Update on MARS simulation and CLICCT geometry

N. Terentiev, CMU / Fermilab

Muon Collider Physics and Detectors Meeting

Nov. 10, 2010
Fermilab

Outline

- MARS new simulation for mu+ 750 GeV 2e+12 beam.
- Checking Tracker Endcap + FTD geometry against MARS 10 degrees nozzle geometry.

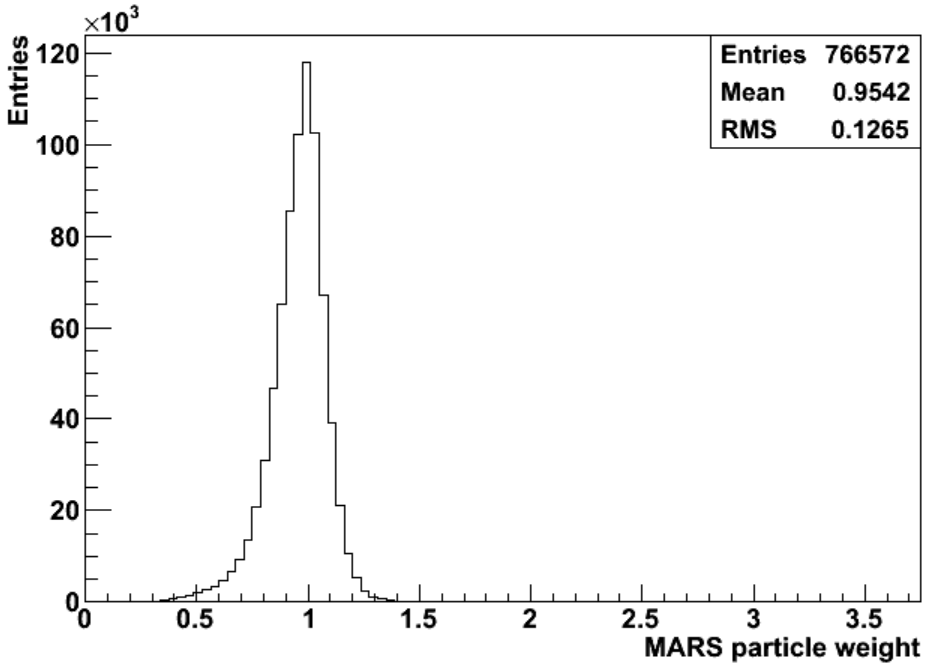
MARS new simulation for mu+ 750 GeV 2e+12 beam.

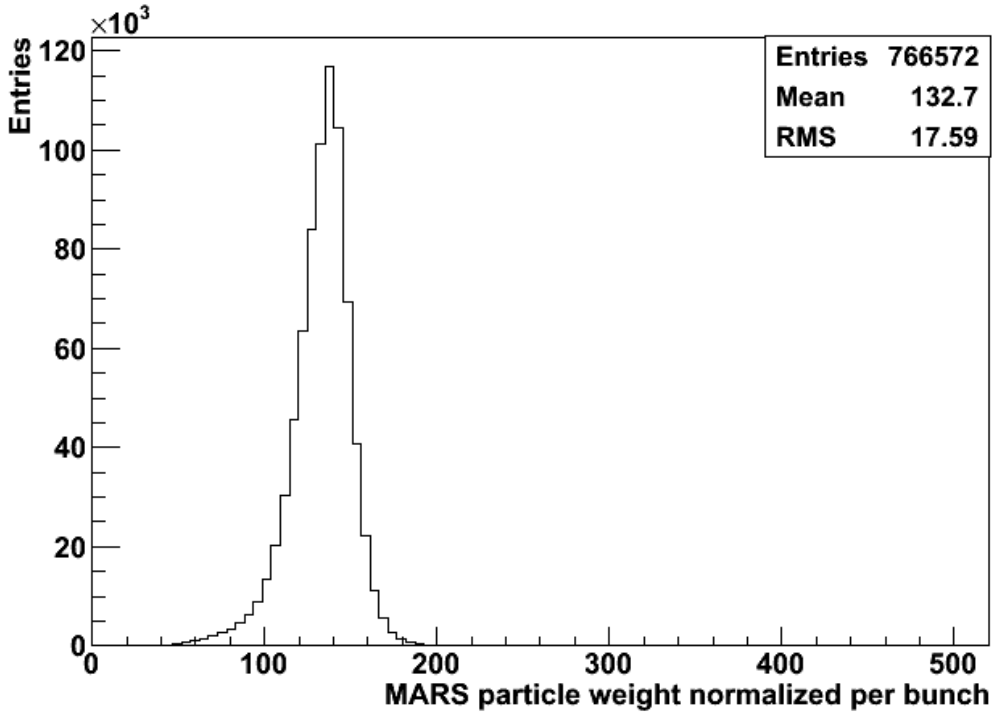
- **MARS new simulation results available since Sep. 24, 2010 (N. Mokhov and S. Striganov, see output file excl-8e4-pl in http://www-ap.fnal.gov/~strigano/mumu/)**
  - **based on 80,000 750 GeV beam mu+ decays simulated on the distance of 26 m (-25 < z < 1)**
  - **new variables are added to the parameters list (more to come in the future)**
  - **the file excl-8e4-pl has information about 766572 particles coming from the outer (faced to detector) surface of the 10 degrees shielding nozzle**
  - **if using weight -> ~ 102M particles to simulate in GEANT**

Physics Carnegie Mellon

- **New outstanding feature of MARS simulation - drastically reduced particle weight variation.**
  - **MARS intrinsic particle weight.**

If normalized per bunch for 750 GeV 2e+12 mu+ beam on decay length of 26m.

