IfR Institut für Raumfahrtsysteme

Institut für Luft- und Raumfahrtsysteme

esa

DEVELOPMENT OF IN-SITU SPACE DEBRIS DETECTOR

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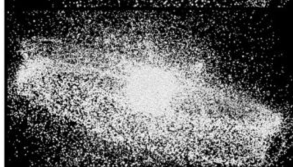
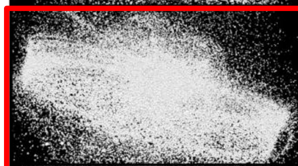
39th COSPAR Scientic Assembly 2012

DLR

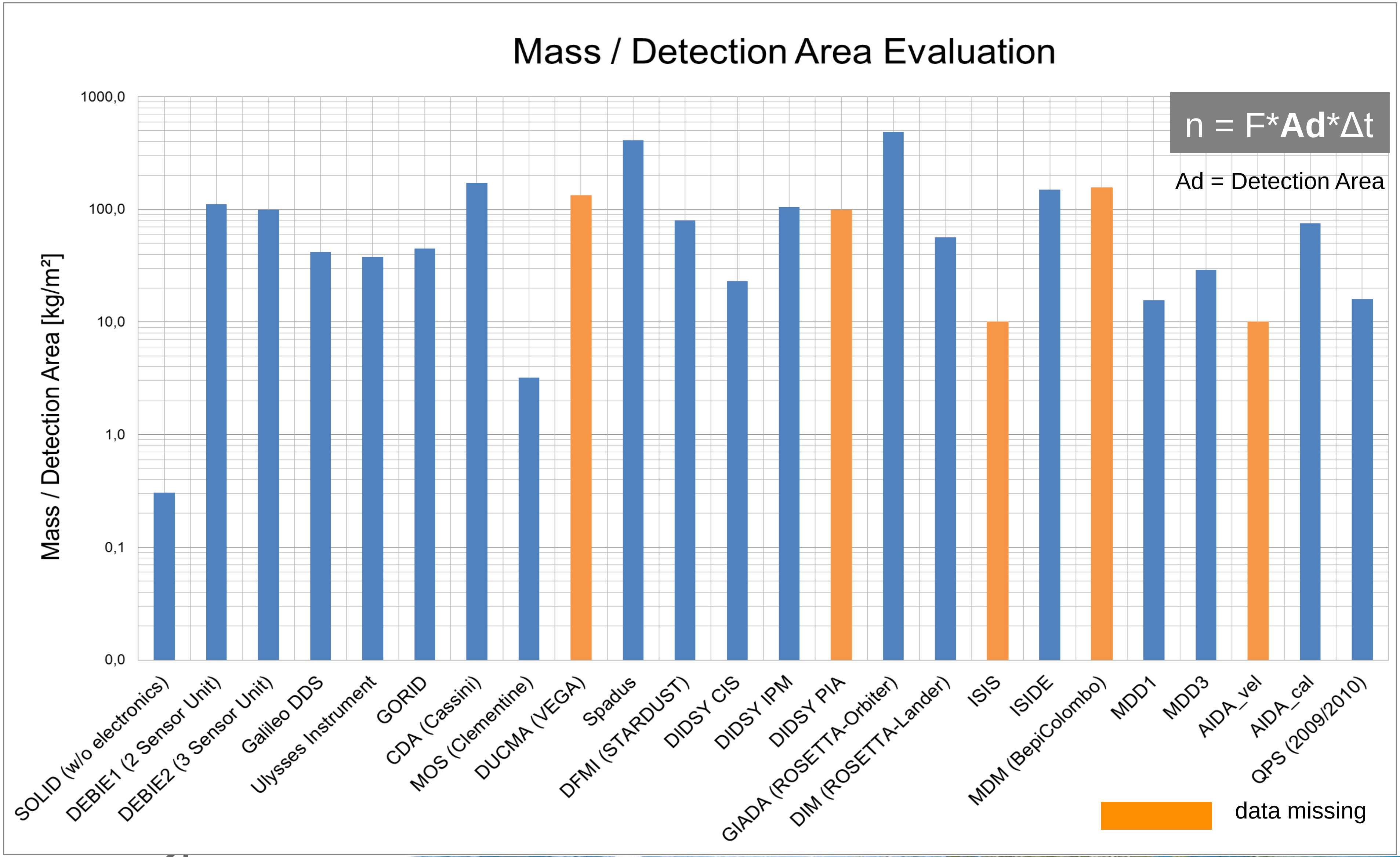
Space Debris Population

2009	Size	Quantity	Comments
	Ground based surveillance (normal) 16.300 Objects within radar catalog (some of them ca. 5cm) Ca. 800 active Satellites Mission lost in case of collision.		
	>10cm	29.000	Ground based surveillance (limited) Mission lost in case of collision.
	>5cm	60.000	Ground based surveillance (limited) Mission lost in case of collision.
	>1cm	700.000	1 cm object releases energy equivalent to hand grenade Mission lost in case of collision.
	>1mm	200 million	***Retrieved Surfaces / In-Situ Detectors,*** High probability of spacecraft damage in case of collision.
	>100µm	trillions	***Retrieved Surfaces / In-Situ Detectors,*** Damage /degradation of spacecraft in case of collision possible.

