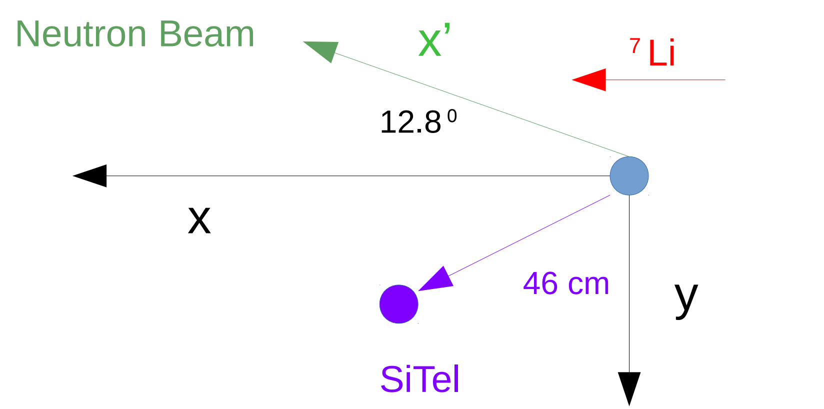
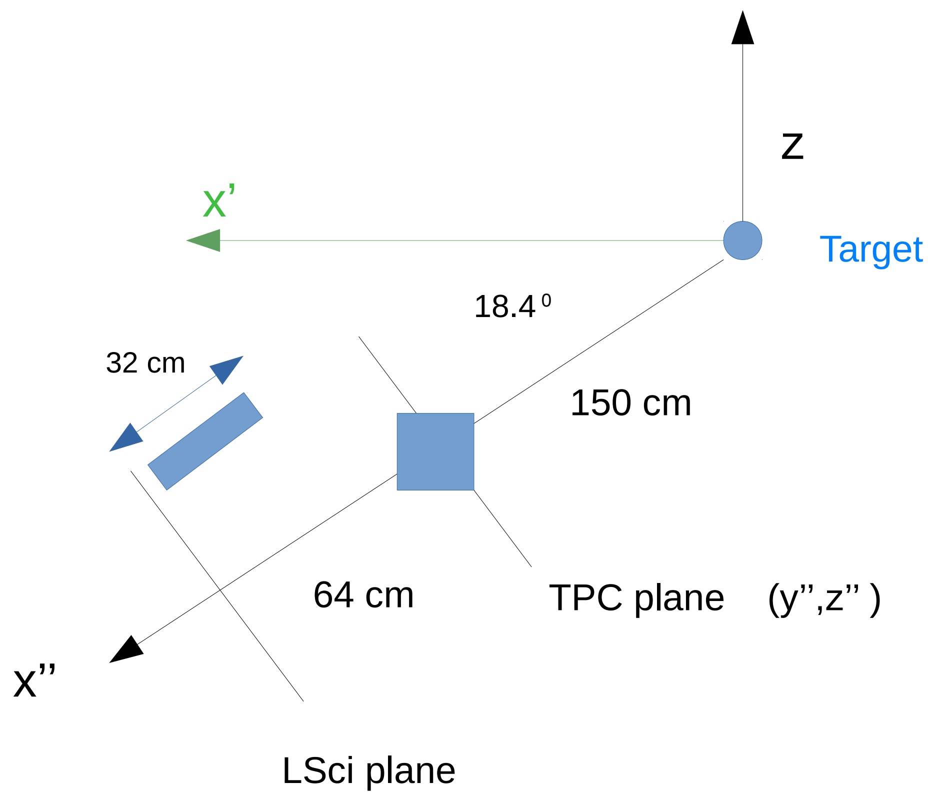
Toy MC descriptyion and comparison with LNS data

