The High Radiation Anisotropy Composition and Electron Spectrometer

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The High Radiation Anisotropy Composition and Electron (**HiRACE**) spectrometer
hockey puck-size Time-of-Flight (ToF) spectrometer
ions (15 keV – 3 MeV) and electrons (30 keV – 1 MeV)

- Collimator assembly
- ToF section
- Solid State Detector (SSD) array
- Shielding system

GEANT4 simulations:

- Shielding design
- Ascertain the background rates
- Estimate the effect of penetrating particles on the detectors and optical systems
- Determine the geometrical factors and efficiencies
- Determine detector and foil thicknesses
- Estimate the radiation doses for mechanical and electrical components

Electron Scattering in Solid State Detectors: GEANT4 Simulations

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Monte Carlo Simulations of CASSINI/LEMMS

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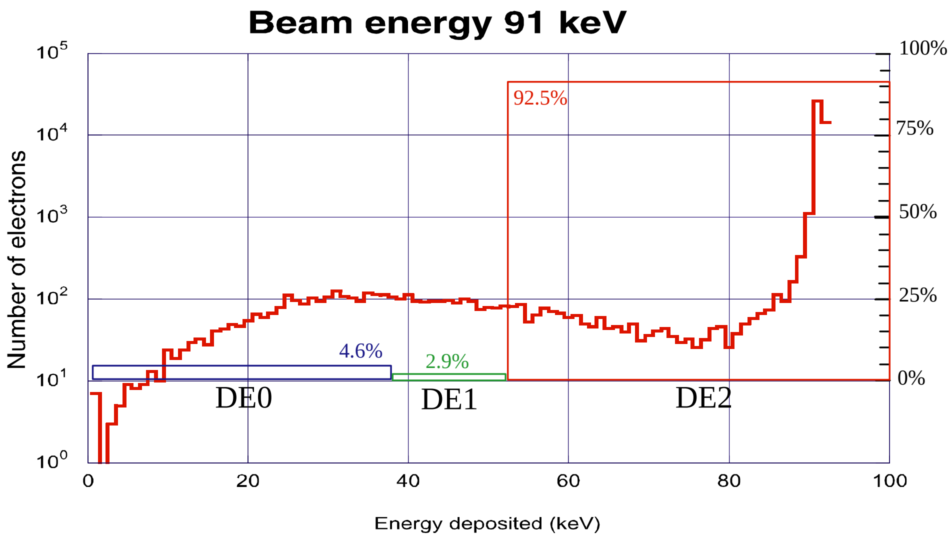
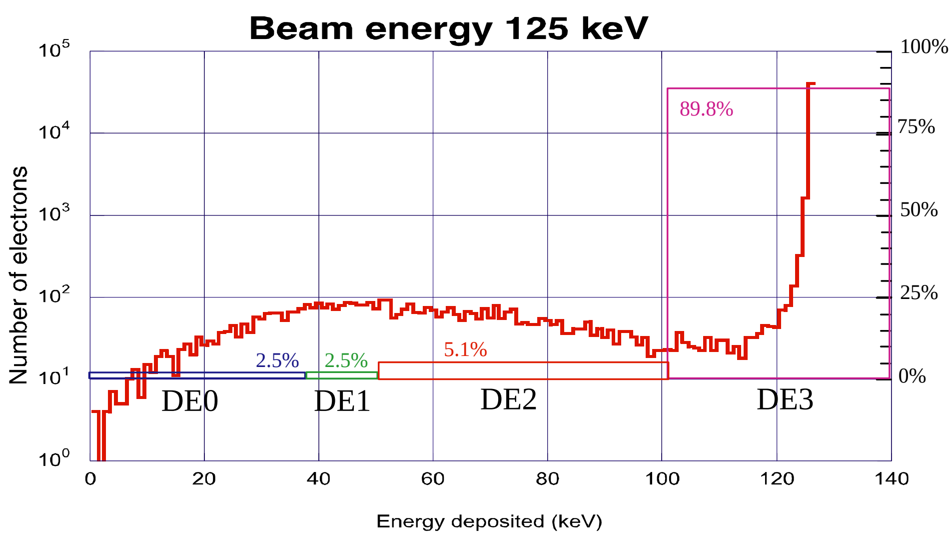
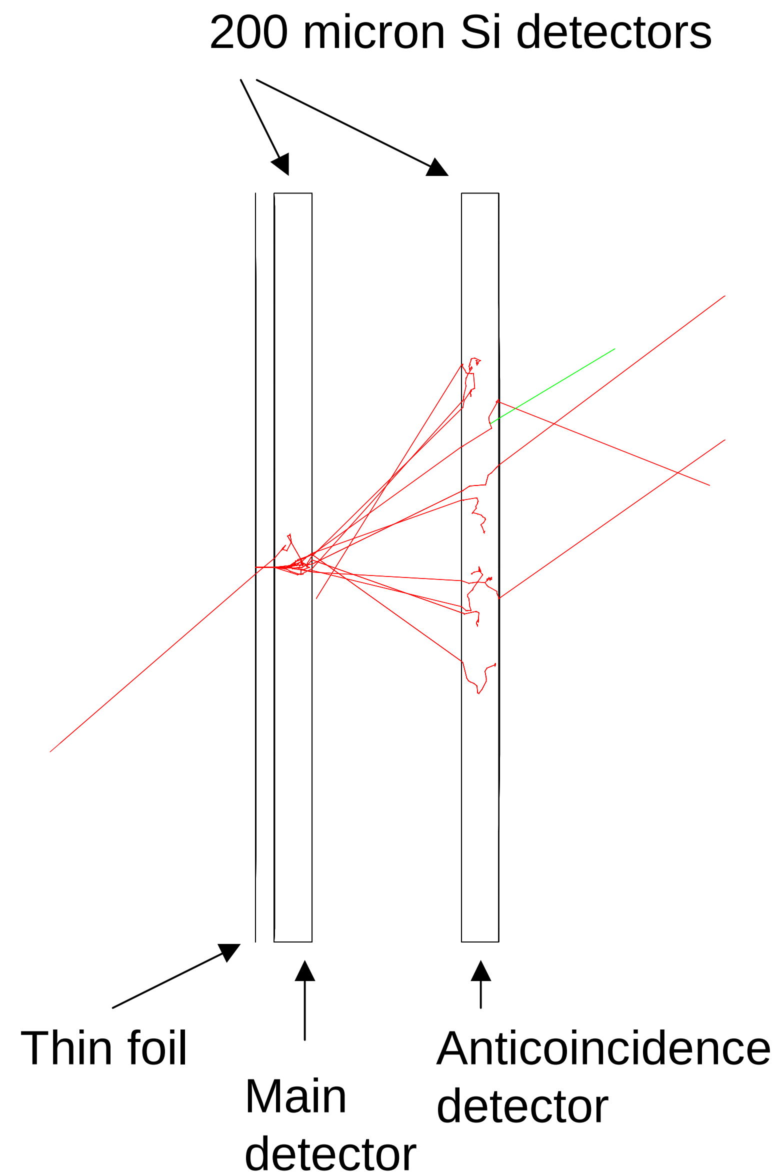
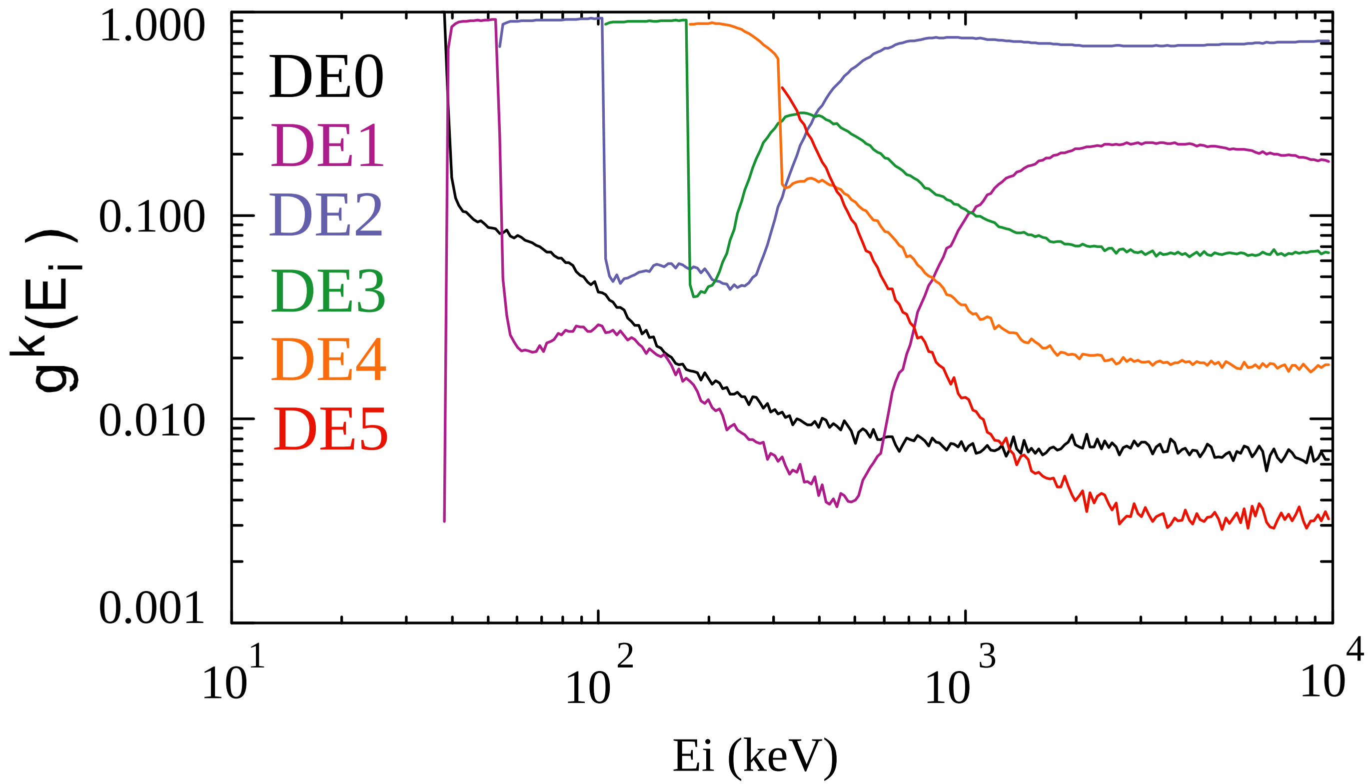
Adv. Space Res. In press, 2004





