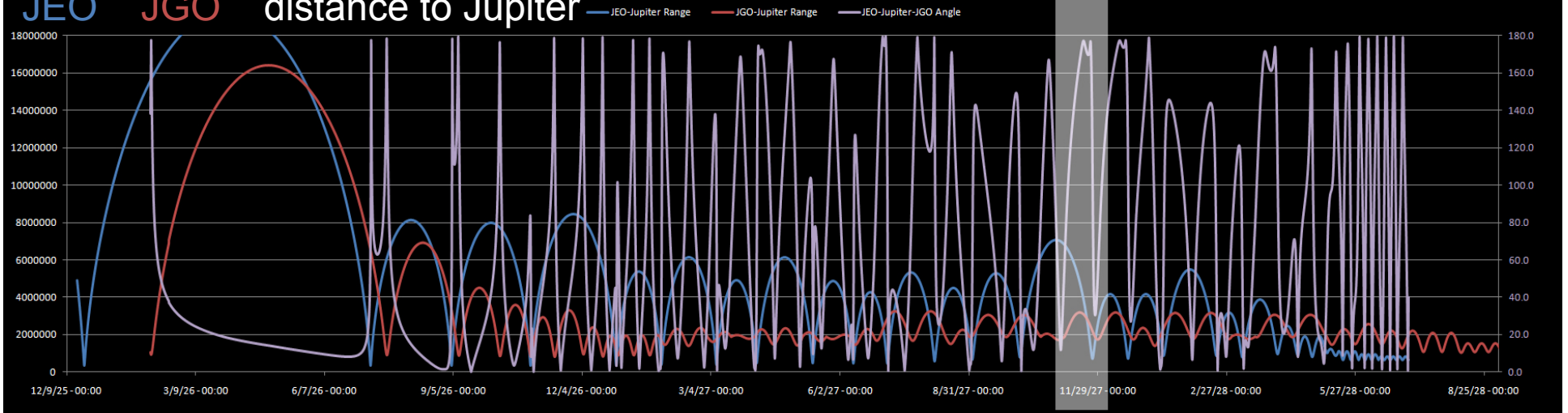
enhanced magnetospheric coverage

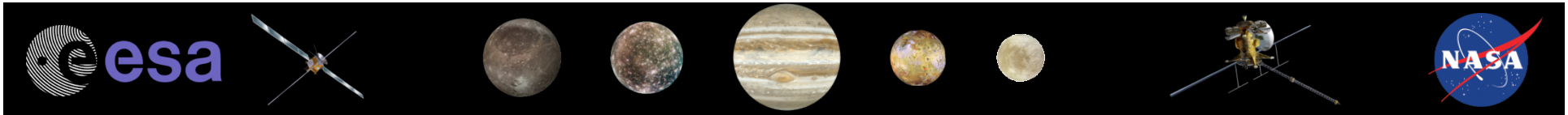


EJSM will provide
enhanced magnetospheric coverage



JEO JGO distance to Jupiter

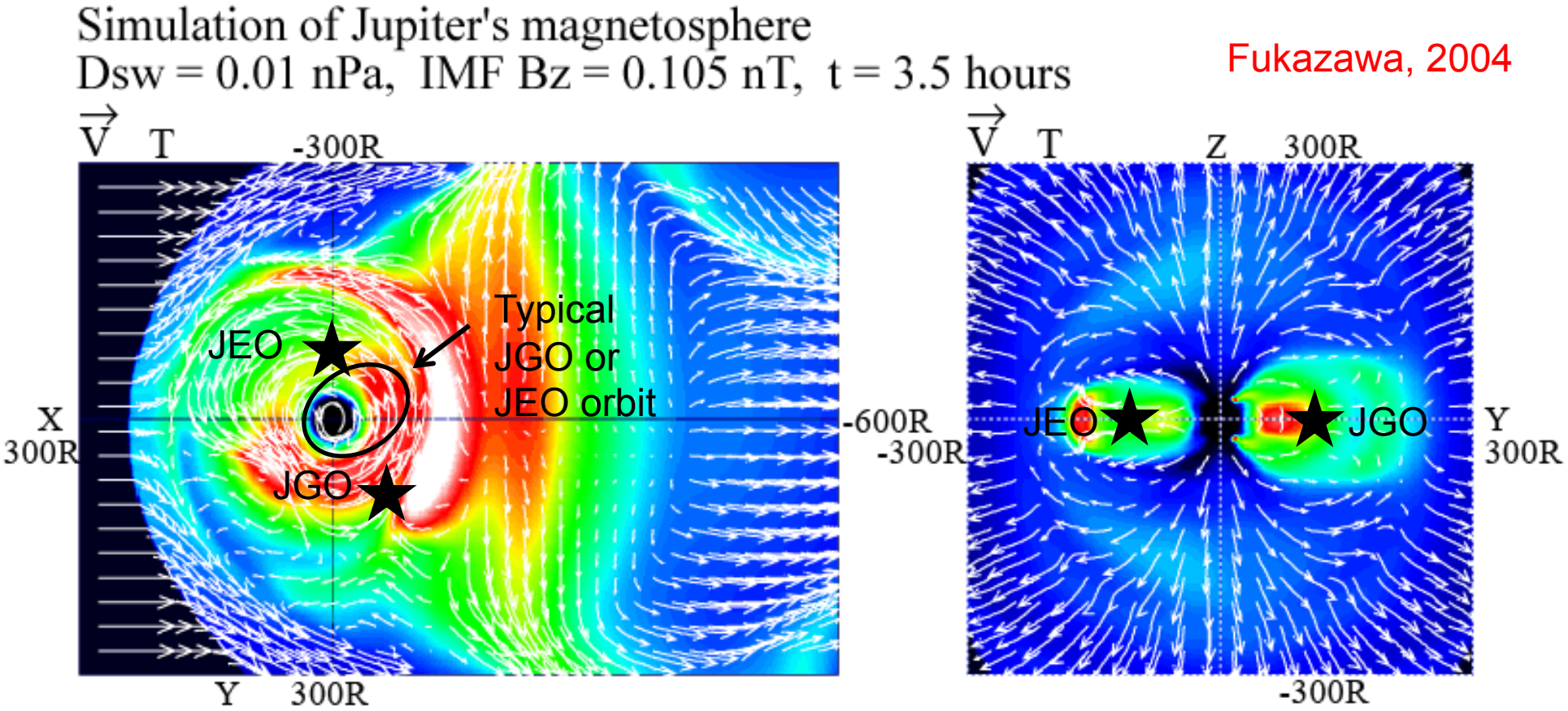




EJSM will be able to perform
multipoint measurements

- One spacecraft in solar wind, the other inside the magnetosphere
- One in the outer magnetosphere, the other in the inner magnetosphere
- One spacecraft in the Jovian magnetosphere, the other in Ganymede‘s magnetosphere
- Two spacecraft in orbit around two moons in parallel