M. Ave , USP

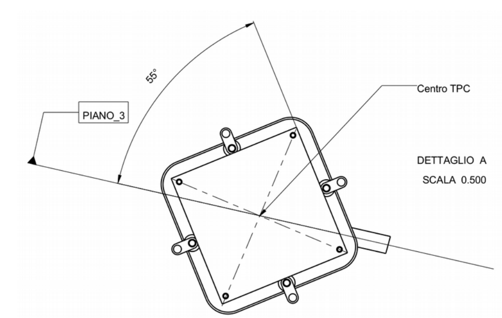
Toy MC



From Top

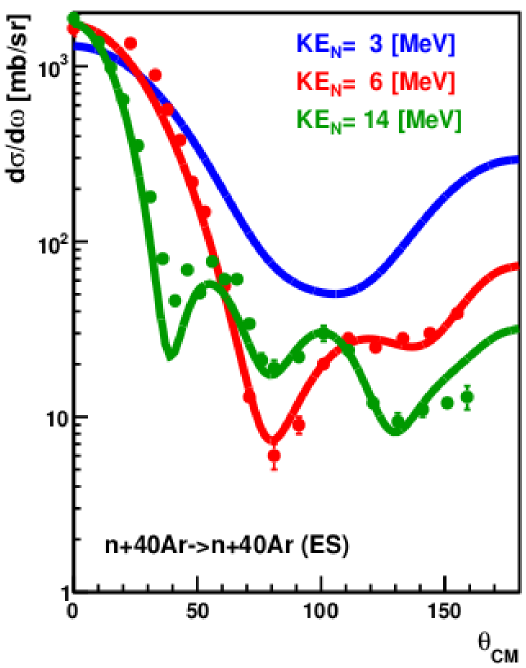


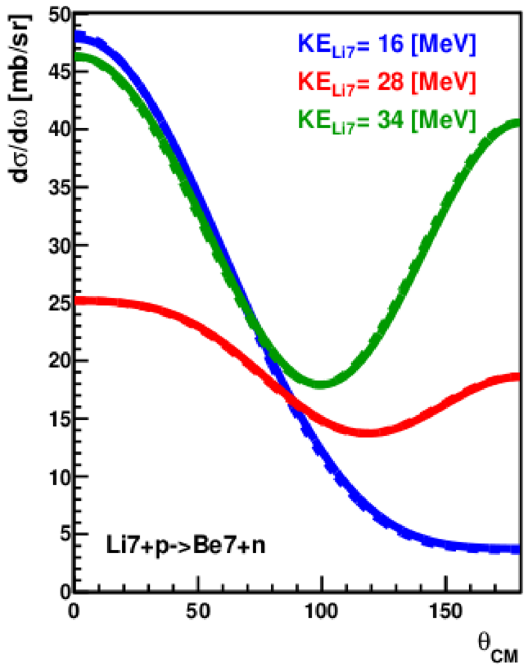
From Side

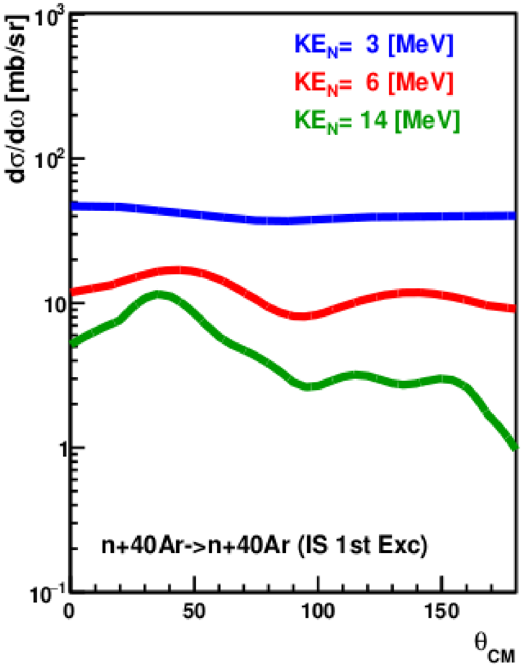


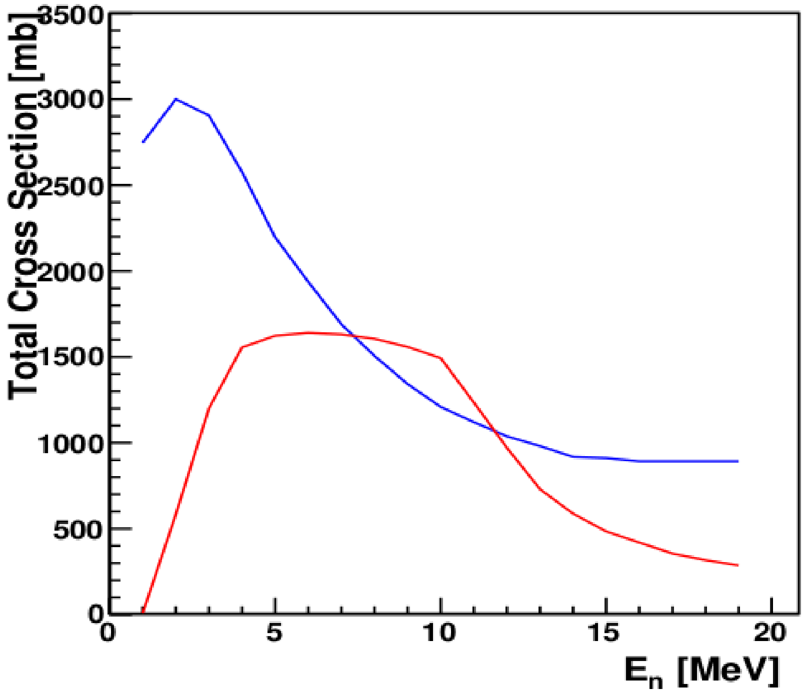
Taken into account in ToyMC

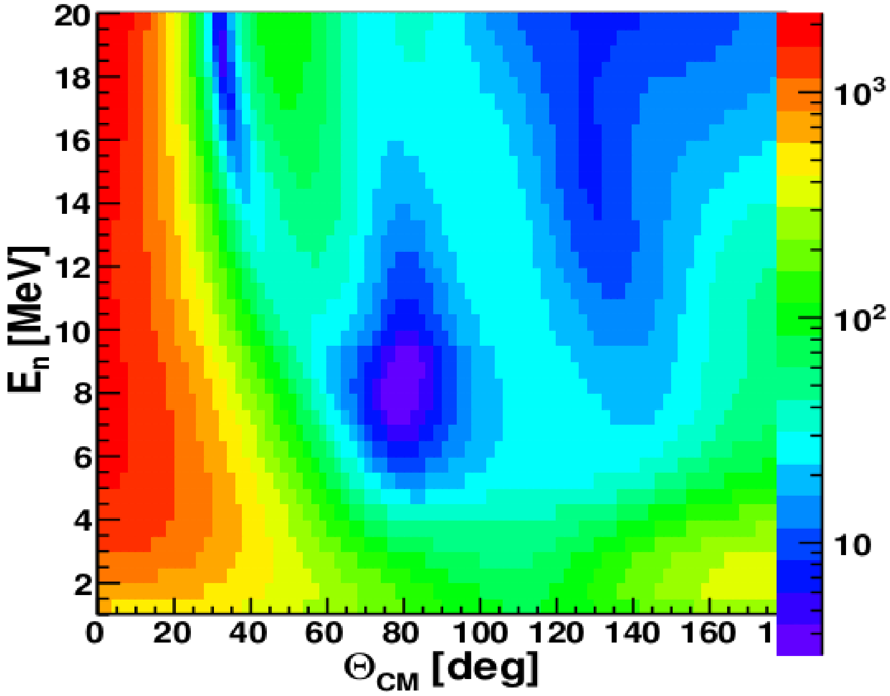
Toy MC inputs: differential cross sections











Total Elastic (blue) and inelastic (red) n+Ar cross section.

Differential Elastic n+Ar cross section.

Toy MC: flow chart

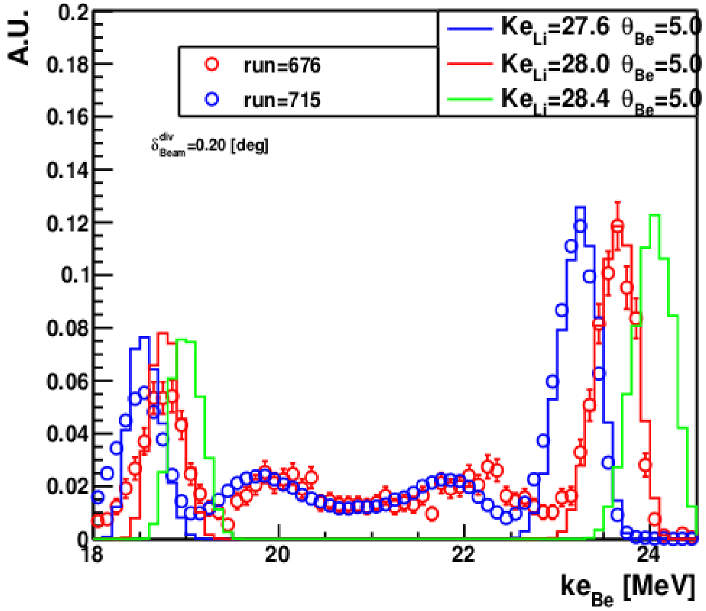
- Choose randomly (position,direction) of ^{7}Li ions in Beam Collimator entrance; uniform in r^2 and cos θ (with cut-off at beam divergence)
- Propagate ^{7}Li ions and decide if it hits the CH_2 target.
- Sample the ^{7}Be differential cross section and generate ^{7}Be direction and energy.
- Propagate ^{7}Be and decide if it hits the collimator centered at (Θ_{SiTel}, Φ_{SiTel}).
- If so, generate the corresponding neutron.

- Propagate neutrons:
  - 3D Intersection with Cryostat and TPC: **pathlength in LAr.**
  - Neutron interaction in LAr using interaction lengths for elastic and inelastic scattering.
  - Deflect neutron : using differential cross sections.
  - Propagate scattered and un-scattered neutrons to the Wheel plane.

