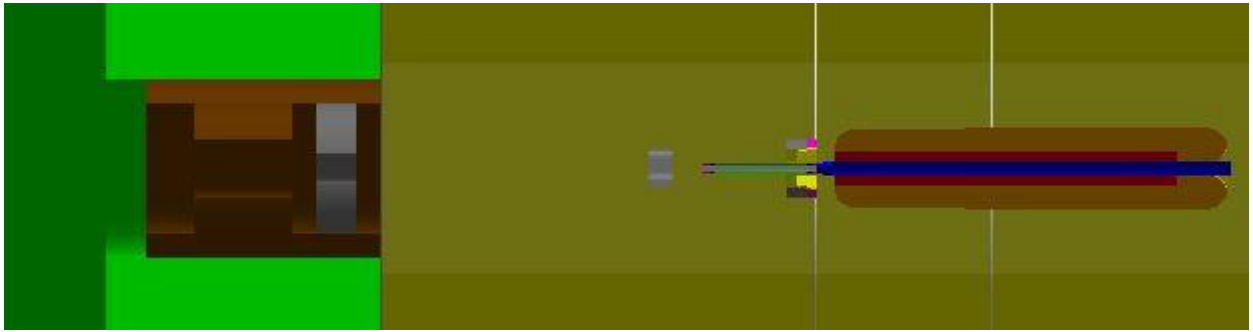
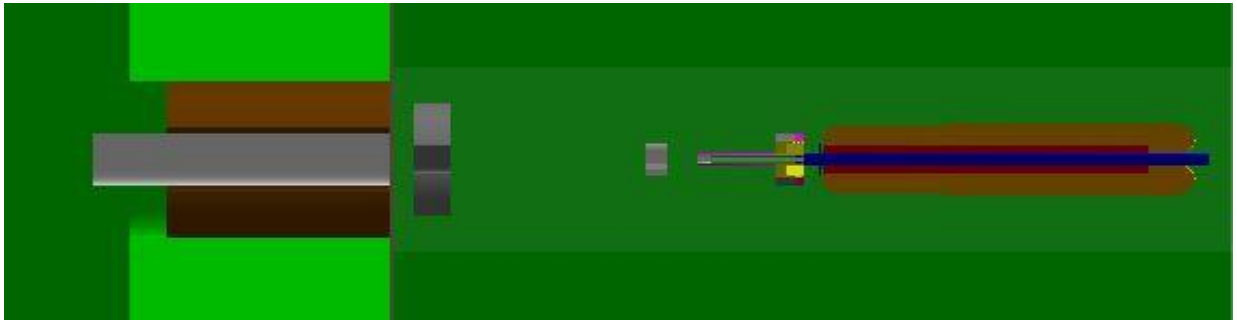
TM0 Insulation Dose

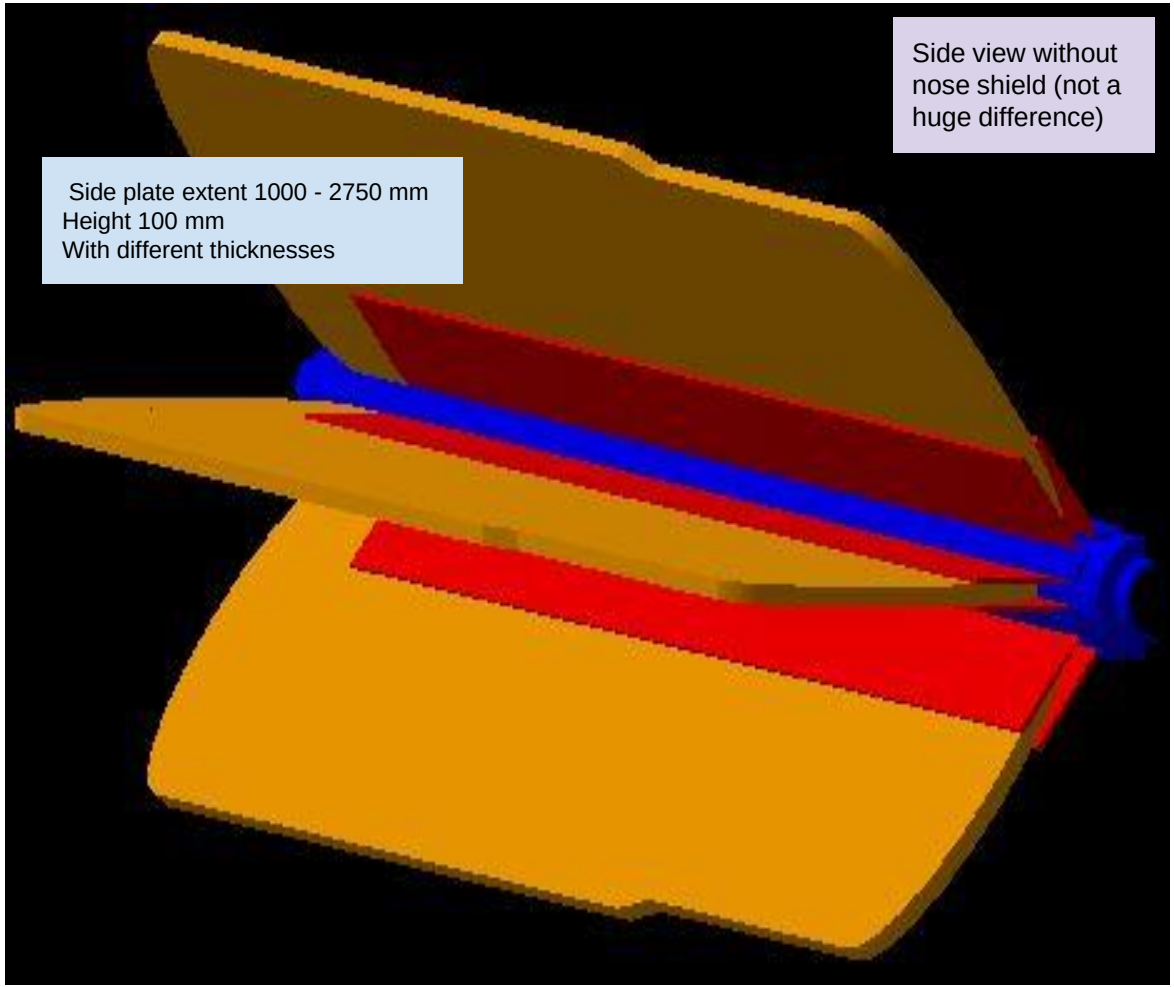
Sakib Rahman and Nazanin Roshanshah
February 16 2023

Changes in geometry since last update



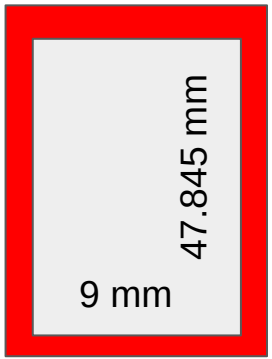


In general,
2 bounce is 2 mm thicker than before now apart from other upstream shielding changes



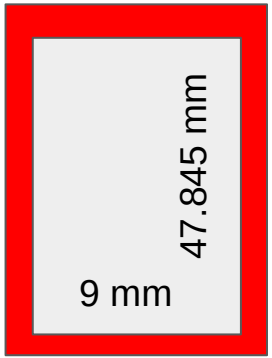
Geometry

- Two bounce shield
- Side plates
- Nose shield
- 9 mm wide Cu Conductor
- Enclosed in 1 mm wide insulation on all sides
- Center of coil filled with insulation
- Insulationation (SiO2+Epoxy) effective density assumed to be 1.3 g/cm^3



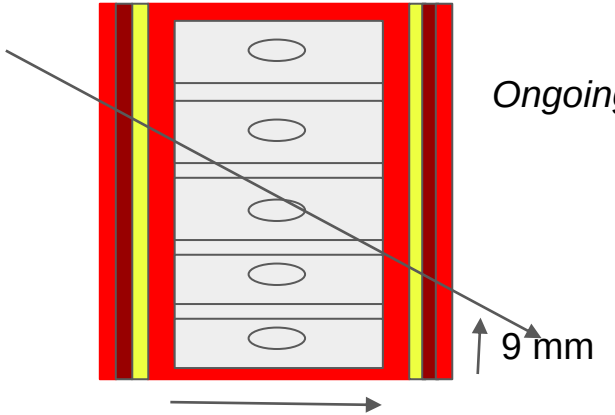
Conductor
xy cross-section

Coil Geometry In Full Sim

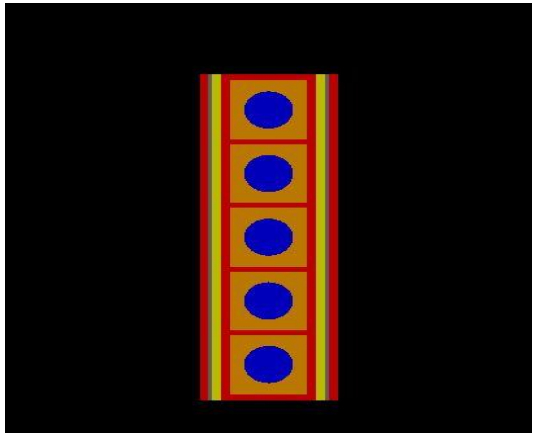


Completed

Coil Geometry for Standalone Sims



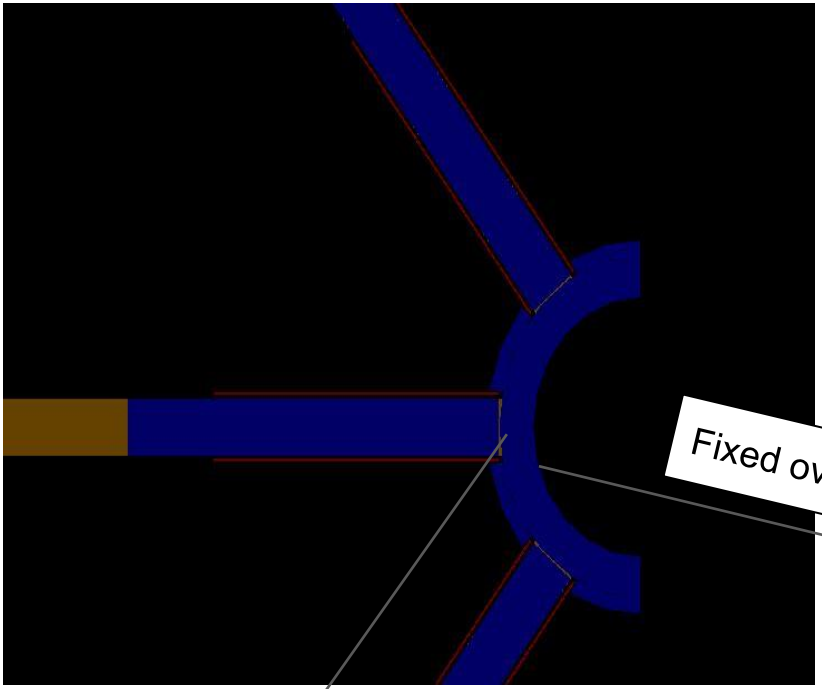
Ongoing



5 layers each with 9x9 mm cross-section with 5.7 mm diameter water tube inside
Total height of copper is 9*5=45
Gap distances = (47.845-45)/4 = 0.71125 mm