EJSM provides significantly enhanced capability to address magnetospheric dynamics



equatorial plane

north-south-plane

EJSM will provide

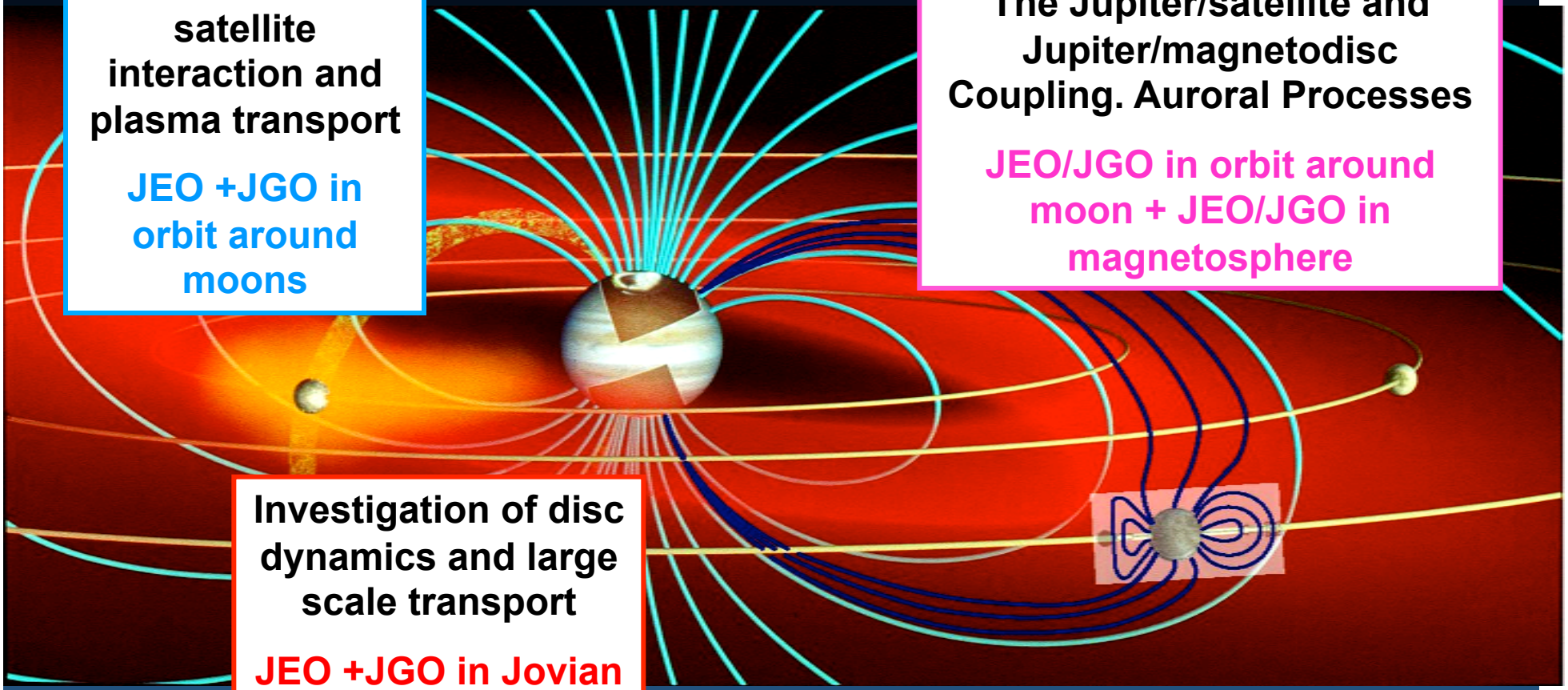
local – and global view of Jupiter‘s magnetosphere