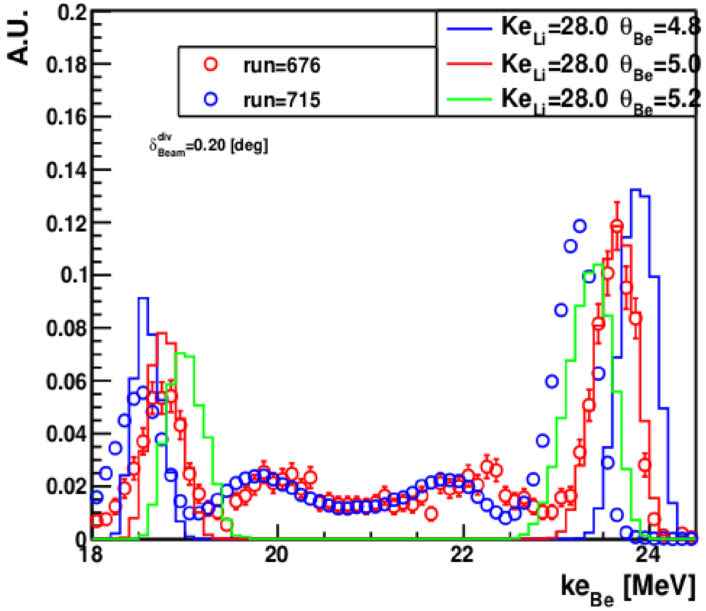
- Calculate fraction of neutrons intersecting TPC (geom. eff.), interacting inside and within the relevant recoil energy range.
- Calculate the ^{7}Be rate per nA using MC.

Toy MC: changes in the ^{7}Be spectrum with beam parameters

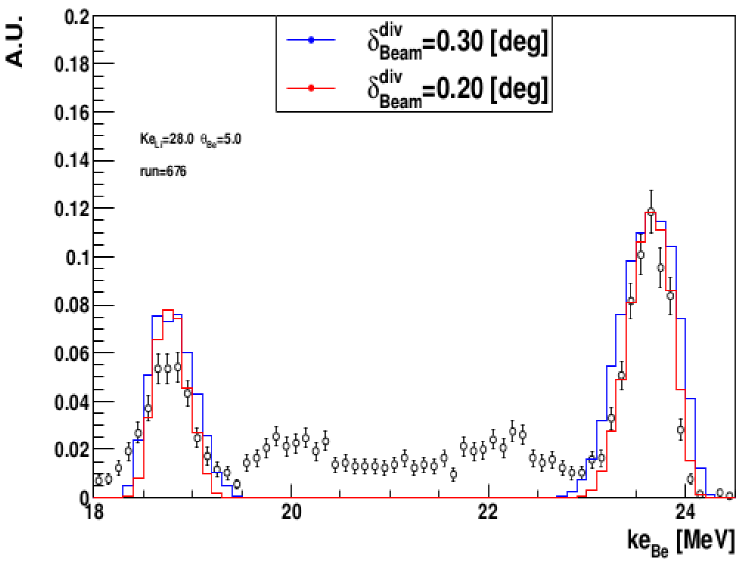
Beam energy



Θ_{SiTel}



Beam divergence



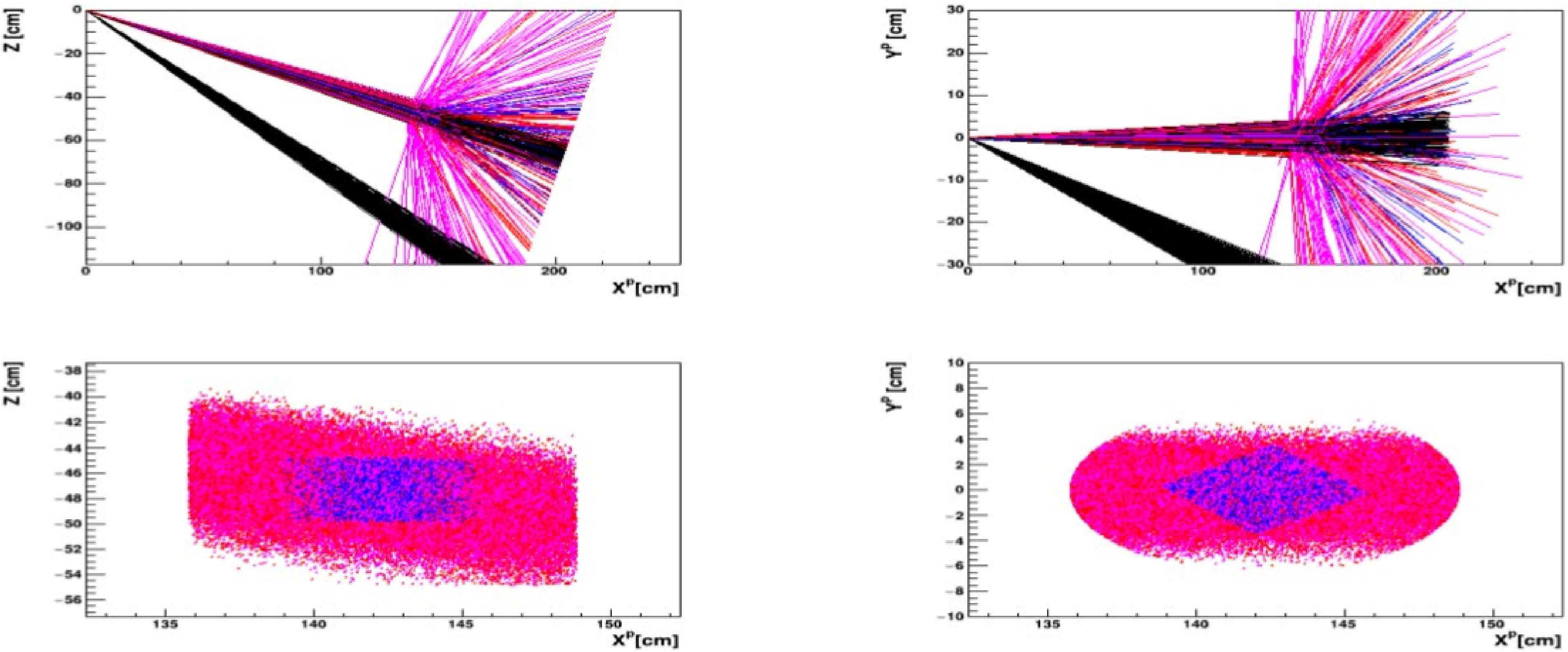
The spectrum not sensitive to Φ_{SiTel}

Toy MC: ^{7}Be rate

Table 1: The rate of the ^{7}Be events in the low energy peak as measured in the september shift and predicted by MC.

