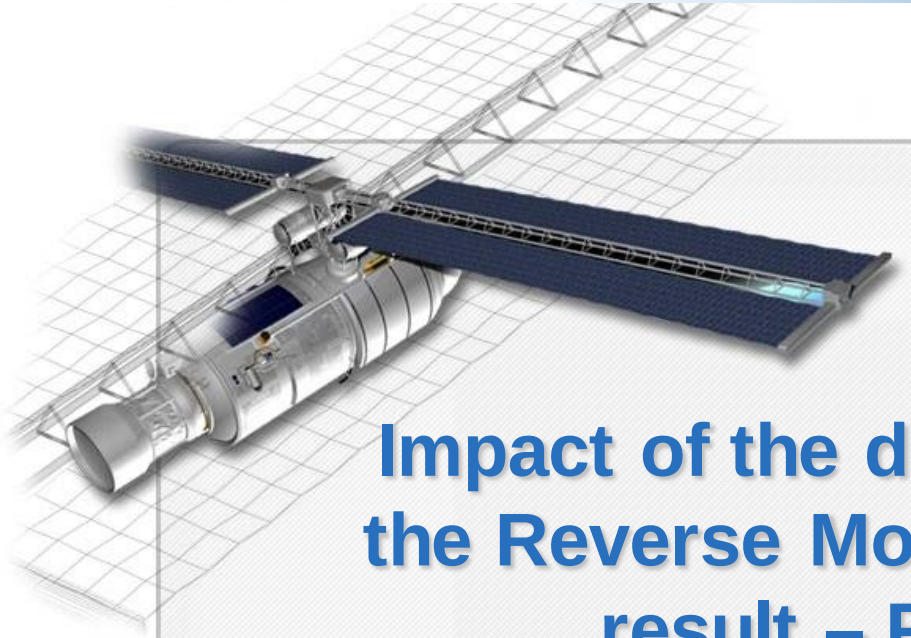


Impact of the detector definition on the Reverse Monte Carlo calculation result – FASTRAD® 3.7

P. Pourrouquet, V. Traisnel, and A. Varotsou (TRAD)

G. Rolland (CNES)

Context

Most of TID calculations performed with point detectors

But

- **How to select their location?**
  - On the surface,
  - At the center,
  - Somewhere in between…
- **Is it possible to compare doses for point and volume detectors?**
  - Shapes to consider: cube, slab
  - Dimensions : 1, 10 or 100µm
- **Is there an impact of the environment?**
  - Protons,
  - Electrons (GEO and Jovian)

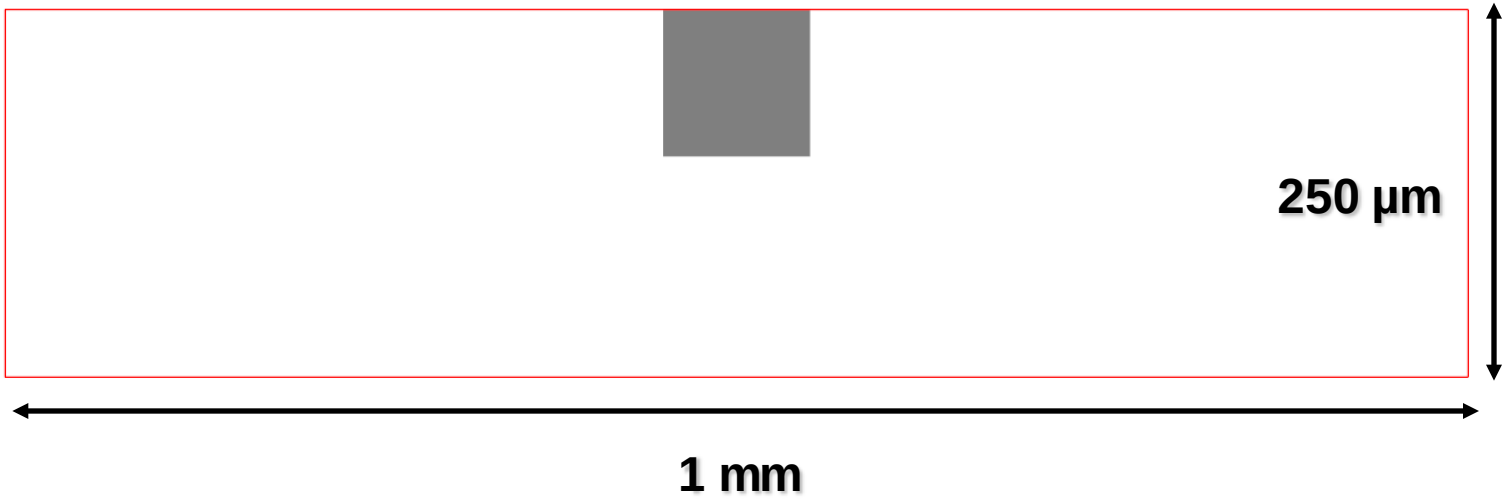
Outline

- **At component level**
  - Detector definition
  - Shielding geometry effect
- **For external materials**
  - Point detector locations
  - Volume detector dimensions and shapes
- **Conclusions**