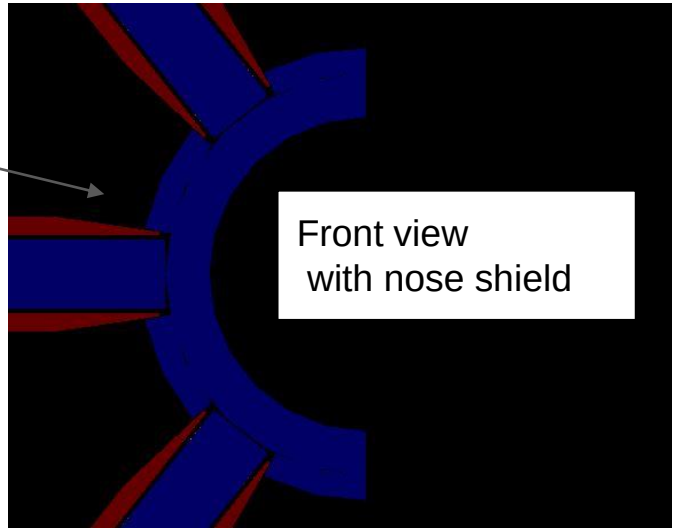
Conductors enclosed in 1 mm S-glass
On the side, 1 mm epoxy, 0.5 mm tungsten, 1 mm S-glass

Differences with MIT CAD



Overlap in simulation

Fixed overlaps



Front view
with nose shield

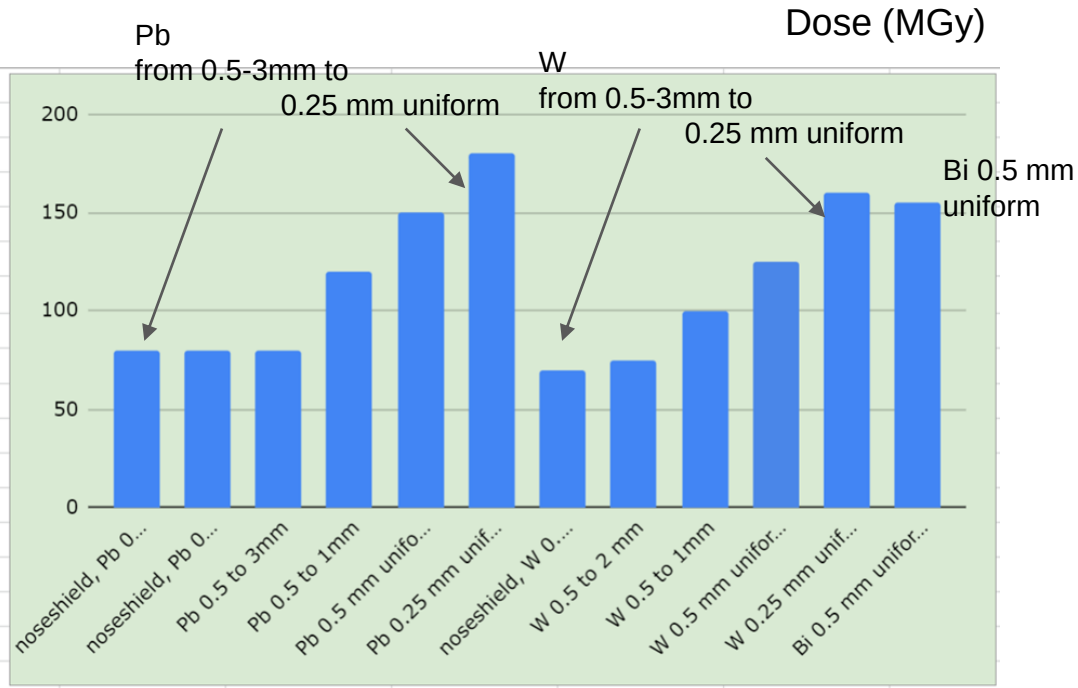
Overlap with insulation if the bottom of slots are at r=33 mm as per MIT CAD. So, changed it to r=32 mm.

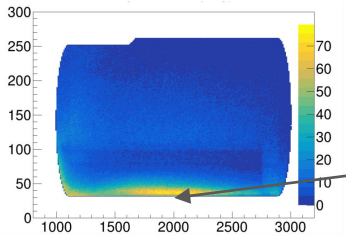
Also increased the angular width of the slots to allow for side shield to slot in.

Kept nose shield in for now

Initial comparison between Pb vs W side plates

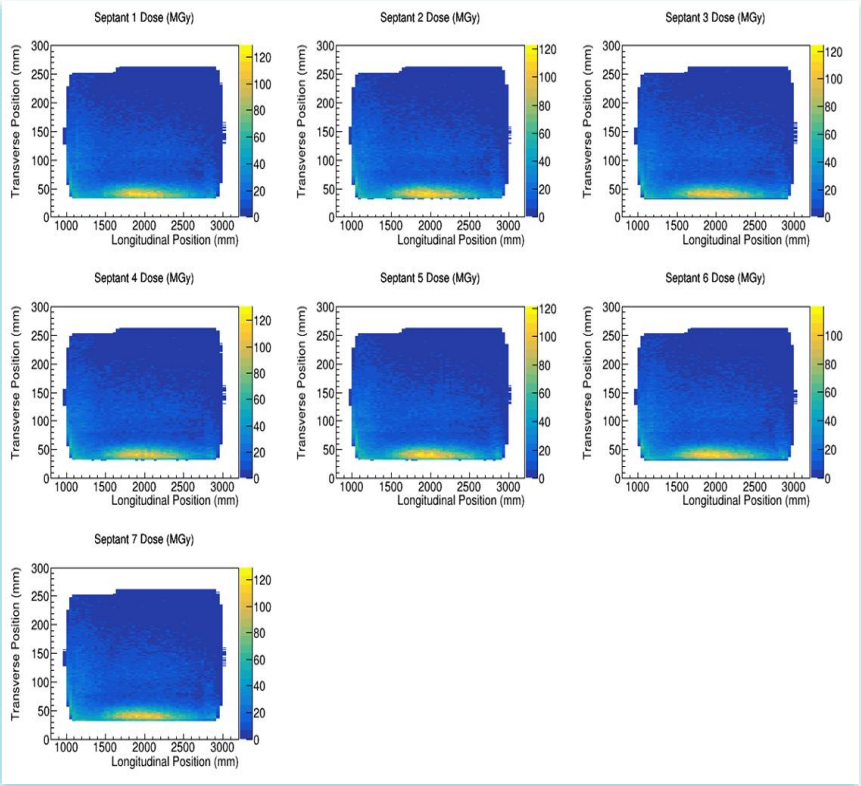
	Dose (MGy)
noseshield, Pb 0.5 to 3mm, nogap	80
noseshield, Pb 0.5 to 3mm	80
Pb 0.5 to 3mm	80
Pb 0.5 to 1mm	120
Pb 0.5 mm uniform	150
Pb 0.25 mm uniform	180
noseshield, W 0.5 to 3mm, nogap	70
W 0.5 to 2 mm	75
W 0.5 to 1mm	100
W 0.5 mm uniform	125
W 0.25 mm uniform	160
Bi 0.5 mm uniform	155



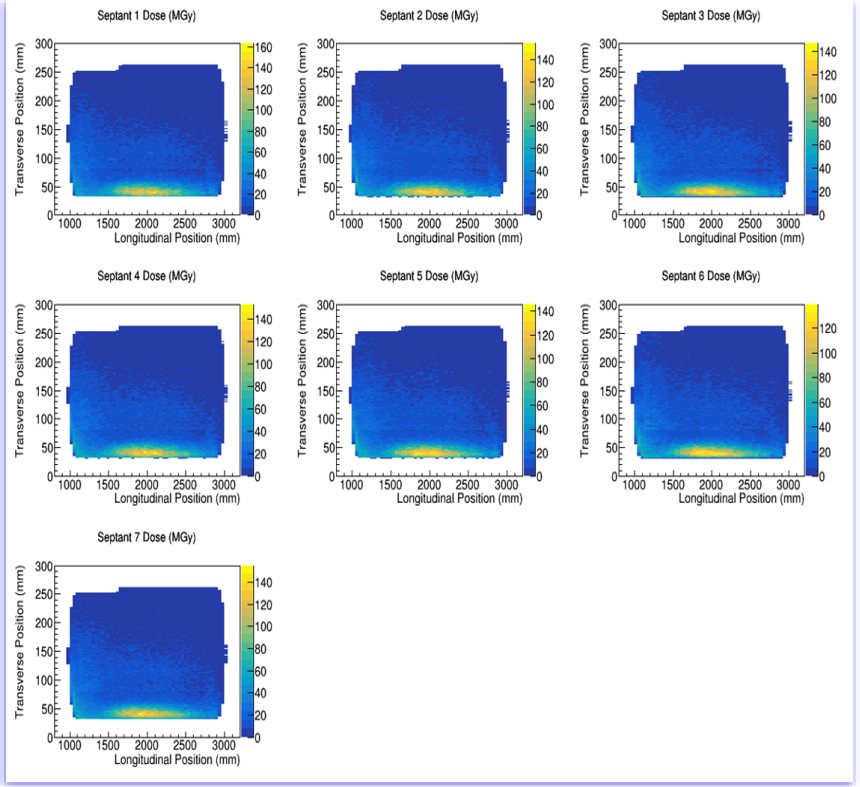


Focusing on this area, Result based on 40x1x1 mm bins, values eye-estimated based on color scale