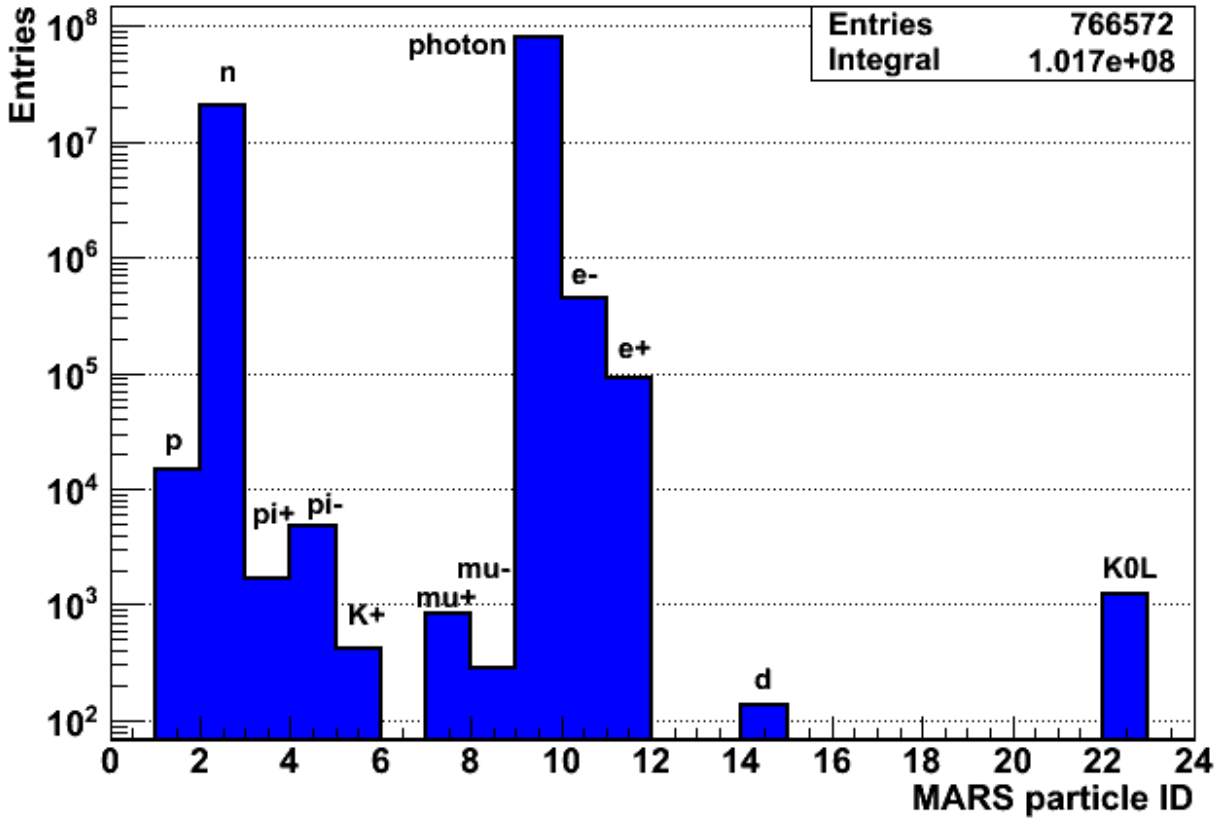




MARS new simulation for mu+ 750 GeV 2e+12 beam.

Physics
Carnegie Mellon

- MARS particle ID's with weight and absolute yields on the nozzle surface



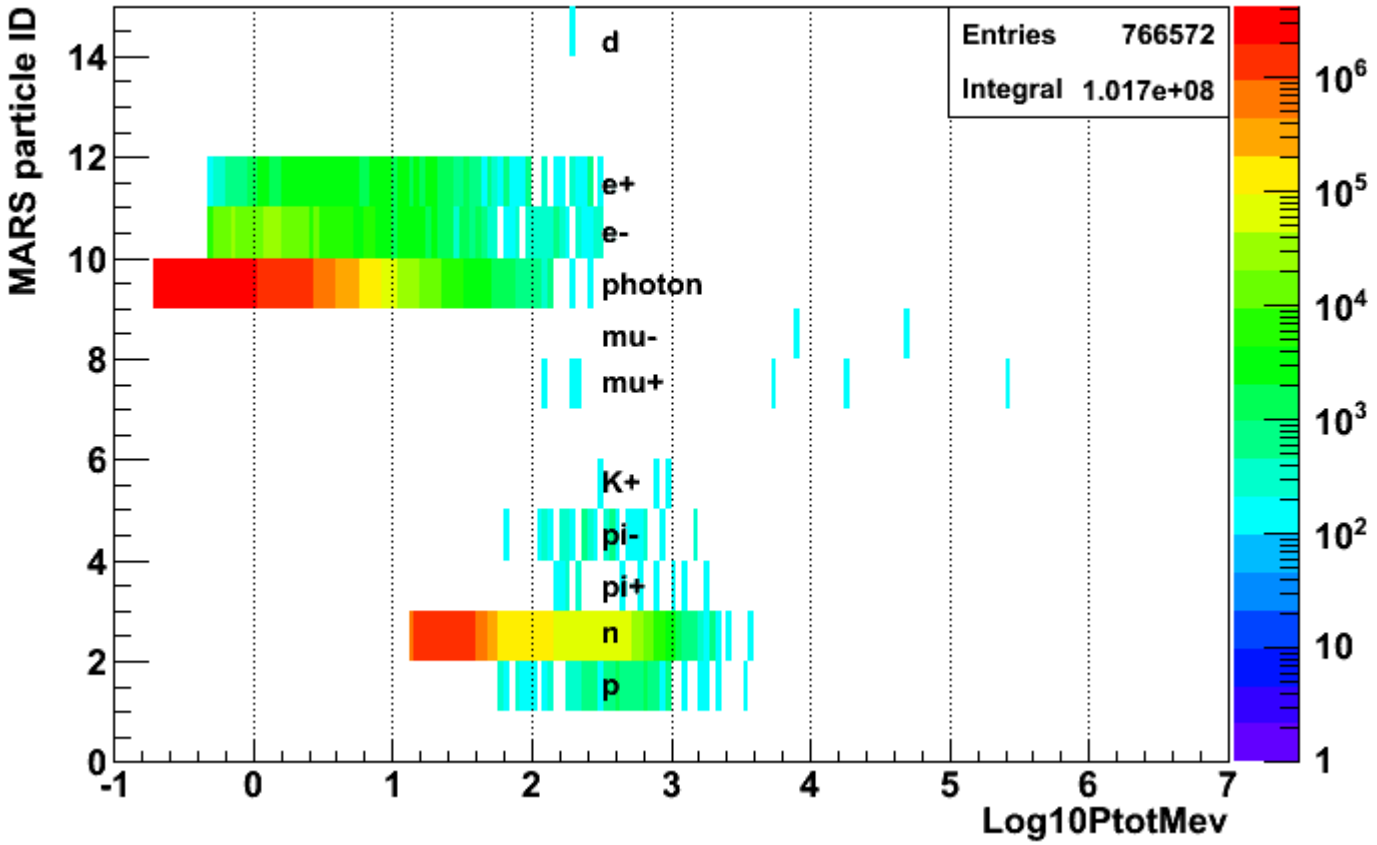
Abs. yields/bunch per beam (E = 750 GeV, #muons = 2.0e+12 and L=26 m)

MARS output	n	mu+	mu-	photon	e-	e+
excl-8e4-pl	2.1e+07	8.3e+02	2.8e+02	8.0e+07	4.4e+05	9.1e+04

MARS new simulation for mu+ 750 GeV 2e+12 beam.

