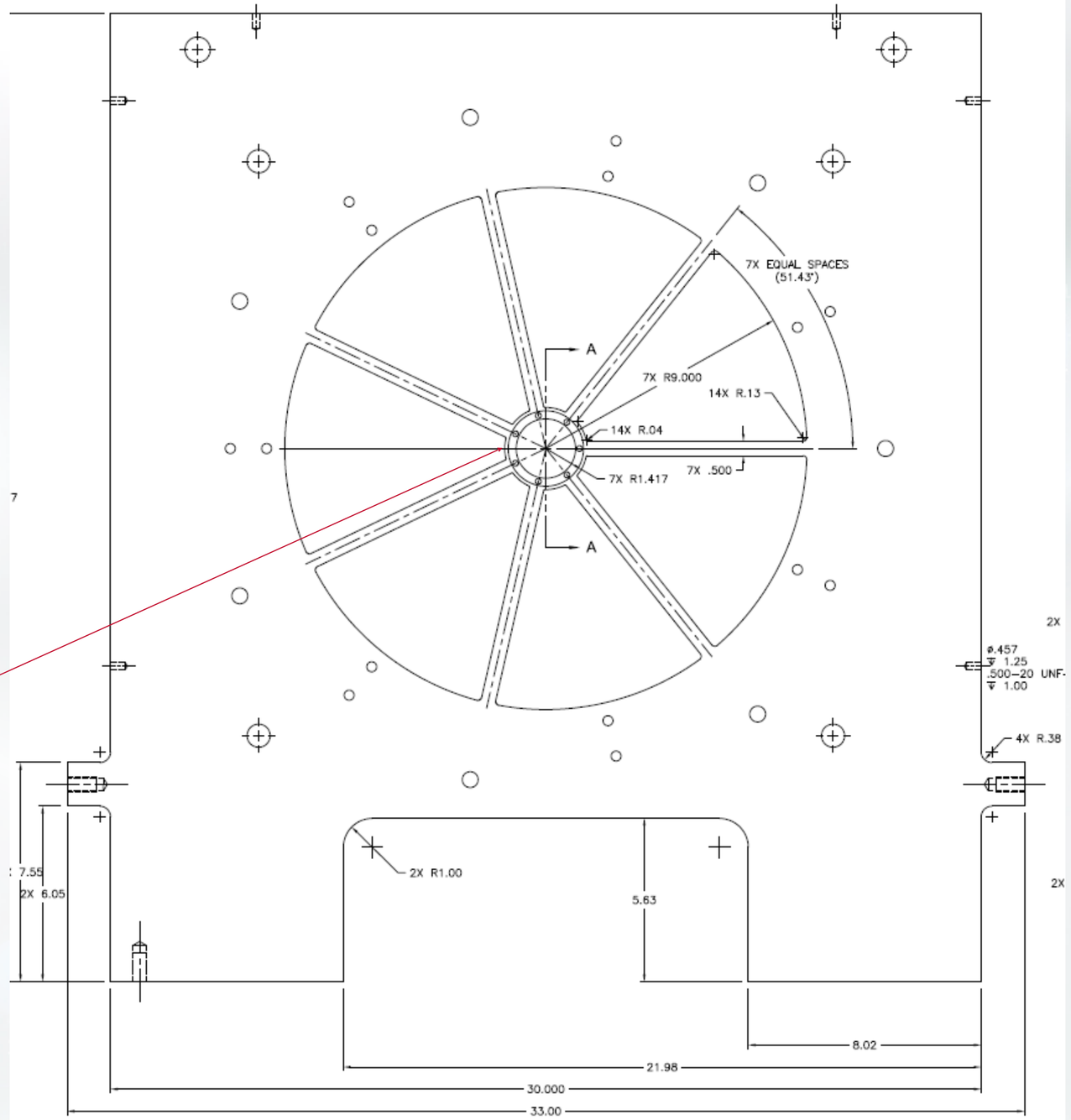
# Collimator 2

# Parts as Designed

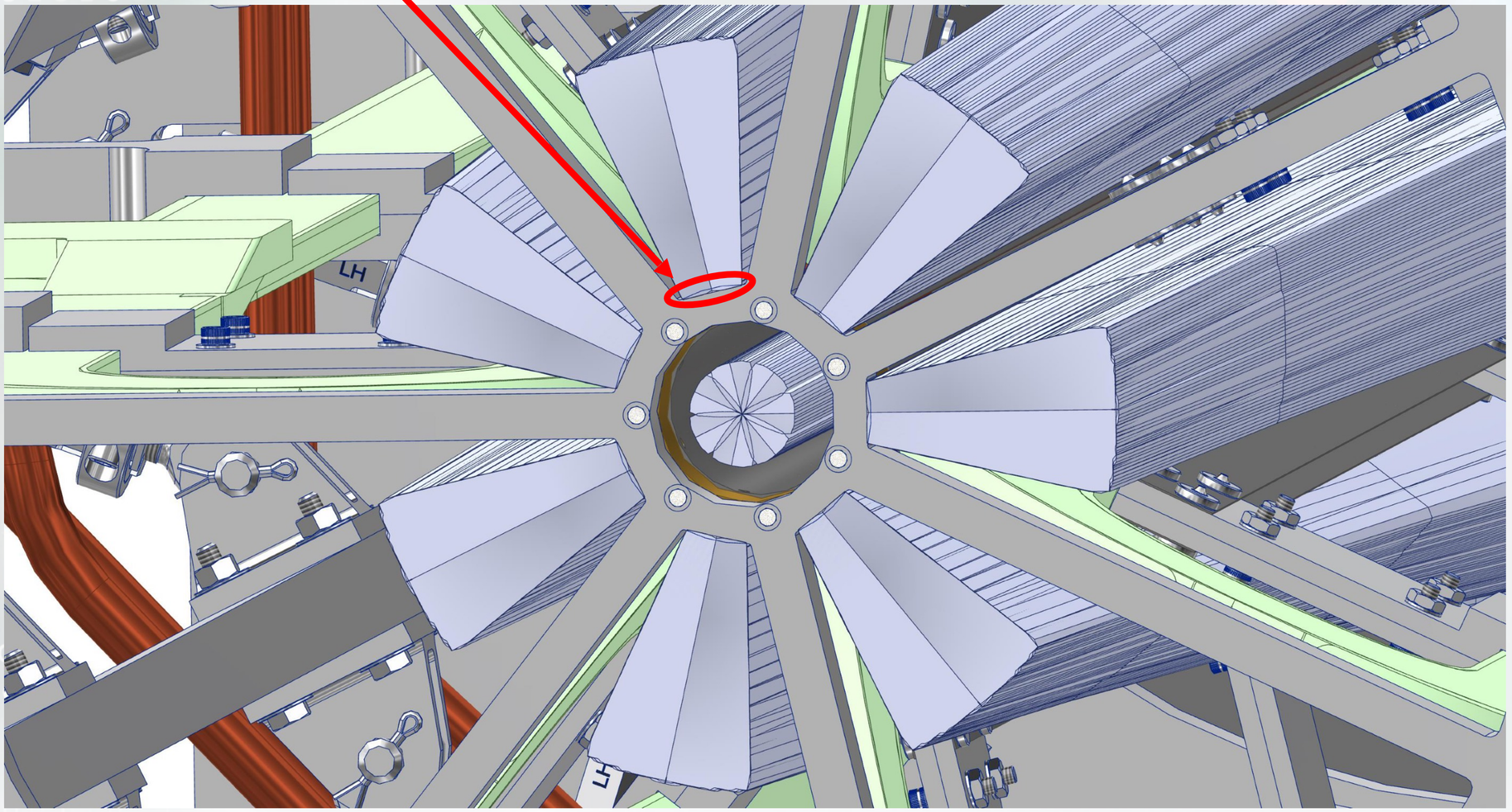
- Upon review of the TM-0 magnet frame components, a discrepancy in dimensions was found.
- Components involved in this review:
  1. Upstream Coil Support Plate (aluminum)
  2. Collimator 2 (W/Cu)
  3. 2 bounce shield (W)
  4. 2 bounce shield US adaptor (brass)
- Larry (and Jlab) reviewed the radial dimension of the US Coil Support Plate
  - As designed is 1.417” = 35.99 mm ~ 36 mm




Eric Sun

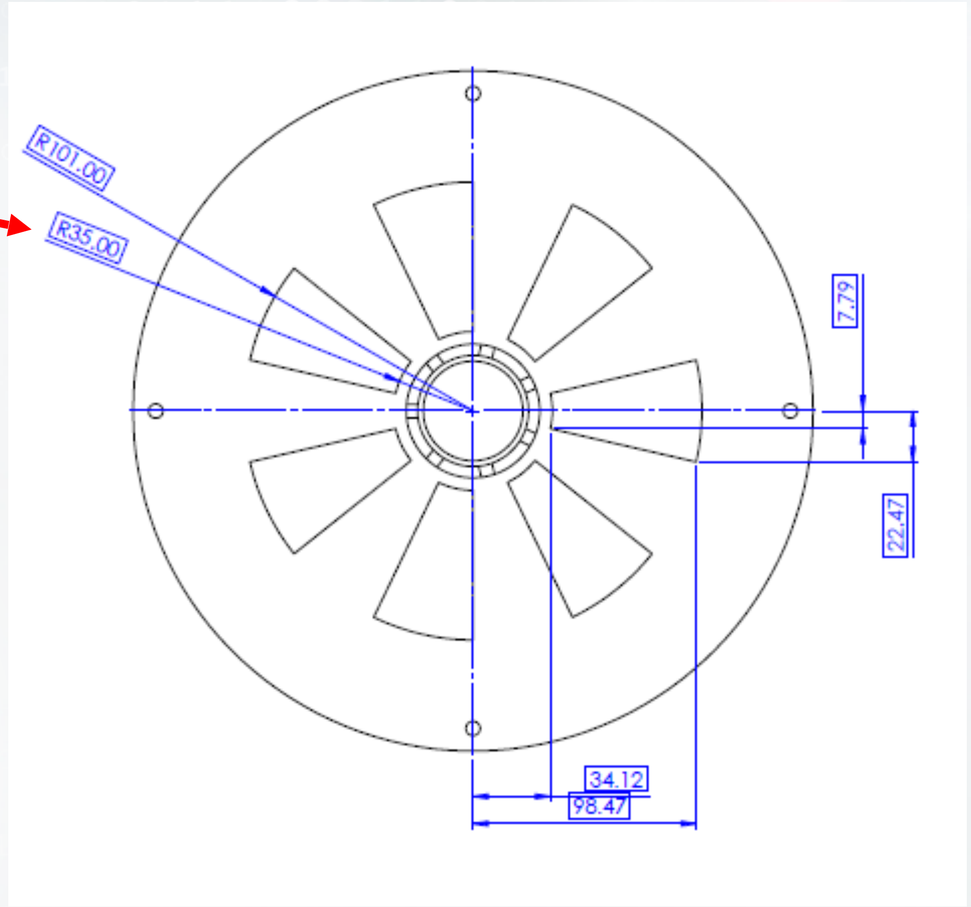
# US Coil Support Frame

- There is an interference (~1 mm) between the inner radius and the ee signal envelope



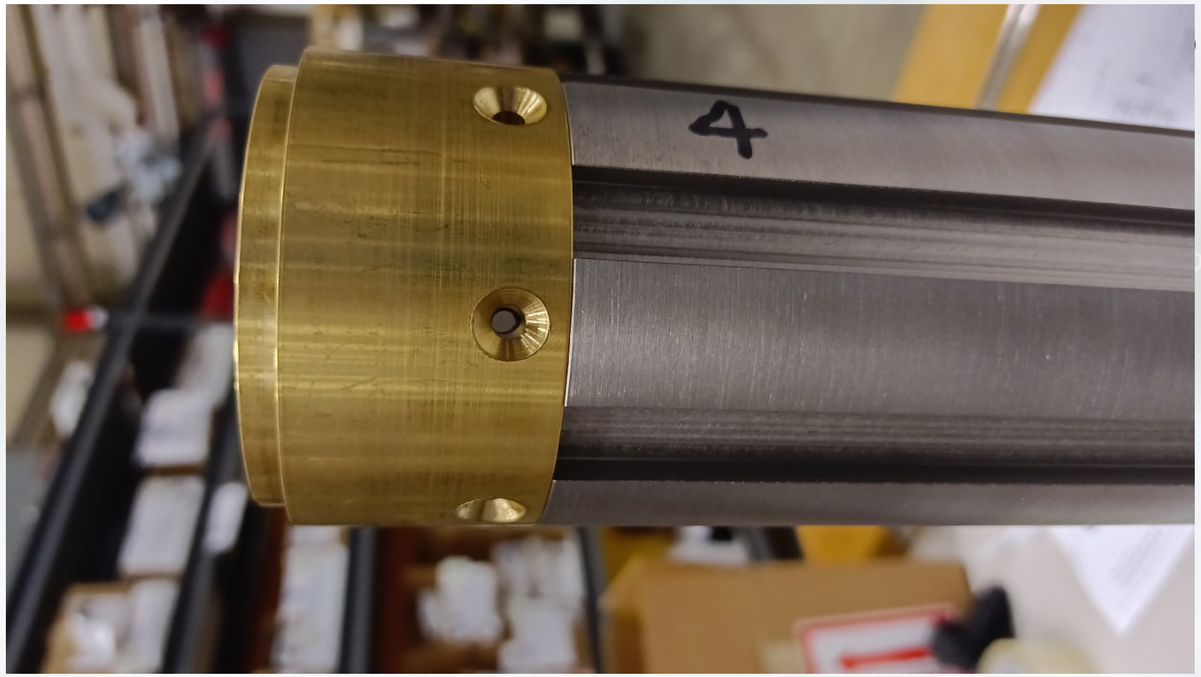
# Collimator 2 as Designed

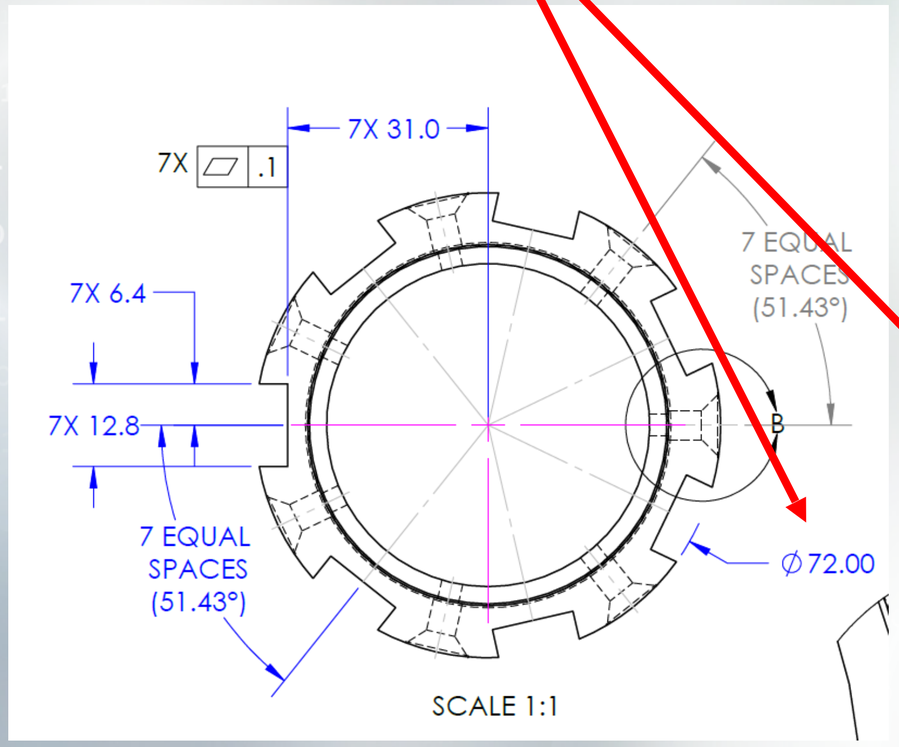
- Once the interference was discovered, other parts were examined
- The “inner” radius of the lower portion of Collimator 2 acceptance cutouts are defined as 35 mm.
  - There is no taper on this dimension



