PARTICLE ENVIRONMENT PACKAGE (PEP) FOR THE ESA JUICE MISSION. S. Barabash[1], C. Brandt[2], P. Wurz[3] and the PEP Team [1]Swedish Institute of Space Physics, Box 812, 98128, Kiruna, Sweden (stas@irf.se), [2]The Johns Hopkins University Applied Physics Laboratory, Laurel, MD, 20723-6099, USA (pontus.brandt@jhuapl.edu), [3]University of Bern, CH-3012, Bern, Switzerland (peter.wurz@space.unibe.ch).

PEP overview: PEP is a suite of six (6) sensors arranged in 4 units to measure charged and neutral particles in the Jupiter magnetospheres and at the moons to answer four overarching science questions:

1. How does the corotating magnetosphere of Jupiter interact with the complex and diverse environment of Ganymede?

2. How does the rapidly rotating magnetosphere of Jupiter interact with the seemingly inert Callisto?

3. What are the governing mechanisms and their global impacts of release of material into the Jovian magnetosphere from seemingly inert Europa and active Io?

4. How do internal and solar wind drivers cause such energetic, time variable and multi-scale phenomena in the steadily rotating giant magnetosphere of Jupiter?

PEP measures positive and negative ions, electrons, exospheric neutral gas, thermal plasma and energetic neutral atoms present in all domains of the Jupiter system over nine decades of energy from < 0.001 eV to > 1 MeV with full angular coverage.

PEP provides instantaneous measurements of 3D flow of the ion plasma and composition to understand the magnetosphere and magnetosphere-moon interactions. It also measures instantaneously 3D electron plasma to investigate auroral processes at the moon and Jupiter. Measurements of the angular distributions of energetic electrons at sub-second resolution probe the acceleration mechanisms and magnetic field topology and boundaries.

PEP combines remote sensing using energetic neutral atoms (ENA) with in-situ measurements and performs global imaging of Europa/Io tori and magnetosphere combined with energetic ion measurements. Using low energy ENAs originating from the particle – surface interaction PEP investigate space weathering of the icy moons by precipitation particles. PEP will first-ever directly sample the exospheres of Europa, Ganymede, and Callisto with extremely high mass resolution (M/ΔM > 1100).

PEP sensors overview: The PEP sensors are (1) an ion mass analyzer, (2) an electron spectrometer, (3) a low energy ENA imager, (4) a high energy ENA and energetic ions imager, (5) an energetic electron sensor, and (6) a neutral gas and ions mass spectrometer. The six (6) sensors are grouped into two (2) groups PEP-Hi for energetic particle measurements and PEP-Lo for low energy particle measurements. PEP-Hi includes two sensors and PEP-Lo 4 sensors and respective electronics. The PEP sensors and their performance are described in Table 1. The overall PEP configuration is shown in Fig. 1.

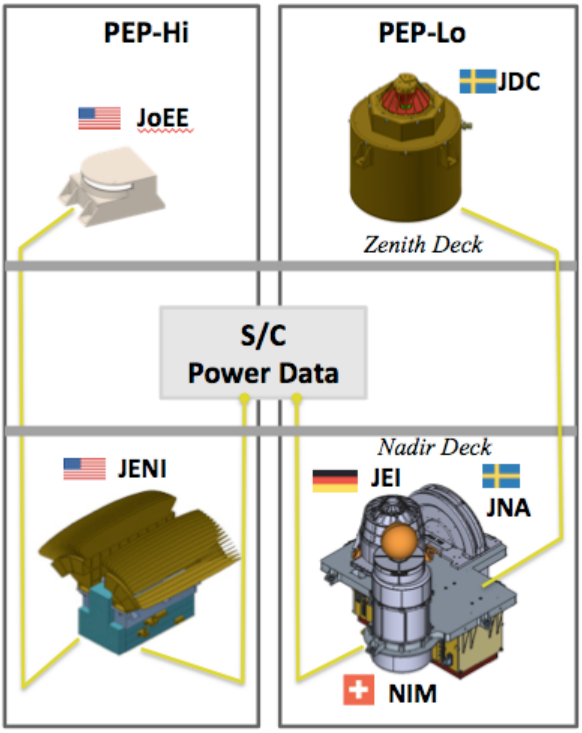

Fig.1 PEP configuration

Table 1. PEP sensors overview

PEP sensor	Key Performance
JDC - Jovian plasma Dynamics and Composition: Design using reflectron and reflecting surface. Instantaneous 3D distributions of positive and negative ions, constraining charge-states, electron measurement capability	Plasma ions and electrons 1 eV – 41 keV, ΔE/E=12% M/ΔM=30 Hemispheric FoV with 5.5˚x19.5˚ ang. resolution
JEI - Jovian Electrons and Ions: Instantaneous 3D distributions of plasma electrons, ion measurement capabilities	Plasma electrons and ions ~1 eV – 50 keV, ΔE/E=4.9% Hemispheric FoV with 20˚x10˚ resolution

JoEE - Jovian Energetic Electrons: Ultra-lightweight energetic electron sensor built on the Galileo energetic particle detector technique. Instantaneous pitch-angle distributions and spectra.	Energetic electrons 25 keV – 1 MeV, $\Delta E/E \leq 20\%$ FoV:12˚x180˚, 12˚x22˚ resolution
NIM - Neutral gas and Ion Mass spectrometer: Compact design based on TOF and reflectron. First-ever exospheric neutral gas and thermal plasma mass spectroscopy at Jupiter's moons.	Thermal neutrals and ions (<5 eV) Mass range: 1-1000 amu $M/\Delta M$=1100 Sensitivity: 2 cm^{-3} ($\sim 10^{-16}$ mbar)
JNA - Jovian Neutrals Analyzer: ENA camera based on successful instrument on the Lunar Chandrayaan-1 mission. Imaging of Io plasma torus, backscattered and sputtered surface products.	Low-energy ENA 10 eV – 3 keV (H) 7˚x10˚ ang. resolution
JENI - Jovian Energetic Neutrals and Ions: Combined energetic ion and ENA camera based on Cassini, IMAGE and Juno. Global imaging of magnetosphere and neutral gas tori.	ENA and ions ~0.5 – 300 keV (ENA), 5 MeV (ions) $\Delta E/E$=14% 90˚x120˚, 2˚ ang. resolution (>10 keV H)

PEP Team: PEP sensors and subsystems have a high technology readiness level and are built on direct flight and team heritage from Galileo, Cassini, Juno, Mars Express (ASPERA-3), Venus Express (ASPERA-4), Rosetta, SOHO, New Horizons, Chandrayaan-1, IMAGE, & RBSP. The PEP team and team member's responsibilities are listed in Table 2.

Table 2. PEP Team

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PI – Principal Investigator
SL – Sensor Lead