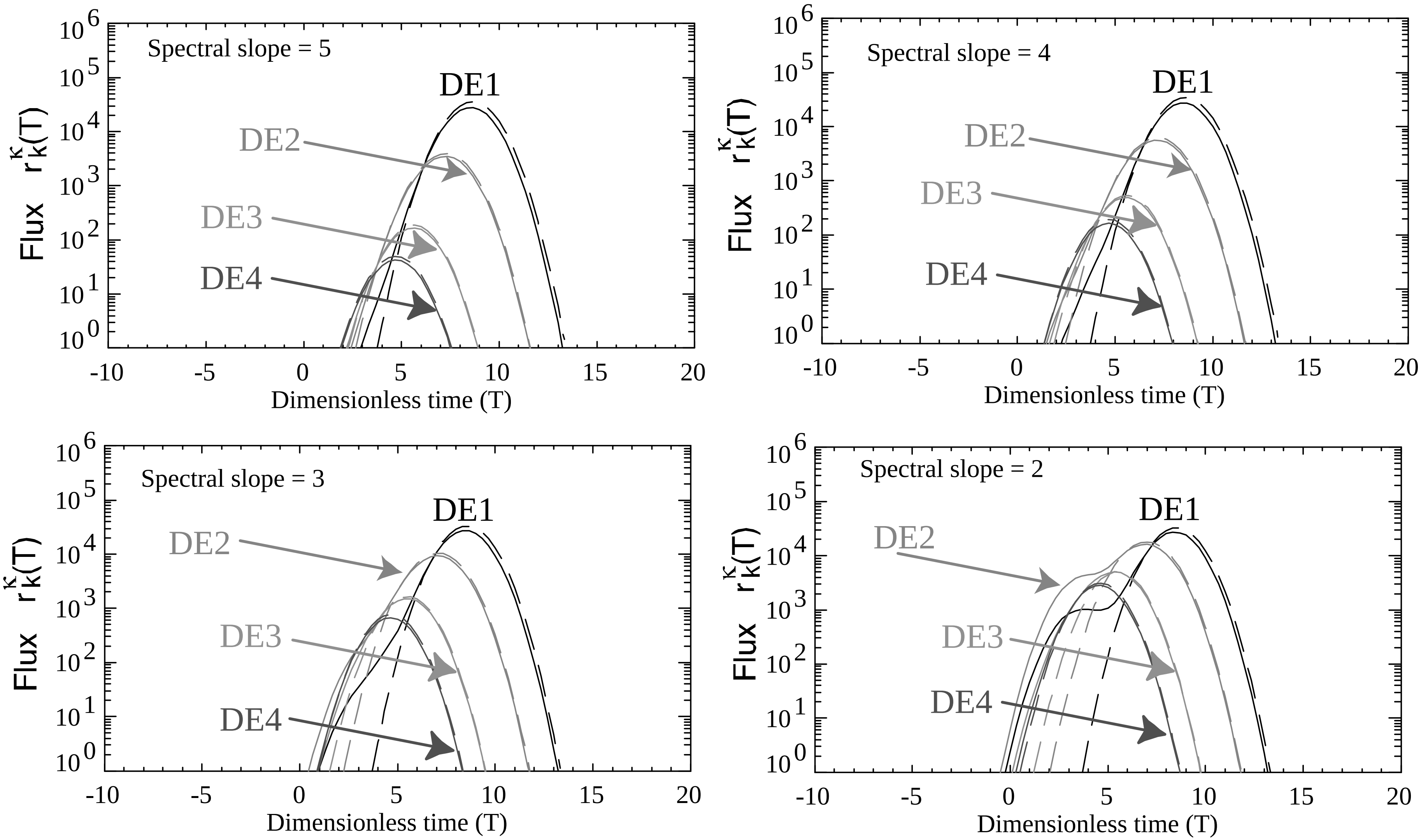
Simulation of energy deposited in the SSD due to a ~91 keV (top) and a ~125 keV (bottom) electron beam. A percentage of the incident electrons will trigger channels lower than the incident energy because some electrons scatter out of the SSD.



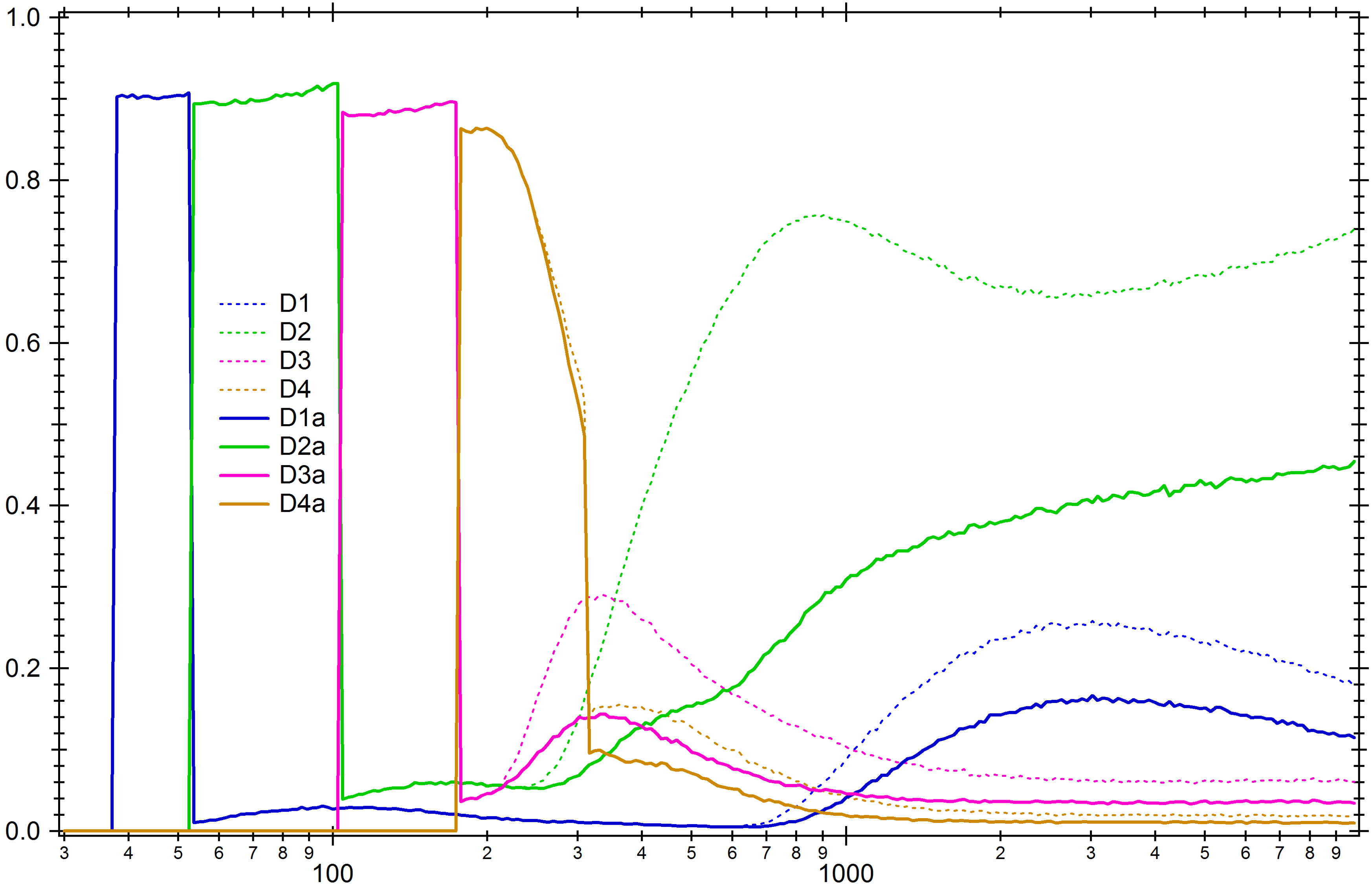


The channel response function gκ(Ei) shows the probability that an electron will be measured in a particular EPAM channel.

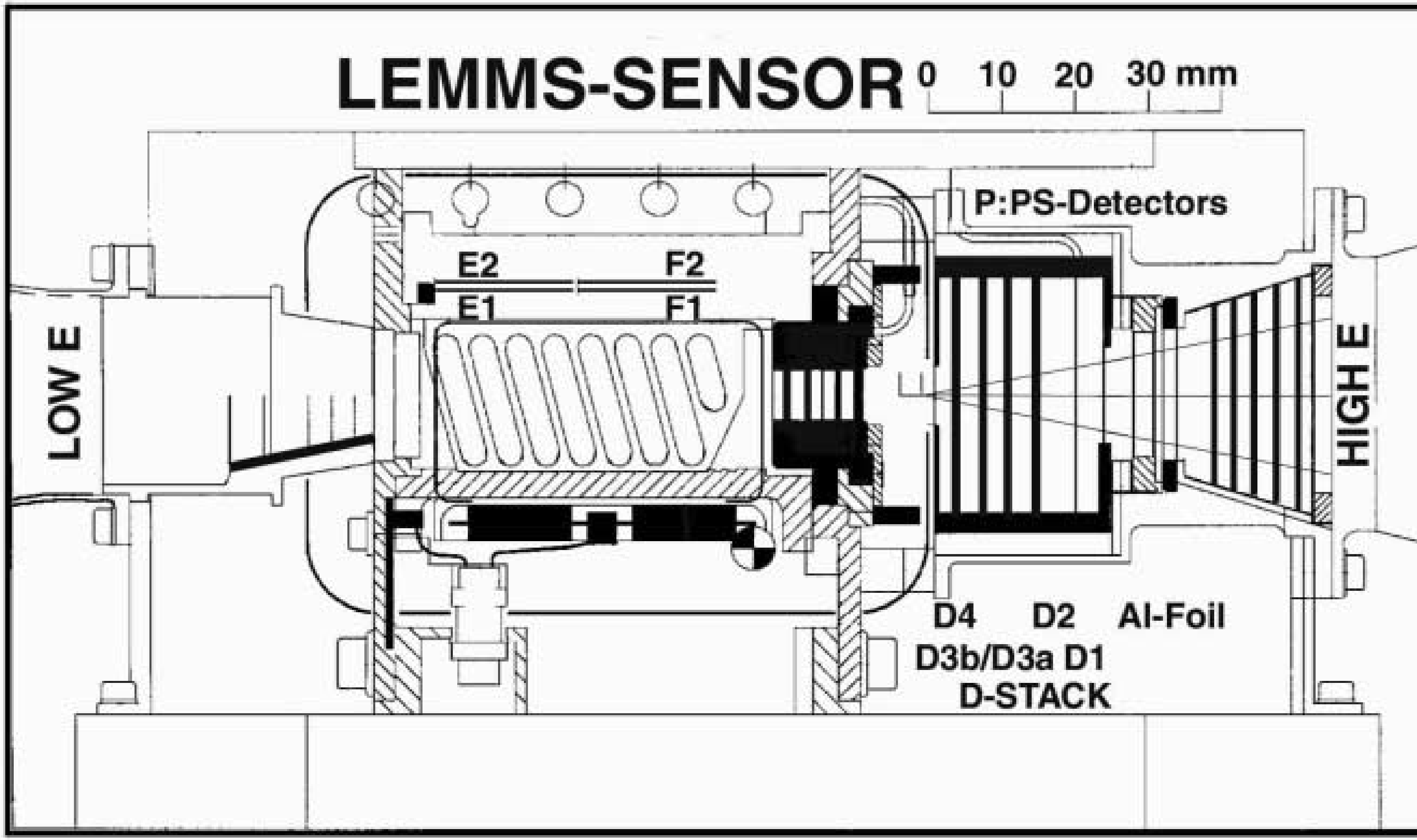
This simulation was done without the “anti” detector



