MOLLER MAG Meeting
Spectrometer Update

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Concerns from last MAG meeting

- Engineers
  - Buckling of the vacuum box
  - Cooling and length changes in the coils and supports
- Physicists
  - Electrical failure of multiple coils
  - Possibility of multiple magnets to replace hybrid

Overview of Meeting

- Spectrometer Update (this talk)
  - segmented hybrid study
  - future work
  - deposited power in coils
- Vacuum vessel (Jim)
- New conductor layout (Ernie)
- Collimators and future work (Jason)

Challenges w/ segmented magnet

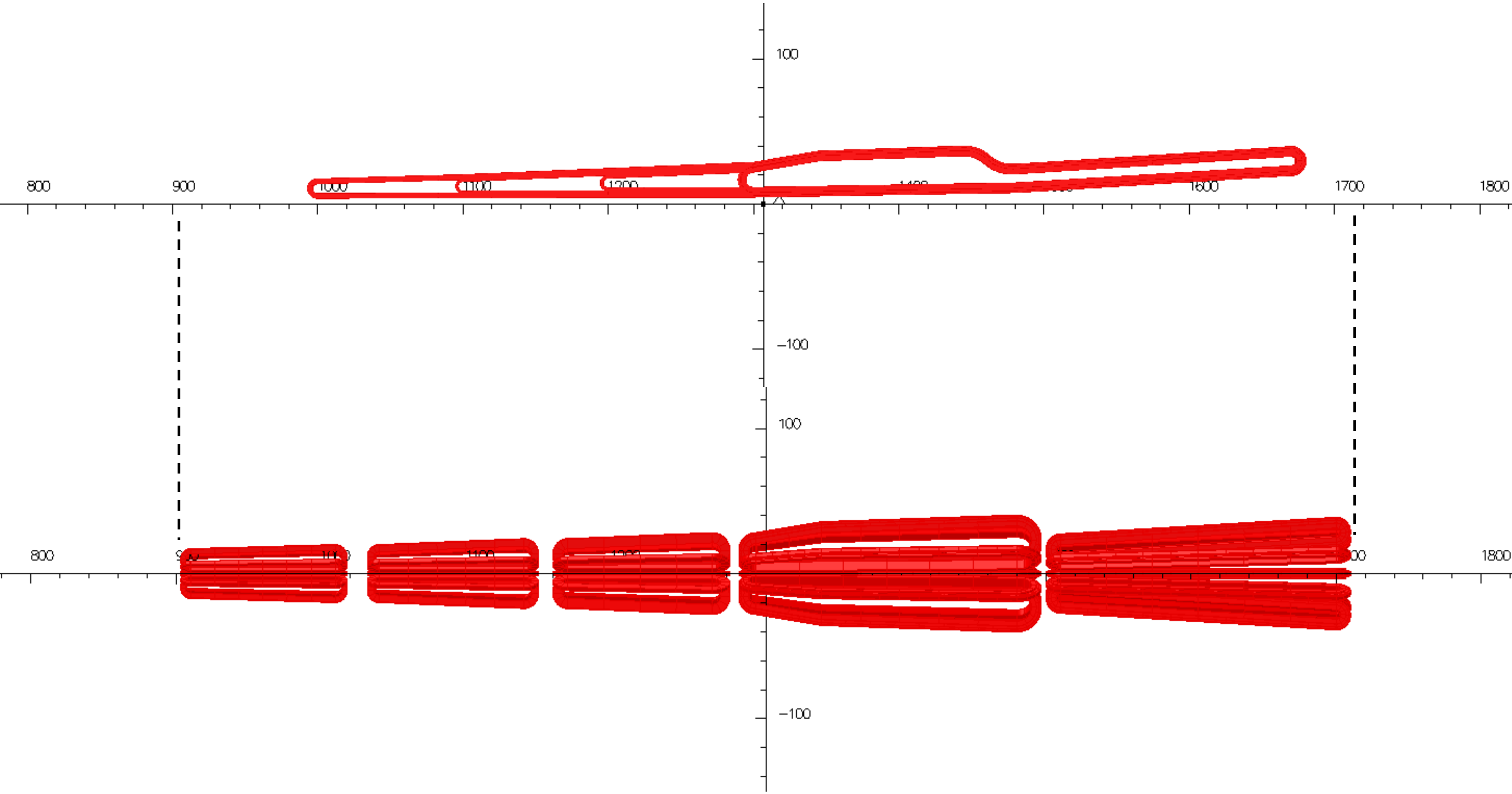
Drawbacks:

- There isn't that much space along z – not sure if it is even possible
  - Already have to move target upstream
  - Need space between the following (lever arm and room for supports)
    - target and upstream magnet
    - upstream and hybrid
    - magnets and detectors
- Multiple power supplies means complications due to power fluctuations
- Position accuracy – make each coil a stiff construct with supports

Benefits:

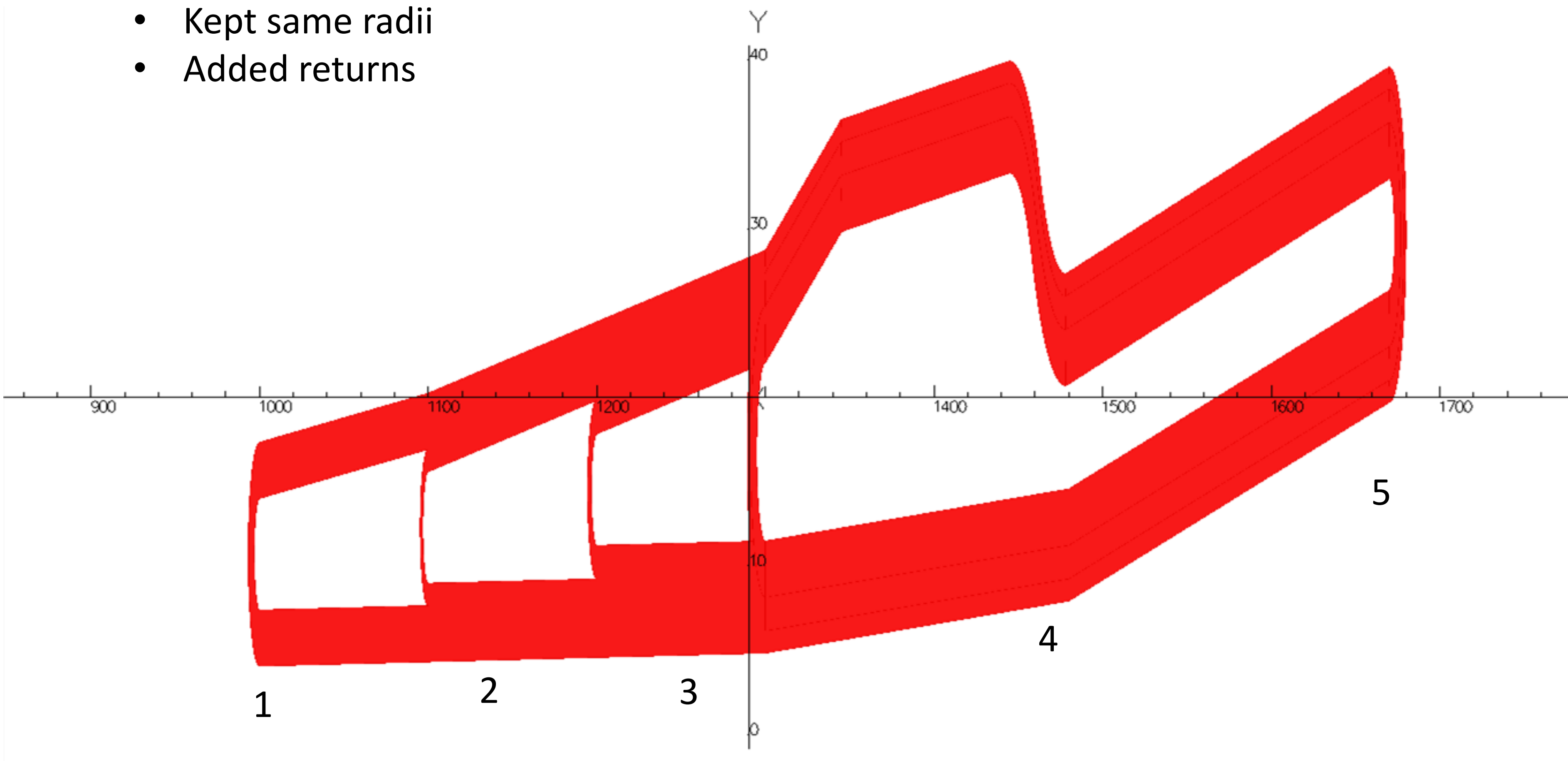
- Eliminate negative bends
- Eliminate out-of-plane bends
- Easier to make
- Easier to cool
- Easier to power

