A background study via simulations for the ComPol CubeSat experiment

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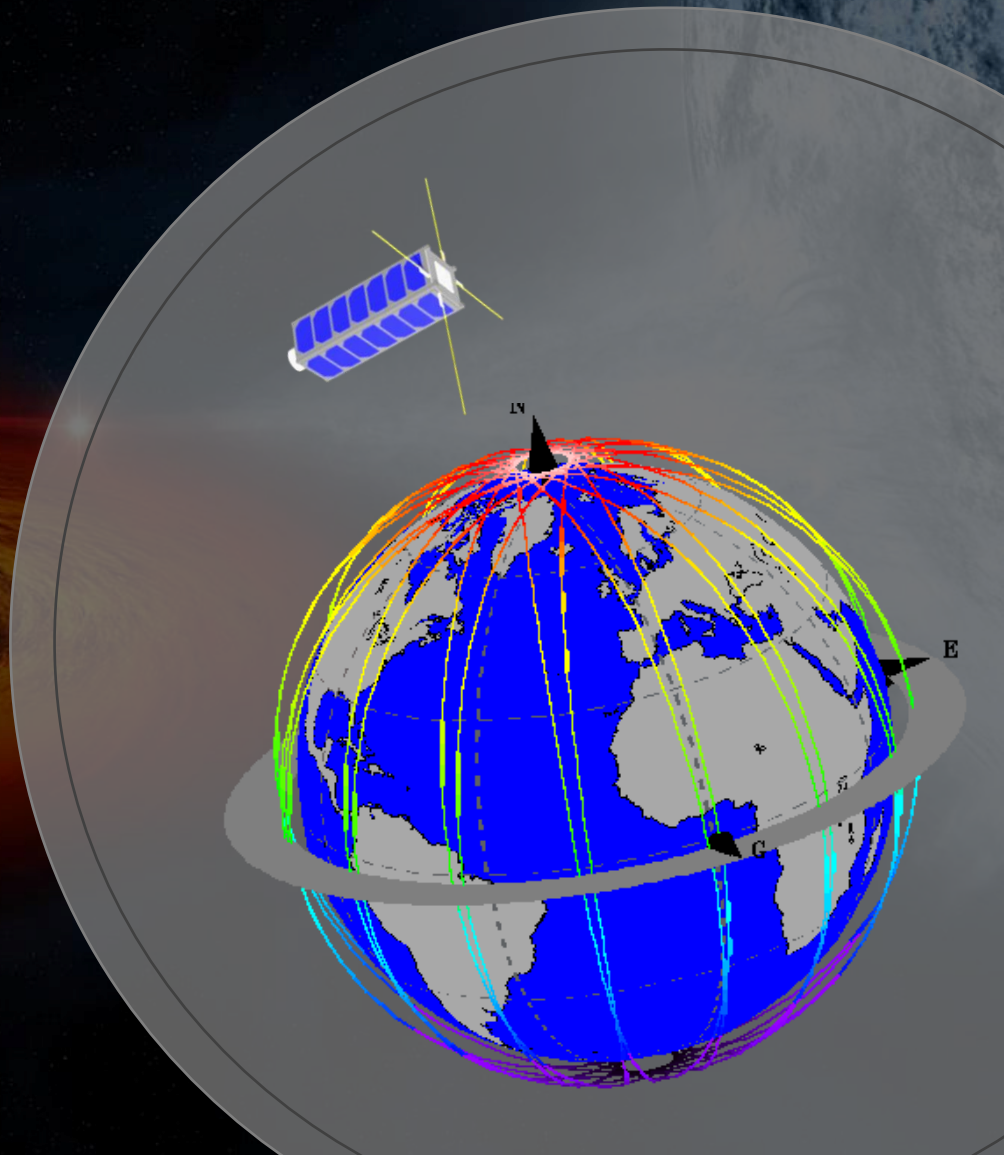


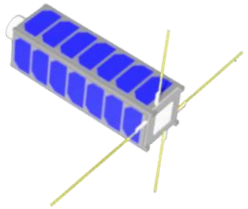
Overview

- The ComPol mission
- Cosmic Radiation Background
- Geant4 simulation
- Simulated geometries
- Results: Shielding efficiency and Activation background
- Orbit dependent background

Overview

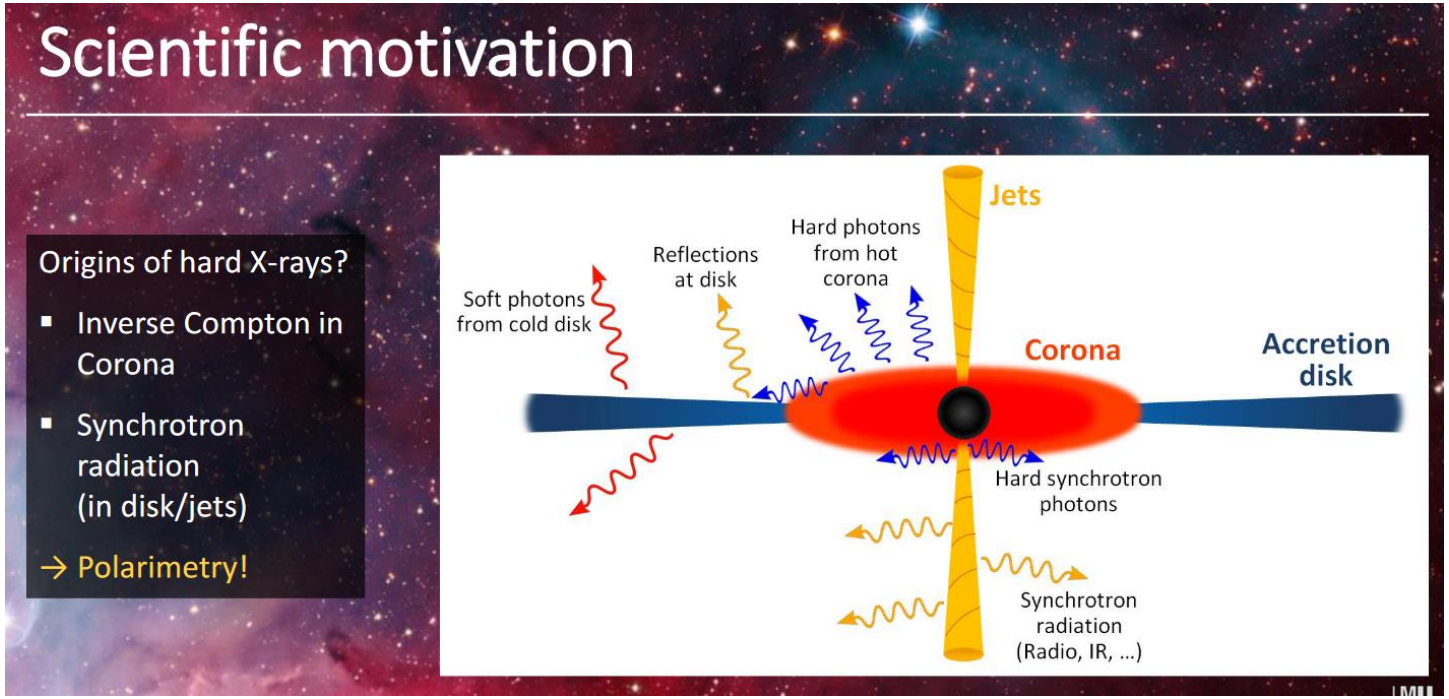
The ComPol mission

The ComPol CubeSat



CubeSat Mission

Remember Matthias‘ presentation:



Detector system:

- Silicon Drift Detector (SDD)
- $CeBr_3$ Calorimeter

Working principle:

- Compton event reconstruction via energy and position detection
- Event selection via Cuts und the scatter angle + energy ROI

→ **MDP and SNR**

Overview

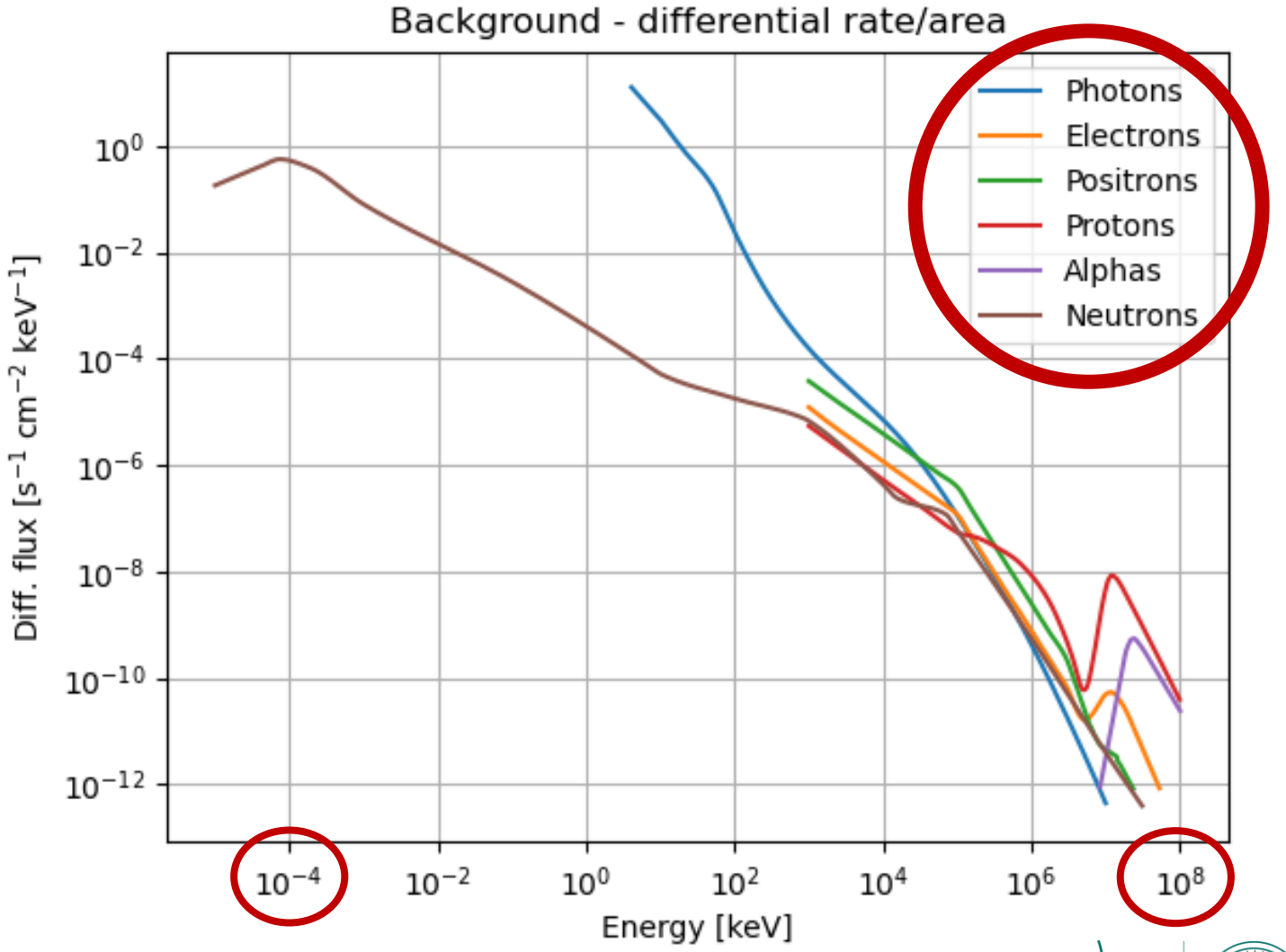
Cosmic Radiation Background

Cosmic radiation in LEO

Cosmogenic Activation

- Spallation
- Neutron capture
- Inelastic scattering (p and n)
- Excitation due to gamma rays
- Electron capture

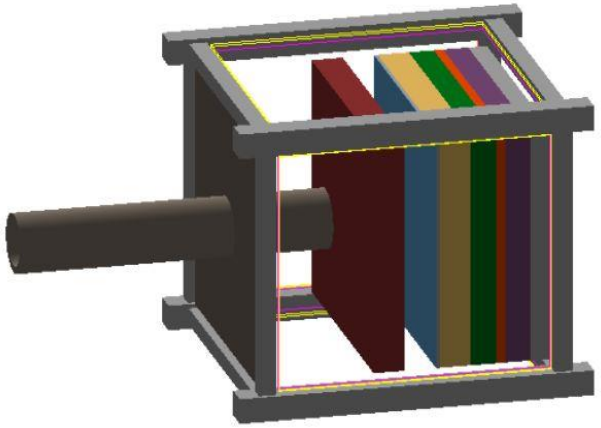
Radioactive decays



Overview

Geant4 simulation

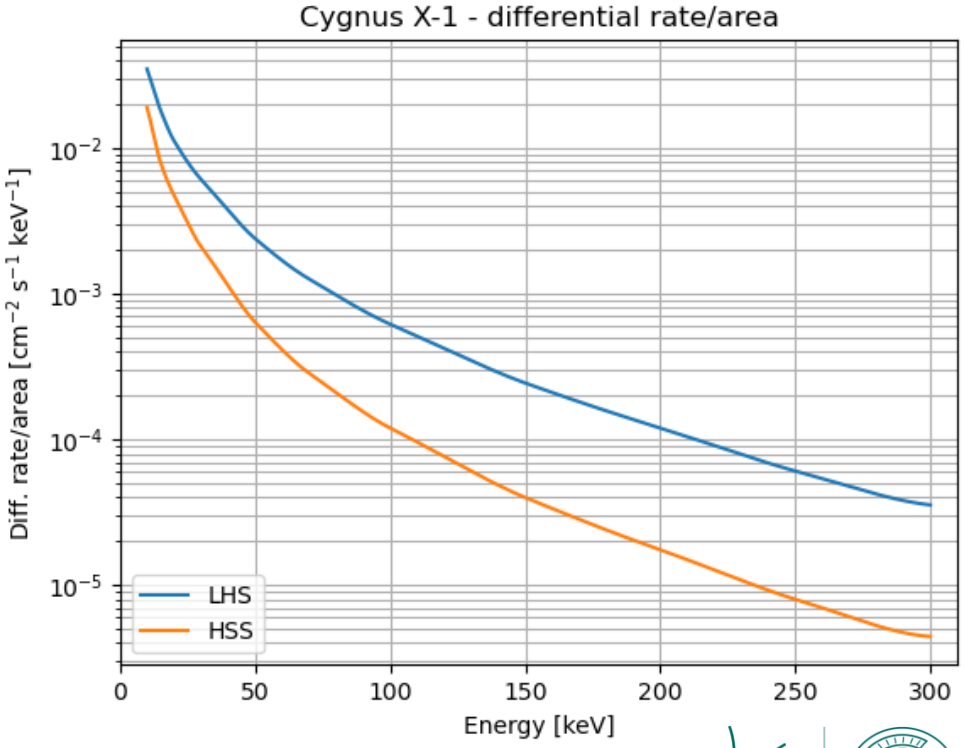
GEANT4 - general



- Monte Carlo simulation
- Based on C++

- User has to:
  - Generate a geometry
  - Set the physical properties (Physics Lists)
  - Choose a particle source and spectrum

