Update on hardware activities

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Panda Collaboration Meeting
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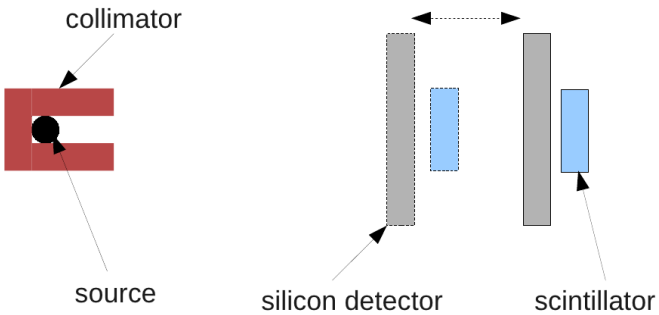
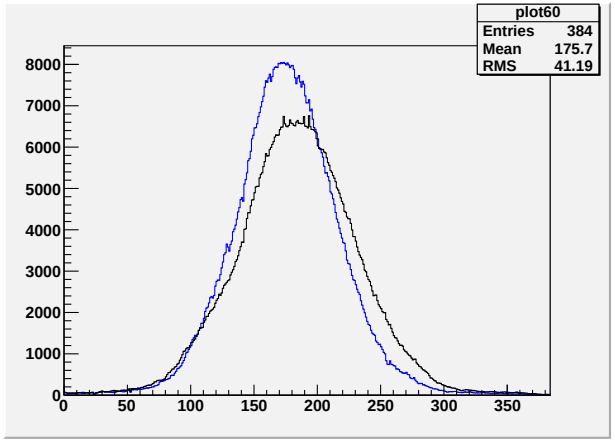
Spatial Resolution





deconvolute hit distribution for different displacements of detector and source $\Rightarrow$ spatial resolution

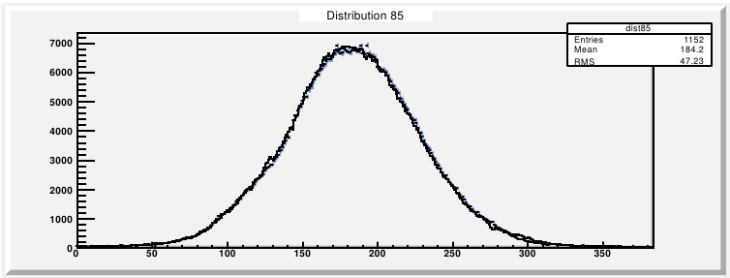
- Unfold detector resolution $\vec{x}_{true} = R^{-1}\vec{x}_{meas}$
- Rescale and center one distribution $\vec{y} = S\,\vec{x}_{true}$
- fold distribution with detector resolution again $\vec{x}_{fin} = R\,\vec{y}$
- find minimum of:

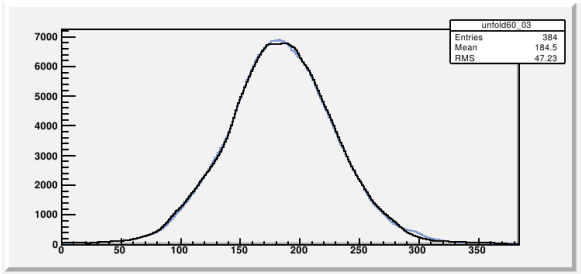
$$F = \sum_{i=0}^{n} \frac{(\text{unfold}_{1,i} + \text{unfold}_{2,i})^2}{\sigma_{1,i}^2 + \sigma_{2,i}^2}$$

