First look at 10 TeV BIB from FLUKA and other things

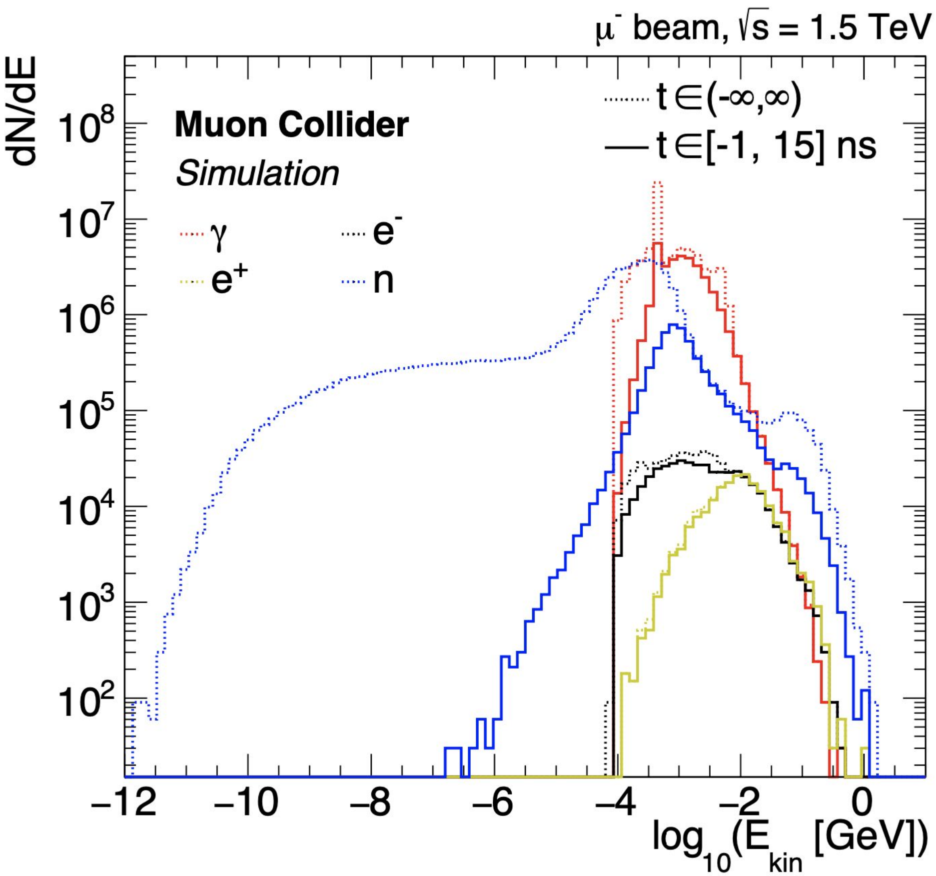
Detector meeting, 20/04/2023

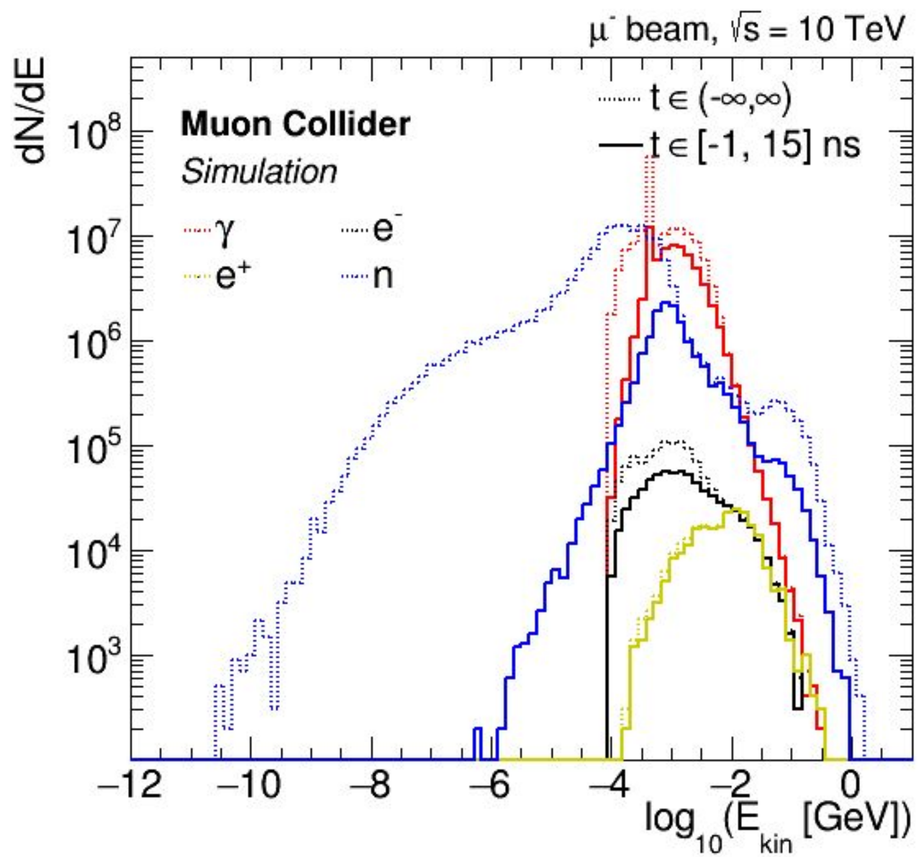
Energy spectrum

Not a lethargy plot

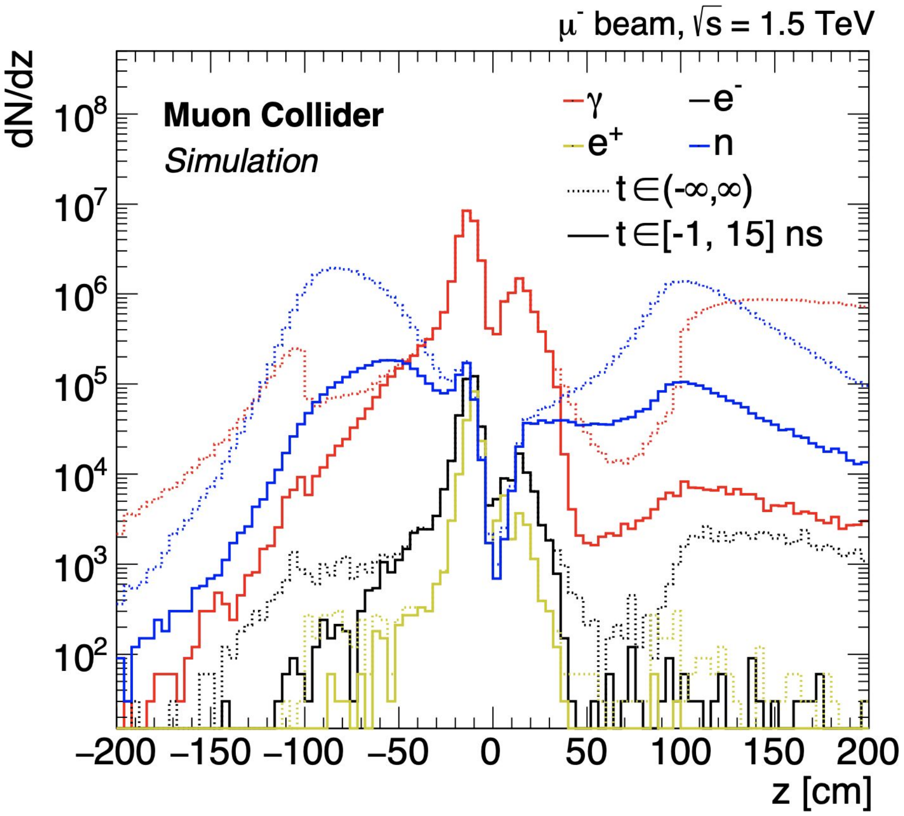
Initial look at BIB@10TeV from Daniele's inputs