The local view of satellite interaction and plasma transport

JEO +JGO in orbit around moons

The Jupiter/satellite and Jupiter/magnetodisc Coupling. Auroral Processes

JEO/JGO in orbit around moon + JEO/JGO in magnetosphere

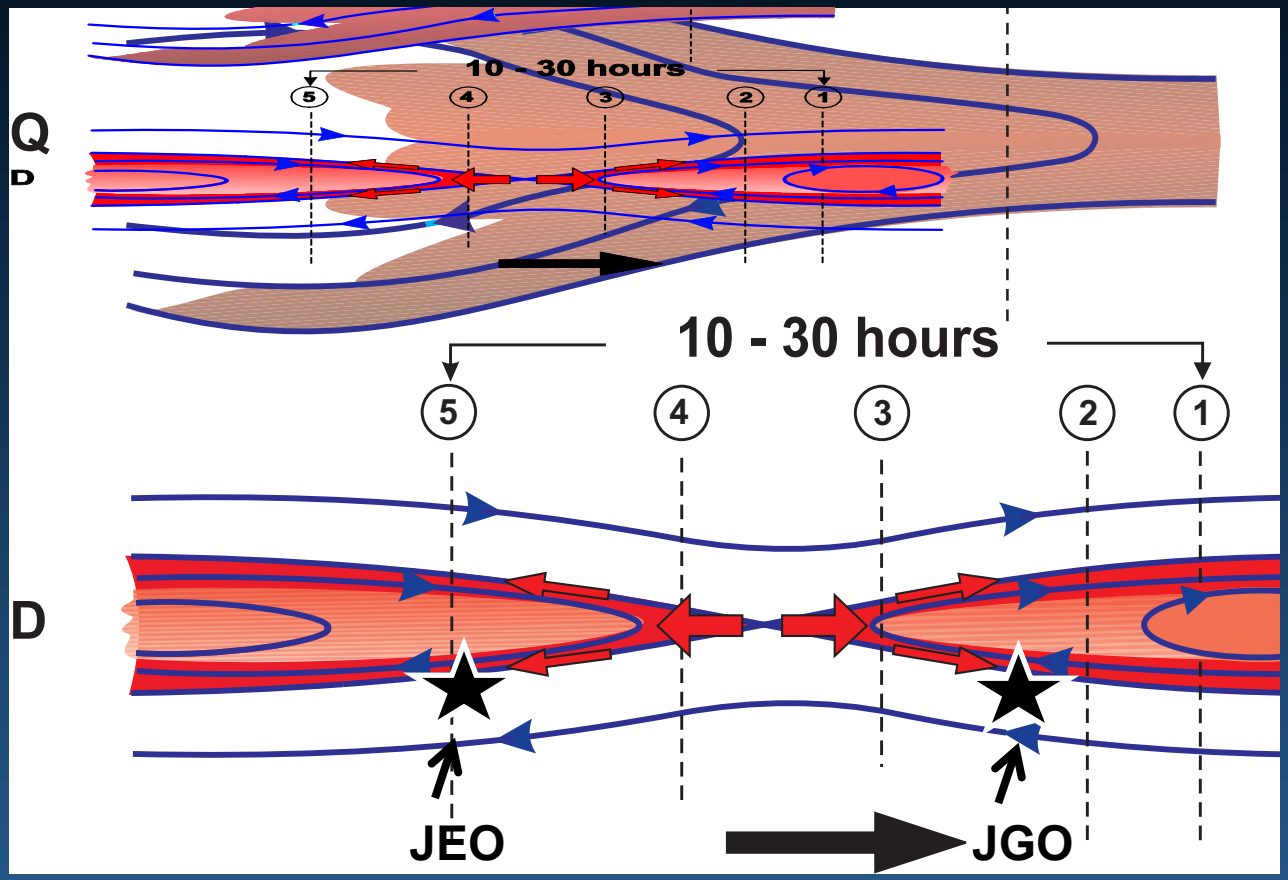


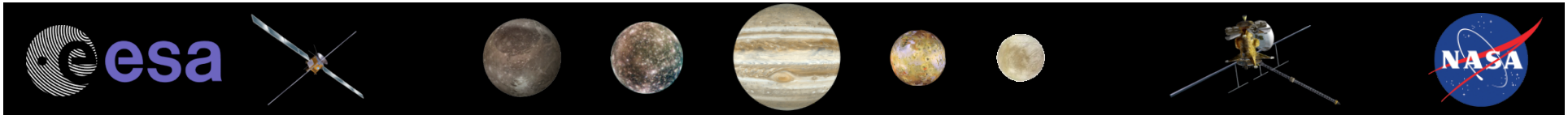
Investigation of disc dynamics and large scale transport

JEO +JGO in Jovian magnetosphere

EJSM capability to perform

multipoint measurements
in inner and outer magnetosphere in parallel

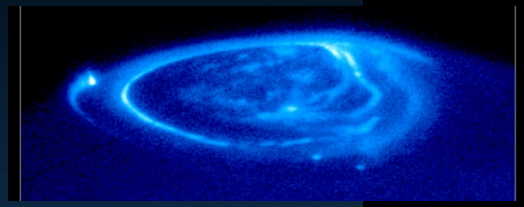


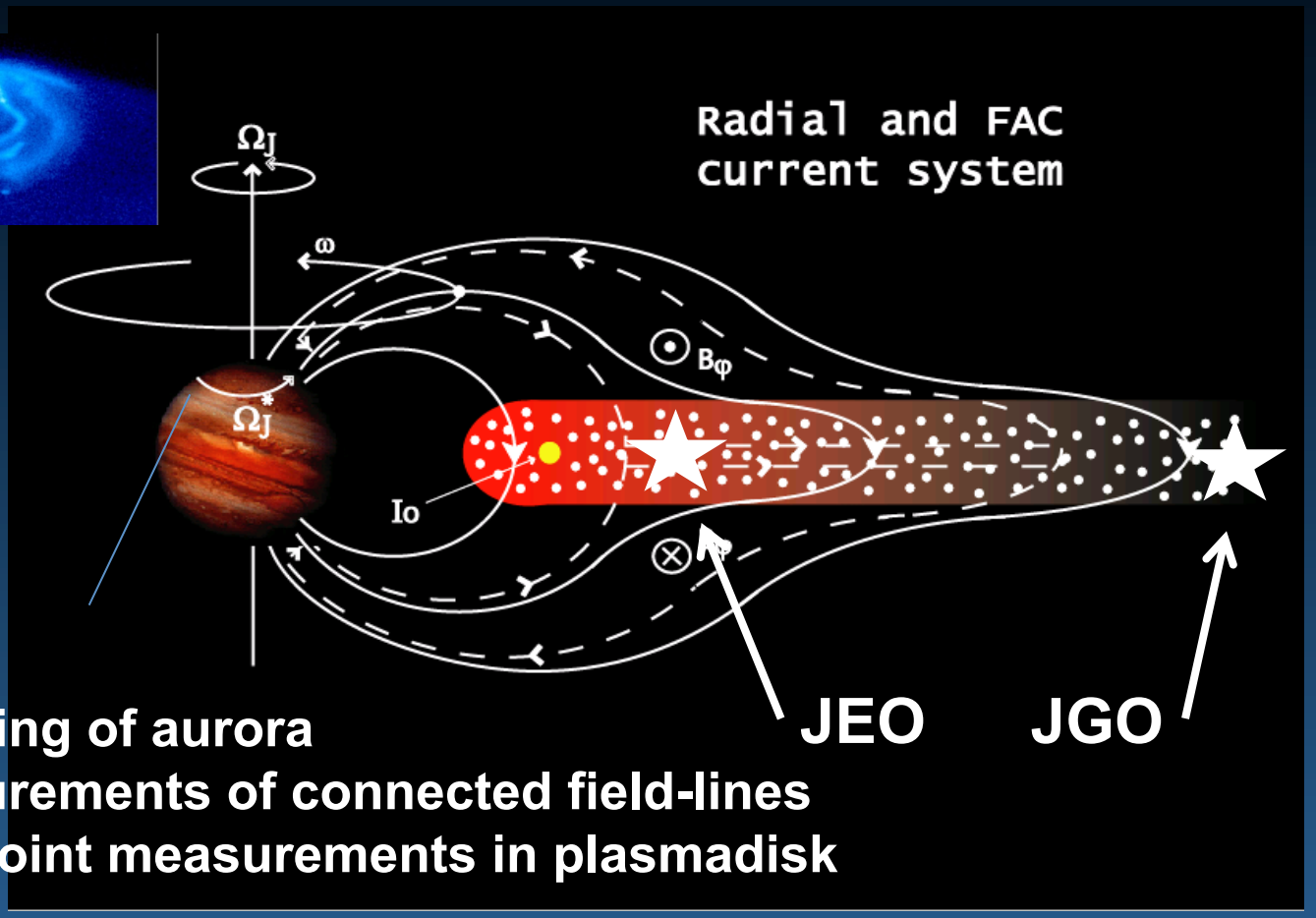


EJSM capability to perform
remote sensing and in-situ measurements in parallel

- Aurora:
  - Remote sensing of auroral emissions in parallel to particle and fields measurements
- Io and Europa torus:
  - Remote sensing of torus emissions (UV, IR, ENA) with JGO when JEO is inside the tori (particles and fields) and vice versa
- Ring current measurements (ENA+in-situ particles)