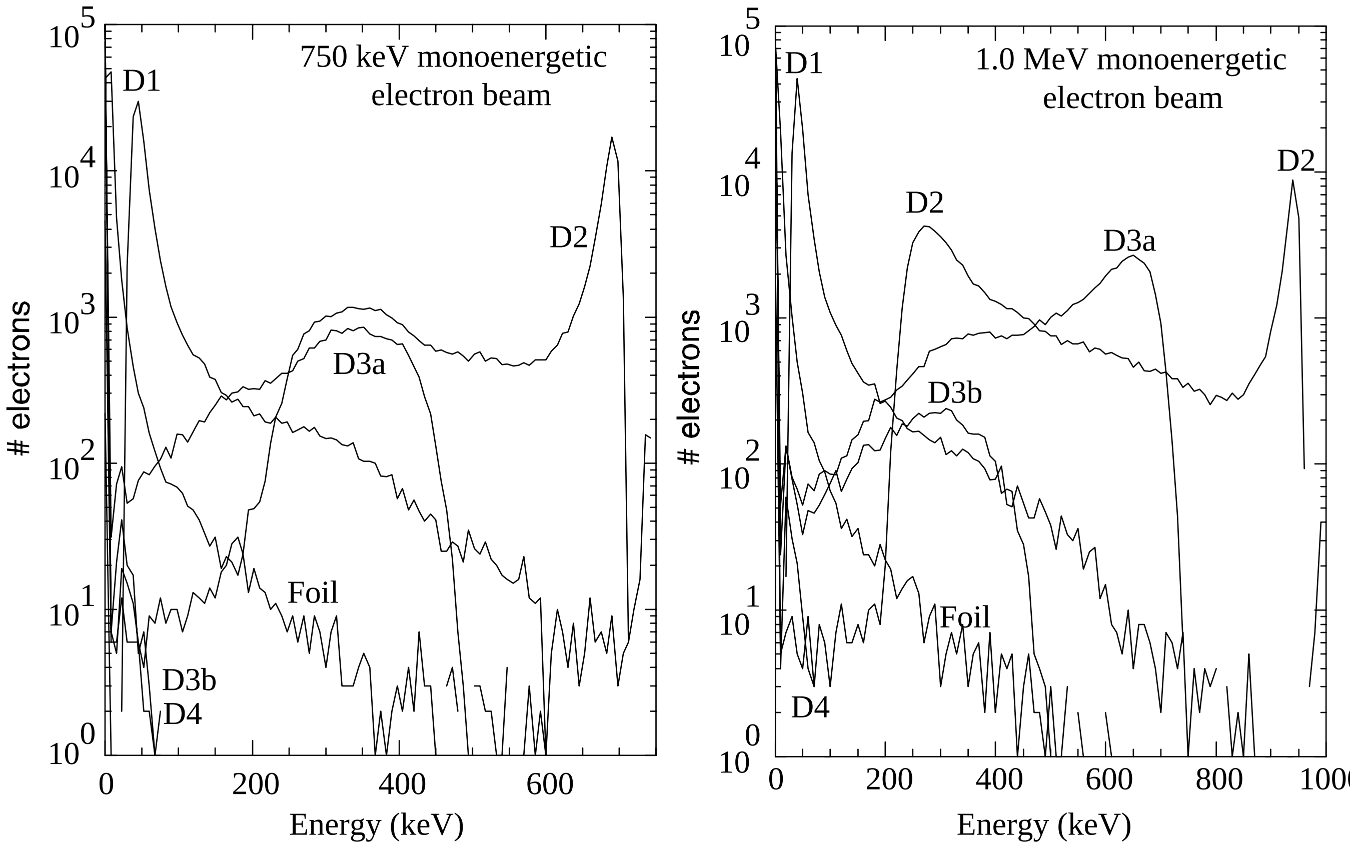
The simulated electron intensity (solid lines) and non-scattered intensity (dashed lines) of each EPAM deflected electron channel. The flux function is based on a gaussian injection in time at the Sun and a power-law spectrum in energy



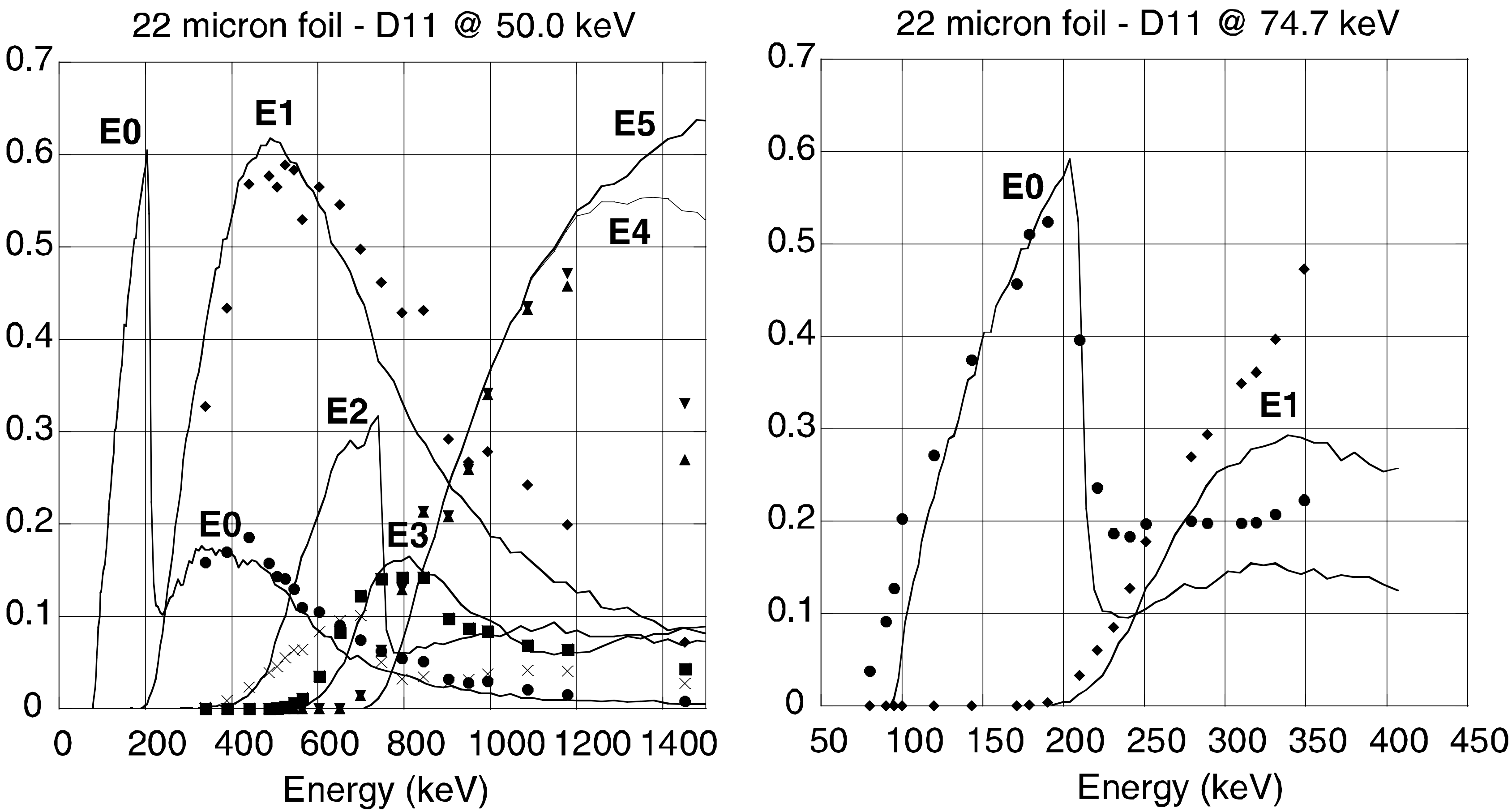
The channel response function shows the probability that an electron will be measured in a particular EPAM channel with (solid) and without (dots) the anticoincidence detector.



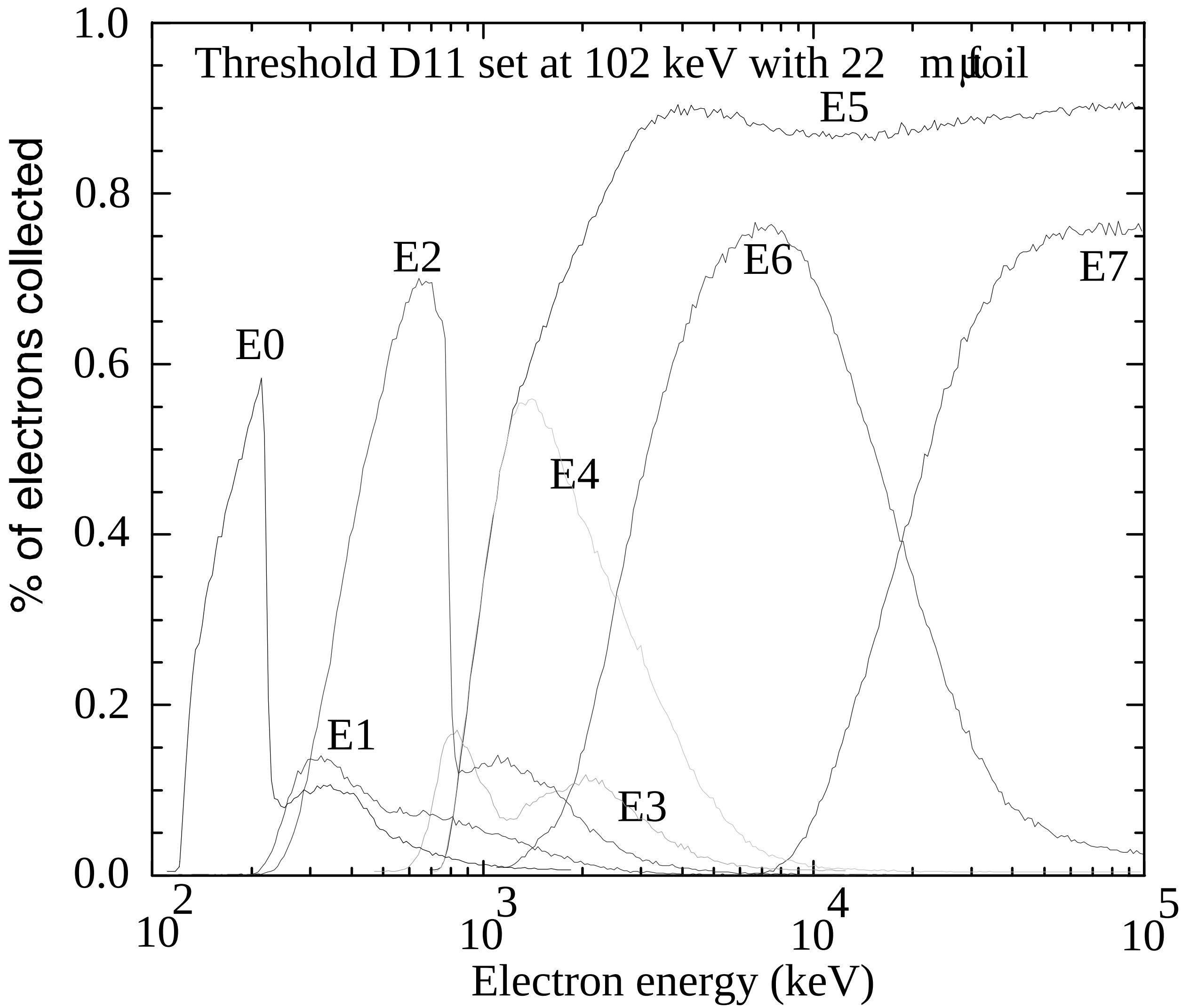
Schematic of the LEMMS sensor showing the Low Energy (left) and the High Energy (Right) sections.