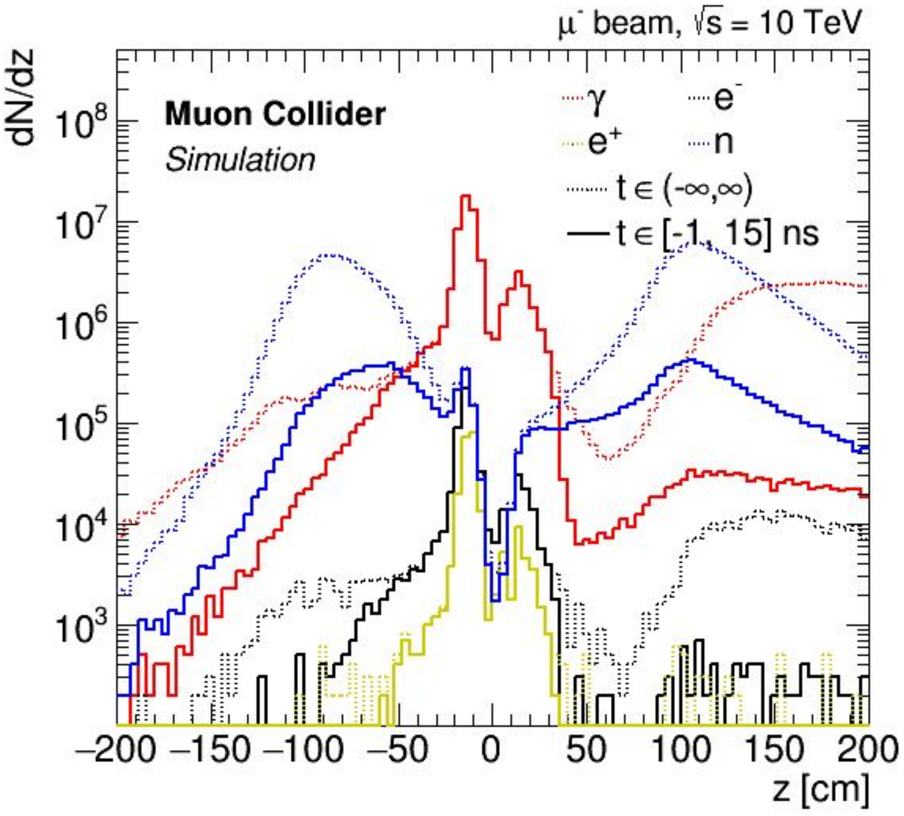
Note, this is actually a mu+ beam



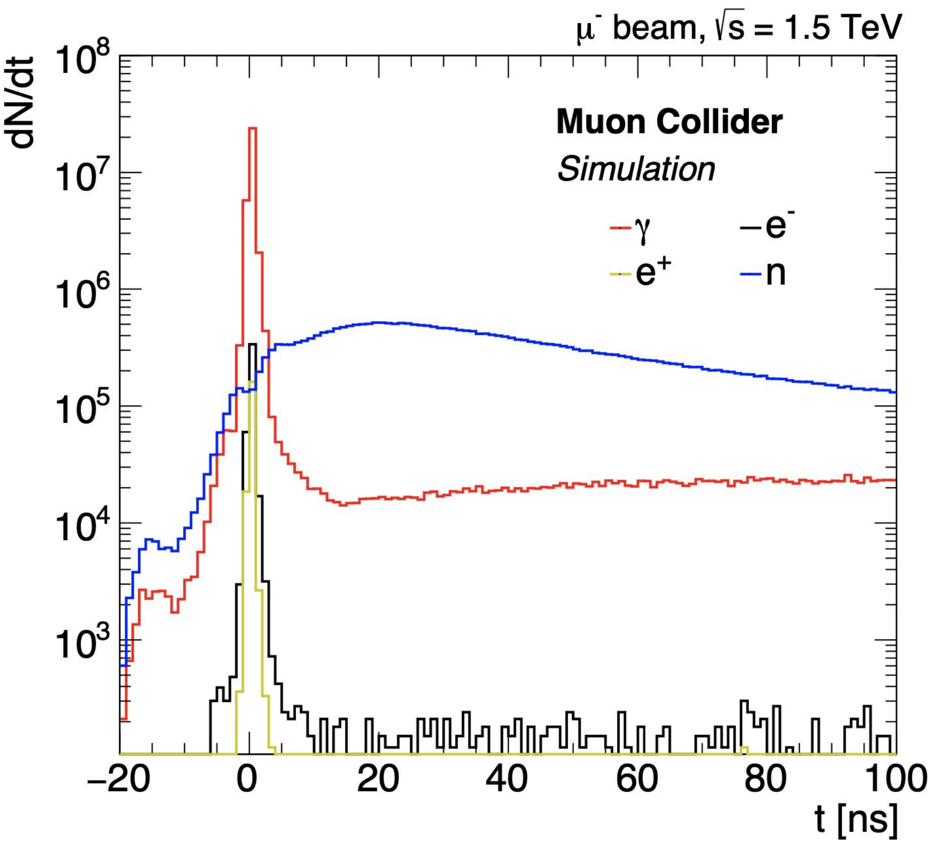


Longitudinal entry in detector volume

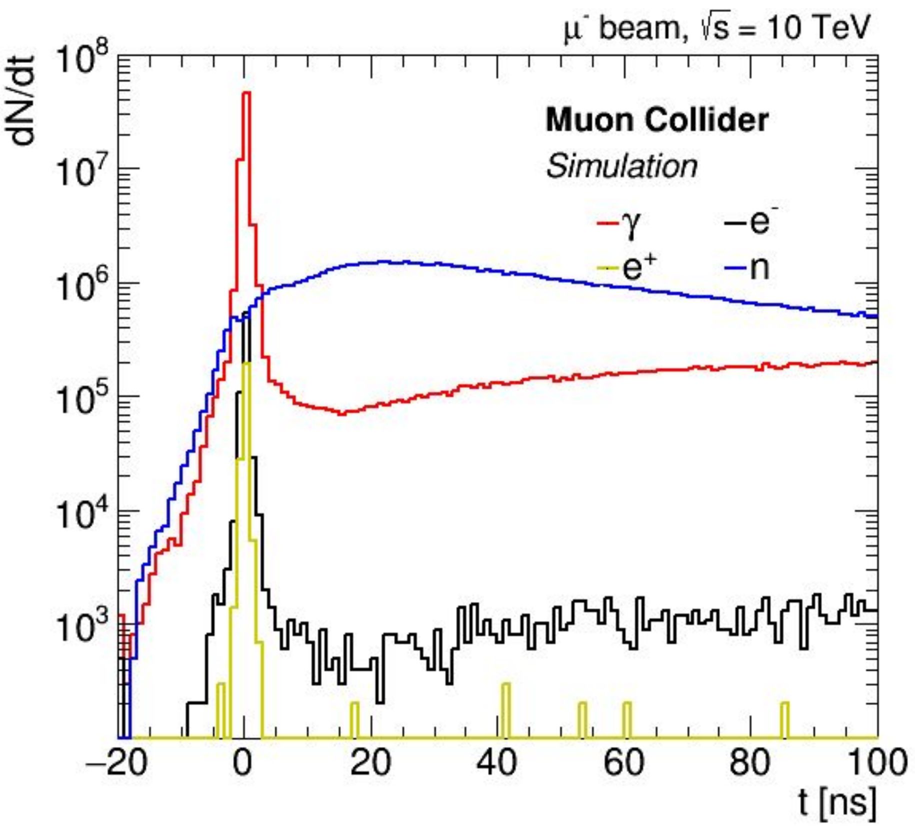




Time