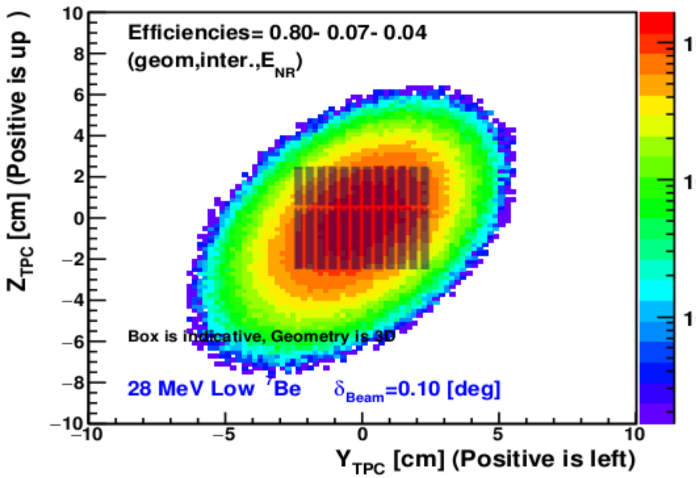
	Run 645 (Data/MC)	Run 715 (Data/MC)
Rate [Hz/Hz^{mon}]	17.21/—	10.41/—
Rate [Hz/nA]	4.9/5.1	3.0/3.6

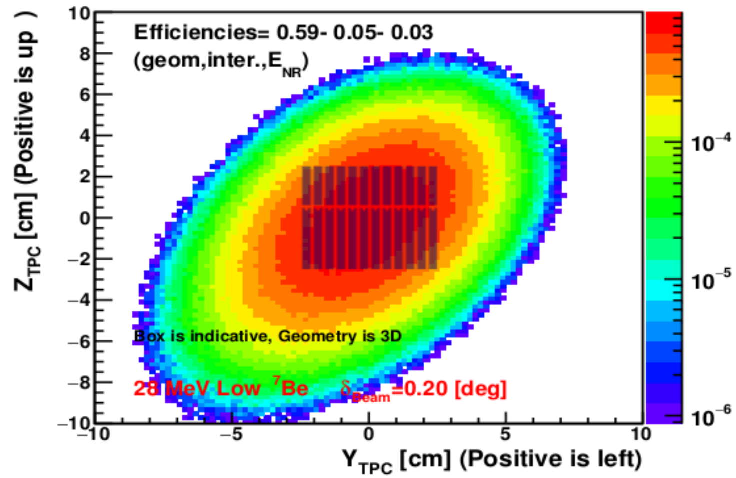
Toy MC: example of neutron propagation



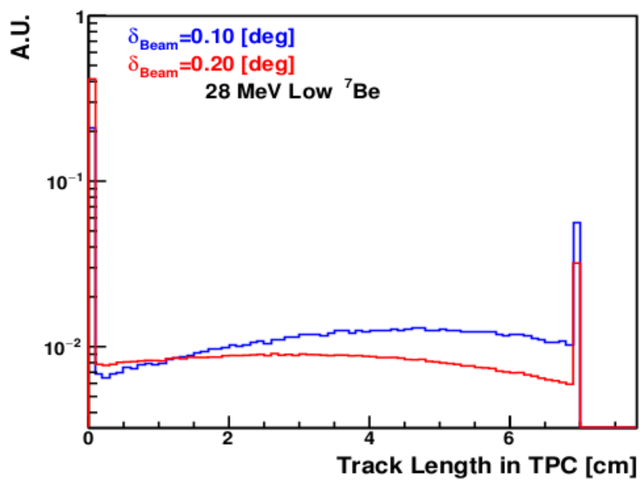
E_{Li} = 28 MeV
Low/High ^{7}Be blobs
$\Theta_{SiTel}=5.15^0$

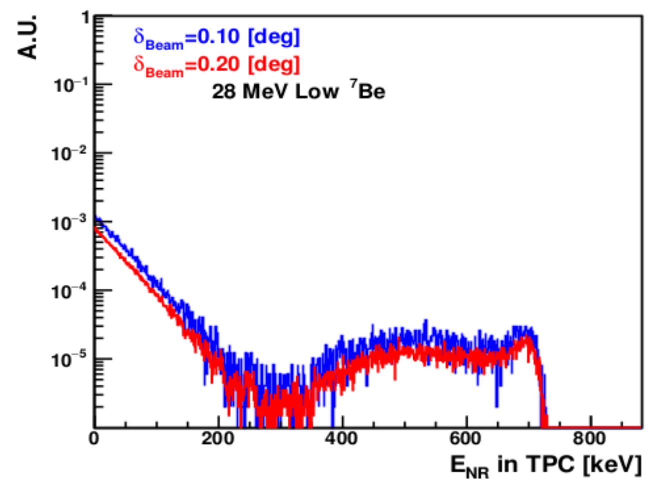
Toy MC: neutron beam at the TPC plane





E $_{Li}$ = 28 MeV
Low ^{7}Be blob
Θ_{SiTel}=5.15^{0}



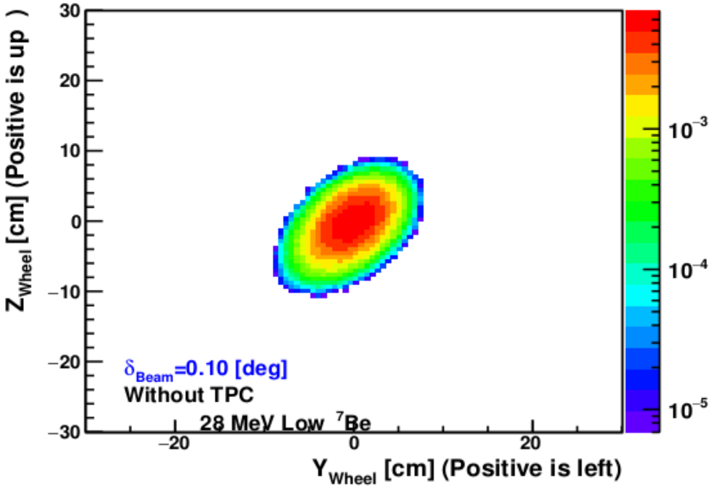


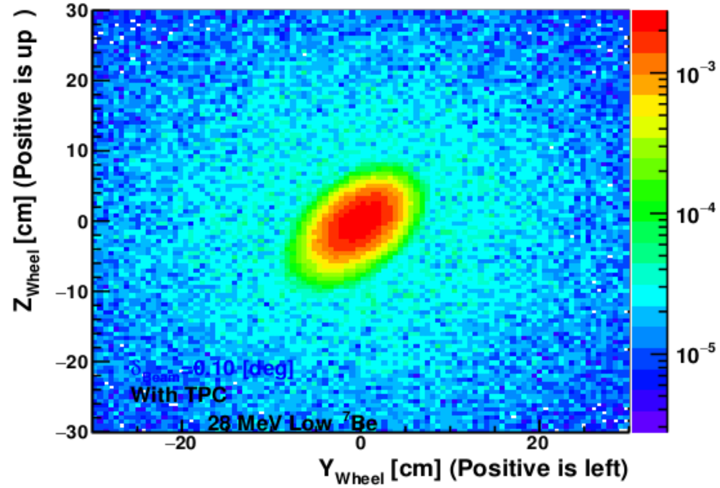
60-80% geometrical interception depending on beam divergence.

