

Callisto's atmosphere and its space environment: Prospects for the Particle Environment Package on board JUICE

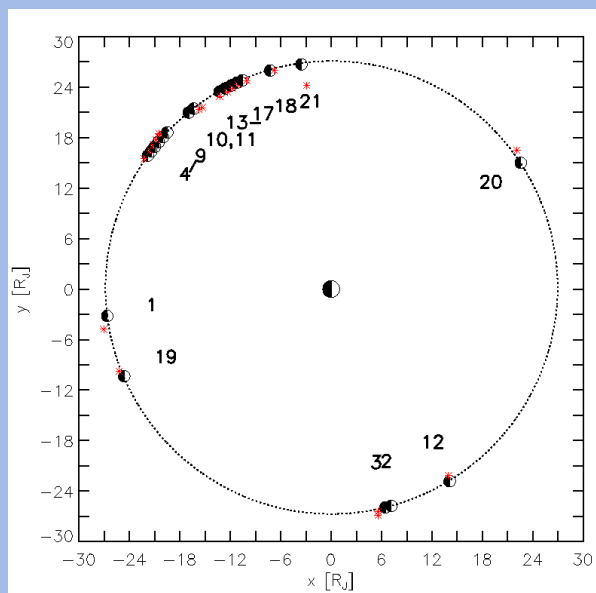


*A. Galli, A. Vorburger,
S.R. Carberry Mogan,
E. Roussos,
G. Stenberg Wieser,
P. Wurz, M. Föhn,
N. Krupp, M. Fränz,
S. Barabash,
Y. Futaana,
P.C. Brandt,
P. Kollmann,
D. Haggerty,
G.H. Jones, R.E.
Johnson, O.J.
Tucker, S. Simon,
T. Tippens, L. Liuzzo*



- *University of Bern, Switzerland*
- *Center for Space Science NYU Abu Dhabi, UAE*
- *Max Planck Institute for Solar System Research, GER*
- *Swedish Institute of Space Physics, SWE*
- *Johns Hopkins University, USA*
- *University College London, UK*
- *University of Virginia, USA*
- *NASA Goddard Space Flight Center, USA*
- *School of Earth & Atmospheric Sciences, Georgia Institute of Technology, USA*
- *Space Sciences Laboratory, University of California, USA*

Planned JUICE trajectory relevant for Callisto (Current baseline: Trajectory 150I0a, CREMA 5.0)

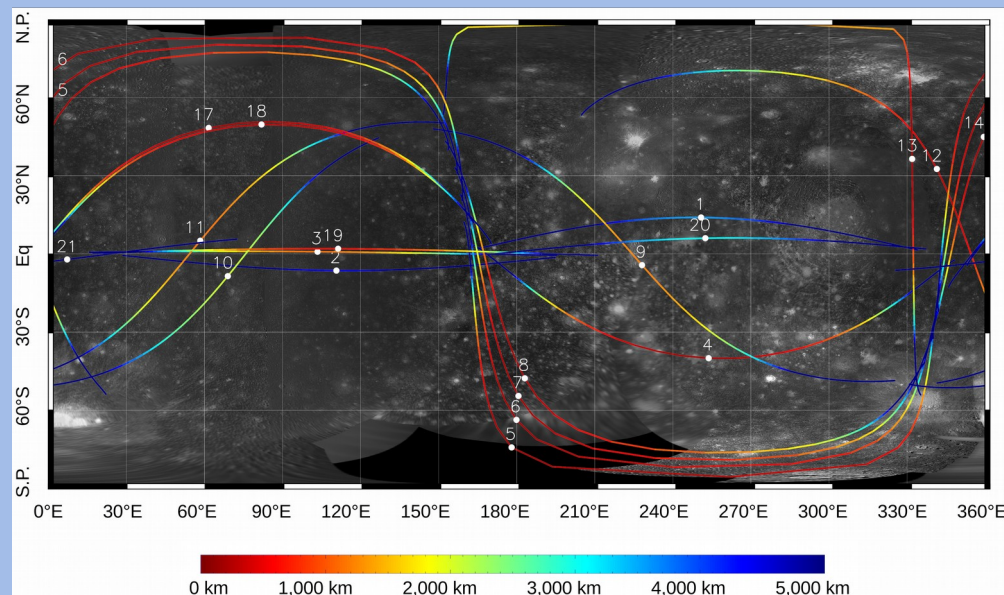


JUICE orbits in Jupiter-Sun-Orbital reference frame:

- **21 Callisto flybys in total**
- Most flybys have similar solar longitude $\sim 120^\circ$

JUICE ground tracks on Callisto's surface:

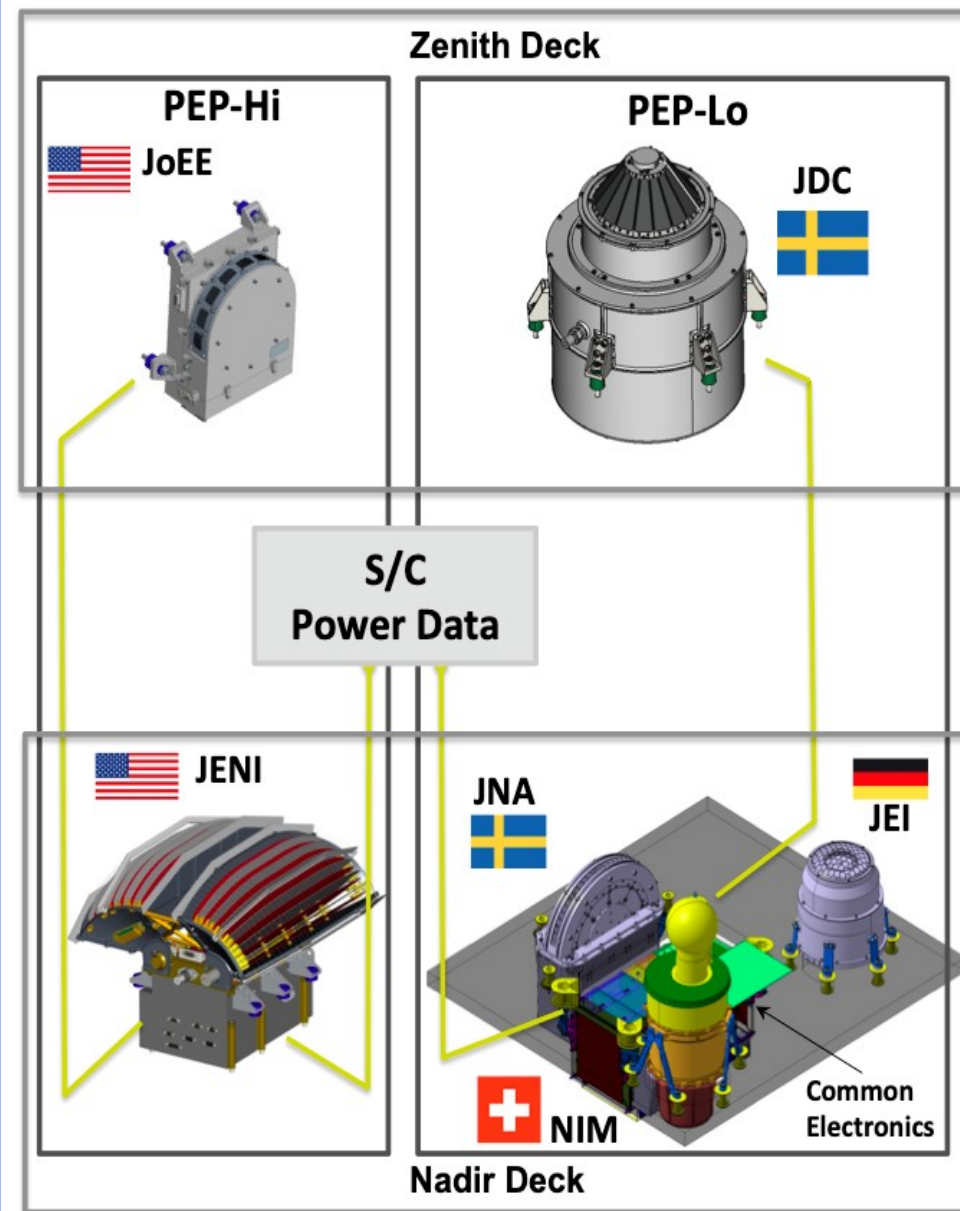
- **12 flybys at $h < 500$ km**
- Polar and equatorial regions covered