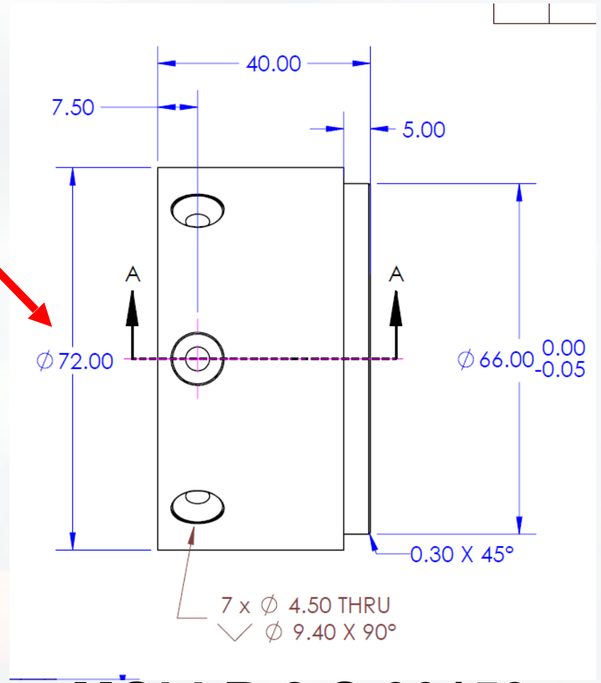
# 2 bounce shield and adaptor

- The as-built 2BS and the US brass adaptor outer radius is 36 mm




MOLLR-2S-00045



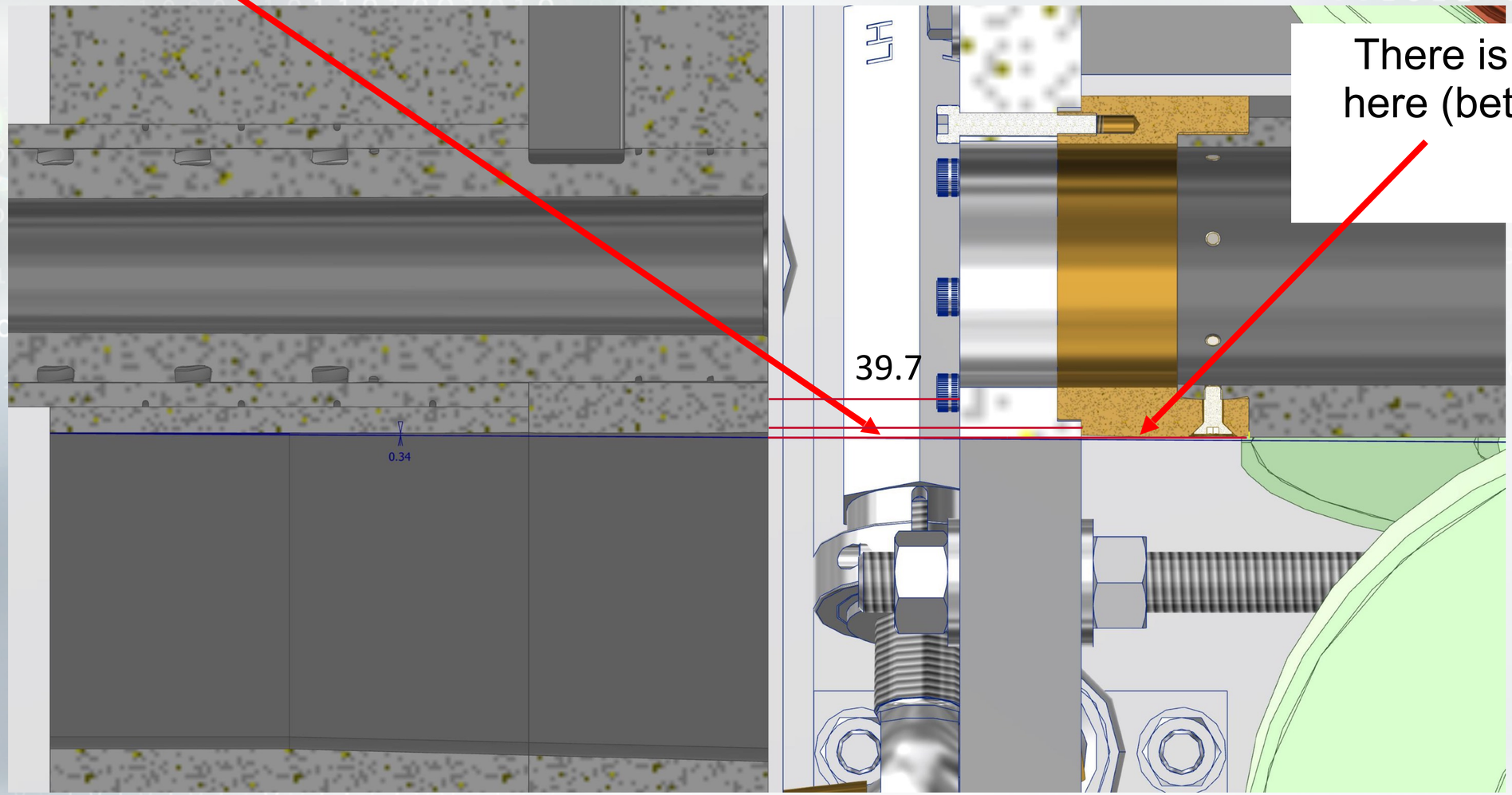

MOLLR-2-S-00153

# Summary so far…

- The 1 mm radial difference of these components can be seen in the CAD model of the US Spectrometer
- Several documents indicate and confirm that the outer radius of the 2BS is 36 mm
  - It is 36 mm in the G4 sim
- The interference between the parts and the envelopes is also observed (in CAD)
- The envelopes appear to not be defined properly
- The 2BS and the brass adaptors are built
- The US coil support plate is in final drawings stages
- Coll 2 is in final drawing stages

# BUT we know that particles “naturally” diverge from the target

This (blue line) shows the 6 mrad divergence from the face of Coll 2 inner radius



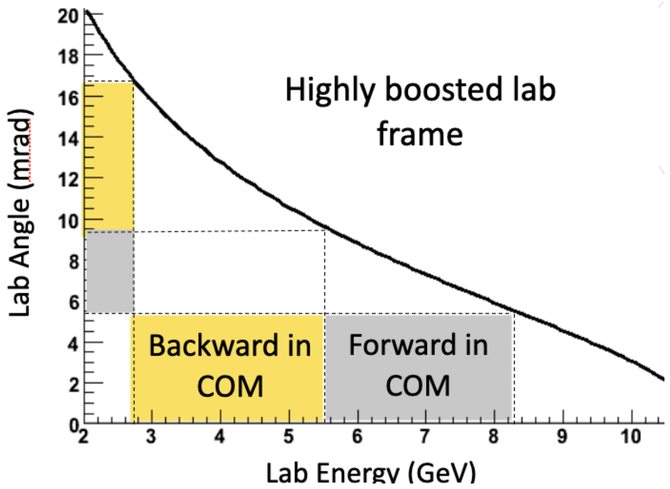

There is 0.5 mm clearance here (between line and 2BS adaptor)

# Solution

Change IR of collimator 2 opening by 0.5mm, now IR = 35.5mm

Machine 2bounce shield (end support, majority of 1st segment) down by 1mm (to 34mm OR)

| | | | | | | |
|---|---|---|---|---|---|---|
| Collimator 2 | length | R | Face Z | Min angle | 6.76 | |
| | 150.00 | 35.5 | 750.00 | (mrad) | | |
| | | | | | | |
| Al frame | length | R | Face Z | | | |
| | 150.00 | 34 | 939.70 | | clearance | 2.5549442 |
| | | | | | | |
| Brass Adapter | length | R | Face Z | | | |
| | 150.00 | 34 | 965.20 | | clearance | 2.6967528 |
| | | | | | | |
| 2bounce Shield | length | R | Face Z | | | |
| | 150.00 | 34 | 1000.00 | | clearance | 2.8902797 |
| | | | | | | |
| 2bounce Shield - unground p | length | R | Face Z | | | |
| | 150.00 | 36 | 1669.70 | | clearance | 4.6145609 |
| | | | | | | |
| | | | | | | |




Back-of-envelope estimate:
about 0.5-1% of FOM loss from design

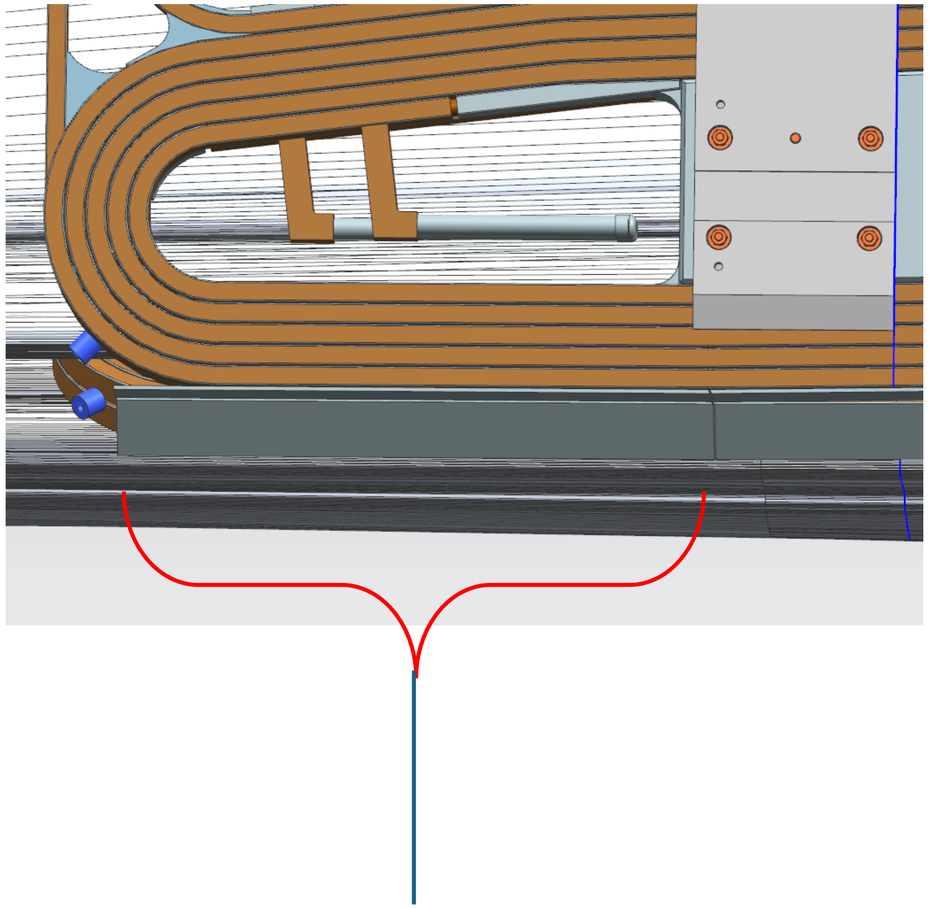
# TM4 Interferences

Interference with collimator 6a and coil clamps of complementary coil
Near-interference (in design, almost certainly a physical interference) with belly plates at upstream end of coils

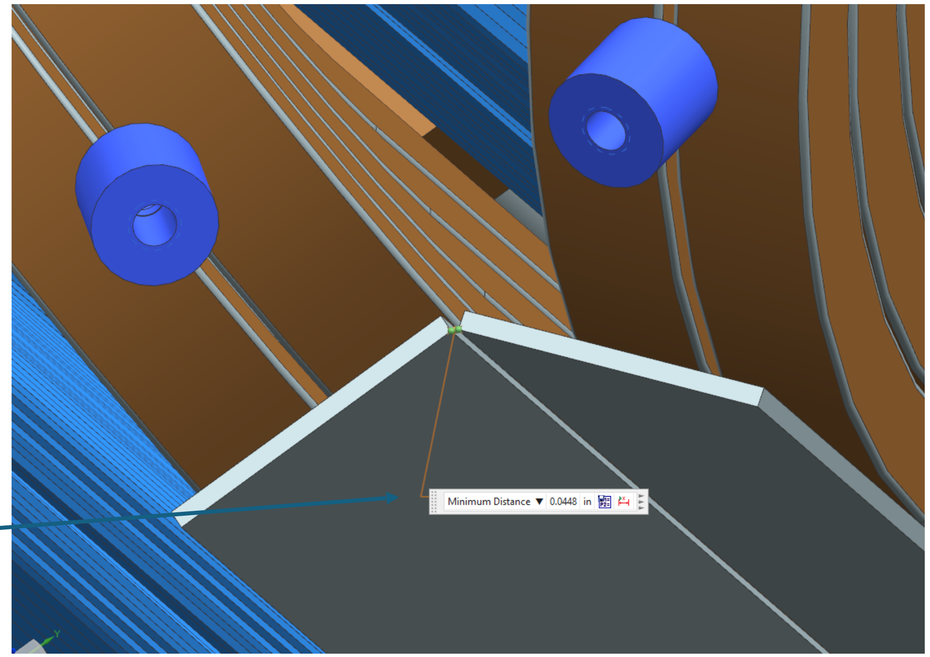
Solution: Move all TM4 subcoil assemblies to a larger radius (R+3mm) to create additional space

Expectation: small changes in magnetic field optics, no interferences with physics signals or additional backgrounds