- Data analysis was done with python

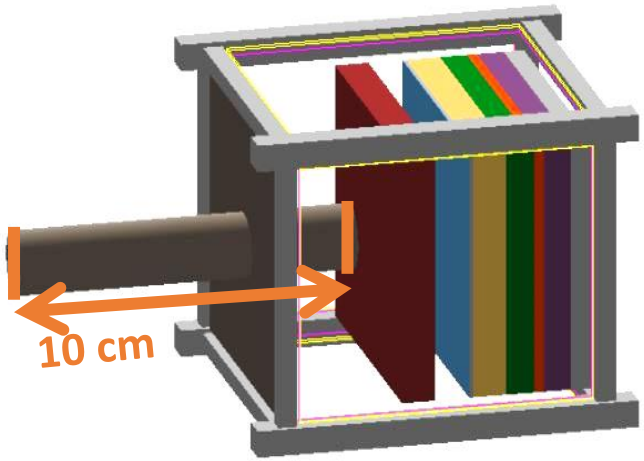


Overview

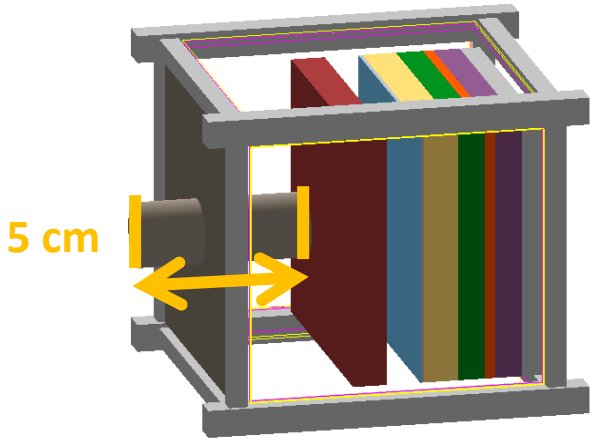
Simulated geometries

Geometries

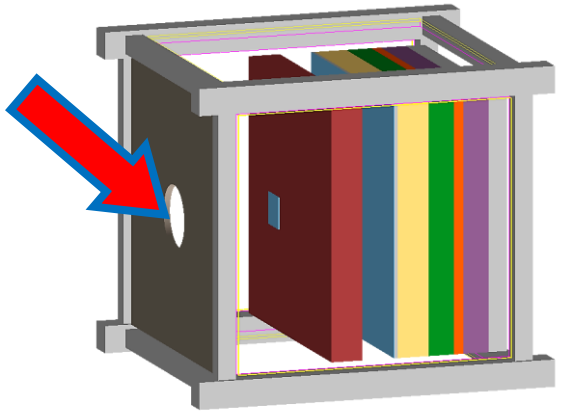
Different Collimator lengths



10 cm Collimator

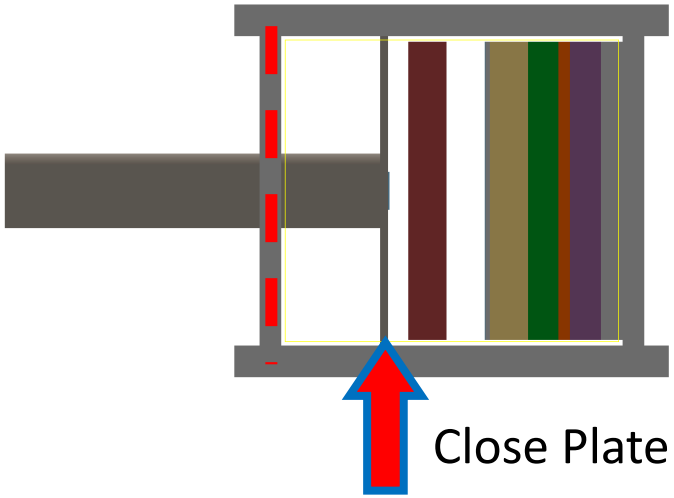


5 cm Collimator

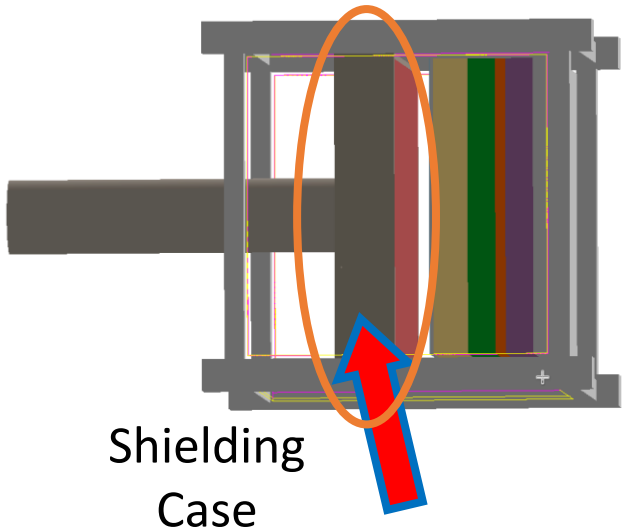


no Collimator

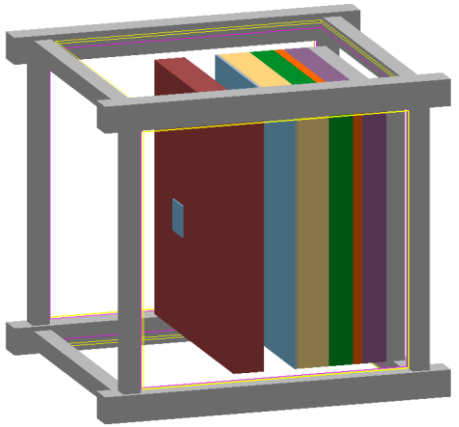
Different Plate Positions and Forms



Close Plate



Shielding Case

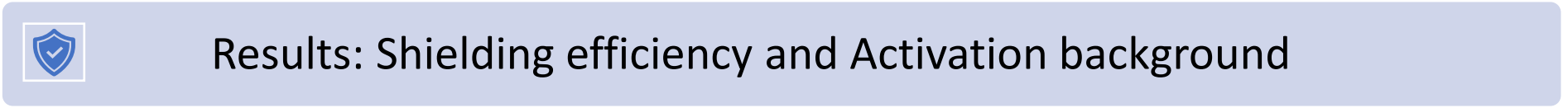


no Shielding

Overview








Results: Shielding efficiency and Activation background

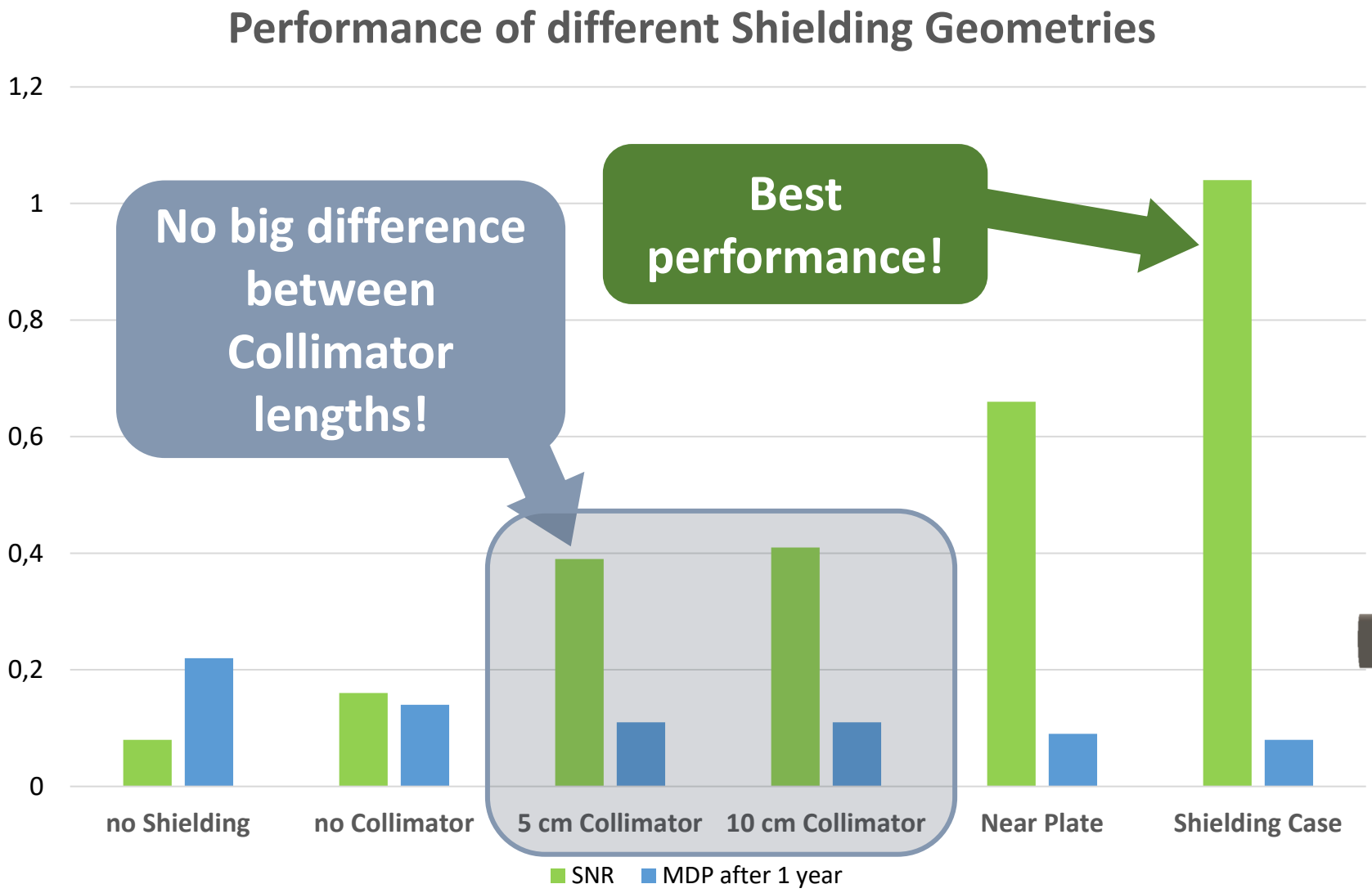
Shielding efficiency …

Shielding reduces
Background count rate
→ **Improved SNR**

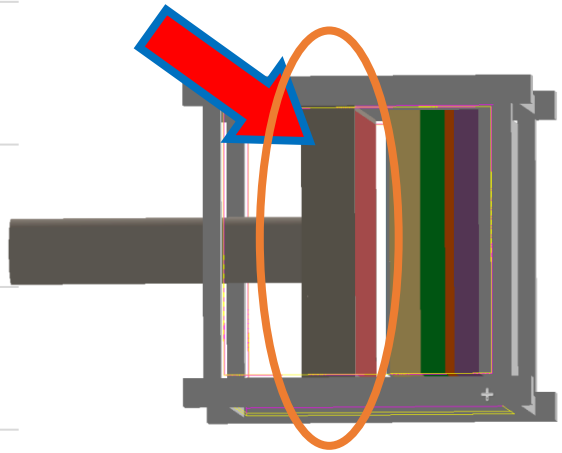
vs.

More material
(close to the detectors) →
Additional background due to cosmogenic activation

