US magnet hotspot

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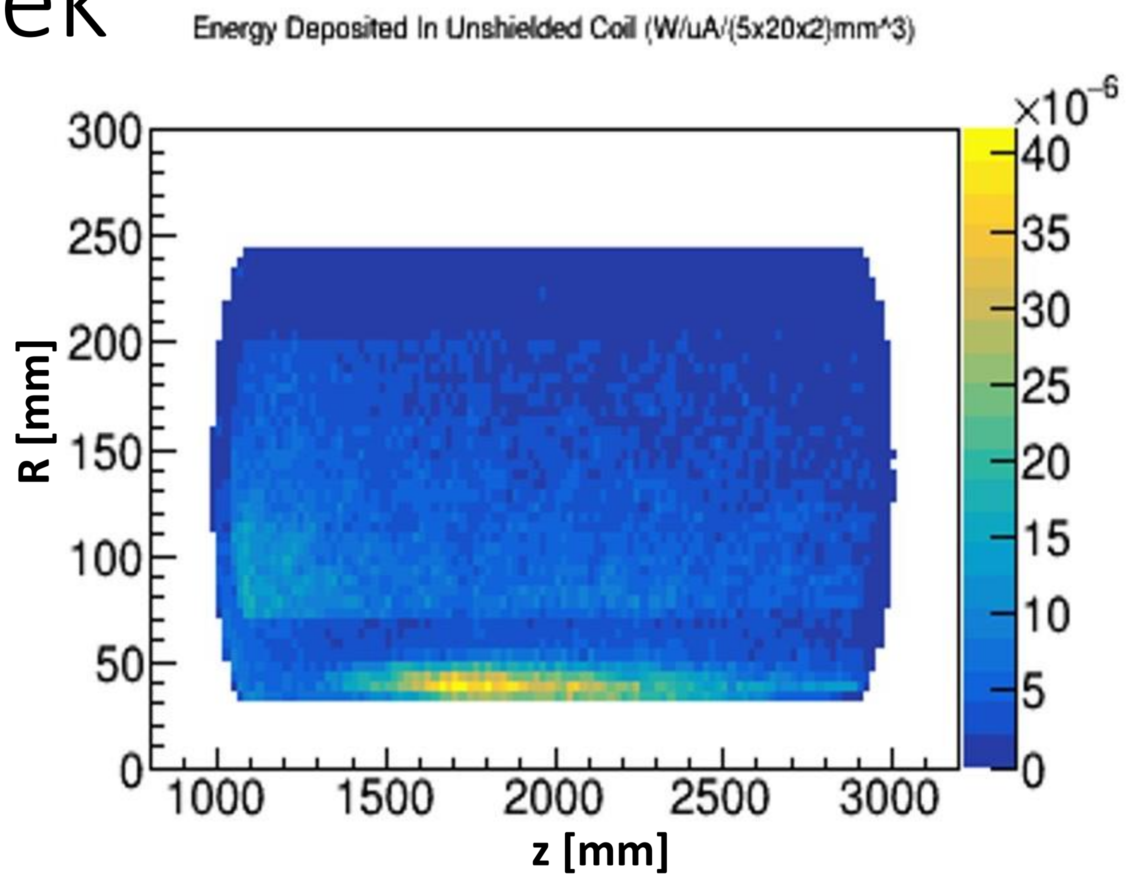
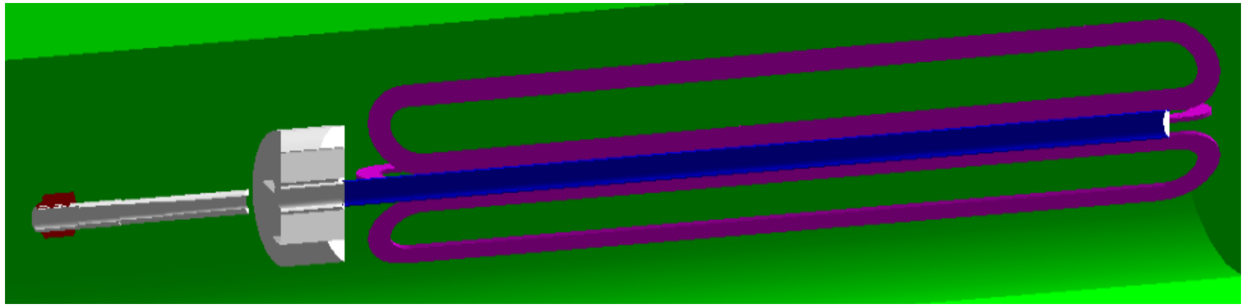
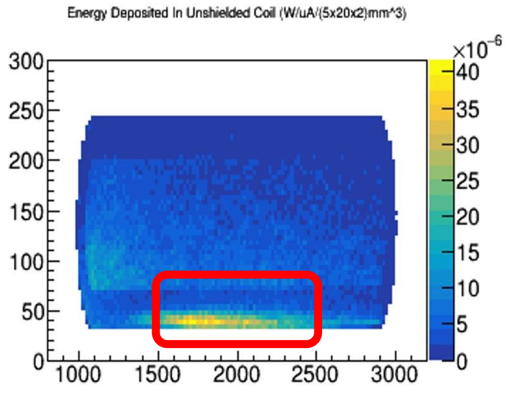
Problem as presented last week