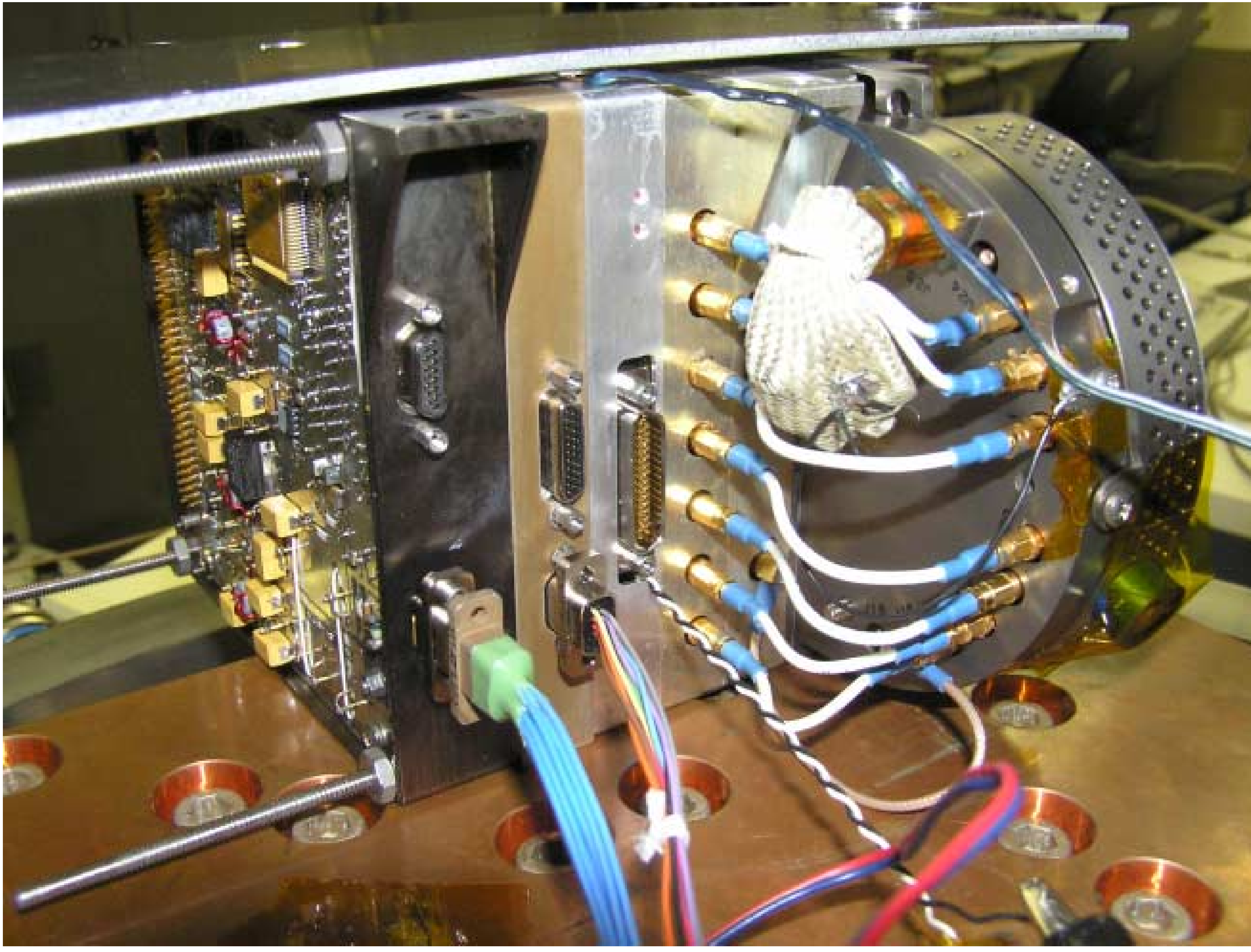
Energy loss histograms from two discreet electron beams with an incident energy of 750 keV (left panel) and 1 MeV (right panel). The ordinate shows the number of electrons while the abscissa shows the energy loss in keV. Note that while detectors D3a and D3b are two distinct detectors, they are logically coupled in the LEMMS electronics system.

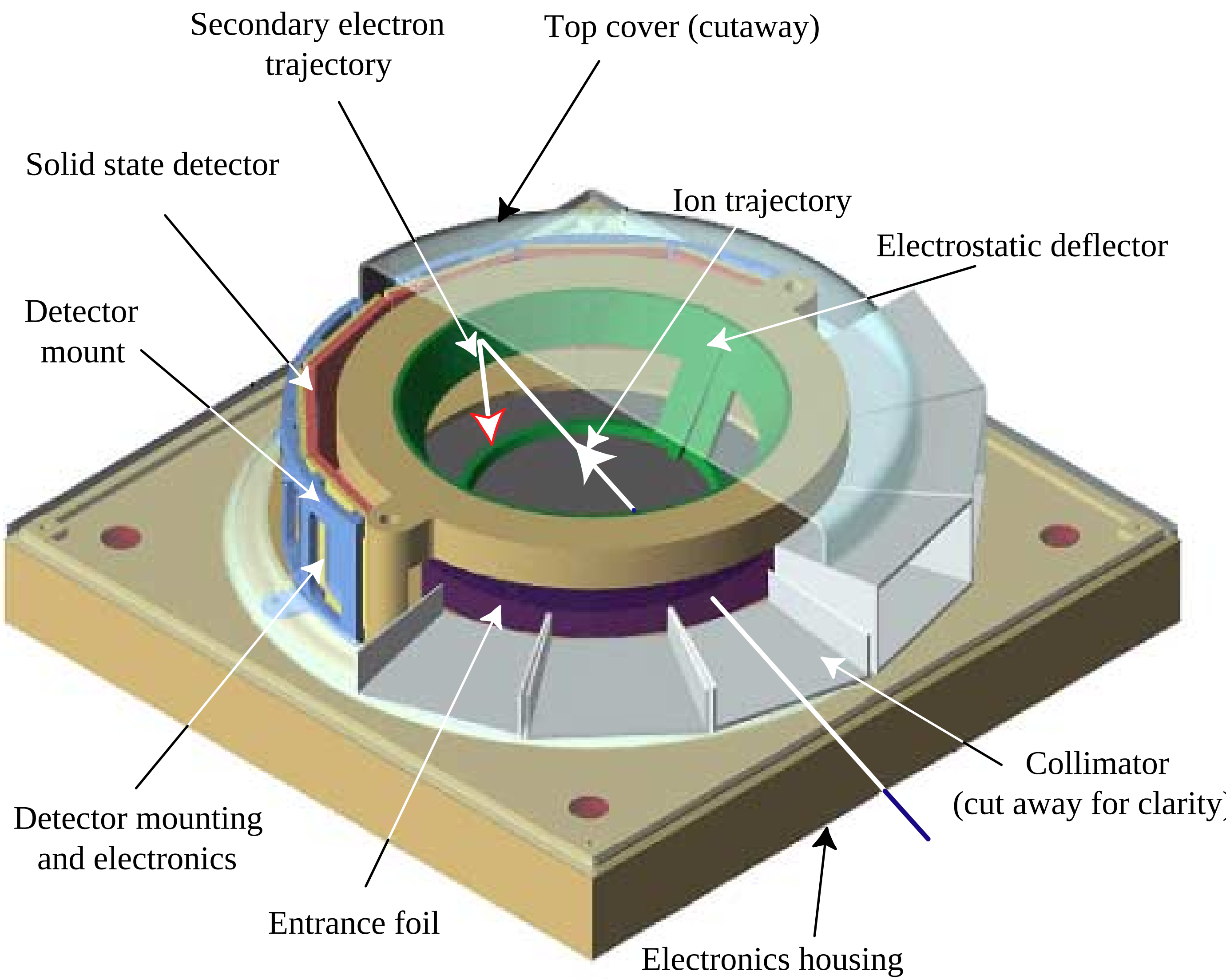


Comparison between GEANT4 Simulations and Calibration runs for two different threshold levels.

