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Development of radiation hard electron monitor RADEM for ESA JUICE mission

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Future mission of ESA to Jupiter – JUICE - will be equipped with a new radiation monitoring instrument RADEM. The main purpose is characterizing of the highly dynamic and hazardous although rather weakly known particle environment of the giant planet. RADEM performance must be tailored with numerous constraints and severe risks put on the instrument and its detection system. The first objective is precise spectroscopy of electrons and protons over more than two energy orders i.e. up to 40 MeV and 250 MeV respectively. It requires an exact identification of particles and supreme suppression of the background. Measurements should in addition provide dynamic maps of particle directionality and be very accurate even for extremely high particle fluxes. Further goals cover detection of heavy ions with their LET and determination of the radiation dose and dose rate absorbed by the spacecraft. Constrains and risks are given by limitations put on the monitor mass, volume and power and by radiation damage hazards imposed on its materials, electronic components and detection sensors. Additional challenge is in required instrument operational longevity. The design of RADEM is supported by extensive modeling and Monte Carlo simulations based on present knowledge of the Jupiter radiation environment. Deeper level of optimization requires taking into account the whole spacecraft with all its modules and structures. For entire detection system of RADEM the Si-sensors equipped with structures minimizing radiation damage are chosen. They have individual design features in accordance to their specific functionality such as pitch angle measurements with the directionality detector or energy spectroscopy with the telescope. Detected signals are processed using specially designed low power, radiation hard ASIC responsible for both analogue and digital branches. Initial results based on the previous ASIC version as well as data from studies of the detector radiation damage already exist. First tests with the ASIC prototype will be available in near future.