Toy MC: neutron beam at the Wheel plane

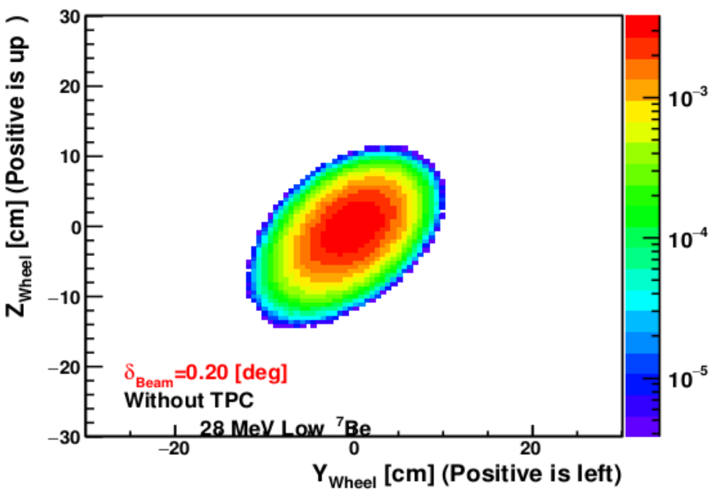
E_{Li} = 28 MeV
Low ^{7}Be blob
Θ_{SiTel}=5.15^0