EJSM capability to perform
multipoint + remote/in-situ measurements

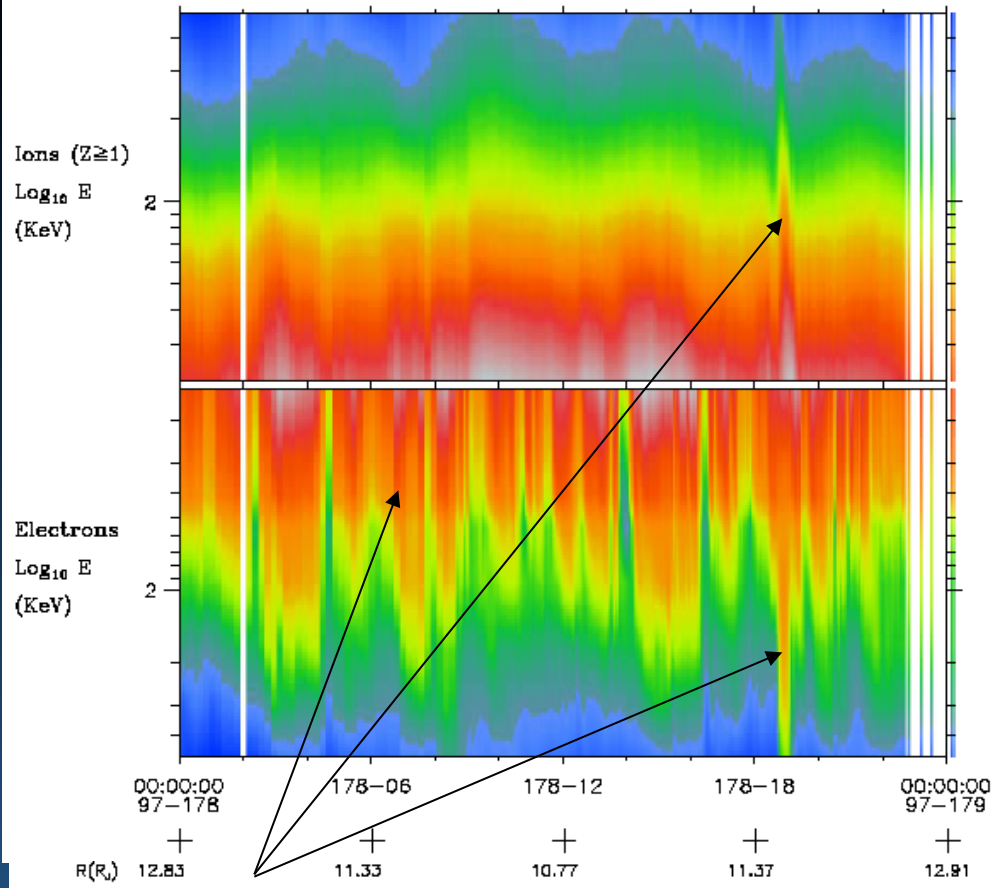




- **Remote sensing of aurora**
- **In-situ-measurements of connected field-lines**
- **In-situ multipoint measurements in plasmadisk**

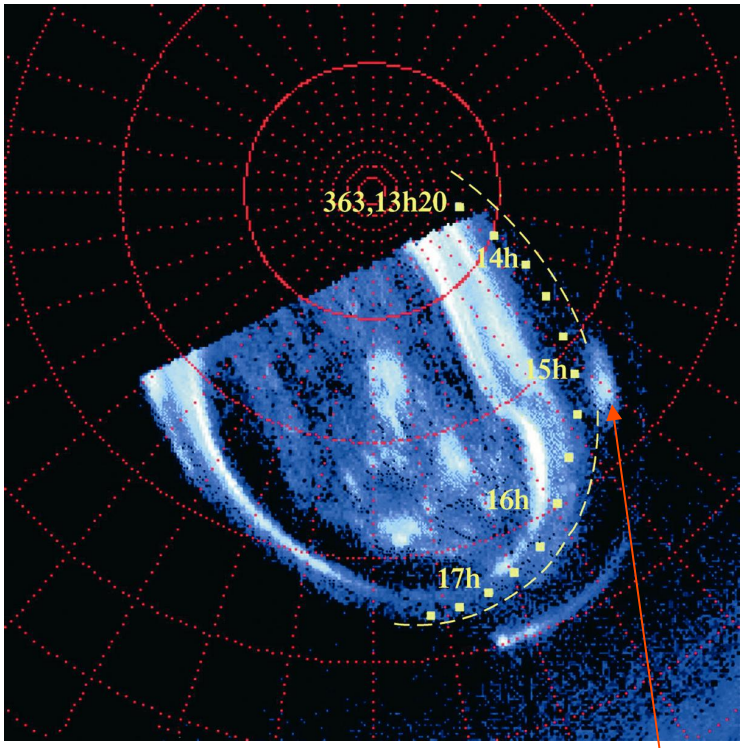
EJSM will enhance the understanding of dynamic processes in the Jovian magnetosphere

24 hour Galileo Energetic Particle Spectrogram



Extreme "storm-time" energetic particle dynamics observed in the vicinity of Europa's orbit

