IR BEAM PIPE: MATERIAL BUDGET AND LUMICAL HITS

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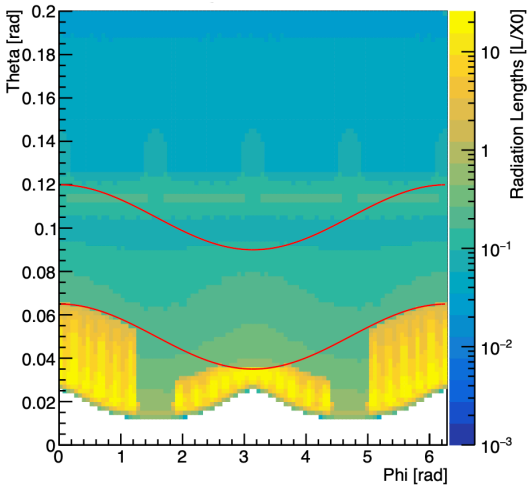
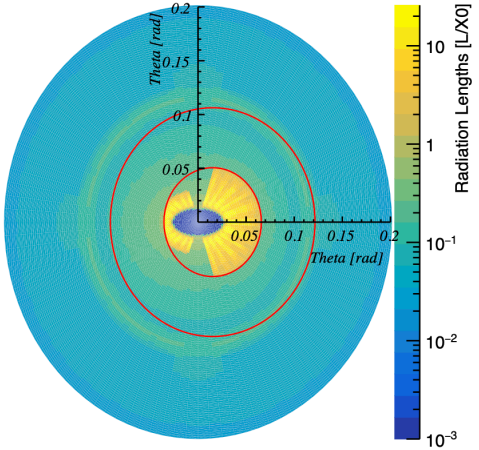
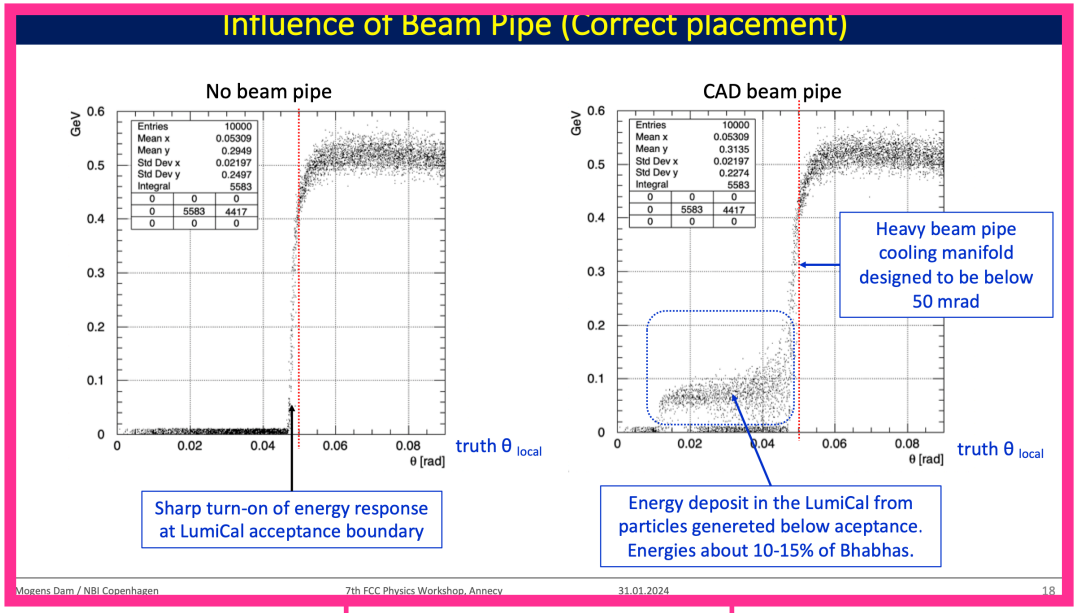
Previous studies

In the previous engineered design of IR beam pipe, two asymmetric **copper cooling manifolds** were foreseen. Their size was **tapered** to fit the LumiCal **angular acceptance**.

However, first **tracking studies** showed an **energy deposit** coming from the beam pipe, probably caused by **secondary showers** off the high-X0 copper just below the LumiCal acceptance.