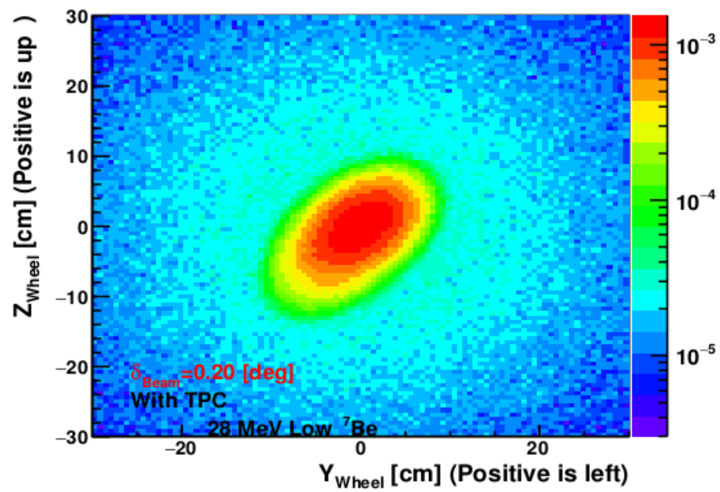
Without TPC | **With TPC**





Beam Divergence 0.1^0

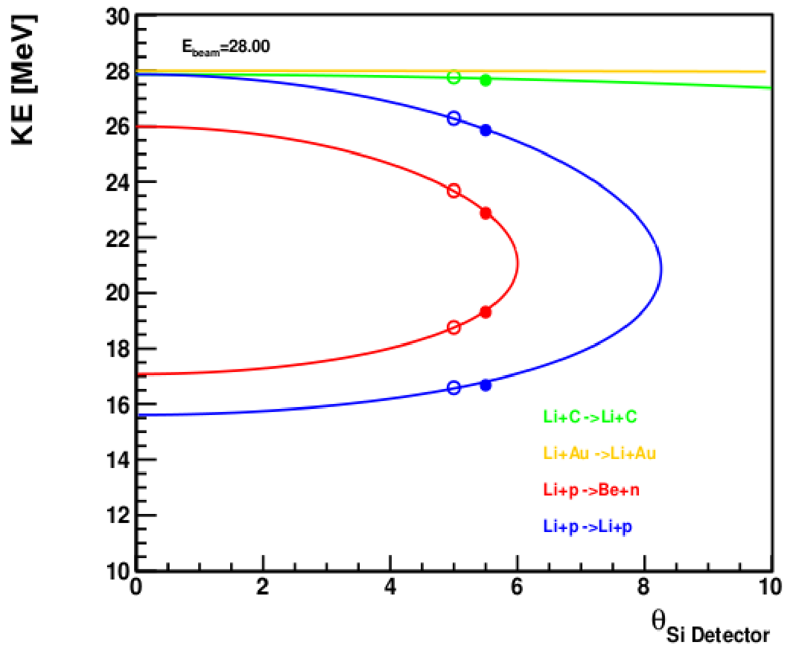


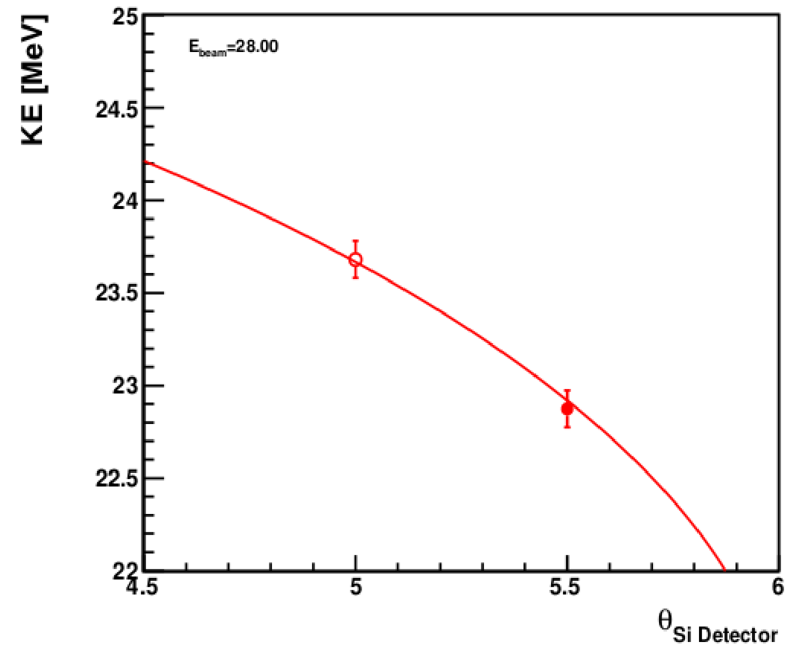


Beam Divergence 0.2^0

LNS September data: SiTel position calibration

Θ_{SiTel}

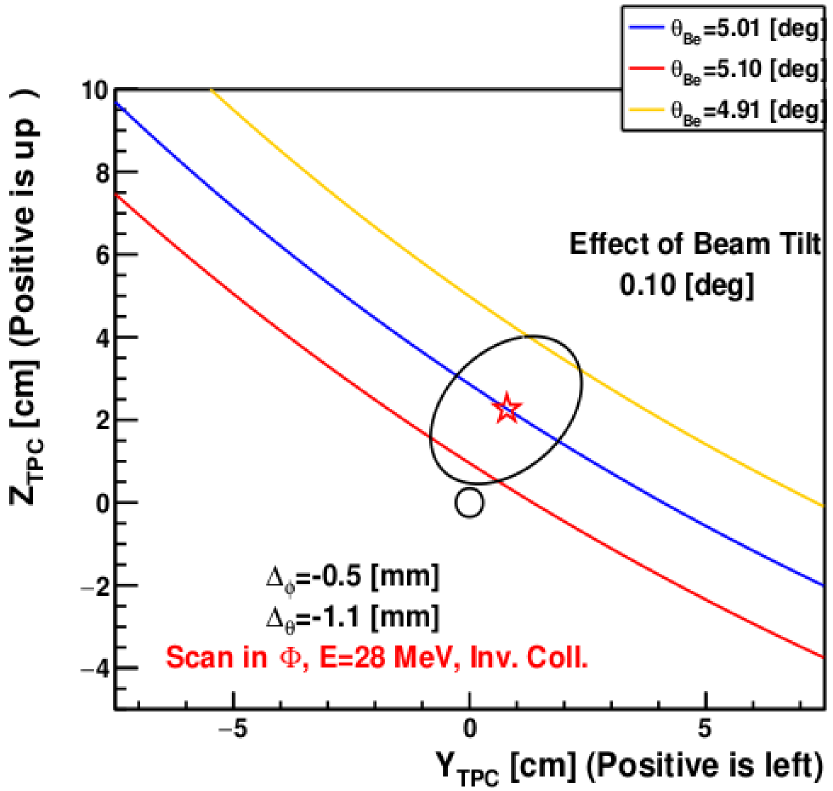


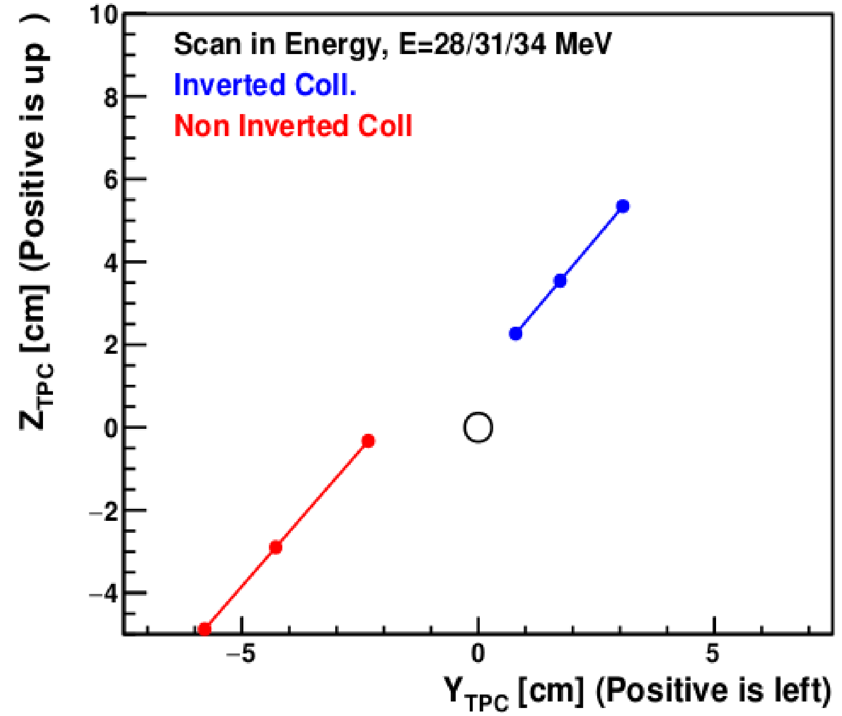


Solid markers : normal collimator
Empty markers: inverted collimator

Optimum value Θ_{SiTel} =5 [deg] (inverted)

Φ_{SiTel}



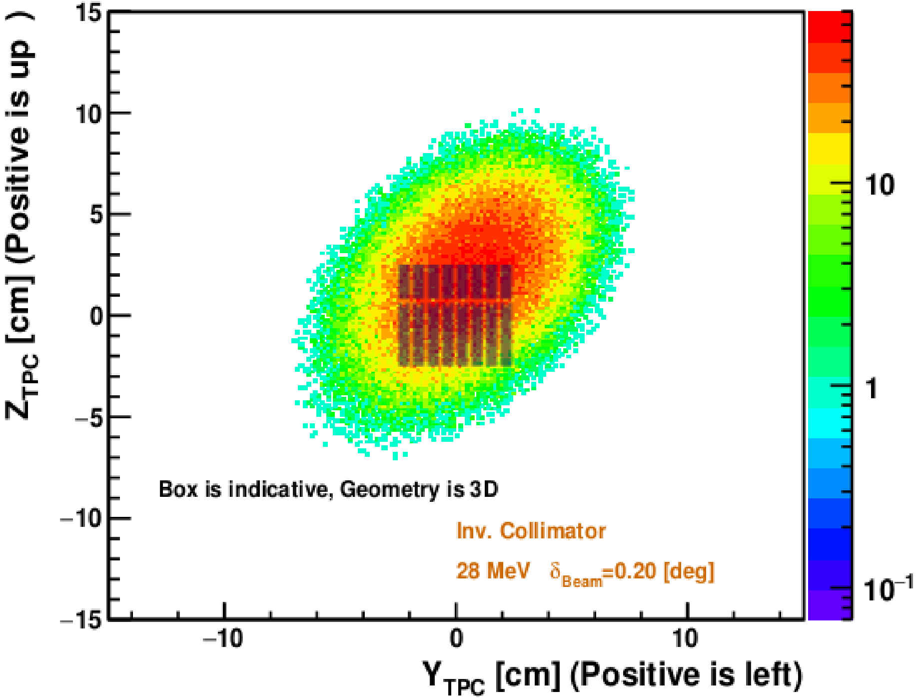


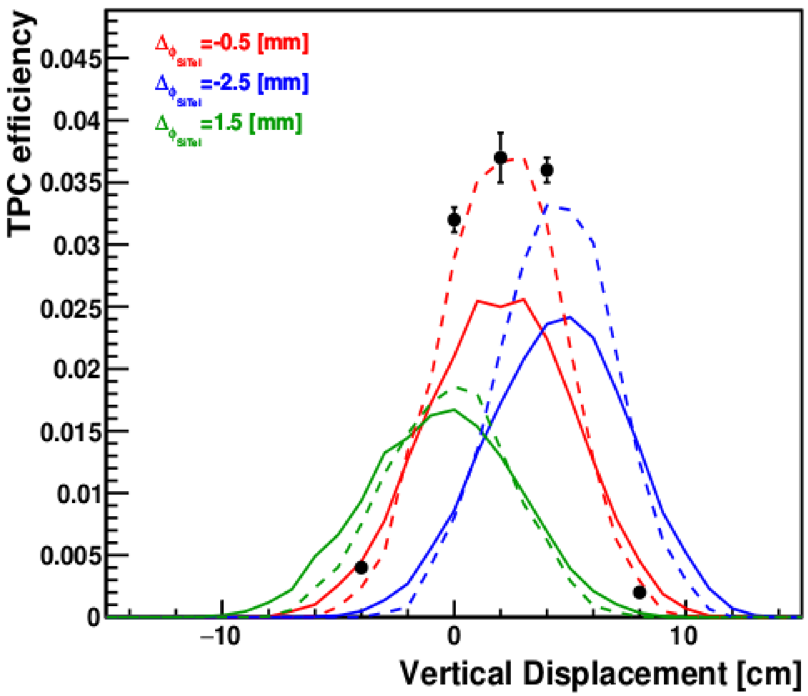
Sctan in Φ_{SiTel} : each line corresponds to a fixed value of Θ_{SiTel}

Scan in Energy : red (blue) is inverted (nominal) collimator, Φ_{SiTel} is -1.1 mm.