Physics
Carnegie Mellon

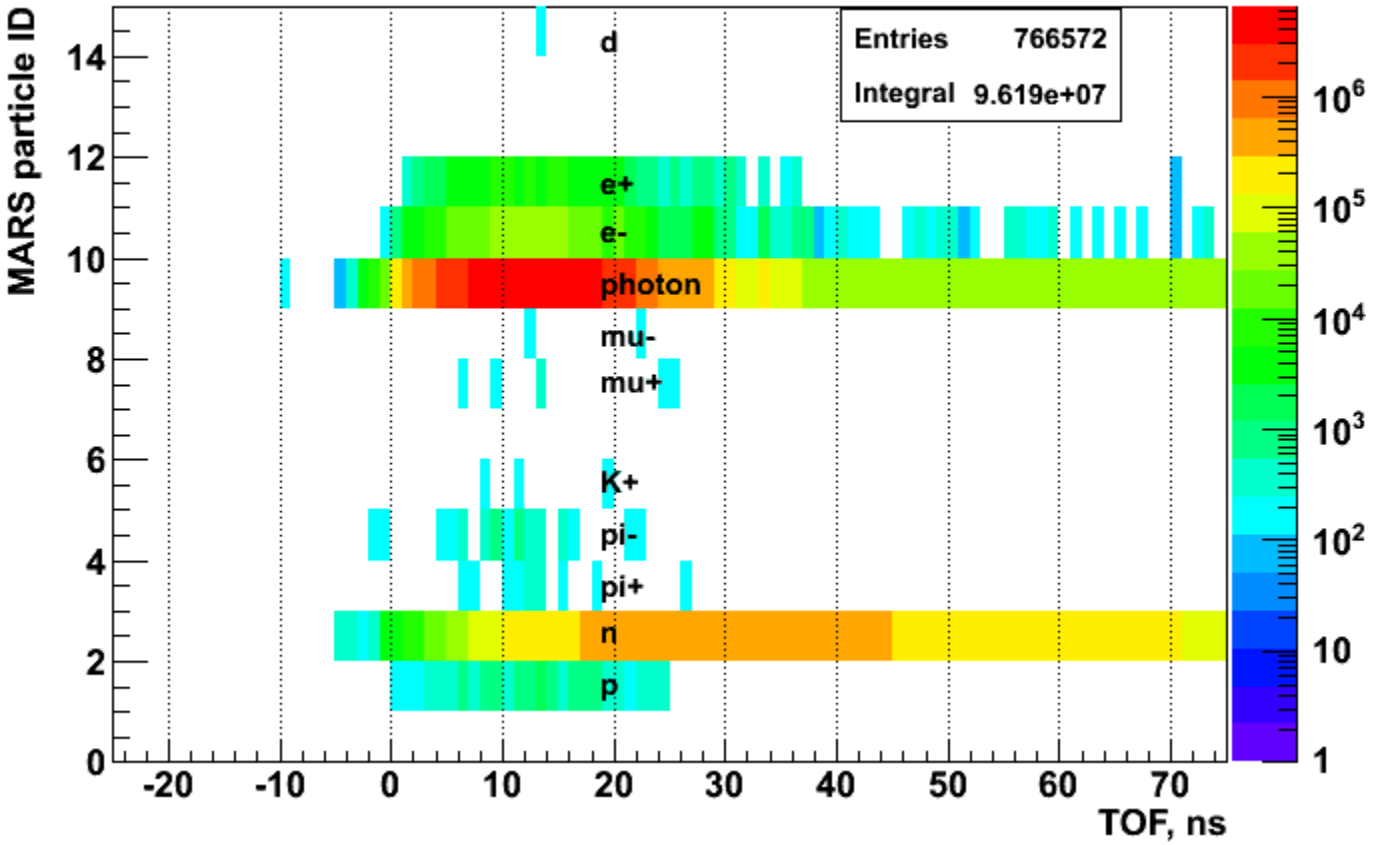
- **MARS particle ID and Ptot (weights included)**
  - neutrons, Ptot ~ 10-100 MeV with tail up to 1000MeV (cut at ~13 MeV)
  - photons, Ptot ~ 0.2-10 MeV with tail up to 100 MeV (cut at ~0.2 MeV)
  - e+,e-, Ptot ~ 0.5-100 MeV with tail up to 300 MeV (cut at ~0.5MeV)
  - mu+,mu-, Ptot ~ 100 MeV-100 GeV



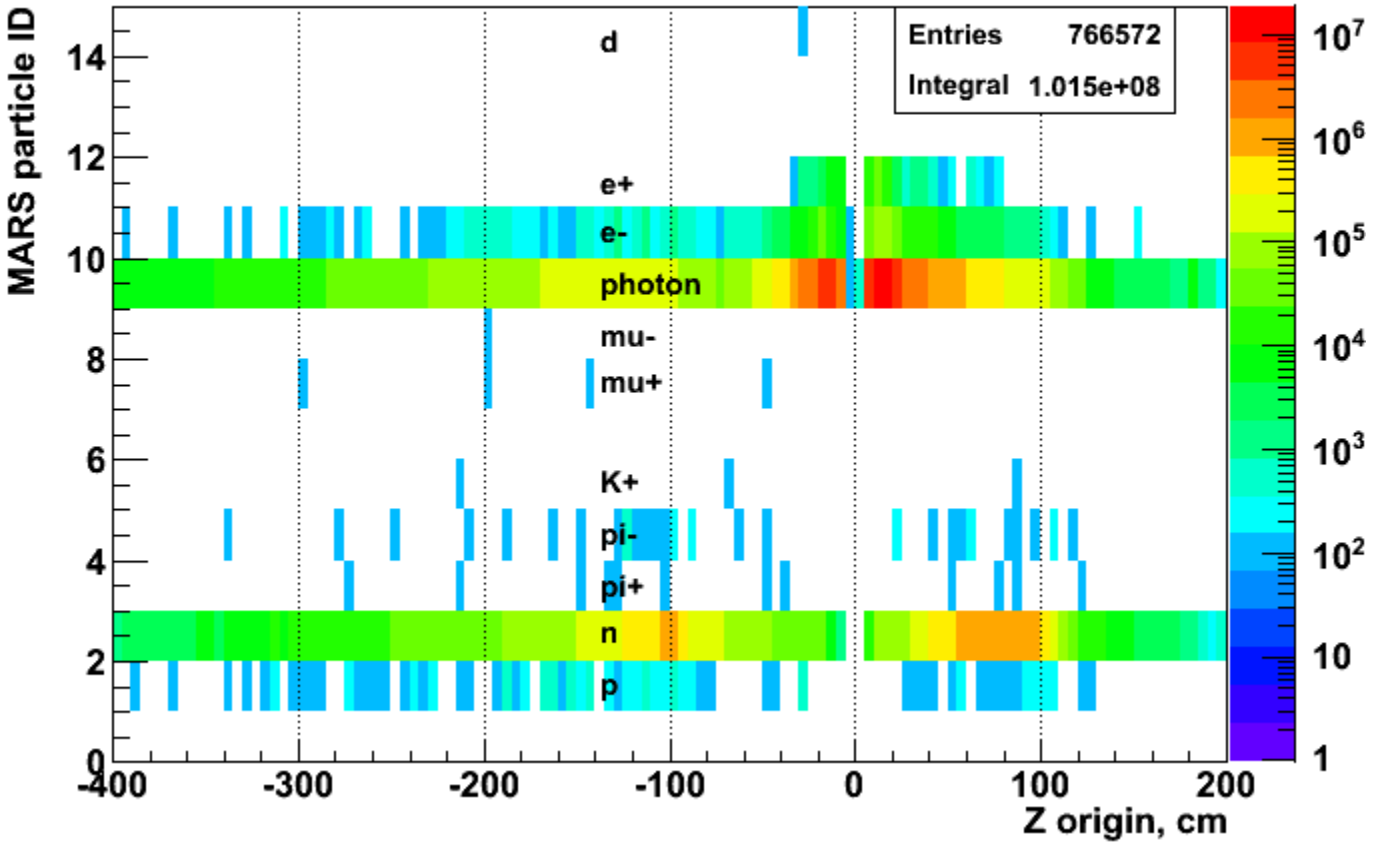
MARS new simulation for mu+ 750 GeV 2e+12 beam.