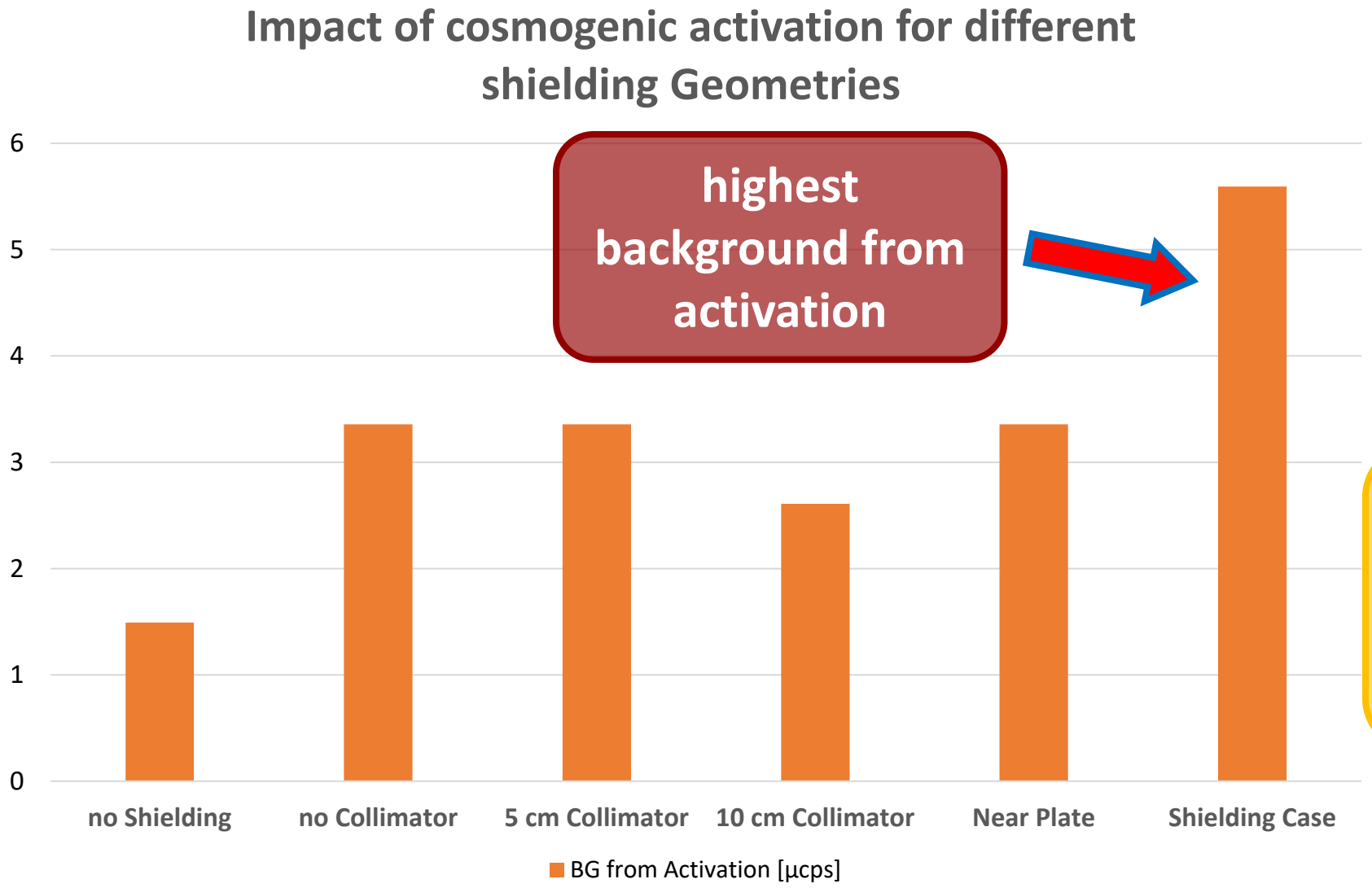
Shielding efficiency …



Improved SNR



… and Activation

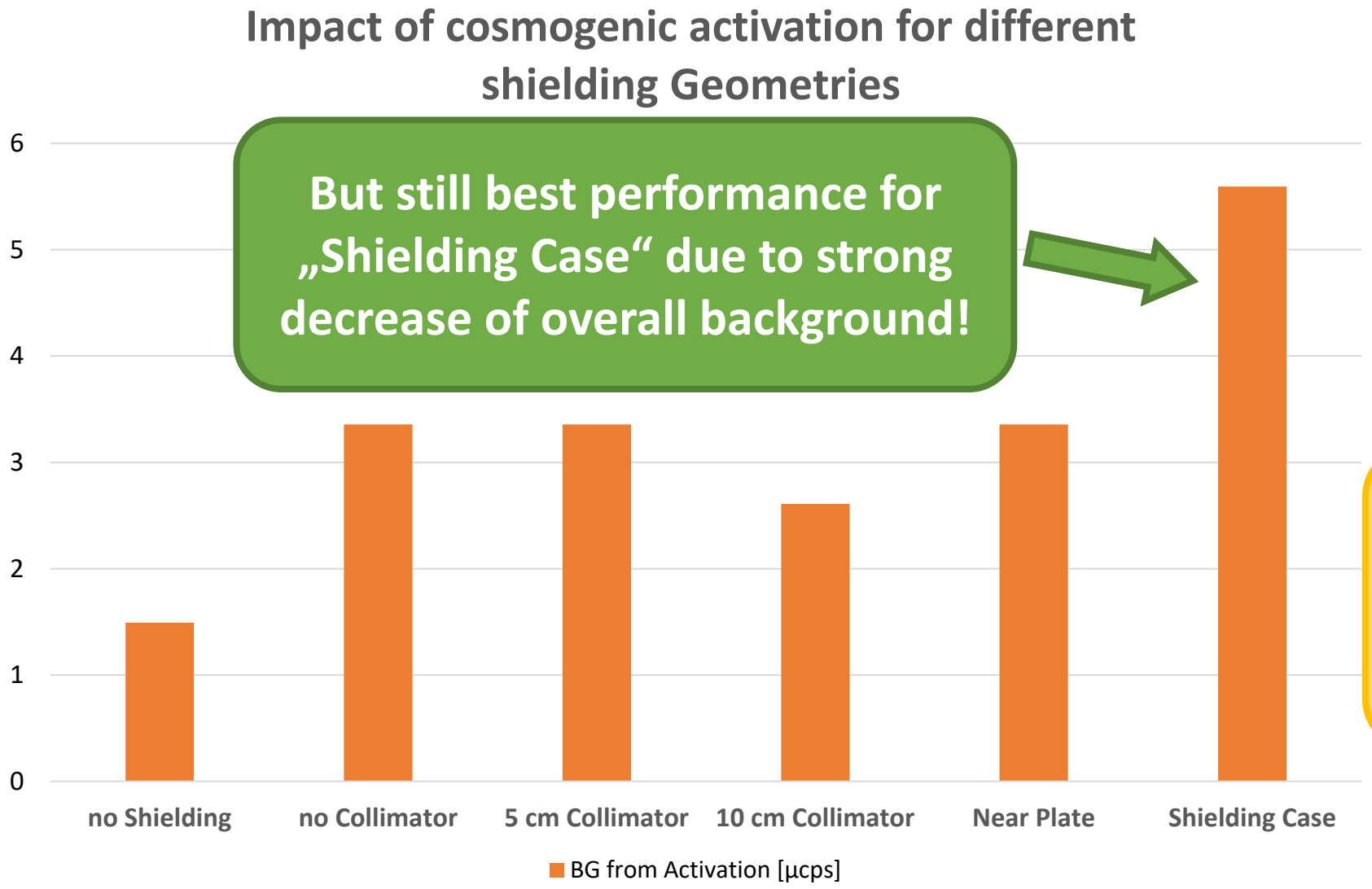


highest background from activation

→ Additional background due to cosmogenic activation

Most Activation in:
- Lead shielding
- CeBr

… and Activation



But still best performance for „Shielding Case“ due to strong decrease of overall background!