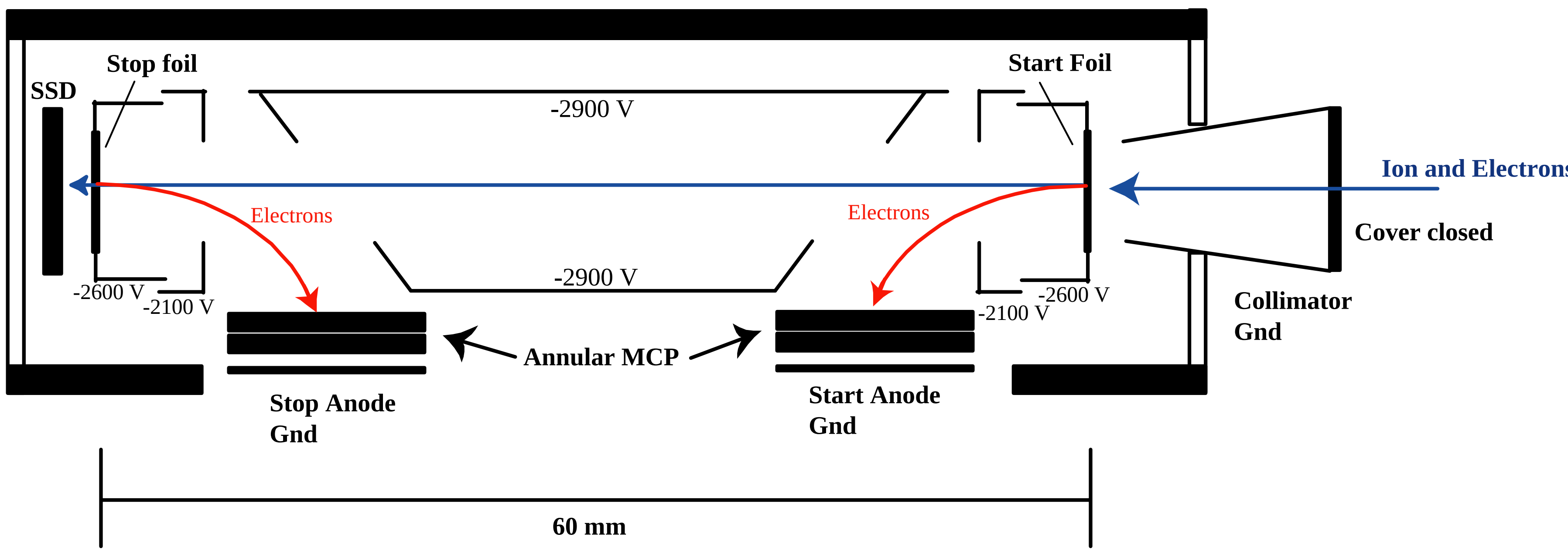


The LEMMS electron channel response with a D11 threshold of 102 keV





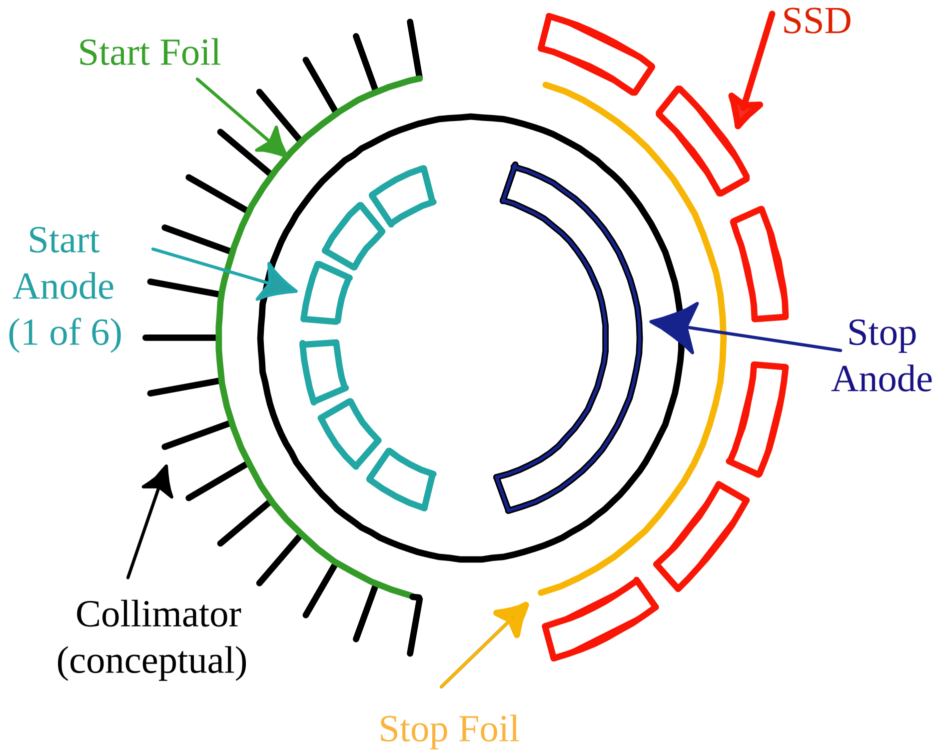
Schematic of the HiRACE spectrometer, based on MESSENGER EPS

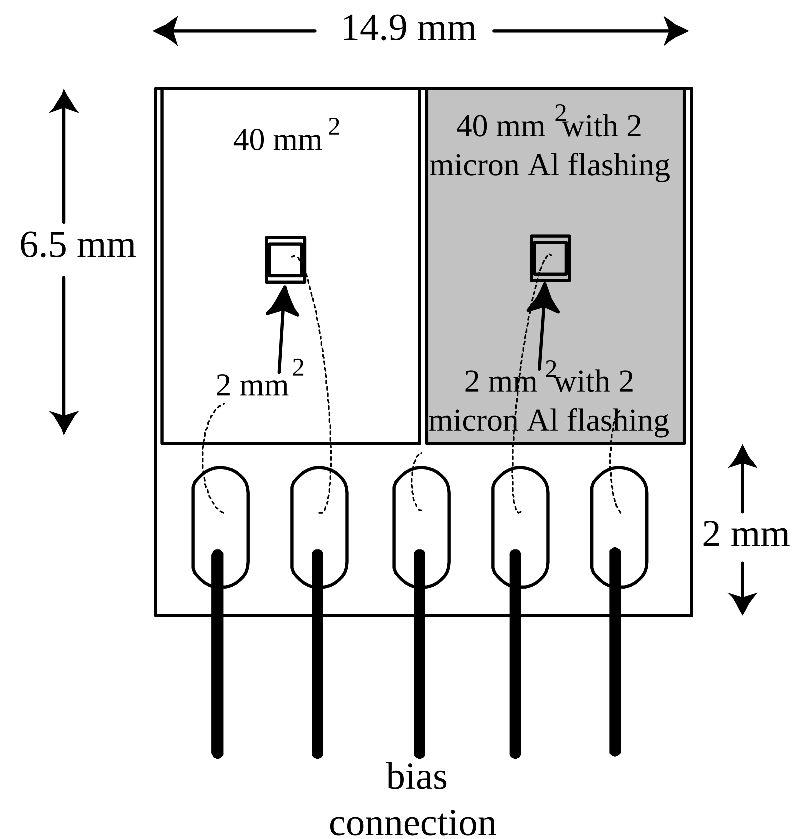


A cross section of the HiRACE spectrometer which highlights the TOF functionality.

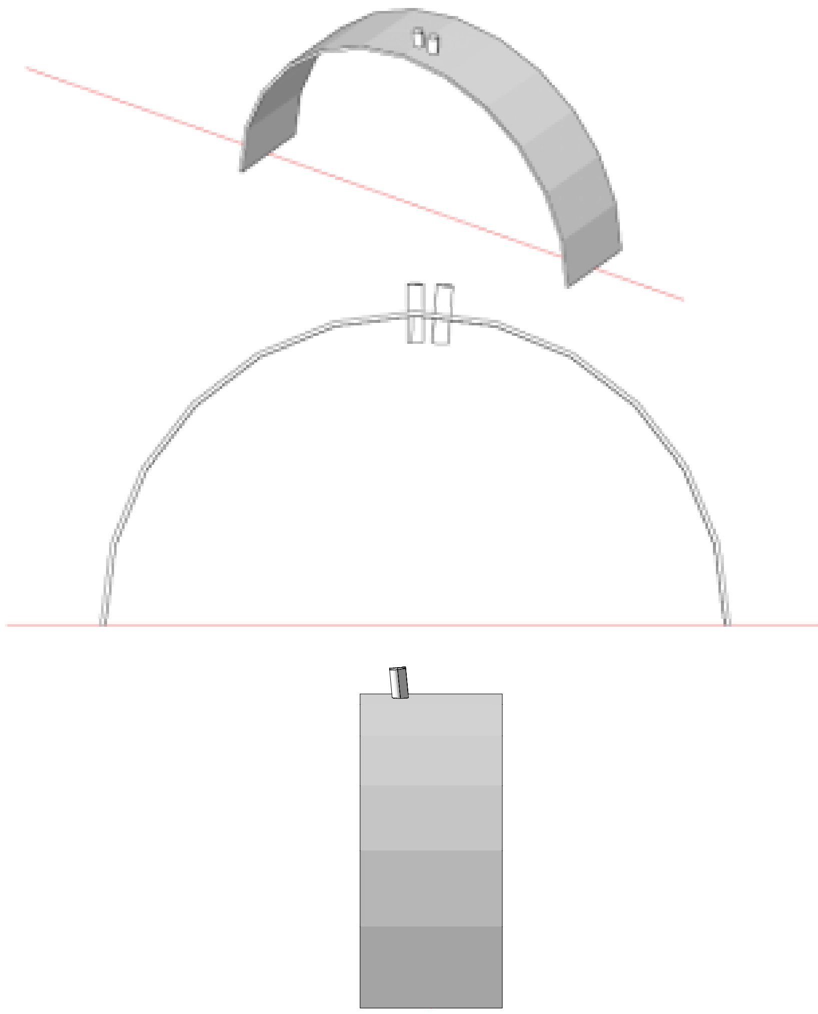
The optical simulations are currently being done with SIMION.

Question: Does GEANT4 currently support the low energy surface physics required to simulate the “production” of these low energy secondary electrons?