Comparison to hybrid



Segment 4 same location

- Pulled magnet apart
- Kept same radii
- Added returns



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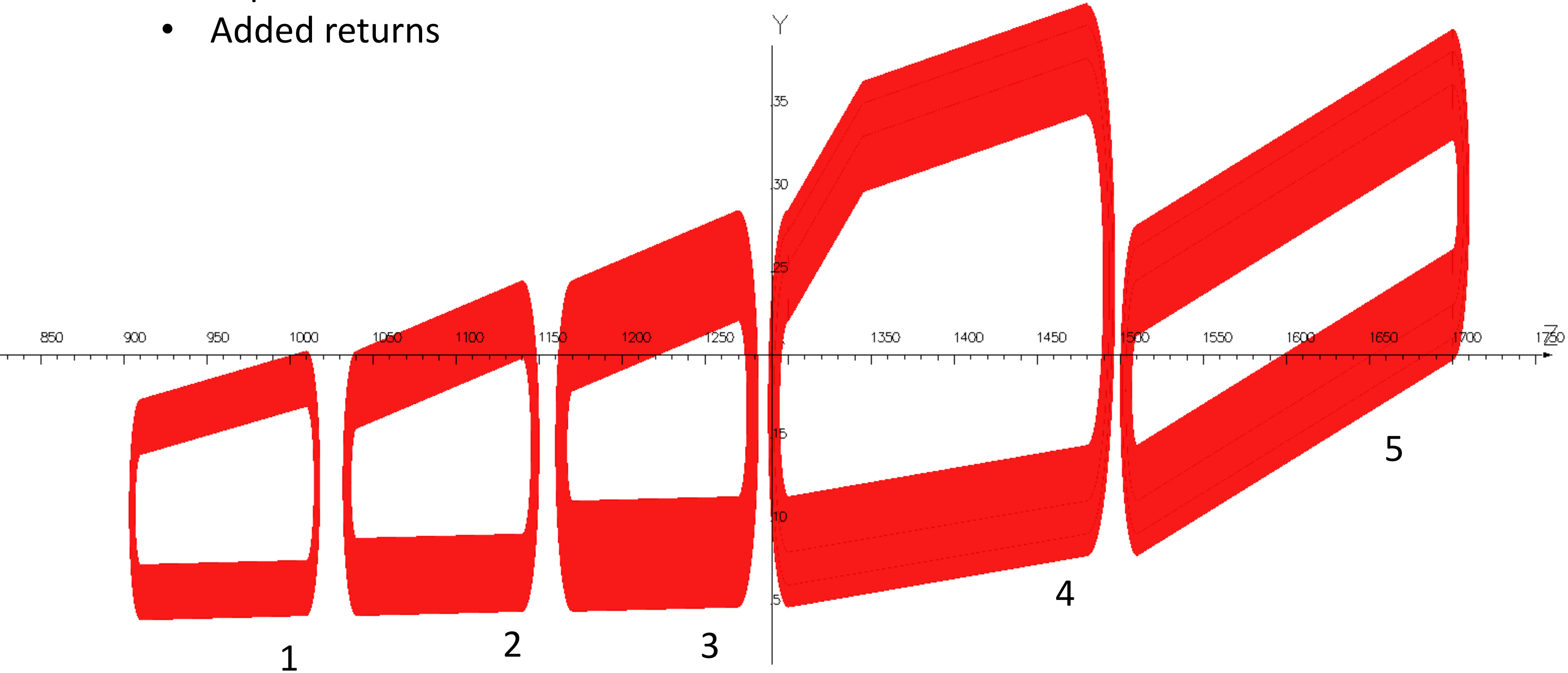
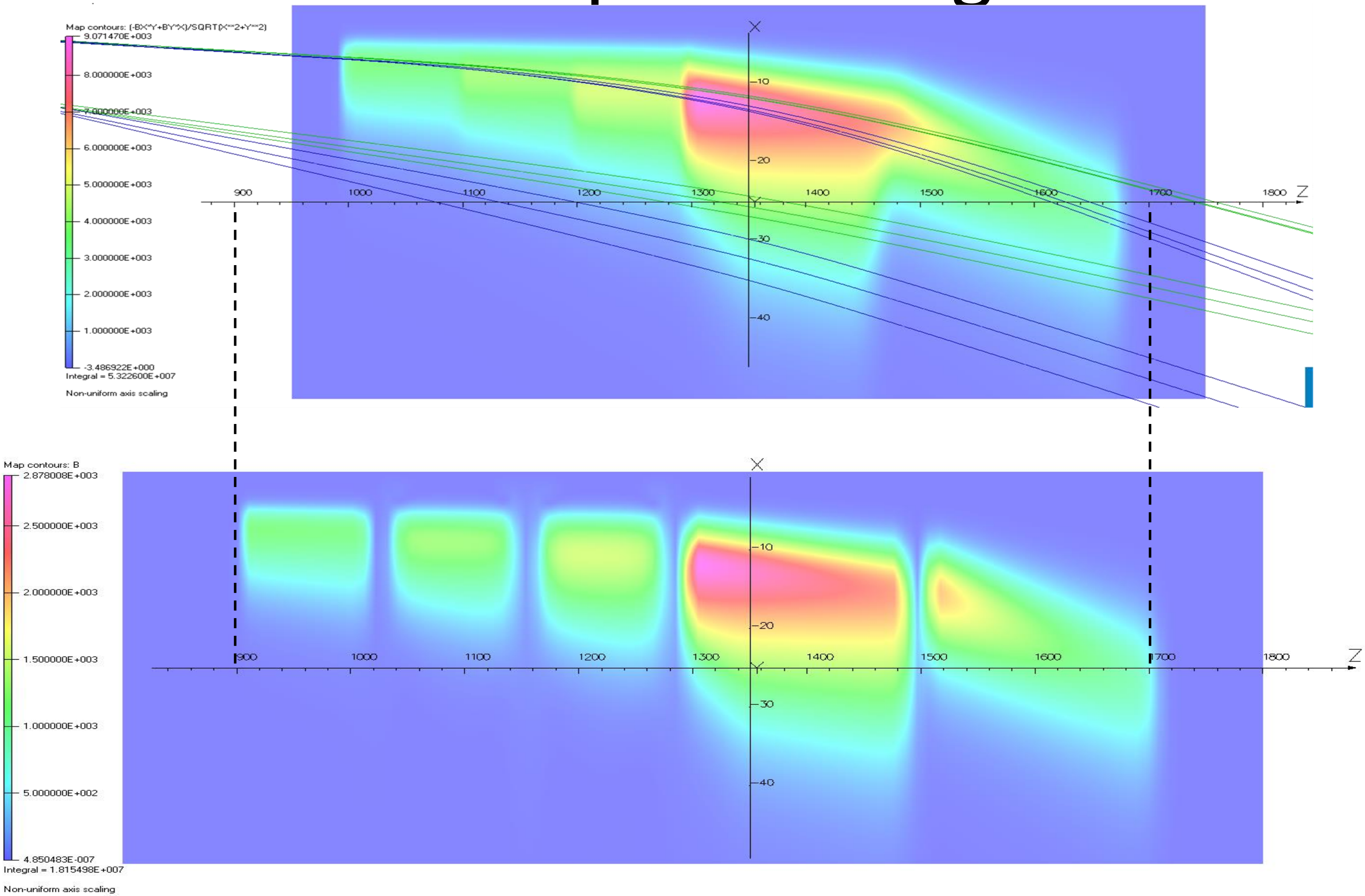
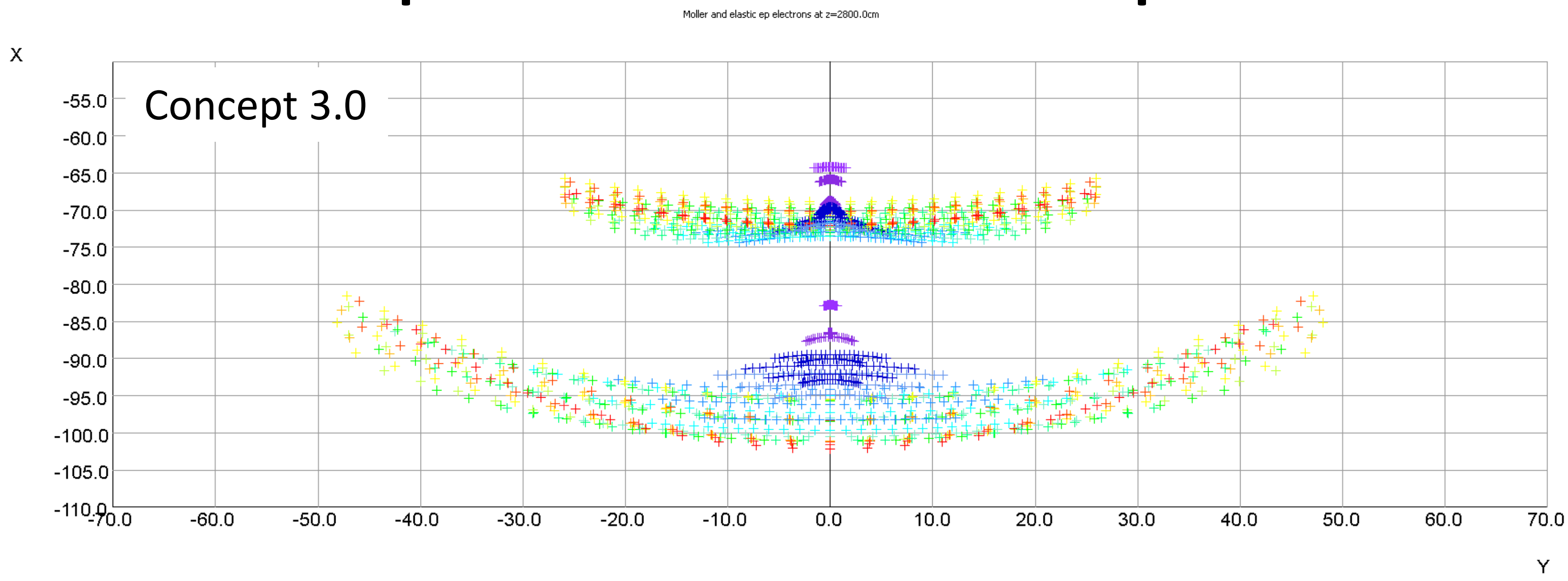
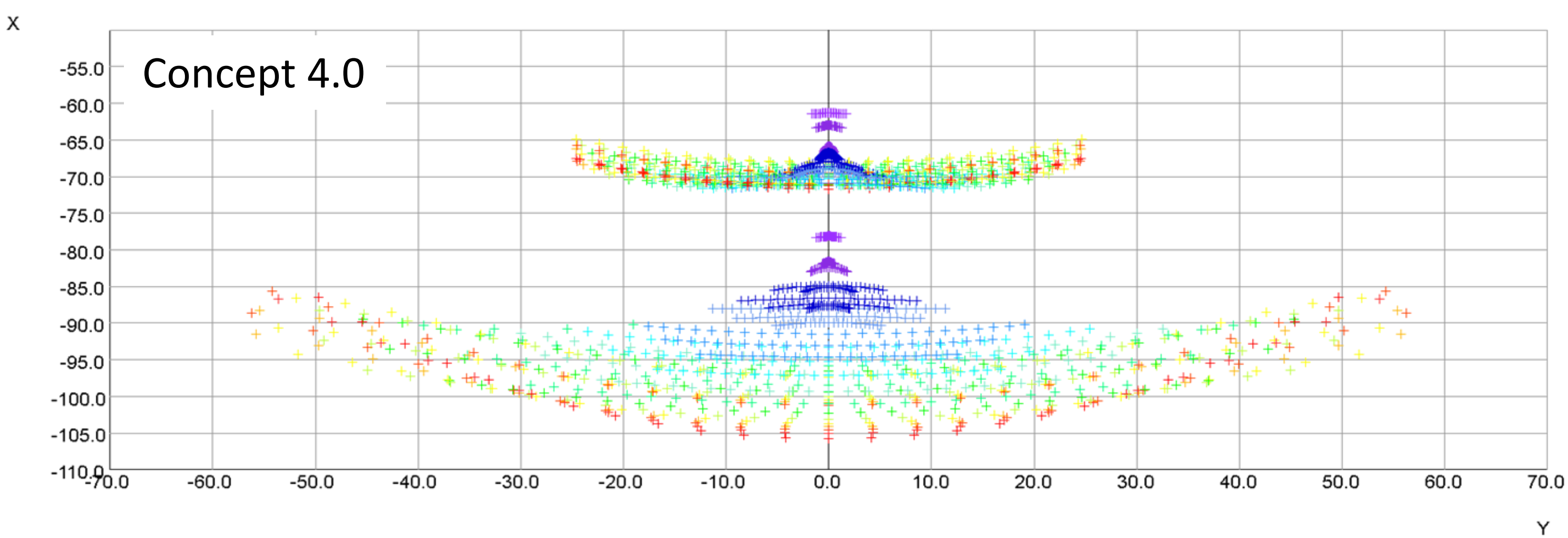