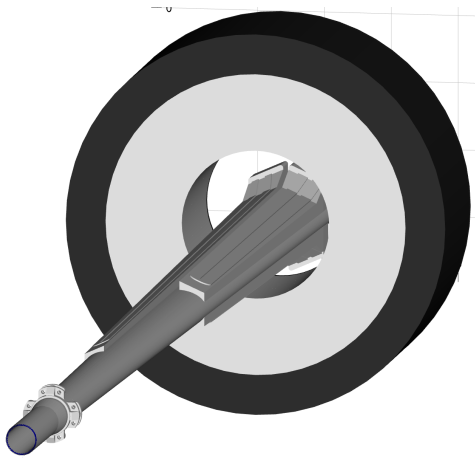




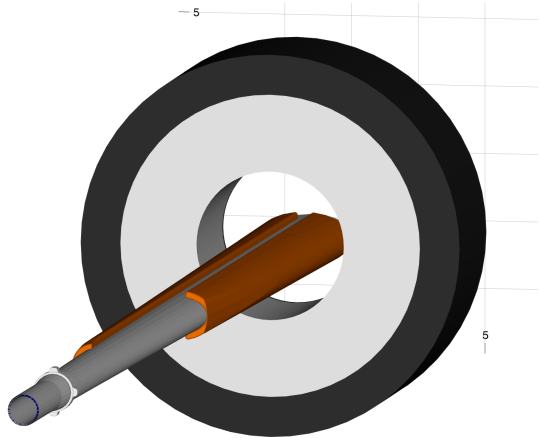
M. Dam - FCCPW2024

New beam pipe and cooling

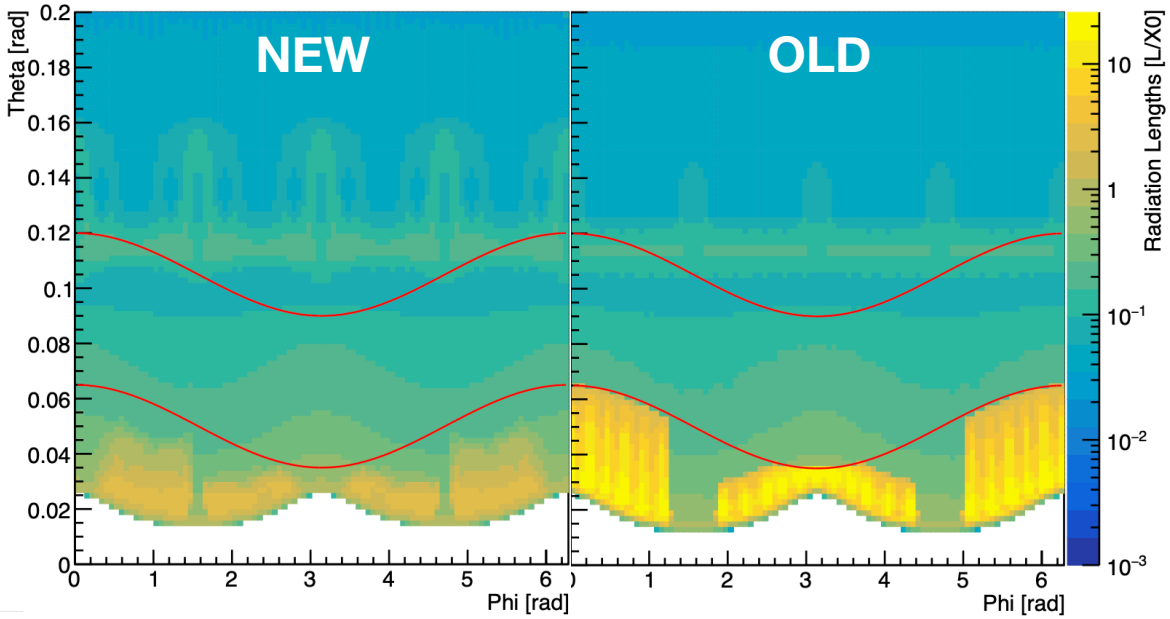
After this feedback, a new solution for the trapezoidal chamber cooling was found. Cooling manifolds are now **all in AlBeMet162** and are placed at **safety margin from the LumiCal acceptance**.