Detector Definition

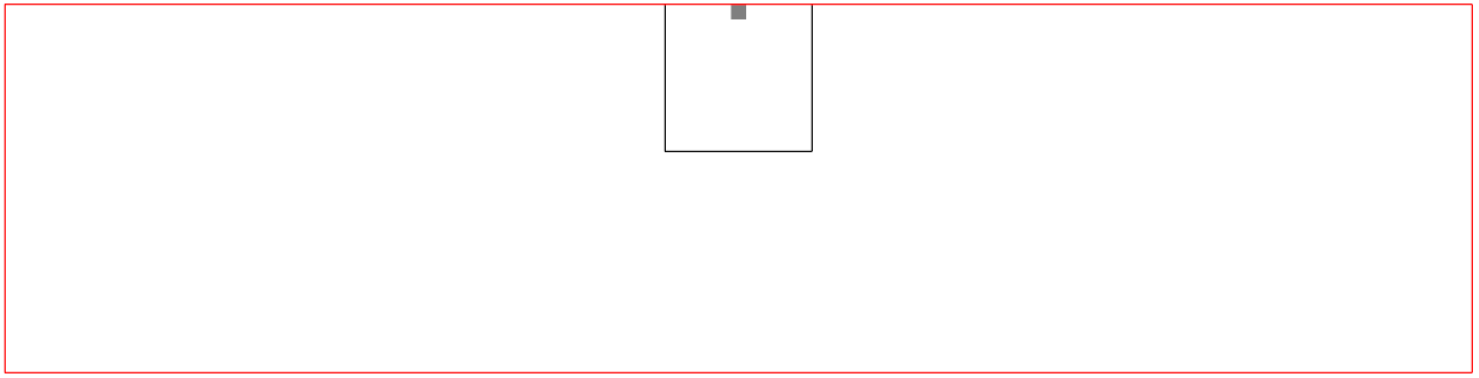
Component – Cube detector definition

- **100µm Cube**



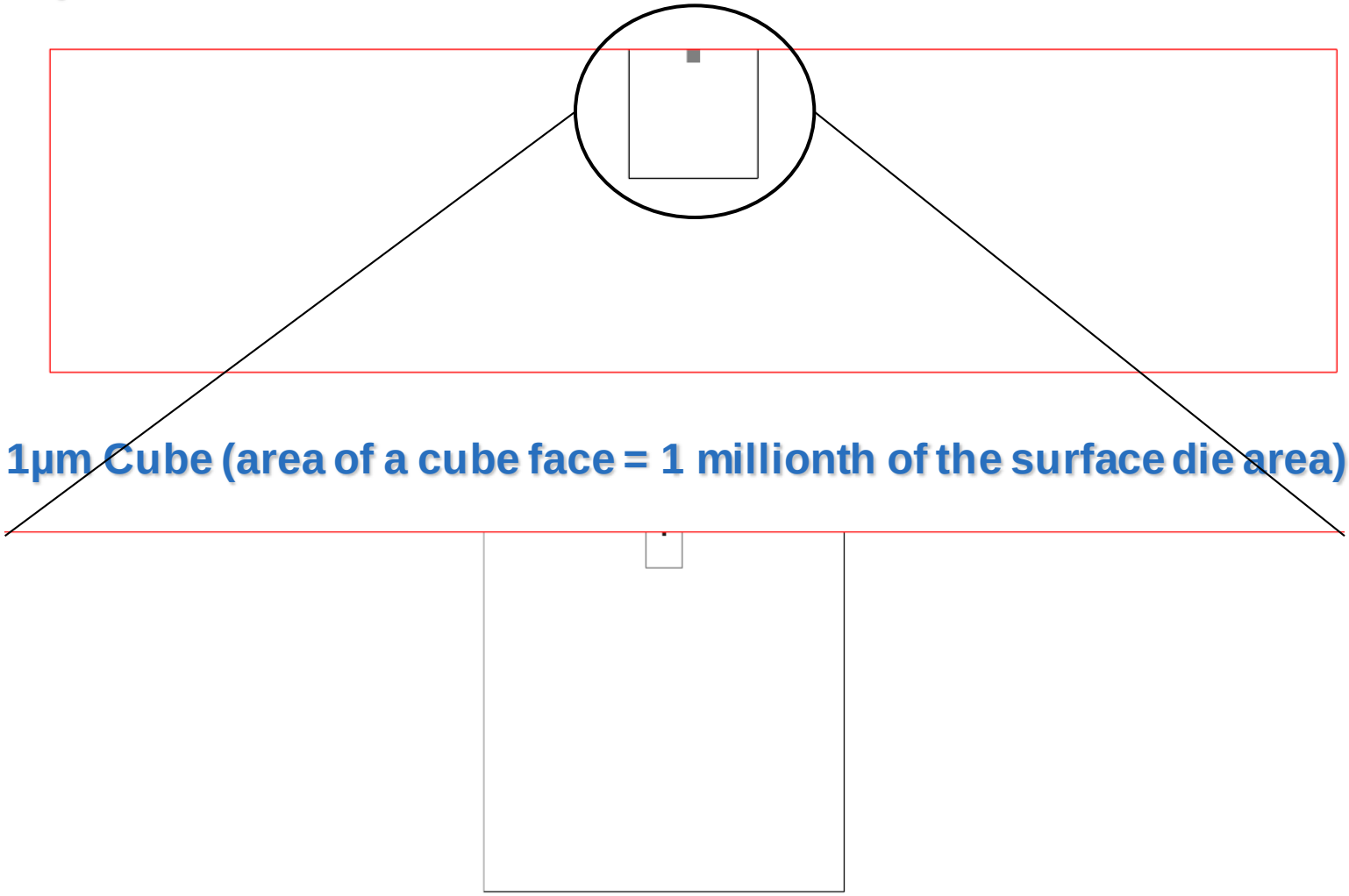
Component – Cube detector definition

- **10µm Cube**



Component – Cube detector definition

- 10µm Cube



- 1µm Cube (area of a cube face = 1 millionth of the surface die area)