# Belly Plate Interference

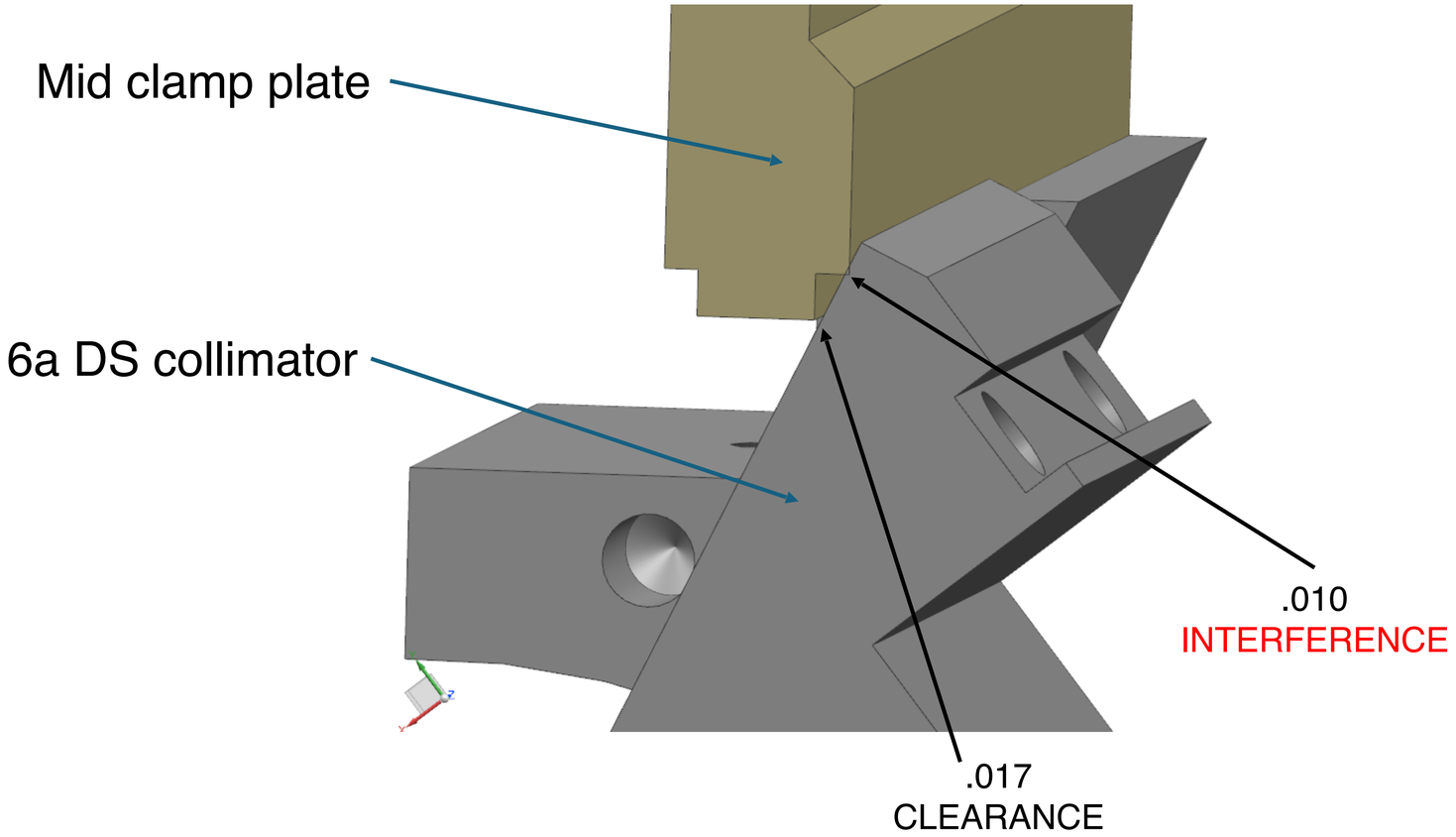


Nominal clearance between belly plates is only 1.1 mm while the actual is **0.58 mm** based on survey data.




Distance between Belly Plates at the upstream/flat section .0448 in (1.1 mm) with Coils in current nominal position

# Collimator 6a interference



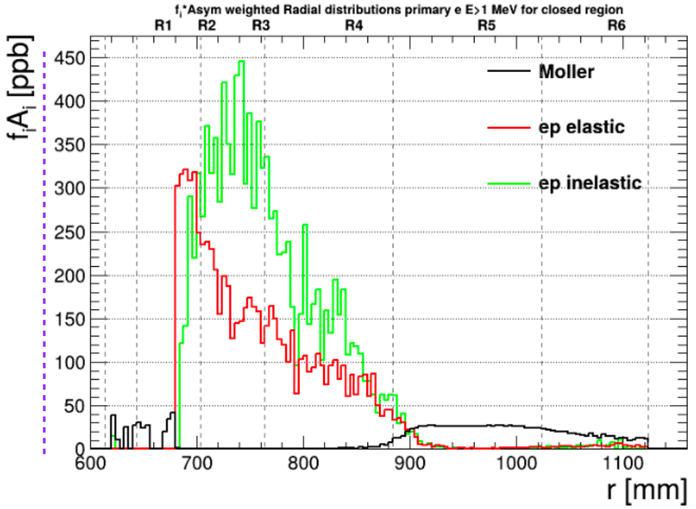

CURRENT INTERFERENCE PROBLEM

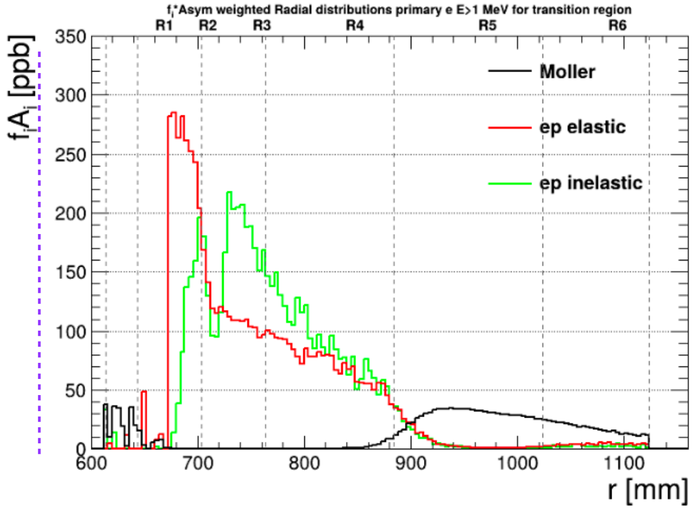
# Deconvolution

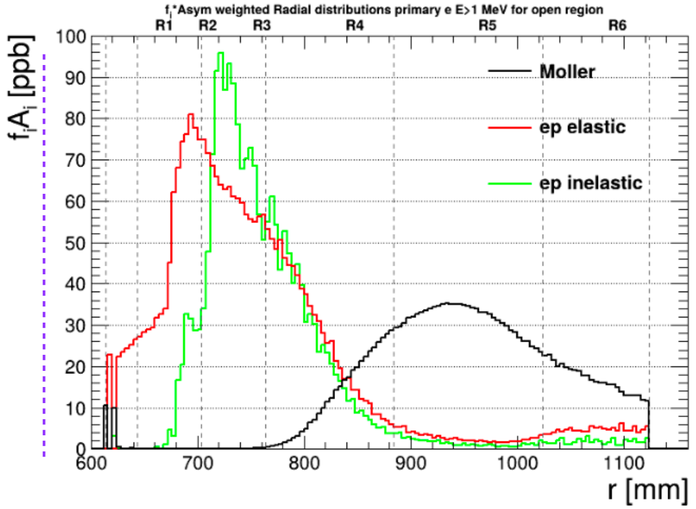
Symmetric magnetic fields with TM4 R+3mm calculated by Juliette in TOSCA

Used by Zuhal in physics generators: moller, elastic, inelastic. Then deconvoluation analysis

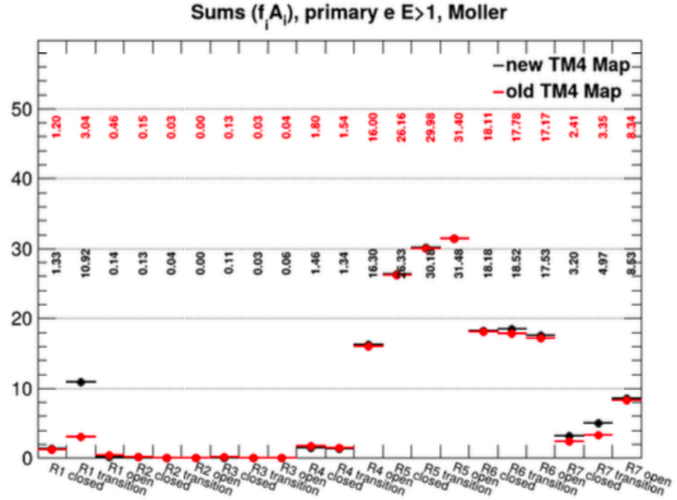
Ring 2 vs 3 separation of inelastics is maintained

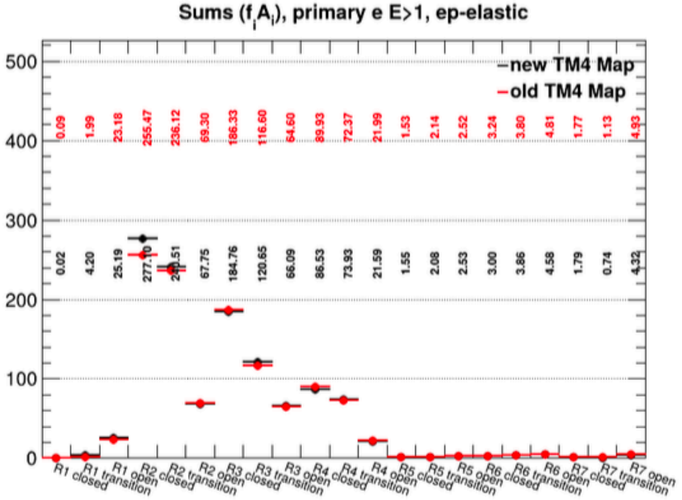


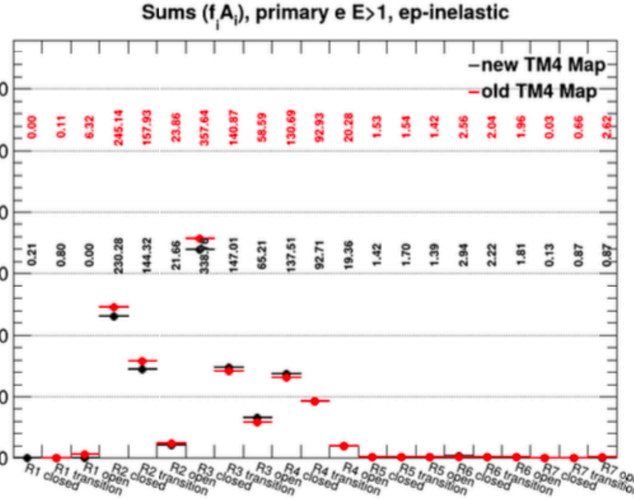




Visible, but not extreme, rate changes



# Deconvolution results

Small to negligible resulting change on precision of extracted physics asymmetries

Some difference in various measures (including or excluding rescattering, physical tile hits vs vacuum detector in front of plane) but nothing looks sigificantly worsened

**primary e E> 1MeV, old TM4 field map**

| Name | Asymmetry [ppb] | uncert [ppb] | rel uncer [%] |
|---|---|---|---|
| moller | -34.87 | 0.72 | 2.07% |
| ep Elastic | -28.90 | 1.46 | 5.04% |
| ep Inelastic W1 | -585.90 | 71.73 | 12.24% |
| ep Inelastic W2 | -486.92 | 30.93 | 6.35% |
| ep Inelastic W3 | -439.33 | 67.66 | 15.40% |

**primary e E> 1MeV, new TM4 field map**

| Name | Asymmetry [ppb] | uncert [ppb] | rel uncer [%] |
|---|---|---|---|
| moller | -34.97 | 0.73 | 2.07% |
| ep Elastic | -28.91 | 1.51 | 5.21% |
| ep Inelastic W1 | -504.67 | 70.96 | 14.06% |
| ep Inelastic W2 | -515.32 | 35.97 | 6.98% |
| ep Inelastic W3 | -445.64 | 69.54 | 15.60% |

# Clearance to signal and photon envelopes

Dave Kashy performed a careful walk through in the spectrometer CAD to look at clearances to the “envelope” edges. There was one close clearance noted: the outer radius of collimator 6B threatened the “Outer Photon Envelope” (OPE) with clearance of about 1.5mm

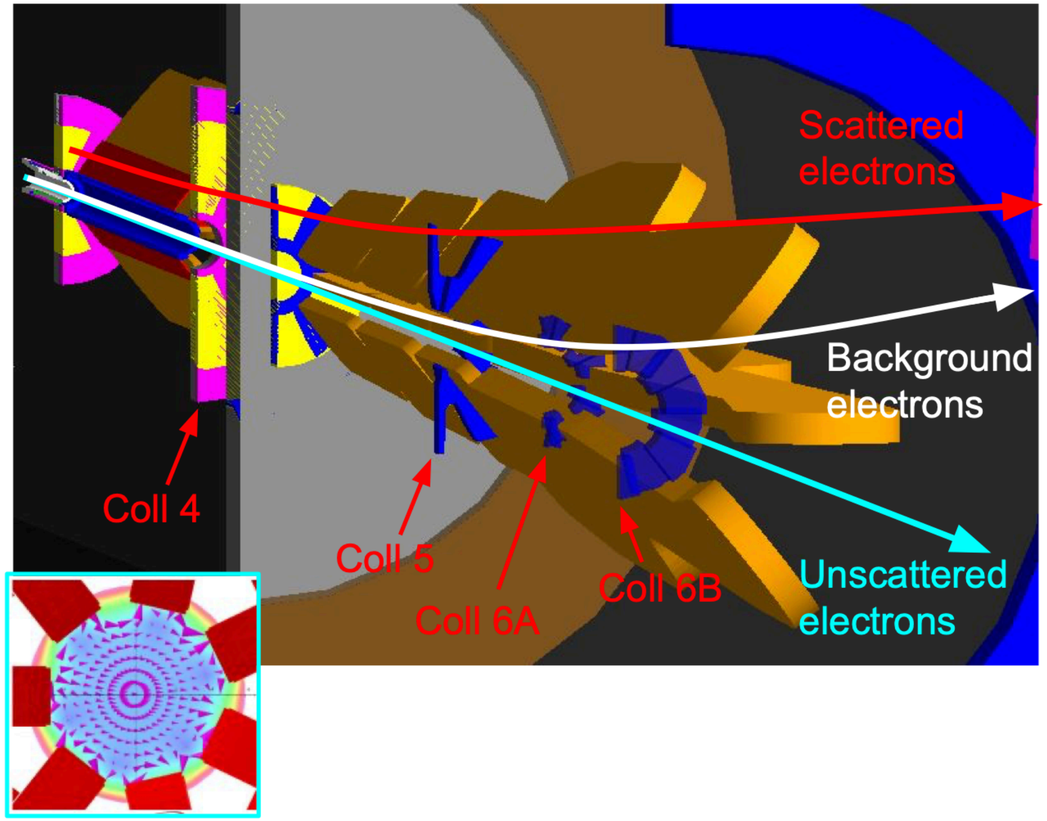
## Clearances at DS Clamps

- Z=-430.305
- **A 3mm radial move will make clearance to OPE significantly smaller. 0.175” to 0.057” (close to 1.5mm)**