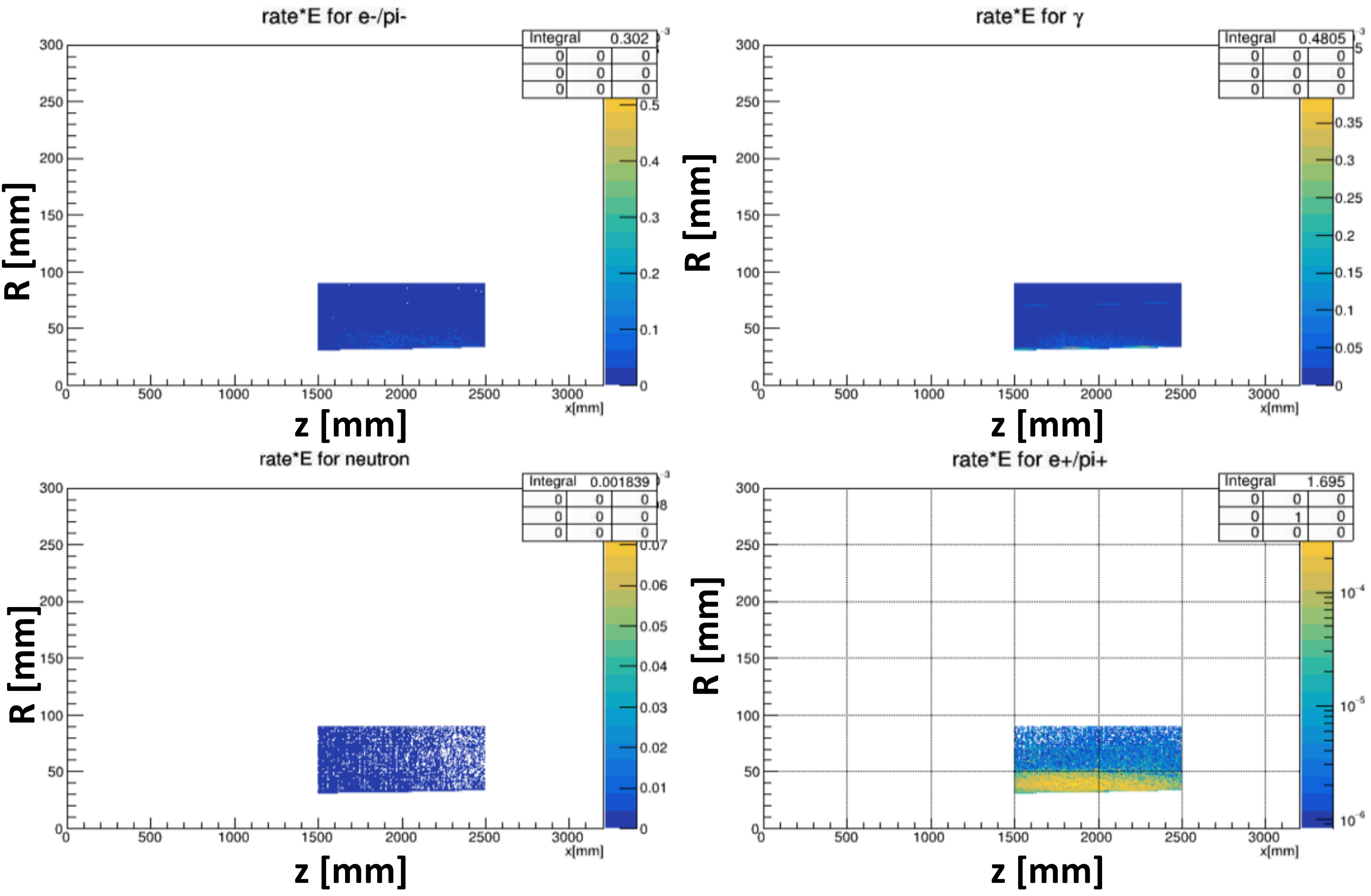
- In the course of the full evaluation the energy deposition on the epoxy in the upstream torus Sakib discovered that the equivalent dose on the bottom of the coil reached a level of 320 MGy
- As a first step took a very careful look at the potential sources of scattering from low radius (close to the z axis)
    - It turned out that beyond reducing the dose on the nose of the coils there was not much we could do to improve the situation over the longer mid-section





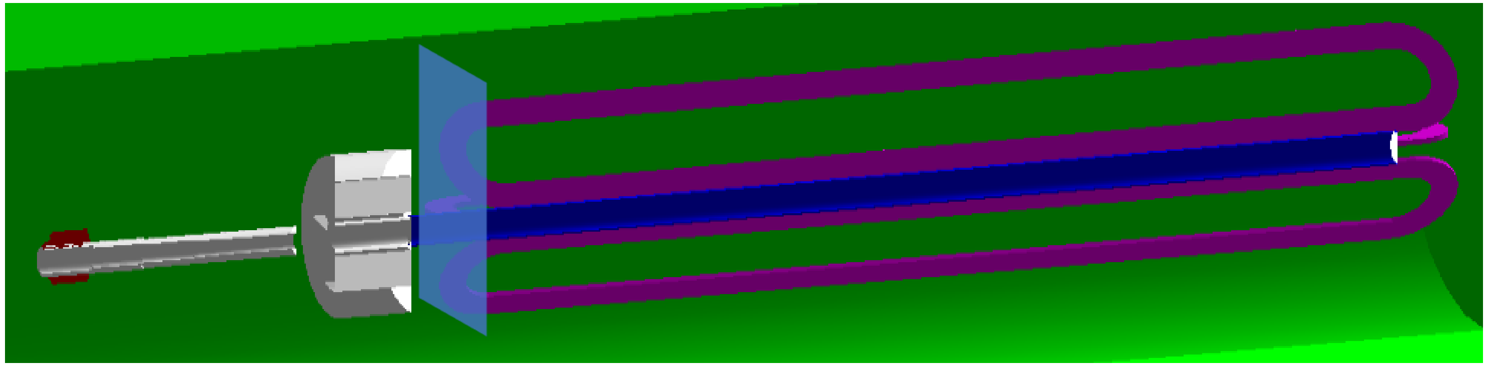
Understanding the problem

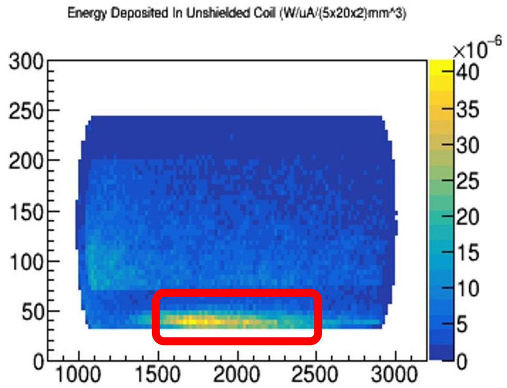


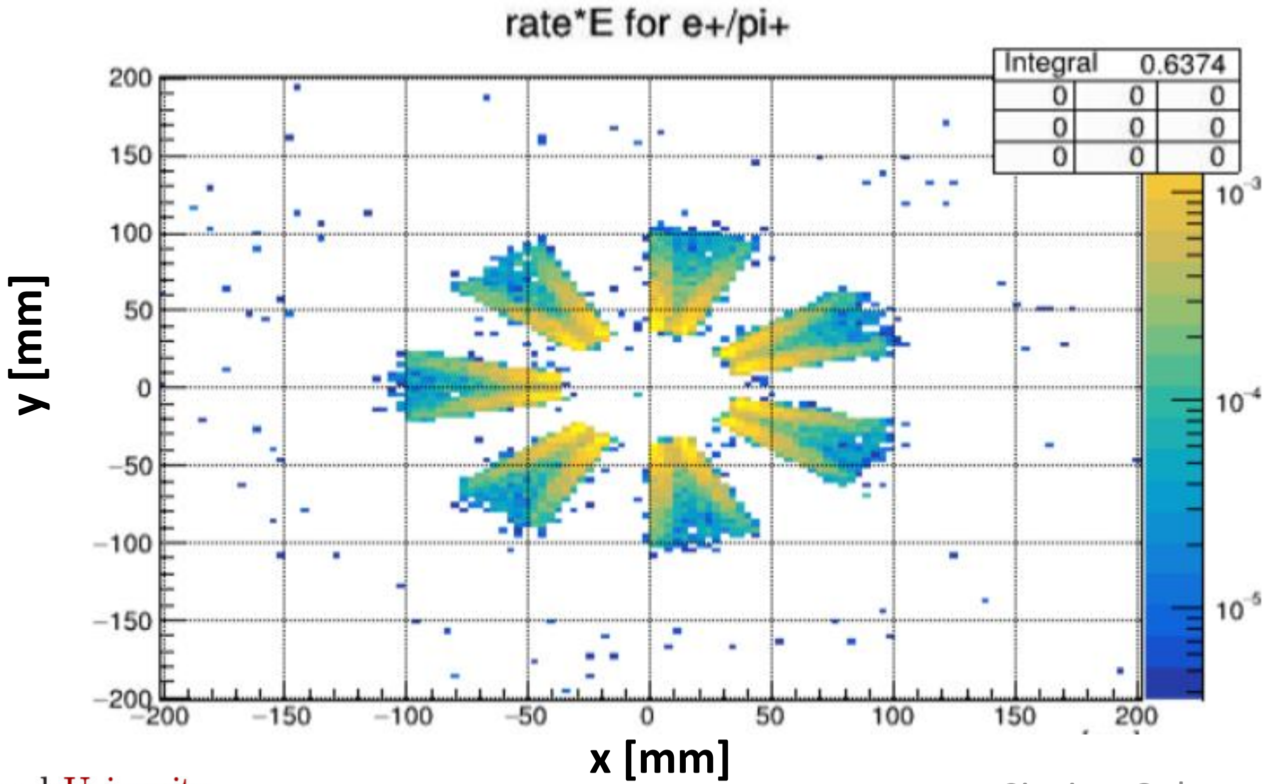


- We focused on the hot-spot on the coils
- If we look at the incident energy we can see that the positrons produce the largest contribution