Component – Slab detector definition

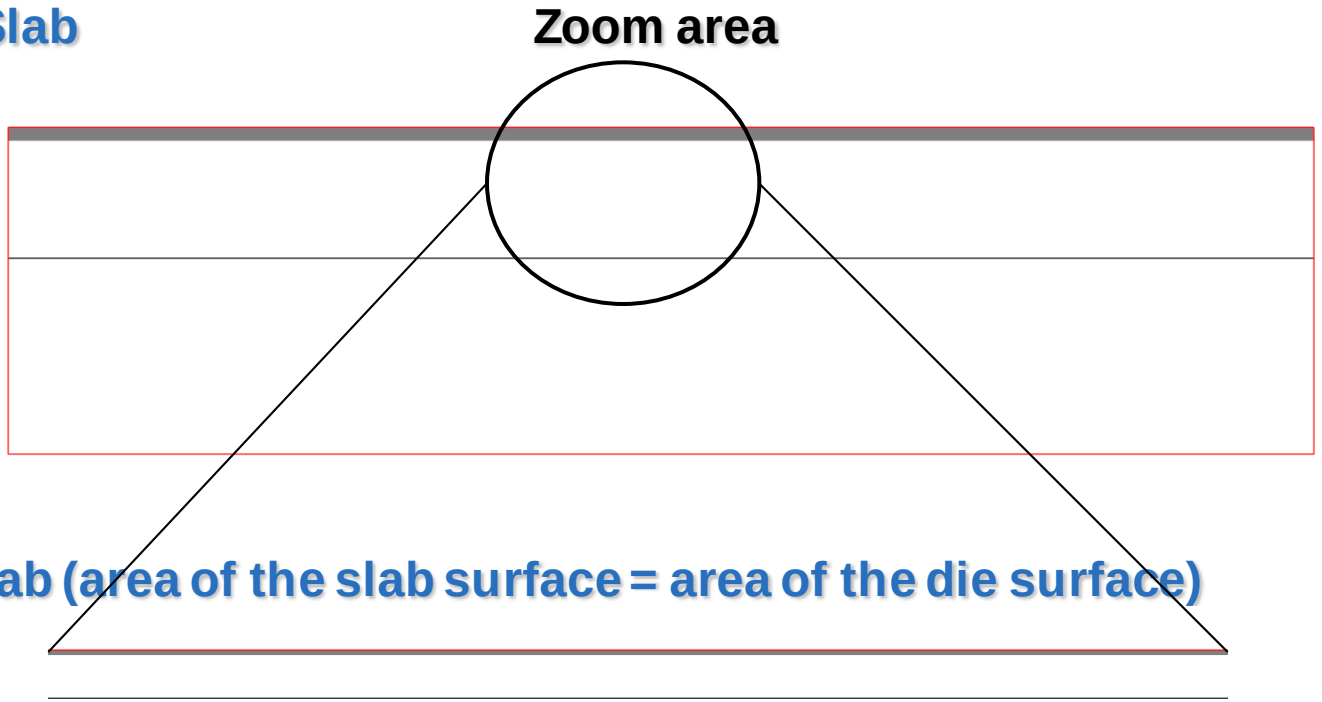
- **100µm Slab**

Component – Slab detector definition

- **10µm Slab**

Component – Slab detector definition

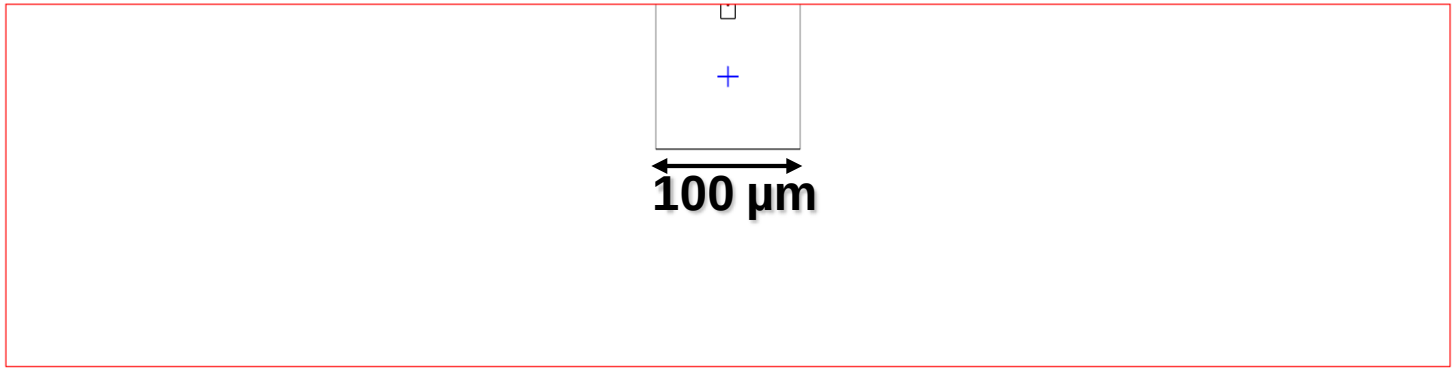
- 10µm Slab



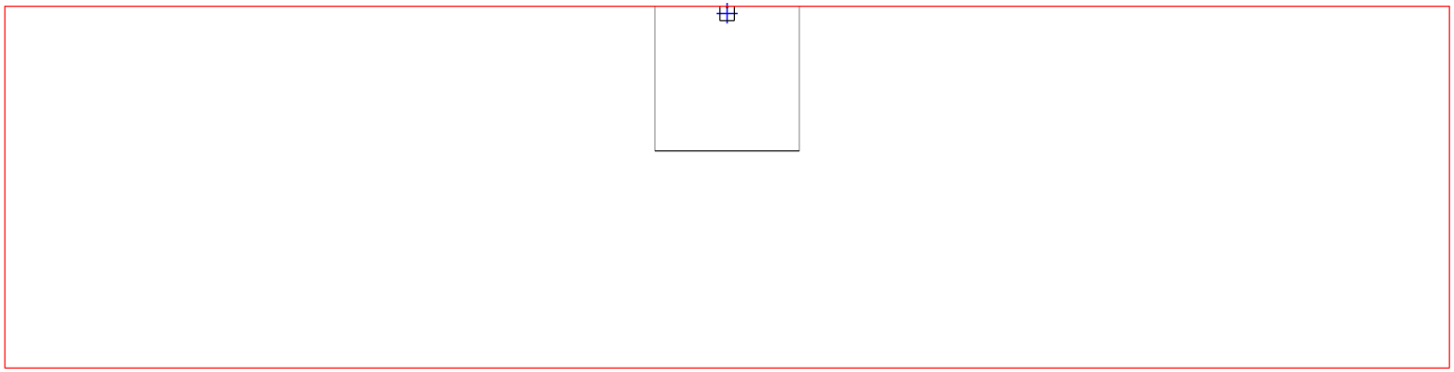
- 1µm Slab (area of the slab surface = area of the die surface)