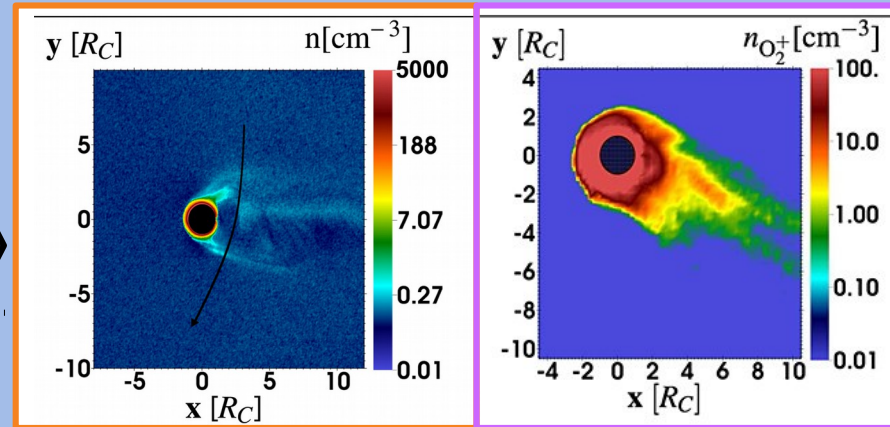
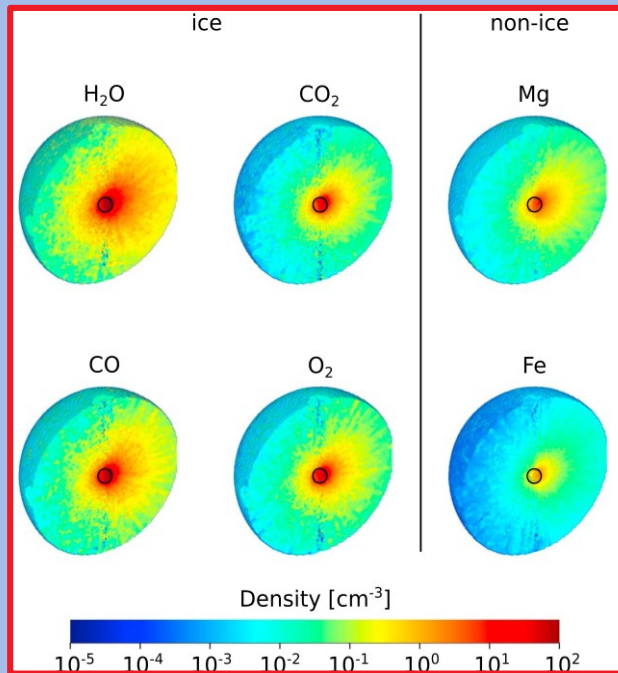
PEP: Combine in-situ **neutrals**, **ions**, **electrons**, and remote **Energetic Neutral Atoms (ENA)** to bigger picture

Particle Environment Package (PEP) = six different instruments:

- **NIM**: Neutral gas and ion mass spectrometer (thermal energies)
- **JDC**: Ion spectrometer and mass analyzer (electron capabilities)
- **JEI**: Electron spectrometer (ion capabilities)
- **JoEE**: Energetic electrons spectrometer
- **JNA**: Low energy ENA imager
- **JENI**: Energetic ion spectrometer and ENA imager (electron capabilities)

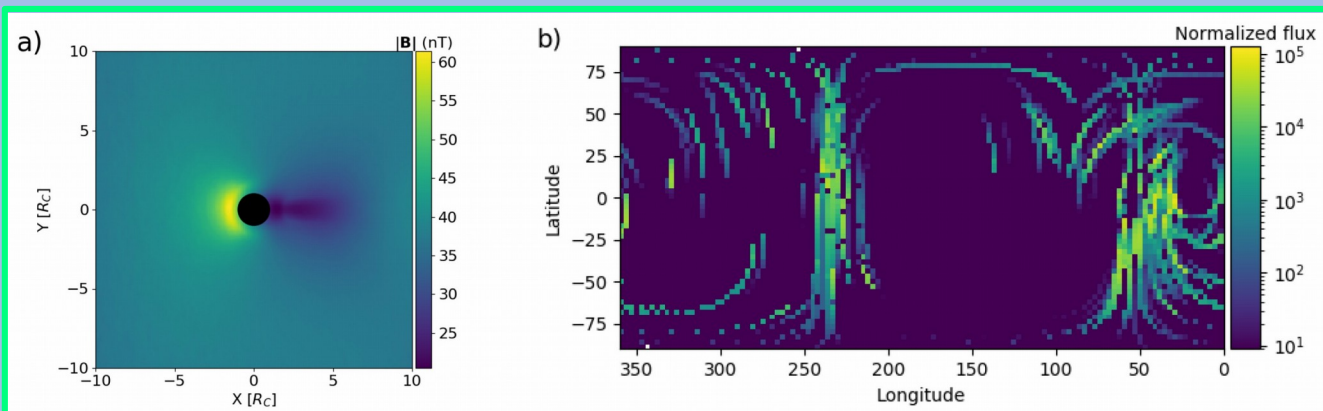


PEP: Combine in-situ **neutrals**, **ions**, **electrons**, and remote **Energetic Neutral Atoms (ENA)** to bigger picture