# Collimators and Outer Photon Envelopes

Collimator 5 and photon scraper shape the photon flux through the acceptance

6a/6b remove disrupted beam pulled out by the beampipe magnetic field

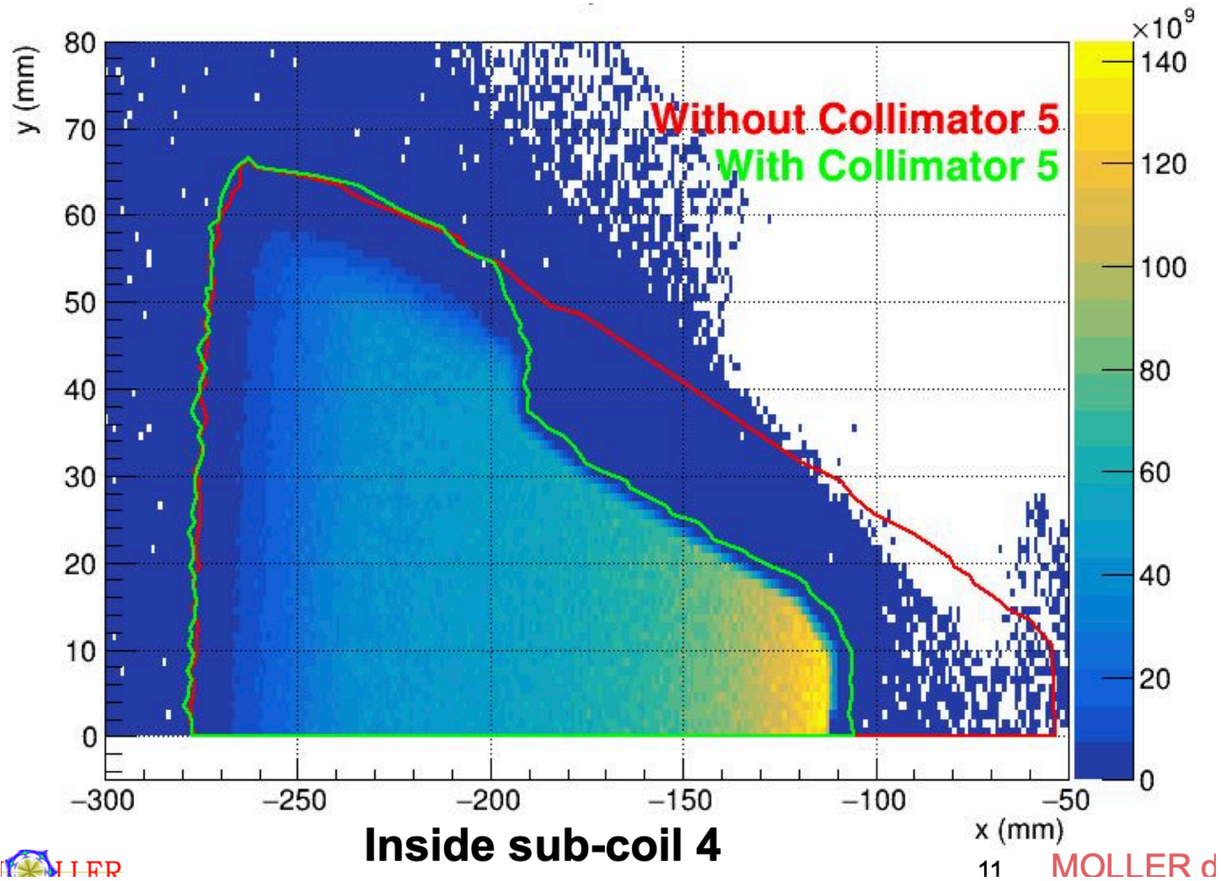



docdb:834 (Ghosh)

Small angle cut enforced by Collimator 5

"Hard shadow" opening is smaller than the OPE boundary

docdb:834, docdb:797



# Simulation

Prakash Gautum

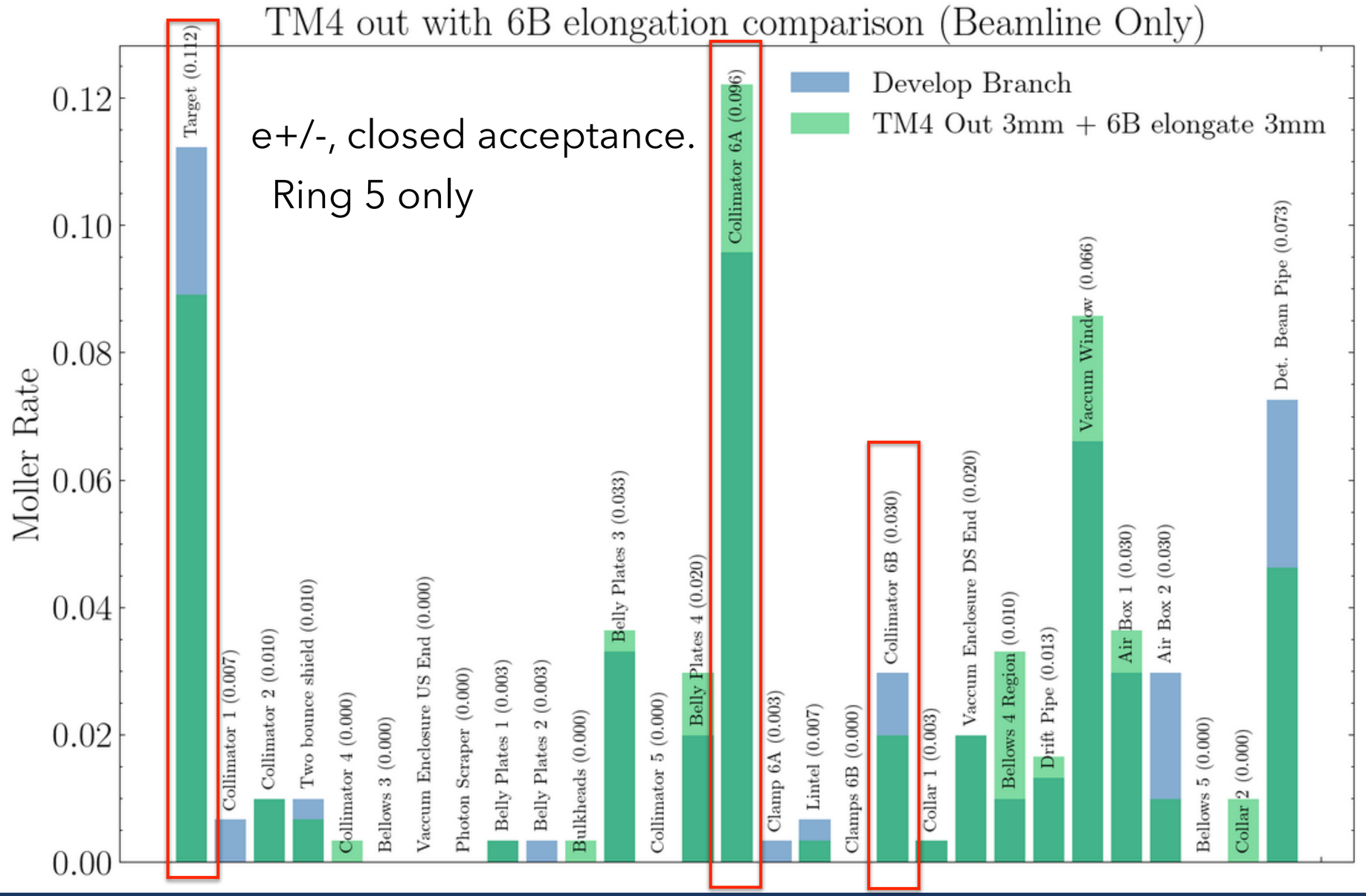
TM4 Movement:

- The components attached to the magnet are moved radially outward.
- These include
  1. The three clamps attached to the coil
  2. Belly plates
  3. Collimator 6A (US/DS) and Collimator 6B(US/DS)
  4. The coils themselves.

Moller rate definition:

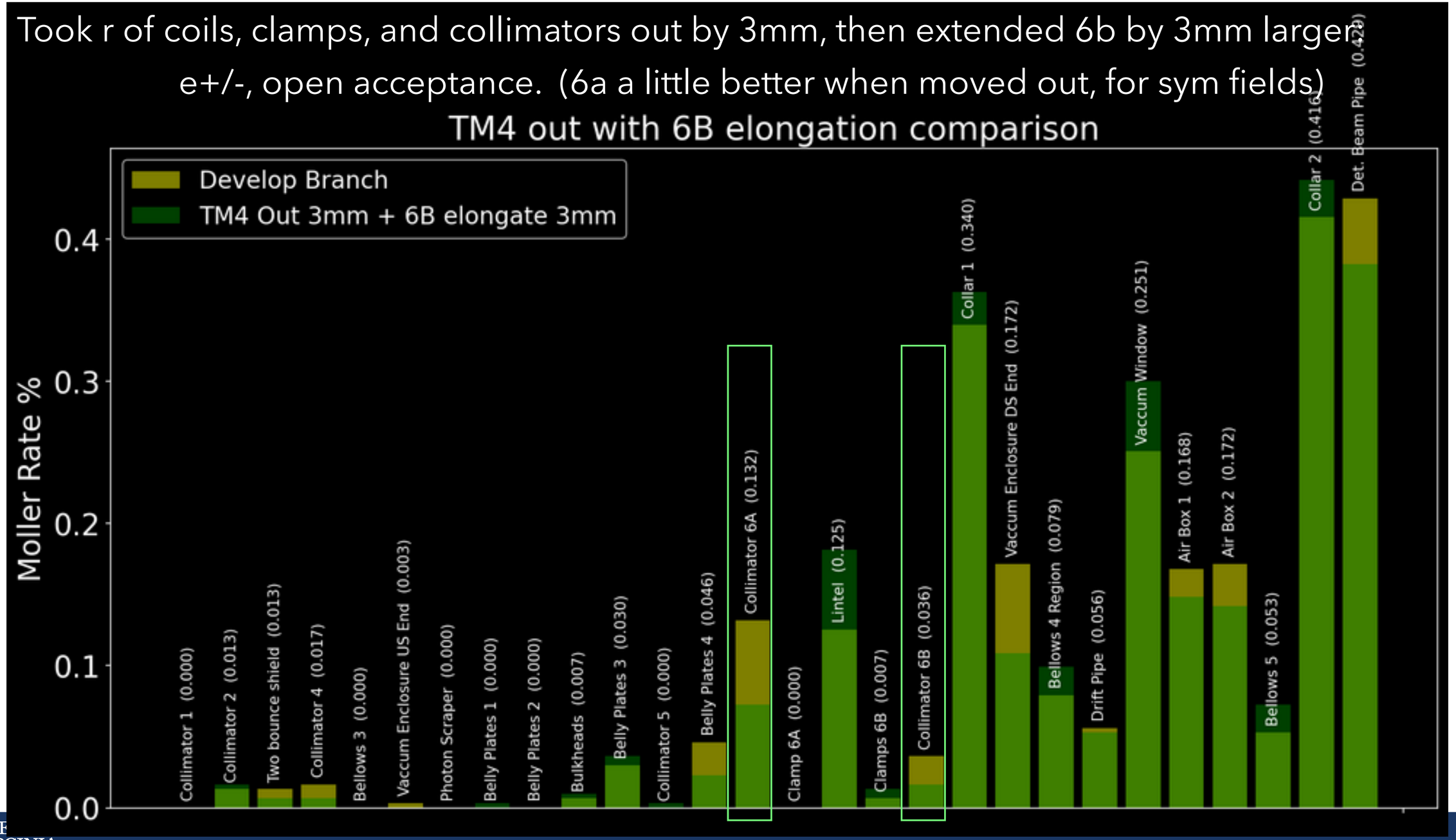
- Assume 1 every 3300 beam event is a Moller event.
- Moller Rate % is the fraction of Moller event.

Took r of coils, clamps, and collimators out by 3mm, then extended 6b by 3mm larger:

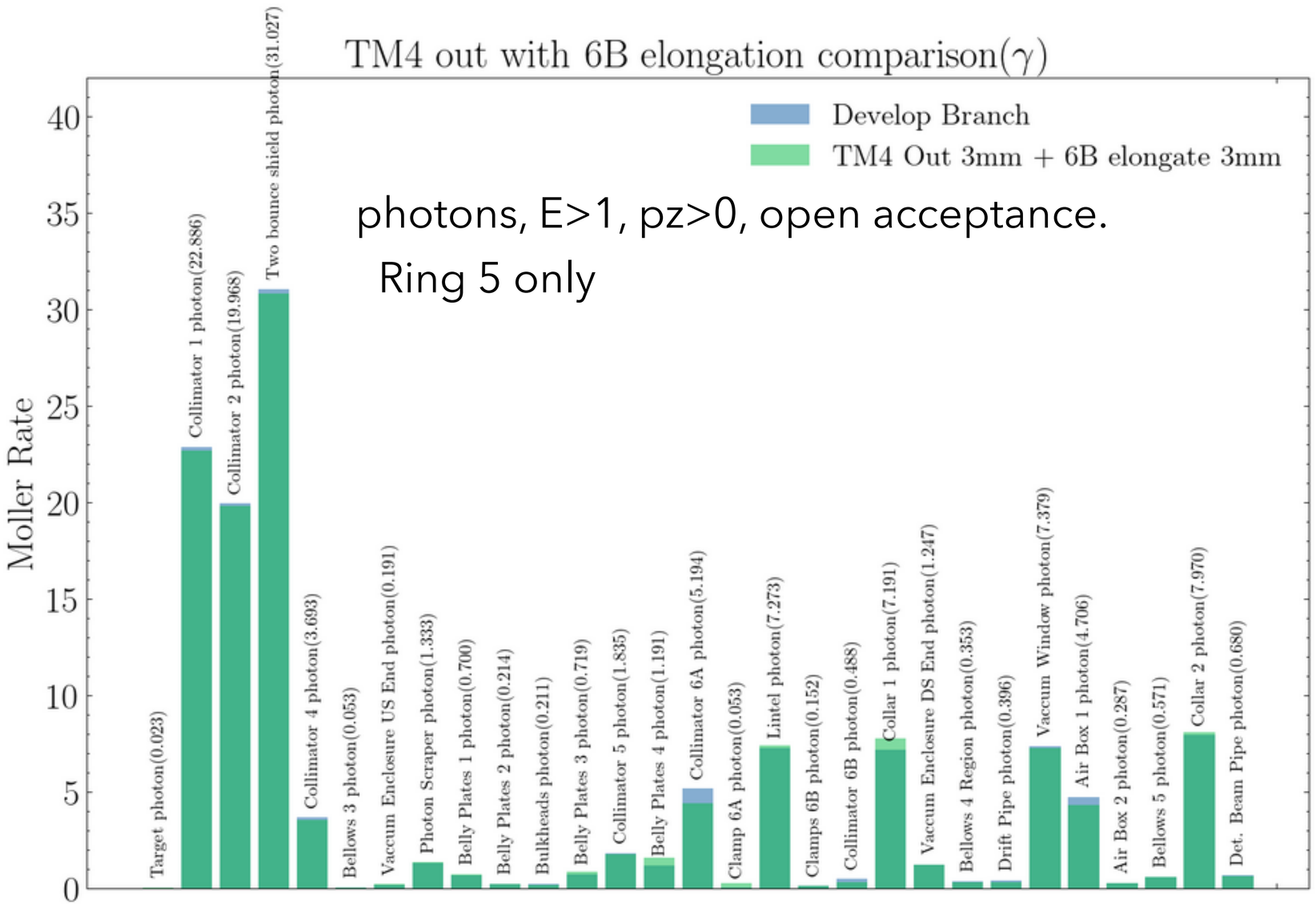



Changes consistent with statistical noise

Took r of coils, clamps, and collimators out by 3mm, then extended 6b by 3mm larger e+/-, open acceptance. (6a a little better when moved out, for sym fields)