Understanding the problem



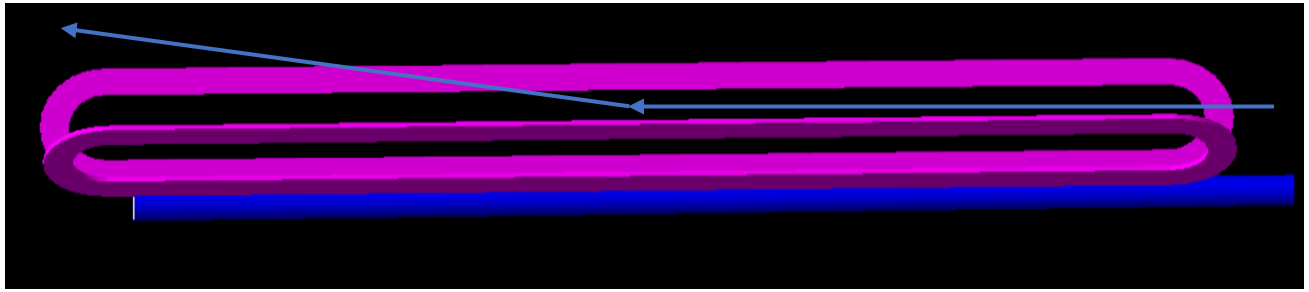


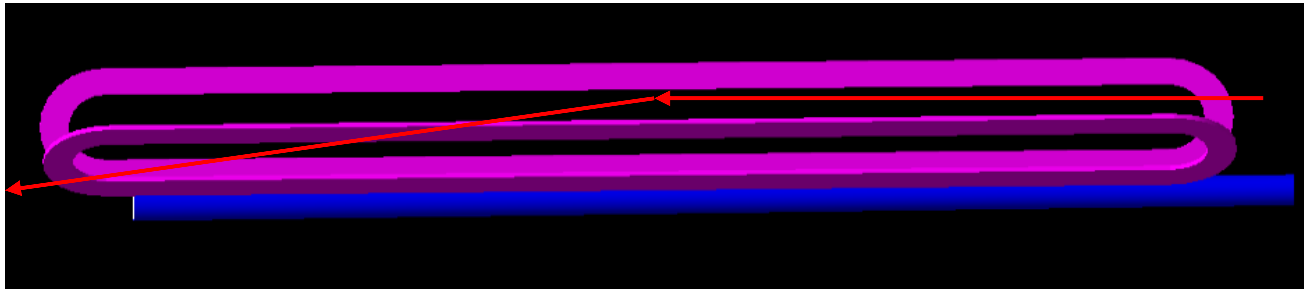


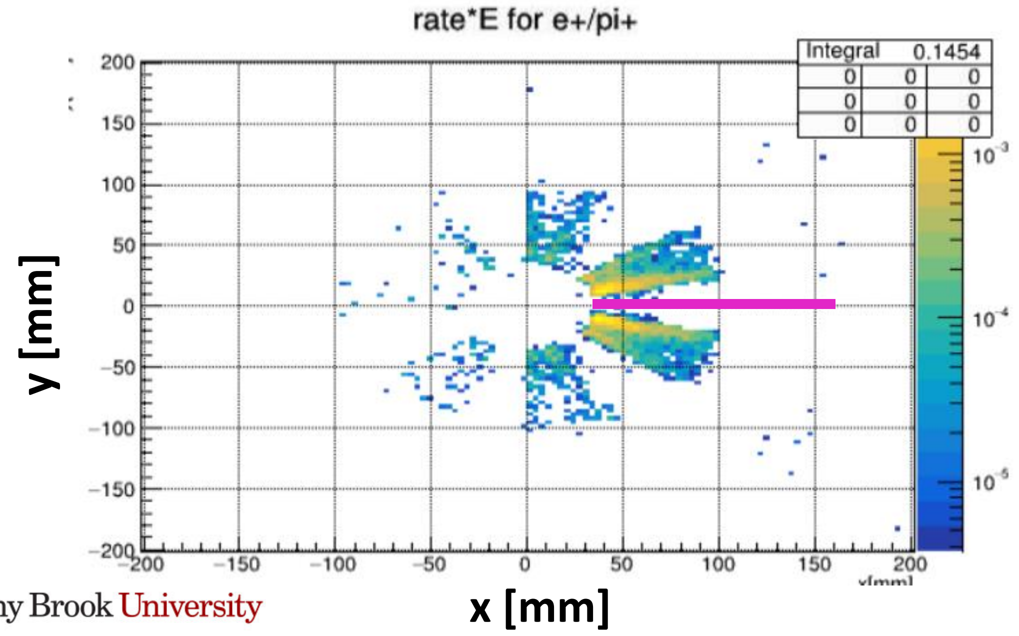
- Look at all particles that hit the hotspot and see where they were after collimator 2
- All particles seem to pass through the acceptance holes in collimator 2 (pictures just shows positrons)

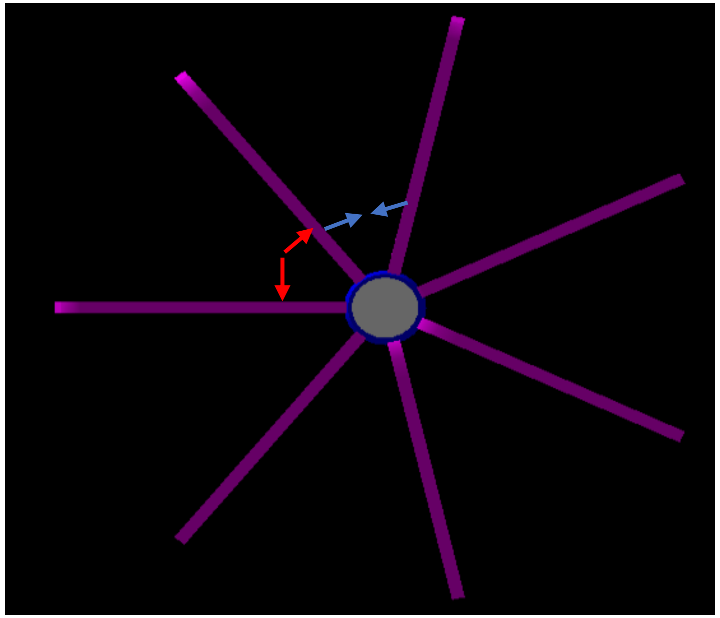
Positrons through the acceptance

- While electrons are bent radially outward, positrons will move towards the beampipe
- Secondly electrons are focused in the azimuth by the magnetic field the positrons will be defocused on the lower leg of the coil
- Depending on the energy the positrons could easily find their way to the size of each coil
    - Looking at one coils shows the two acceptance holes on each side are the sources