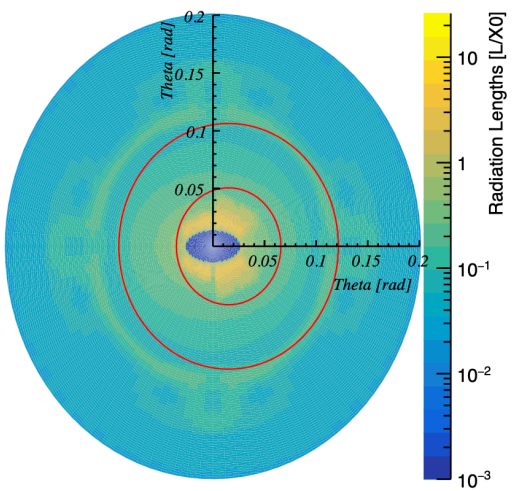


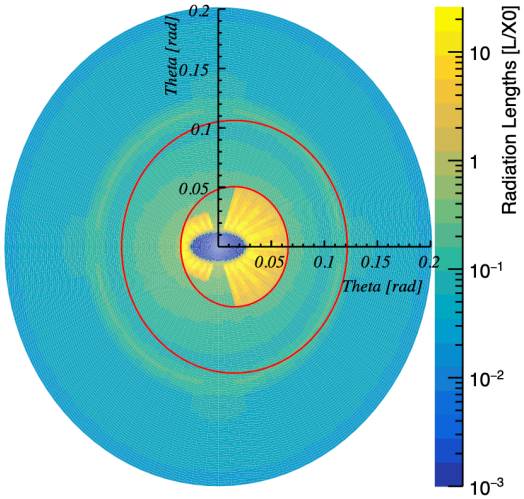
New

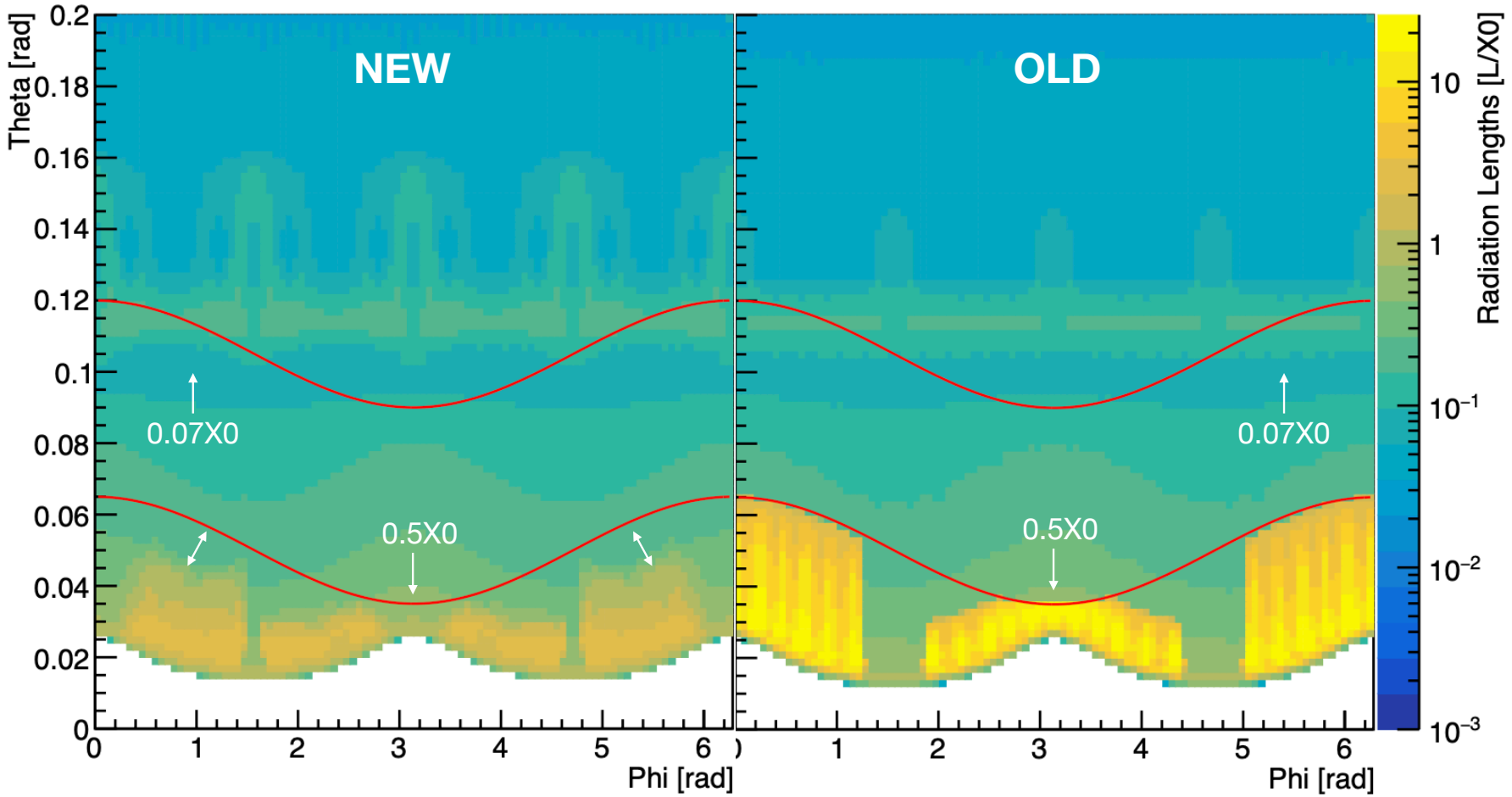


Old







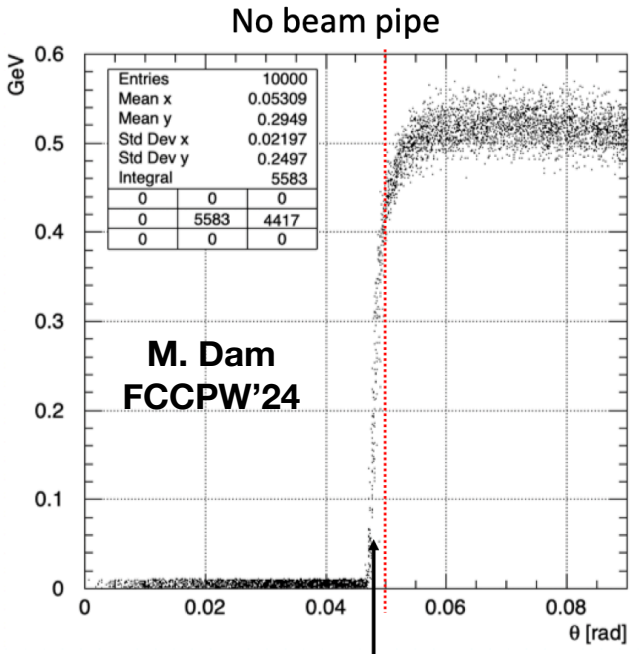


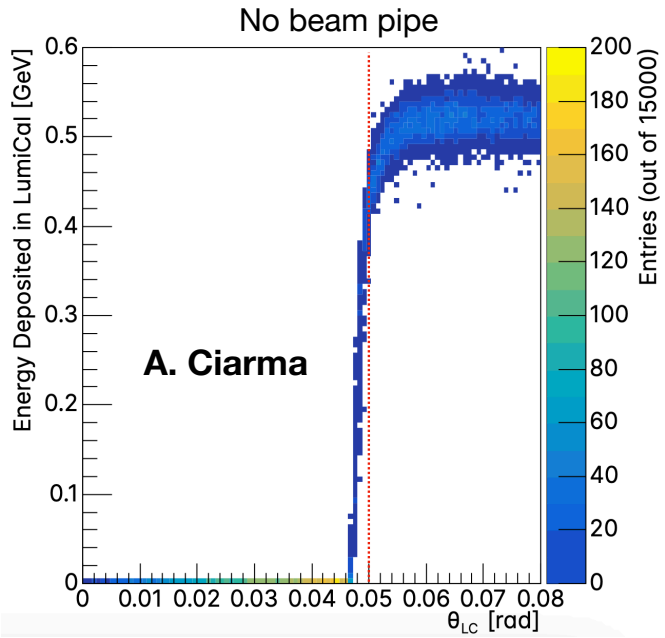
- Same trapezoidal chamber: max = 0.5X0 , min = 0.07X0 within LC acceptance
- Larger paraffine inlet/outlet: very small impact
- Water cooling manifolds in AlBeMet162: much lighter (2.5X0 vs 20X0) and distance from 50mrad cone

Unwanted Hits in LumiCal

I replicated the study shown by Mogens on the LumiCal (LC) hits. Tracking performed using ddsim.

15'000 45.6GeV electrons generated flatly in $cos(\theta)$ in a range of $0 \leq \theta \leq 80\,mrad$ in the experiment's reference frame.