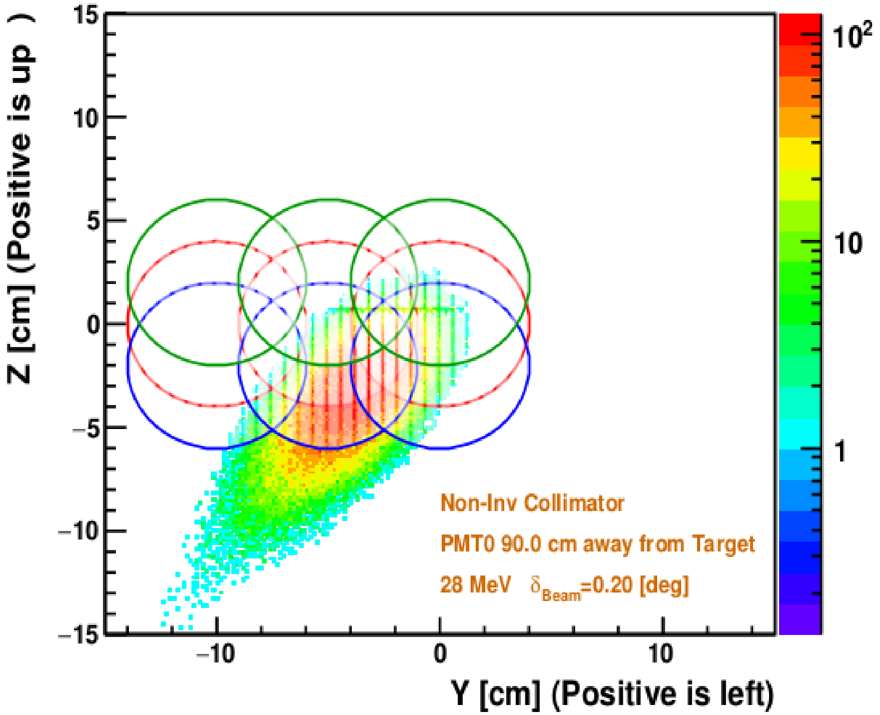
Use a vertical scan with TPC to fix Φ_{SiTel}