Component – Point detector definition

- **Point detector set at 50µm below the surface of the die**

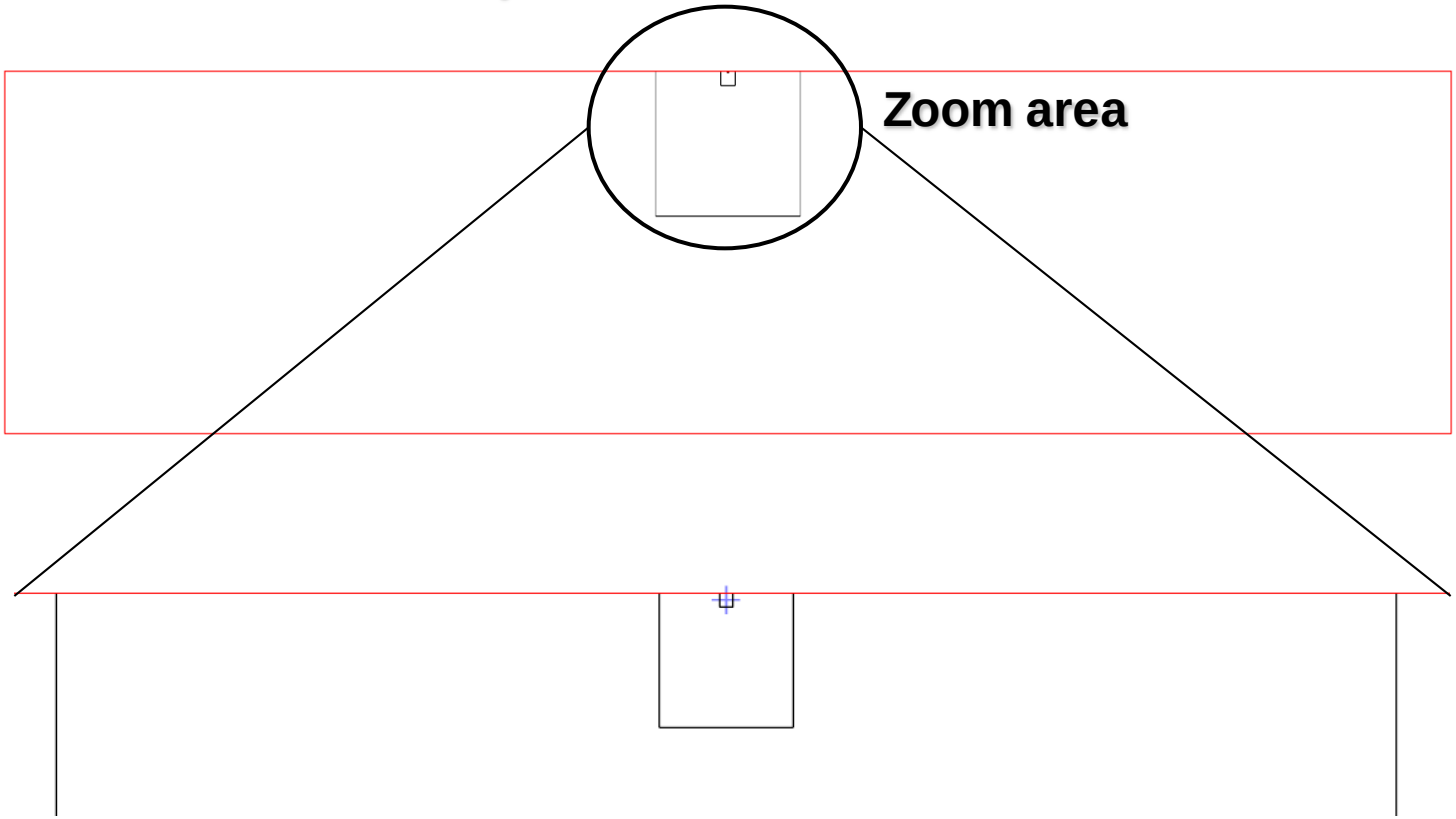


- **Point detector set at 5µm below the surface of the die**



Component – Point detector definition

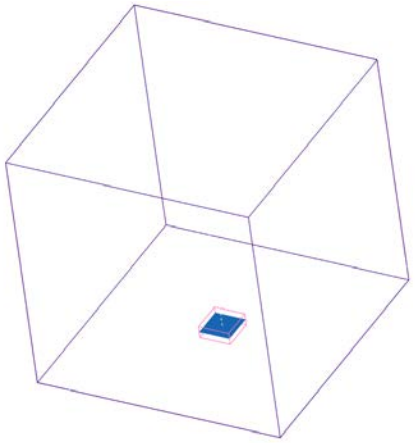
- Point detector set at 0.5µm below the surface of the die