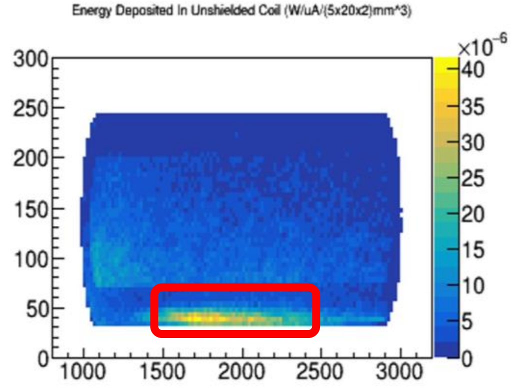


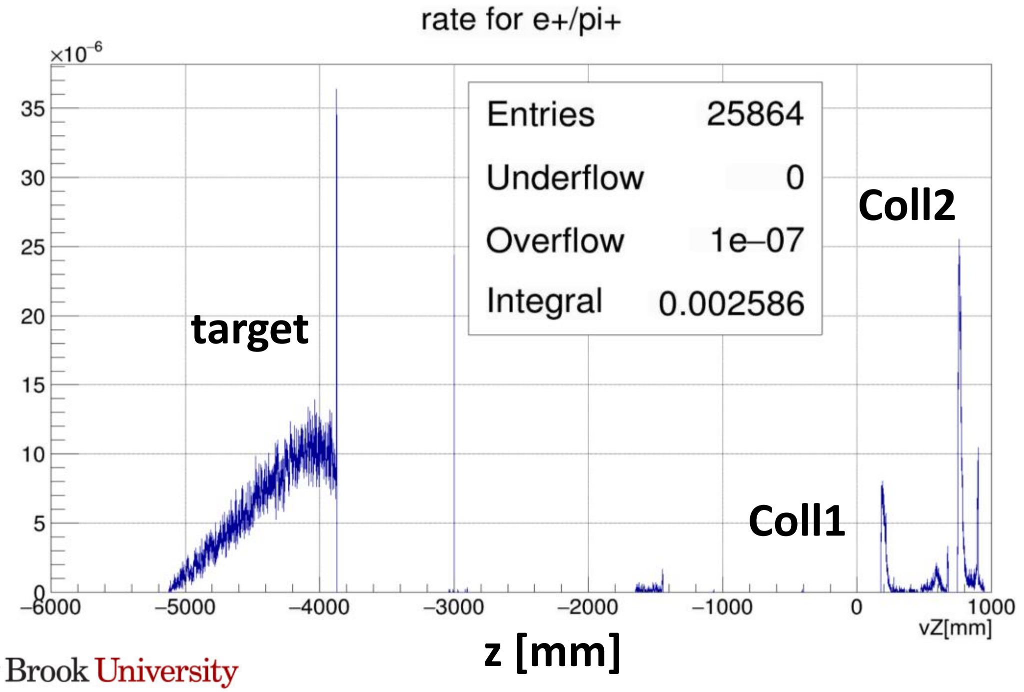


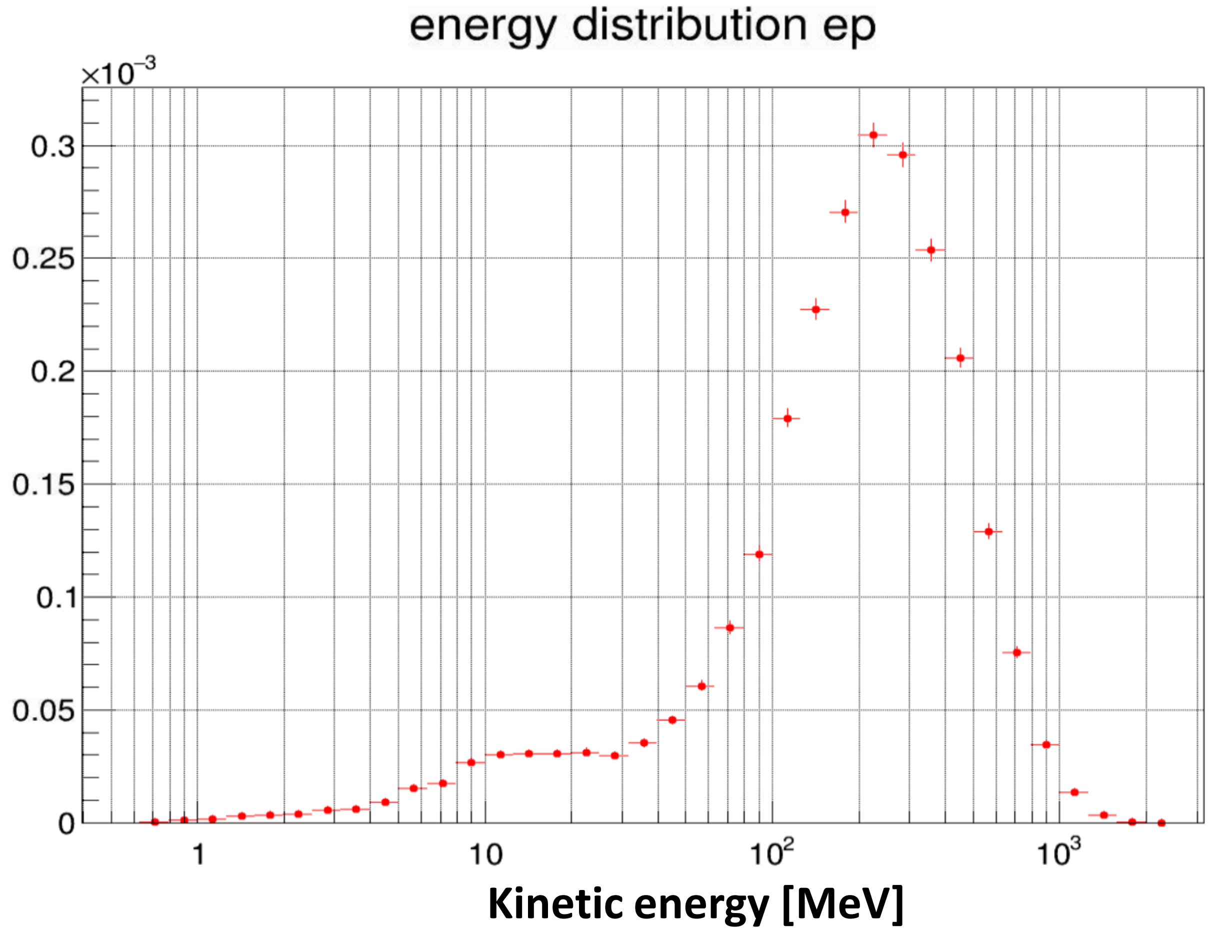


Understanding the problem

- These positrons come from the target and collimator 1 and 2
- The low energy “plateau” is from interceptions in collimator 1 and 2
- The high energy positrons come from the target directly
  - These high energy positrons will also have a small incidence angle on the coils (have to pass through collimator 2)