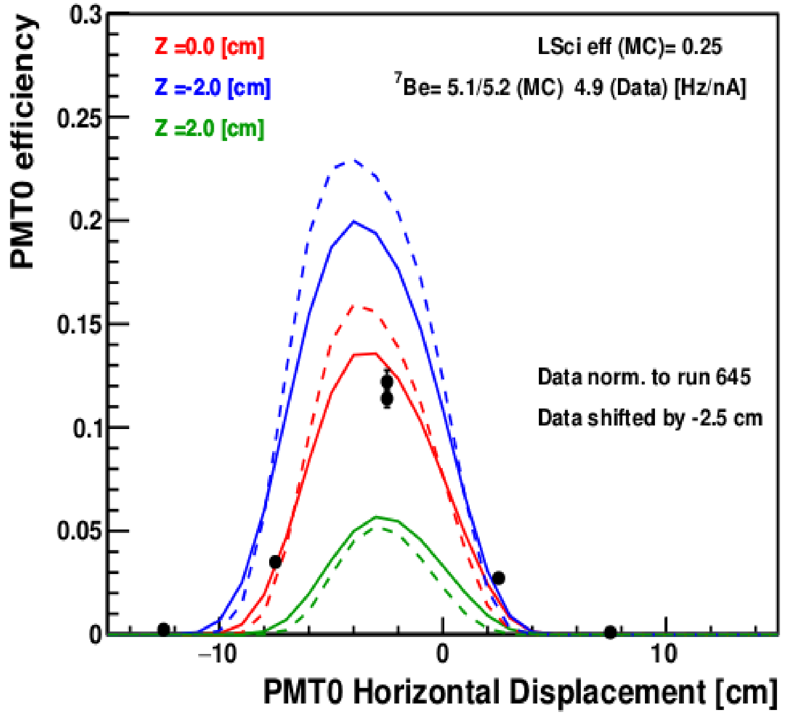
Φ_{SiTel} = -0.5 mm





PMT0 horizontal scan close to Scattering Chamber

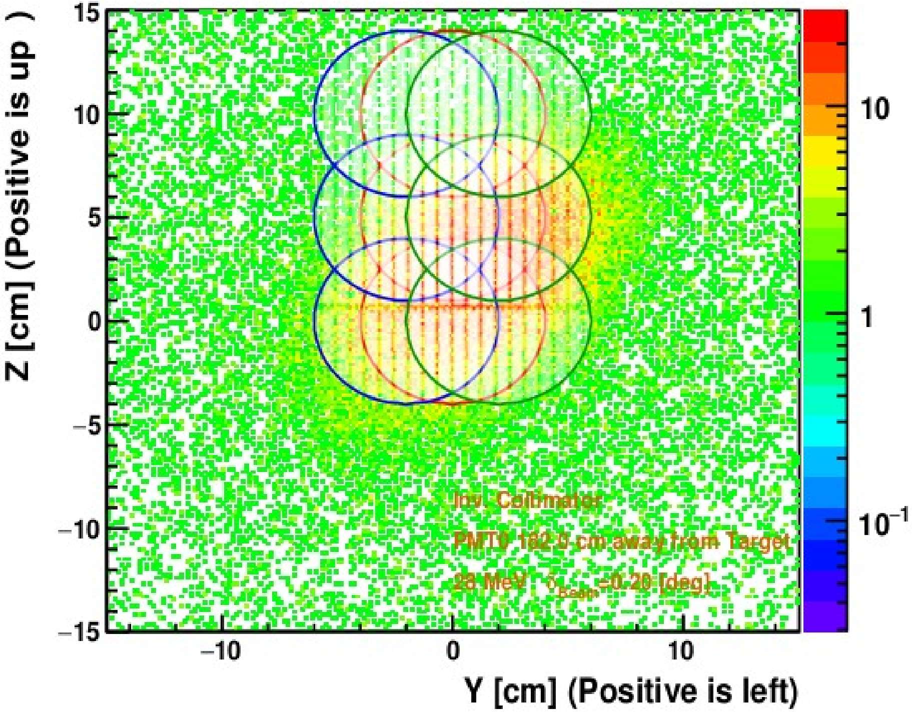


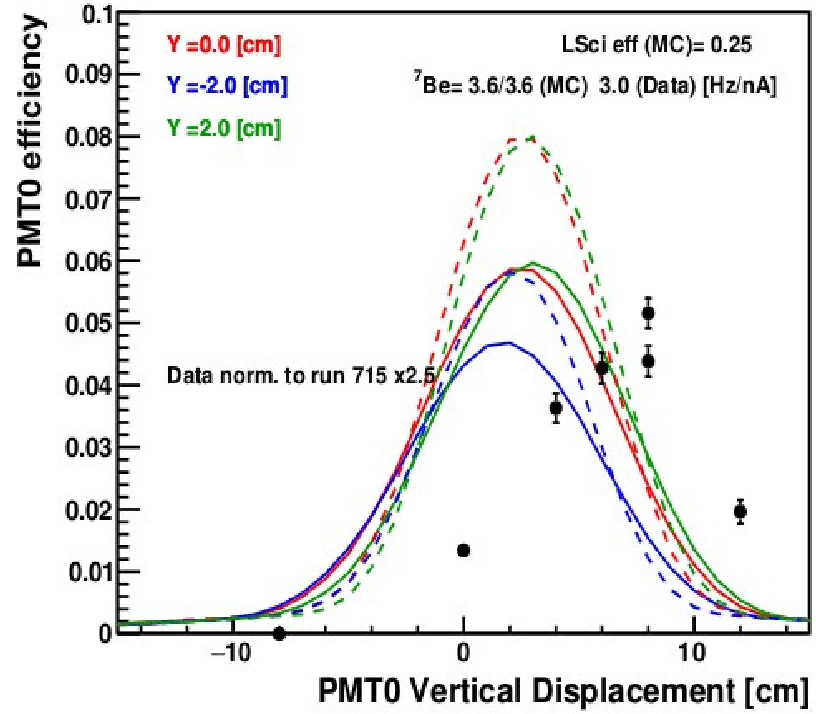


Overall good agreement but difficult to derive conclusions due to uncertainties in PMT0 placement at the level of 2 cm.

25% LSCi neutron efficiency assumed.

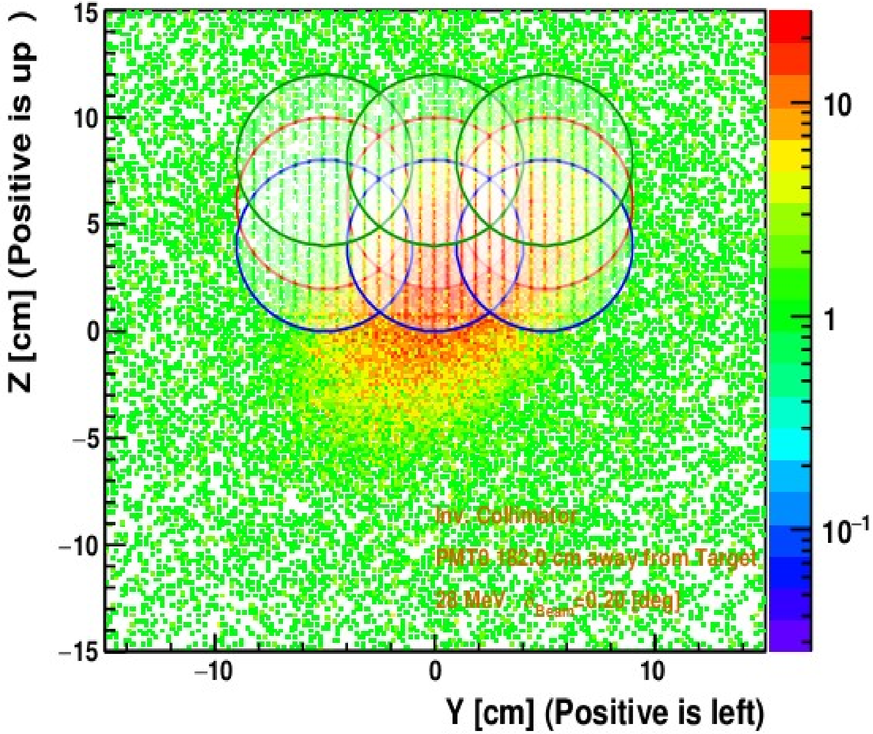
PMT0 vertical scan at the Wheel

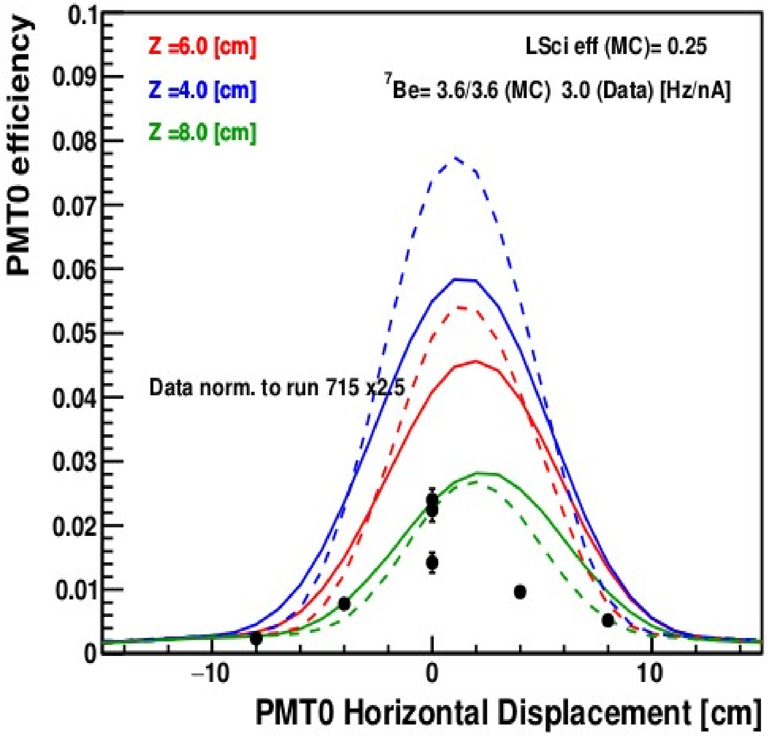




- There is a 5 cm displacement between data and prediction from MC (which uses **Φ** $_{SiTel}$ from TPC vertical scan): it indicates relative missalignment of PMT0 and TPC.
- PMT0 efficiency in the plot has been renormalized by a 2.5 factor, i.e. LSCi efficiency 10%.

PMT0 horizontal scan at the Wheel





Overall good agreement with previous scan but difficult to derive conclusions due to uncertainties in bar placement at the level of 2 cm.

Conclusions

- We presented a procedure to calibrate θ_{SiTel} and ϕ_{SiTel} based on the Be band spectrum and a TPC vertical scan. The results can be strengthed if the XY position of the recoils in the TPC is used.
- Neutron beam shape can reduce the TPC coincidence rate by at most a factor of 2.
- Horizontal (vertical) neutron beam displacement w.r.t to the TPC center is 0.8 (2.2) cm for the *inverted* collimator.
- It is plausible that there is relative missalignment between TPC and LSCi wheel of $\sim$5 cm.
- Either the Toy MC is substantially wrong or the LSci neutron detection efficiency is lower than expected.

Future work

- Neutron detection efficiency of LSci.
- Implement in the ToyMC the other LSci and check if the efficiency is consistent.