Physics Carnegie Mellon

- **MARS particle ID and TOF (weights included)**
  - time of flight wrt. bunch crossing time
  - ~20% of neutrons have TOF < 25 ns (5 times reduction if using timing)
  - other particles ~ 90%



- **MARS particle ID and Z of origin (weights included)**
  - photons, e+, e- and neutrons are mostly from -100cm < Z origin < 100 cm

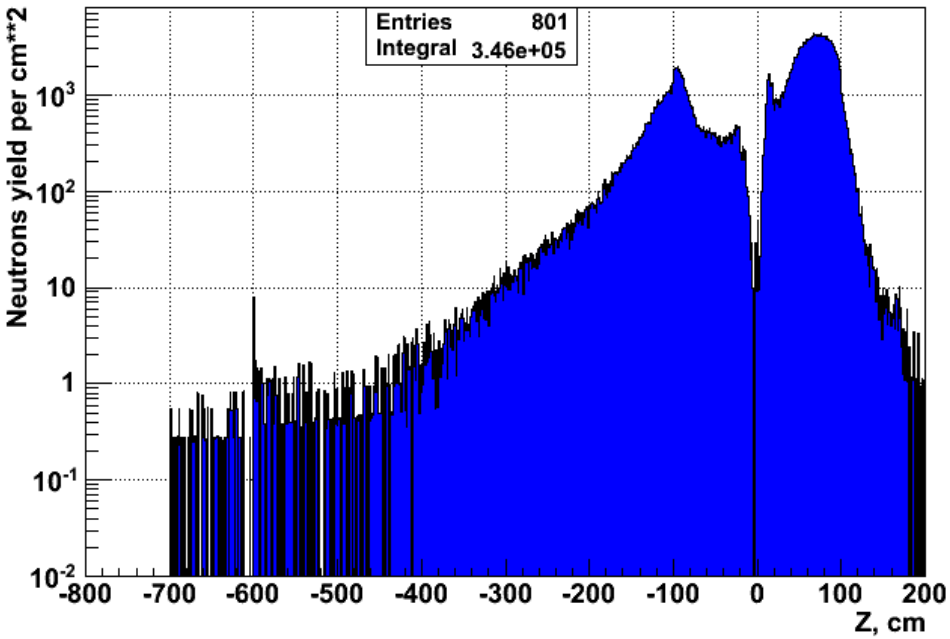


MARS new simulation for mu+ 750 GeV 2e+12 beam.