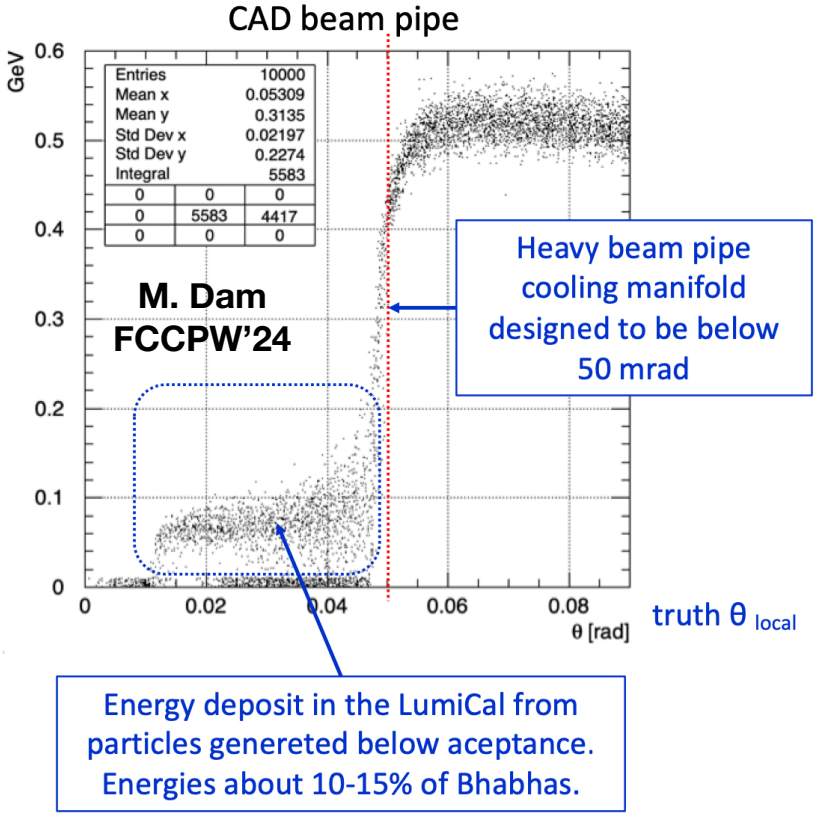


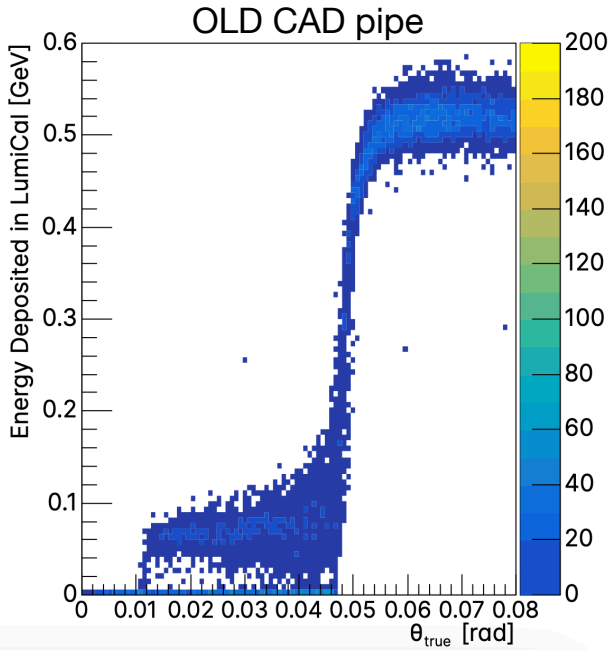


Benchmark plot with no beampipe seems to reproduce neatly Mogens plot.

1 Entry = 1e$^-$ + secondary showers

Most of the events cause no deposit for production angle below the LC acceptance (50mrad on downstream beam), and sharply rise to 500MeV deposit around this value.



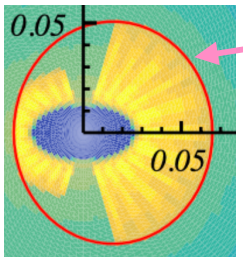


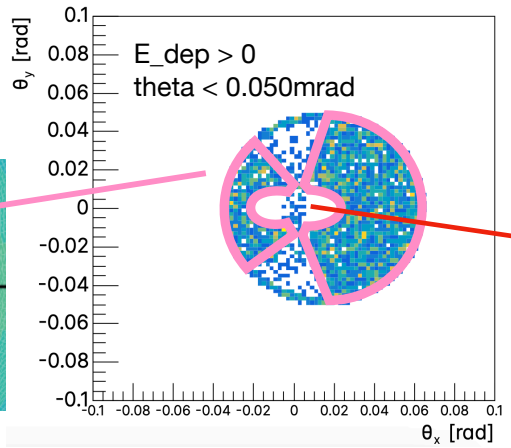
OLD CAD

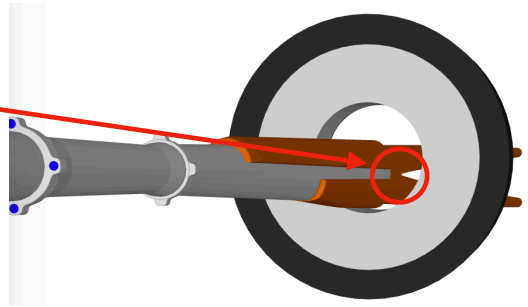
Also the plots with the old CAD are in agreement with those shown in Annecy.

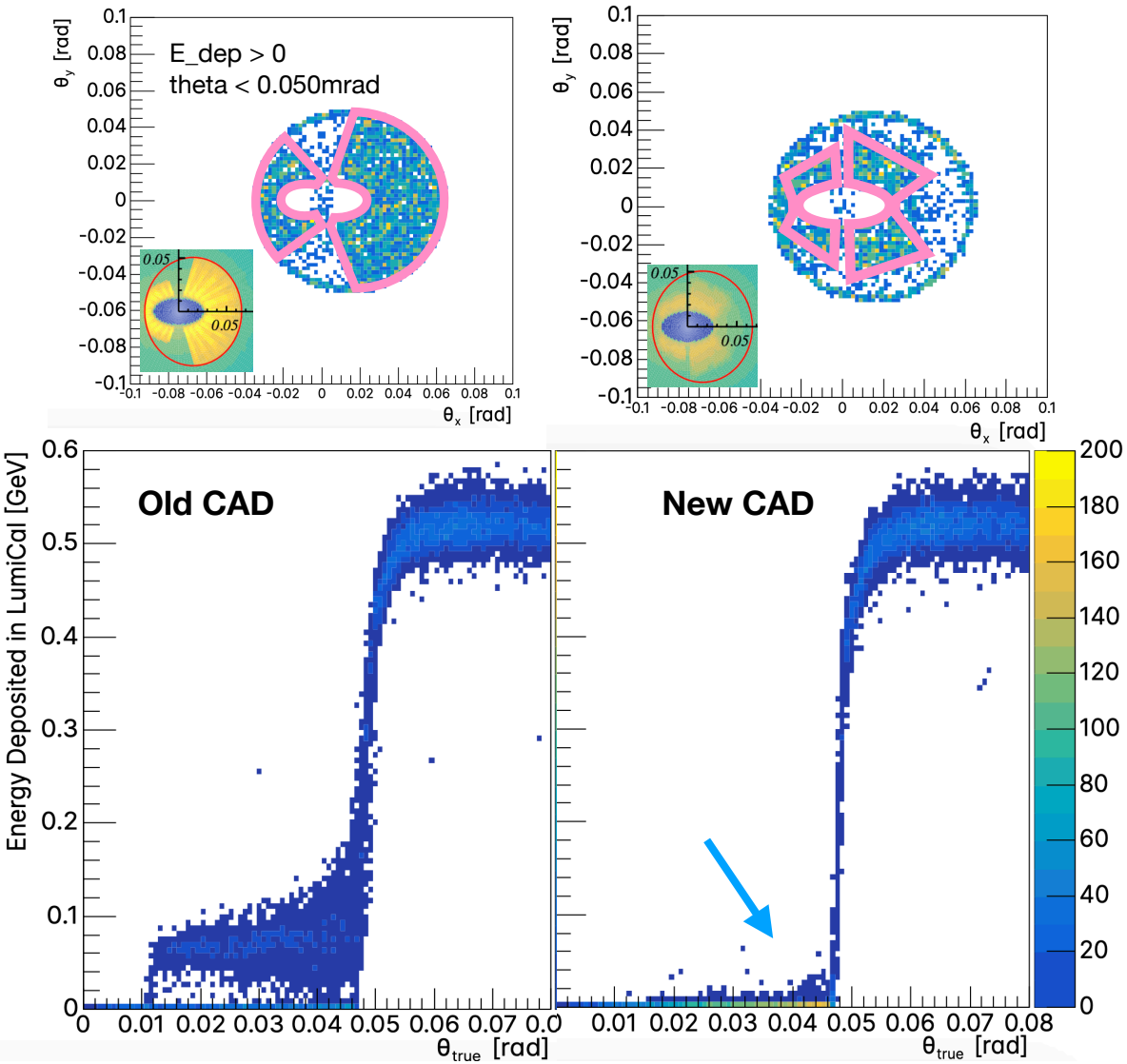
Outline of the copper cooling manifolds clearly visible.