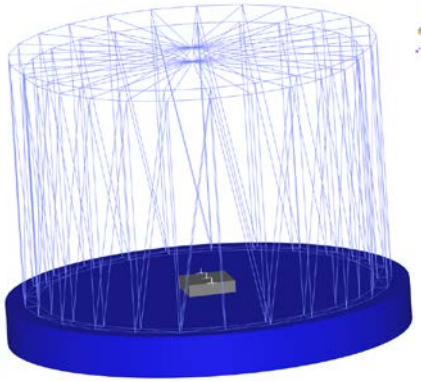
3D Radiation Models

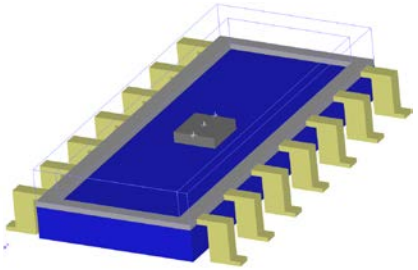
Component – model definition

- **Simple models**



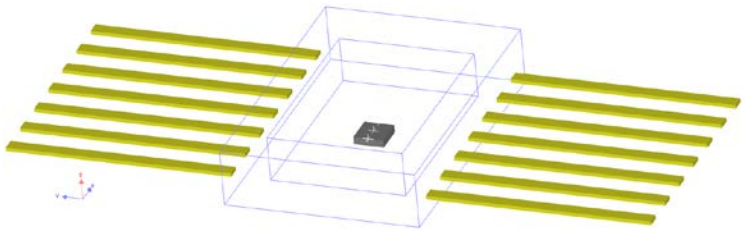
TO 39



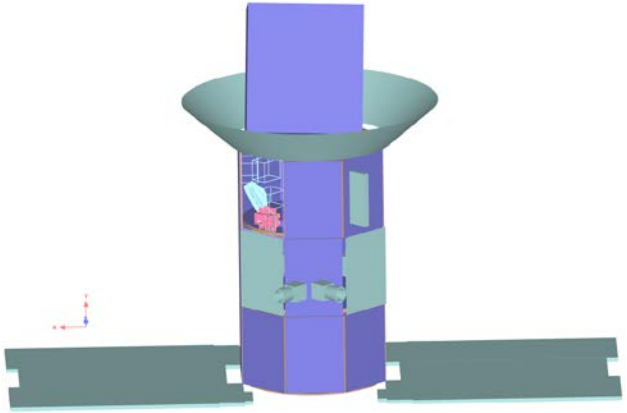


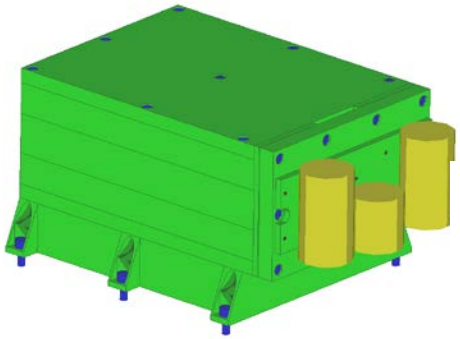
SO 14

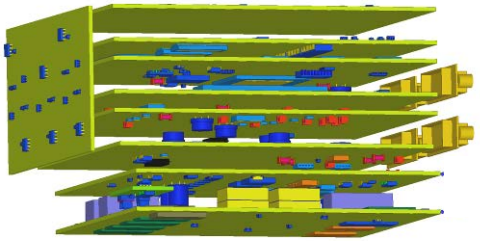
FP 14



- **Complete satellite model**







Results
for Components

Component – Results per type

Location/dimension impact for point and volume detectors

- **No effect for protons (discrepancies below 10%)**
- **Electrons : non negligible impact**
  - $Dose_{Point0.5} \sim Dose_{Point5} \geq Dose_{Point50}$ (max. 11%)
  - $Dose_{Slab1} \geq Dose_{Slab10} \geq Dose_{Slab100}$ (max. 25%)
  - $Dose_{Cube1} \geq Dose_{Cube10} \sim Dose_{Cube100}$ (max. 44%)

