

## Towards a SiPM based fluorescence camera

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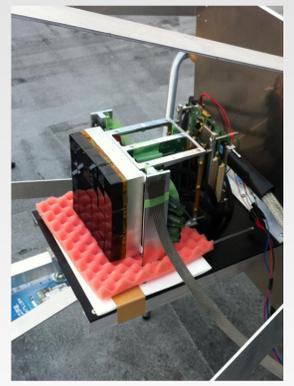
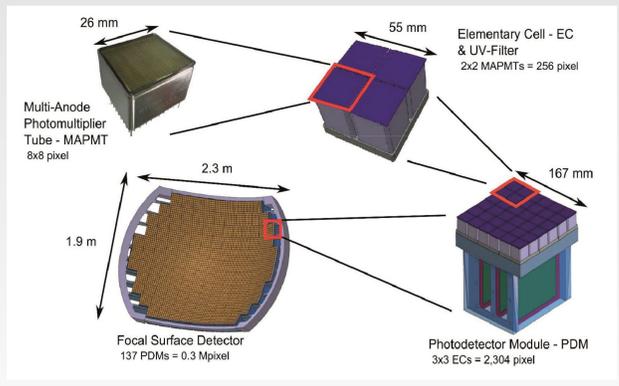
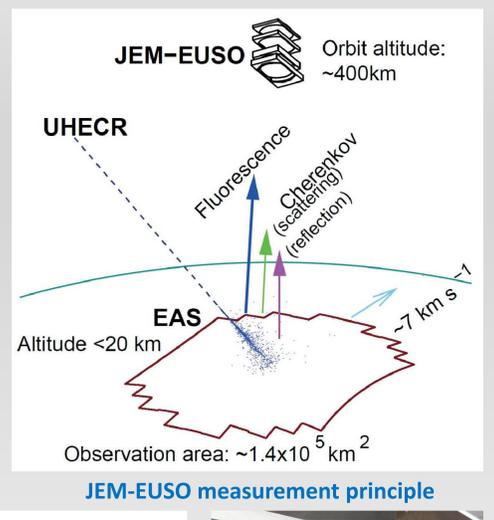
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Poster 3 CR/171



### JEM-EUSO

JEM-EUSO aims to explore the origin and nature of the extreme energy cosmic rays (EECRs) through the observation of air-shower fluorescence light from space.



### EUSO – Test Experiments

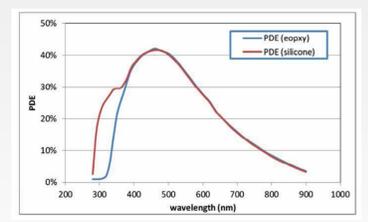
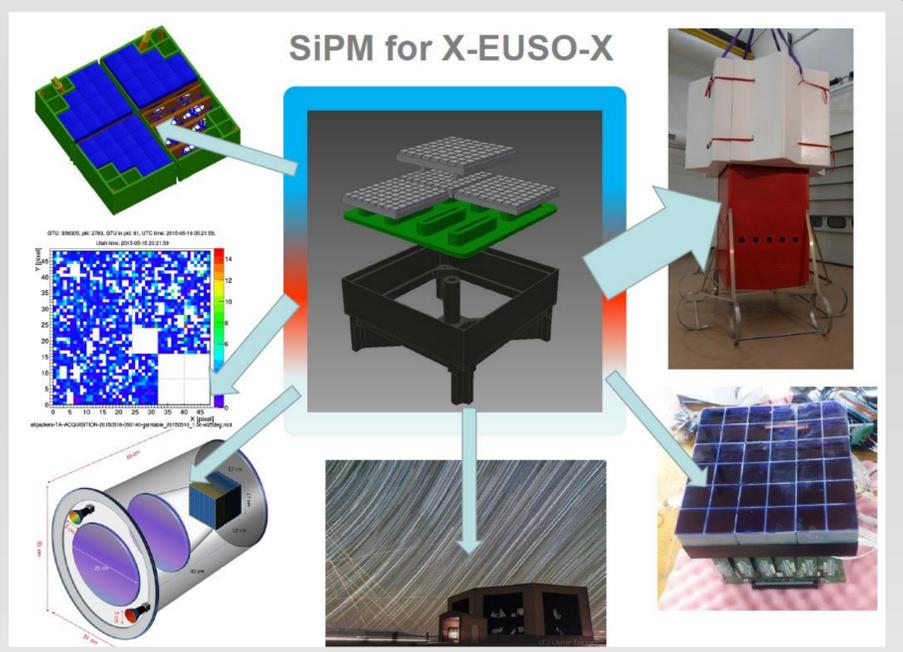
- On the way to getting the full instrument, several test or pathfinder experiments (1 PDM, each) are needed and currently under development or in operation.
  - EUSO-Balloon** had a first flight on August, 25, 2014
  - More balloon flights, including a NASA long duration flight with a super pressurized balloon (**SPB-EUSO**)
  - EUSO-TA** is a ground-based telescope located at Utah, USA, making use of the LIDAR and an Electron Light Source at TA
  - Mini-EUSO** is foreseen to operate inside the ISS for observation of the UV emission from the night-Earth

- SiPM-EUSO:** R&D program to evaluate if SiPMs can replace the heavy, HV-operated and expensive MAPMTs. The development plan includes several steps with the aim to complete the program on a time scale of 2-3 years.

- Development of an EC-like photo sensor based on SiPMs
- Integration of the SiPM-EC into the electronics and data stream of the JEM-EUSO test experiment devices
- Prototype of a SiPM based PDM
- R&D to apply the PDM in a space-based experiment
- Design study of a full SiPM focal surface detector

### SiPM for JEM-EUSO: Issues to consider

- Goal: SiPM-EC within next 1 to 2 years**
  - a large sensitive area with a high filling factor
  - improvement in sensitivity to fluorescence light (UV 300nm)
  - fast readout (e. g. specific ASIC, monolithic SiPM/ASIC)
  - characteristics of the new generation SiPMs
- Work packages:**
  - Going for different SiPMs:** various companies produce (arrays of) SiPMs, (their dark current, gain stability and crosstalk have to be compared)
  - Going for single photon calibration:** required for space EAS measurements
  - Going for larger arrays of SiPM:** no light cones at focal surface
  - Going for UV sensitivity:** fluorescence spectrum is down to 300 nm
  - Going for temperature control:** needed operation in stable (space) low (dark current) temperatures
  - Going for dynamic range:** is needed as low-light (EAS) and high-light (meteors, lightning, cities) measurements are done in parallel
  - Going for fast readout:** probably dedicated ASIC is needed best would be a monolithic design
  - Going for simulations** of sensitivities for all measurement modes
  - Going for integration as EC:** concept to integrate SiPM-EC in EUSO-DAQ
  - Going for integration in PDM:** concept to integrate SiPMs in EUSO-PDM
  - Going for vibration tests:** do SiPM arrays have space qualification
  - Going for radiation tests:** damage of SiPM lattice structures in space?



	PMT	SiPM
PDE	20-40%	20-60%
Gain	$10^6$	$10^6$
TTS (Transit Time Spread)	~1 ns	~1 ns
Dynamic range	$10^6$	$10^3$
Dark noise rate	~kHz	~MHz
Behavior in magnetic fields	☹️	☹️
Operation Voltage	1000+ V	50-70 V
Temperature sensitivity	☹️	☹️
Robustness and compactness	☹️	☹️

**Comparison MAPMT SiPM**