0.5 mm uniform W side plates ,ue_rz_left

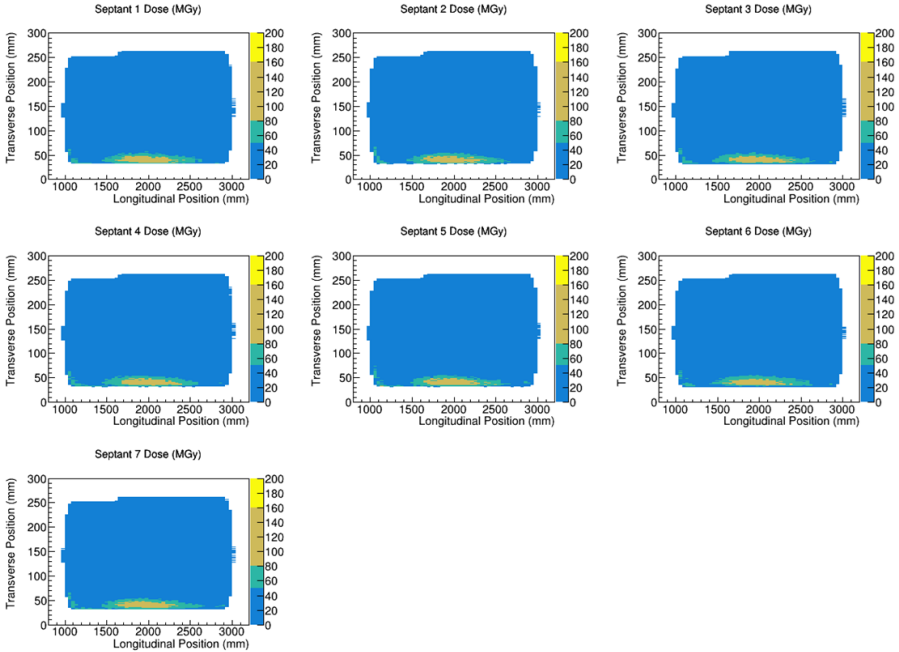


0.5 mm uniform Pb side plates ,ue_rz_left

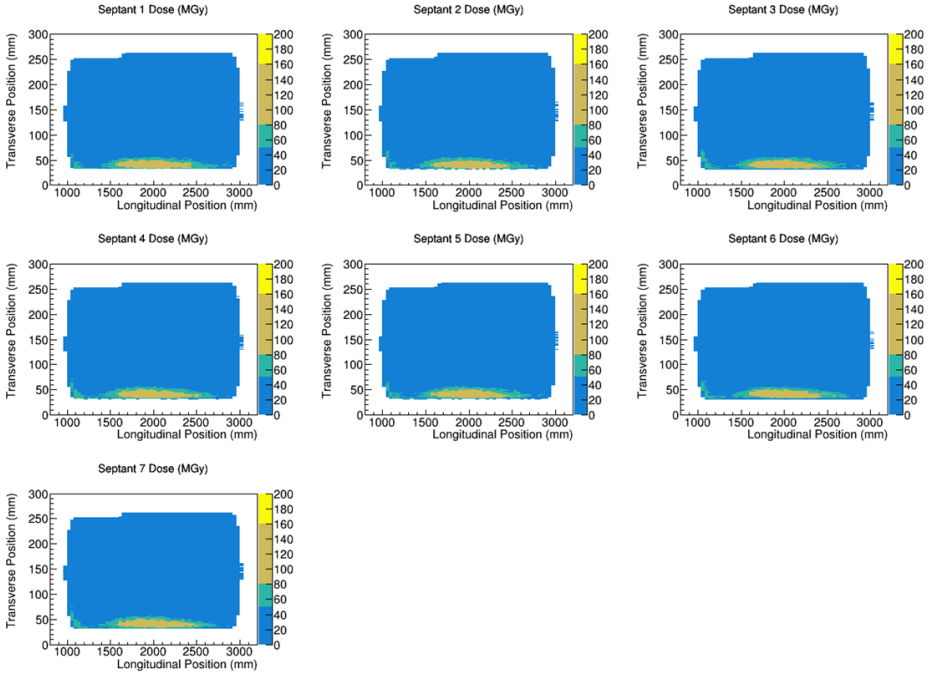


4 level

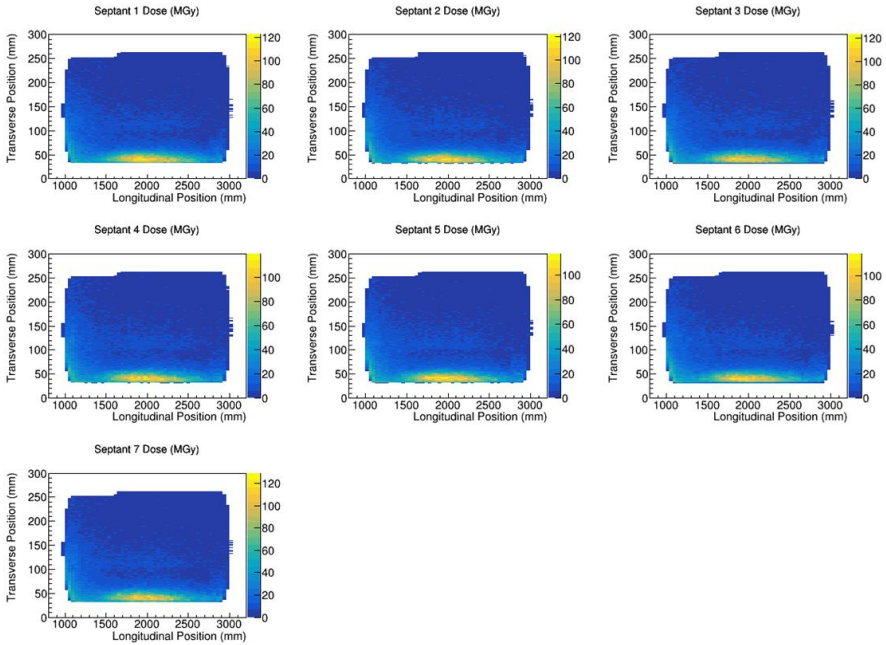
0.5 mm uniform Pb side plates ,ue_rz_left



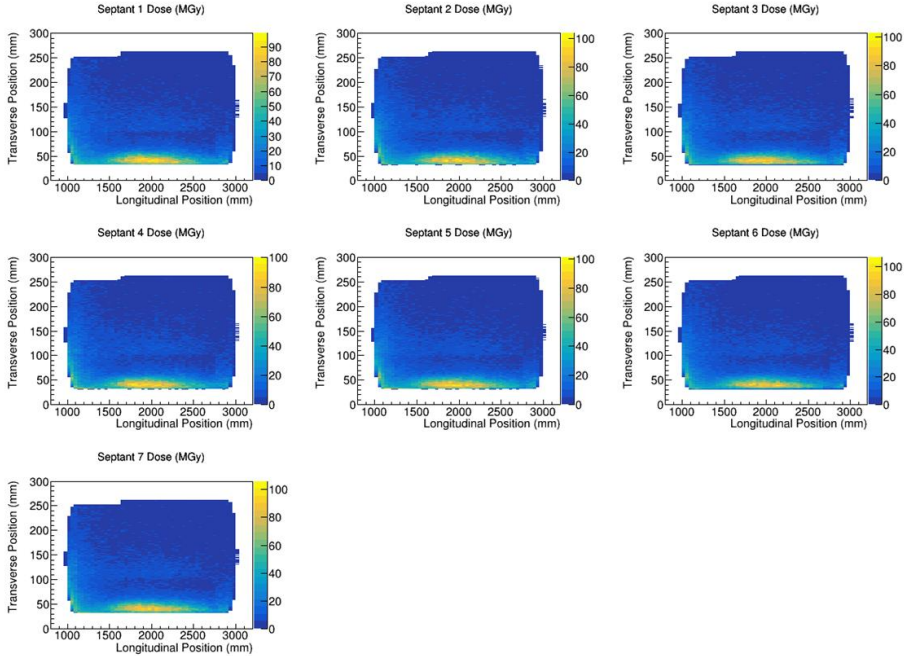
0.5 mm uniform Pb side plates ,ue_rz_left



0.5 mm uniform Pb side plates ,ue_rz_right

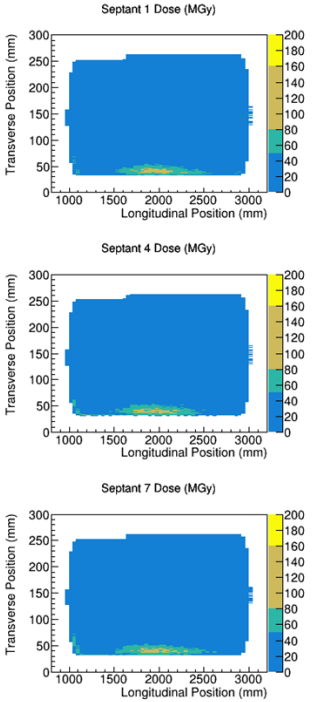


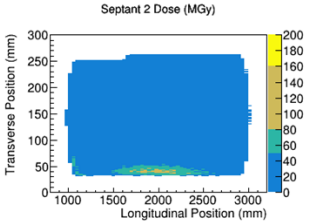
0.5 mm uniform W side plates ,ue_rz_right

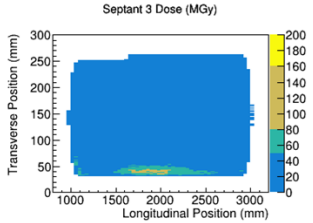


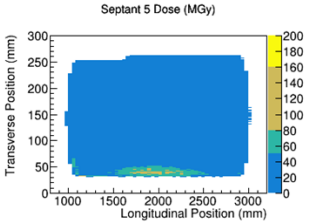
4 level

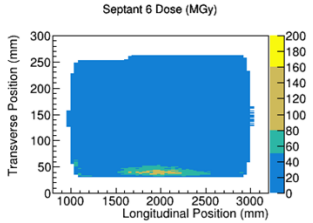
0.5 mm uniform W side plates ,ue_rz_right