Only difference in the dd4hep model is the copper crotch+separated pipes. Very few backscattered hits are visible! Consider a shielding?





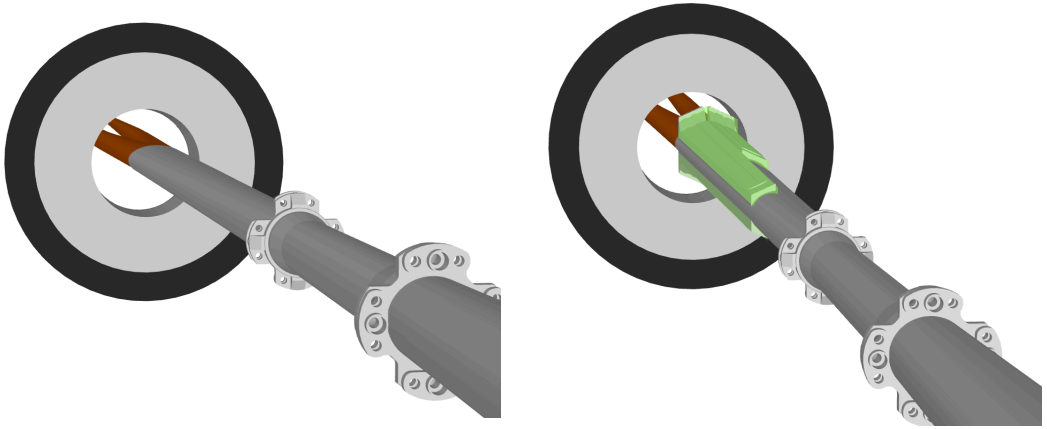


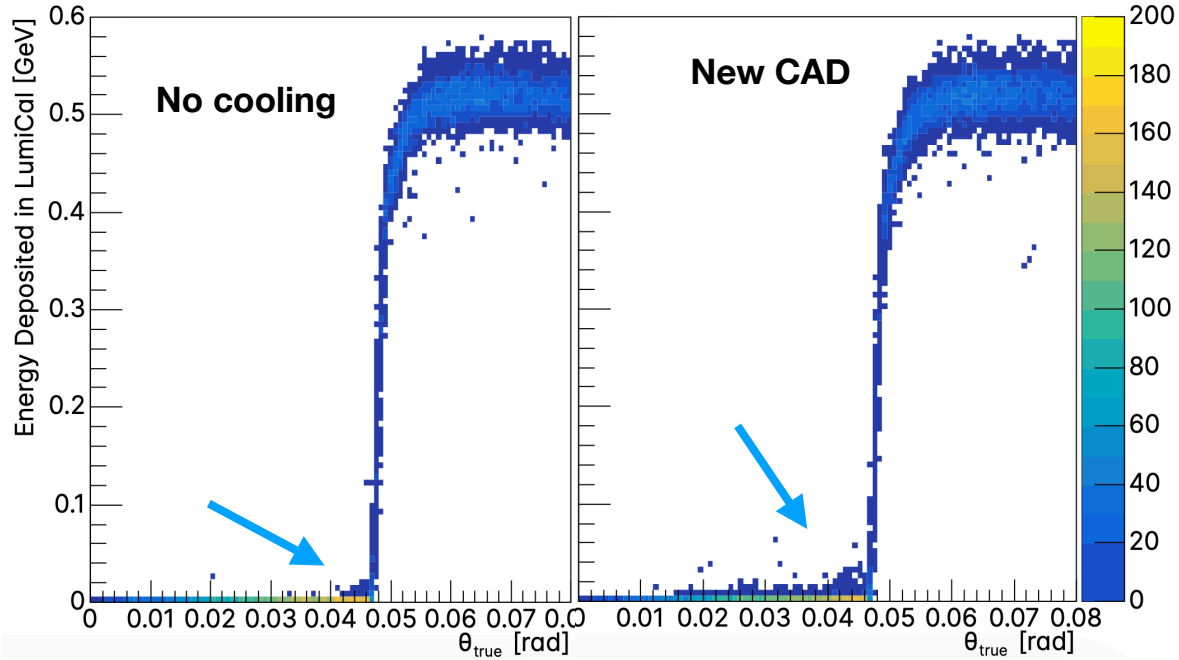


NEW CAD

Water cooling manifolds in new CAD model are in AlBeMet instead of Copper, and also with a smaller angular coverage.

As expected, large reduction of the energy deposit coming from below LumiCal acceptance.





NEW CAD

Water cooling manifolds in new CAD model are in AlBeMet instead of Copper, and also with a smaller angular coverage.

As expected, large reduction of the energy deposit coming from below LumiCal acceptance.

Compared with the same model but **without the cooling manifolds** (AlBeMet+Water) we see that the **improvement margin is very small.**

The (very small) contribution coming from the bare AlBeMet beam pipe is **unavoidable**. A thinner beam pipe would not resist thermo-mechanical stresses.