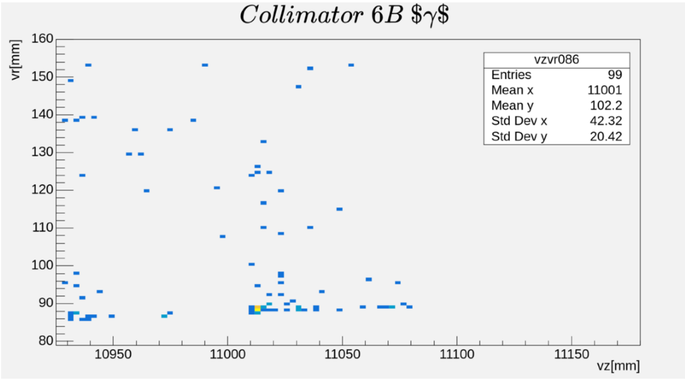
# Photons backgrounds



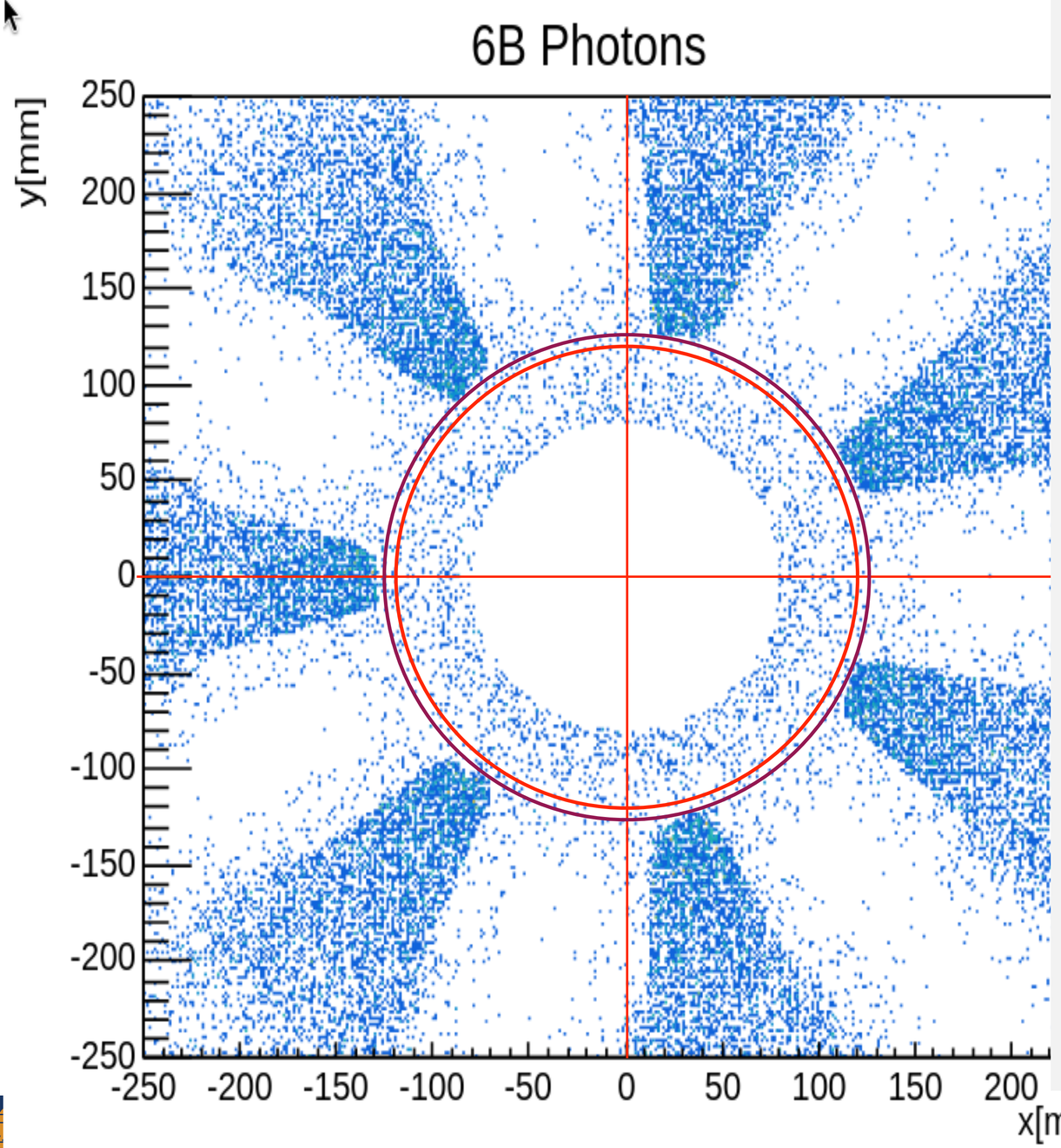

photons, E>1, pz>0, open acceptance.

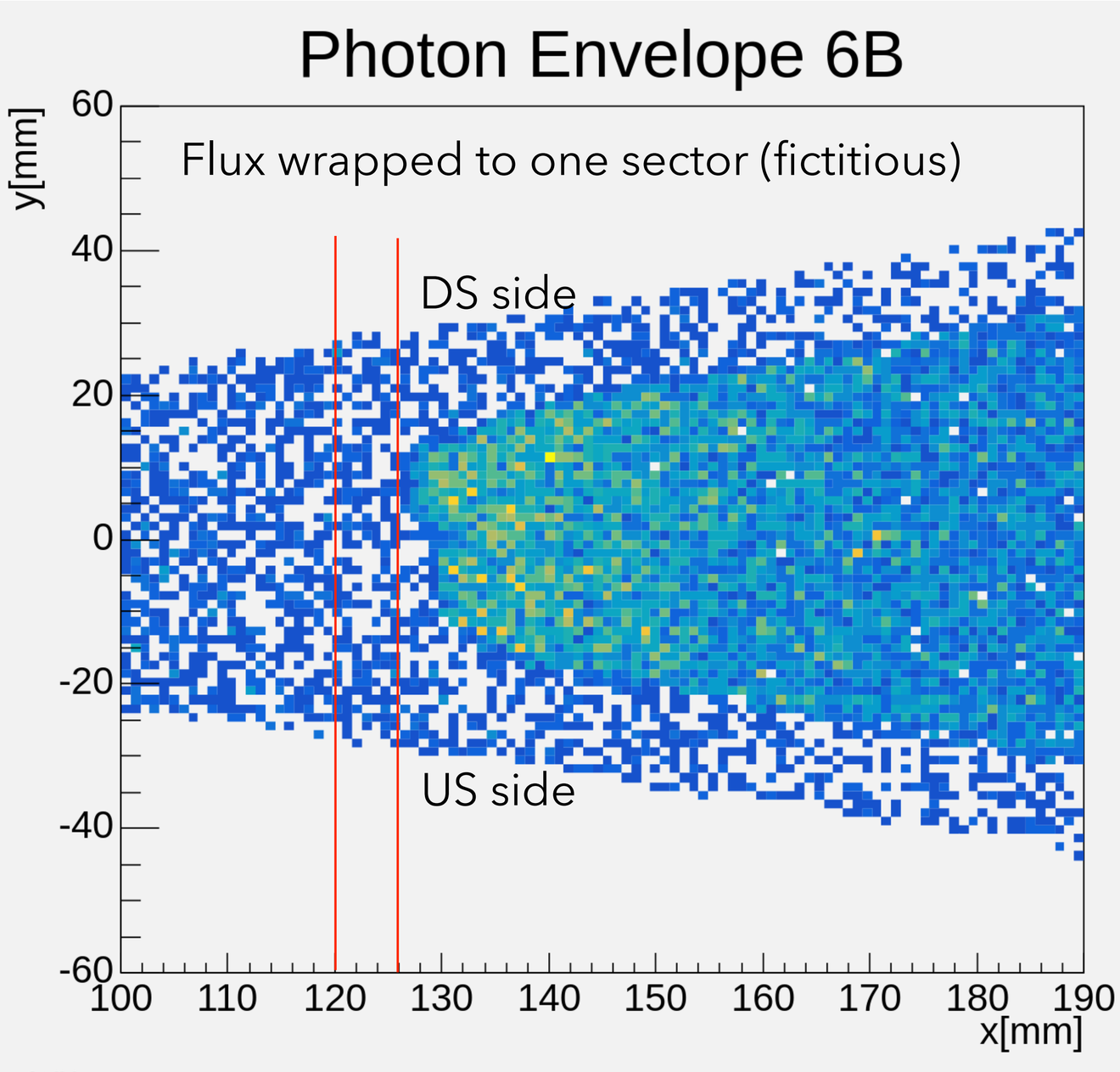
Ring 5 only

6b cut included large R (older version of plot but same cut)



# 6mm shift in the nominal 6b position does not intersect with hard shadow



# Conclusions

- Signal clearance at collimator 2 requires change in collimator 2 aperature minimum raduius (35mm ⟶ 35.5mm)
  - Small loss in precision (~1% of the 2% uncertainty) expected from increase in radius of collimator 2

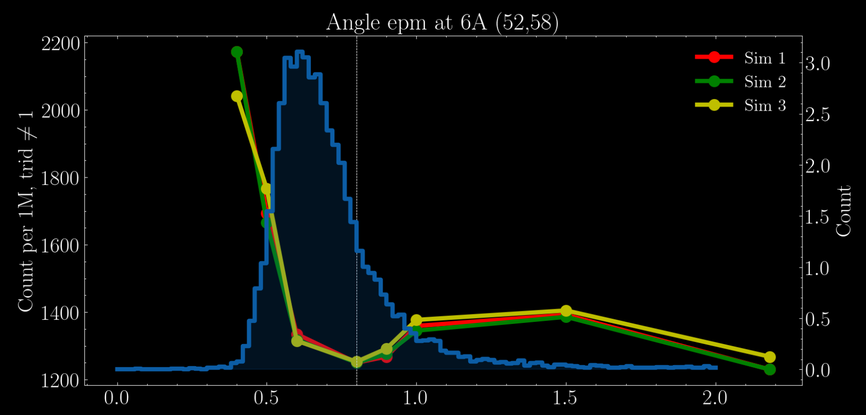
- Belly plate interference and collimating 6a interference in TM4 requires change
  - Moving all subcoils out R+3mm
  - Small loss to deconvolution contrast
  - No additional background (for symmetric fields)

- To Do:
  - Zuhal: deconvolution, New col2 with new field map
  - Zuhal: deconvolution, New col2, new field map, new TM4 gdml
  - Prakash: pull request for TM4 gdml
  - Prakash: pull request for IR+0.5mm and other tapers etc in collimator 2
  - Rakitha: check on TM4 gdml
  - Prakash: background with TM04 R+3mm asymmetric fields (blocked)
  - Juliette: calculate asymmetric fields with TM04 R+3mm
  - Prakash: Col 5 visualization vs 6b photon shadow
  - Zuhal: Q2 vs c/t/o for inelastics - deconvolution, dip in f*A