Component – Detector type

Impact of detector type

- **No effect for protons (discrepancies below 11%)**
- **Electrons : non negligible impact**

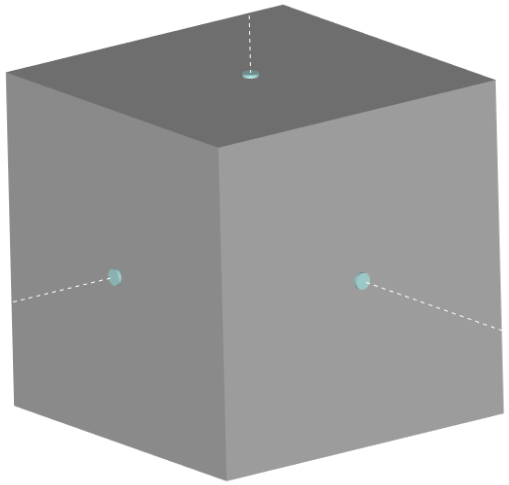
$$Dose_{Point} \geq Dose_{Slab} \geq Dose_{Cube}$$

Except for a GEO mission at surface: $Dose_{Slab} > Dose_{Point} > Dose_{Cube}$ (max. 27%)

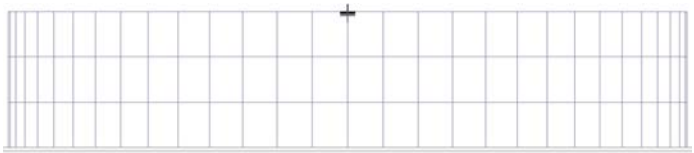
Results
for External Materials

External materials

- **Sampling on different materials located outside the satellite**
  - NBK7 for lenses
  - Zerodur and SiC for mirrors