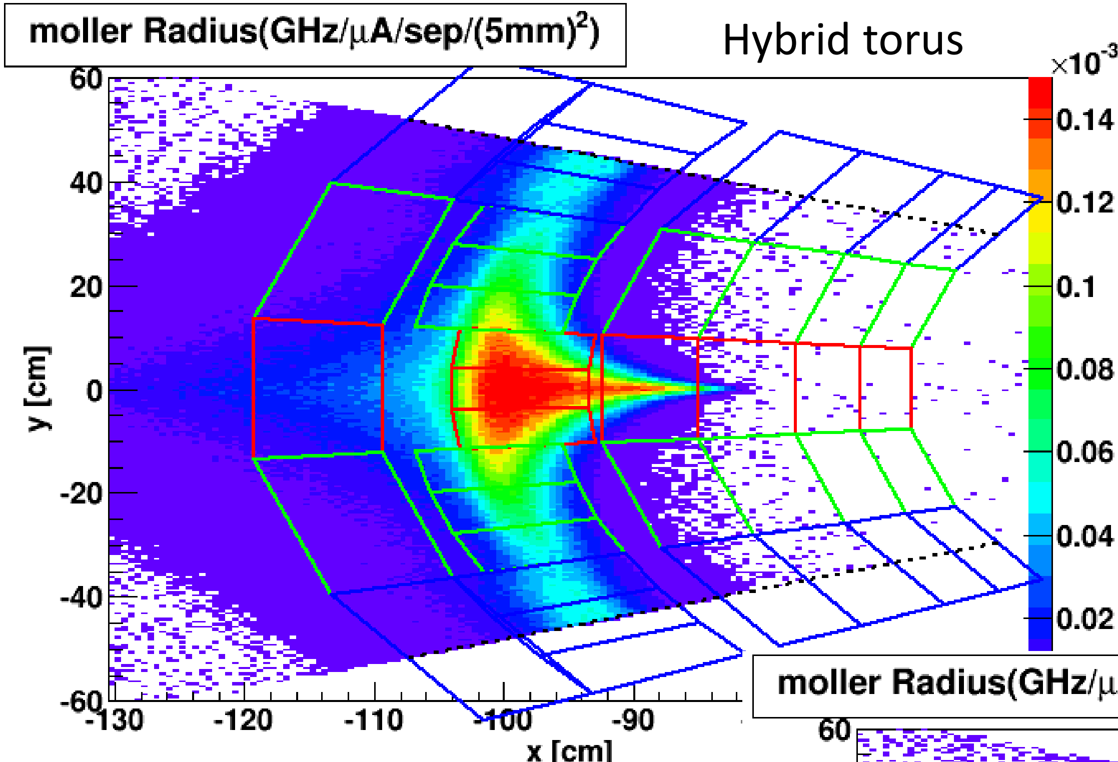
Field of separate magnets



Comparison of TOSCA profiles

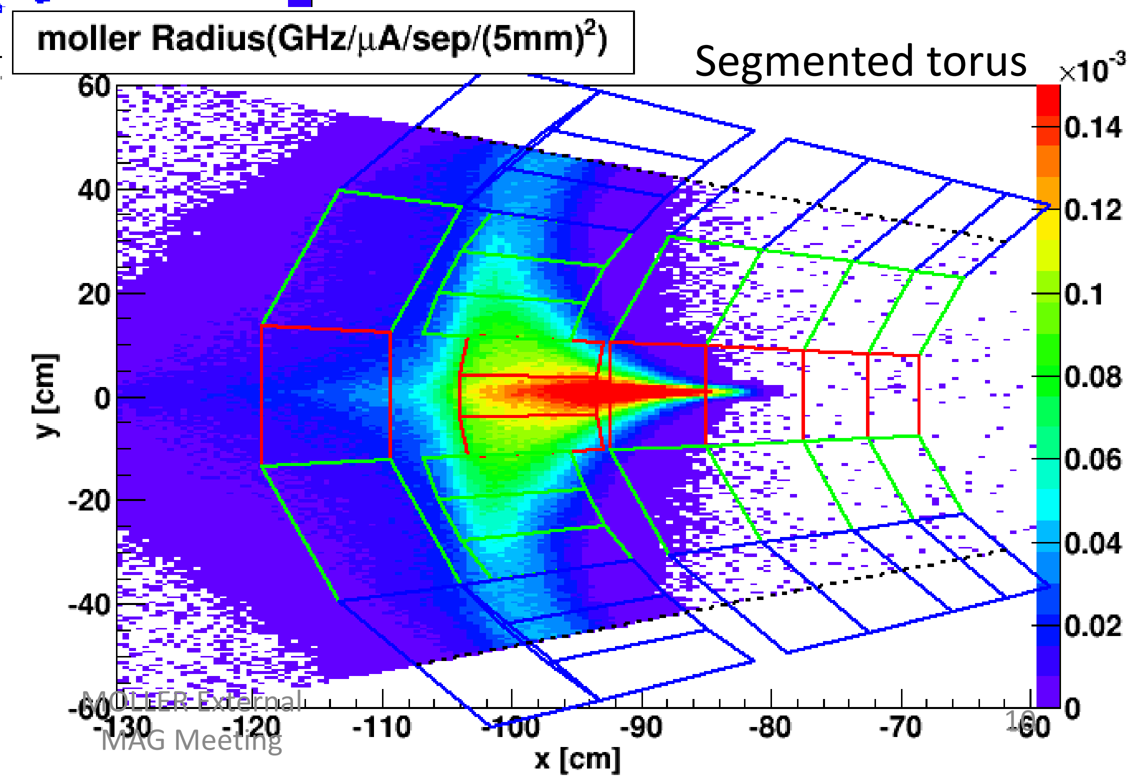






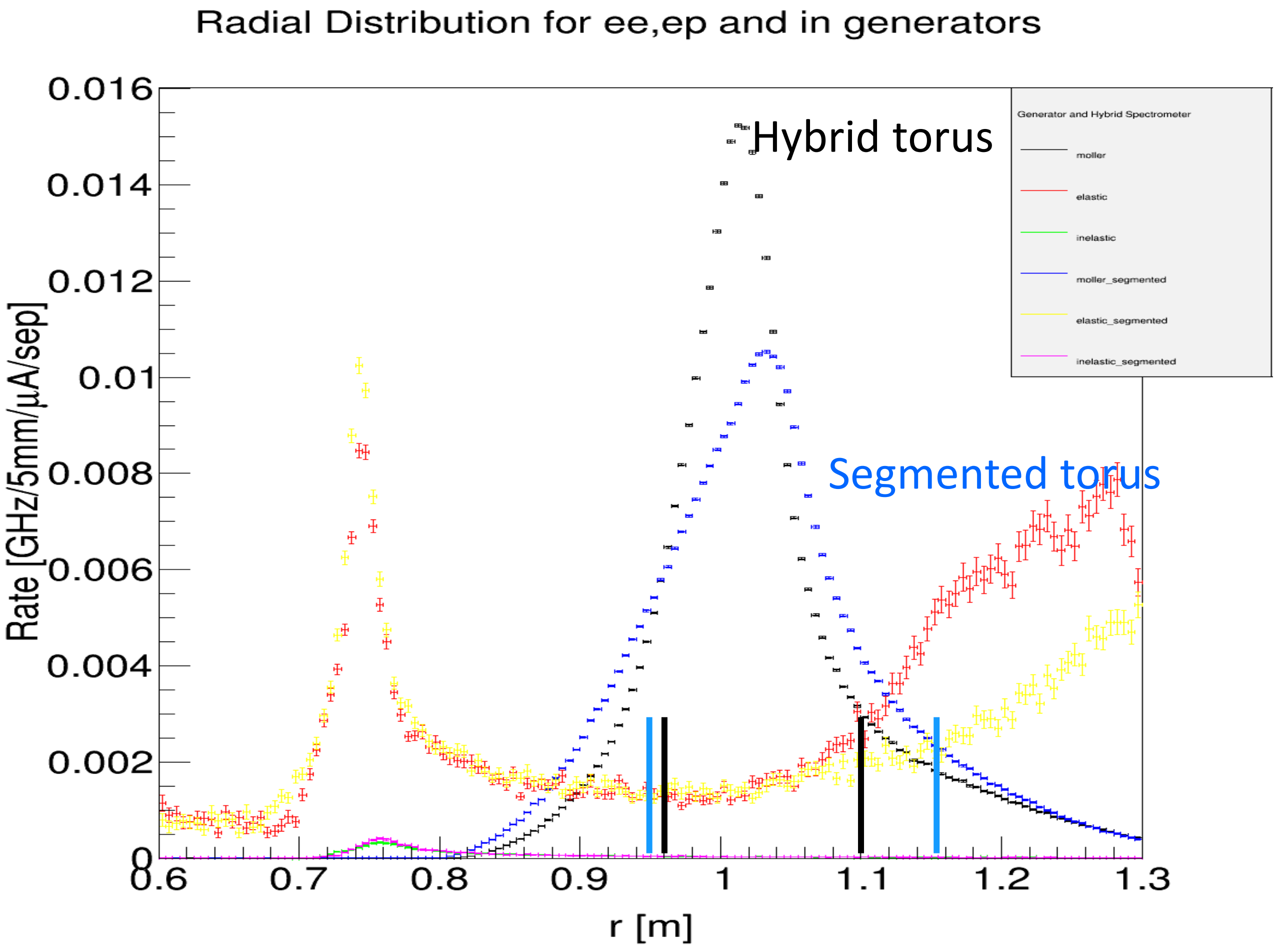
The GEANT4 profiles show similar behavior, but have the radiative effects from the target

We can also quantify the increase in backgrounds



The moller peak is also more concentrated onto a single quartz piece; this could cause issues in the design of the electronics for the detectors