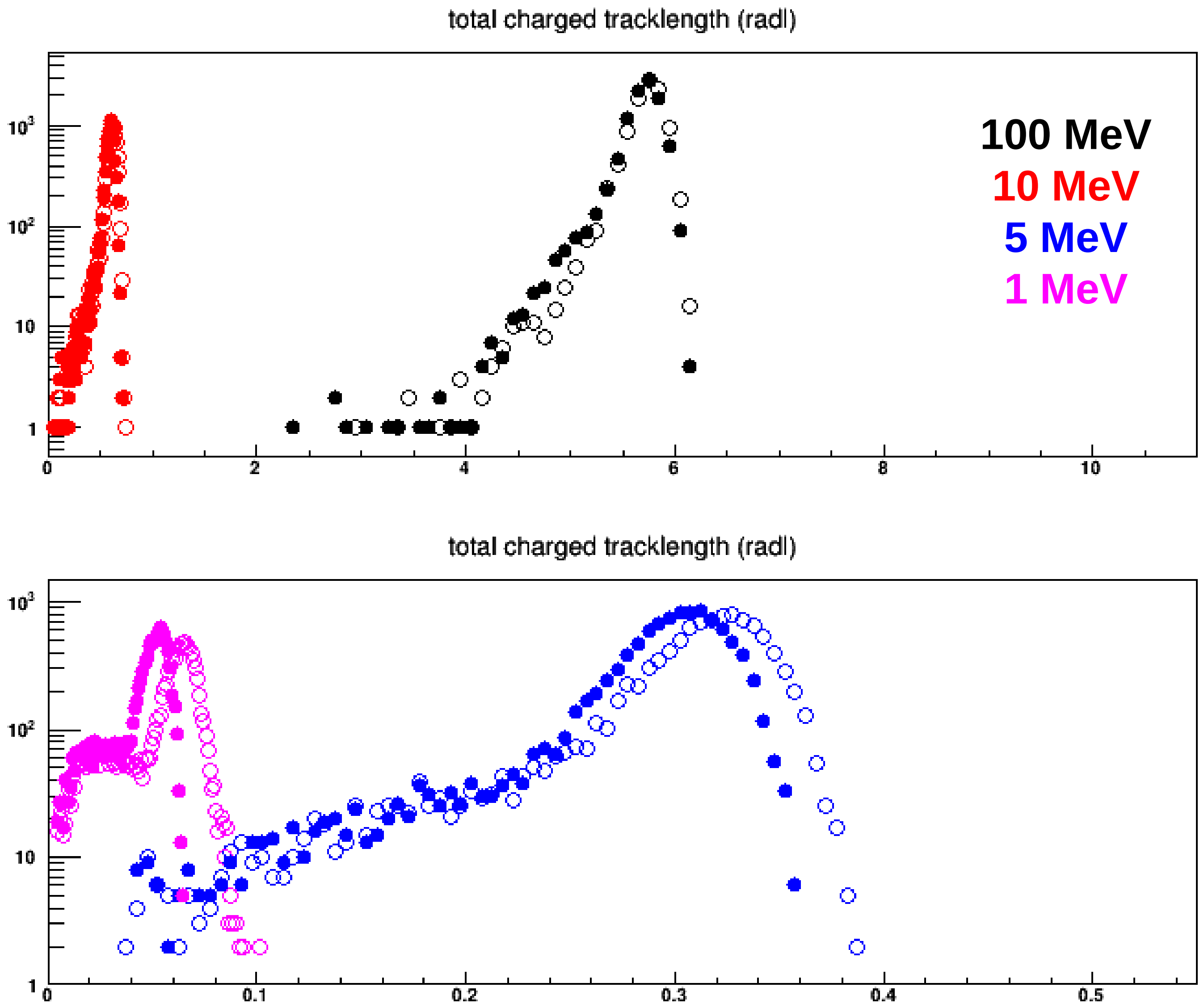






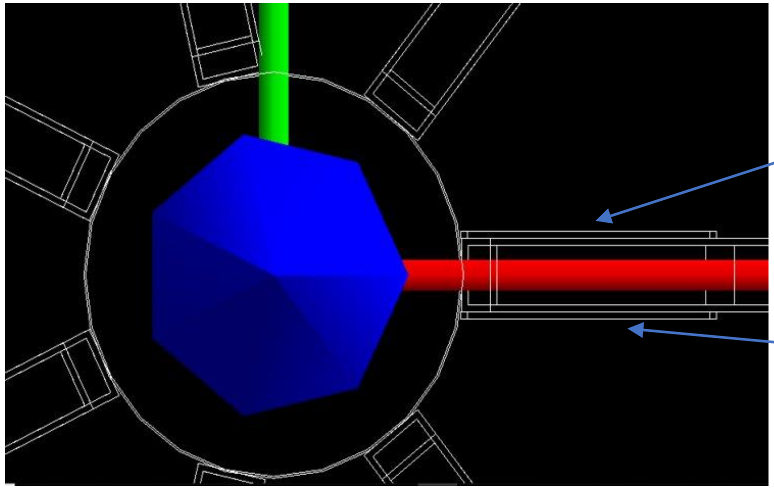
Energy deposition in G4

- Energy deposition in materials (similar for Cu and epoxy) differs drastically with energy
  - High energy (100MeV) particles have a track lengths in material that is almost 6 radiation lengths
  - 10MeV stops around 1 radiation length while lower energy seem to deposit all of the energy "on the surface" within half of radiation length
- This is especially important for the 1mm thick epoxy

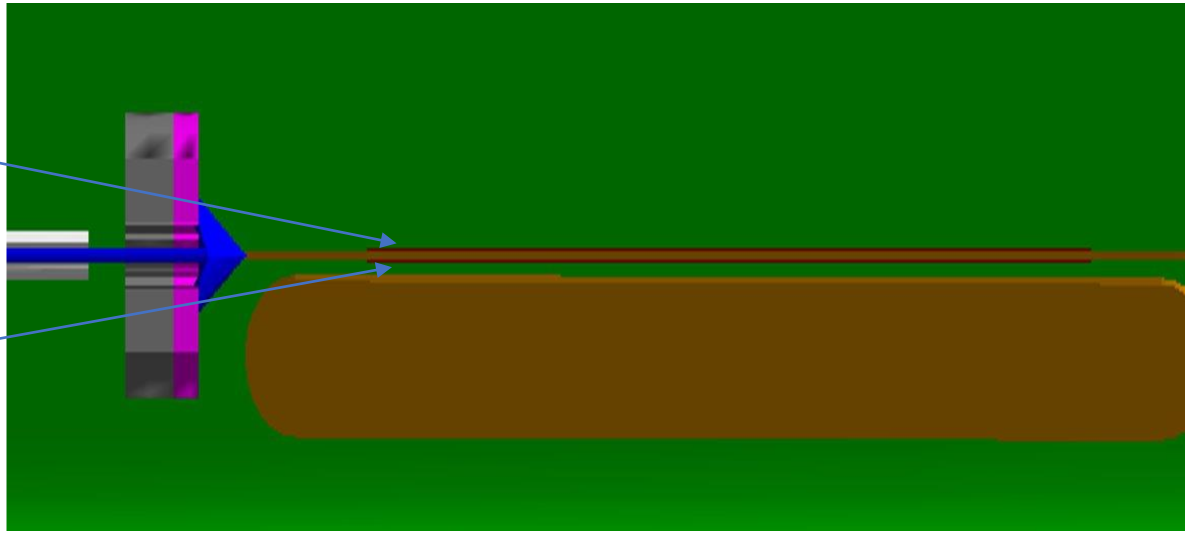


Solution

- Shielding the side of the coils (in the region of the hotspot) should significantly reduce the radiation deposition in the bottom of the coils
- We have enough space to place these plates without interfering the with the “signal” envelopes
    - Most of the hotspot lies underneath (radially) the envelopes