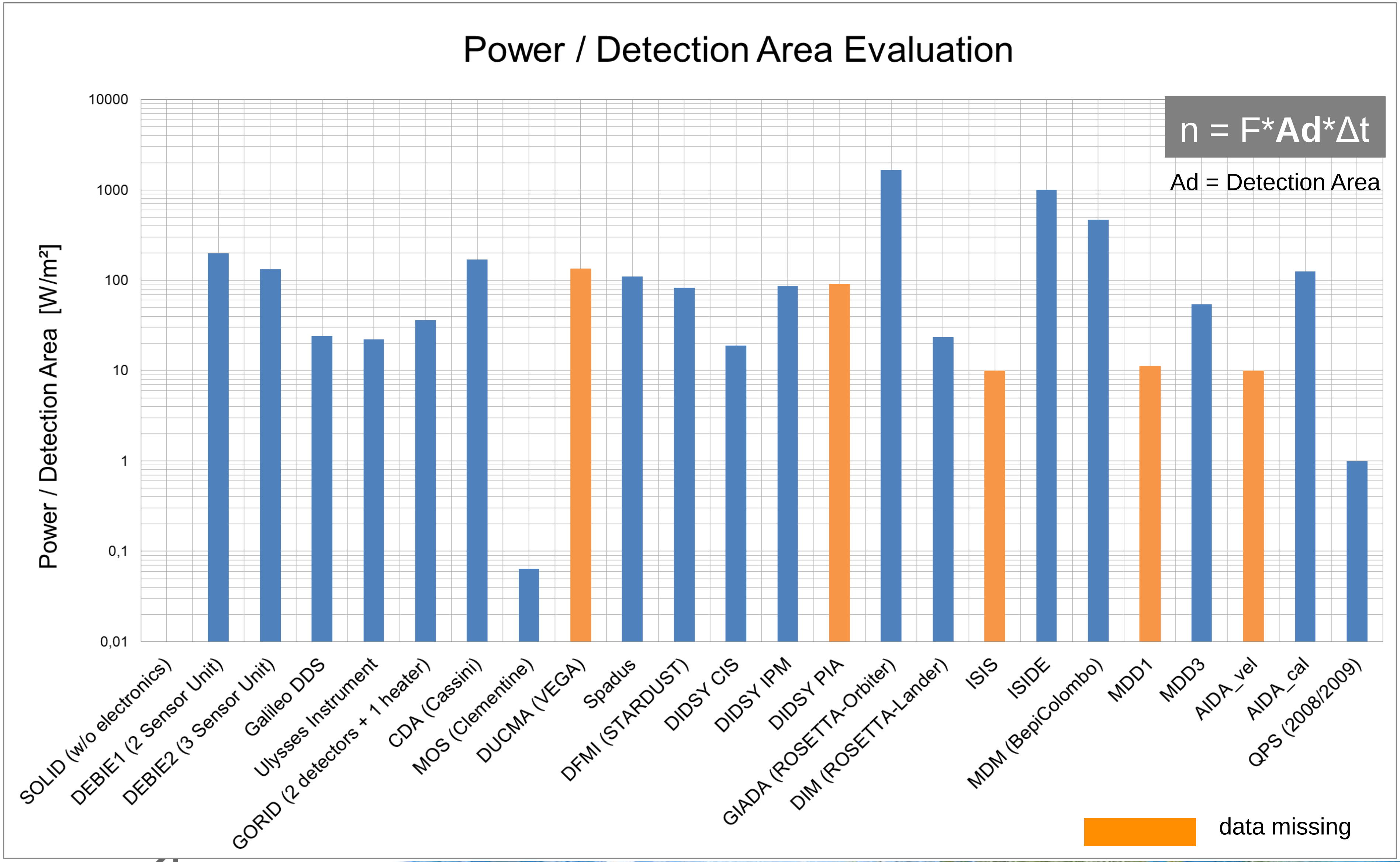
Ref. data based on: C. Wiedemann, Technical University Braunschweig, June 2012

Probability of collision with small particles (SD, MM) very high!

Detector Comparison



Detector Comparison



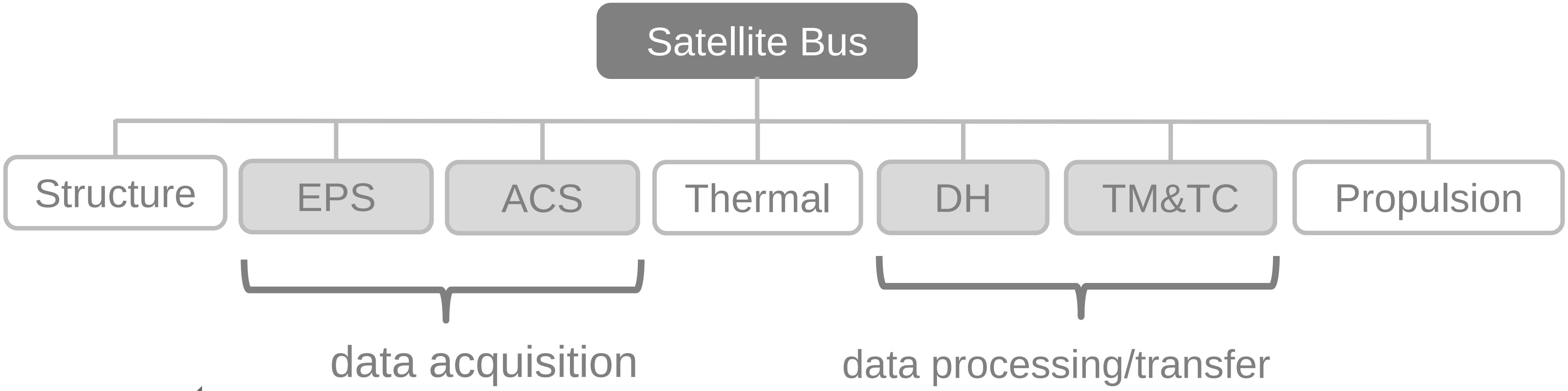
Main Key-Issues for Detector Development