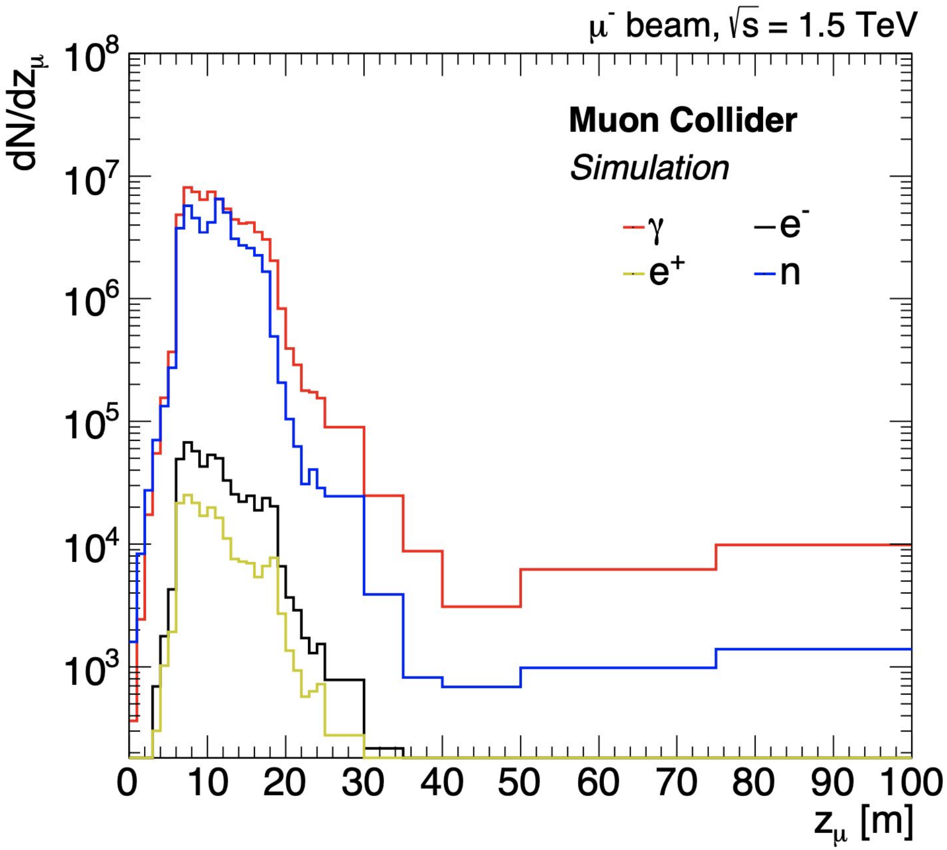


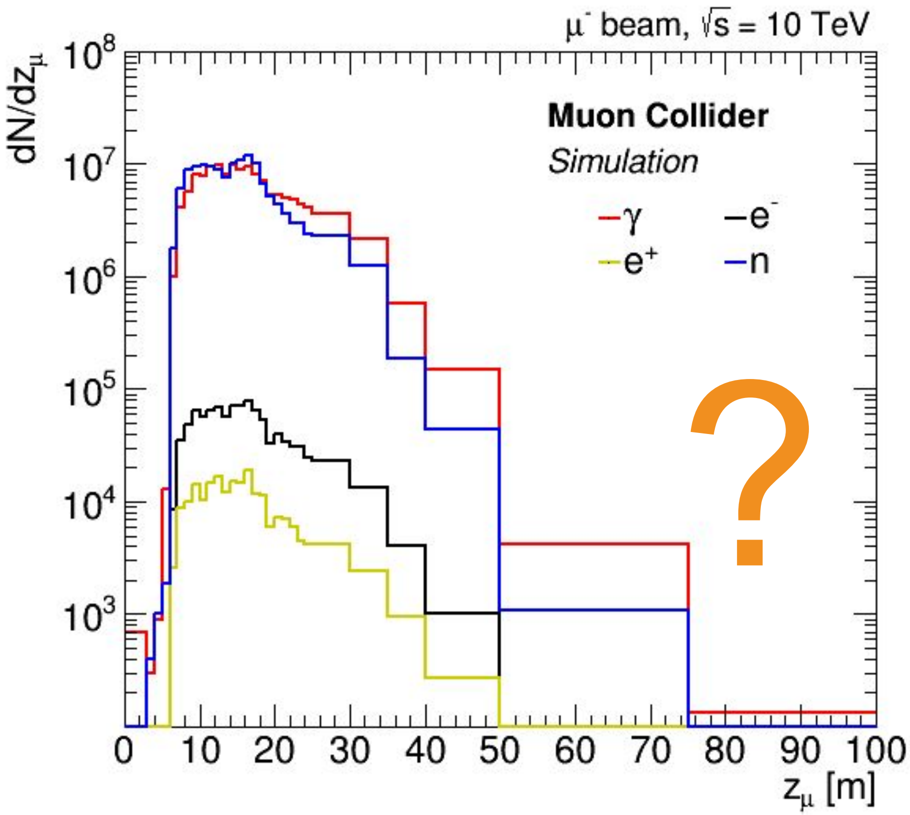
μ⁻ beam, √s = 1.5 TeV
Muon Collider
Simulation
γ
e⁻
e⁺
n
dN/dt
t [ns]



μ⁻ beam, √s = 10 TeV
Muon Collider
Simulation
γ
e⁻
e⁺
n
dN/dt
t [ns]

