ESA's activities related to the meteoroid environment

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- **Engineering flux models**
- **In-situ impacts**
- **Fireball database as part of SSA**

Meteoroid flux models

- ESA routinely performs impact risk assessments for space debris and meteoroids for its missions.
  - Soft parts of EVA suits can be penetrated by 0.5 mm particles
  - Pipes and tanks can be punctured (and made to burst) by mm sized particles
- Engineering flux models are required
- Standard meteoroid models are defined in ECSS-E-ST-10-04C:
  - Interplanetary flux model from Grün et al. or Divine-Staubach model for Earth Orbits
  - Grün et al. model near 1 AU (incl. moon and L1,L2)
  - Grün et al. model shall be used with Taylor HRMP velocity distribution
  - For interplanetary space no standard is defined (use, what is available, e.g. Divine-Staubach, MEM, IMEM)

Meteoroid flux models

IMEM/Dikarev model (2003)

Applicable regime:

- Between 0.1 and 10 AU from sun
- Mass range: 10^{-18} – 1 g

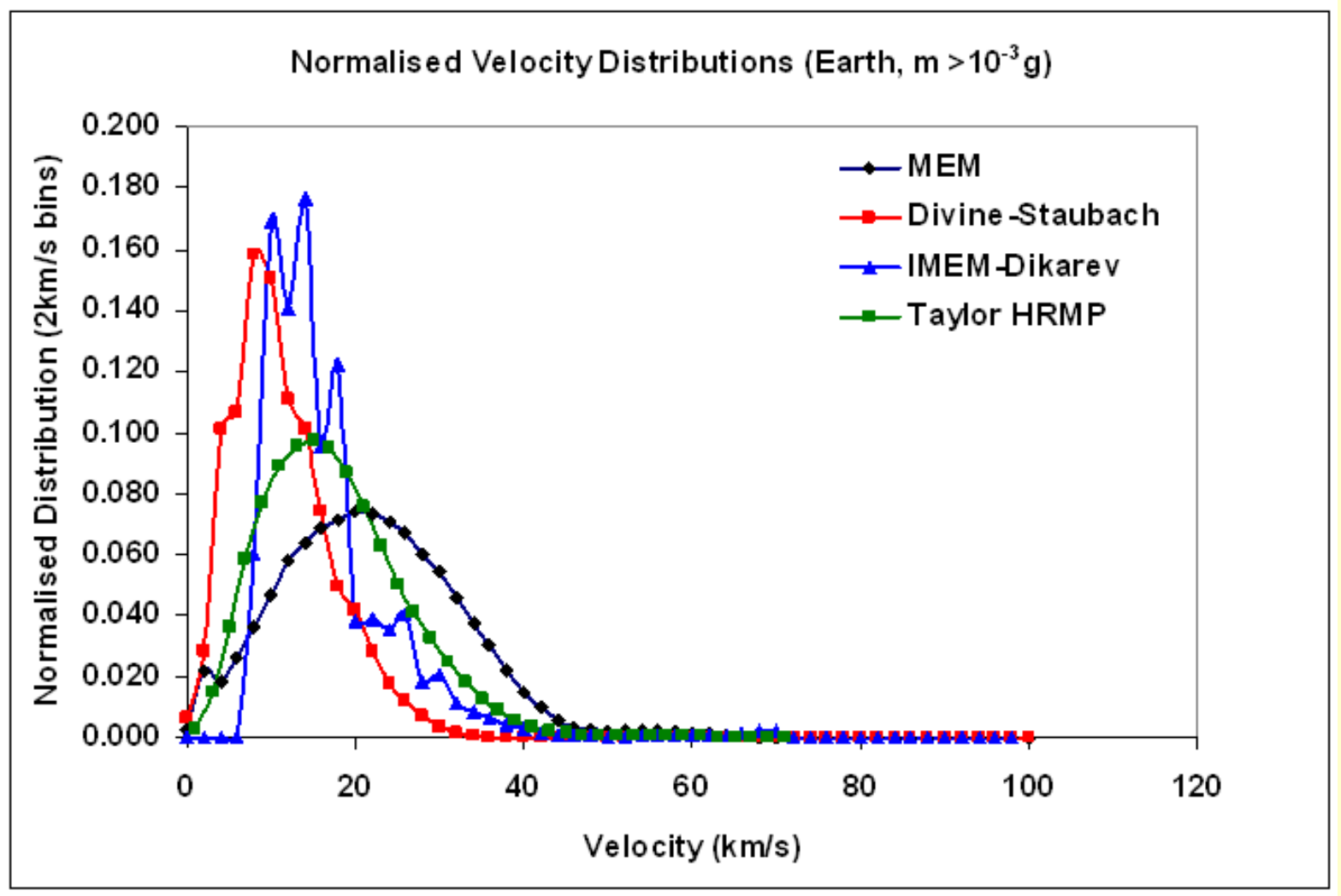
Basic composition of the model: 5 different populations:

- Asteroidal collisions
- Asteroidal Poynting-Robertson
- Comets collisions
- Comets poynting-robertson
- Interstellar dust (Adopted from Divine-Staubach model, re-fitted with Ulysses data)

Comparison of meteoroid flux models

Orientation averaged velocity distributions

1 AU



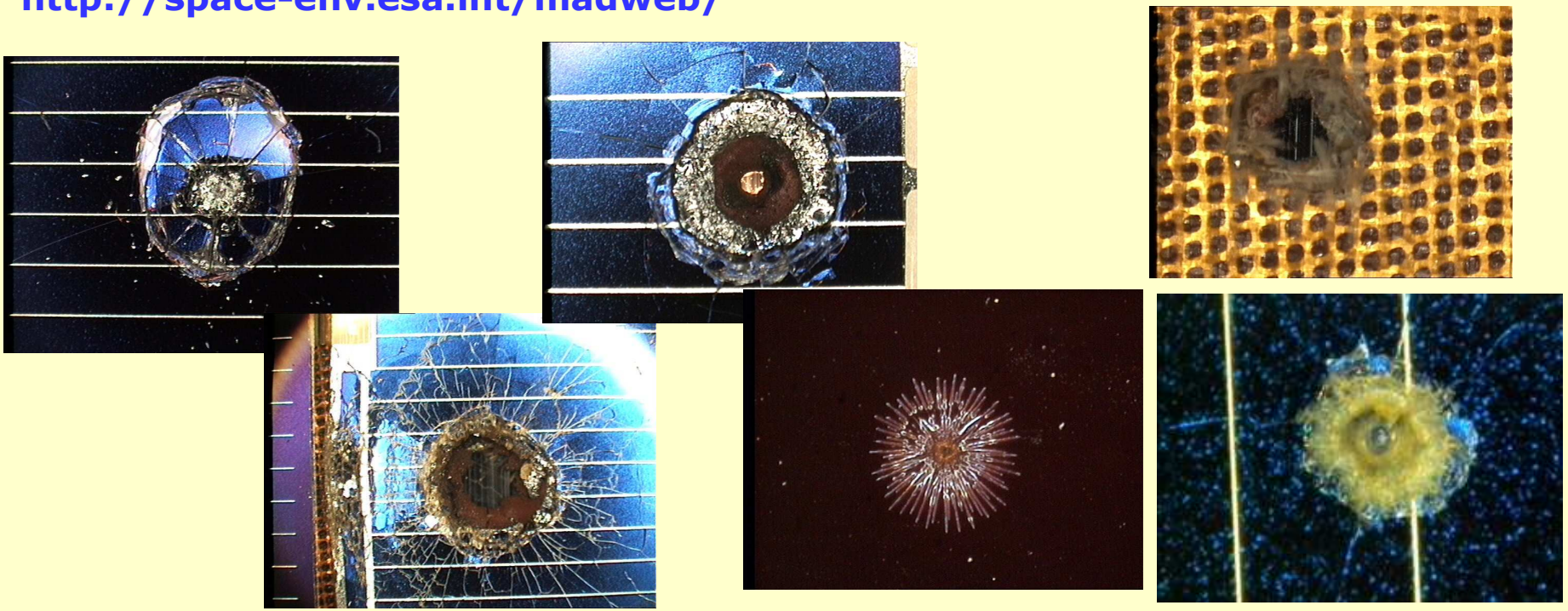
Meteoroid flux models

- The Interplanetary Meteoroid Engineering Model (IMEM) is presently being enhanced to IMEM2 (by V. Dikarev, Univ. Bielefeld)
  - The activity mainly targets the user interface
  - Minor upgrades of the physical model itself are planned
  - Completion is expected for end of 2010
- A new upgrade of IMEM2 is planned which mainly addresses the physical model:
  - Consideration of recent radar data
  - Consideration of meteor data
  - Option for ground based observer
  - Other improvements
- A TRP study of 150K is planned (TBC). Start could be mid of 2011.