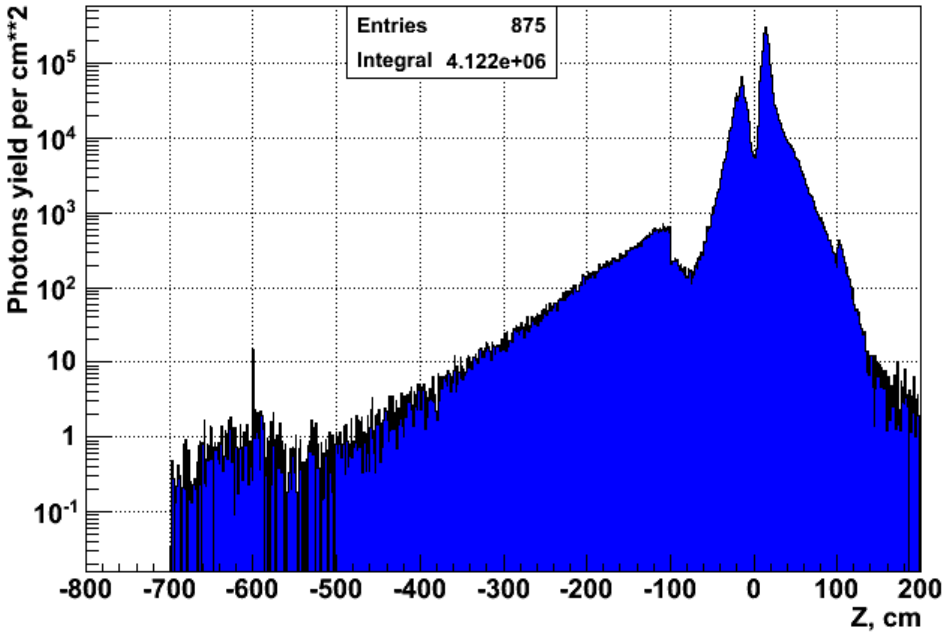
Physics
Carnegie Mellon

- **Absolute yields per cm**2 of the nozzle outer surface**

Neutrons



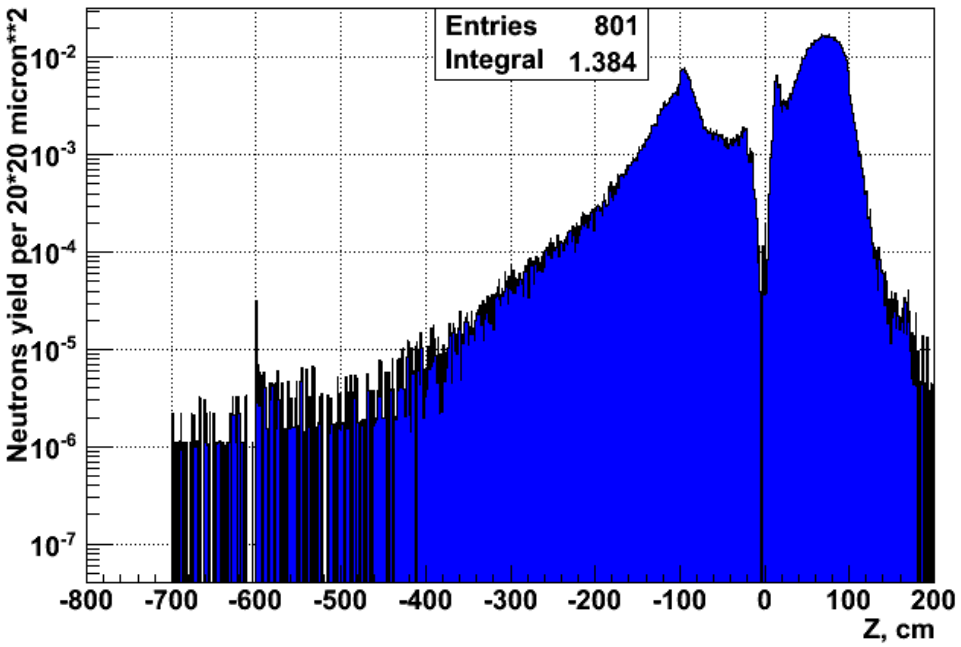
Photons

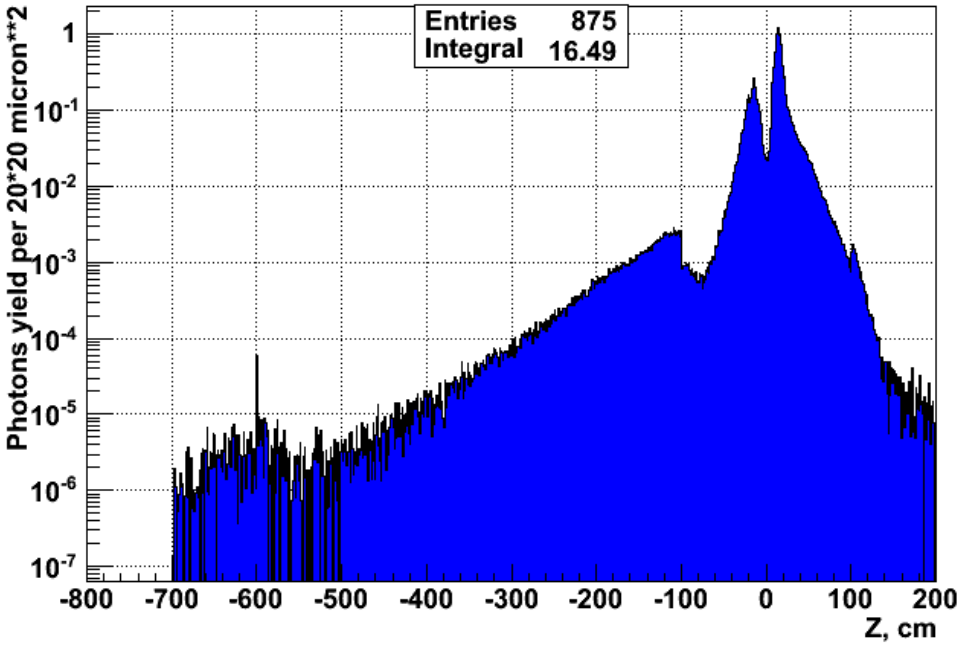


Physics
Carnegie Mellon

- **Absolute yields per 20*20 micron**2 of the nozzle outer surface**

Neutrons **Photons**





MARS new simulation for mu+ 750 GeV 2e+12 beam.

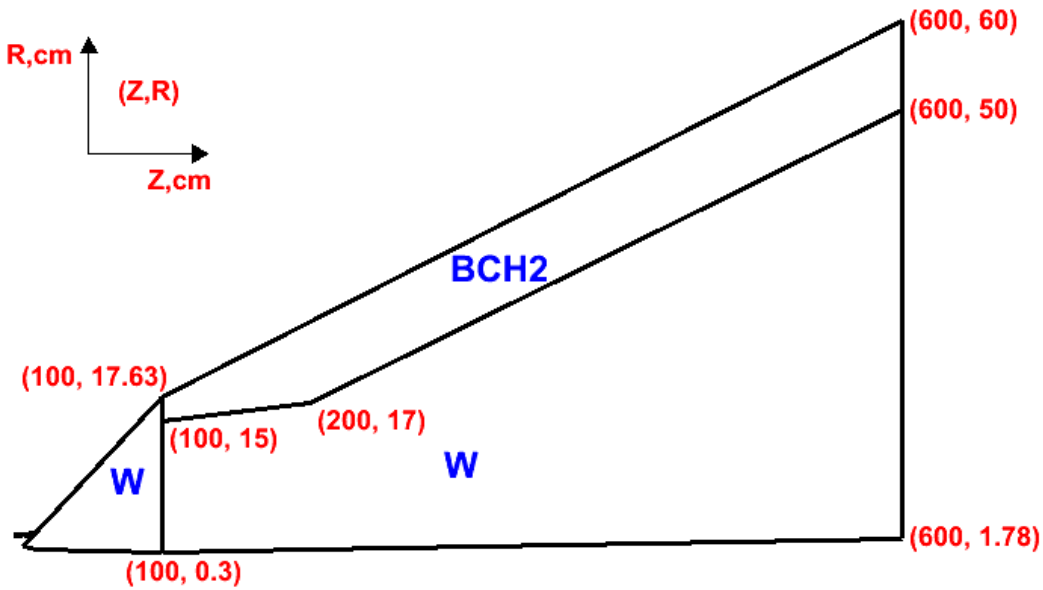
Physics
Carnegie Mellon

- **Conclusion**
  - The best nozzle simulation and geometry so far
  - Lowest secondary particles yield
  - Minimal variation of the weight
  - More parameters available
  - Thanks to N. Mokhov and S. Striganov for help with MARS output file information
- **Plans**
  - The plans were to run ILCroot for current MARS output file excl-8e4-pl to get hits in Tracker and VXD and look at hits occupancy
- **Problem**
  - excl-8e4-pl nozzle geometry does not fit into geometry of the CLICCT (SiD Tracker Endcap + FTD) – there are overlaps with nozzle (next slides)
  - The following is one of the nozzle geometry options having no overlaps
  - Detailed nozzle geometry modifications study is underway (N. Mokhov, S. Striganov, simulation in MARS)

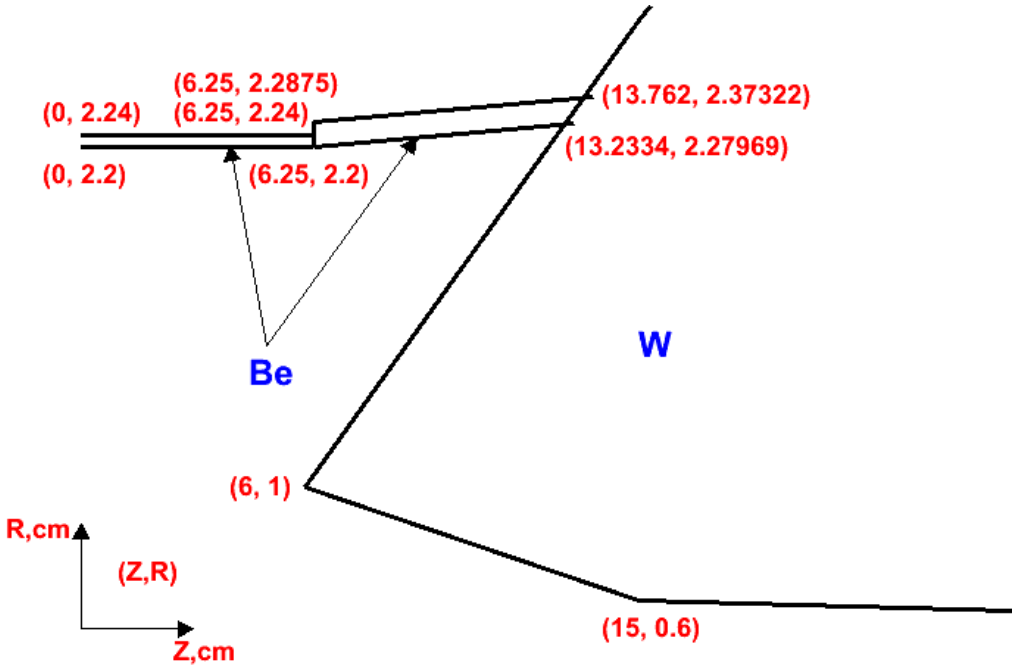
Checking Tracker Endcap geometry against MARS 10 degrees nozzle geometry.