Muon longitudinal decay position

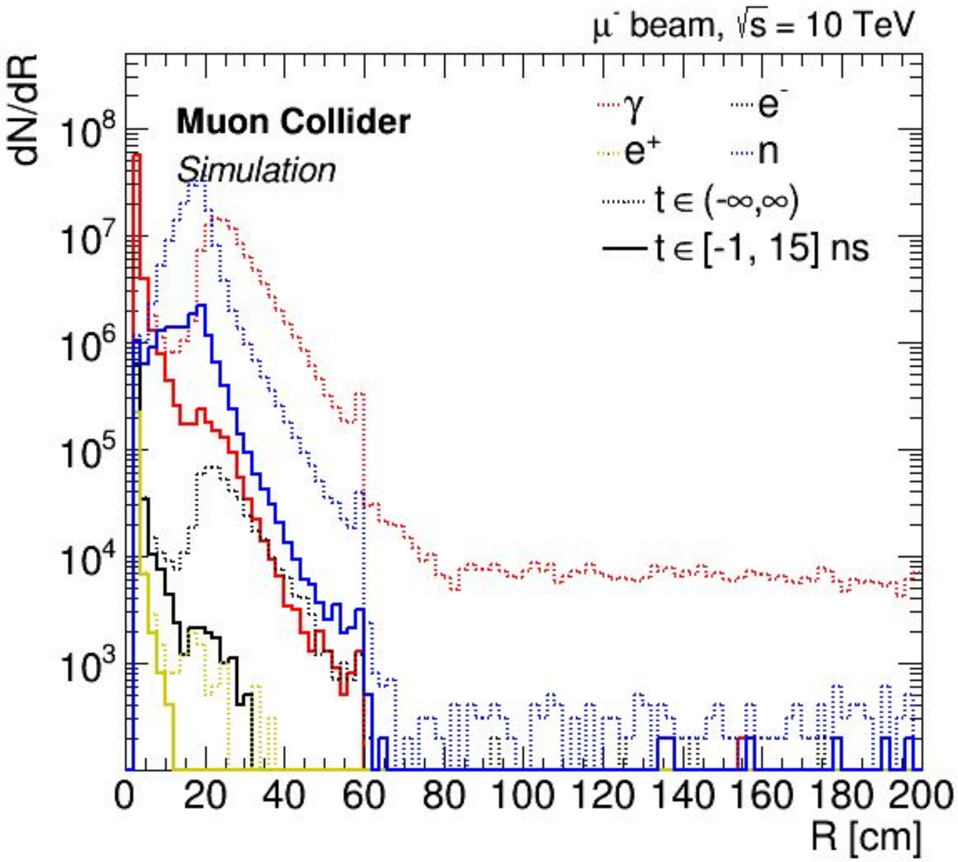


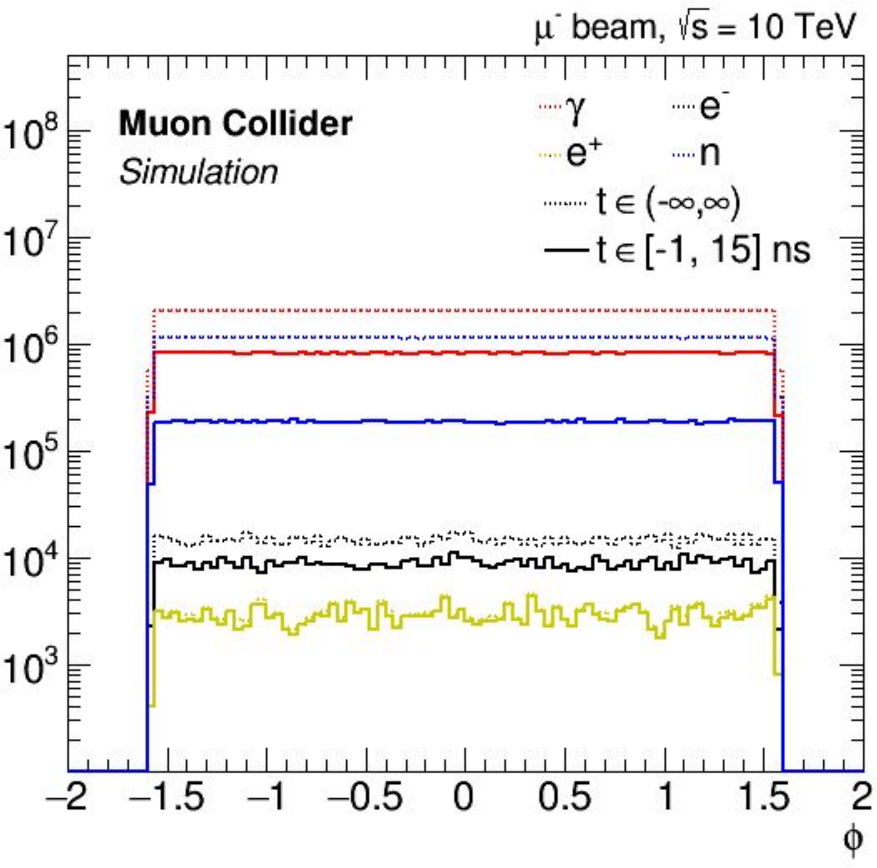


Daniele tells me this is correct and the old one was not.