- Mission Duration (Δt) : *long*
- Detection Area (Ad): *large*

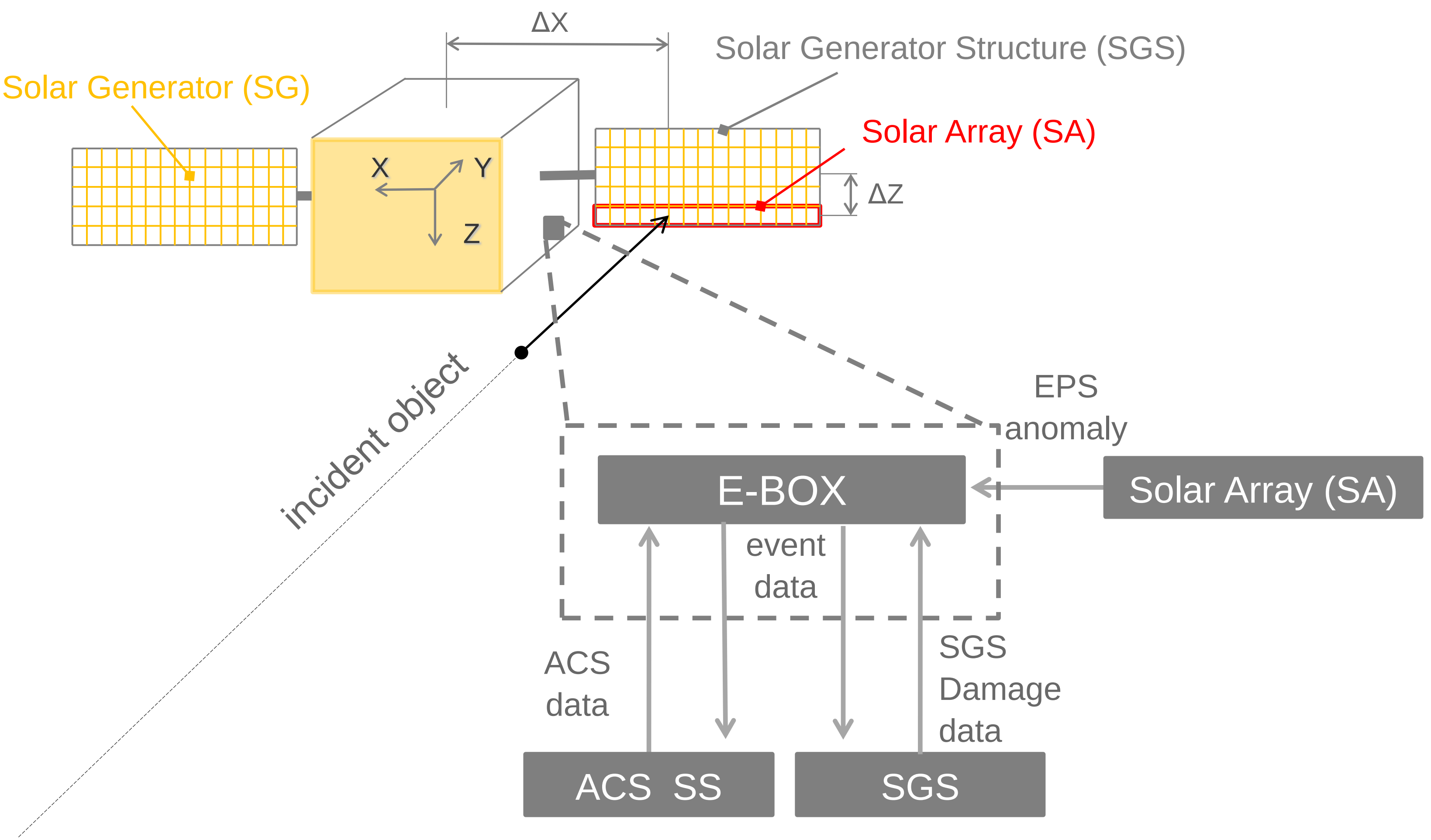
$$n = F*Ad*\Delta t$$

- Mass, Volume, Power Consumption, Data Rate: *low*
- Implementation to S/C : *simple*