→ Additional background due to cosmogenic activation

Most Activation in:
- Lead shielding
- CeBr

Overview



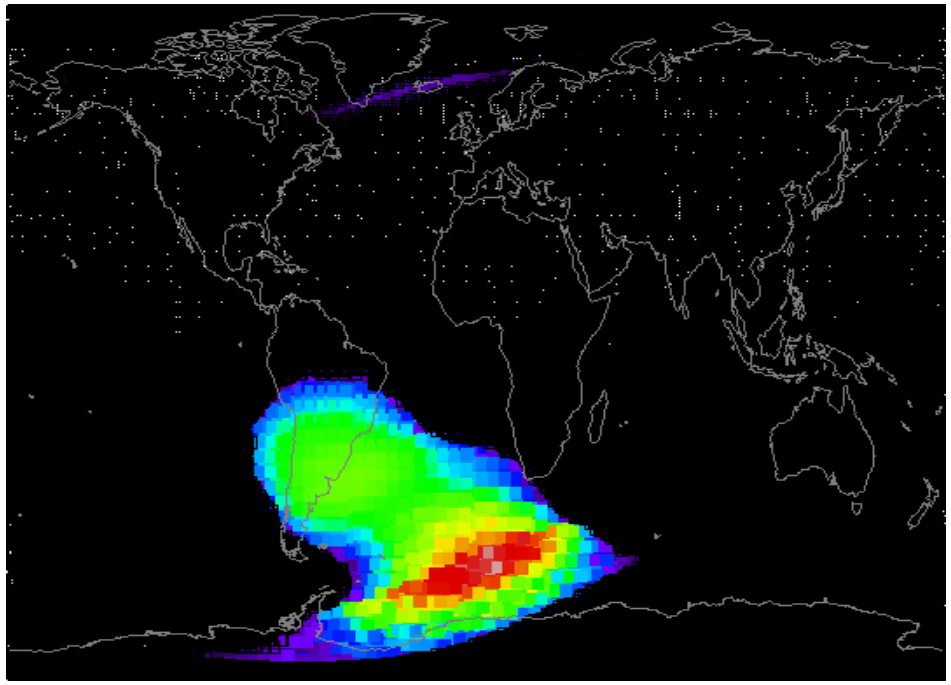


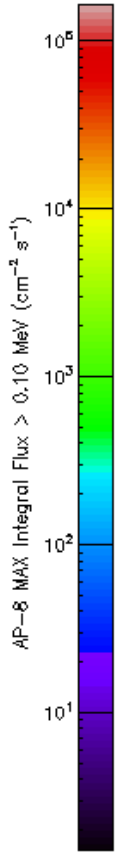
Orbit dependent background

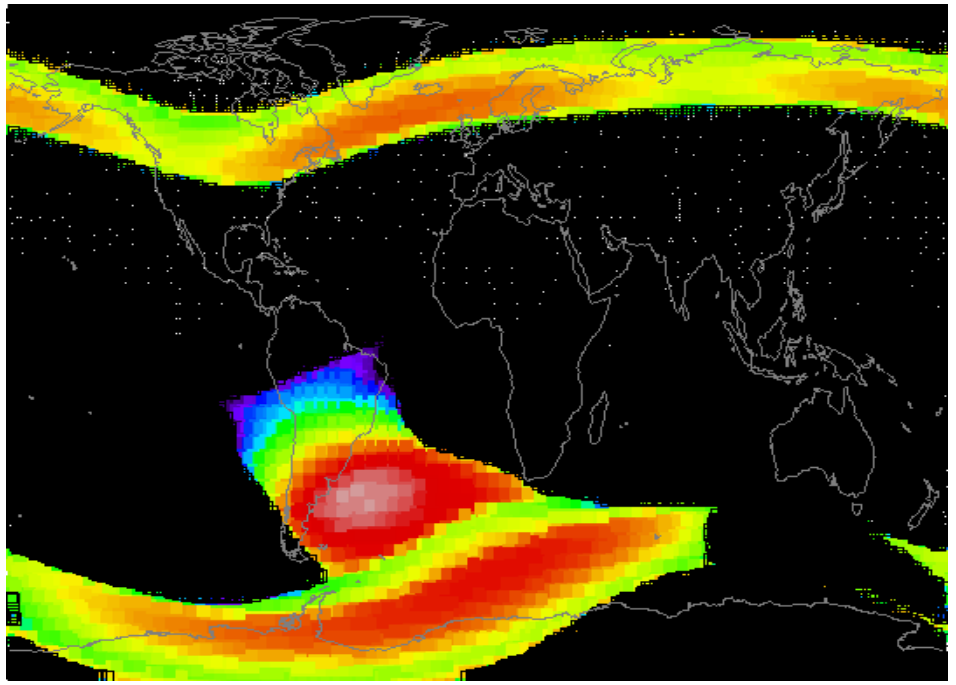
The South Atlantic Anomaly

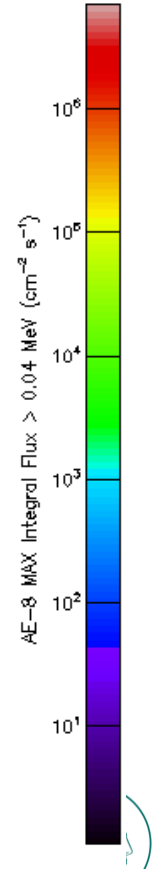
Area above the south atlantic where Earth's inner Van Allen radiation belt comes closest to Earth's surface