Extras

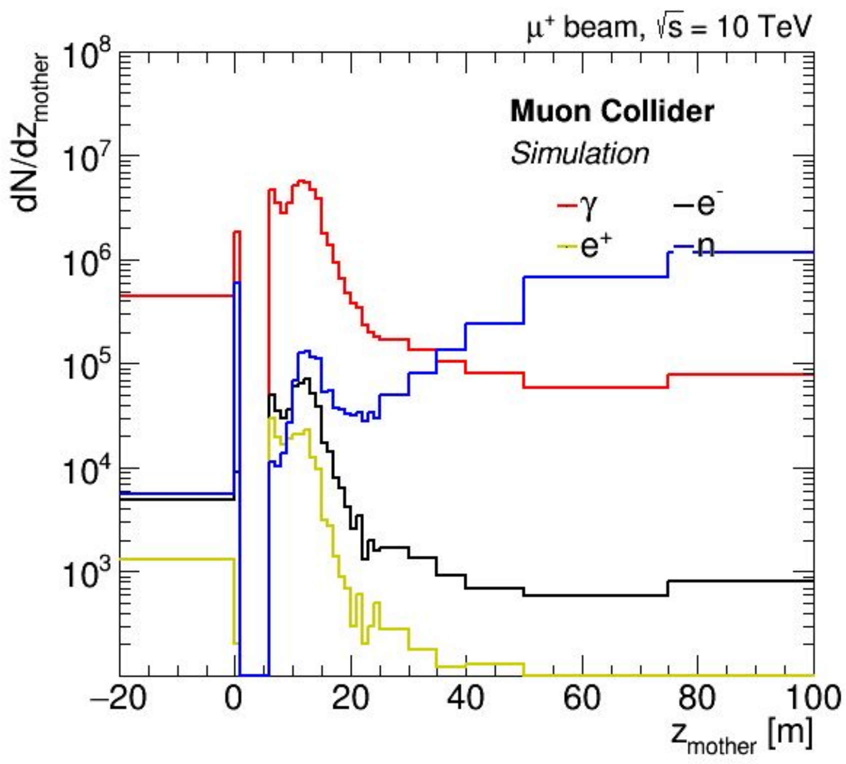
No comparison with EPJC report



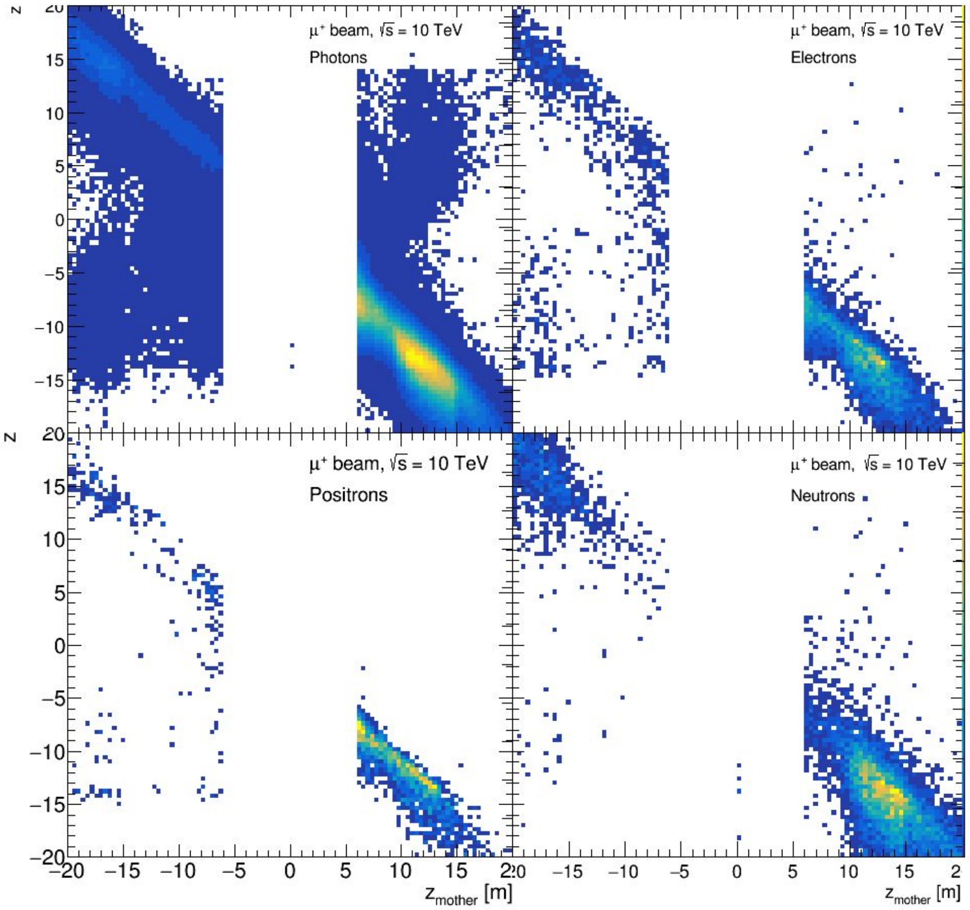


Entrance and exit correlations

No comparison with EPJC report