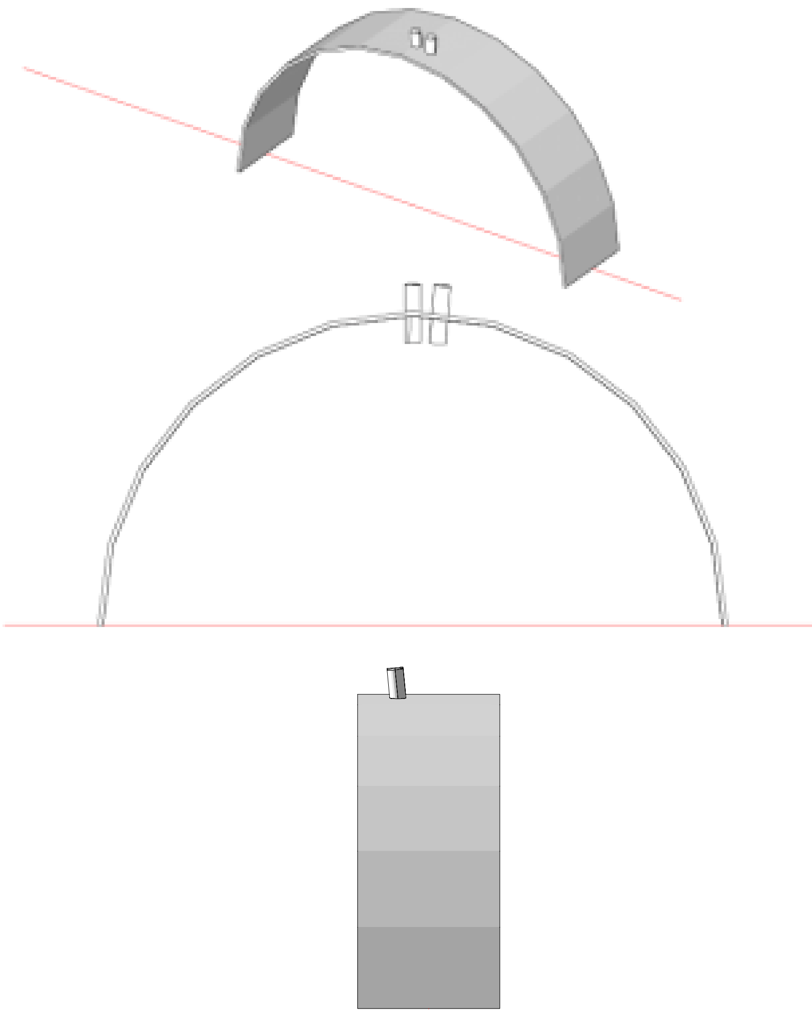


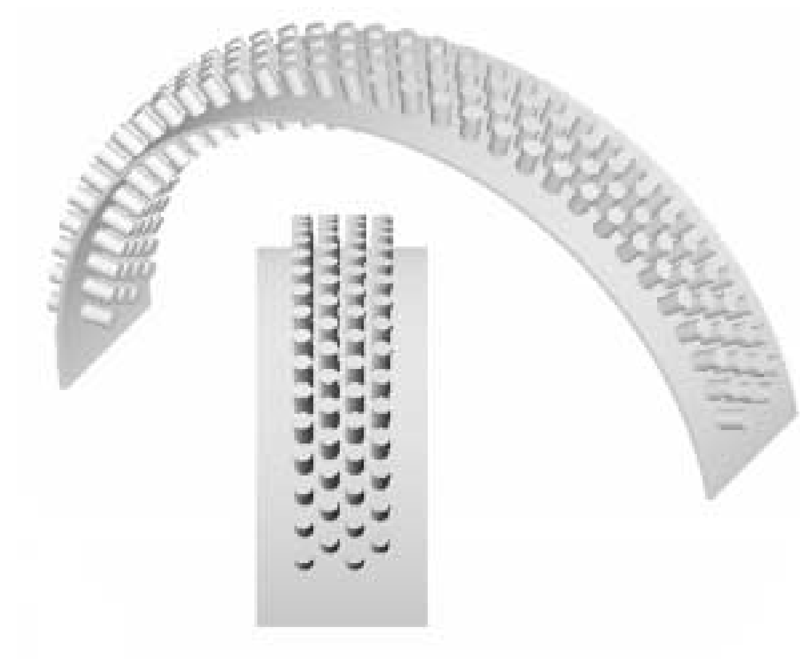


Left shows a top view of the HiRACE spectrometer with the orientation of the SSD array. Right shows a schematic of a SSD to be used on HiRACE.

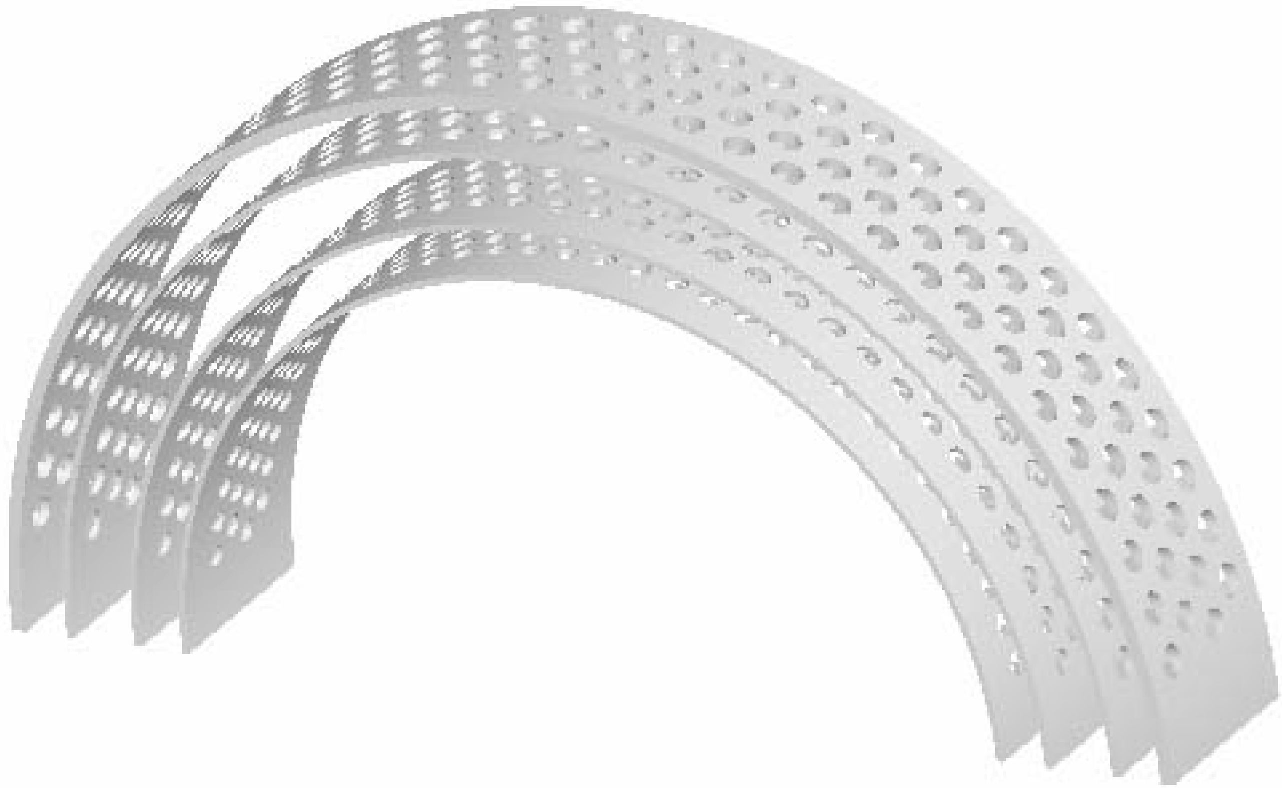


For your amusement pictures of the Collimator assembly development:



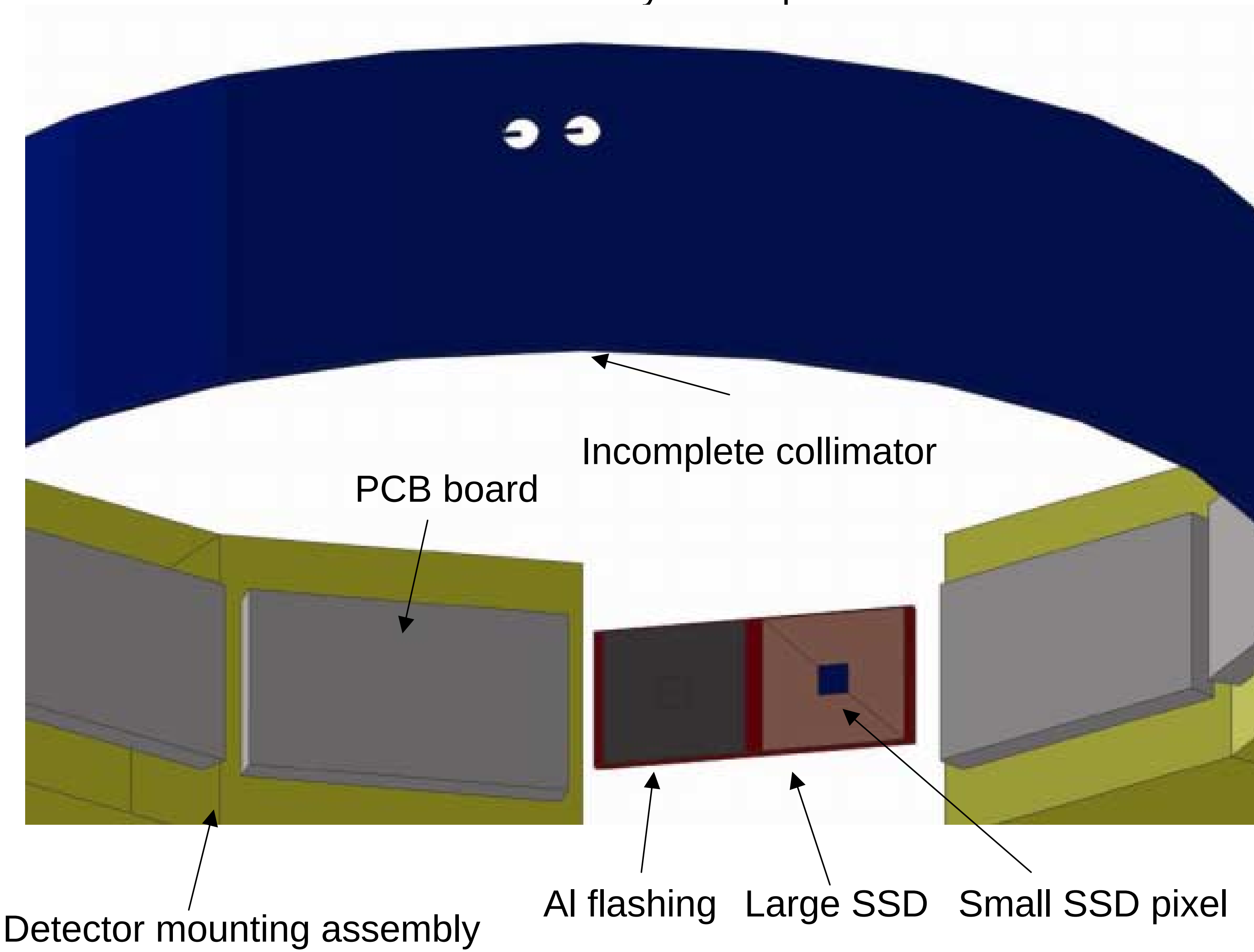


For your amusement pictures of the Collimator assembly development:

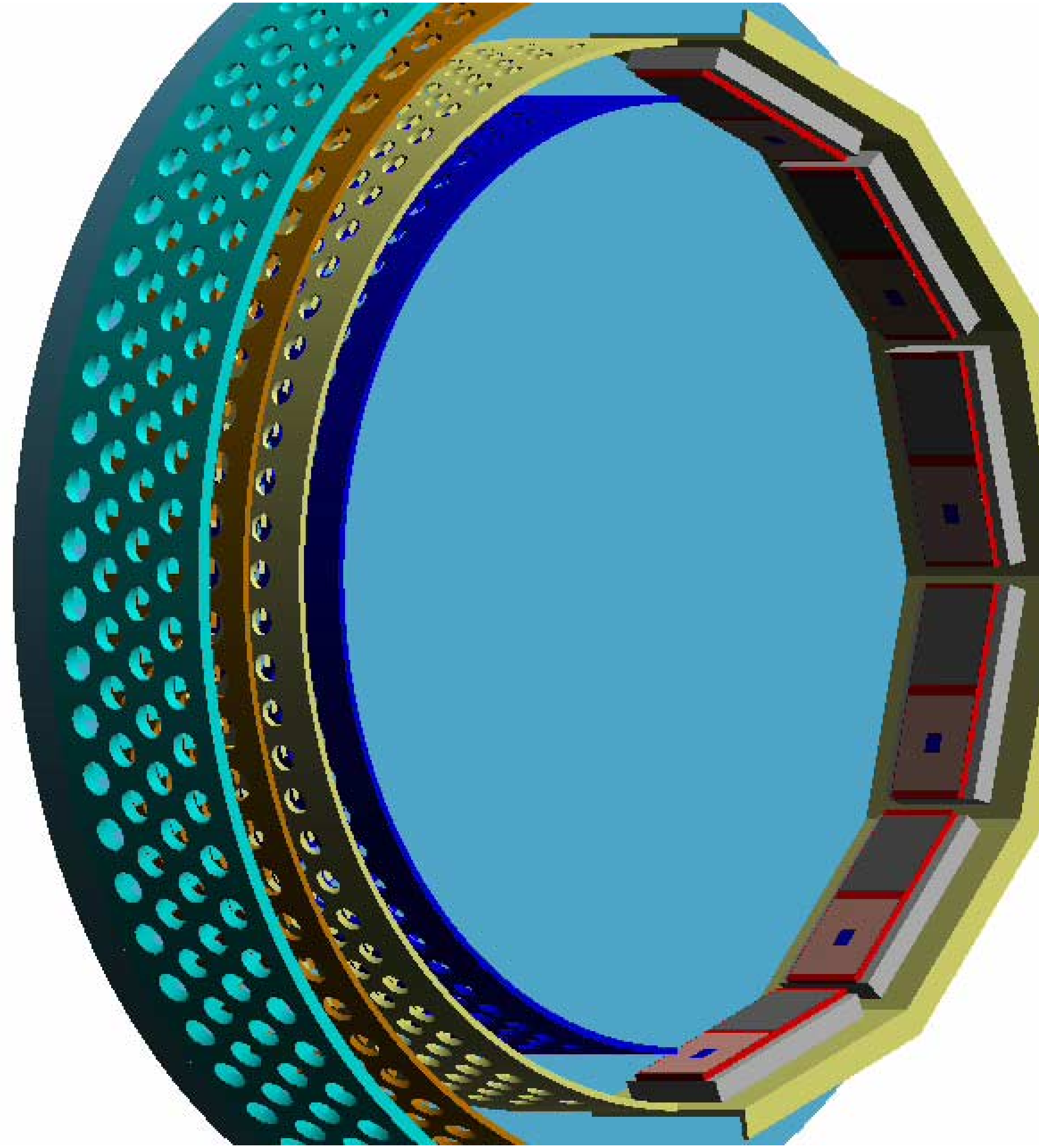


A completed HIRACE collimator assembly

Solid State Detector array development

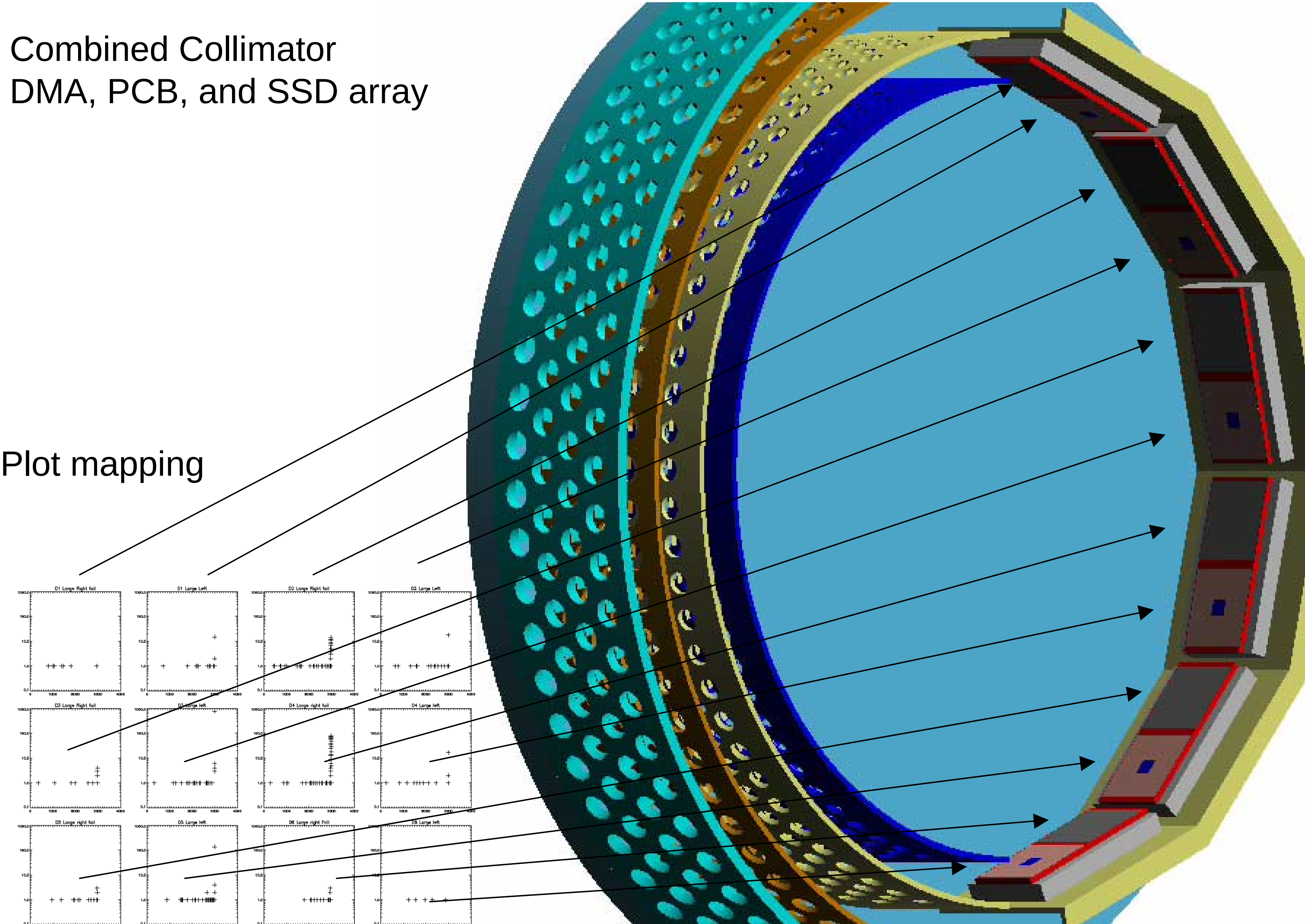


Combined Collimator
DMA, PCB, and SSD array



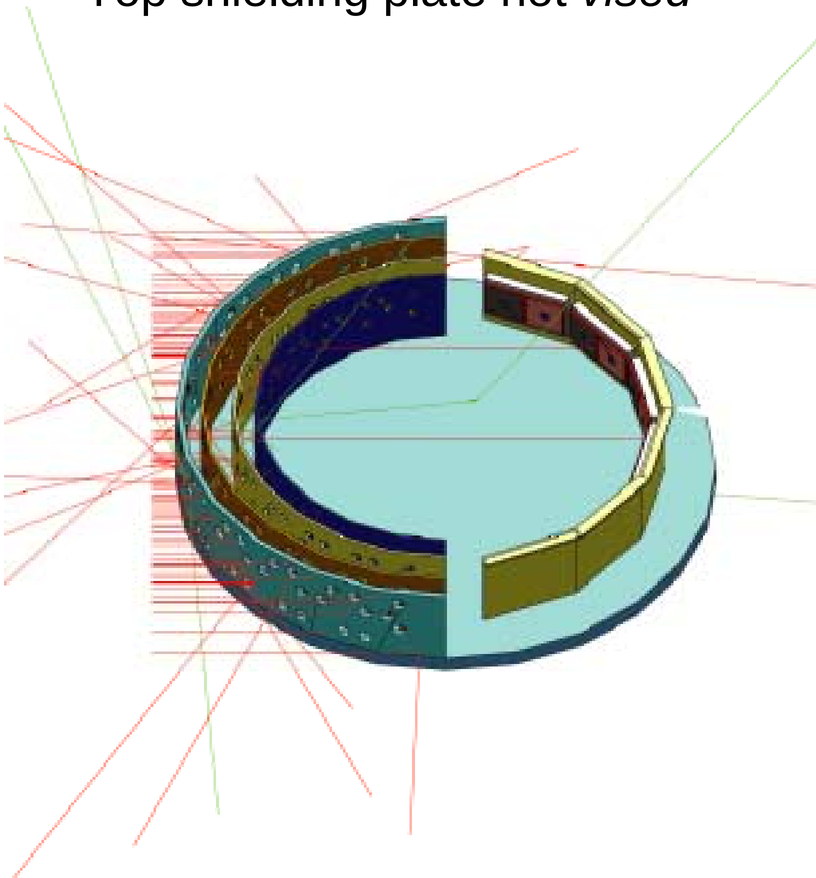
Combined Collimator
DMA, PCB, and SSD array

