Target

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- Basics
- MS considerations
- Other considerations (C. Lourenco)

Basics

- The target should be enough heavy to have high statistics; should be enough light to have low Multiple Scattering; Energy Loss; background effects.
- Statistics goes with

$$N = N_{\mu} \cdot \sigma \cdot n\ell \cdot \Delta t$$

Incoming beam intensity

Cross section

Target number density and target length

Running time

$$\text{number of scattering centers: } n = \frac{\rho N_A Z}{A}$$

(N_A=Avogadro number; density, Z and A of target)

Basics

Material	Z	ρ	Z/A	N=ρ*Z/A	Stat	X0 (cm)	√n*X0
Be	4	1.85	0.44	0.814	1	35,24	35.24
C	6	2.2	0.5	1.1	1.35	19.4	22.5
Al	13	2.7	0.48	1.296	1.6	8.9	11.22
Si	14	2.3	0.5	1.165	1.43	9.36	11.2

60 cm Be -> 0.2% on a_μ^{HLO}

$\sigma_{stat} \sim 1/\sqrt{n}$; $\sigma_{syst} \sim 1/X0 \rightarrow \sigma_{stat} * \sigma_{syst} \sim 1/\sqrt{n}X0$

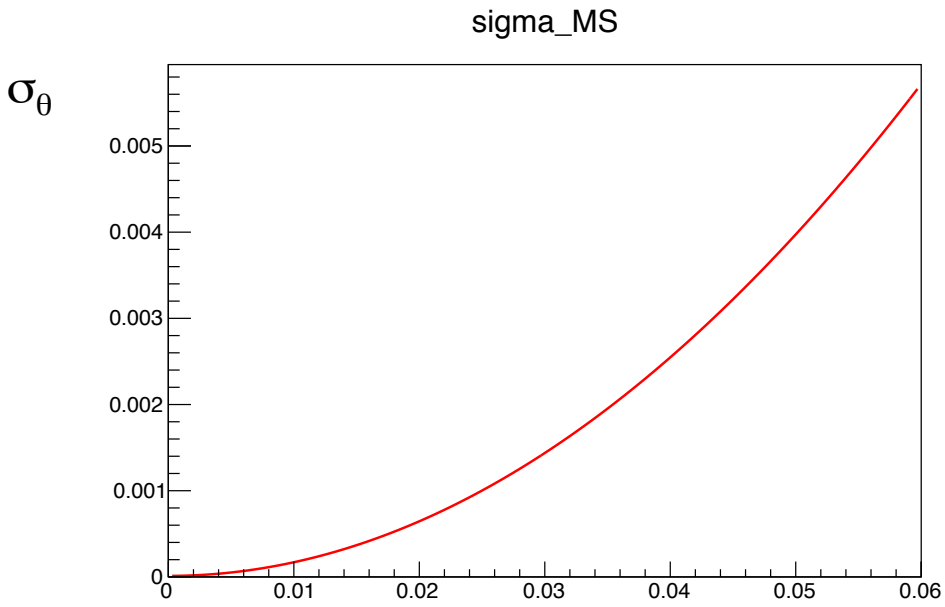
Multiple scattering

- Multiple scattering goes with

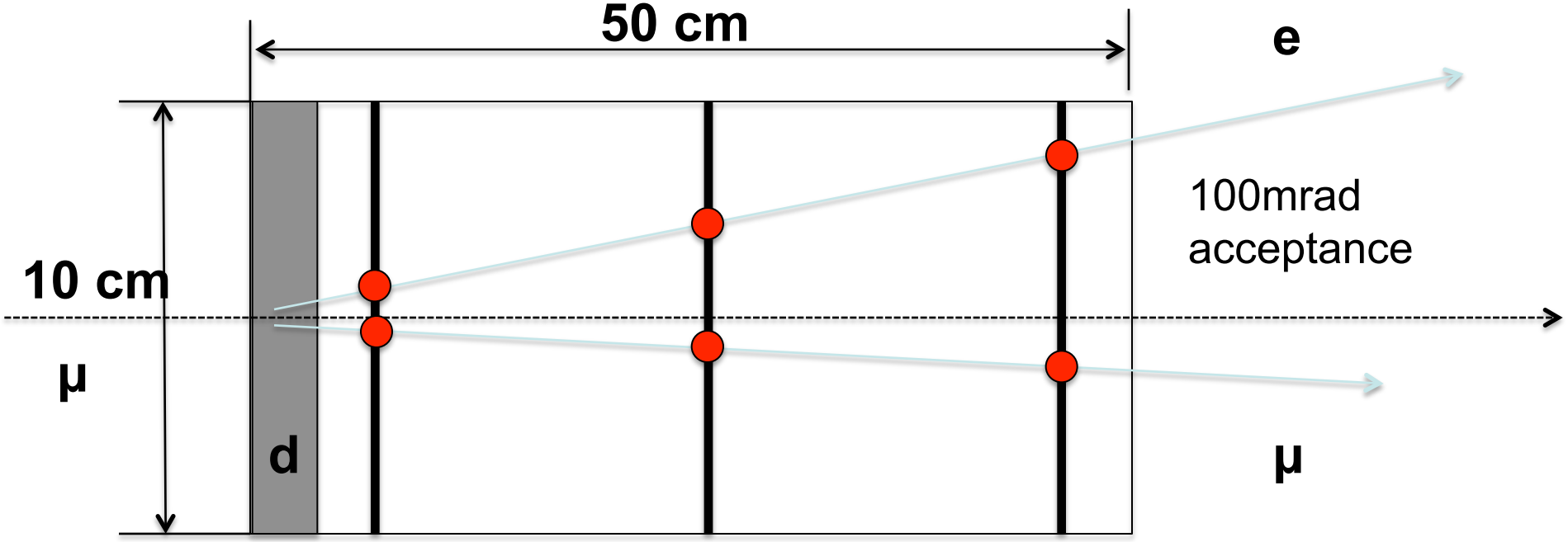
$$\sigma_\vartheta = \frac{13.6MeV}{\beta pc} z\sqrt{x / X_0}\left[1+0.038\ln(x / X_0)\right]$$