Impacts on retrieved hardware

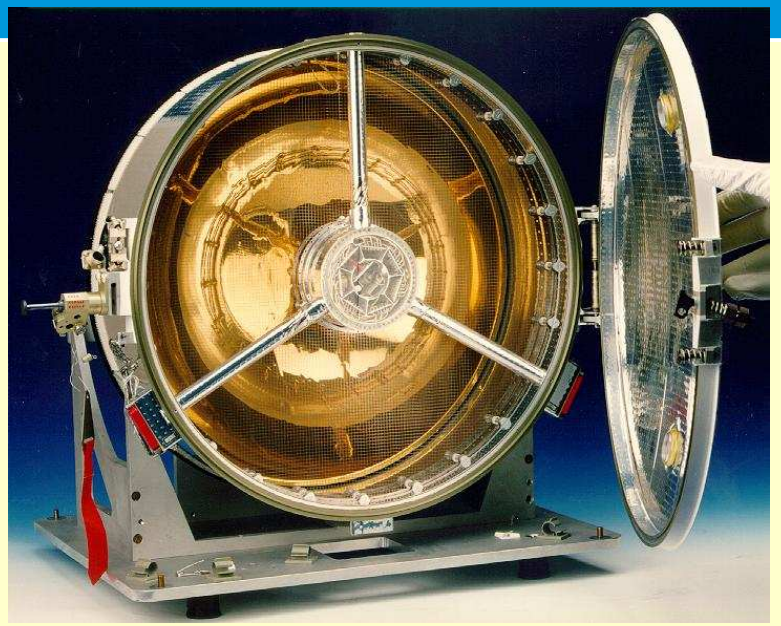
ESA performed post-flight impact studies on EURECA and Hubble Space Telescope solar arrays retrieved in 1993 and 2002.

- Thousand of impact craters were visible with the naked eye.
- Chemical analysis of impact residues allowed a distinction between meteoroids and space debris.
- Detailed info and more than 1000 impact craters images are available under: **http://space-env.esa.int/madweb/**



In situ impact detectors

- ESA has flown 3 active impact detectors in Earth orbits
- GORID in GEO
- DEBIE-1 in polar orbit
- DEBIE-2 on ISS
- Other detectors are planned or under development (AIDA, trajectory analyzer)



- GORID uses impact ionisation technique. Sensor size: 0.1 m^2
- DEBIE uses a combination of impact ionisation and momentum detection. Up to 4 sensors, sensor size: 0.01m^2

SSA Overview

- In November 2008 ESA member states approved the new Space Situational Awareness (SSA) Programme
- The European SSA System can be broken down in three distinct segments:
  - **Space surveillance** of man-made objects in Earth-bound orbits
  - **Space Weather effects** (e.g. solar radiation)
  - **Near Earth Objects (NEOs):** hazardeous asteroids and comets
- The approved Preparatory Programme Phase runs from 2009 – 2012 and is funded with 50M€

SSA-NEO System
Planned structure and activities

- The European SSA NEO system will focus on
  - risk computations
  - follow-up observations
  - wide NEO survey (TBC)
  - NEO characterisation
  - Support of mitigation measures
  - coordination and cooperation activities

- Initially, services will be based on existing tools and facilities

SSA-NEO Segment
Planned scope and activities

- No fixed size threshold for NEOs/meteoroids has been set.
- It is foreseen to keep a record of all larger fireballs (m < -10) and to provide statistical information and predictions on meteoroid fluxes.
- Activities related to atmospheric entry, impact effects and mitigation issues can be supported.
- Amateur astronomers could be involved

SSA-NEO Segment
Basic concept