HST Image of Jupiter's UV aurora

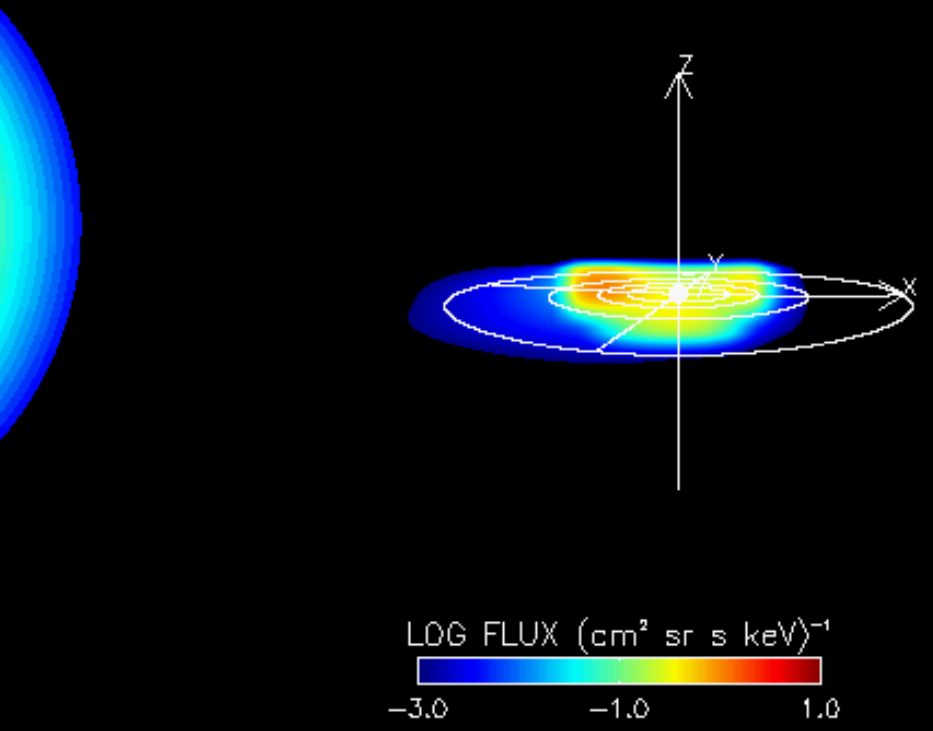


Mauk et al., 1997; 1999, 2000

Auroral manifestation (HST) of near-Europa storm dynamics

EJSM capability to perform

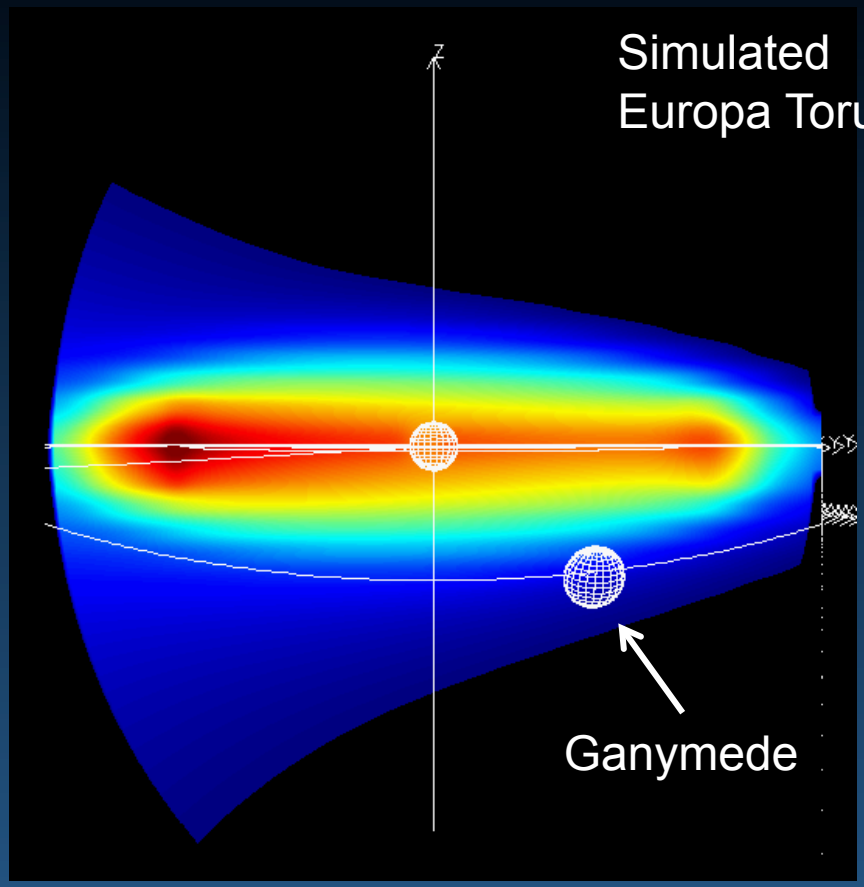
remote sensing (JGO) with in-situ (JEO) measurements

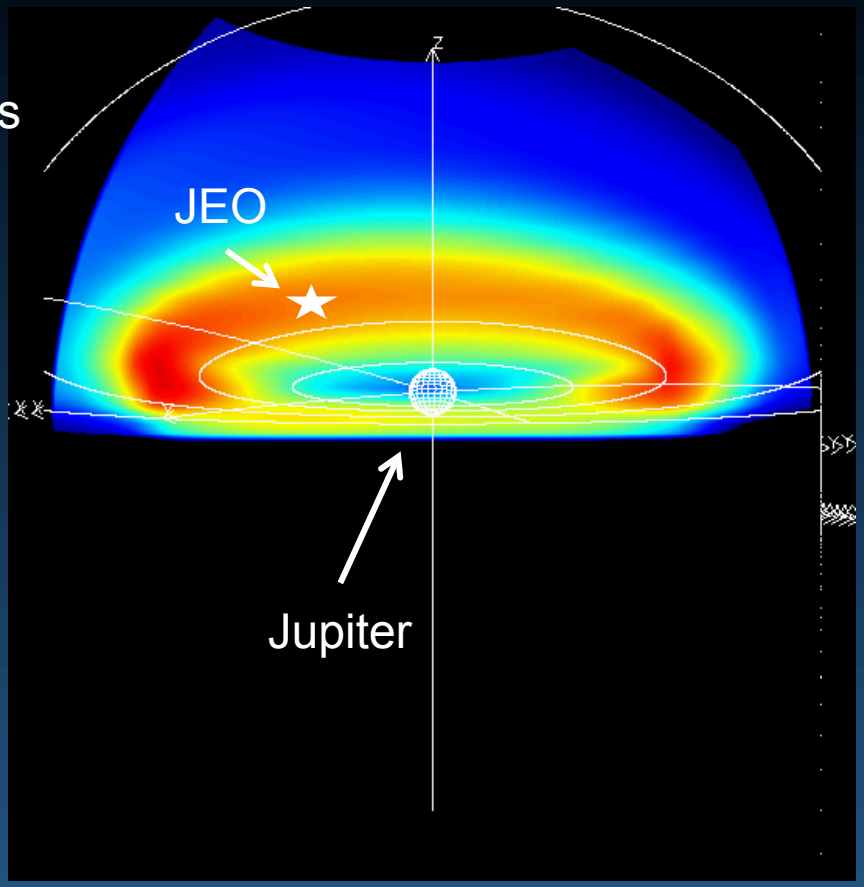


Expected ENA emissions from the EUROPA torus as viewed from JGO orbit (P. Brandt)

40 keV protons

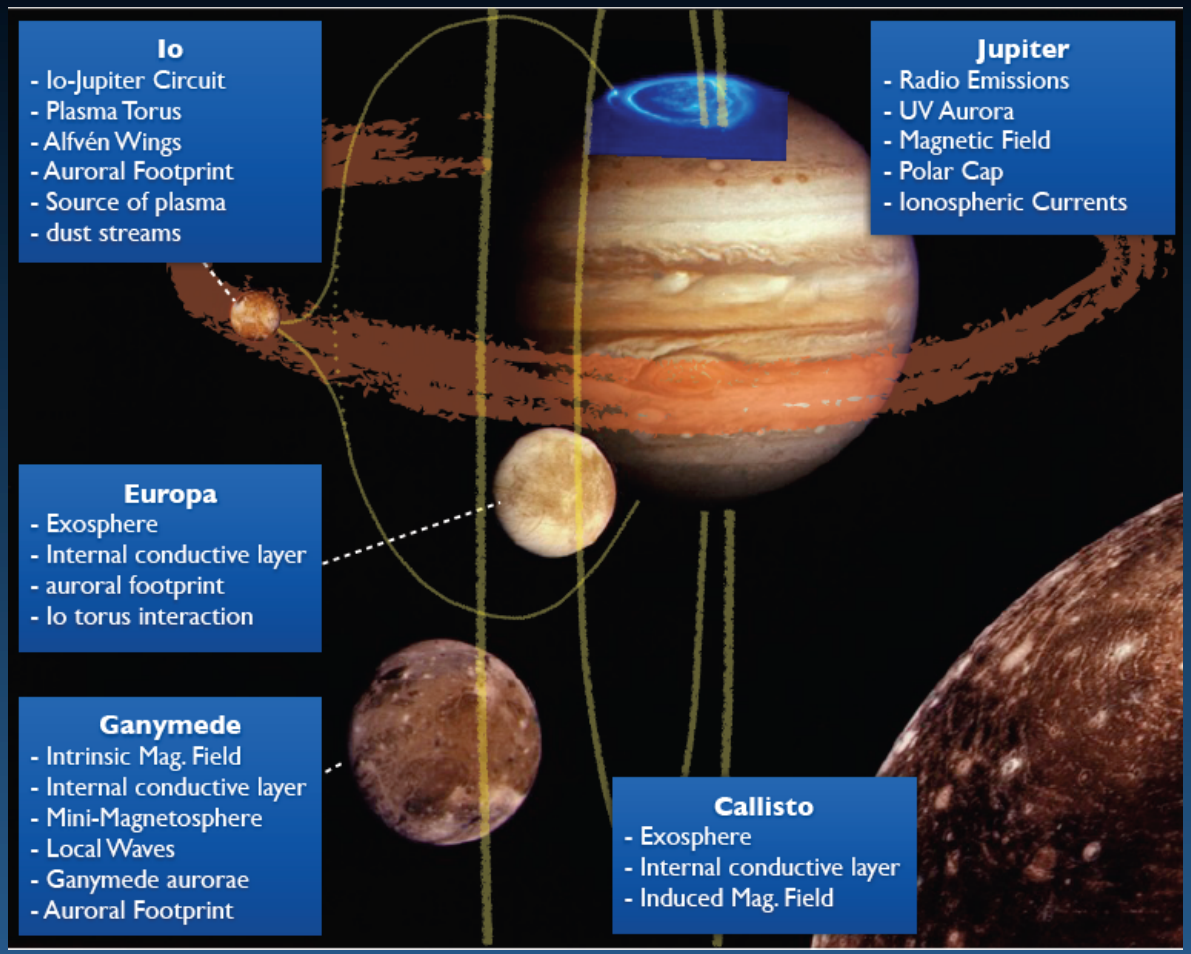
EJSM capability to perform
remote sensing (JGO) with in-situ (JEO) measurements