σ_θ quadratic in θ_e

Material	X0 (cm)
Be	35,24
C	19.4
Al	8.9
Si	9.36



Measuring e- and muon angle:
Repetition (x50) of this single module



Target **State-of-art Silicon strip detectors**

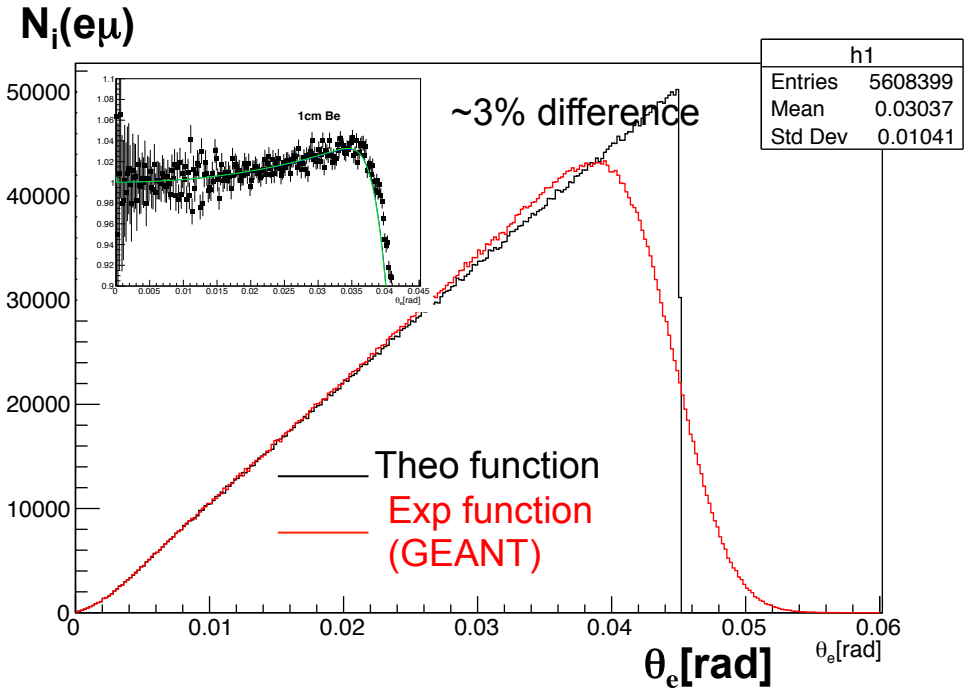
hit resolution ~10 μm

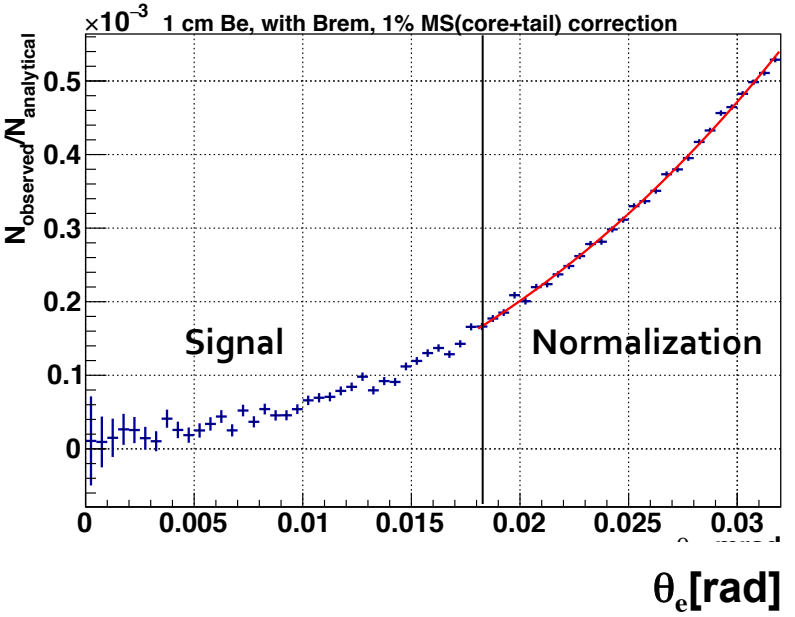
expected angular resolution ~ 10 μm / 0.5 m = 0.02 mrad

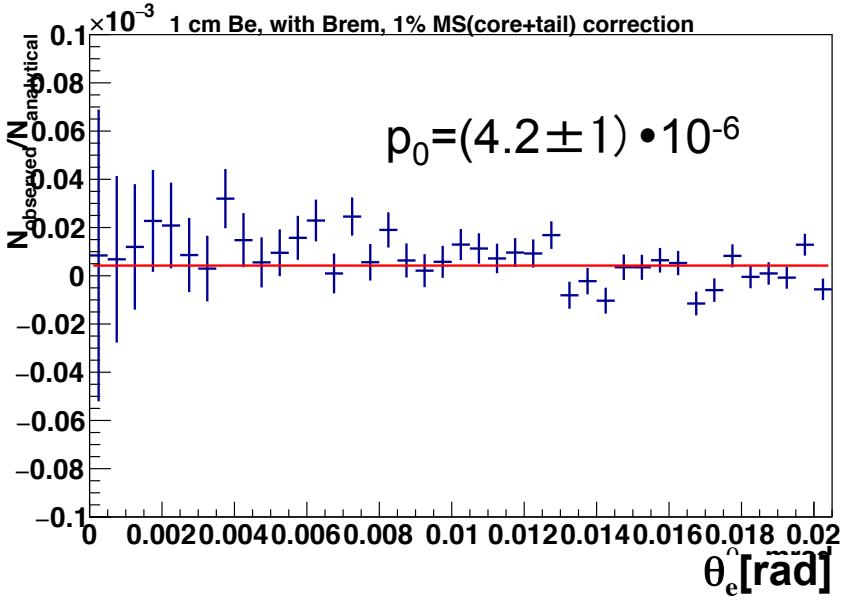
Multiple Scattering resolution:

a worst-case scenario

1cm Be

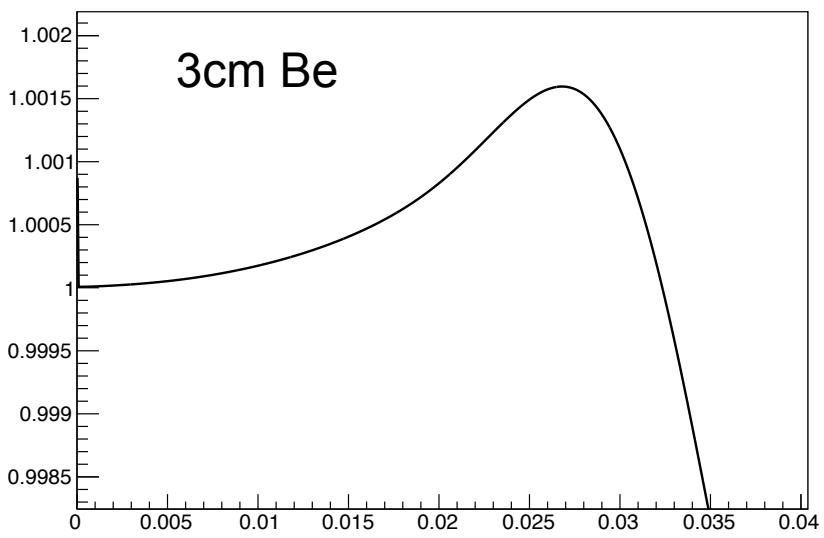




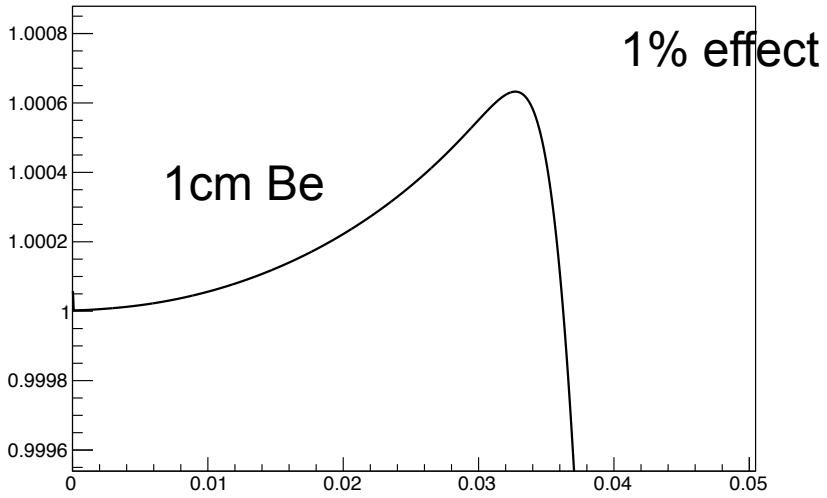


- The detector effects (mostly MS in the target) modify the theoretical spectrum ($N(\theta_e)$)
- We assume a 1% miscalibration on the GEANT model for $\sigma_{\theta e}$ MS (N_{mis})
- N_{mis} quadratically in θ_e respect to NO bias (N_i)
- By correcting N_{mis}/N_i in the normalization region → residual effects $<10^{-5}$ in the signal region

With 3 cm Be effects x3 higher

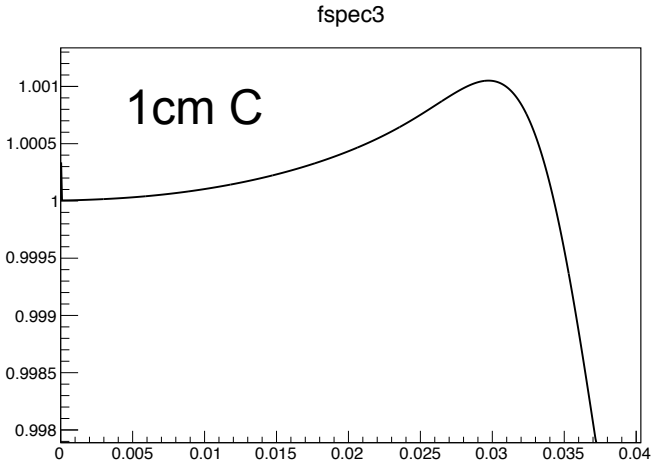


Effect ~linear in X/X0
quadratic in θ_e



- 3cm Be maximum effect (q~0.03mrad) ~1.5 10^{-3}
- 1cm Be maximum effect (q~0.03mrad) ~0.6 10^{-3}

Different material have different behavior!



Conclusions

- 1cm Be MS at 1% →~10^{-5} effects on cross section
- Different material/thickness give different sensitivity to the MS
- Other Ideas?