→ increased flux of energetic particles in this region

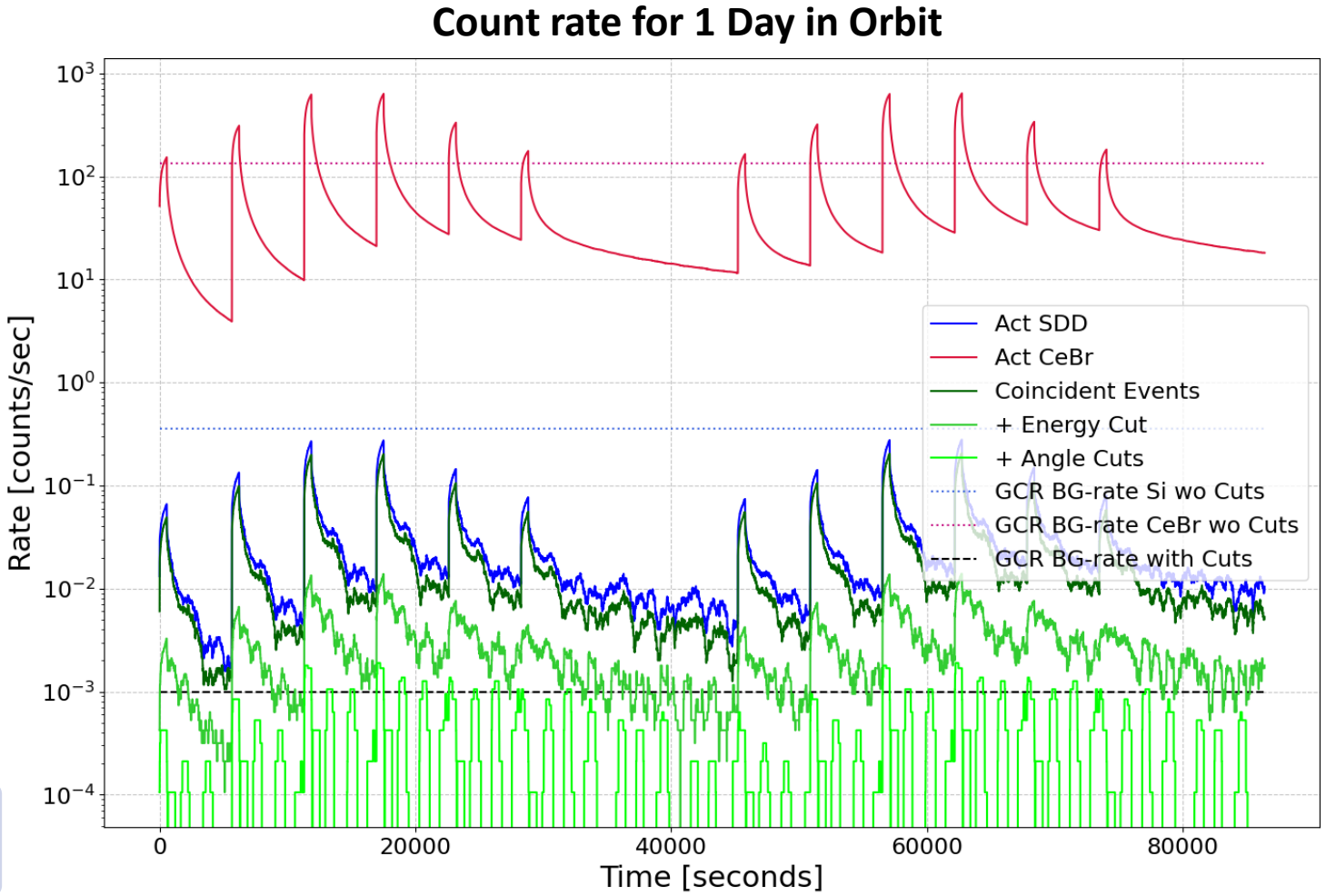


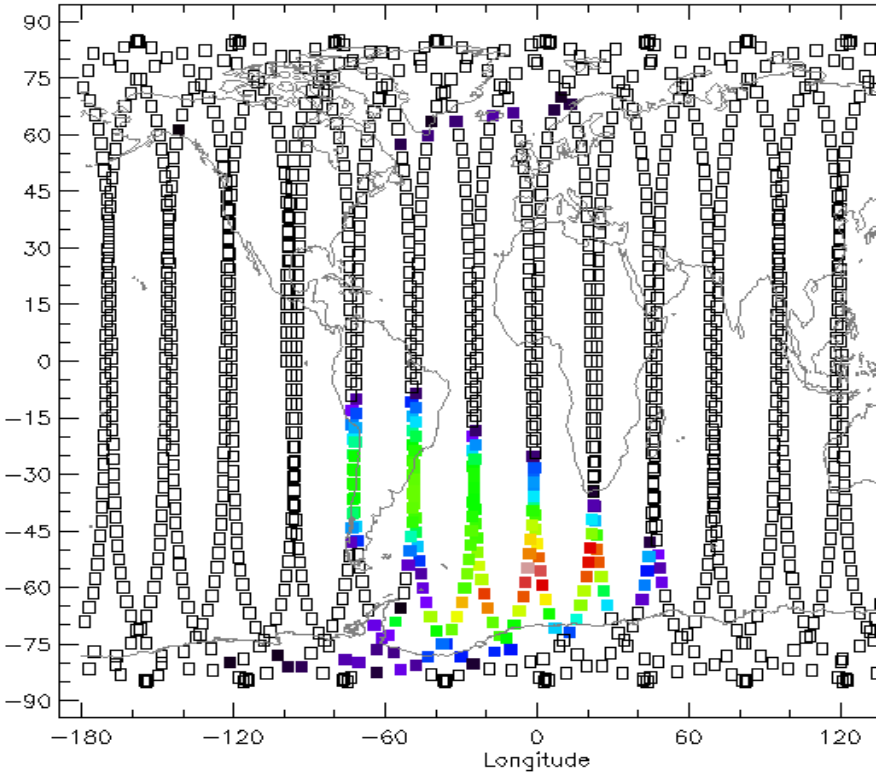




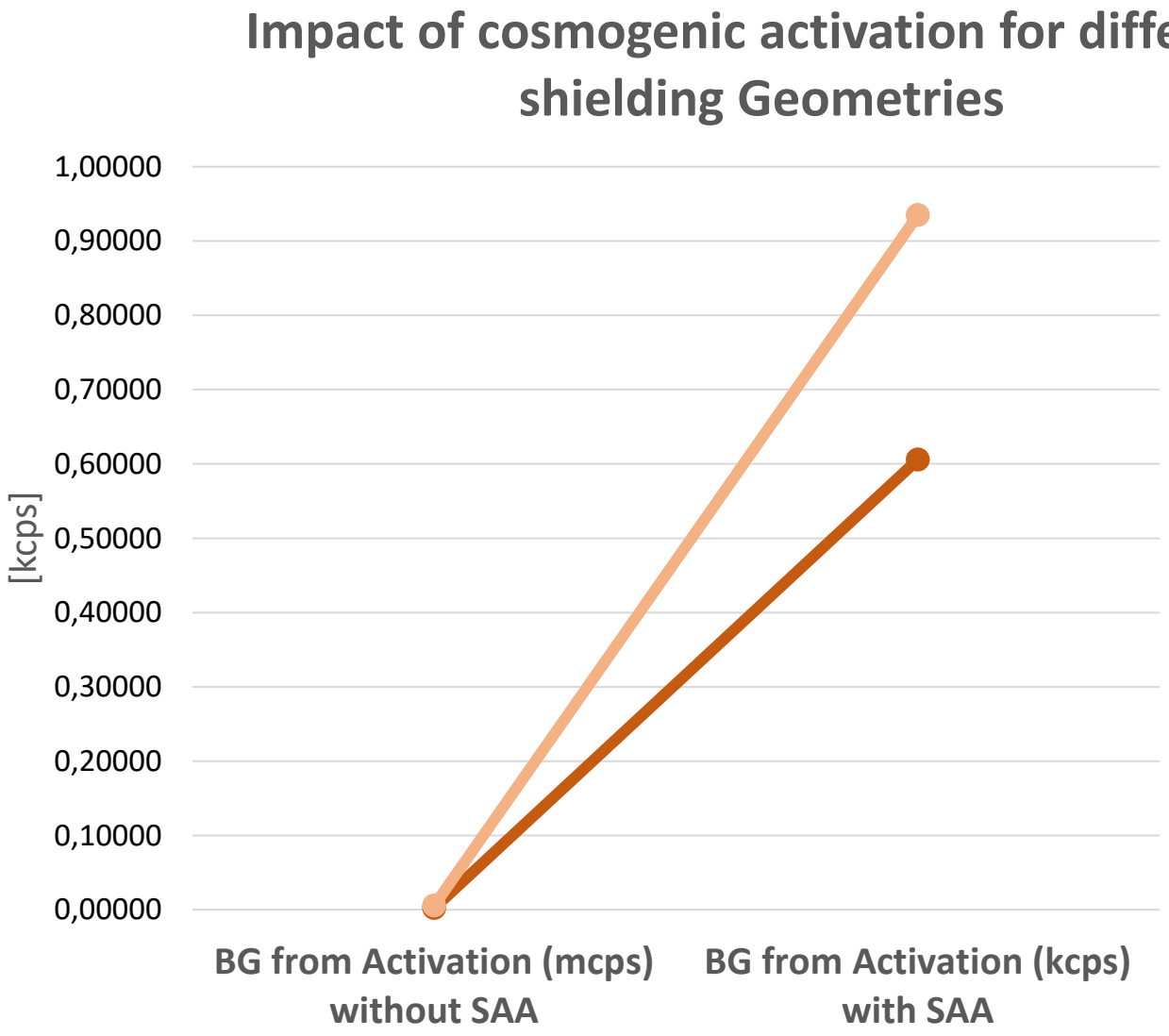


The South Atlantic Anomaly





The South Atlantic Anomaly



10 cm Collimator

BG rate: **0, 88 mcps**
SAA BG rate : **0, 61 mcps**