Here the mother is defined as the particle that enters the nozzle material without exiting if not in the detector volume



Didn't digest this plot yet…

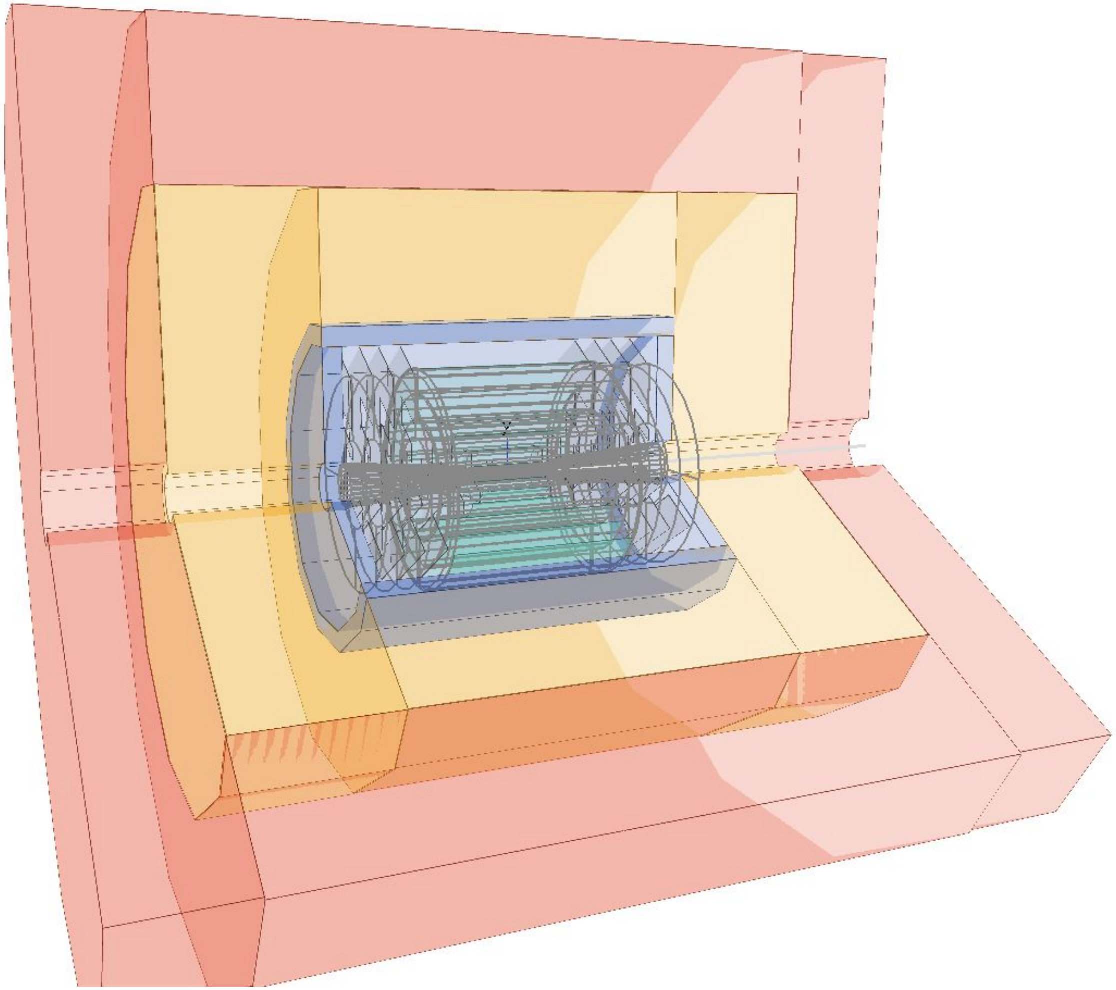
10 TeV detector geometry (MuColl10_v0B)