simple deconvolution

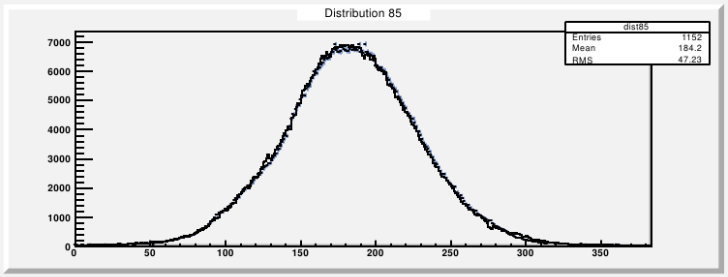
regularization

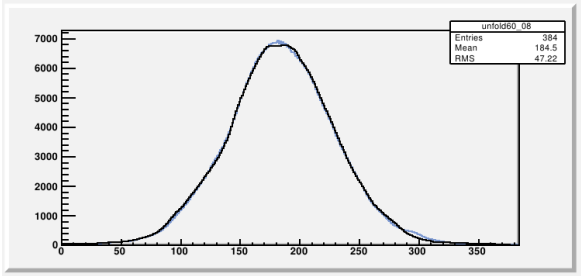
$\sigma_D = 0.3$



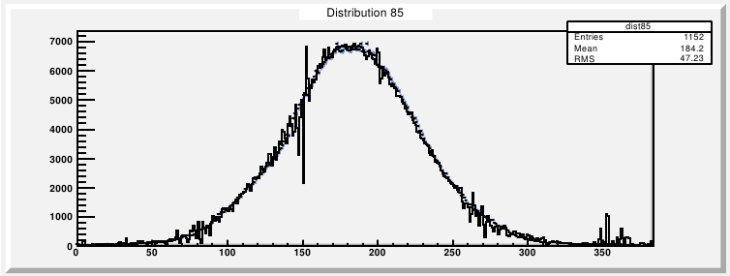


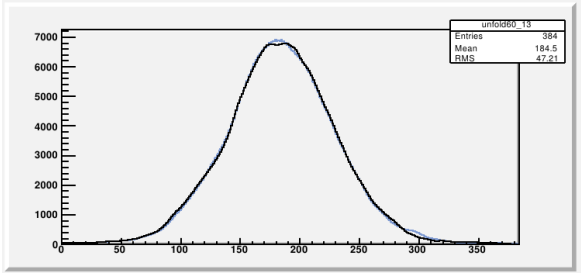
$\sigma_D = 0.8$



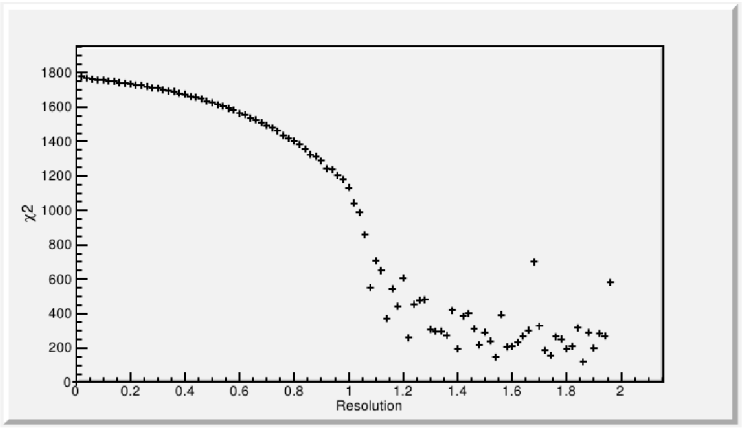


$\sigma_D = 1.3$





spatial resolution



Results so far:

- test of algorithms with simple distribution (gaussian) ✓
- neither simple deconvolution nor deconvolution using regularisation give a value for spatial resolution

Ideas:

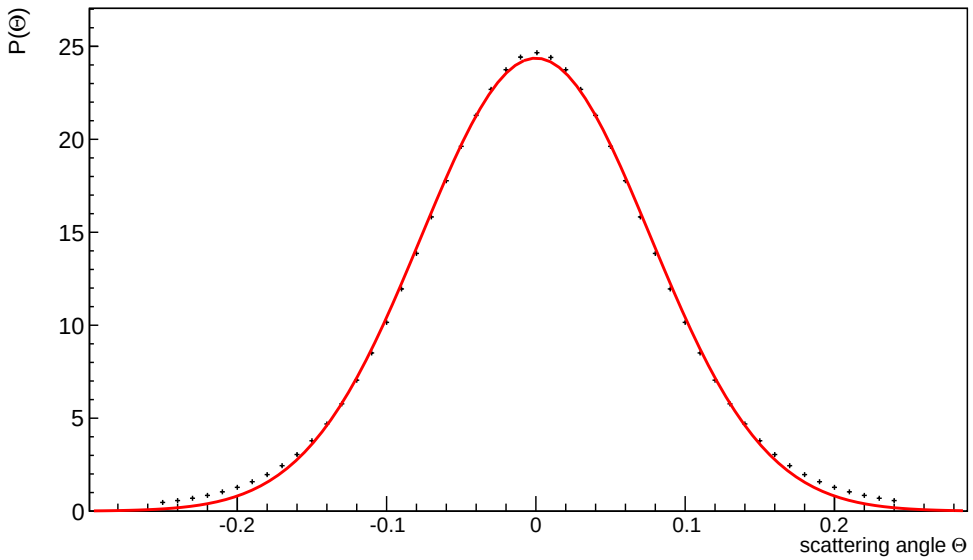
- check multiple scattering

multiple scattering

multiple scattering can be described by Moliere distribution:

$$P(\Theta)d\Omega = \eta\, d\eta \left(2exp(-\eta^2) + \frac{F_1(\eta)}{B} + \frac{F_2(\eta)}{B^2} + \cdots \right)$$