# extra

# Pretty soft minima on angle of collimator

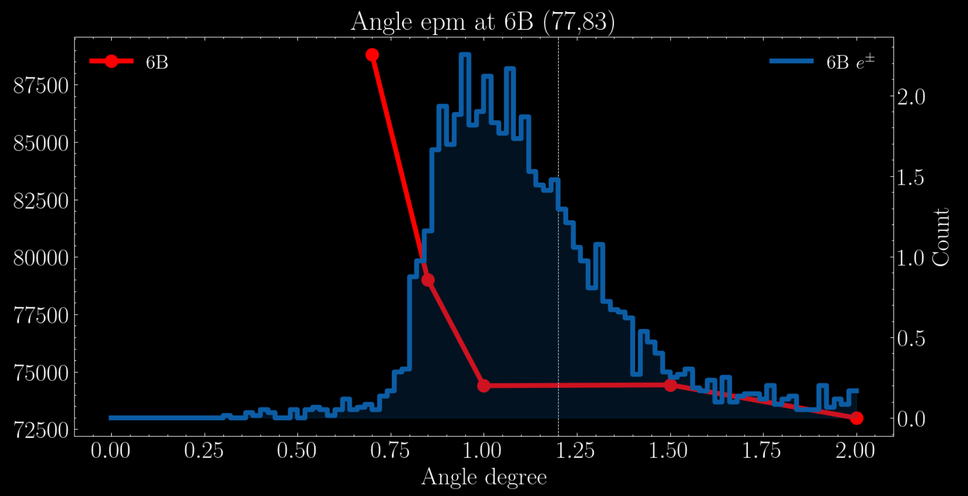
## Taper 6A



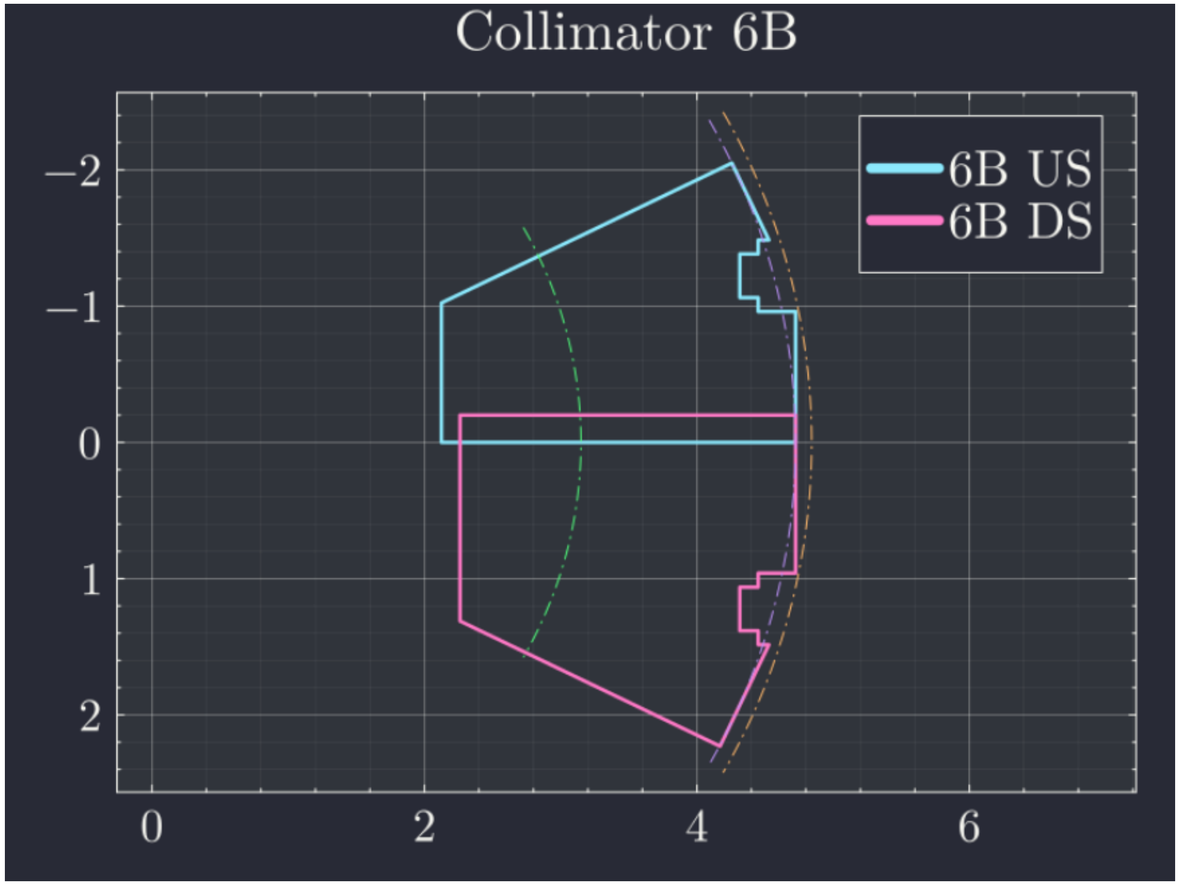

- Taper angle slightly higher than the peak of beam angular distribution.
- For 6A: The taper angle : 0.80°.



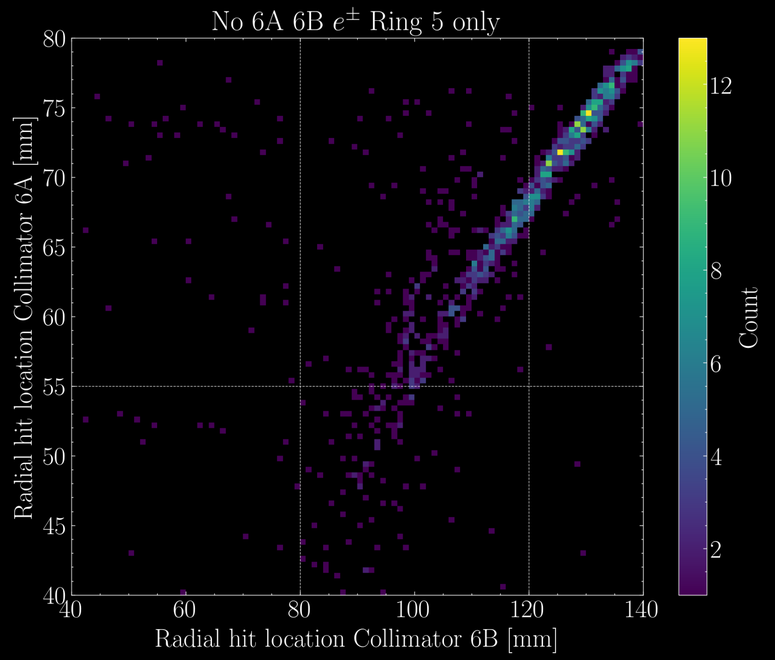
## Taper 6B

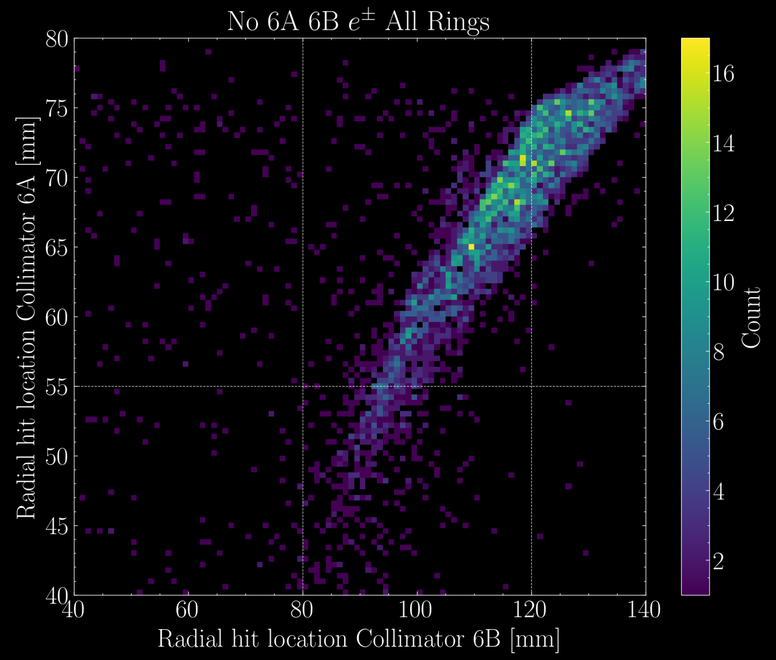



- Taper angle slightly higher than the peak of beam angular distribution.
- For 6B: The taper angle: 1.20°.

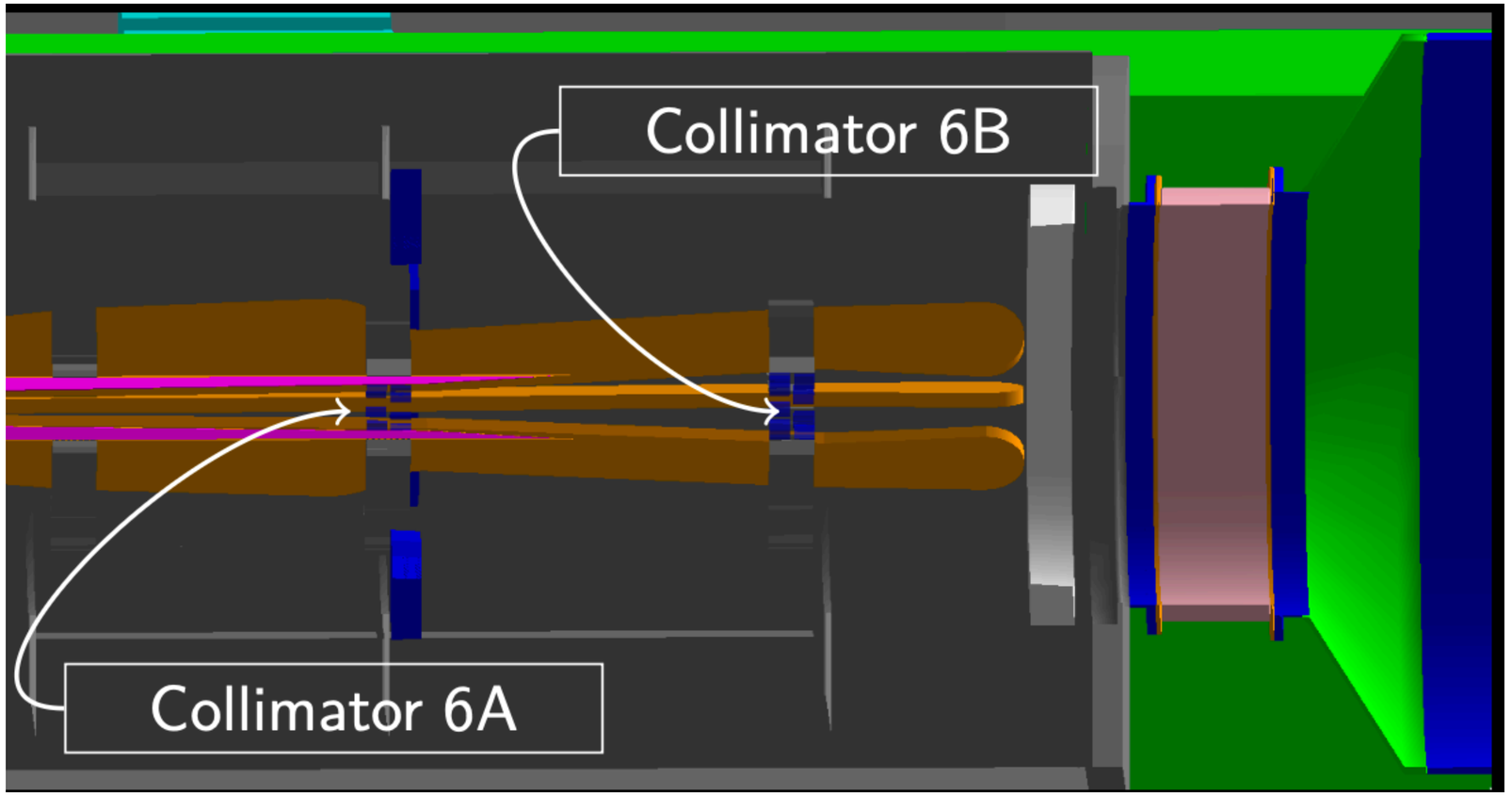

Collimator 6B
6B US
6B DS
−2
−1
0
1
2
0
2
4
6

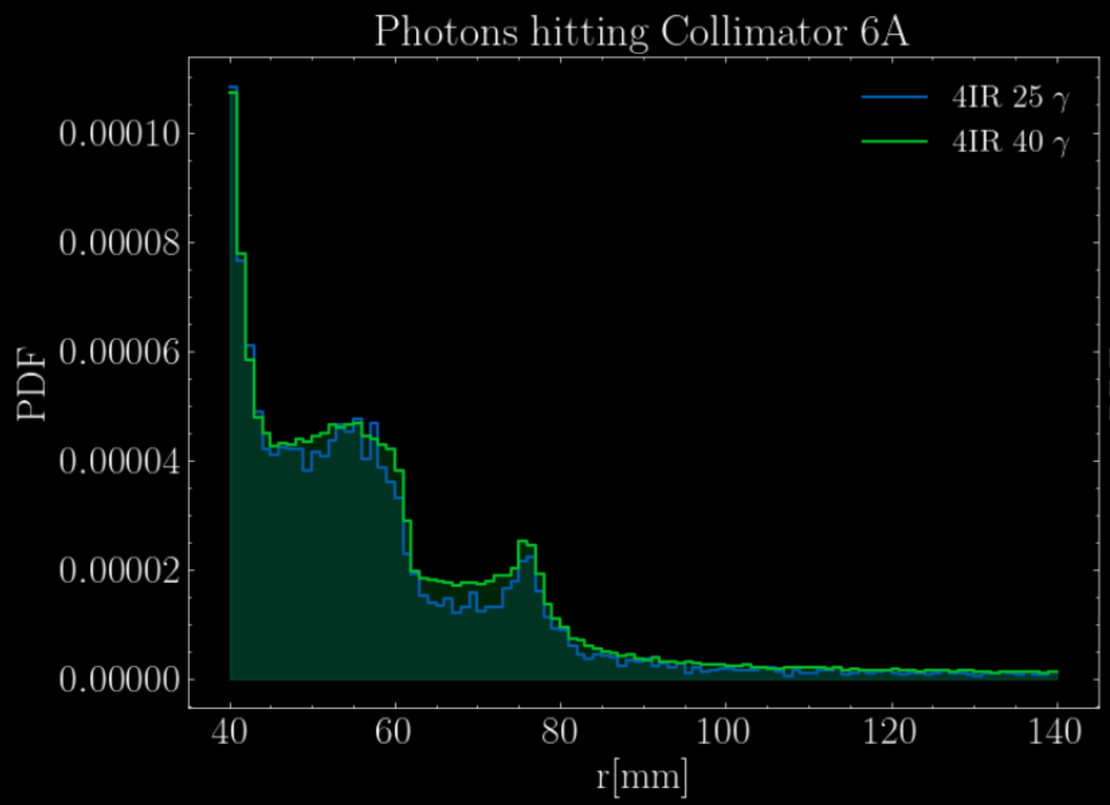
# New Simulation without 6A 6B

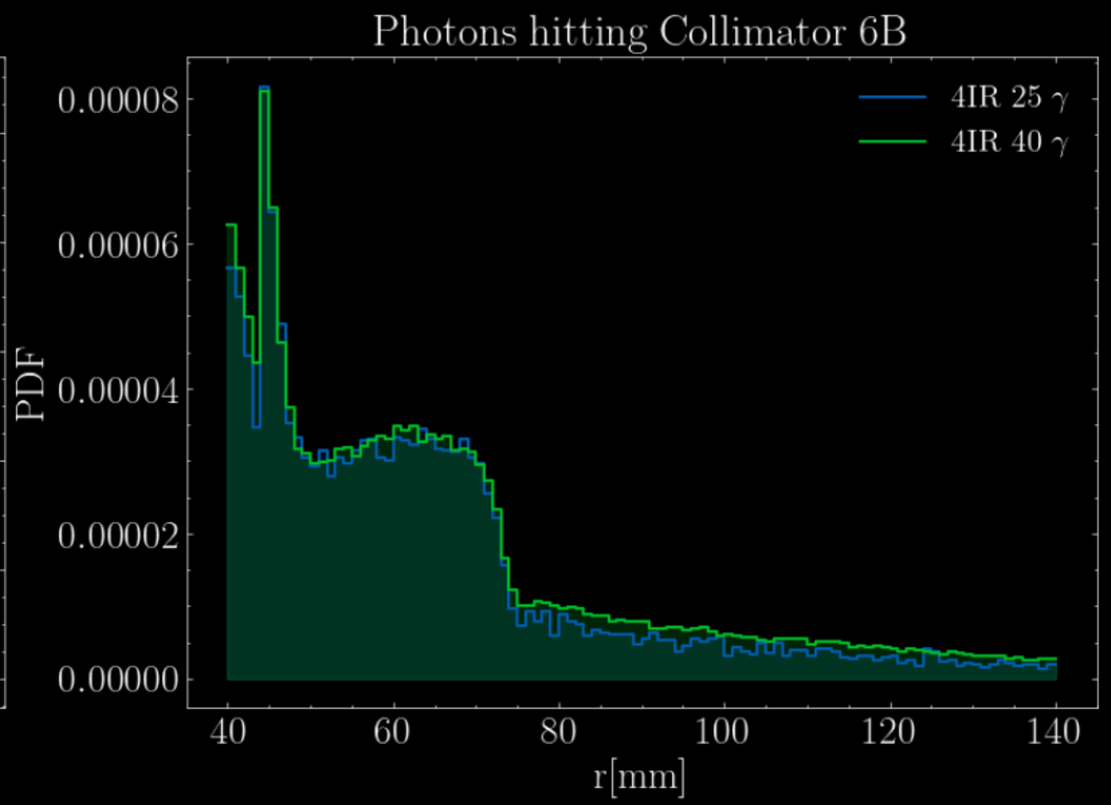



- What gets to Moller Detector(MD) from 6A 6B Region?
- Plot shows those tracks that hit both 6A, 6B virtual plane and go on to hit MD.