Expected ENA emissions from the EUROPA torus as viewed from JGO orbit (P. Brandt)

EJSM capability to study
the electromagnetic environment of Jupiter

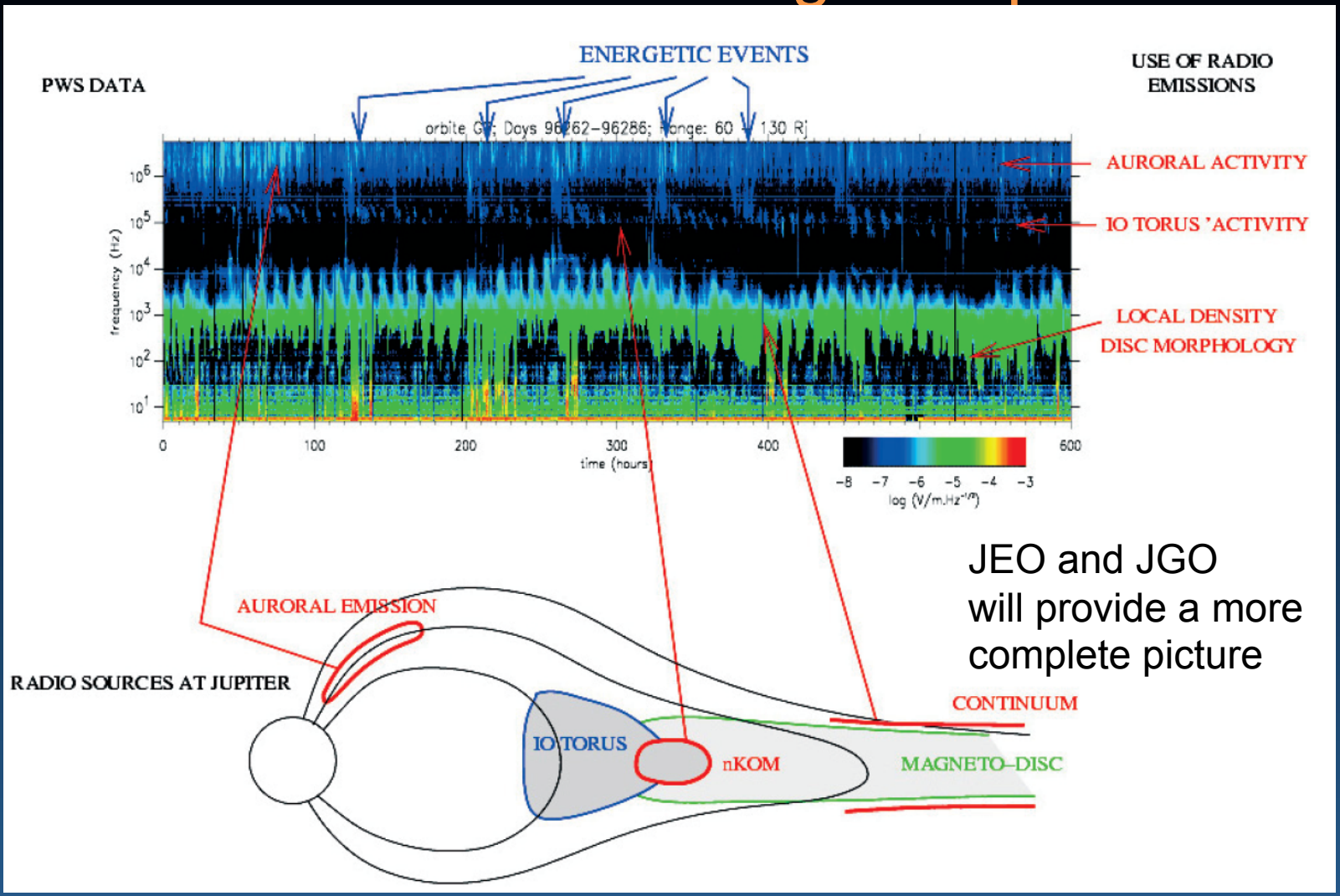


remote and in-situ

plasma wave (JGO only)

UV, particle and field measurements (JGO and JEO)

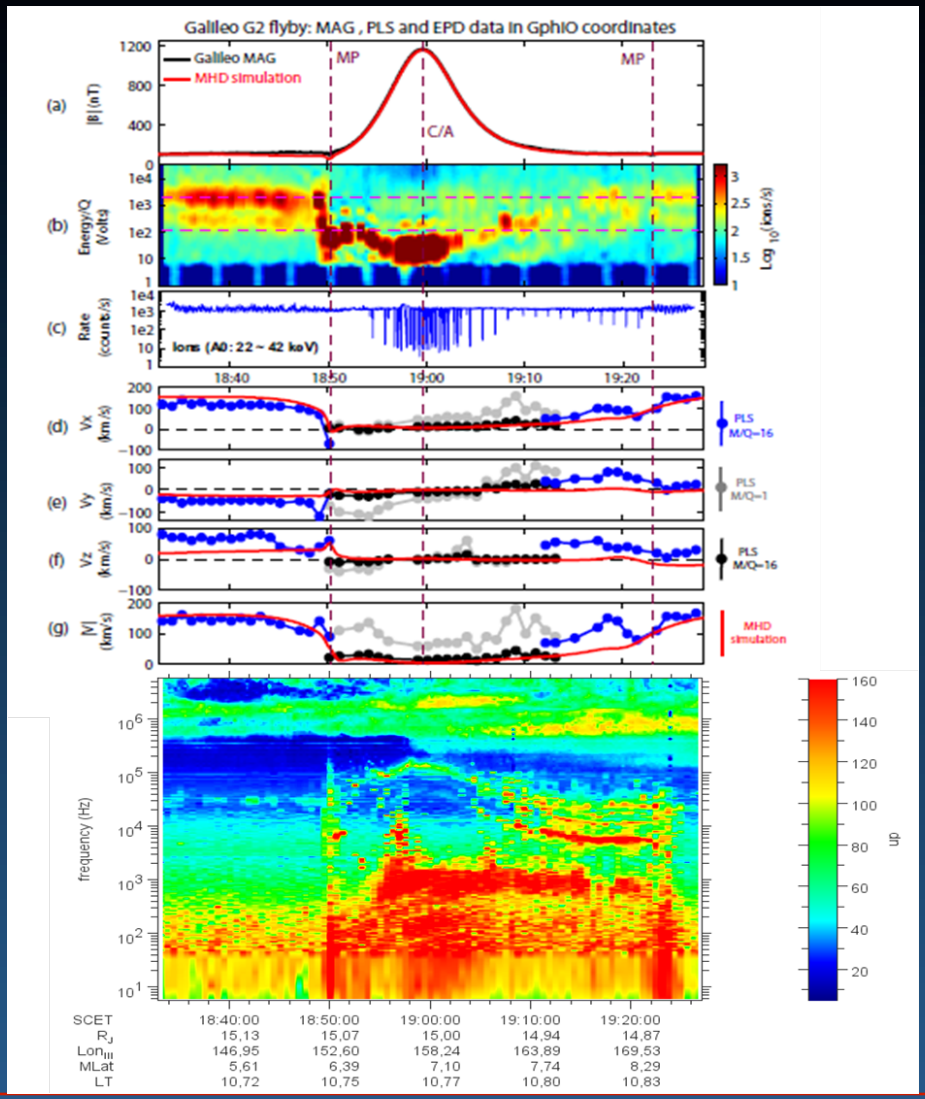
Radio emissions from various regions inside the Jovian magnetosphere