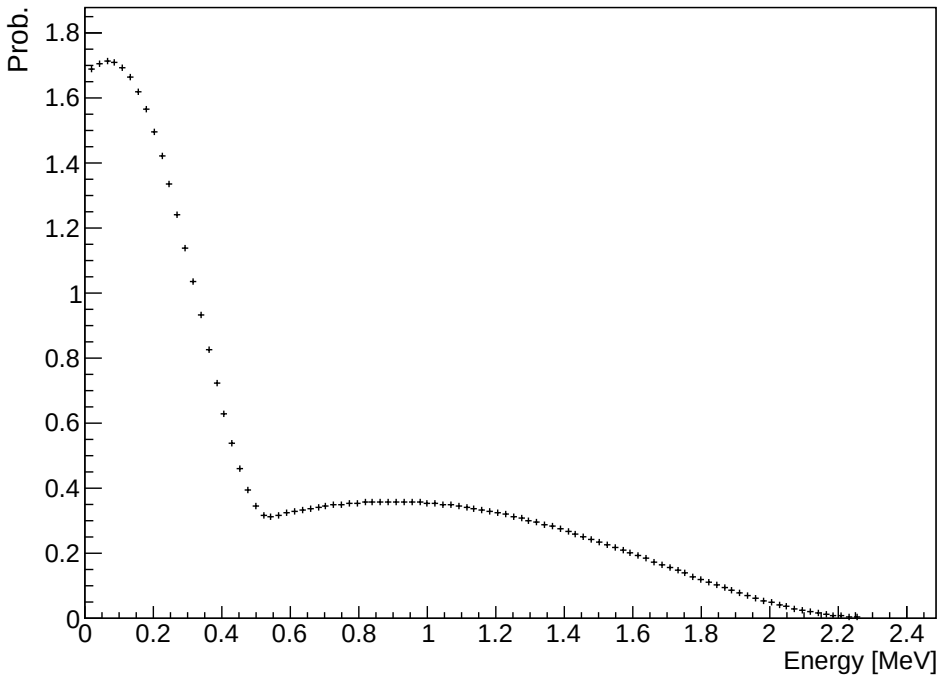
$$F_k(\eta) = \frac{1}{k!} \int J_0(\eta y) exp\left(\frac{-y^2}{4}\right) \left[\frac{-y^2}{4} ln \frac{-y^2}{4}\right]^k y dy$$



energy spectrum

energy spectrum of a β-source can be described by:

$$\frac{d\Gamma}{dE_e} = C \cdot E_e \sqrt{E_e^2 - 1} \left(\frac{E_{max}}{m_e c^2} - E_e \right)^2$$



$$^{90}\mathrm{Sr} \xrightarrow{\beta^-} {}^{90}\mathrm{Y}$$

$$\xrightarrow{\beta^-} {}^{90}\mathrm{Zr}$$

multiple scattering

$$\langle\sigma\rangle = \int P(E)\sigma(E)dE$$

- mean displacement for $0.26 < E < 2.3$MeV:

$$\begin{aligned}\langle\sigma\rangle &= 1.2 \text{ mm at } d = 8 \text{ cm}\\ \langle\sigma\rangle &= 2.6 \text{ mm at } d = 11 \text{ cm}\end{aligned}$$

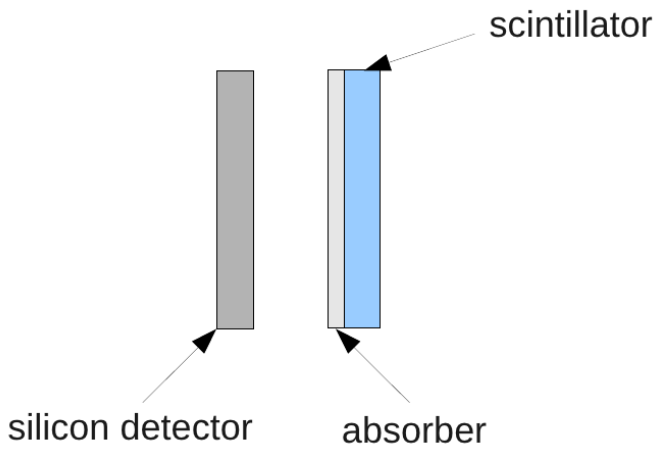
Results for multiple scattering:

- $\langle\sigma\rangle$ bigger than active area of triggering szintillator ($r = 2.5$ mm)
- $\langle\sigma\rangle >> \sigma_d(\text{pitch}/\sqrt{12} \approx 14\mu\text{m})$

spatial resolution

next steps:

- install szintillator which covers complete sensor area
- place absorber in front of szintillator
  $\Rightarrow$ measure only high energy part of spectrum



- (test setup has to be placed in vacuum)