- **excl-8e4-pl 10 degrees nozzle geometry**

General view



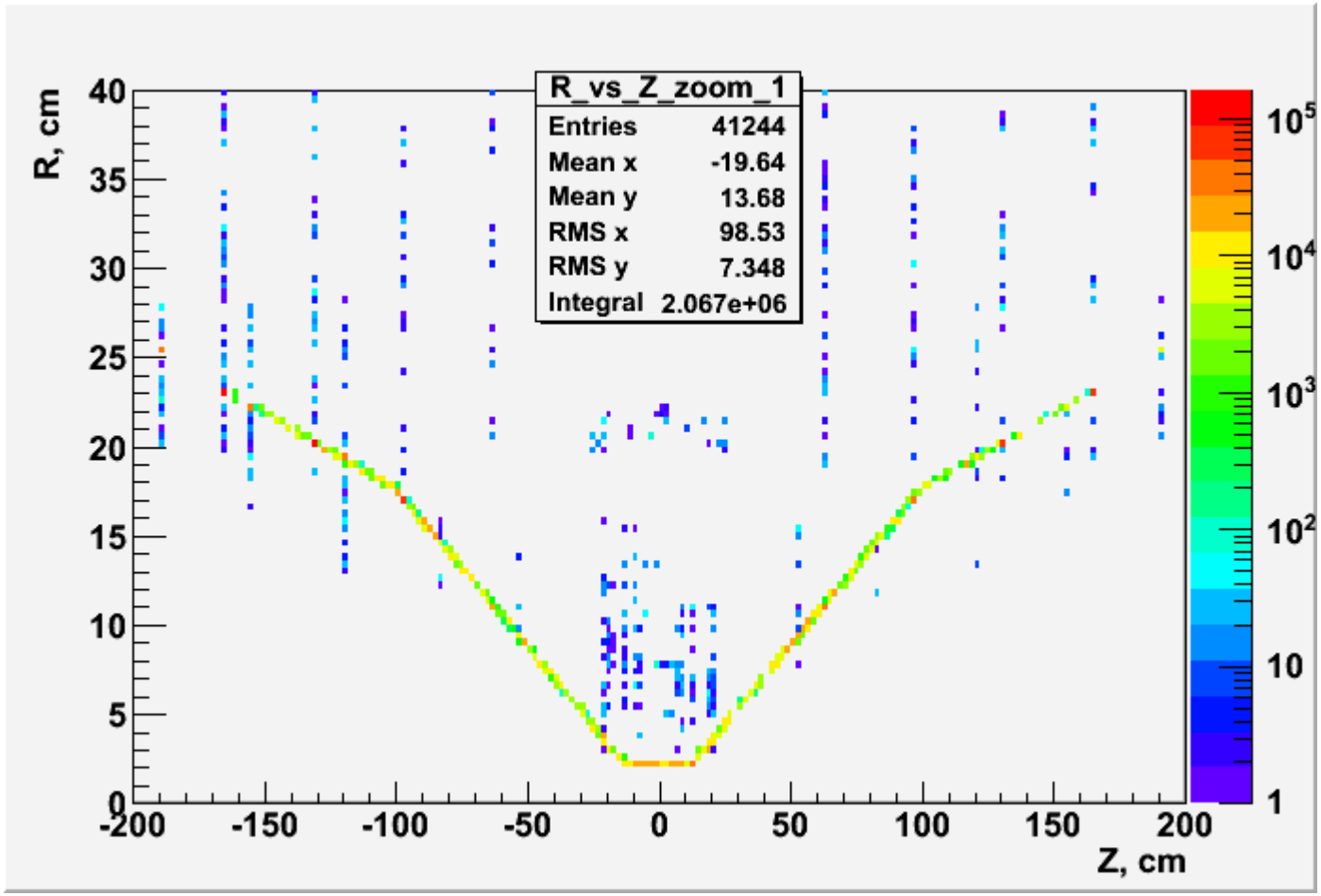
Zoom in beam pipe



Checking Tracker Endcap geometry against MARS 10 degrees nozzle geometry.