Adaptation of existing Satellite Subsystems for Impact Detection

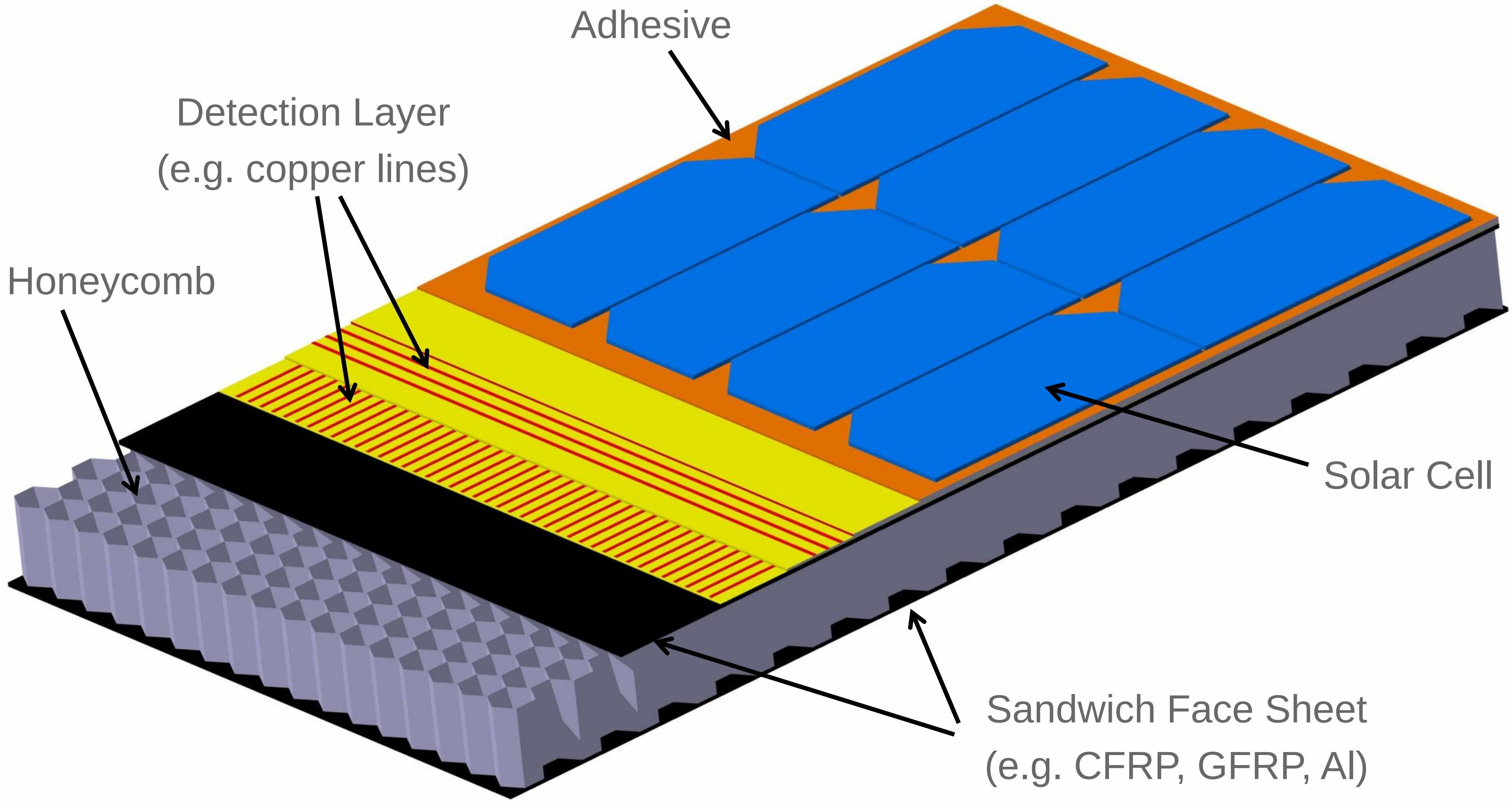


SOLID (SOlar generator based Impact Detector)

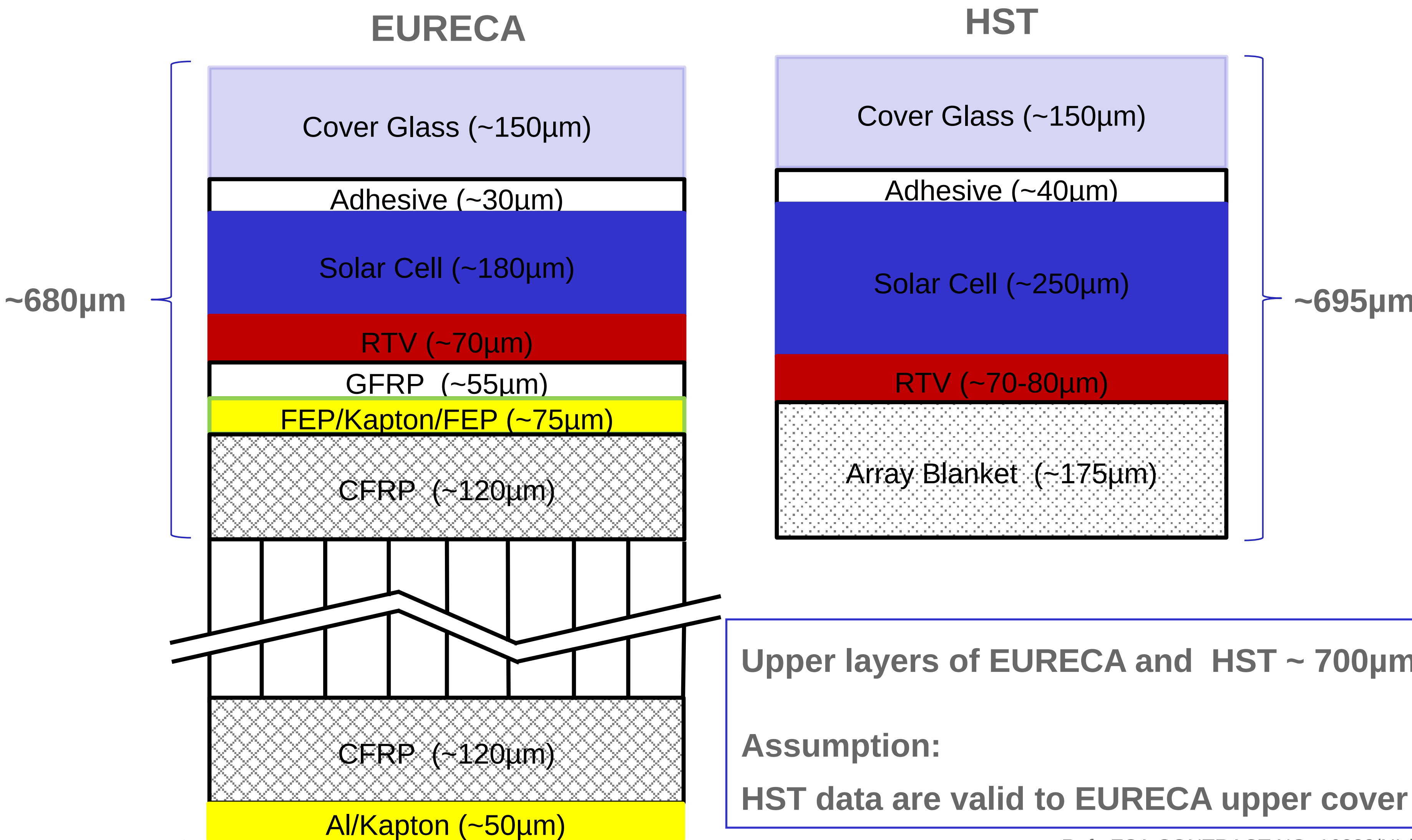


- Derive of particle properties (e.g. diameter, velocity) and damaged area on solar generator (mechanical/ESD) by using damage equations and ACS data