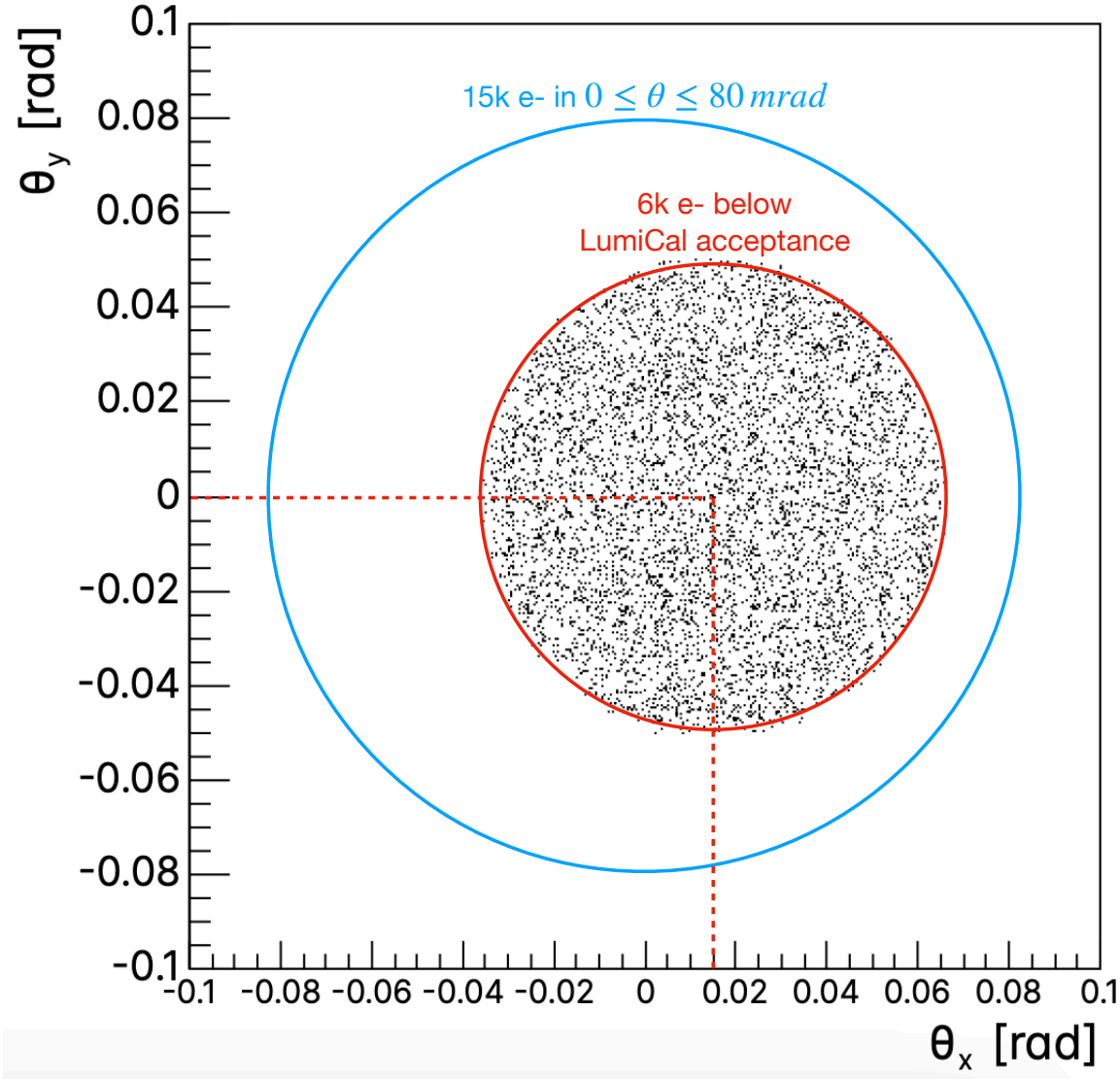
Conclusions

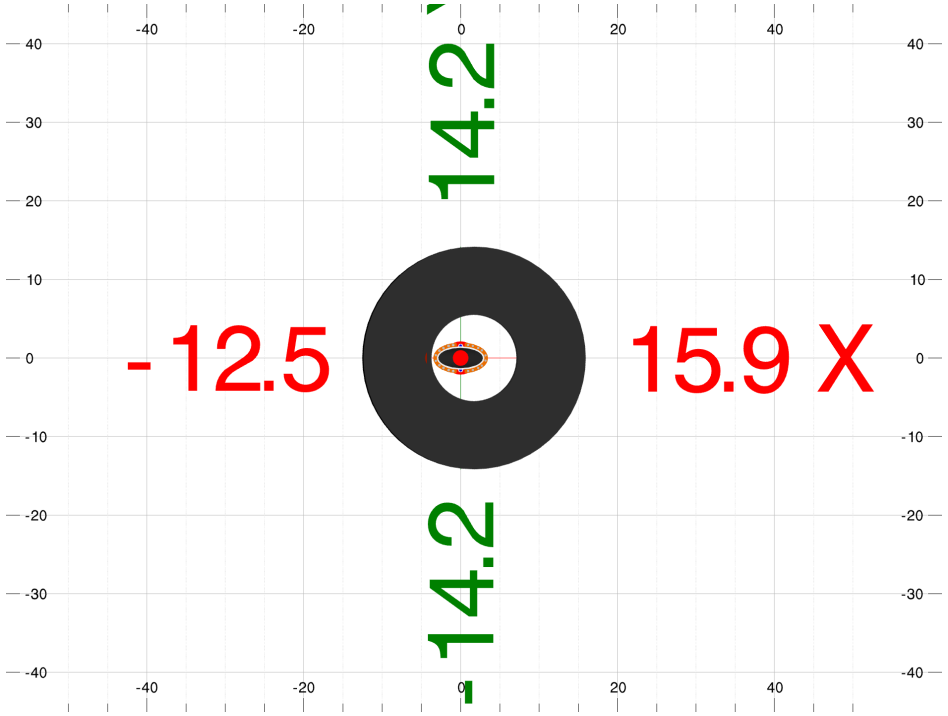
Large effort put from the LNF engineers to **design from scratch a new cooling manifold** in AlBeMet162, after Mogens presentation at Annecy physics workshop.

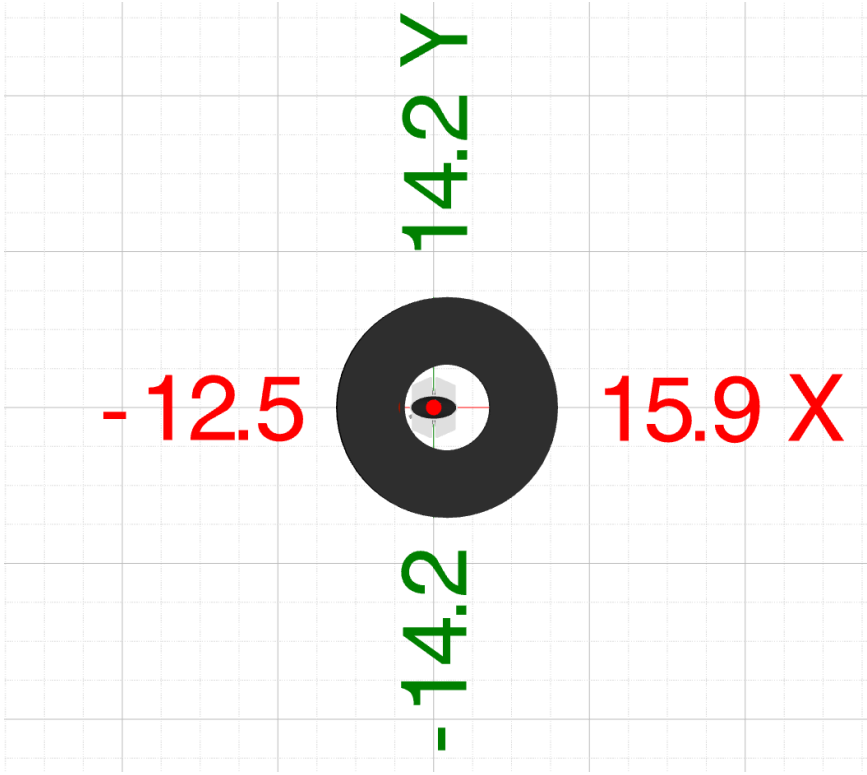
The **material budget** for this new pipe is presented and compared to the old model.
- Significant **reduction of the material from the cooling manifold** is observed (2.5X0 vs 20X0)
- Clearance between cooling manifold and acceptance cone increased
- **Conical chamber unaltered** (7%~50% X0 within Lumical acceptance)