JEO and JGO will provide a more complete picture

Ganymede environment (Galileo multi instruments)

JGO/JEO would allow to do this kind of combined measurements from two perspectives



Magnetic field

Plasma composition

Energetic particles

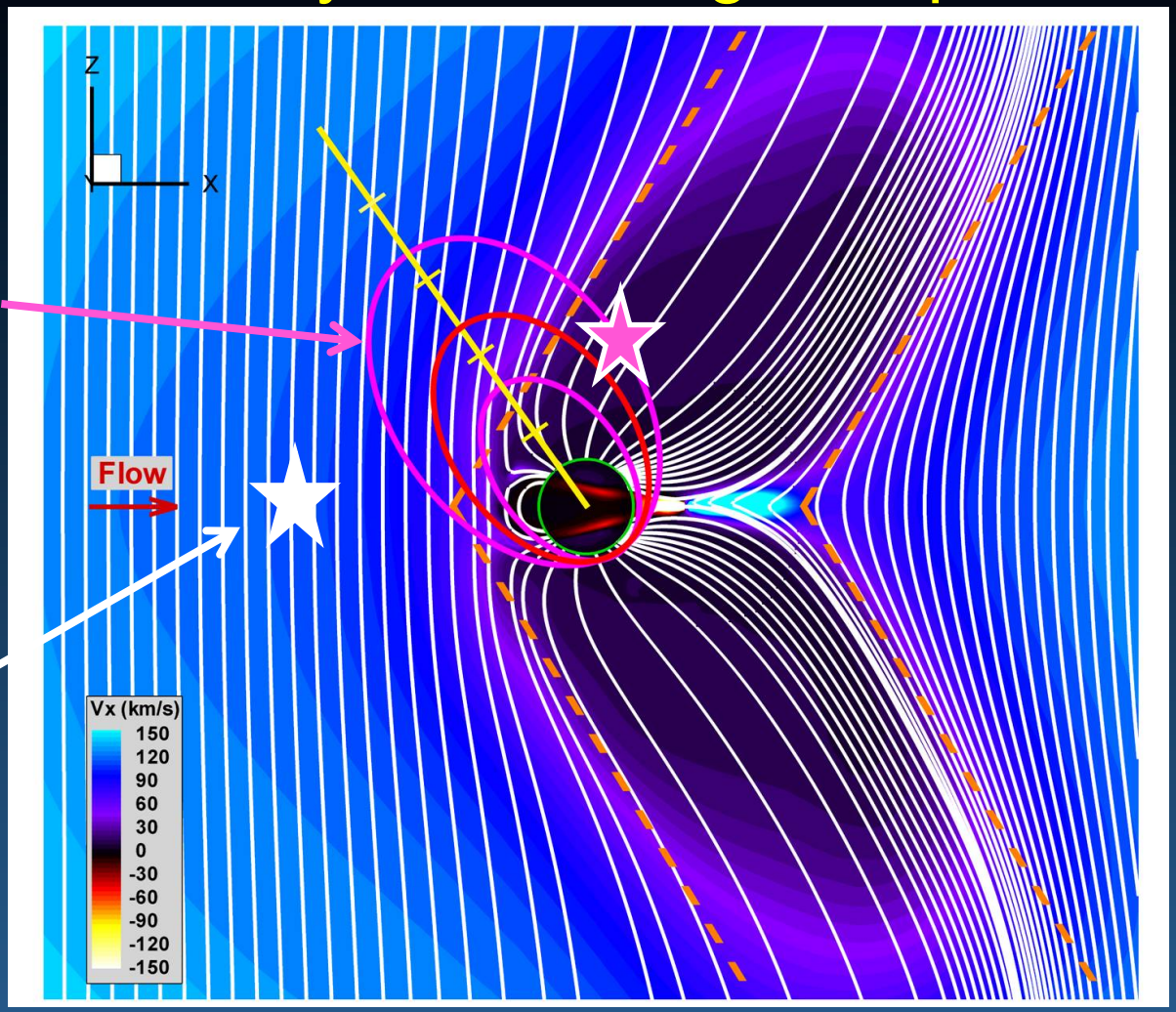
Plasma velocity

Plasma waves

EJSM capability to investigate
the boundaries of Ganymede‘s magnetosphere in detail

JGO in elliptic / circular orbit around Ganymede

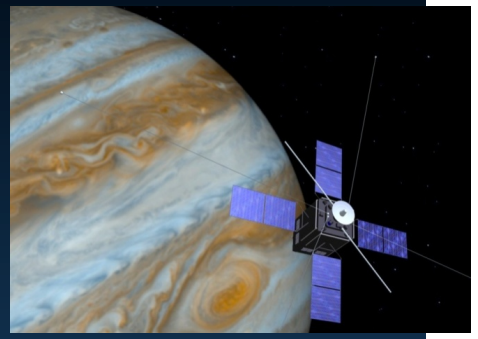
JEO outside Ganymede‘s magnetosphere providing parameters of Jupiter‘s magnetosphere



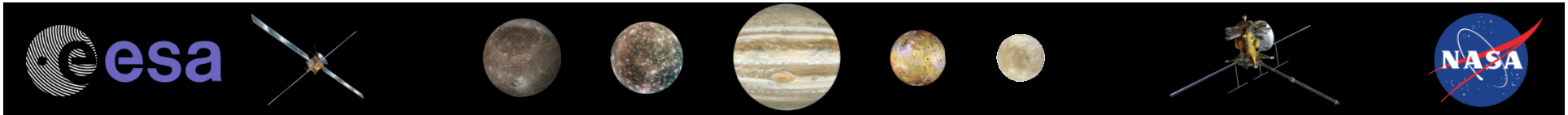
MHD Simulation of Ganymede‘s magnetosphere from Jia et al. 2009