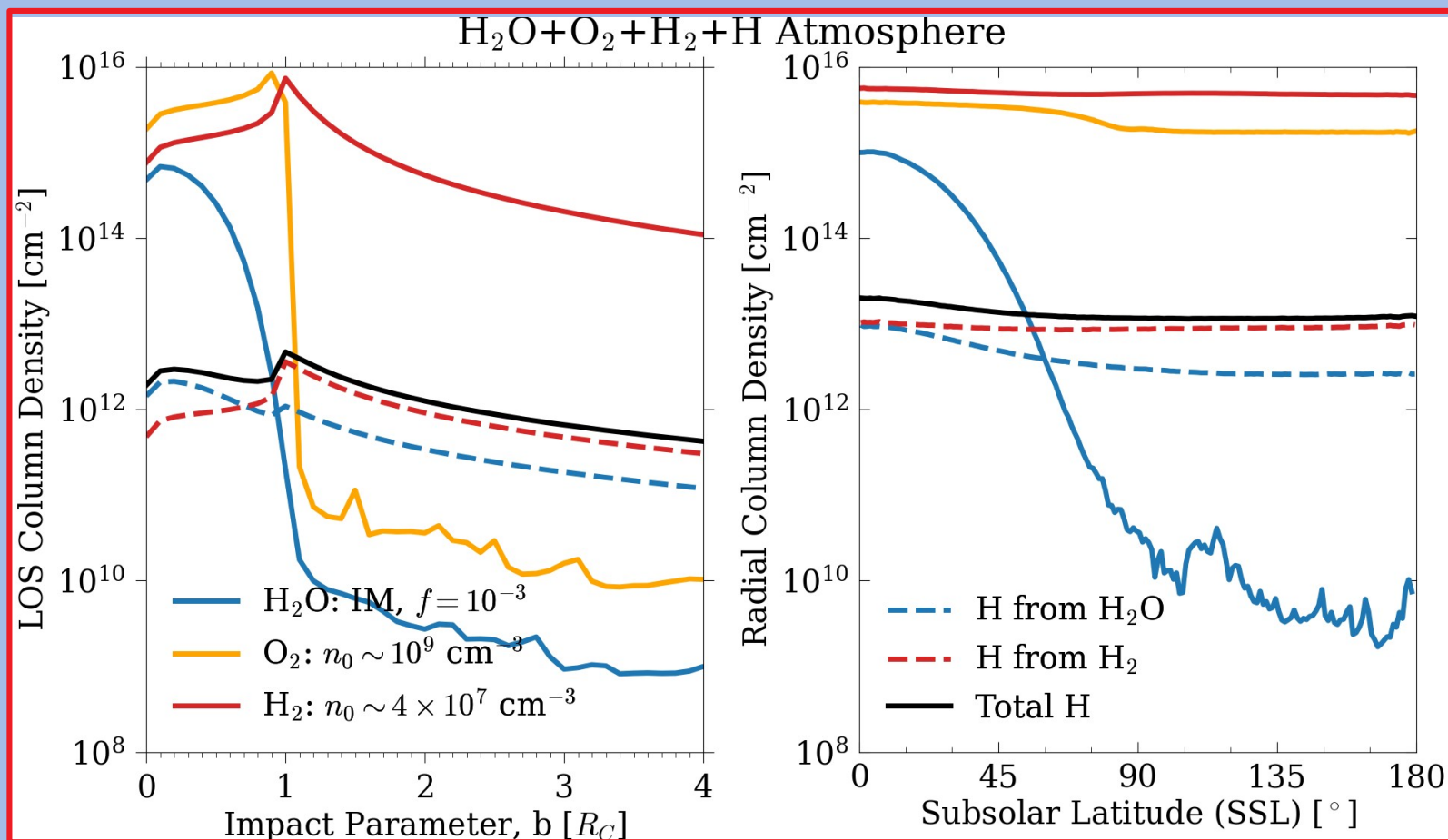
Plasma wake behind Callisto: modelled electron and pick-up ion densities [Liuzzo et al. 2018,2015]

Modelled neutral densities [Vorburger et al. 2019]



Magnetic field strength and predicted ENA flux from Callisto's atmosphere

PEP: Combine in-situ **neutrals**, **ions**, **electrons**, and remote **Energetic Neutral Atoms (ENA)** to bigger picture



Recent update: Modelled neutral densities
[Carberry Mogan et al. 2022, under review]

- > Current JUICE trajectory (launch in April 2023): 21 Callisto flybys in total, closest approaches both on day and night side. Good variety for Callisto surface coverage; for atmosphere and plasma science more downstream flybys and more flybys at sol. long. outside 90°–180° would be welcome.
- > 13 flybys with closest approach below 1000 km crucial to detect heavy neutrals and ions, but neutral measurements to be started at $d > 40 R_C$ from Callisto → Putative neutral torus and extended hydrogen corona!
- > Try to measure electrons, ions, and neutrals in parallel during approach, after closest approach no useful neutrals measurements possible
- > ~10s shortest measurement interval except for electron data (~1s)
- > Background rates at Callisto much lower than near Europa or Ganymede.
- > Tasks for theory and experiments until 2032:
 - Improve atmosphere models (3d, collisions,...) incl. plasma
 - Improve model predictions of ENA images
 - Re-analyse existing plasma data from Galileo
 - Perform laboratory experiments on Callisto surface analogues
- > Looking forward to PEP measurements of plasma, neutrals, and ENAs
- > **This paper is published: <https://doi.org/10.1029/2021EA002172>**