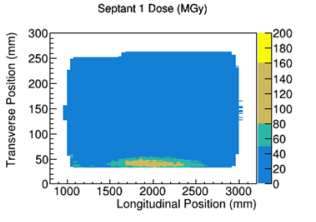


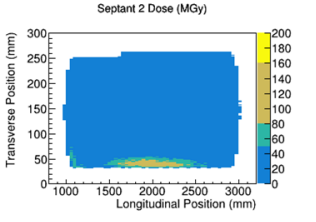


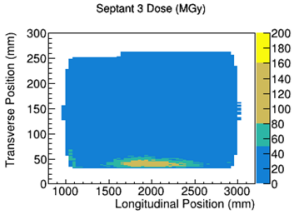


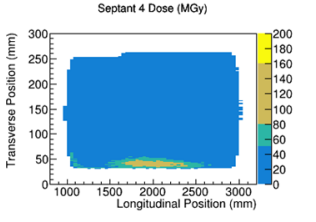


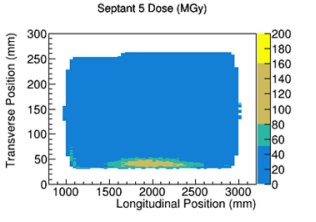
0.5 mm uniform Pb side plates ,ue_rz_right

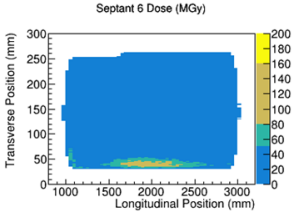


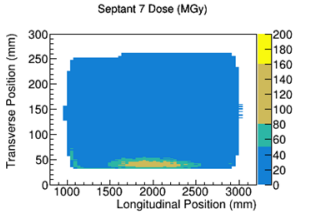




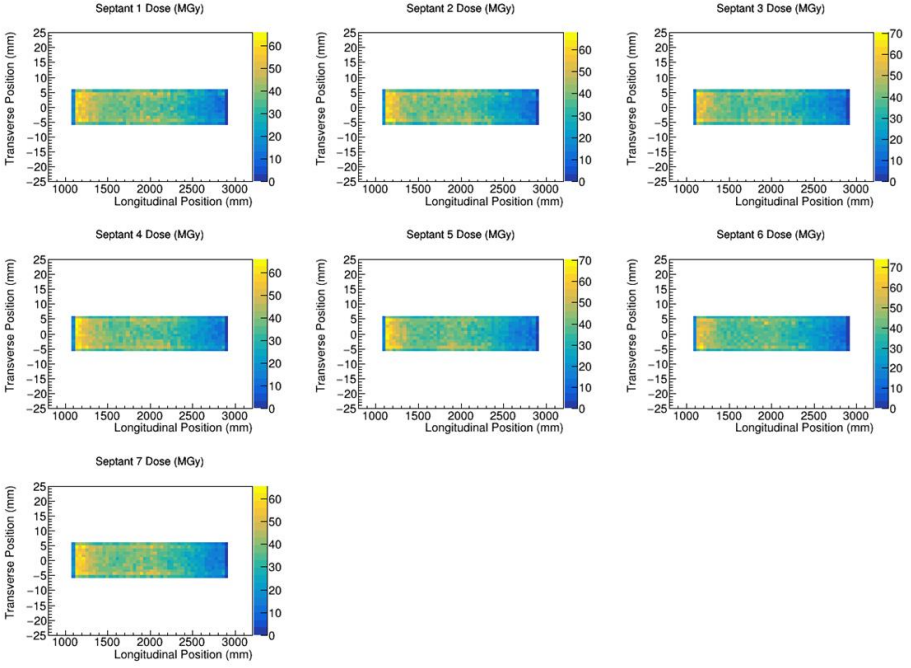




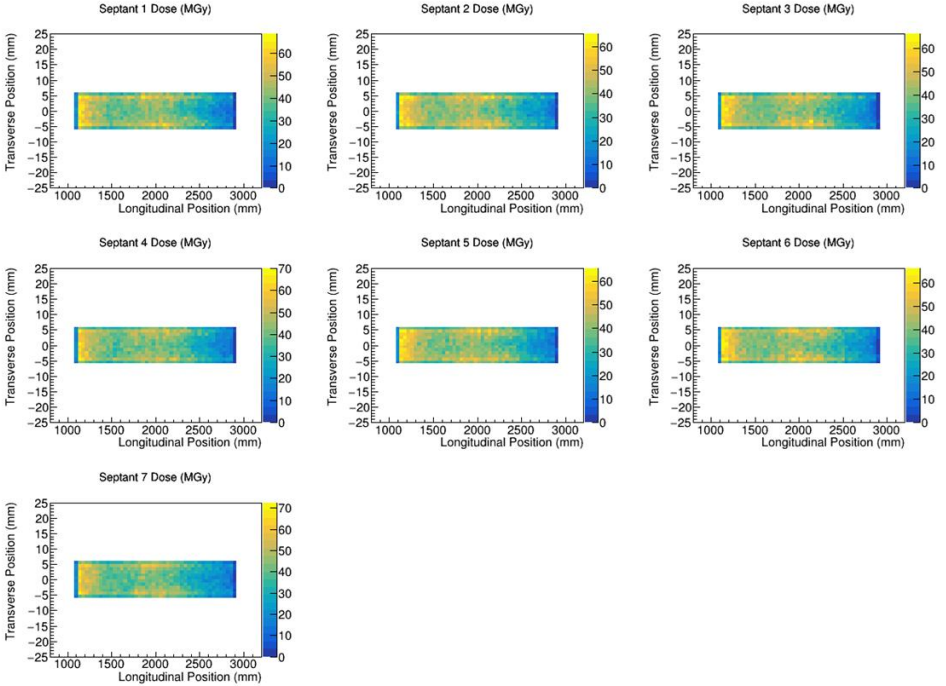




0.5 mm uniform W side plates, ue_phz_bottom

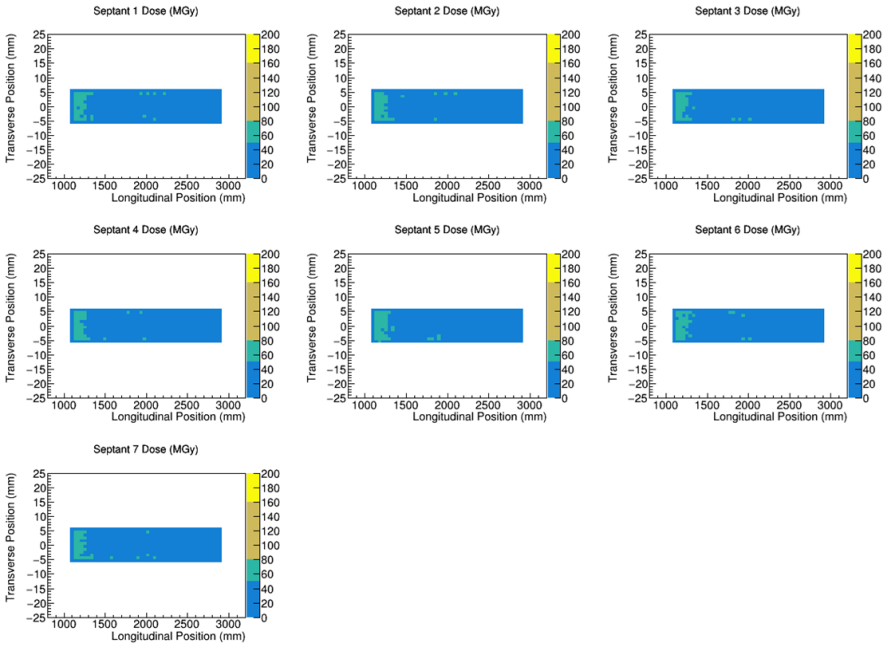


0.5 mm uniform Pb side plates, ue_phz_bottom

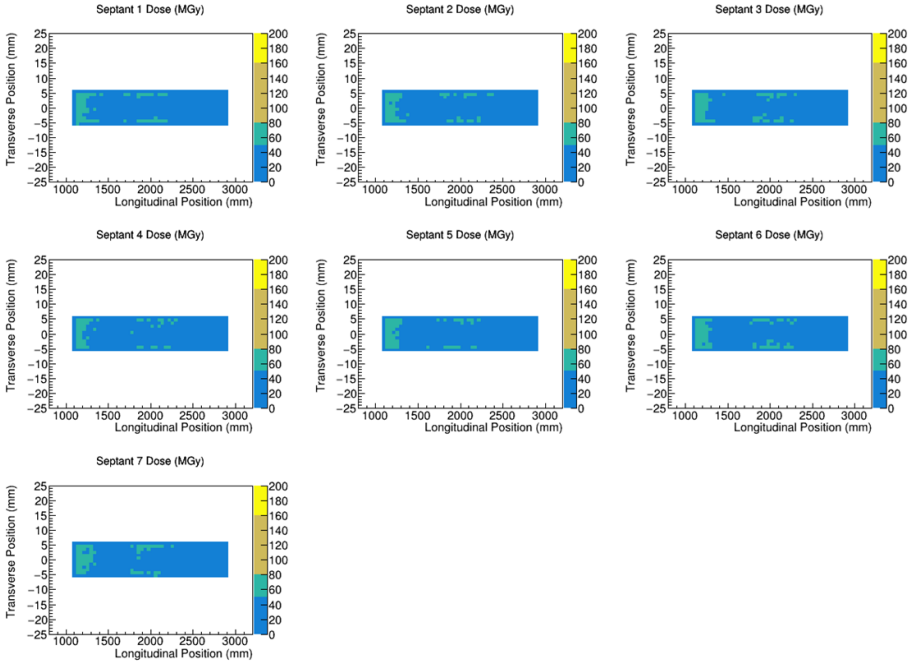


4 level

0.5 mm uniform W side plates ,ue_phz_bottom



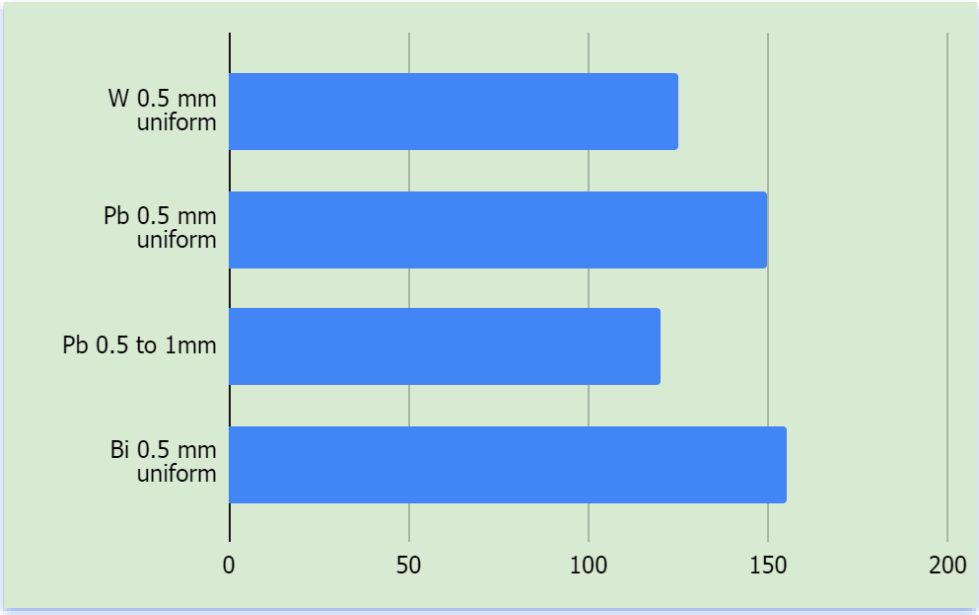
0.5 mm uniform Pb side plates ,ue_phz_bottom



