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Feasibility study of in-situ measurements of Europa's neutral and plasma plumes with JUICE/PEP

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We investigate the spatial distribution of the neutral and plasma particles originating from the Europa plume [1] by simulating their trajectories in order to evaluate their in-situ detection by the PEP (Particle Environment Package) instrument, a part of the JUICE scientific payload. We first produced neutral test particles by assuming source characteristics (temperature and mass flux) of the water plume. Subsequently these particles were traced under Europa's gravity field to obtain the density distribution of the plume gas. Then test particles representing water molecule ions were produced by combining the neutral density distribution and a time constant for electron impact reactions. Subsequently the trajectories of the produced water molecule ions were traced under the Jovian corotational electromagnetic field. Finally, from the calculated neutral density and the plasma velocity distributions, we emulated the observations of the neutrals and ions along the two Europa flybys planned for the JUICE mission. We did this specifically for the PEP/NIM (Neutral gas and Ion Mass Spectrometer) and PEP/JDC (Jovian plasma Dynamics and Composition analyser) sensor. The derived signal to noise ratios are well above the detection limits of NIM and JDC (S/N>100 and >10, respectively), even if we assume a rather low-mass-flux plume ($\sim$0.7 kg/s, which is 10^4 times less than what was reported in [1]). The flux is significantly asymmetrical between the inbound and outbound trajectory, because the charged particles are flowing downtail (leading hemisphere direction) due to the Jovian co-rotation flow.

[1] Roth, L., J. Saur, K. D. Retherford, D. F. Strobel, P. D. Feldman, M. A. McGrath, and F. Nimmo, Transient water vapor at europa's south pole, Science, 343(6167), 171–174, doi:10.1126/science.1247051, 2014.