SOLID (SOlar generator based Impact Detector)



EURECA vs. HST Solar Generator



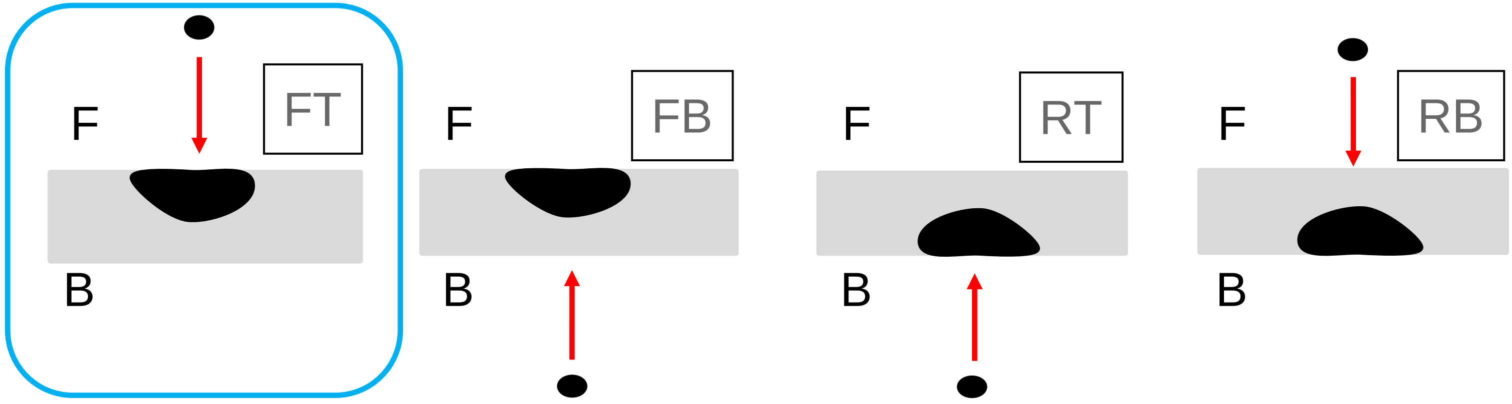
Upper layers of EURECA and HST ~ 700µm

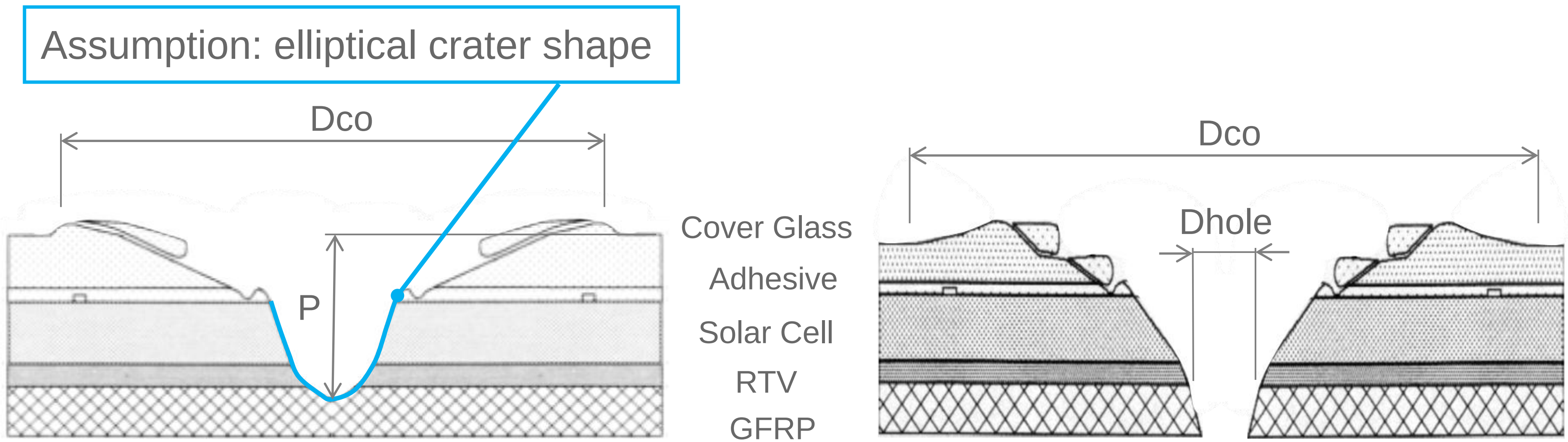
Assumption:

HST data are valid to EURECA upper cover

Ref.: ESA CONTRACT NO. 16283/NL/LvH

Damage Morphology



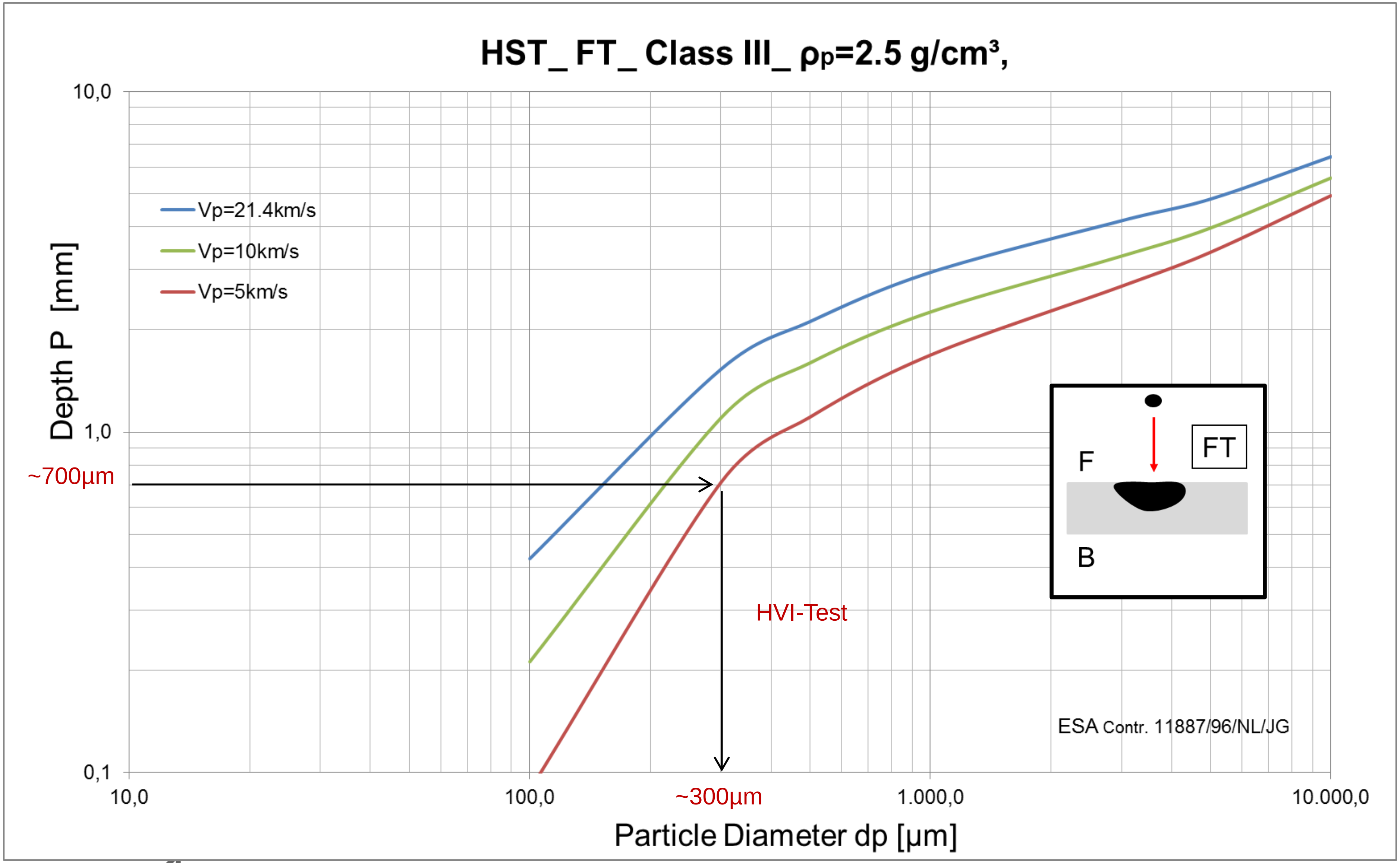


Class III impact morphology – (Front-Top/Near-Circular Impact)

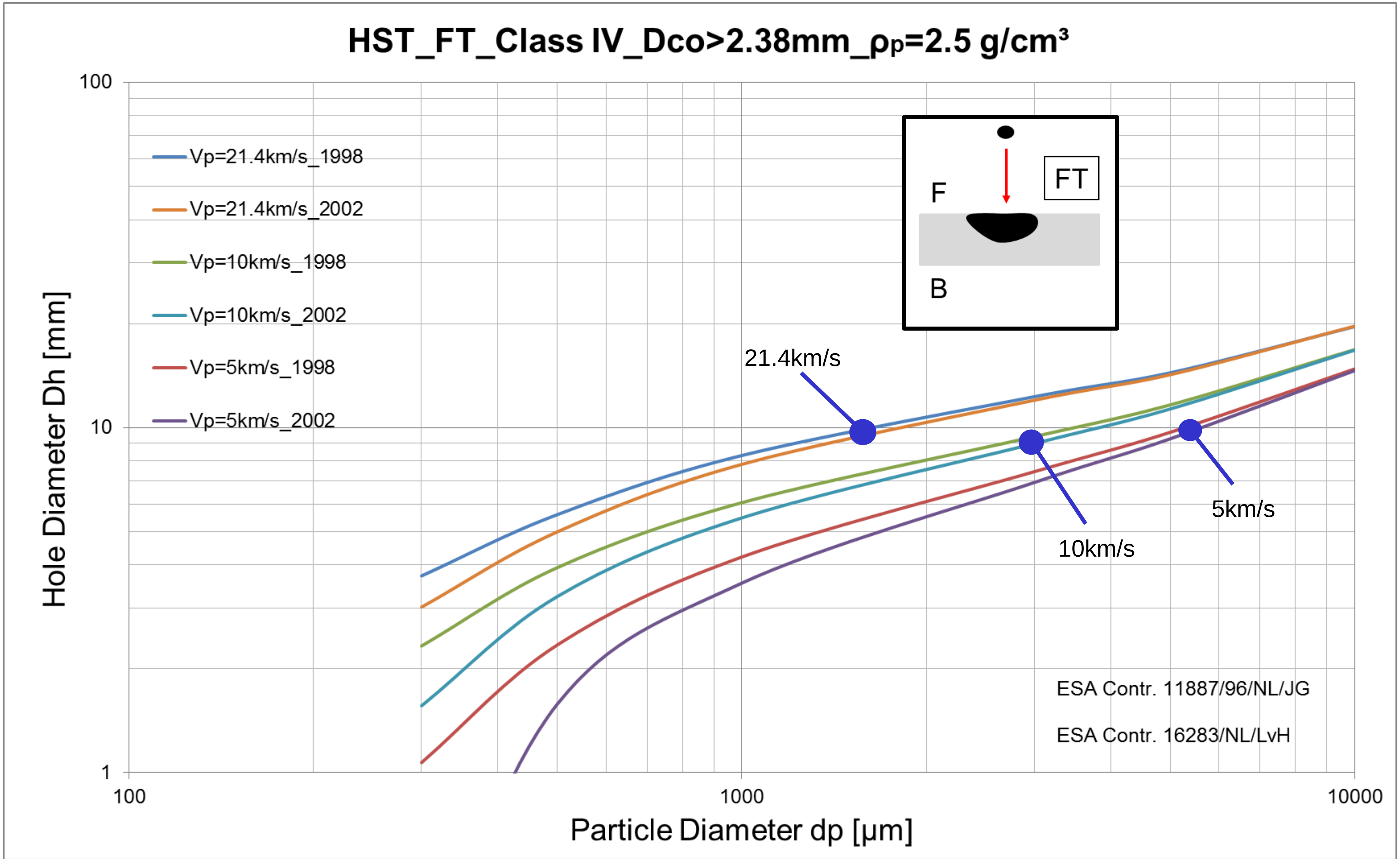
Class IV impact morphology – (Front-Top/Near-Circular Impact)