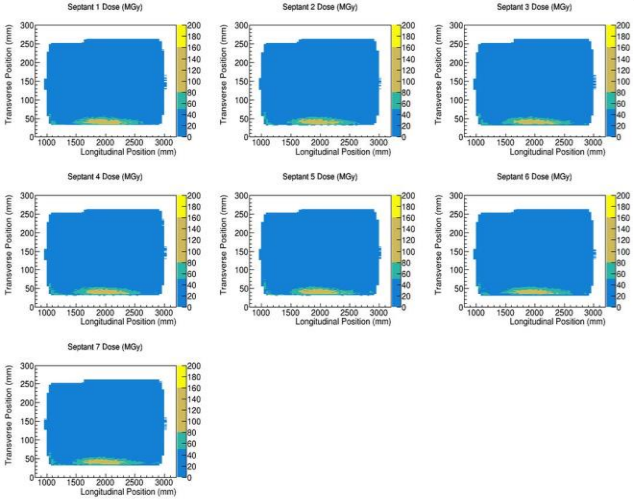
A quick comparison between W, Pb and Bi

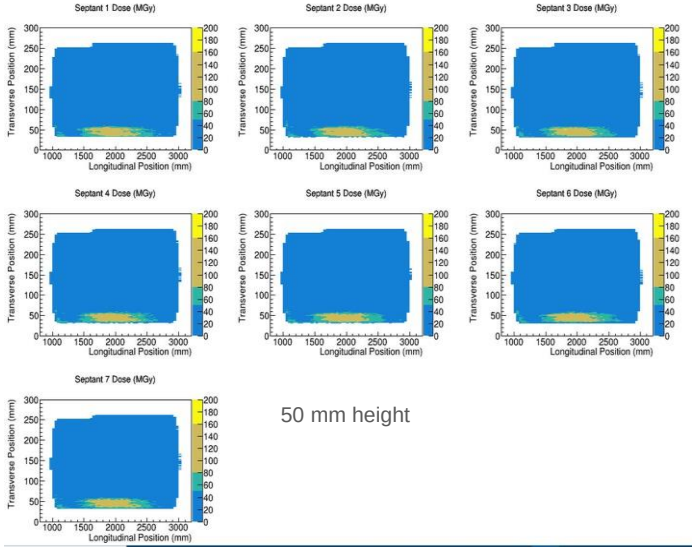
	Dose (MGy)
W 0.5 mm uniform	125
Pb 0.5 mm uniform	150
Pb 0.5 to 1mm	120
Bi 0.5 mm uniform	155

- No nose shield is required
- Bi and Pb are quite similar according to the plots.
- Different thicknesses shows the better result than the uniforms, but in terms of geometry, harder to build

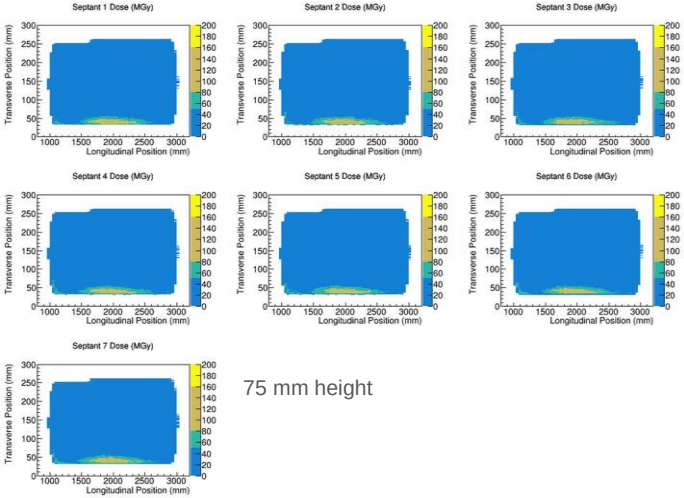


reducing the height from 100 mm to 50 mm for 0.5 mm uniform tungsten pushes the dose from ~120 to ~160 (MGy)





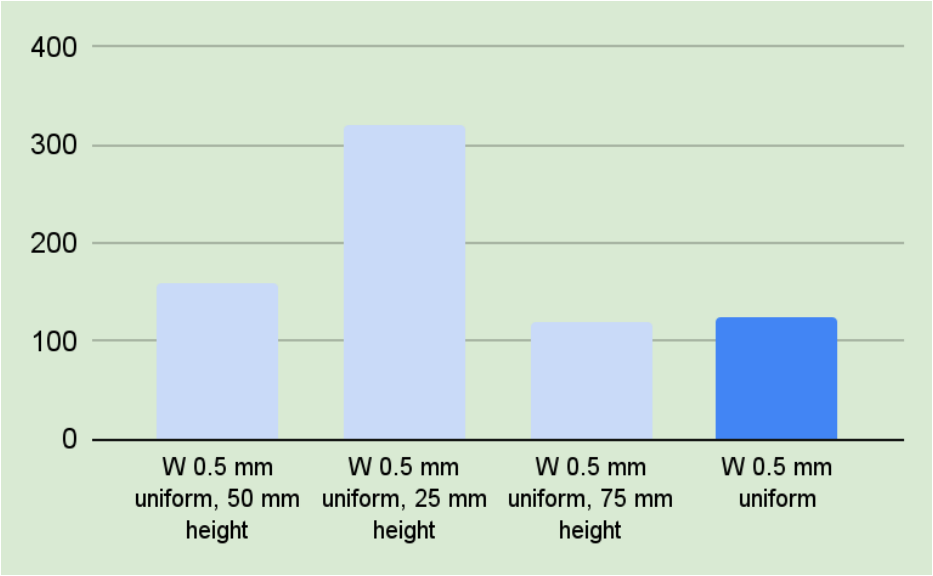
50 mm height

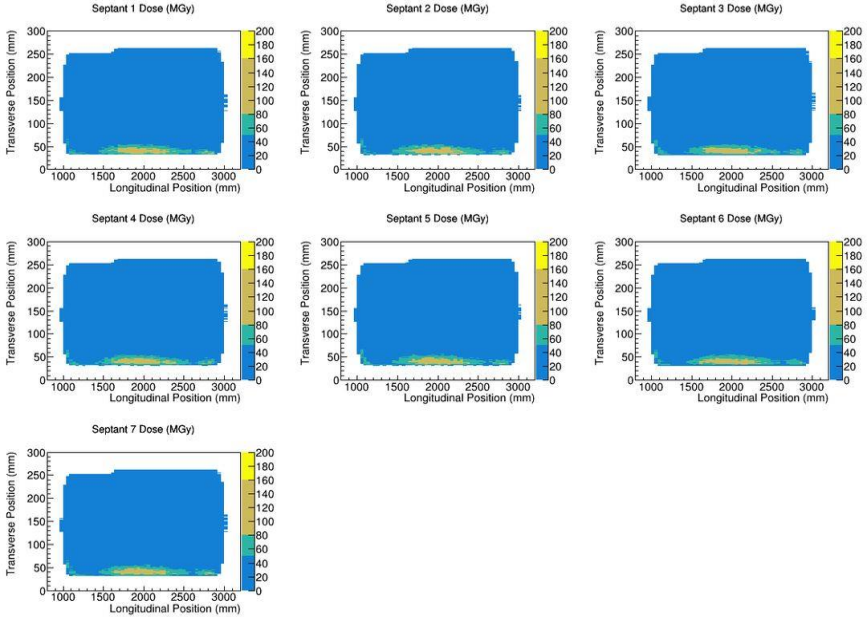


75 mm height

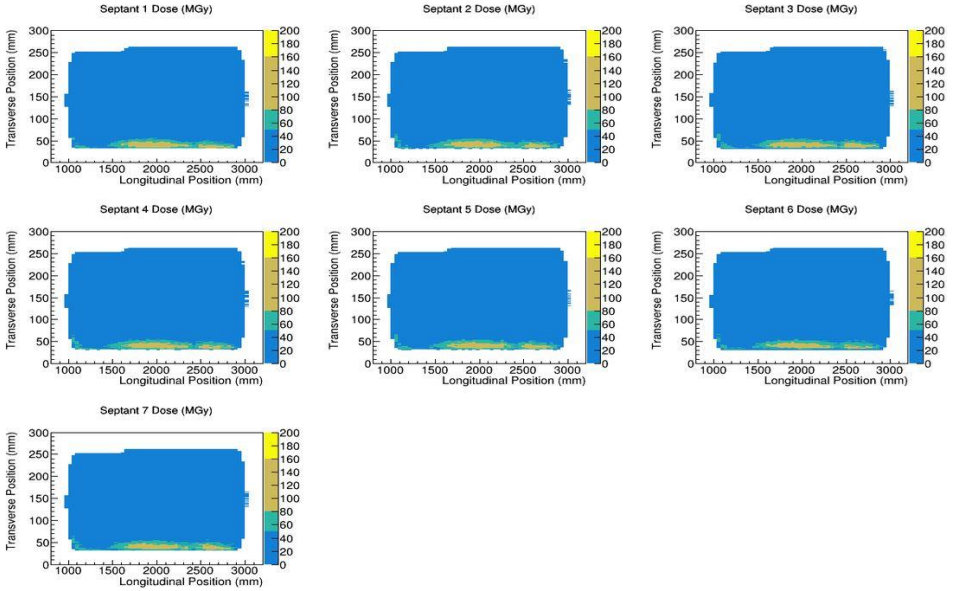
W 0.5 mm uniform side shield case

Comparing different heights for side plates





Z-extent =1000 to 2600 mm extent
Less localized hotspot compared to default (1000-2750 mm) but peak value remains same



