Multiple scattering in TB19

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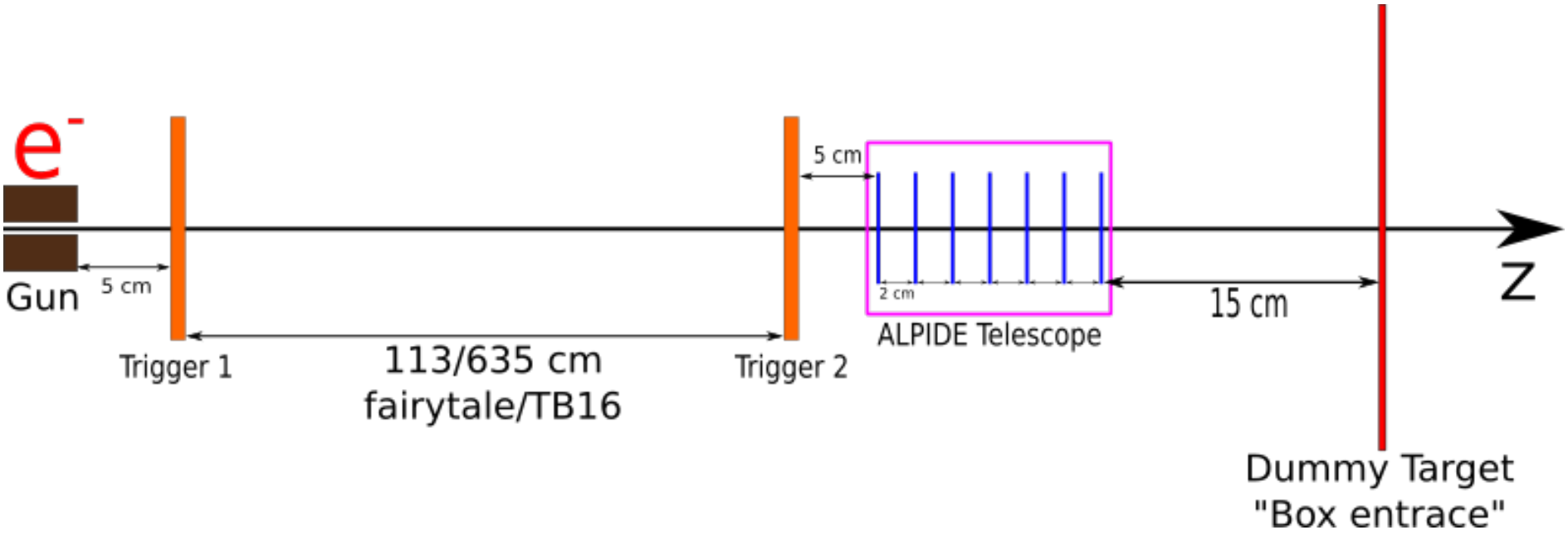
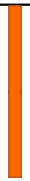
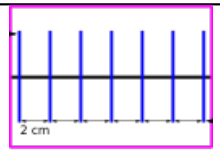
MC Geometry setup for TB19



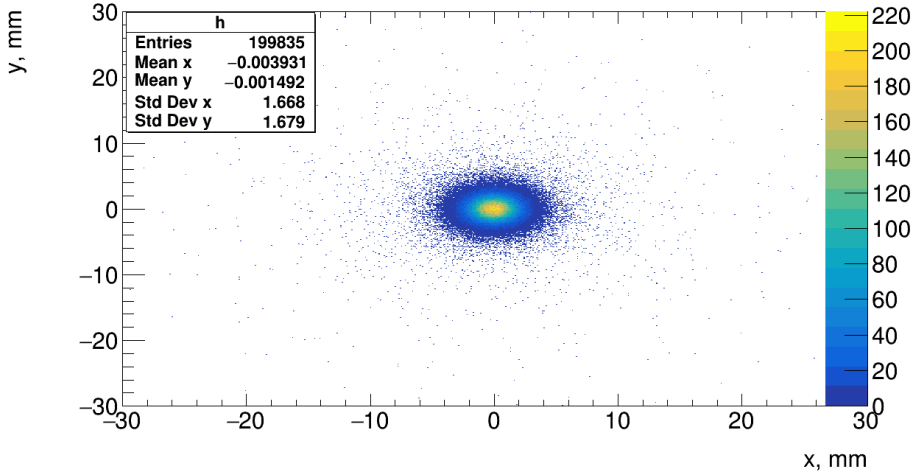
Tested:

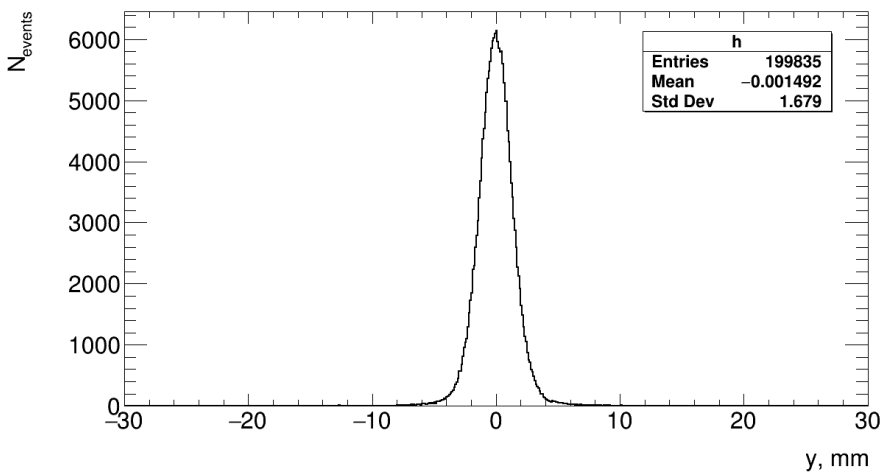
- E_e: 1 GeV; 5 GeV
- Gun to dummy distance: 1.5 m; 6.7 m
- Configuration: Only air; only telescope; only trigger; both telescope and triggers

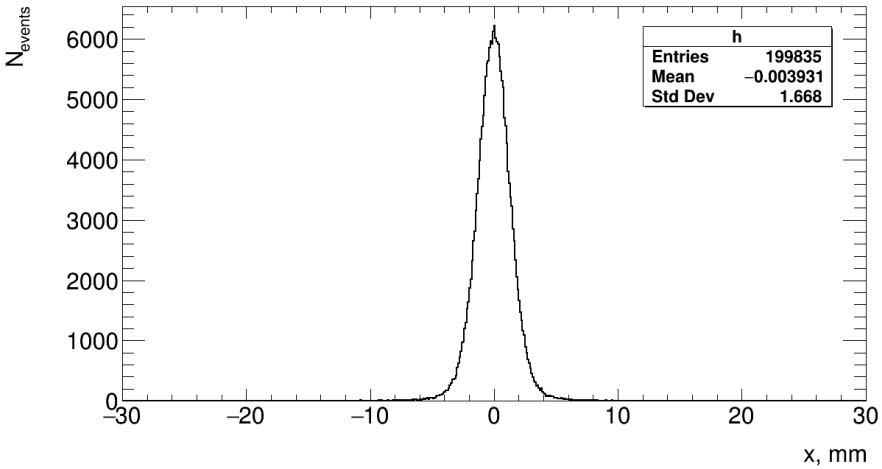
MC simulated facilities

 Gun	Particle: e^- Energy: 1 GeV / 5 GeV (mono-energetic) Direction: $\frac{p_z}{p} = 1$ (no angular smearing)
	Material: *G4_PLASTIC_SC_VINYLTOLUENE* Width: 4.128 mm
 ALPIDE Telescope	Material: *G4_Si* Width: 50 μm each plane Number of planes: 7
	if (particle_is_primary && boundary) {Write it's position;}