Fixed a number of issues wrt to initial draft at KITP.

- Added back forward HCAL
- Yoke is technically useless, but kept it in to have a muon system

Iterating with Thomas Madlener (DESY) to implement toroidal magnetic field in outer region.

→ will then remove yoke and add tracking layers for muon spectrometer



Solenoids: field, thickness and aperture

Based on emails with Luca Bottura, Herman Ten Kate, Akira Yamamoto and the PDG

1. The conductor consisting of the current-carrying superconducting material (usually Nb-Ti/Cu) and the quench protecting stabilizer (usually aluminum) are wound on the inside of a structural support cylinder (usually aluminum also). The coil thickness scales as B^2R, so the thickness in radiation lengths (X_0) is

$$t_{\rm coil}/X_0 = (R/\sigma_h X_0)(B^2/2\mu_0)\ , \qquad (34.47)$$

where $t_{\rm coil}$ is the physical thickness of the coil, X_0 the average radiation length of the coil/stabilizer material, and σ_h is the hoop stress in the coil [308]. $B^2/2\mu_0$ is the magnetic pressure. In large detector solenoids, the aluminum stabilizer and support cylinders dominate the thickness; the superconductor (Nb-TI/Cu) contributes a smaller fraction. The main coil and support cylinder components typically contribute about 2/3 of the total thickness in radiation lengths.

Atomic and nuclear properties of aluminum (Al)

Quantity	Value	Units	Value	Units
Atomic number	13			
Atomic mass	26.9815385(7)	g mol^{-1}		
Density	2.699	g cm^{-3}		
Mean excitation energy	166.0	eV		
Minimum ionization	1.615	MeV g^{-1}cm^2	4.358	MeV cm^{-1}
Nuclear interaction length	107.2	g cm^{-2}	39.70	cm
Nuclear collision length	69.7	g cm^{-2}	25.81	cm
Pion interaction length	136.6	g cm^{-2}	50.62	cm
Pion collision length	95.6	g cm^{-2}	35.41	cm
Radiation length	24.01	g cm^{-2}	8.897	cm
Critical energy	42.70	MeV (for e^-)	41.48	MeV (for e^+)
Muon critical energy	612.	GeV		
Molière radius	11.93	g cm^{-2}	4.419	cm
Plasma energy $\hbar\omega_p$	32.86	eV		
Melting point	933.5	K	660.3	C
Boiling point @ 1 atm	2792.	K	2519.	C

I scaled the 3 TeV solenoid using this relation: it's thick (~3 X_0)!

Thickness	344	mm	264,90	mm
B	3,57	T	5	T
R	3821	mm	1500	mm

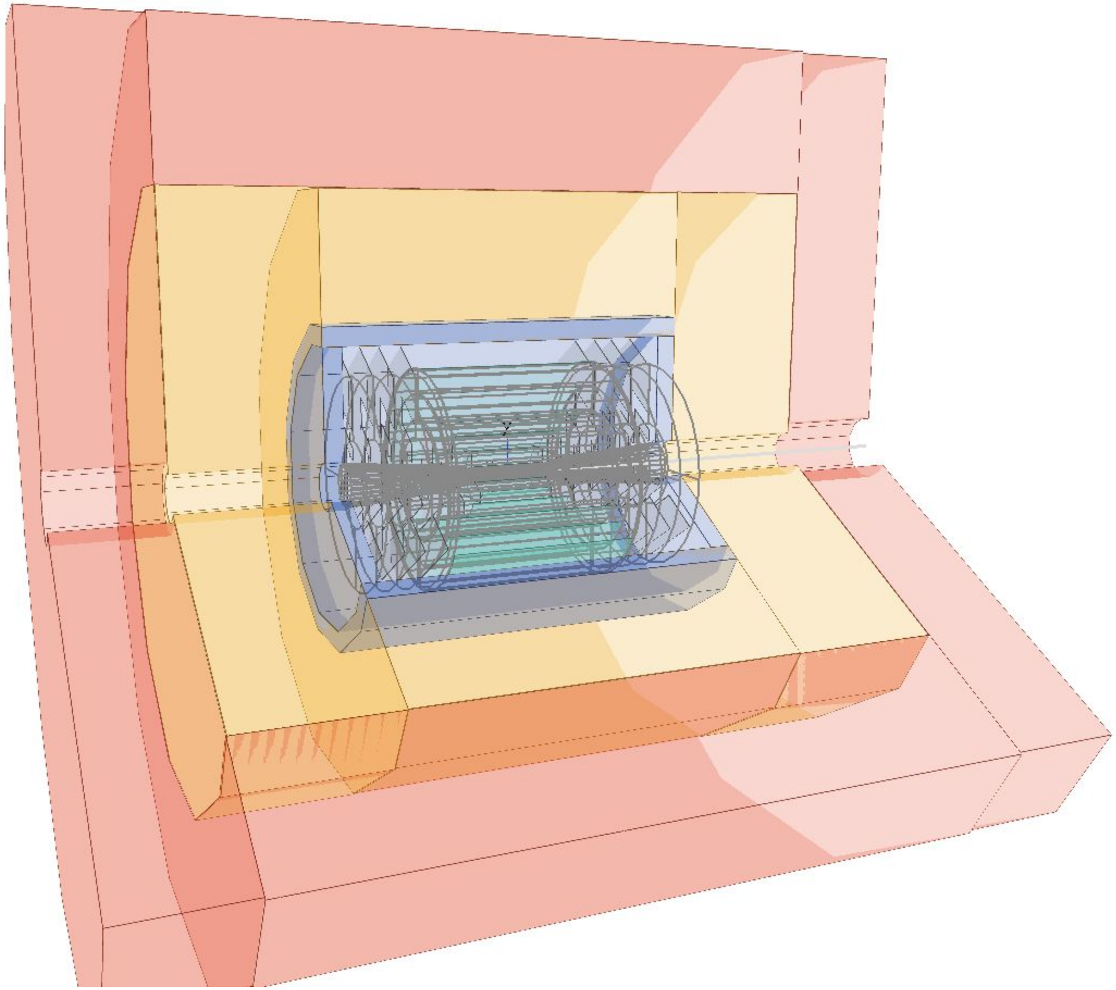
I still went on and generated the particle gun samples with this solenoid to see quantitatively how does this perform. We might go to v0A if this is too bad.