Physics
Carnegie Mellon

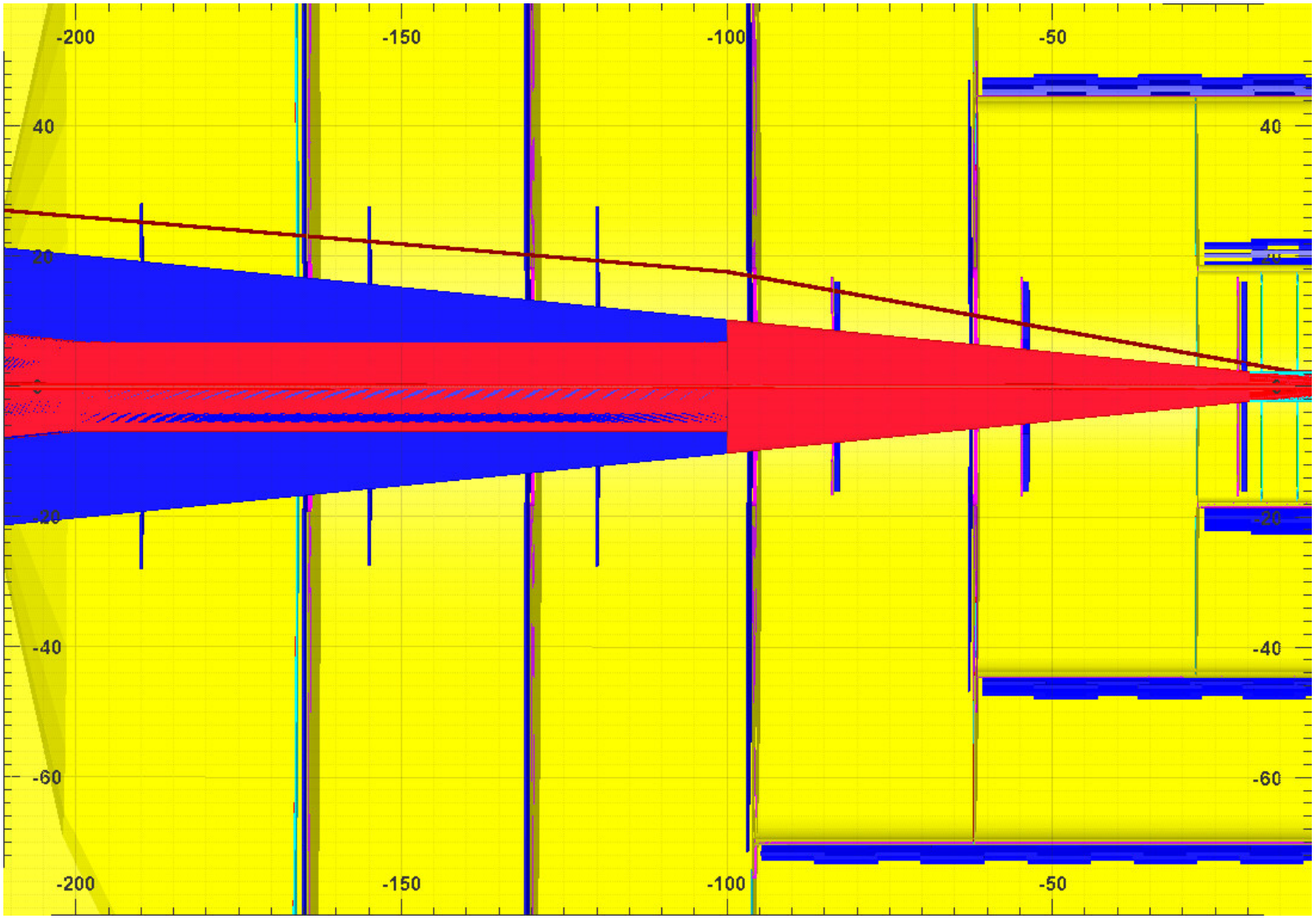
- **SiD Tracker Endcap + FTD + VXD hits and nozzle overlapping**
  - hits are from CLICCT.Hits.Root file made for MARS output file MUPL-75210_1e6 (old 6 degrees nozzle)
  - latest 10 degrees nozzle geometry (high occupancy points) is superimposed



Checking Tracker Endcap geometry against MARS 10 degrees nozzle geometry.

- **SiD Tracker Endcap + FTD and nozzle overlapping (from Vito)**

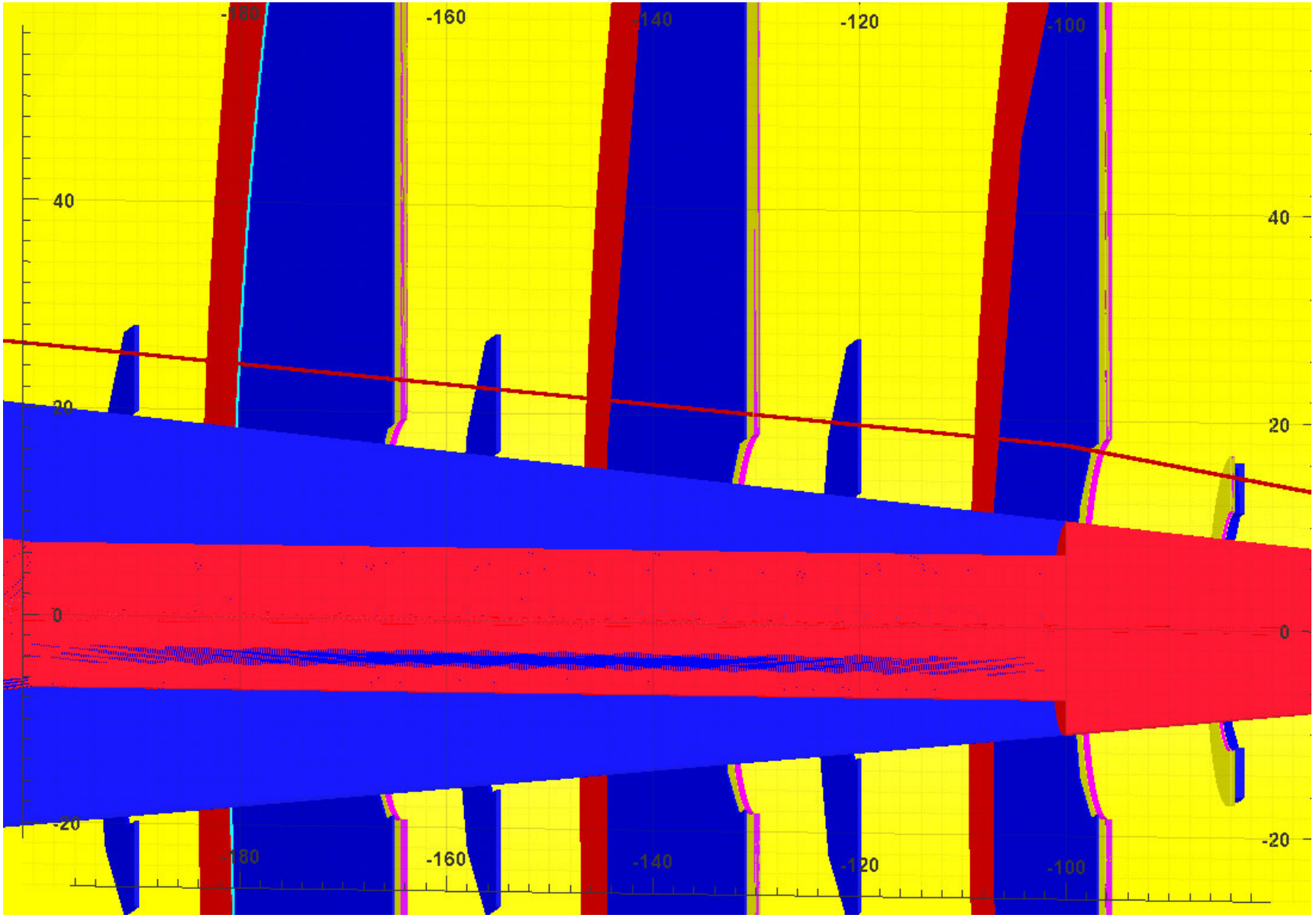
  (red line - excl-8e4-pl 10 degrees nozzle)



Checking Tracker Endcap geometry against MARS 10 degrees nozzle geometry.

Physics
Carnegie Mellon

- **SiD Tracker Endcap + FTD and nozzle overlapping (from Vito)**
  (red line - excl-8e4-pl 10 degrees nozzle)



Checking Tracker Endcap geometry against MARS 10 degrees nozzle geometry.