Comparison of radial distributions

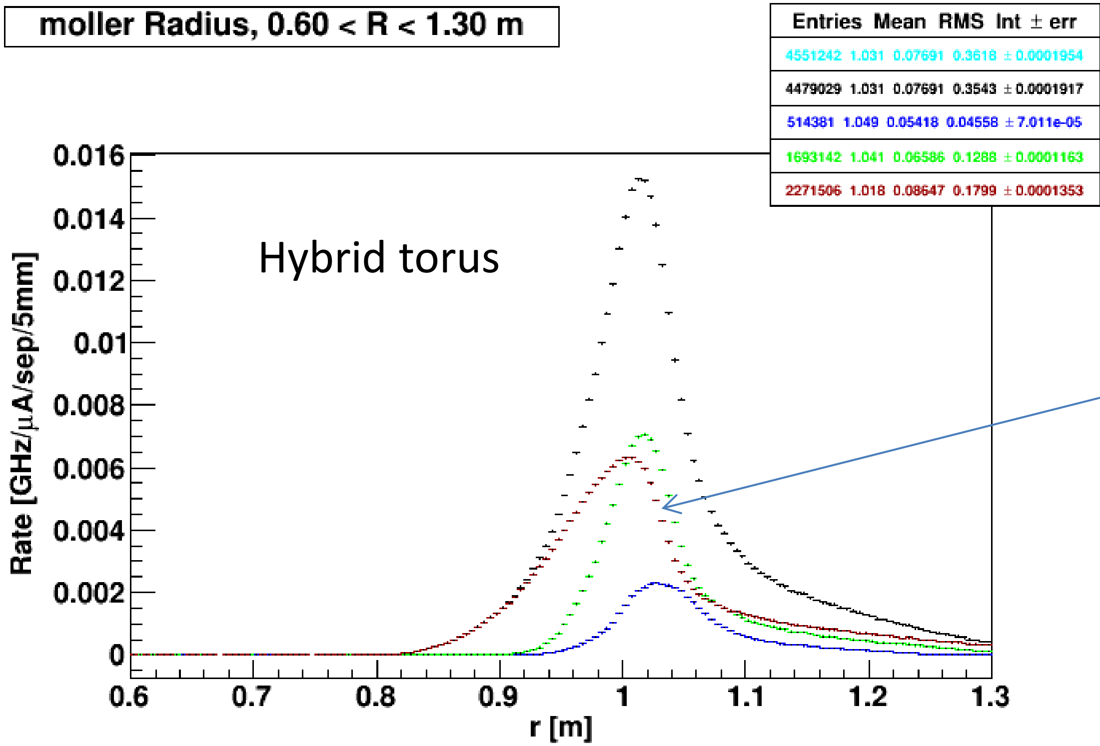


The elastic and inelastic rate distributions are approximately flat in the moller region

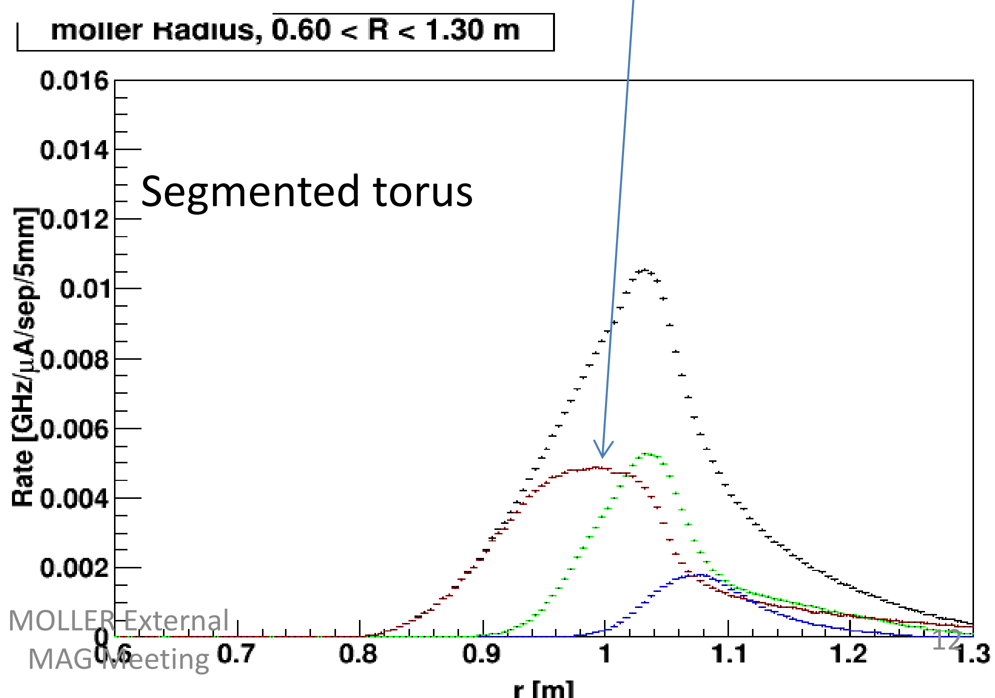
In order to preserve the statistical precision, we would have to increase the radial width of the moller detectors

An increase in the moller peak width therefore translates into an increase in the background dilutions

Lines indicate the approximate radial widths for the moller ring for the segmented (blue) compared to the hybrid (black) torus



The central segment is at a radically different radial ring with the segmented torus. It is also considerably wider.



“Tuning” would be trying to push the lower radius of that central segment out to a larger radius. Not sure if it is possible.

Comparison of Rates

- Sectors have different radial ranges, as indicated in the tables
- Top table is the nominal background percentages
- Bottom table is for the detectors adjusted percentages with the segmented torus
- Moller rate in both cases ~144 GHz
- Inelastic percentage is a bit higher, but the elastic goes from about 12% to about 15%

Sector	Moller %	Elastic %	Inelastic %
Open: 0.935-1.04 m	84.88	14.83	0.30
Transition: 0.96-1.075 m	90.46	9.33	0.22
Closed: 0.96-1.10 m	89.90	9.94	0.16
All Sectors	87.84	11.91	0.25

Sector	Moller %	Elastic %	Inelastic %
Open: 0.92-1.04 m	82.79	16.85	0.36
Transition: 0.94-1.1 m	86.81	12.94	0.25
Closed: 1-1.2 m	82.09	17.73	0.18
All sectors	84.25	15.45	0.29