Z-extent =1000 to 2400 mm extent
Less localized hotspot compared to default (1000-2750 mm) but peak value remains same

End

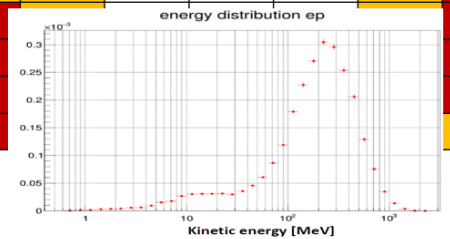
Backup

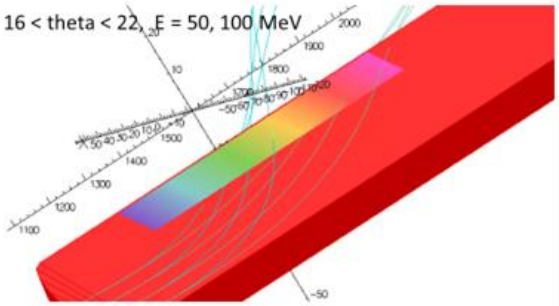
- Add plots
  - From July 22 report
  - From new no-gap sim
- New plots
  - Origin of things hitting side and bottom (compare the gap and no-gap)
  - Energy spectrum of positrons hitting (maybe a fn of z)
- Standalone
  - compare positron energy loss in Pb and W
- Questions
  - How did we get from 37 MGy (Sept. ‘20) to 40-60 MGy (July 2022)?
    - Collimator 2 re-designed (May ‘21 opened a bit to have an angle to reduce slit scattering)
    - inner bore increased to reduce power deposition (Dec ‘21) Still - how getting to epoxy?
    - collimators merged (pre-Dec ‘21)
    - Material of collimator changed to include water?
  - What has changed from (July 2022) till now (Feb. ‘23)?
    - Gap between collimator 2 and 2-bounce shield?
    - Zuhal collar 0, US shielding (Aug. ‘22)

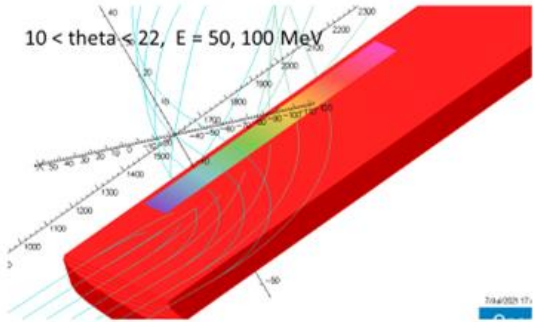
https://umanitoba.sharepoint.com/:p:/r/sites/NazAdvising/_layouts/15/Doc.aspx?sourcedoc=%7B2EEDEC47-1D1F-430D-8388-B4CE5D6666DB%7D&file=us_torus_dose_072820211.pptx&action=edit&mobileredirect=true

Ranges hitting hot spot

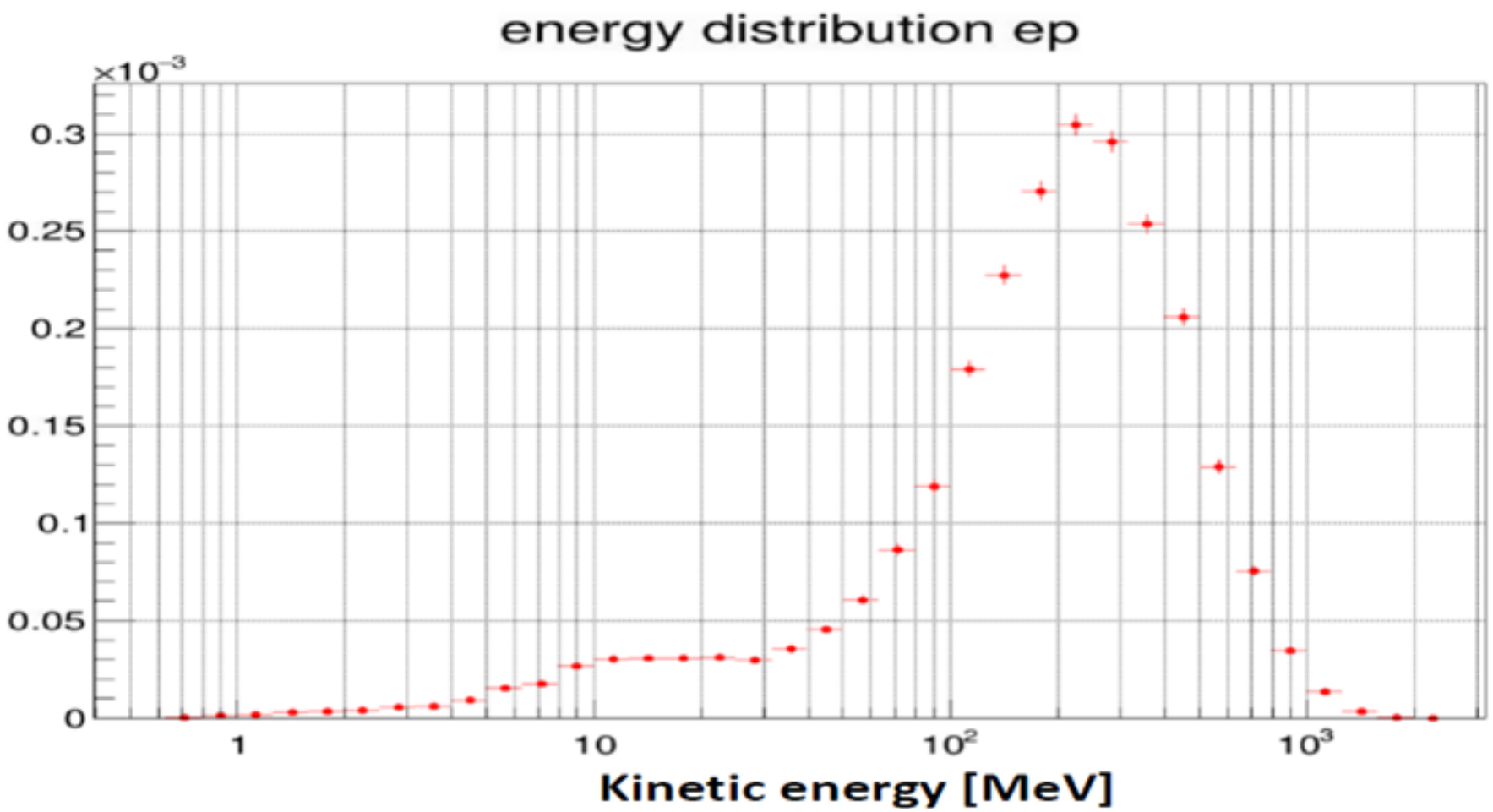
	E (MeV)	6	8	10	12	14	16	18	20	22
1	20									
2	30									
3	40									
4	50									
5	75									
6	100									
7	125									
8	150									
9	175									
10	200									





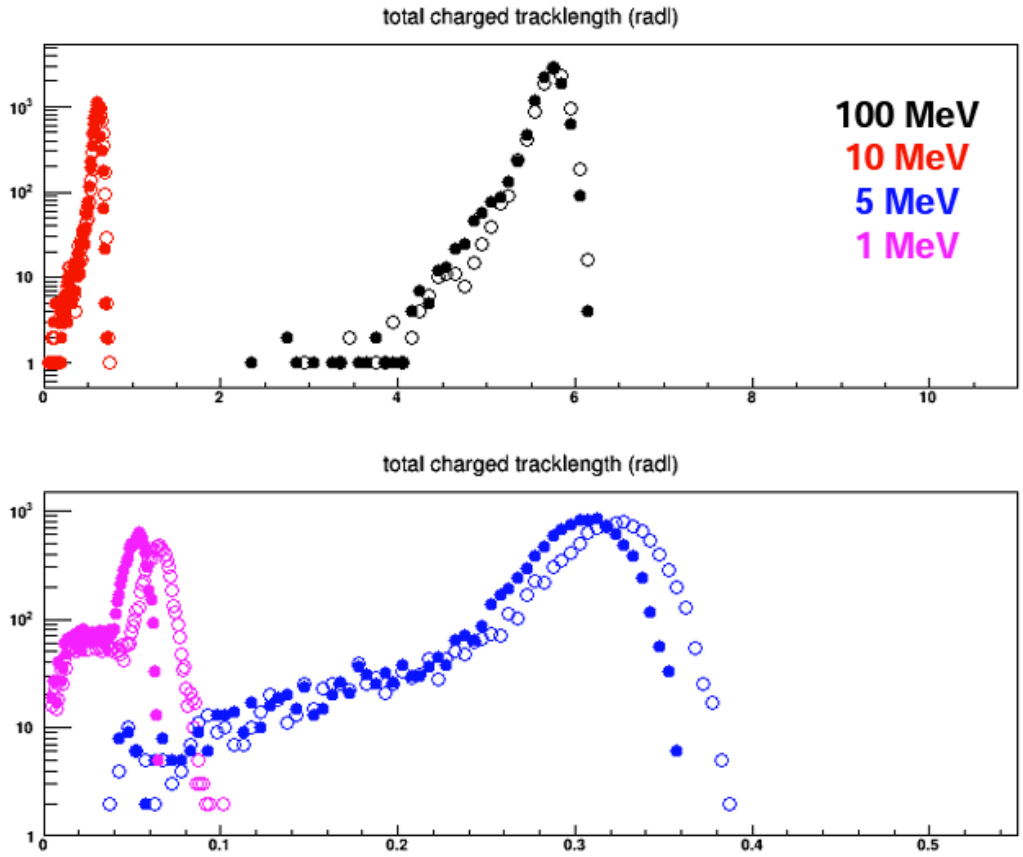


https://moller.jlab.org/DocDB/0006/000622/001/200709_US-magnet-HotSpot_CGal.pdf



Energy deposition in G4

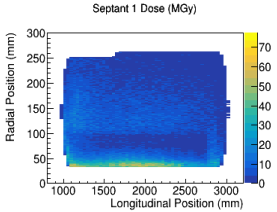
- Energy deposition in materials (similar for Cu and epoxy) differs drastically with energy
  - High energy (100MeV) particles have a track lengths in material that is almost 6 radiation lengths
  - 10MeV stops around 1 radiation length while lower energy seem to deposit all of the energy “on the surface”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