10 TeV detector geometry (MuColl10_v0B)

Wrt 3 TeV (v1 geo) made calorimeters thicker, but kept same sampling fraction

- Could be changed in the future

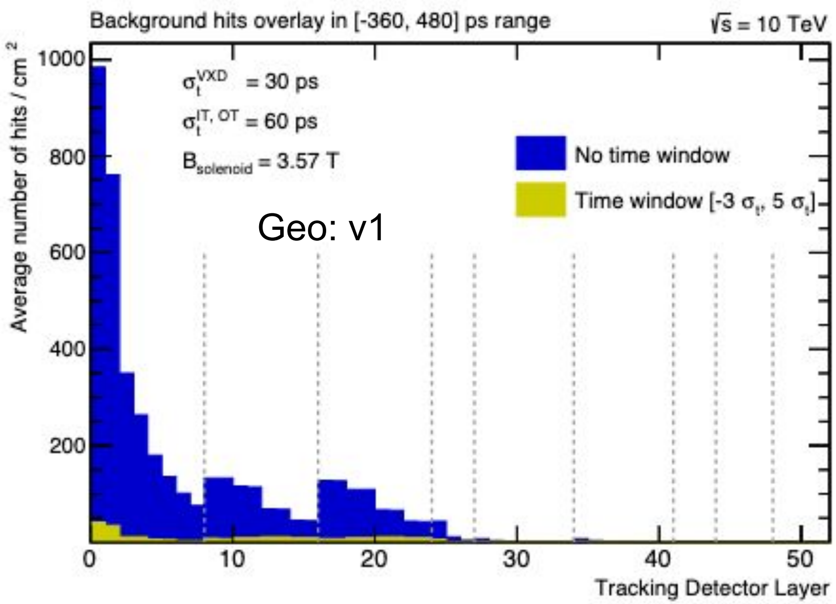
It would be incredibly useful if somebody could check my volumes in the config.xml

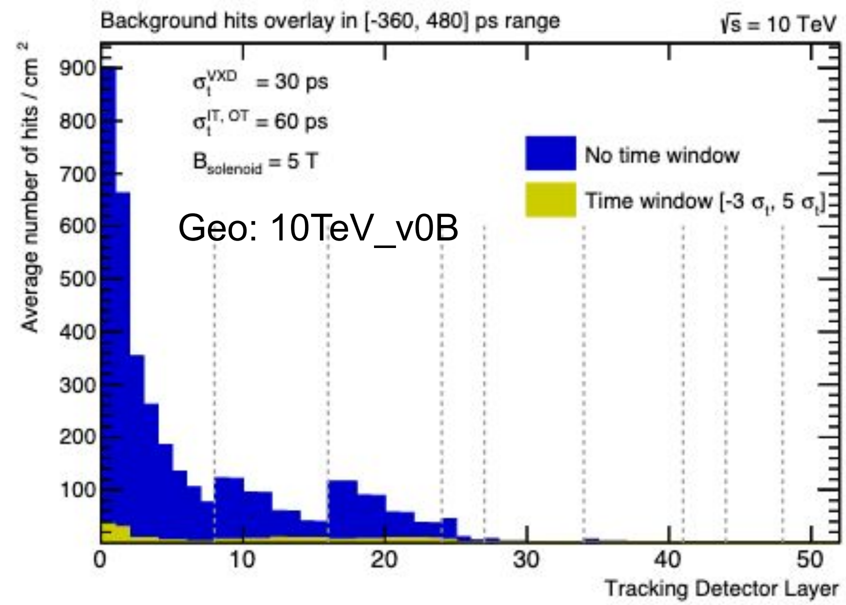


Silly stuff:

- Need a name for the detector concept
- Need a color palette (I picked this one at ~random)

Hit density in nuGun samples





5T fields has an effect of the order of 10% pre-timing

- Could keep lower field (and make a thinner solenoid!)

Timing selections seem much more effective than at 3 TeV

- Need to check/compare arrival time at detector

If result is confirmed:

- Move innermost layer closer to IP and remove double layers

Thank you!