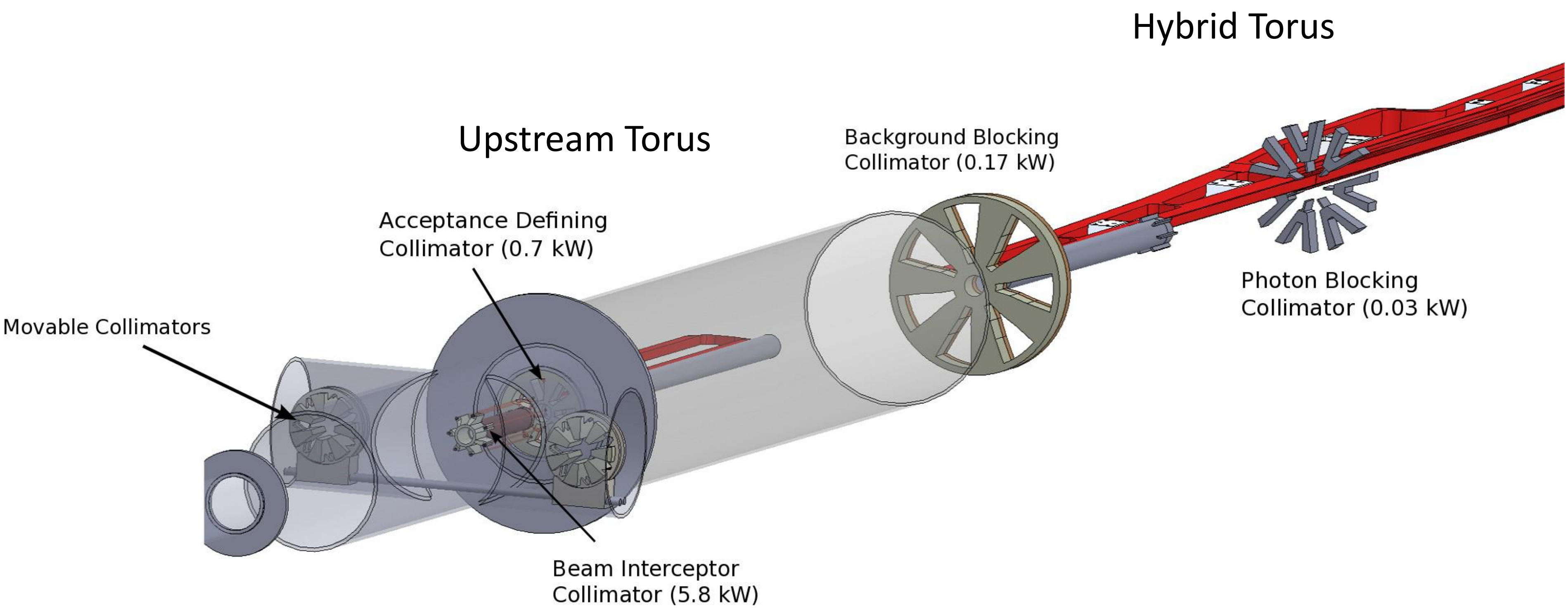
This is a 20% increase in both the elastic and inelastic dilutions, which results in an unacceptable increase in the uncertainties on the background asymmetries

Radiation shielding concept

Goal of the shielding is to reduce the EM and neutron radiation into the hall A and reduce background at the detector region

- Single collimator to intercept low angle scattered beam
  - isolate neutron production
  - shielding the coils
- Target shielding required a lead wall
  - stop EM power from the target
  - Reduce backgrounds in the detector region
- Concrete and Tungsten for high energy neutrons
- Polyethylene for low energy neutrons (< 10 MeV)

Collimators



Power deposited in coils

- Upstream (US) magnet power split equally between coils
- Hybrid has "US" and "DS" part
  - Most of the power is deposited on US part of the hybrid
  - Negligible power deposited on the DS part
- Power comes mostly from positrons

US Magnet

Type	E Rnge (MeV)	Total Power (W/uA)	Total Flux (per uA)
electrons	E<10	0.007	1.89E+10
	0<E<100	0.036	6.69E+09
	100<E	0.057	1.50E+09
Positrons	E<10	**0.009**	1.37E+10
	0<E<100	**0.083**	1.35E+10
	100<E	**1.140**	2.11E+10
Photons	E<10	0.110	3.12E+11
	0<E<100	0.297	6.44E+10
	100<E	0.276	7.69E+09
Neutrons	E<10	0.003	1.08E+10
	0<E<100	0.001	1.94E+08
	100<E	0.003	4.37E+07
Total	E<10	0.116	3.22E+11
	0<E<100	0.373	7.56E+10
	100<E	1.534	3.07E+10

DS Magnet

Type	E Rnge (MeV)	Total Power (W/uA)	Total Flux (per uA)
electrons	E<10	0.002	3.78E+09
	0<E<100	0.014	2.62E+09
	100<E	0.051	1.01E+09
Positrons	E<10	**0.004**	4.84E+09
	0<E<100	**0.039**	6.57E+09
	100<E	**0.240**	4.35E+09
Photons	E<10	0.032	7.25E+10
	0<E<100	0.141	2.75E+10
	100<E	0.184	5.26E+09
Neutrons	E<10	0.000	1.32E+09
	0<E<100	0.000	5.62E+07
	100<E	0.000	6.24E+06
Total	E<10	0.034	7.34E+10
	0<E<100	0.173	3.22E+10
	100<E	0.501	1.03E+10

Future Work

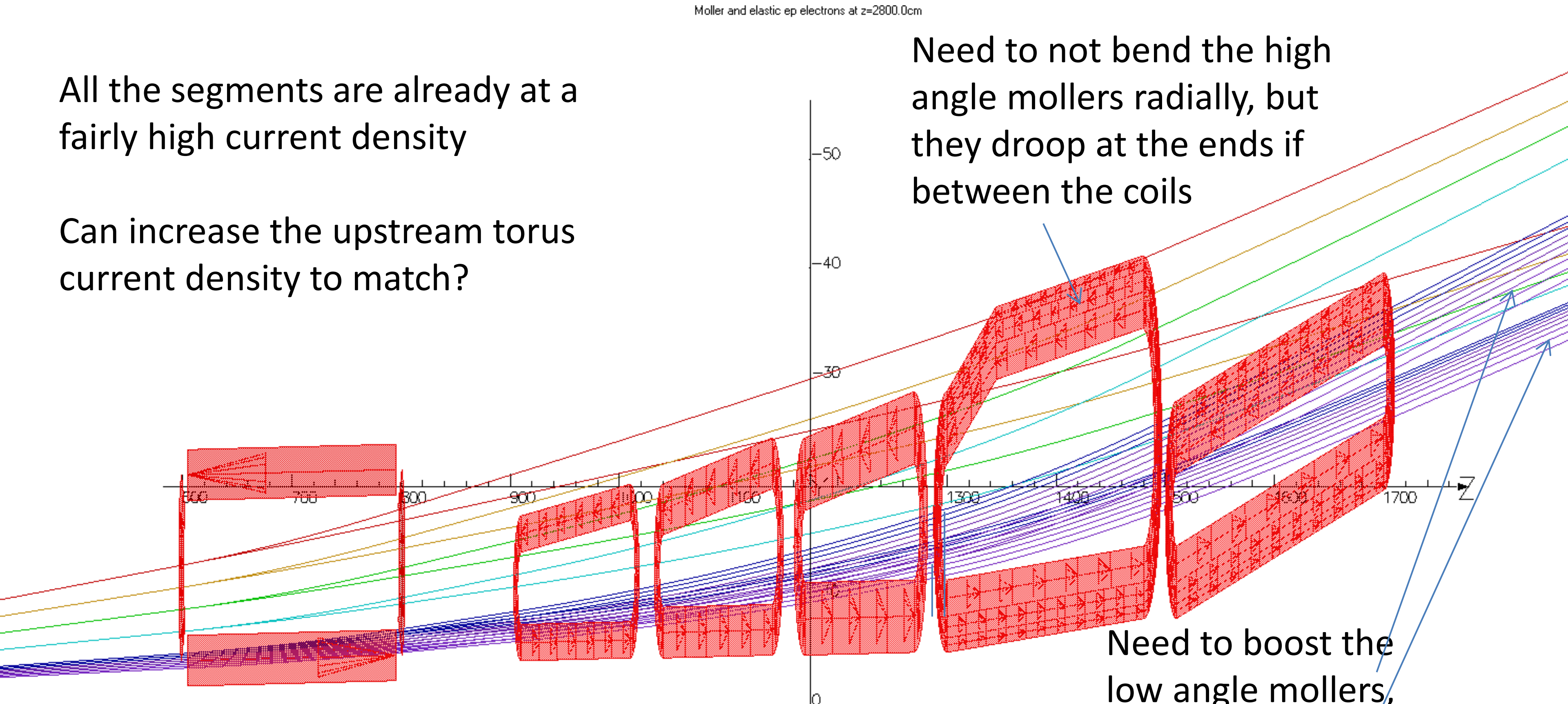
- Segmented coils
  - Keep the hybrid torus as a baseline version
  - Test the prototype
  - Pursue tuning of the segmented torus as a medium priority, as backup
- Electrical failure of multiple coils
  - "turn off" one coil in TOSCA
  - do a force study