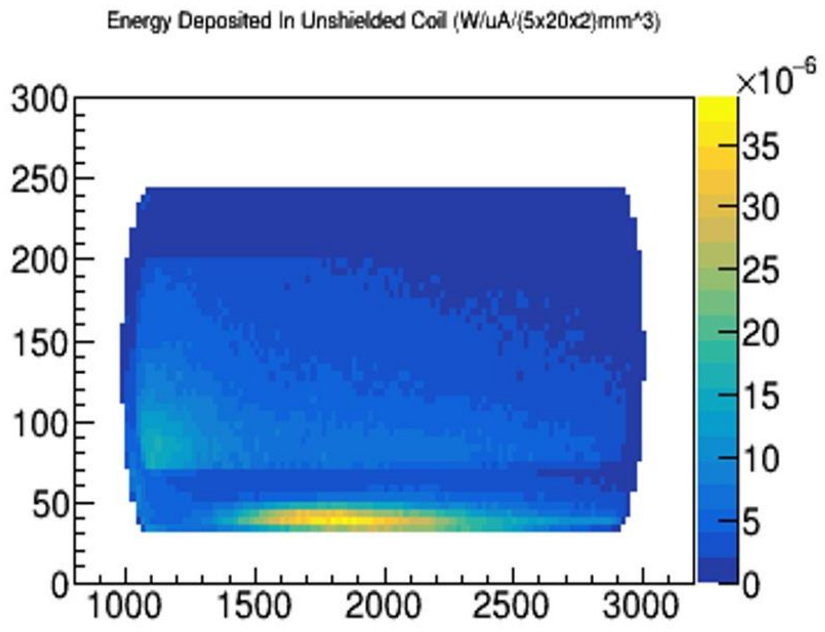


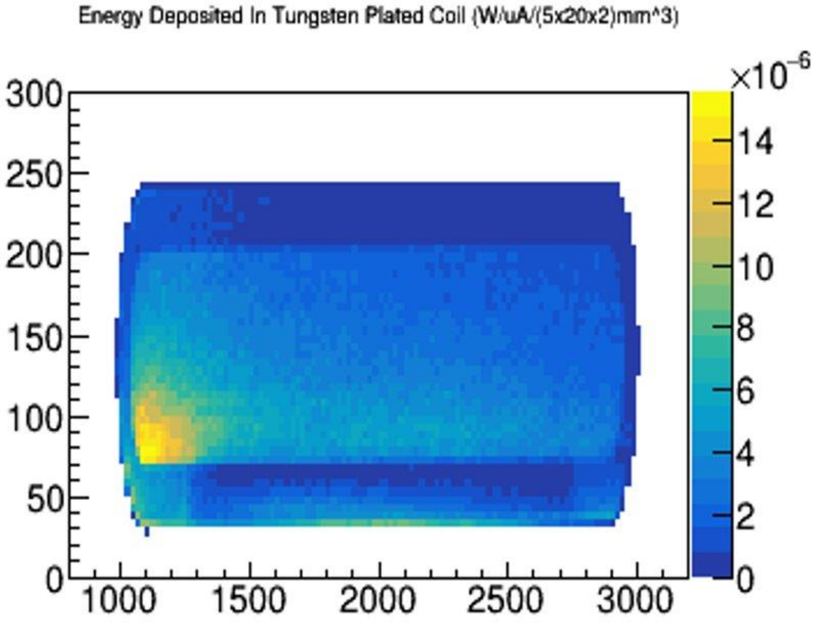
2mm W plates

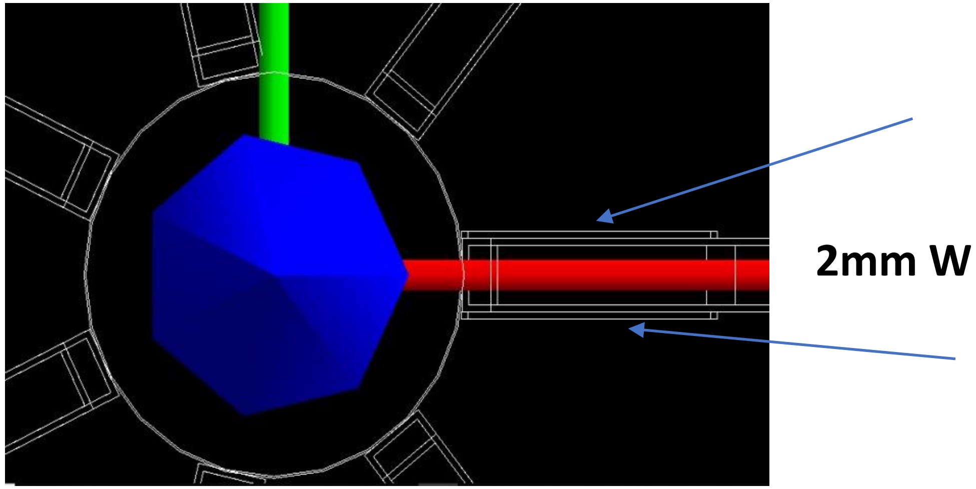


Results and next steps

- The shielding proved to be very efficient getting the dose in the "affected" region from 320 to ~37 MGy
- While this will not be the final design it shows that we have a very efficient way to handle the radiation load on the epoxy (and copper)
  - Optimization of the thickness and location will follow