Collimator 6B
Collimator 6A

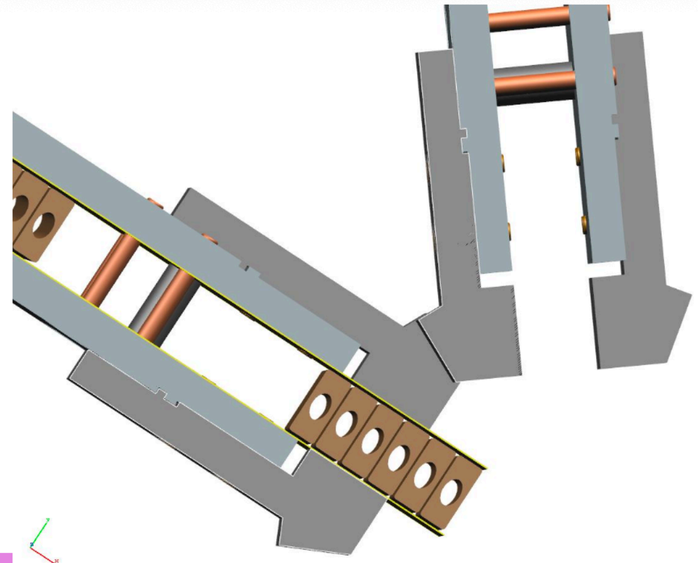


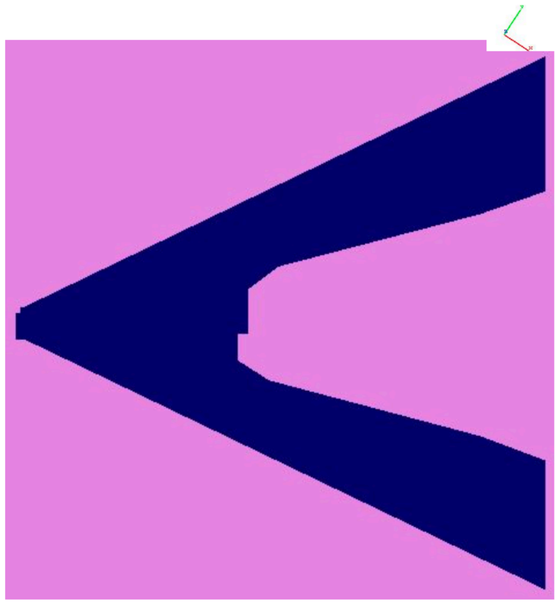



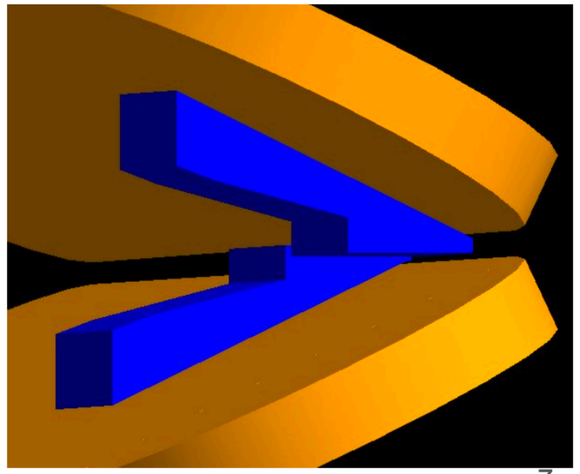

- What hits 6A 6B virtual plane?
- Everything that hit Collimator 6A and 6B.

# Modified Coll5

The old Coll 5 was not near any of the coil-support structures - moved it near the second bulkhead of subcoil 3







7

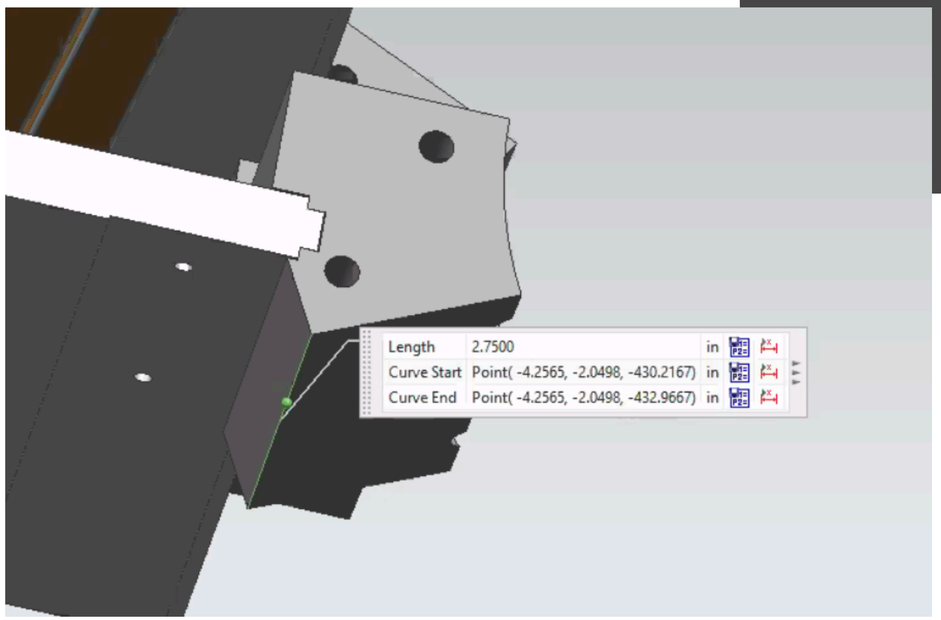
# Collimator 6

US

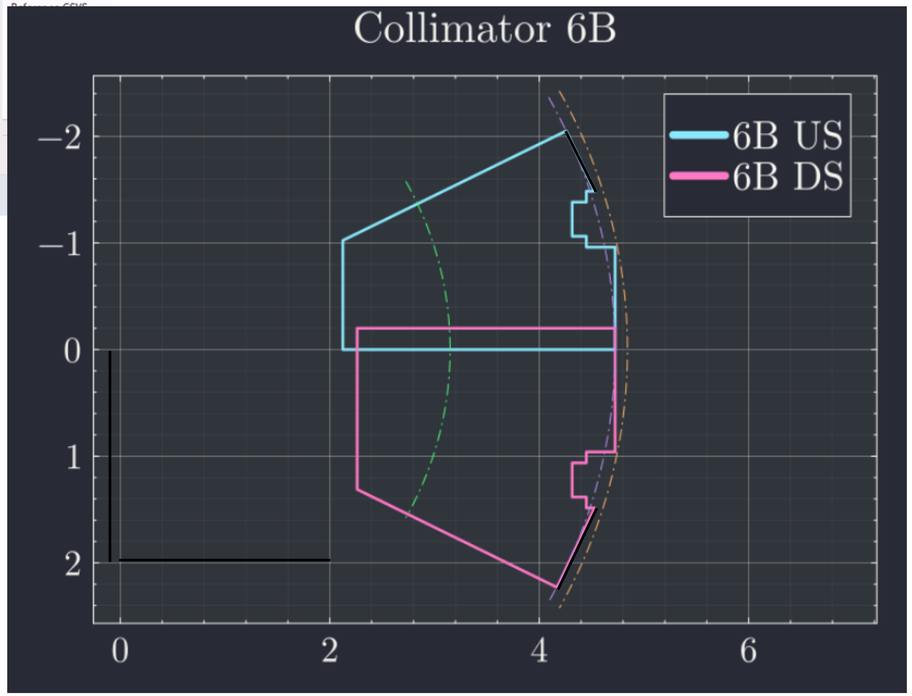
surface about 0.6”long
from r=120mm-121mm