Jupiter magnetospheric Orbiter (JMO)

- JAXA considers a Jupiter Magnetospheric Orbiter JMO
  - Spin stabilized
  - P/L resource > 40kg (**In-situ ~20kg, Remote ~15kg)**
    - *** Low / Medium / High Energy Particle Packages**
    - **DC Electric / Magnetic Field & Wave Measurements**
    - *** Wide Field ENA Imager for Energetic Regions**
    - *** Wide Field EUV Imager for Io-Torus**
    - *** Multi-Element Radio Receiver (kHz ~ 50MHz [+ Synchrotron monitor])**
    - *** Dust**
    - *** Camera**

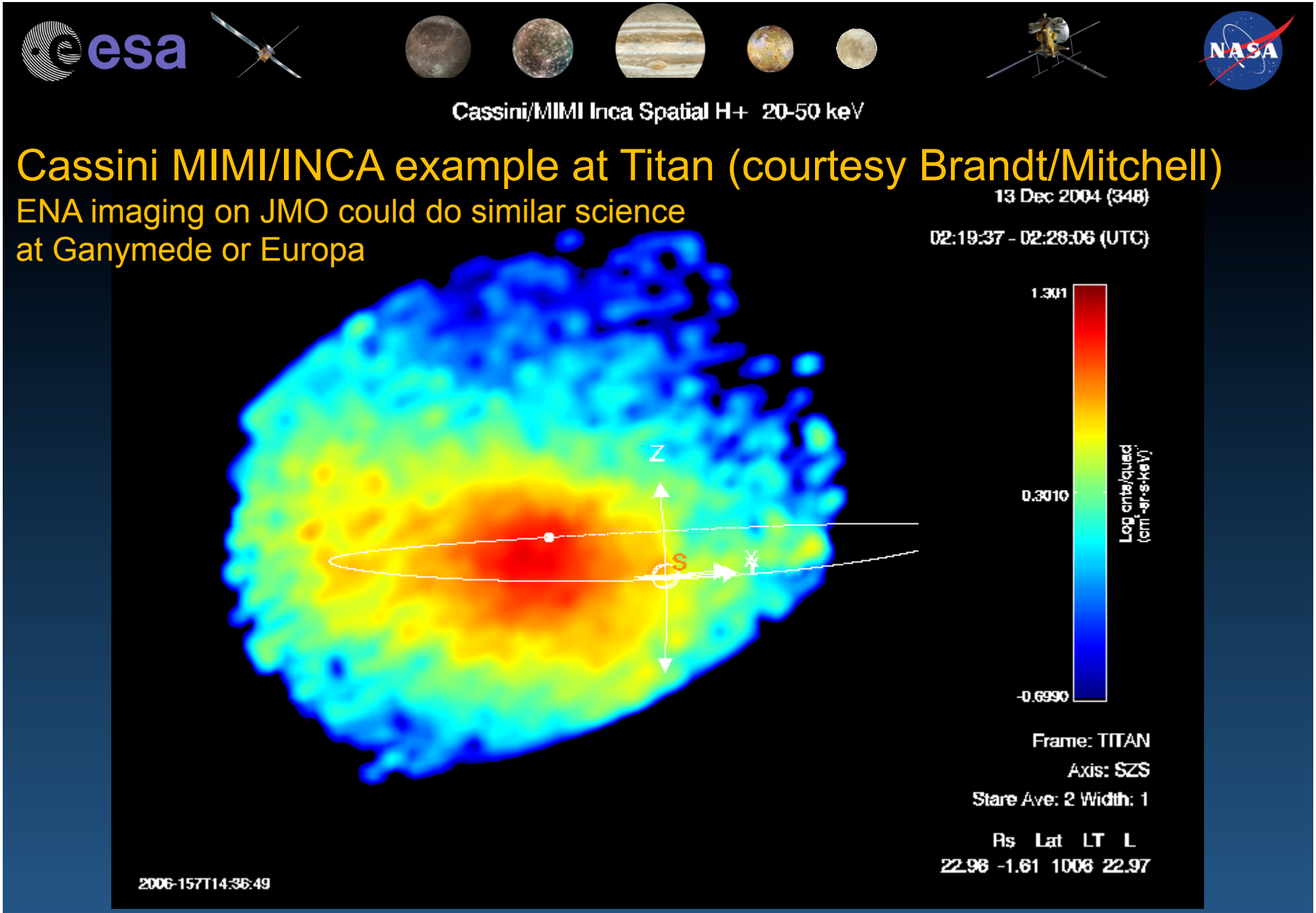


  - Orbit 10 ~ 100Rj, w/o detailed analysis such as the flyby tour for inclination raising
- Launch schedule :
  - 2022 Launch, ~2028 arrival to Jupiter for joint observation with JEO/JGO



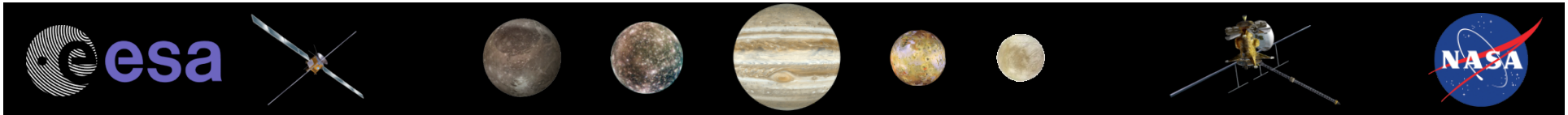
Unique magnetospheric science from JMO

- JMO would allow 3-point measurements inside the magnetosphere and additional remote/in-situ possibilities
- JMO would allow high-latitude (10-30 deg inclination) measurements from large distances (>100 RJ) during phases when JGO and JEO are deep in the inner magnetosphere
- If launched slightly later than EJSM JMO could serve as solar wind monitor
- Additional instrumentation such as x-ray spectrometer, dust detector, ENA high-energy instrument would complement EJSM
- JMO as a spinning spacecraft would allow particle and fields measurements from all directions.



Cassini MIMI/INCA example at Titan (courtesy Brandt/Mitchell)

ENA imaging on JMO could do similar science at Ganymede or Europa



Summary of
EJSM Synergistic Magnetospheric Science

- Multipoint measurements will dramatically enhance the understanding of complex processes in magnetosphere
- Remote and in-situ measurements in parallel will provide new insights into related processes in completely different regions
- The JEO-JGO synergy enables us to address how material from the moons is circulated throughout the magnetosphere, accelerated and re-impact the moons.
- The JEO-JGO-JMO synergy gives us an unprecedented opportunity to reveal the global machinery of the Giant Particle Accelerator of the solar system, providing the ground truth for the planetary environments of other stars.