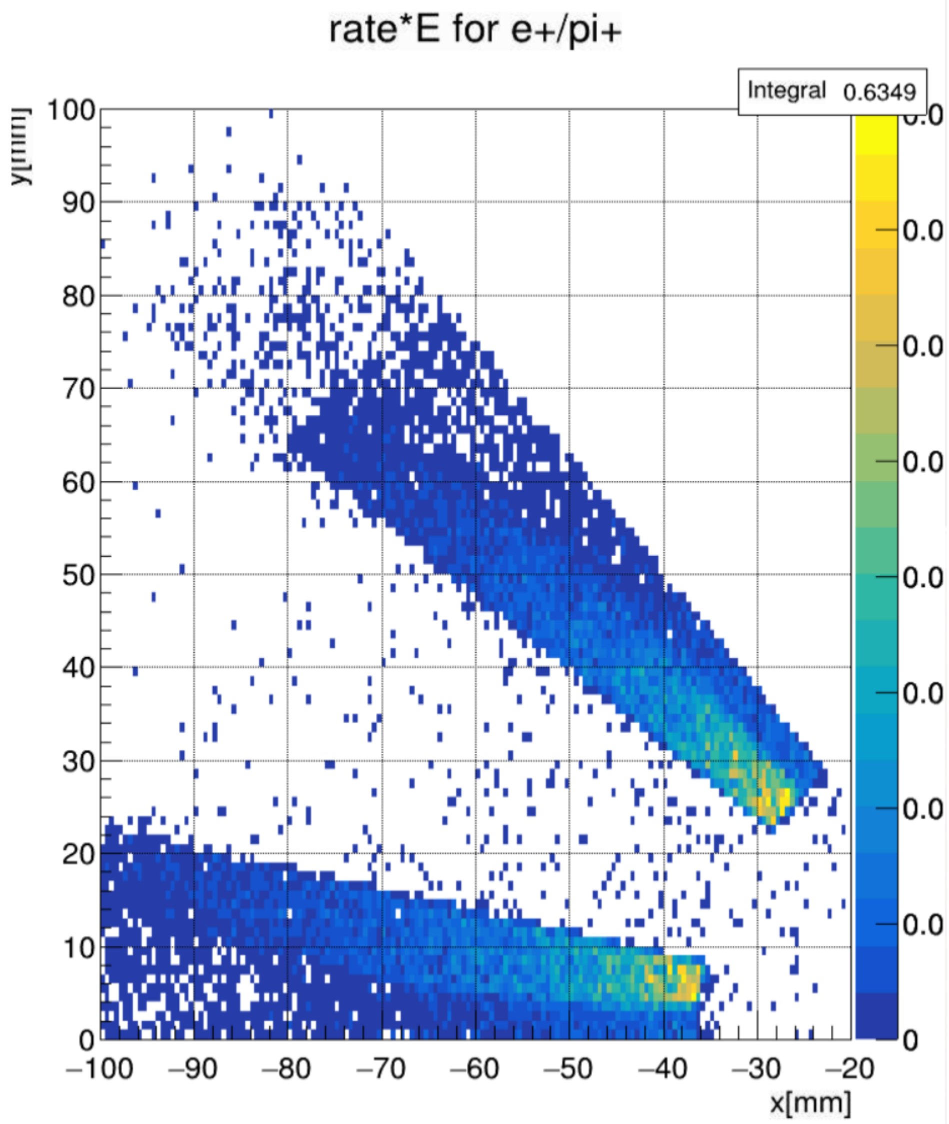
2mm W plates

Backup

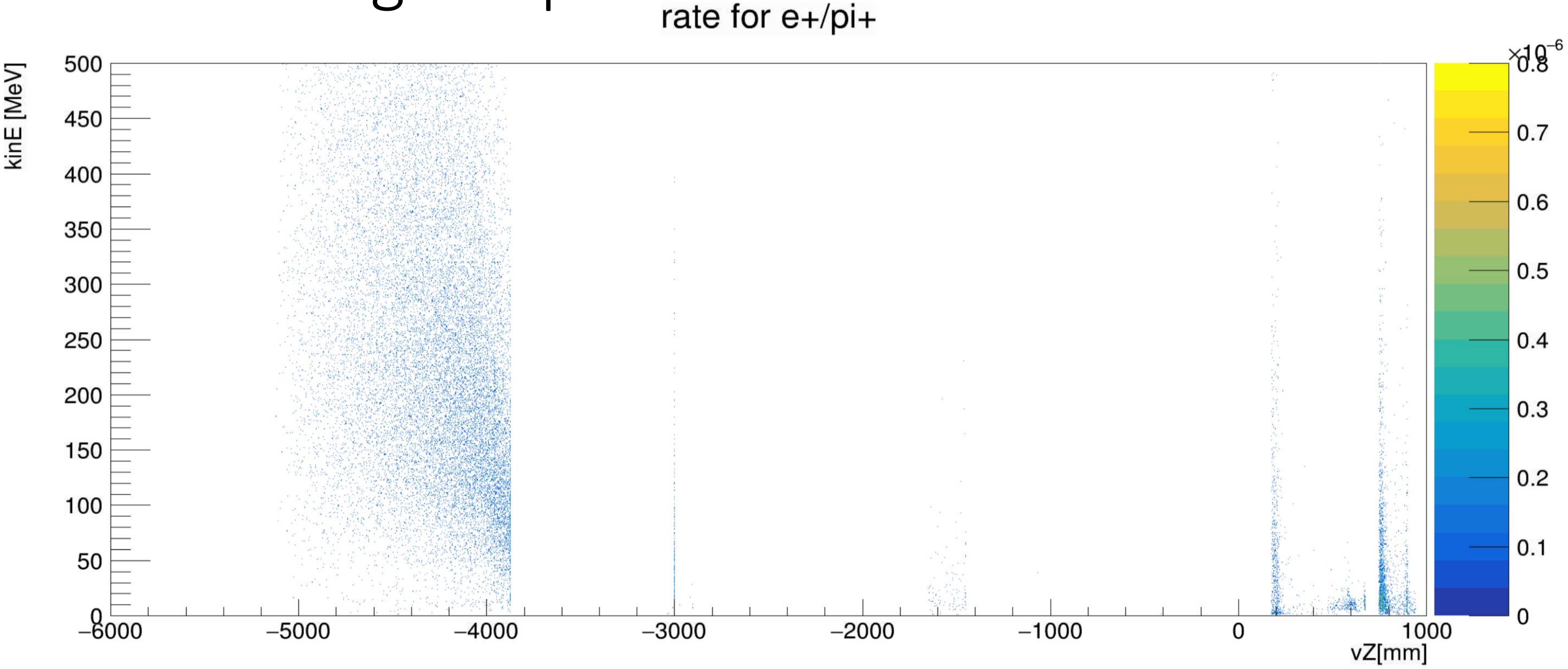
Understanding the problem

- Folding all the septants gives us enough statistics to see where the positrons are coming from
  - Restricting them would be quite difficult

	rate		energy	
region y[0,20]	total	percent of total	total	percent of total
x[-100,-20]	0.00119	100%	0.3125	100%
x[-40,-20]	0.00013	11%	0.04965	16%
x[-38,-20]	6.74E-05	6%	0.02602	8%
x[-37,-20]	3.42E-05	3%	0.01272	4%