Ref.: ESA CONTRACT NO. 11887/96/NL/JG

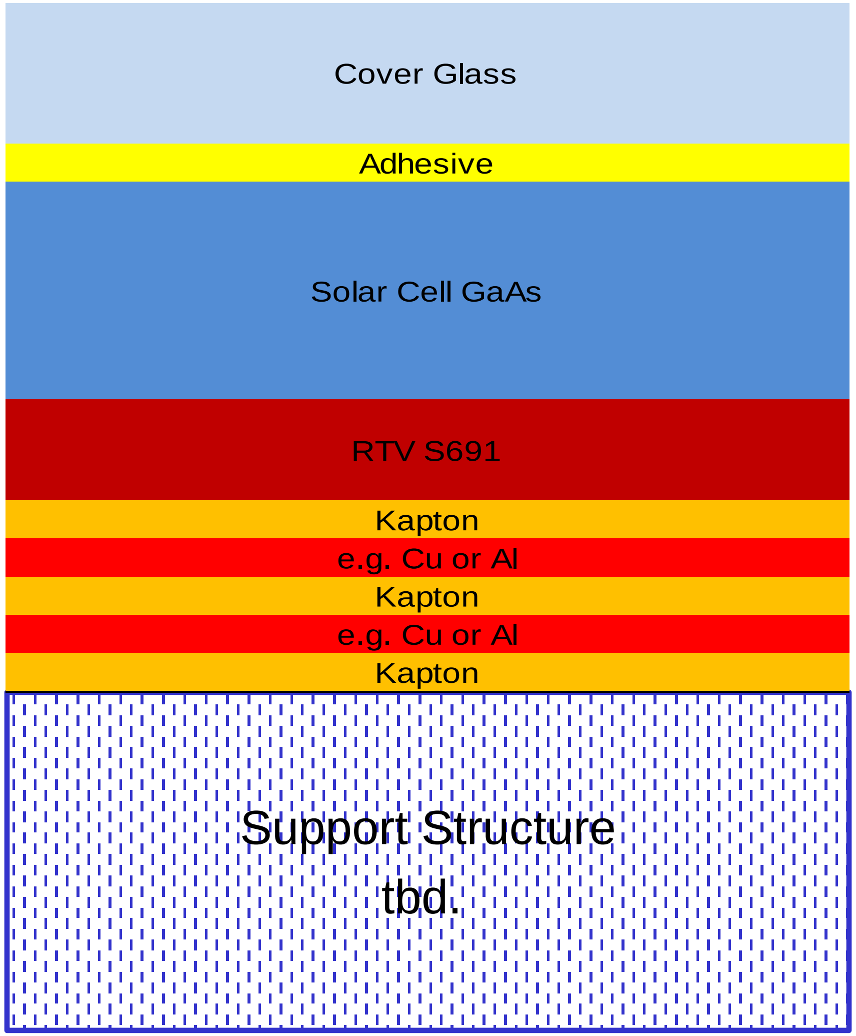
Damage Morphology



Damage Morphology



SOLID Adaptation Option for Large S/C



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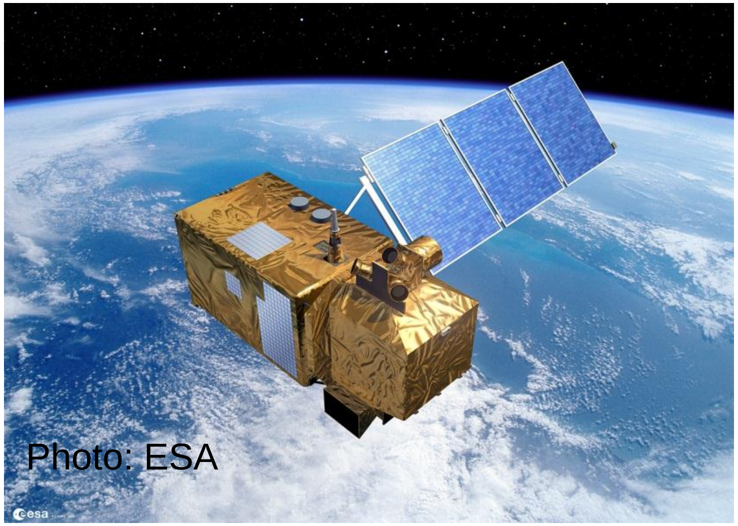
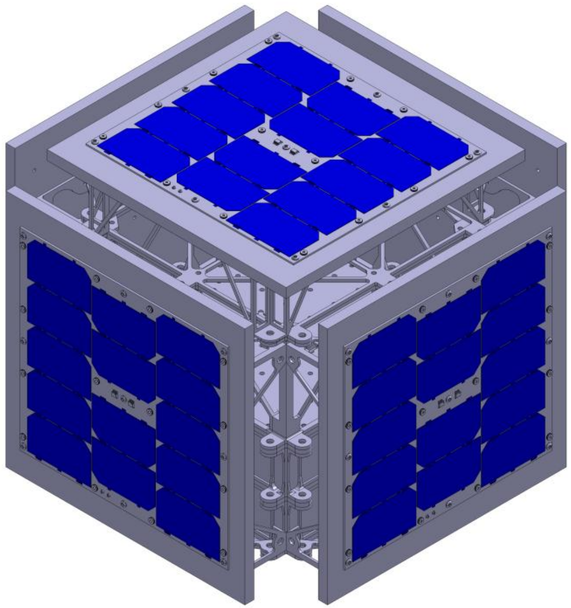
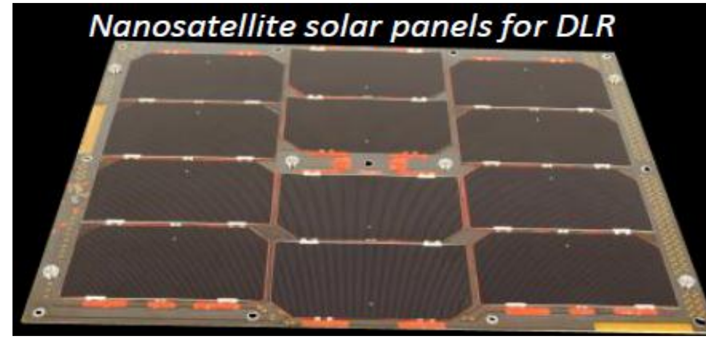
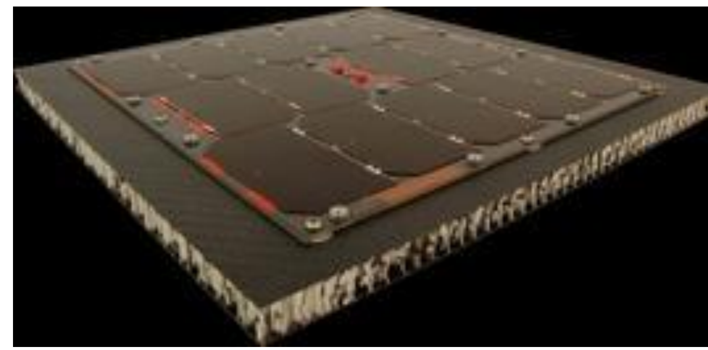


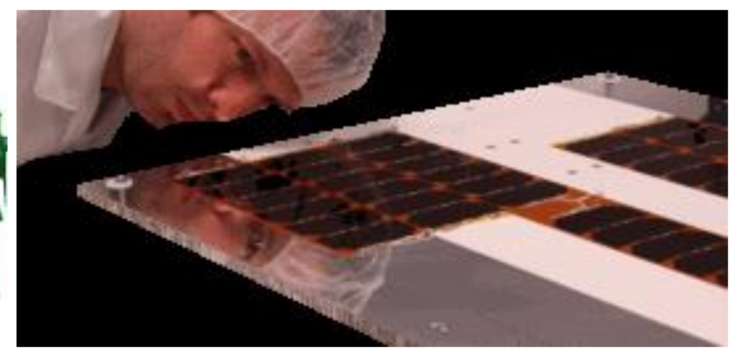
SOLID Adaptation Option for Small S/C

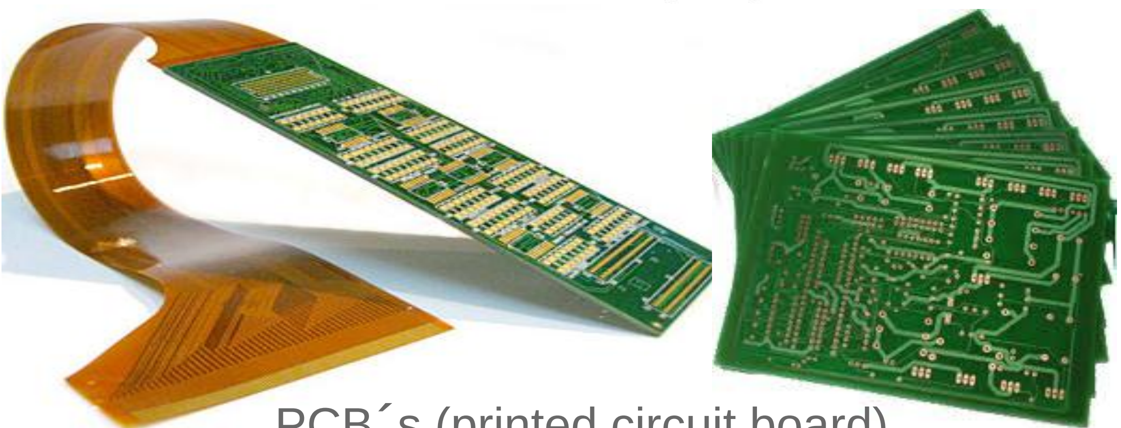
Clavis
nano satellite











PCB´s (printed circuit board)

Photo: http://www.clyde-space.com/products/solar_panels

Conclusion / Outlook

Knowledge concerning SD / MM in space very important

Advantages of the SOLID concept:

- Low cost
- Applicable to all S/Cs with solar generator
- High spatial coverage with respect to software validation
- No disturbances of normal S/C operation
- Active only in case of impact event
- Electronic is robust against impact effects e.g. electro-magnetic emission and local plasma
- Small adaptations in S/C manufacturing process

HVI – Tests are foreseen for Autumn / Winter 2012