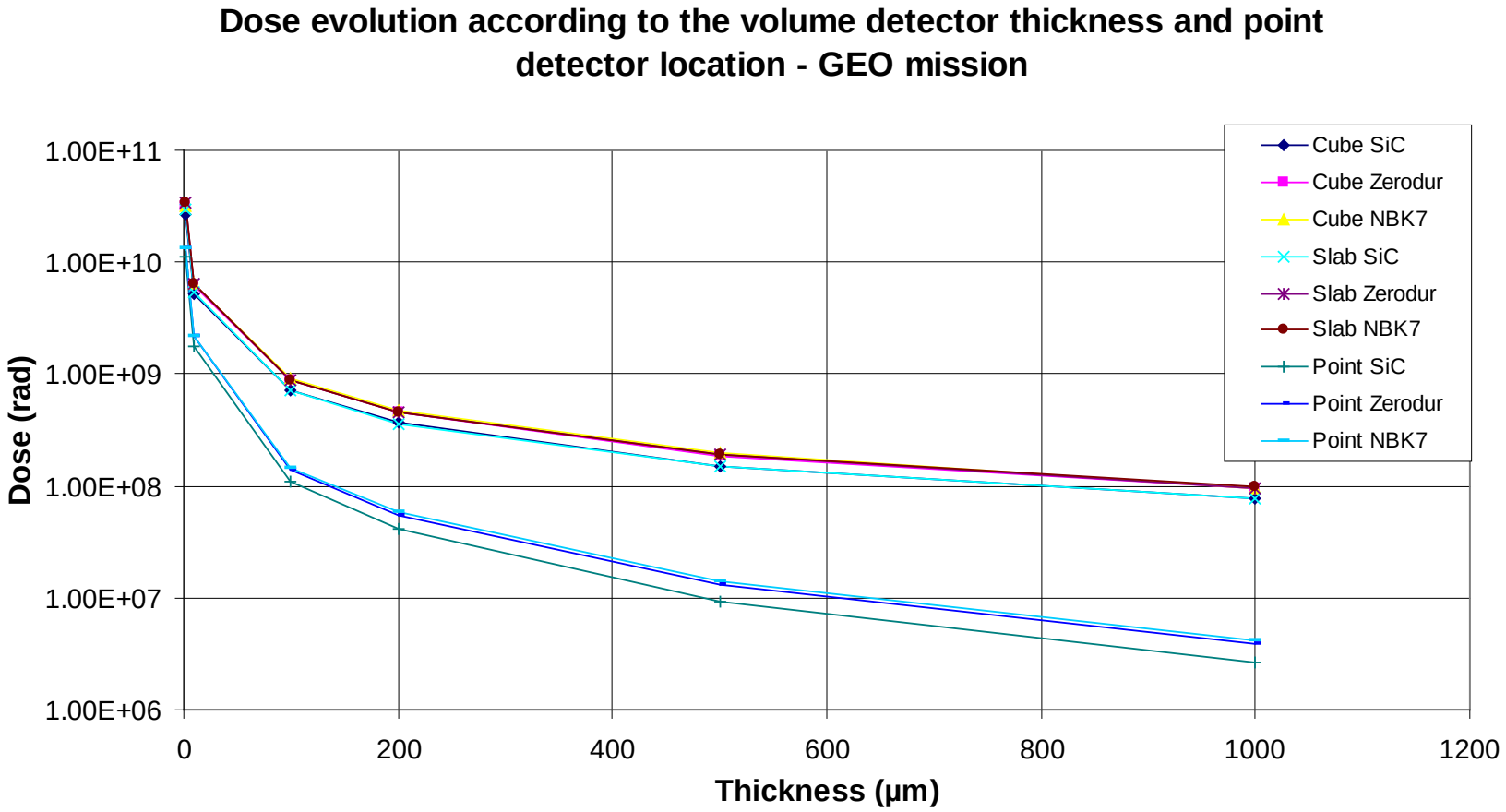


- **Cylindrical models**
  - 5 cm radius and 2 cm thickness
  - Detectors set from 1µm to 1mm



External materials

Study on locations/dimensions for same detector type confirms the steep dose gradient for satellite external surfaces



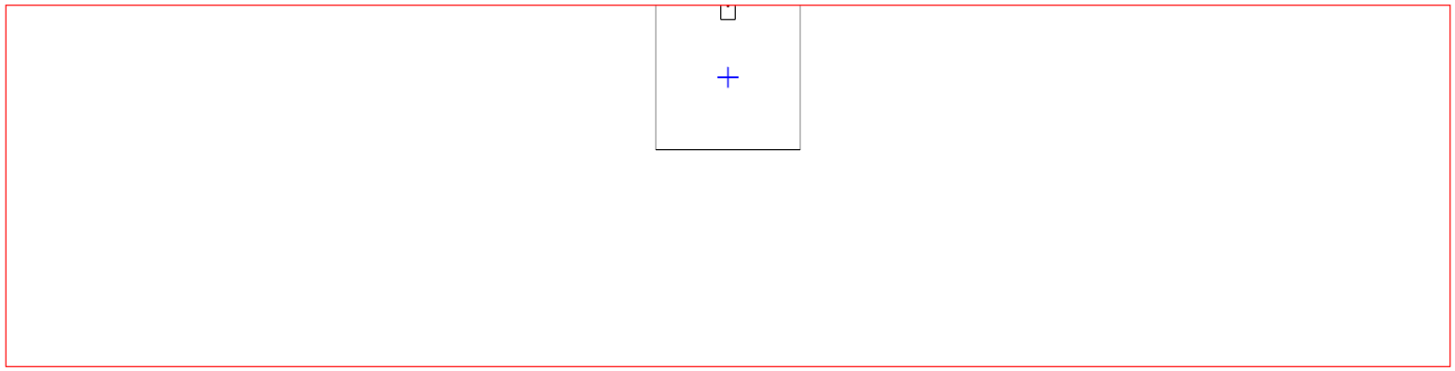
External materials

Impact of detector type:

- **No effect between volume detectors except at surface with:**
  - $Dose_{Cube} < Dose_{Slab}$ (up to 27%)

- **High impact between volume and point detectors due to the steep gradient dose**
  - For example $Dose_{Point}$(50µm depth) < $Dose_{Cube}$(100µm thickness)

    Up to 300% difference for protons



Conclusions - Components

Proton environment:

- No effect of the detector type or location/dimension

Electron environment:

- Detector location/dimension:
  - Gradient for volume detectors for GEO mission (Cube: max. 44% / Slab: max. 25%)
  - Lower gradient for point detectors (up to 13%)

$$Dose_{100\mu m} < Dose_{10\mu m} < Dose_{1\mu m}$$

- Detector type:
  - Generally observed effect

$$Dose_{Cube} < Dose_{Slab} \leq Dose_{Point}$$

Conclusions – External materials

Comparison on detector dimensions/locations:

- Very steep gradient according to the point detector depth or the volume detector thickness

Comparison on the detector types:

- Difference between cubes and slabs only at surface
- Important difference between volume and point detectors

It is important to adapt the choice of the detector to the sensitive effect to study (volume or at a certain location/depth)

Thank you for your attention