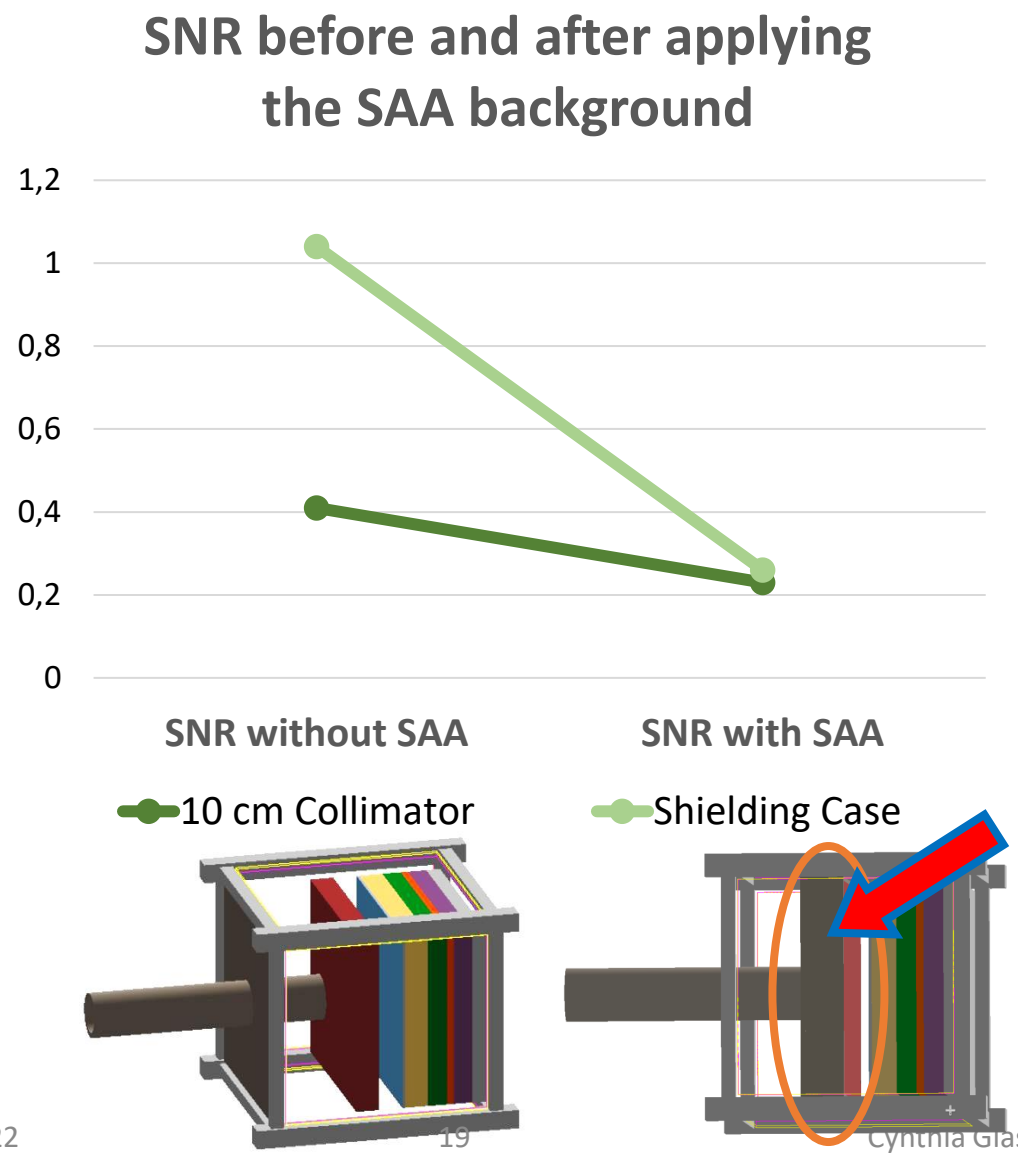
x 2/3

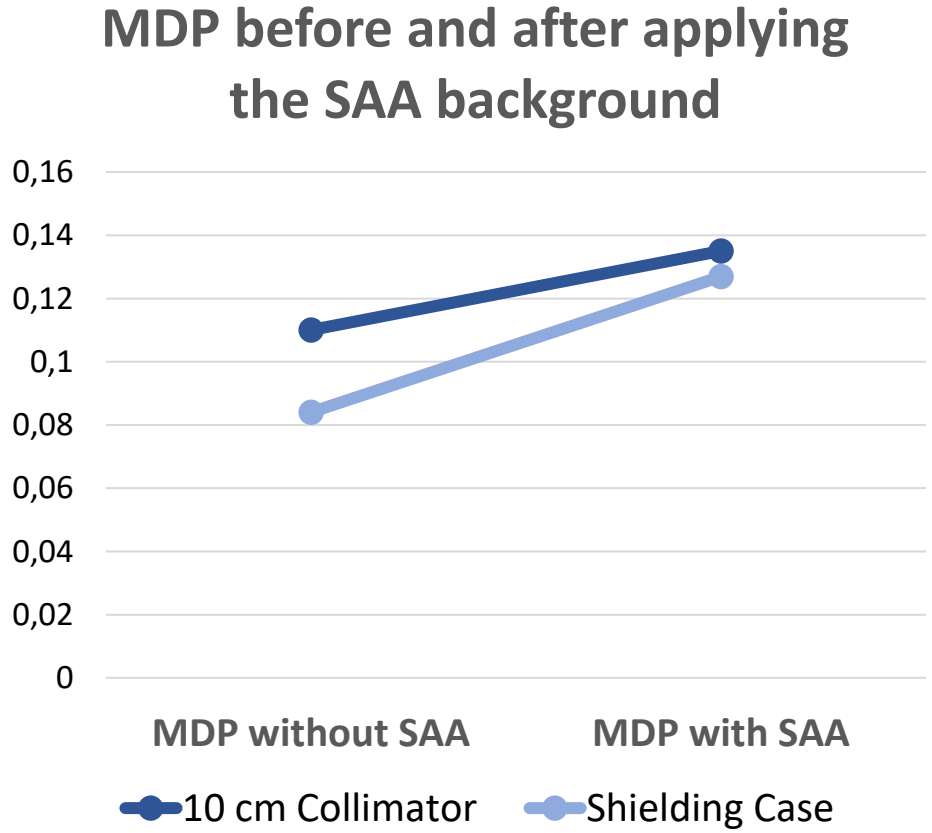
Shielding Case

BG rate: **0, 35 mcps**
SAA BG rate: **0, 94 mcps**

x 3

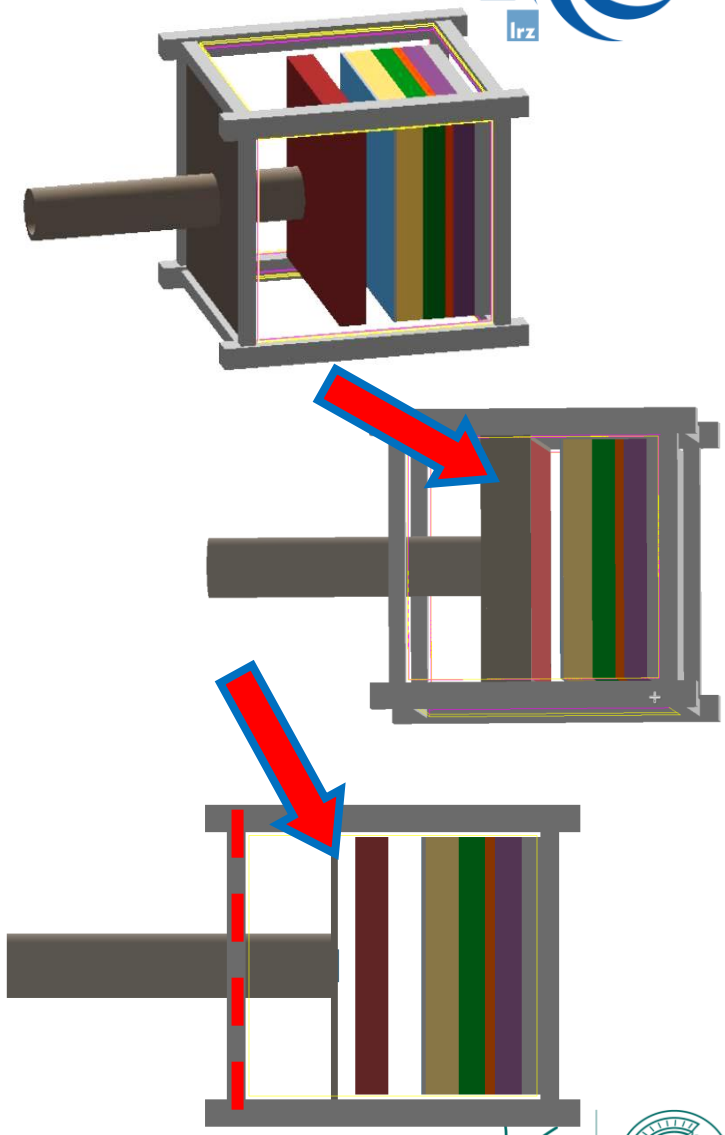
The South Atlantic Anomaly





Summary

- Different Geometries simulated with Geant4
- SNR, MDP, and Activation background investigated:
  - With cosmic radiation spectrum
    -> The „Shielding Case“ performs best
  - South atlantic anomaly added
    -> „Shielding Case“ leads to no significant improvement
- Outlook:
  - Simulate SAA background on “Close Plate” geometry
  - Try Graded shielding: Lead and Copper



Thank you for your attention!

Do you have questions?