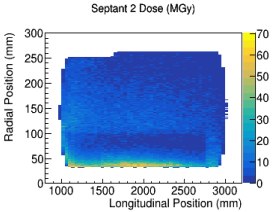


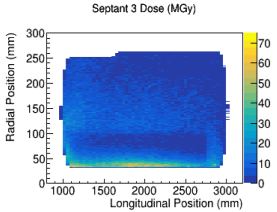
Collimator-1 Bore Increase (Dec 2021) (https://moller.jlab.org/DocDB/0008/000819/003/Collimator_2021.pdf)

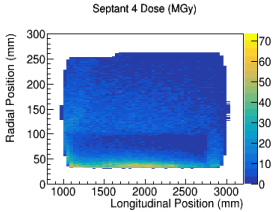
Collimator 2 Redesign (May 2021) https://moller.jlab.org/DocDB/0007/000725/003/Collimator2Redesign.pdf

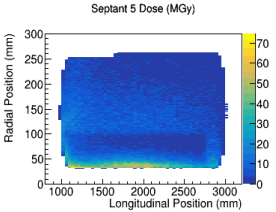
Merged Collimator (https://moller.jlab.org/DocDB/0006/000615/001/merged_coll1_2.pdf)

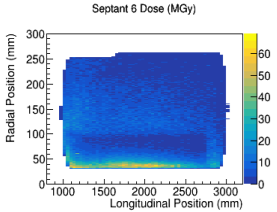


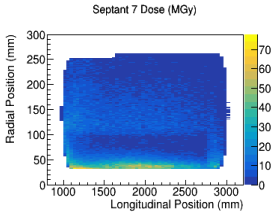




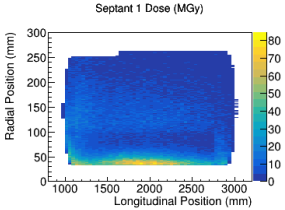


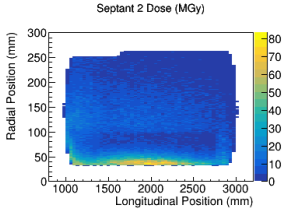


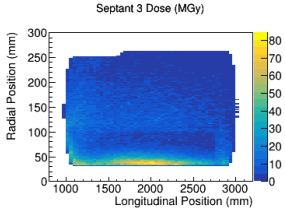


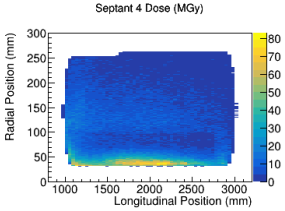


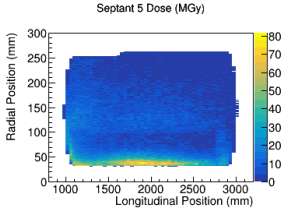
W side plates and
nose shield

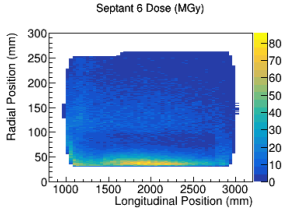


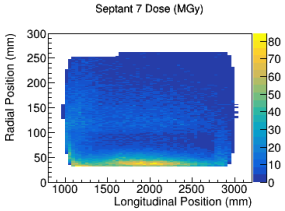










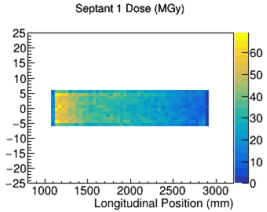


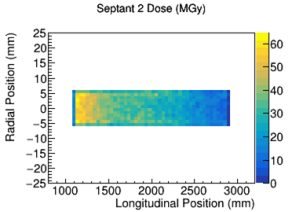
Pb side plates
and nose shield

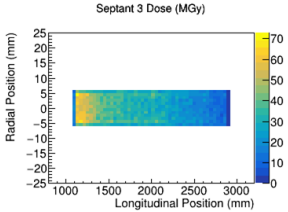
PRELIMINARY

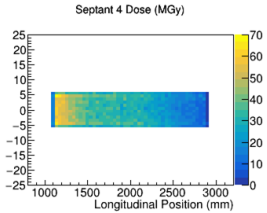
40x1x1 mm bins

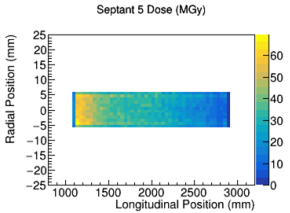
Side

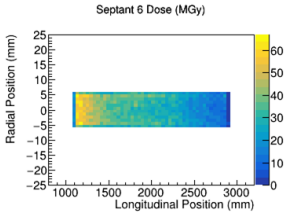


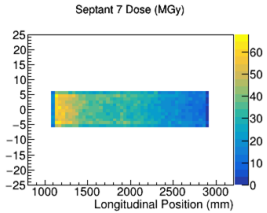




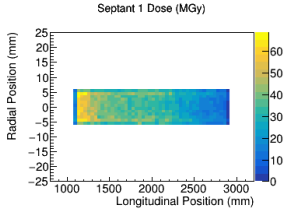


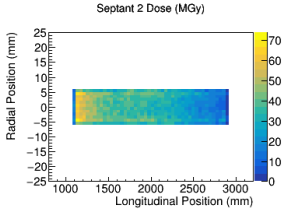


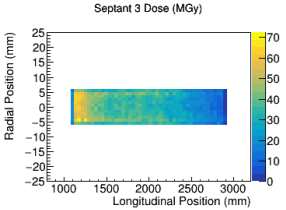


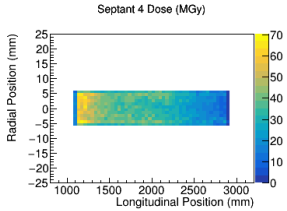


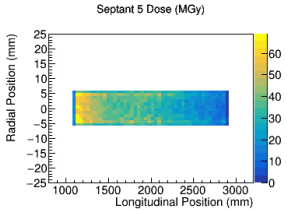
W side plates and
nose shield

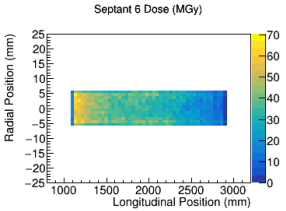


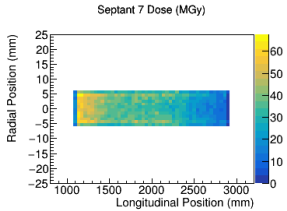