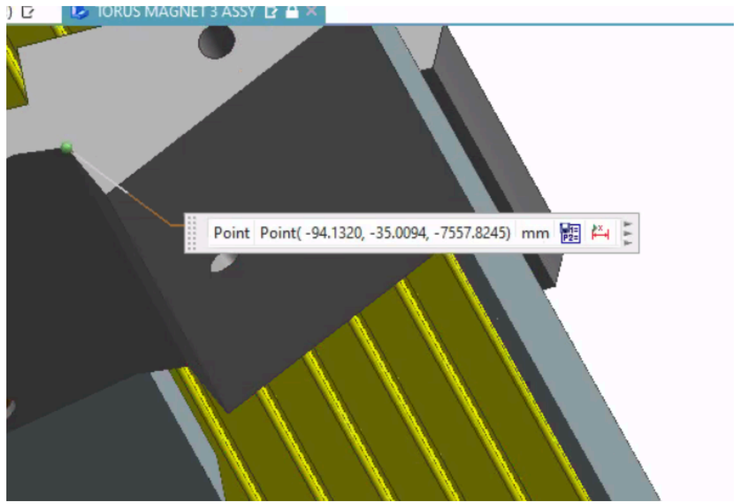


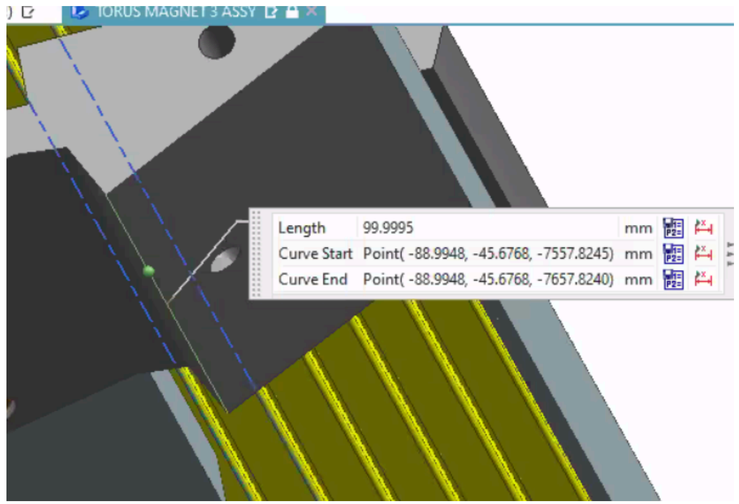



DS
surface about 0.91”long
from r=120mm-121mm



# Collimator 5

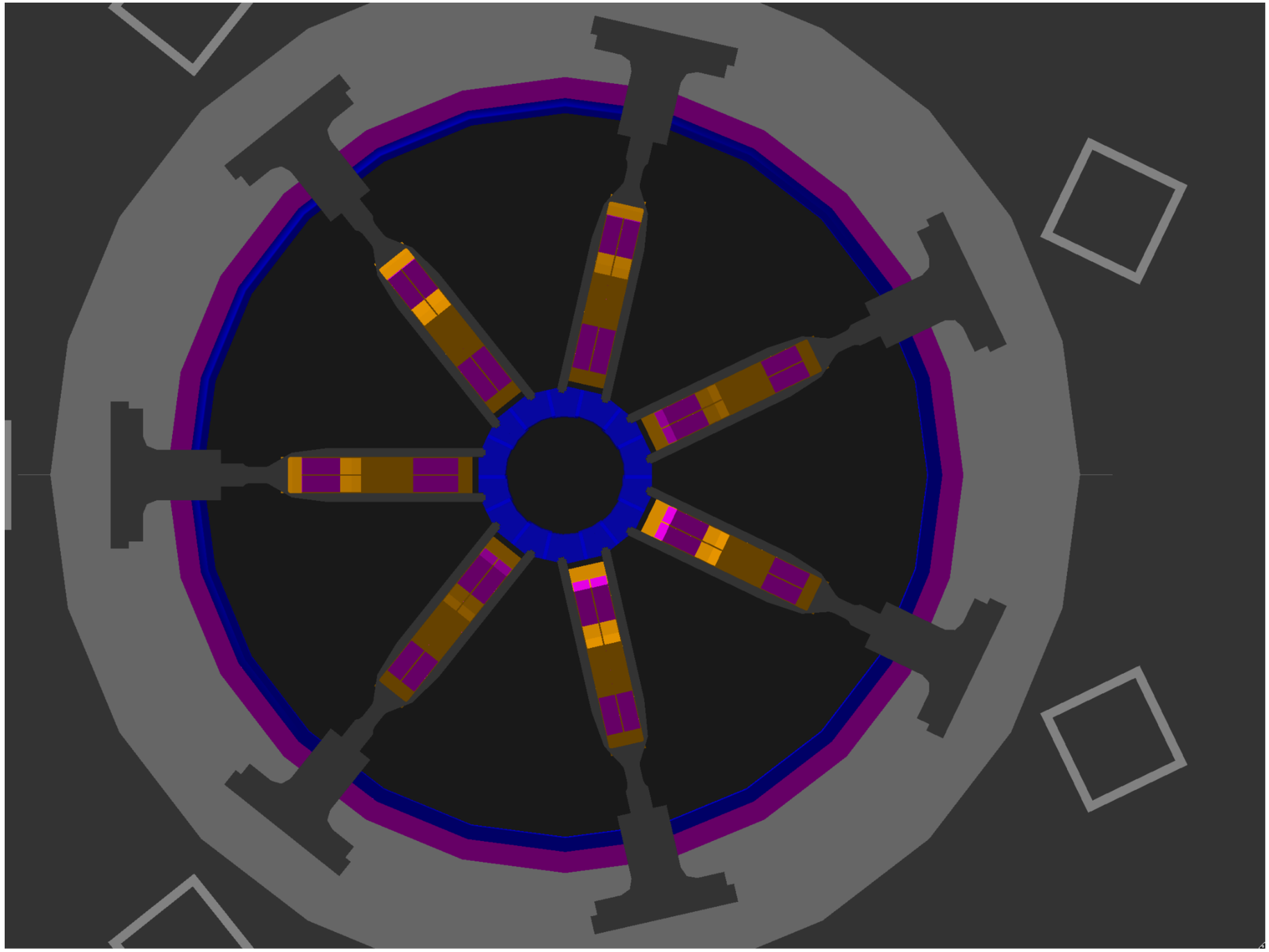


# TM4 Moved by 3mm

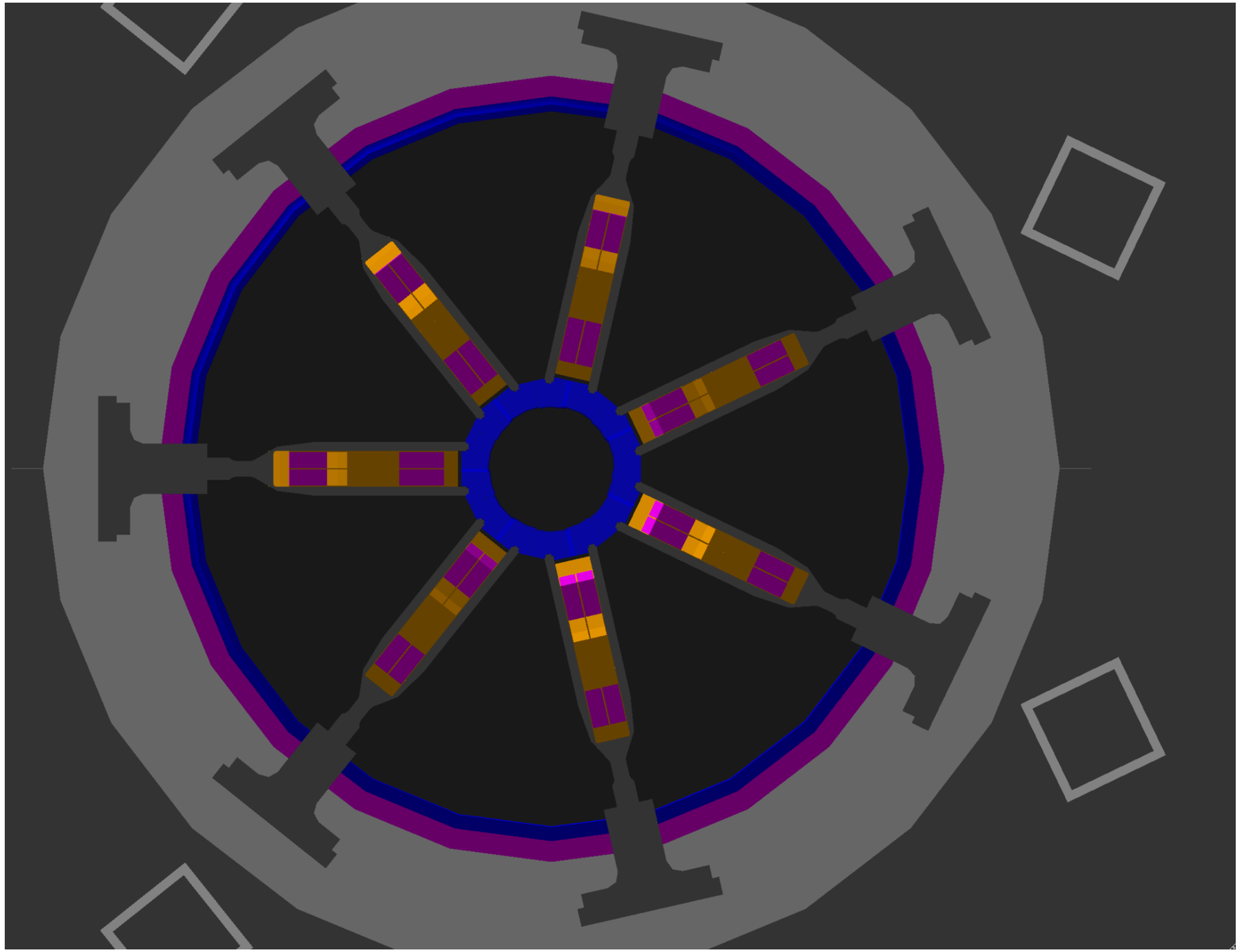
2025-07-08

Prakash Gautam



Looking Downstream at the location of 6B.

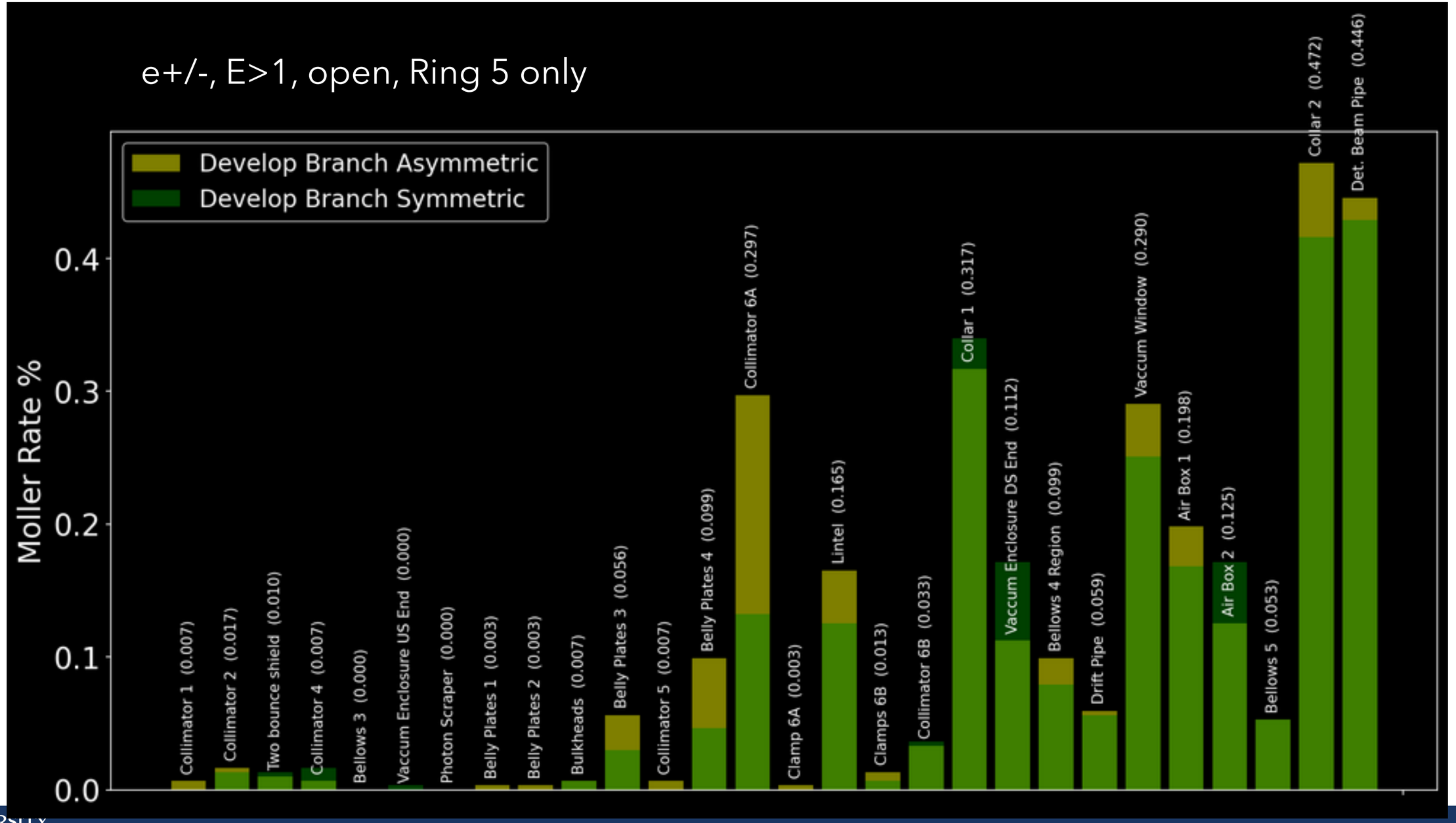
Develop branch



Looking Downstream at the location of 6B.

Magnets out 3mm
Coll 6B out 6mm
Clamps out 6mm

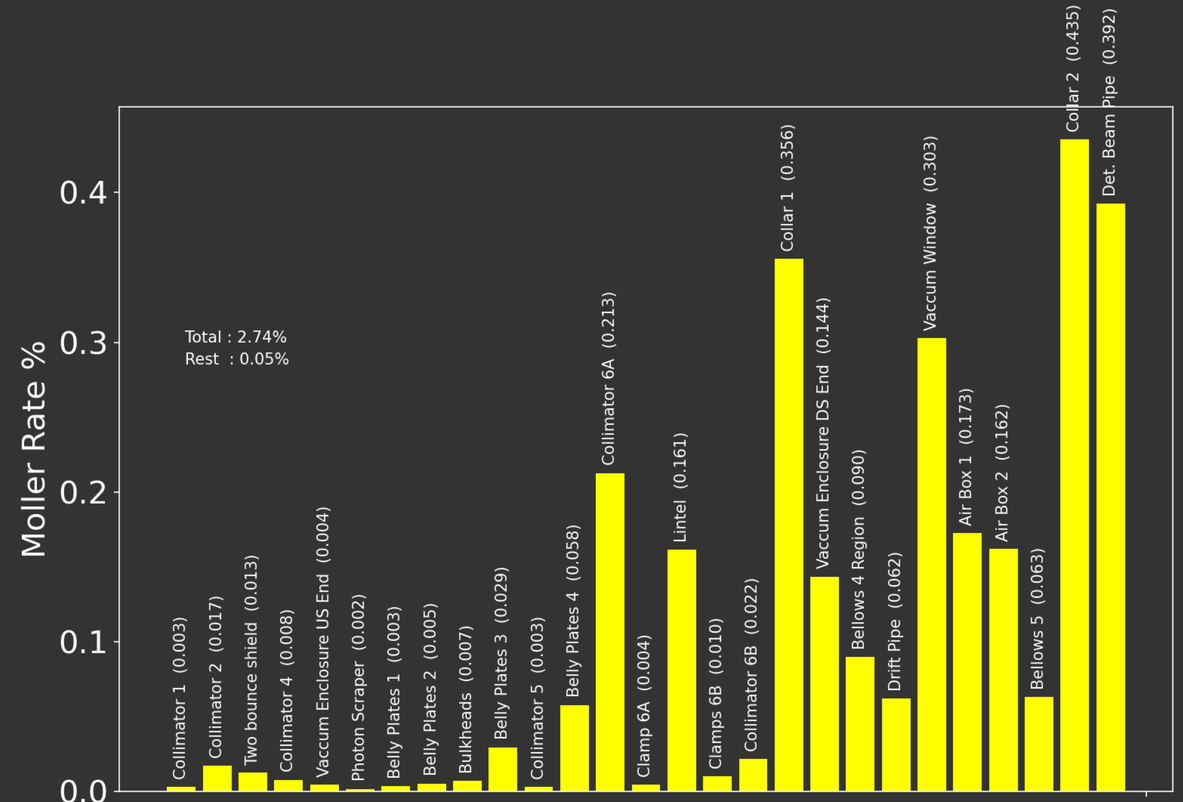
# Reproducing old results



# Consistent with Old results

https://moller-docdb.physics.sunysb.edu/cgi-bin/DocDBTest/private/ShowDocument?docid=1156

## Charged Backgrounds $e^{\pm}$

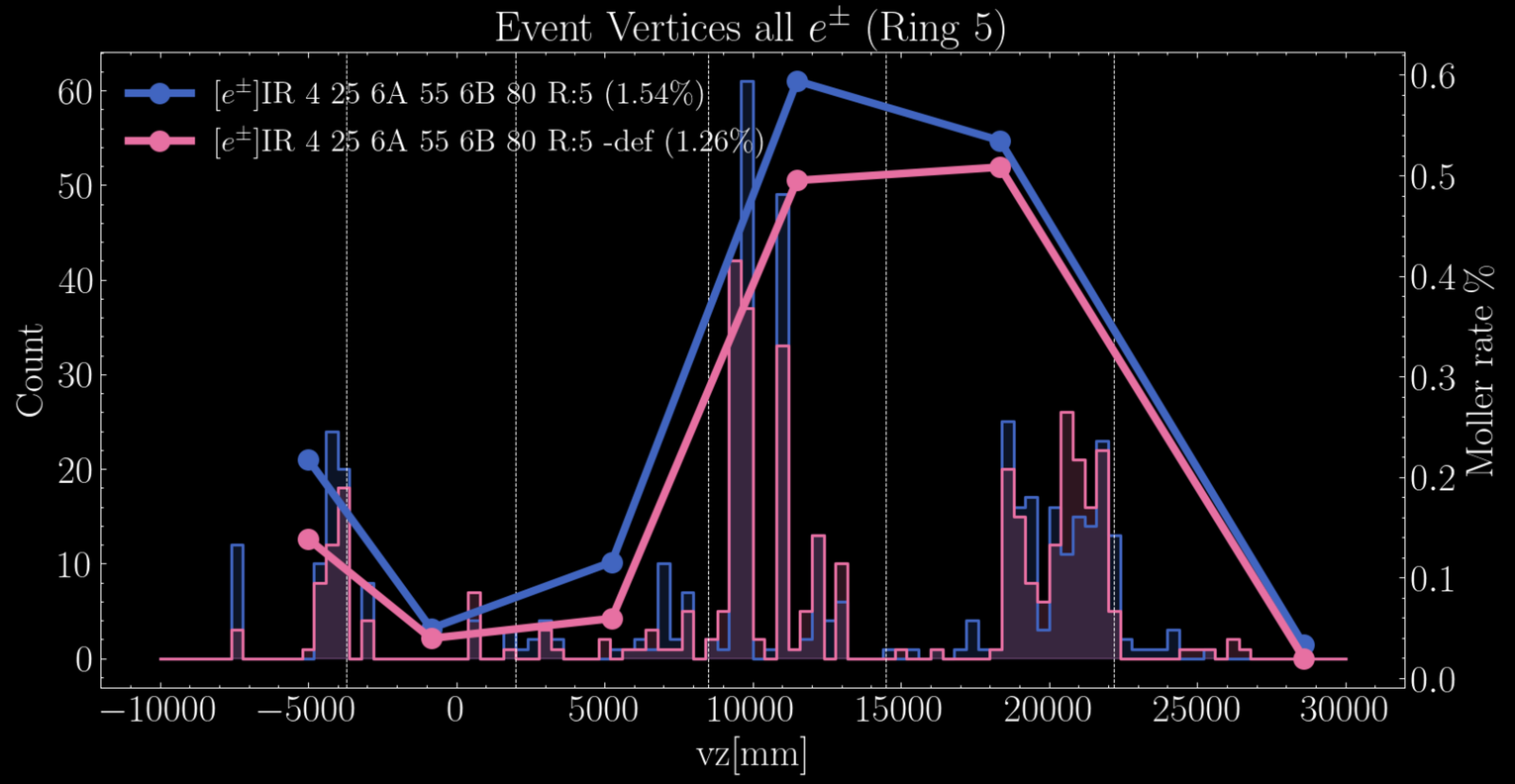



- Approximately in z order.

# Previous results

https://moller-docdb.physics.sunysb.edu/cgi-bin/DocDBTest/private/ShowDocument?docid=1060

## Comparison of field maps for optimal combination




- Blue: "Real asymmetric" field map.
- Pink: Default field map.



Target only 0.1%
(now we see 0.5%)

6a/6b only 0.5%
(now we see 0.8+%)

Ring 5 only