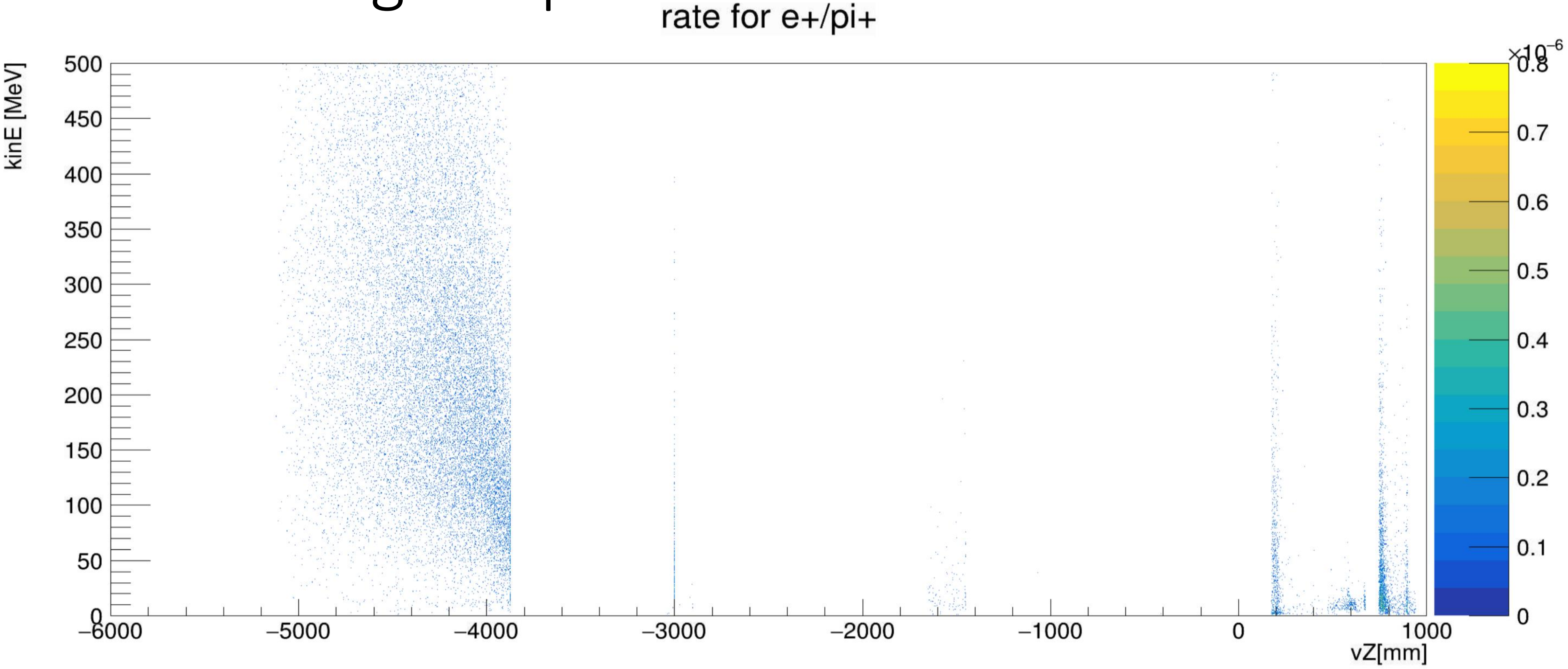


Understanding the problem



- “high energy” positrons come from the target; low energy from Collimator 1 and 2

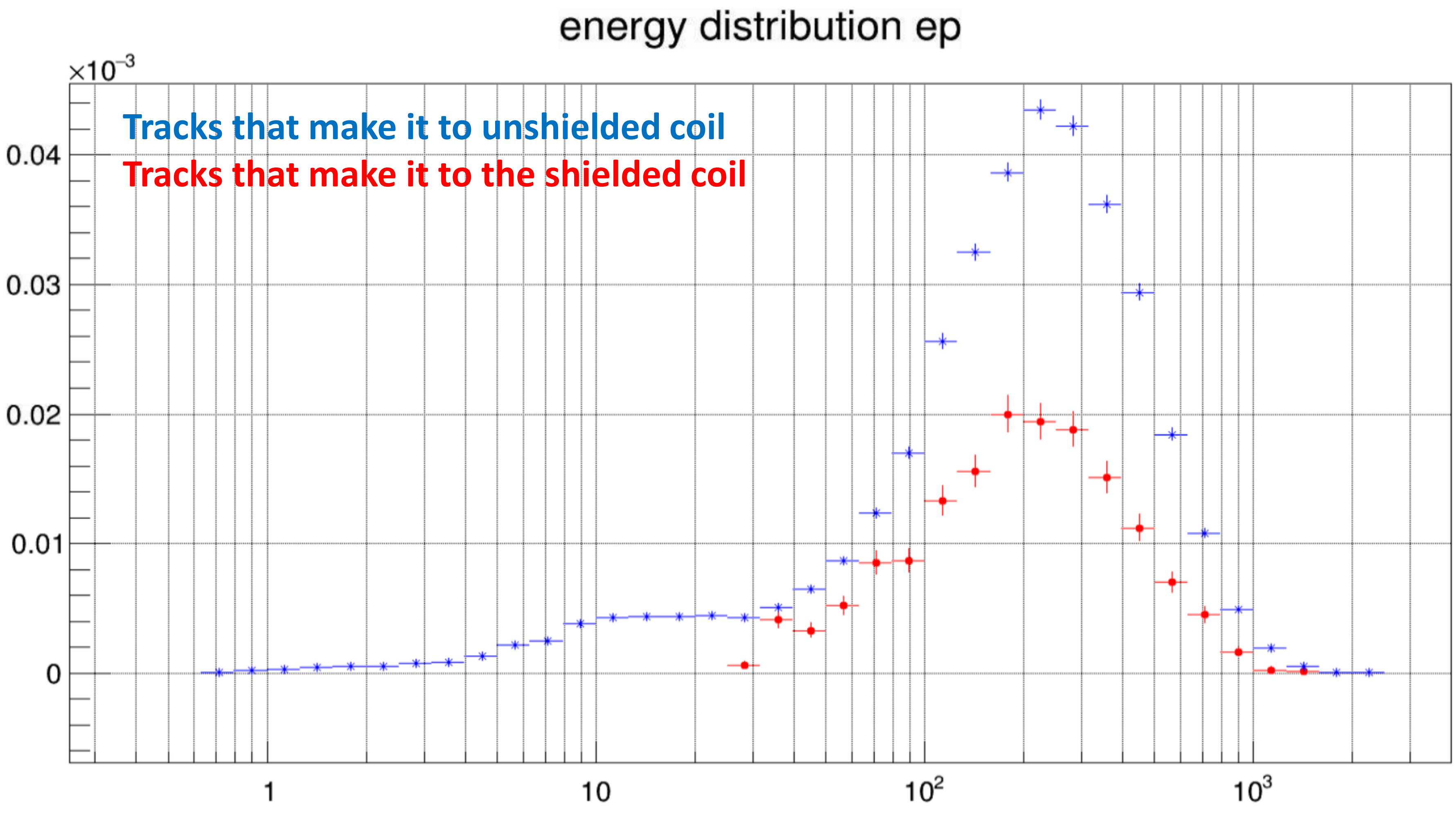
Understanding the problem



- "high energy" positrons come from the target; low energy from Collimator 1 and 2

Incident energy after Collimator 2 (1mm W)

- Compared to the unshielded coil the low energy tracks do not make it at all to the shielded coil
- The high energy particle population is significantly reduced



Incident energy at coil (**1mm**)

- Looking at the incident energy on the W plate we can recognize the same distribution we had on the unshielded plate
- Looking at the epoxy we can see that these tracks get moderated and we have low energy tracks again (these will deposit a lot of their energy on the surface)
- This simulation showed a ~4x reduction in dose (we moved on to 2mm)