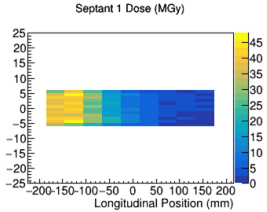


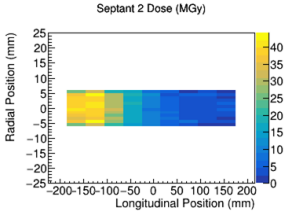
Pb side plates
and nose shield

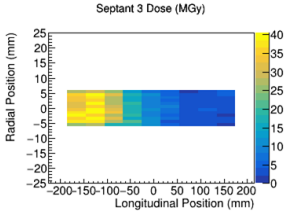
PRELIMINARY

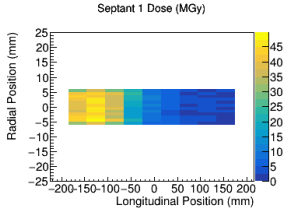
40x1x1 mm bins

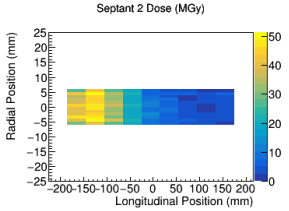
Bottom

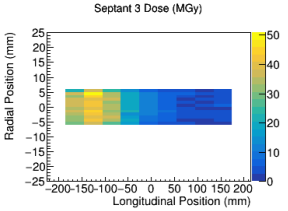


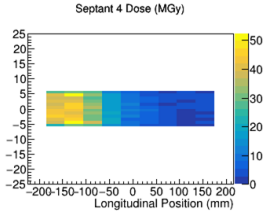


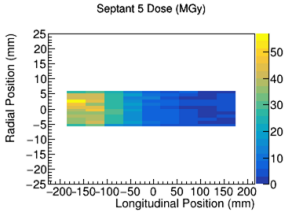


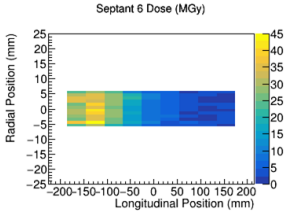


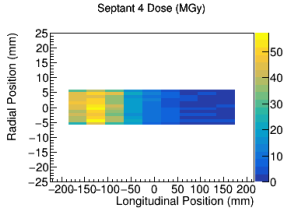


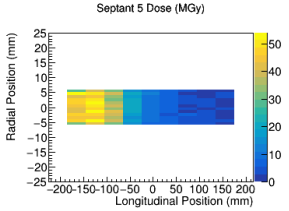


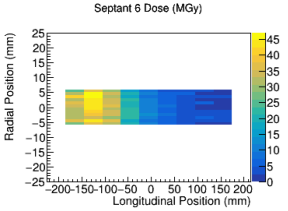


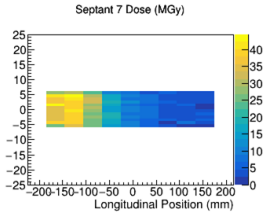


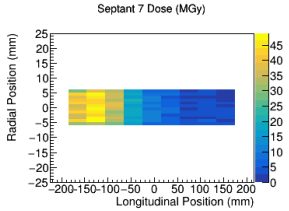












W side plates and nose shield

Pb side plates and nose shield

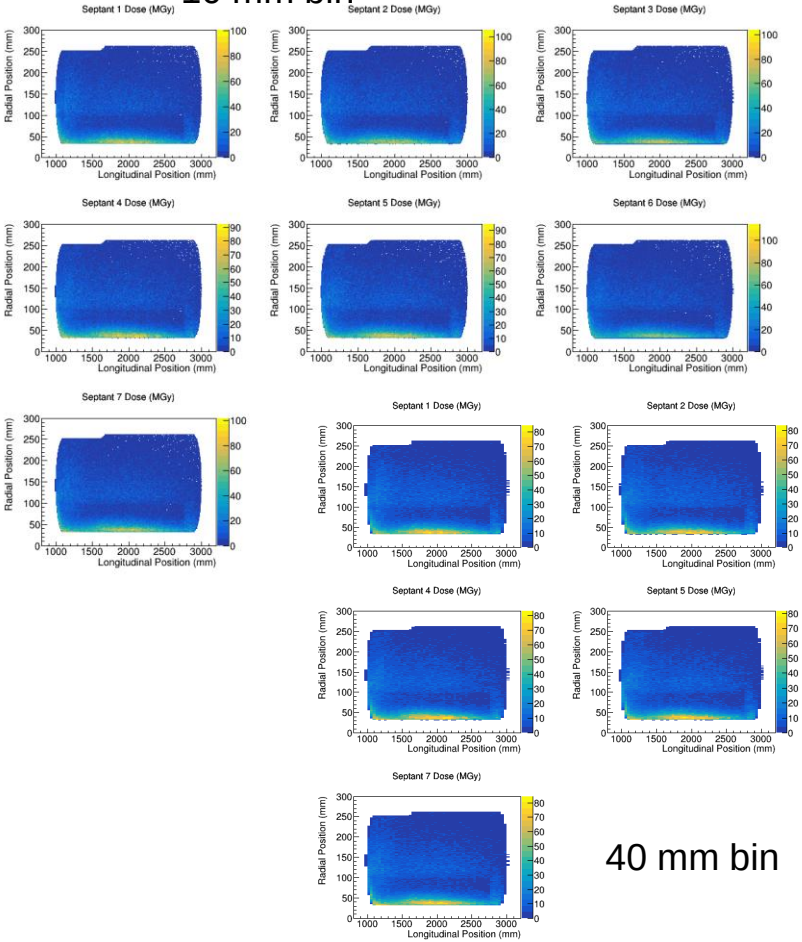
PRELIMINARY

40x1x1 mm bins

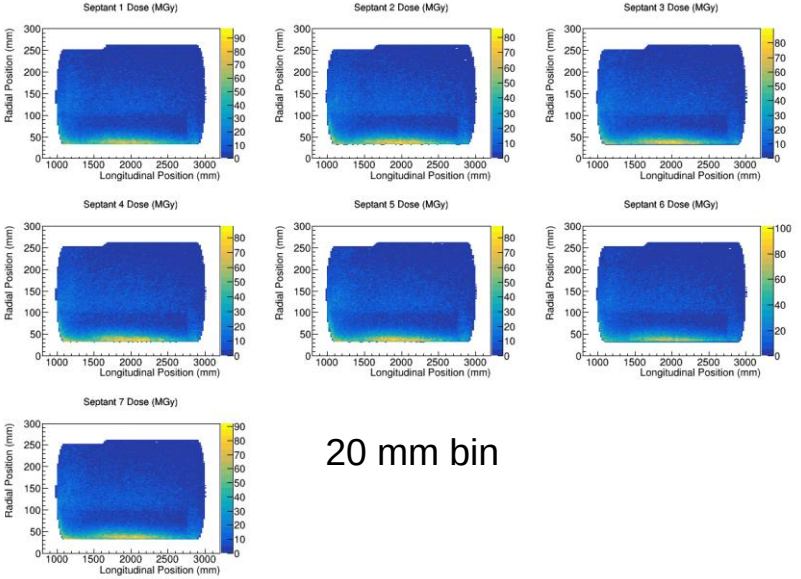
Nose Region

Bin size variation

10 mm bin



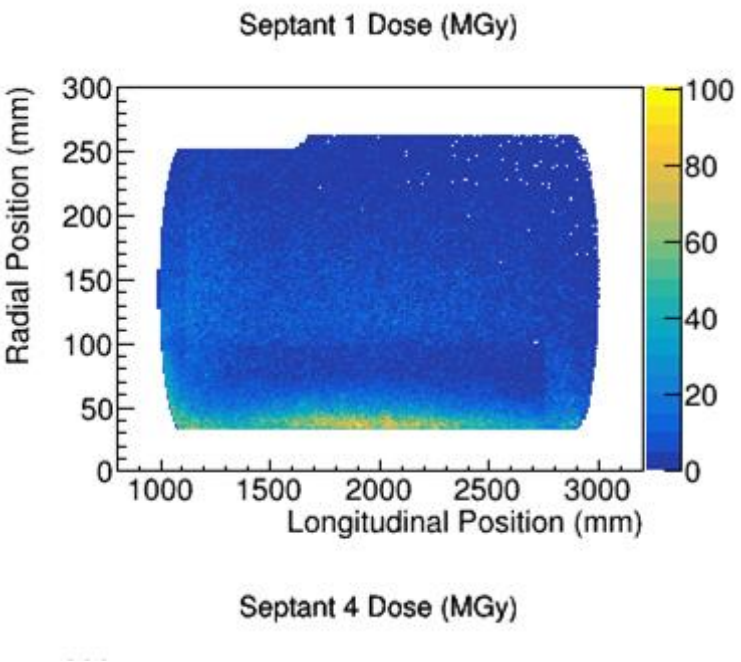
20 mm bin



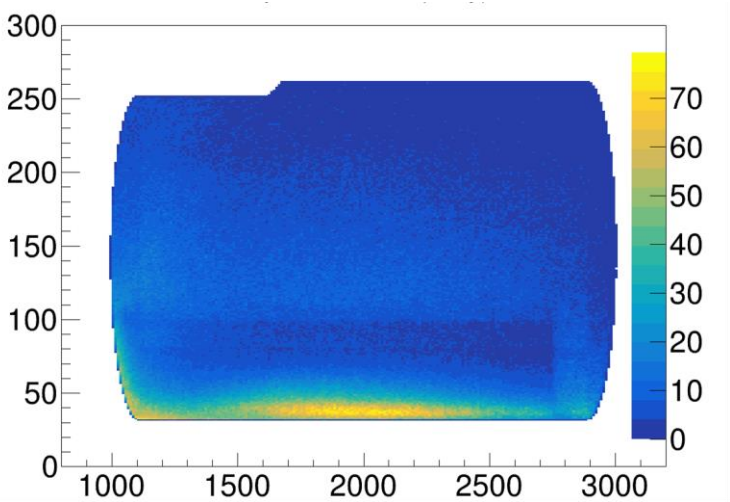
40 mm bin

PRELIMINARY

Pb side plate config



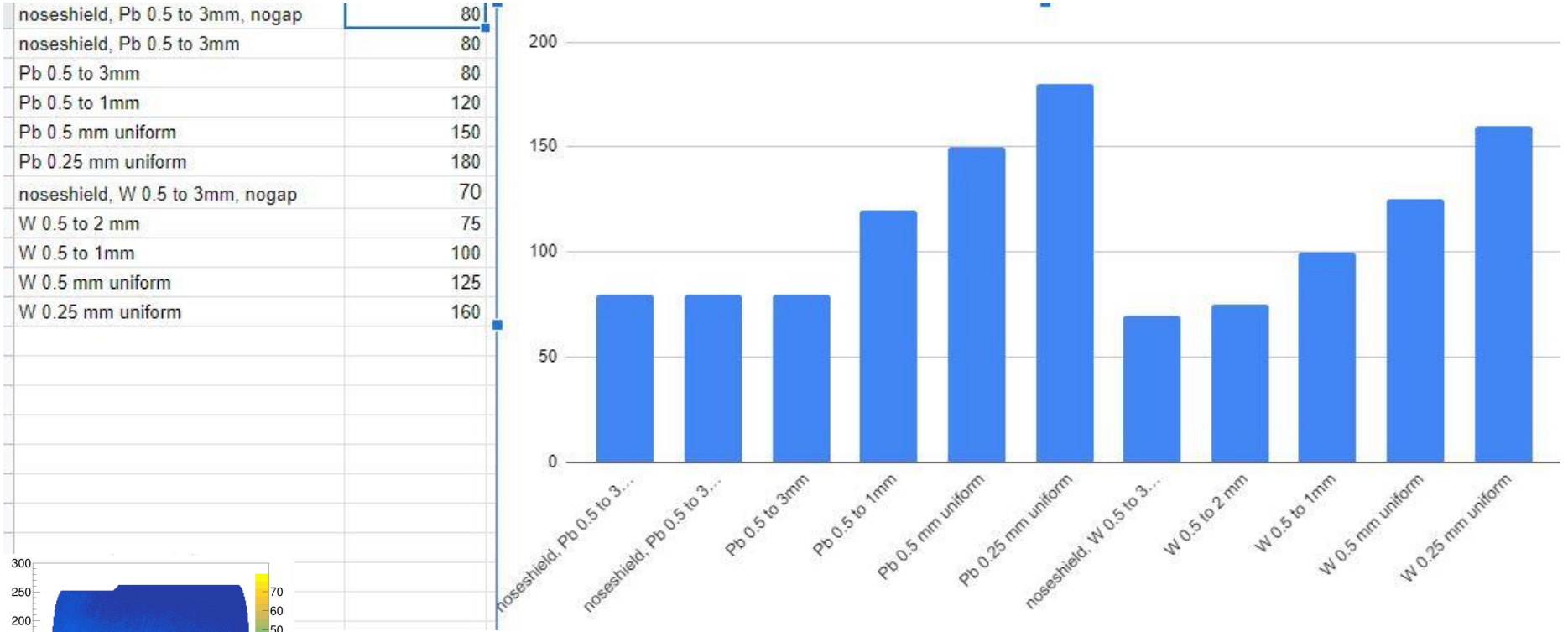
Combined Statistics
from 7 coils

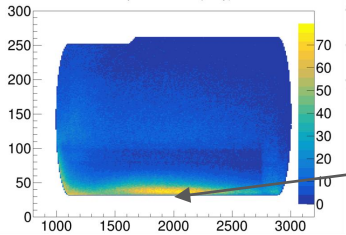


PRELIMINARY

Initial comparison between Pb vs W side plates

noseshield, Pb 0.5 to 3mm, nogap	80
noseshield, Pb 0.5 to 3mm	80
Pb 0.5 to 3mm	80
Pb 0.5 to 1mm	120
Pb 0.5 mm uniform	150
Pb 0.25 mm uniform	180
noseshield, W 0.5 to 3mm, nogap	70
W 0.5 to 2 mm	75
W 0.5 to 1mm	100
W 0.5 mm uniform	125
W 0.25 mm uniform	160





Focusing on this area, Result based on 40x1x1 mm bins, values eye-estimated based on color scale

All the plots