Extra slides

Tuning is difficult

All the segments are already at a fairly high current density

Can increase the upstream torus current density to match?



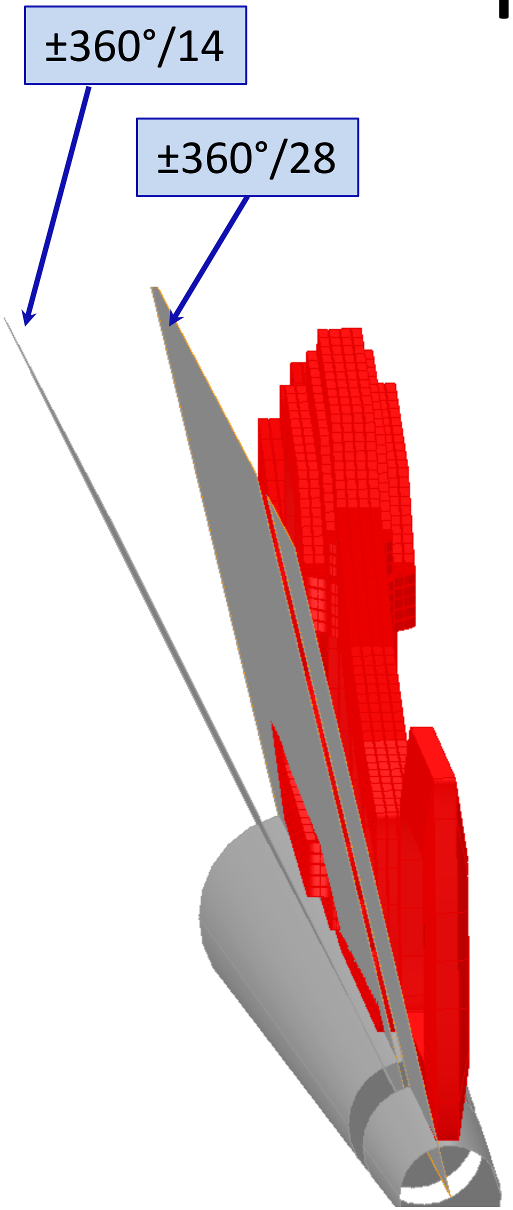
Need to not bend the high angle mollers radially, but they droop at the ends if between the coils

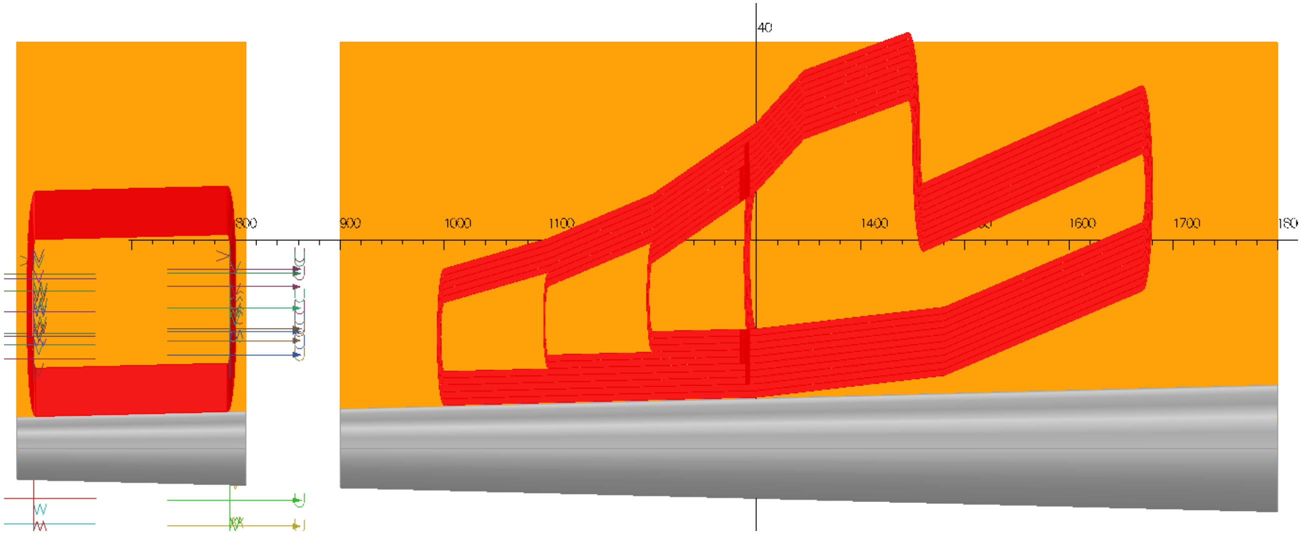
Need to boost the low angle mollers, but not the eps

Have a 5σ multiple scattering angle limit at low radius

Conductor already fills available azimuthal space (still have to guard against interferences)

Keep Out Zones/Concept 2





Tuning violating keep-outs