Physics Carnegie Mellon

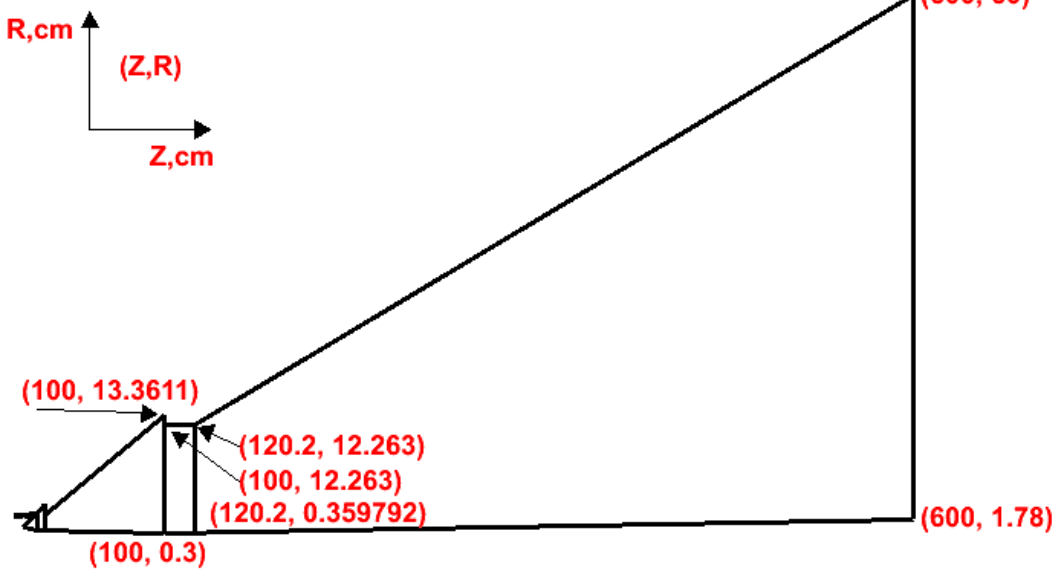
- SiD Tracker Endcap + FTD and nozzle overlapping
  - Z, DZ, Rmin of layer volumes and Rnozzle (all in cm) for Z>0
  - Overlap = Rnozzle(Z+DZ) – Rmin
  - total (Z<0 and Z>0) – 16 overlaps for detector (SiD, FTD), 10 – for supports

	Layer	Z	DZ	Rmin	Rnozzle	Overlap
SiD	TrackerEndcap_layer4	20.594	0.445	2.680	3.661	0.981
	TrackerForwardSupports_layer0	21.525	0.225	2.680	3.786	1.106
SiD	TrackerEndcap_layer5	54.044	0.445	7.250	9.578	2.348
	TrackerForwardSupports_layer1	54.715	0.225	7.410	9.658	2.248
SiD	TrackerEndcap_layer6	83.144	0.445	11.200	14.727	3.527
	TrackerForwardSupports_layer2	83.825	0.225	11.550	14.808	3.258
FTD	TrackerEndcap_layer14	120.000	0.200	12.723	19.342	6.619
	TrackerEndcapSupports_layer2	129.916	0.364	18.300	20.196	1.896
SiD	TrackerEndcap_layer2	131.016	0.117	17.850	20.268	2.418
FTD	TrackerEndcap_layer15	155.000	0.200	16.200	22.308	6.108
	TrackerEndcapSupports_layer3	164.117	0.364	19.300	23.094	3.794
SiD	TrackerEndcap_layer3	165.117	0.118	18.800	23.158	4.358
FTD	TrackerEndcap_layer16	190.000	0.200	19.676	25.274	5.598

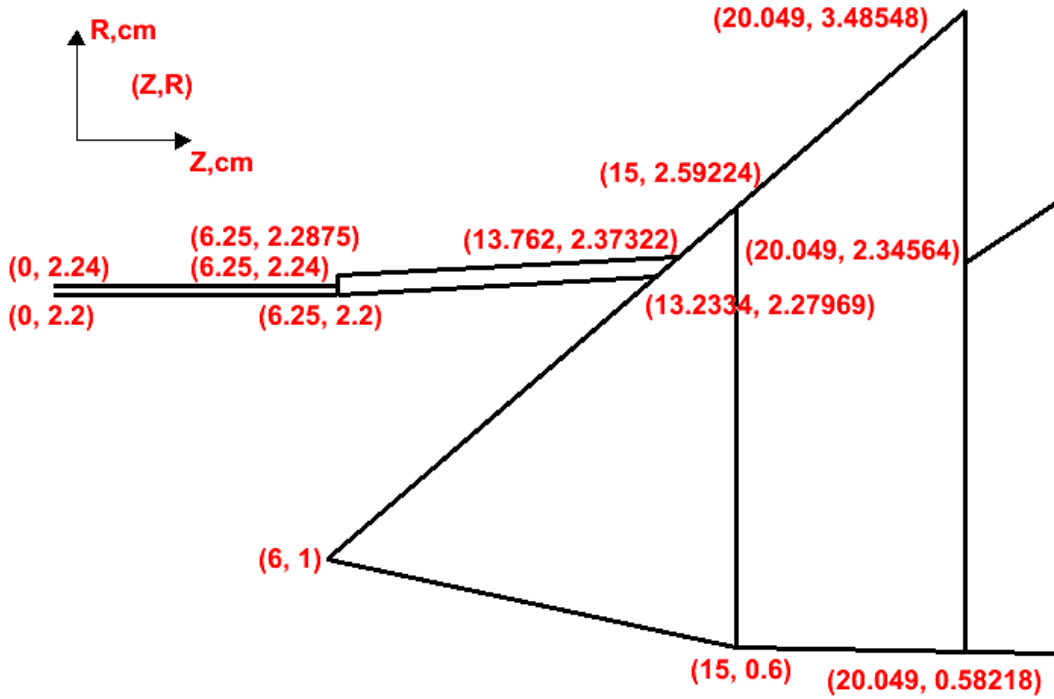
Checking Tracker Endcap geometry against MARS 10 degrees nozzle geometry.

- **Temporary solution:**
  - modify nozzle to fit into existing SiD+FTD geometry
  - provide 1 mm space between the nozzle and SiD+FTD layer volumes (including supports)
  - only CLICCTV base volume was changed to follow modified nozzle geometry
  - run thru ILCroot gGeoManager->CheckOverlaps() method to make sure that there are no remaining overlaps

General view



Zoom



Checking Tracker Endcap geometry against MARS 10 degrees nozzle geometry.

Physics
Carnegie Mellon

- **Summary**
  - The current nozzle geometry was temporary modified to fit into Tracker Endcap and FTD GEANT volumes
  - The corresponding changes are in IlcSHILvMuX.cxx and IlcPIPEvMuX.cxx code
  - In Config.C use “Shielding Version MuX 2010” instead of “Shielding Version MuX”
  - CLICCTV bounds were adjusted in CLICCTgeom.C macros, exported to ILCroot (see also IlcCLICCTvSiPT.cxx)
  - Thanks to C. Gatto, V. Di Benedetto and A. Mazacanne for valuable help with ILCroot code and geometry