Plot mapping

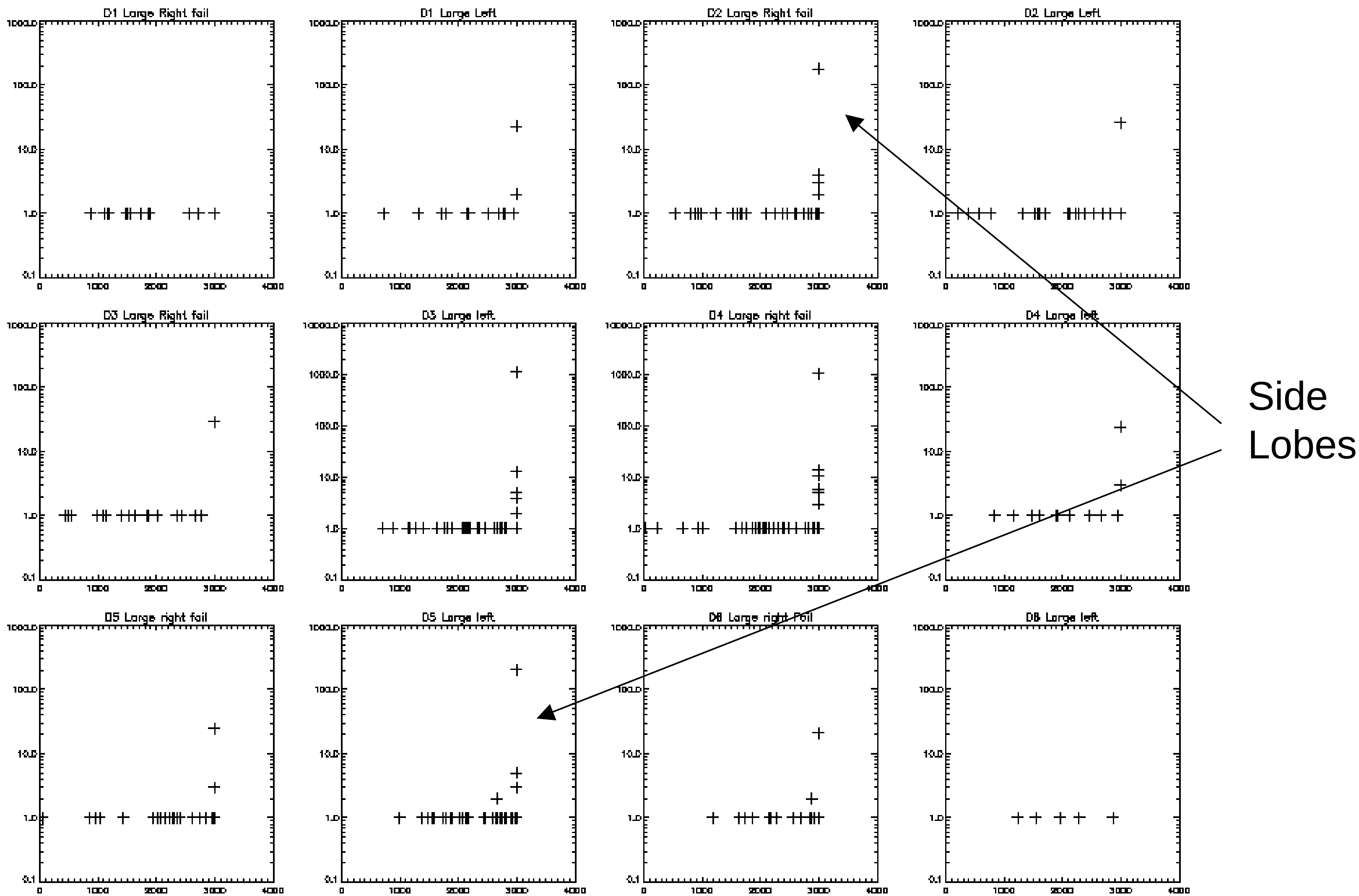


Time for the FUN.

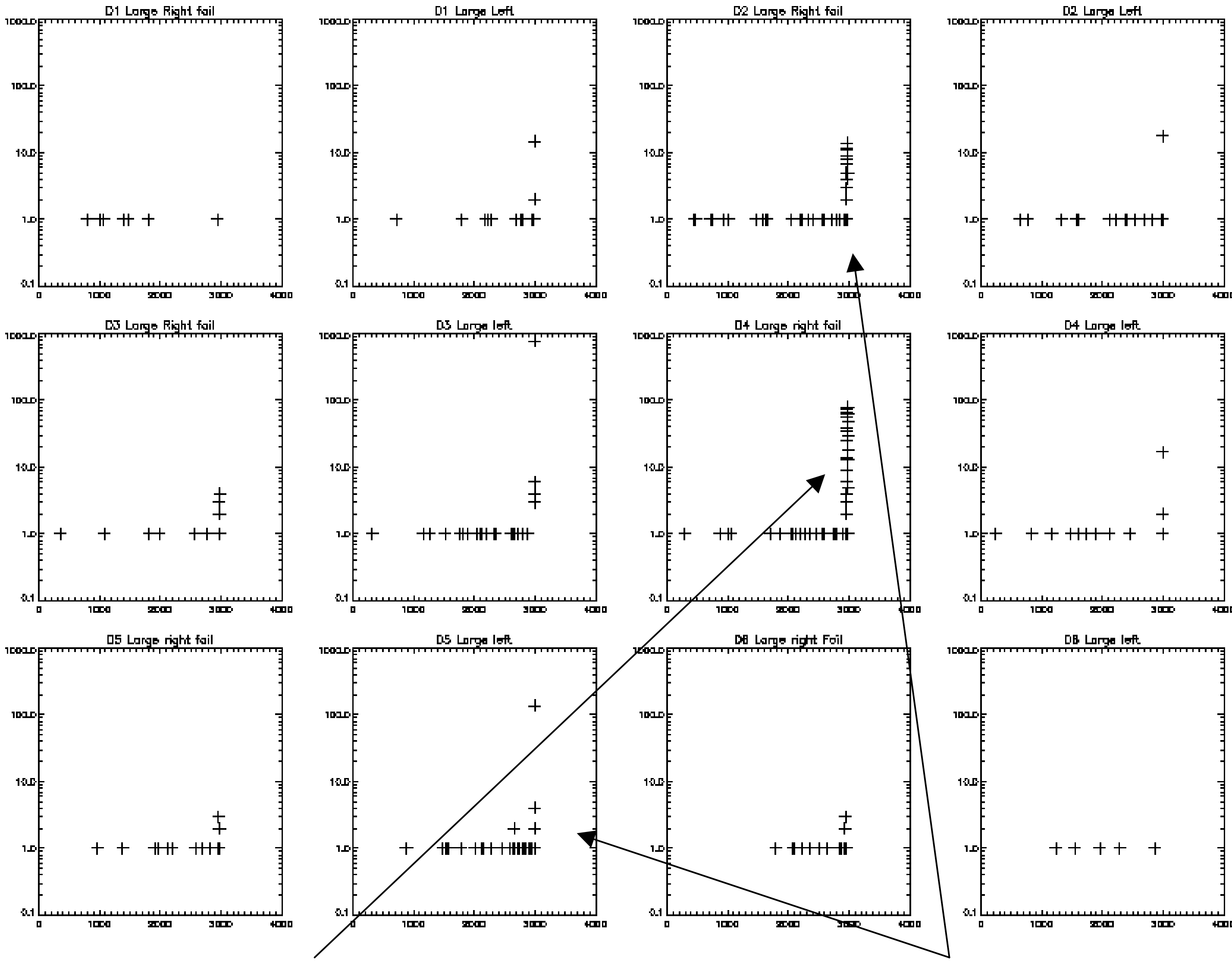
Top shielding plate not *vised*



3 MeV monoenergetic electron beam: Symmetrical as expected



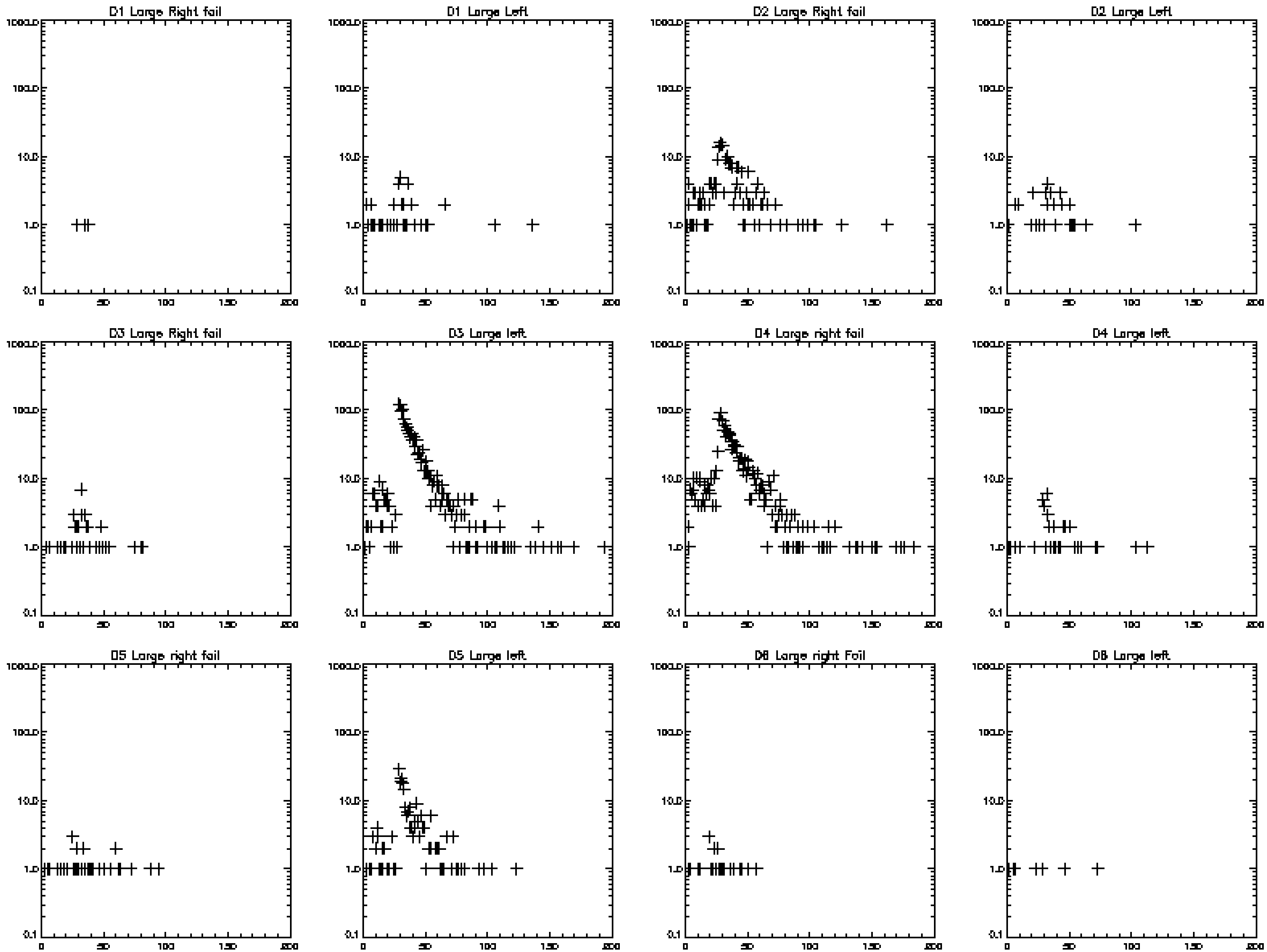
Monoenergetic 3 MeV proton run.



Energy dispersion in foil covered detector

Side lobes clearly observed

GPS Proton power law input



TBD on the HIRACE spectrometer.

- Accelerator test. This will be done @ Berkeley. Multiple angles at various points on the system (scheduled for this Summer)
- Summer intern will assist in Future simulations
- Add optical elements in G4 (perhaps even potentials?)
- Use calibration data obtained at accelerator test and correlate with GEANT4 simulations
- Use GEANT4 to improve the shielding system
- Second accelerator test with improved shielding system
- Determine Geometrical factors, background rates, etc…
- Publish results of simulations, combined with calibration data