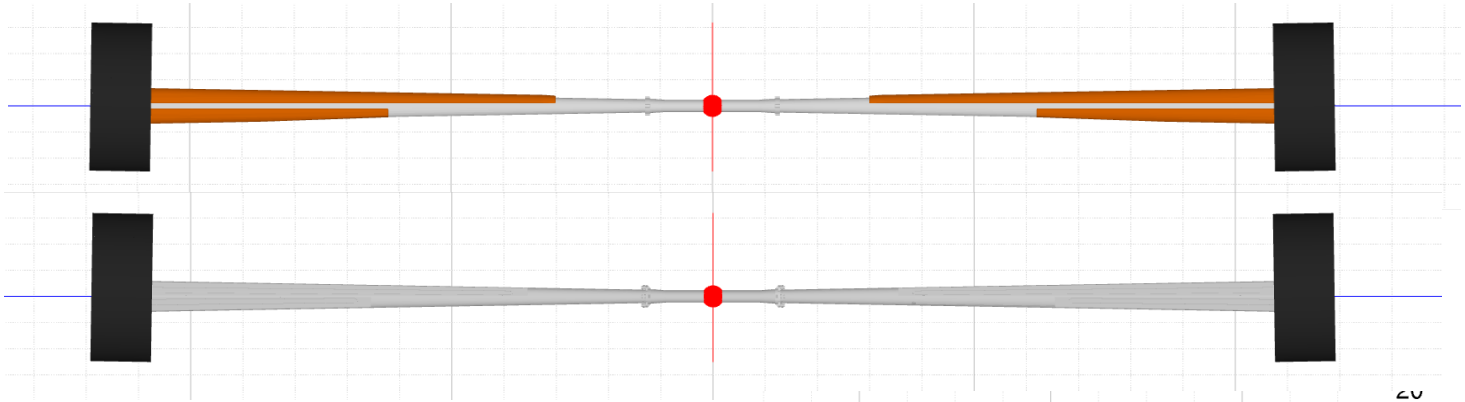
The **energy deposit in the LumiCal** from a 45.6GeV e- uniform distribution was studied for the old and new models.
- **Large reduction** of energy deposit from below the LC acceptance (i.e. showers from the cooling manifolds)
- **Small improvement margin** if compared with the bare beam pipe
- Contribution from bare beam pipe is **unavoidable** (cannot reduce pipe thickness) **but very small**

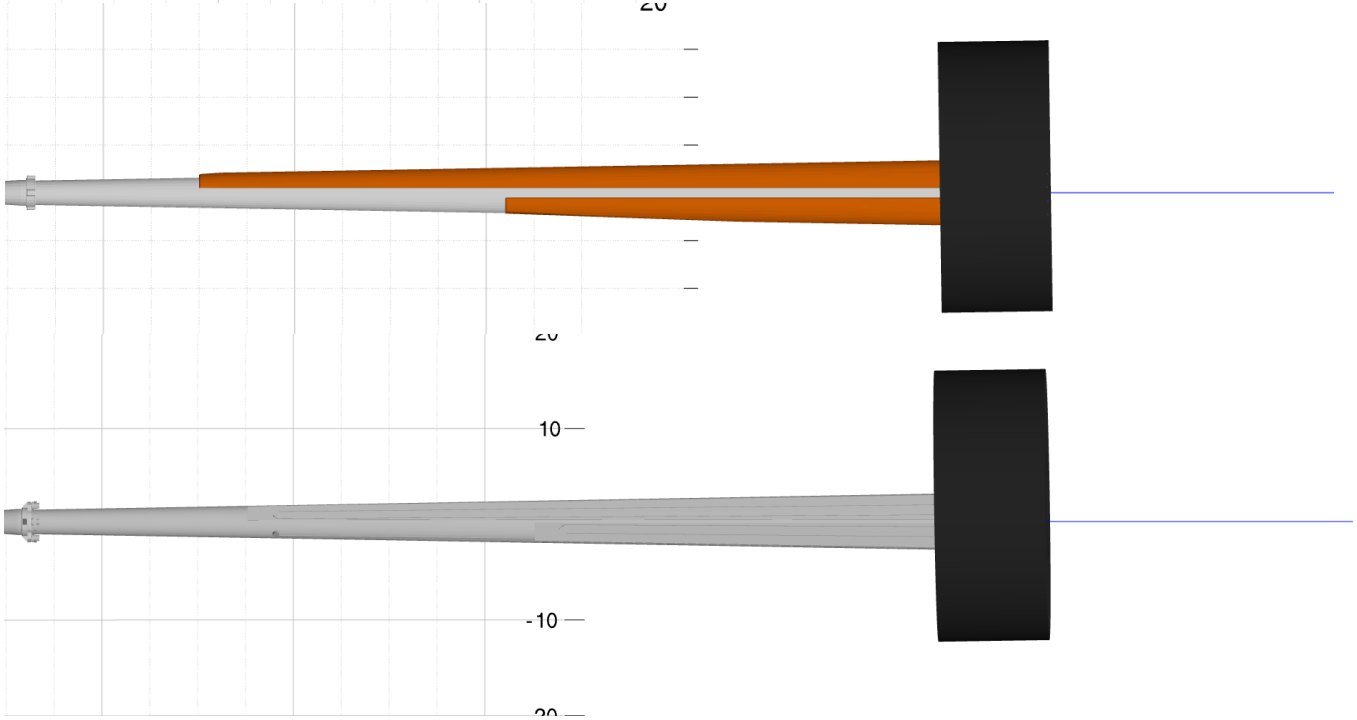
Backscattered particles from beam pipe crotch (copper): small contribution, but further studies required to decide if a downstream shielding is necessary


15k e- in $0 \leq \theta \leq 80\,mrad$
6k e- below
LumiCal acceptance
θ_y [rad]
θ_x [rad]
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.1 -0.08 -0.06 -0.04 -0.02 0 0.02 0.04 0.06 0.08 0.1

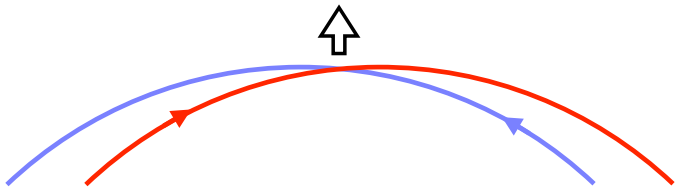

14.2
-12.5
15.9 X
-14.2


14.2 Y
-12.5
15.9 X
-14.2

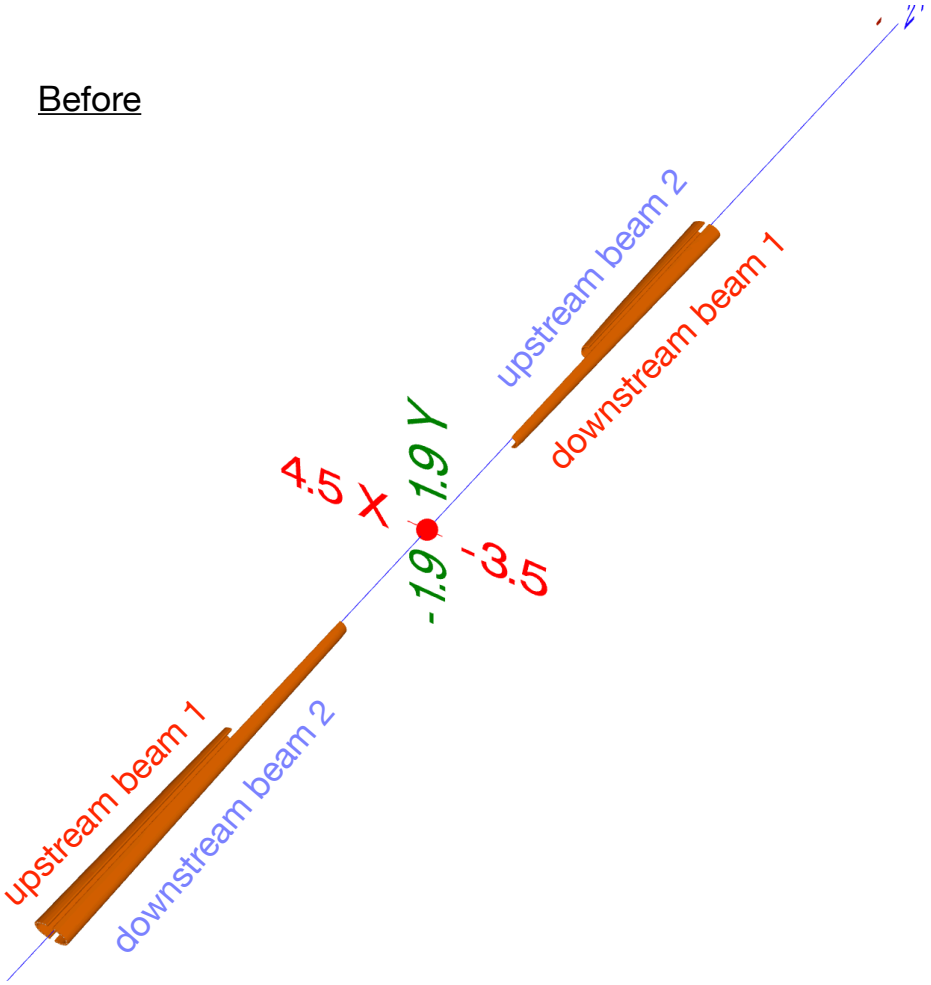



10
-10

Convention: positive x-axis direction points **outside** the ring

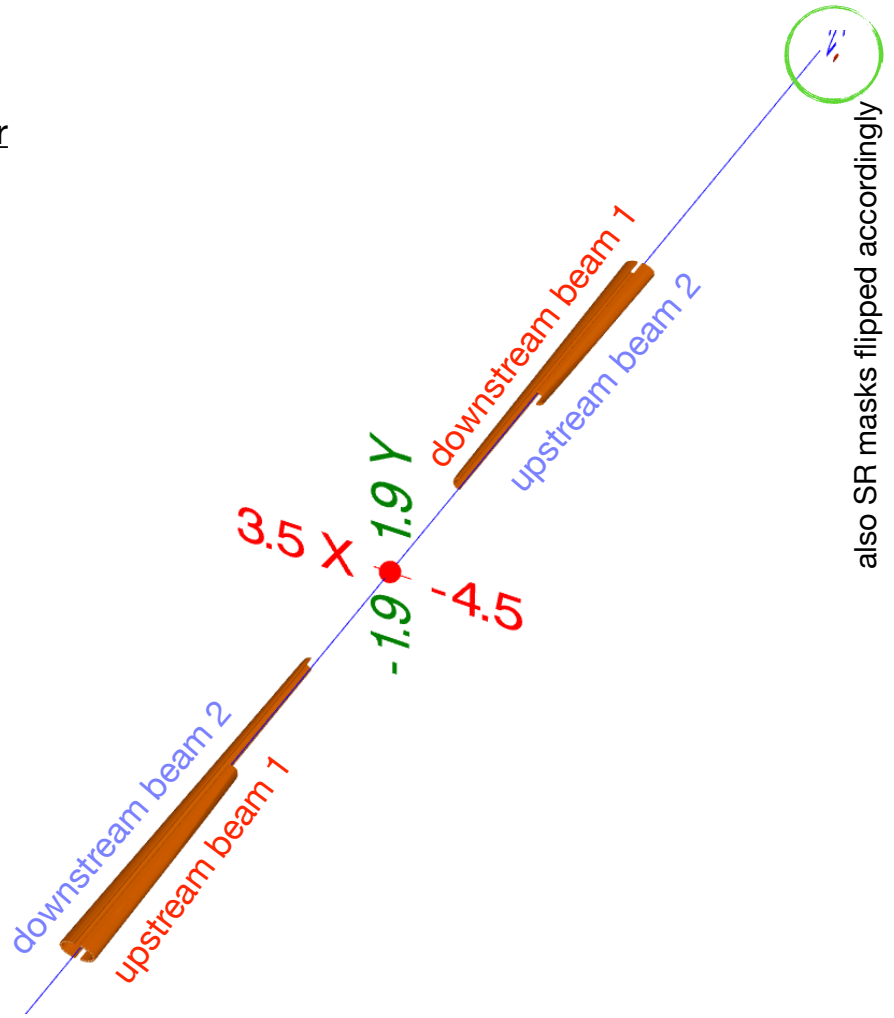


Before



LumiCal is centered on downstream beam

After



also SR masks flipped accordingly