Only Air; 5 GeV; 6 meters example







$$\sigma^{5GeV}_{6m\ Air} = 1.67 \text{ mm}$$

Results on multiple scattering

σ, mm	5 GeV, 6.7m	5 GeV, 1.5m	1 GeV, 6.7m	1 GeV, 1.5m
Air	1.67	0.2	7	0.85
Telescope	1.68	0.22	7.03	0.87
Triggers	2.51	0.55	10.1	2.18
Both	**2.51**	**0.55**	**10.11**	**2.22**

There is also angular beam spread! (assumed isotropic)

$$\theta_{beam} = [0, 752\ \mu rad]$$

$$d = 6.7\ m \Rightarrow y_{box,max} = \pm 5.04\ mm \Rightarrow \sigma_{beam} = \frac{10.08}{\sqrt{12}} = 2.91\ mm$$

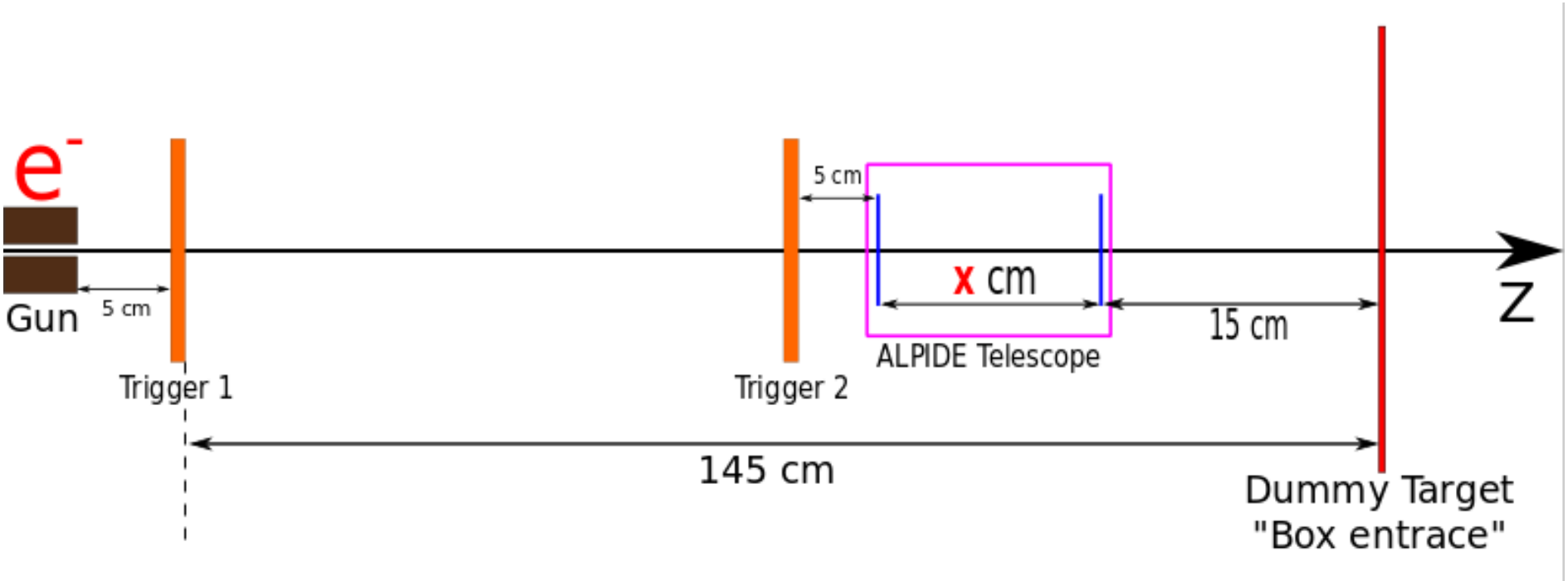
$$d = 1.5\ m \Rightarrow y_{box,max} = \pm 1.13\ mm \Rightarrow \sigma_{beam} = \frac{2.26}{\sqrt{12}} = 0.65\ mm$$

Conclusions on multiple scattering

1. Distance change from 6.7 m to 1.5 reduces multiple scattering spread by factor 4.5
2. Distance change from 6.7 m to 1.5 m reduces angular beam spread by factor 4.5
3. Telescope negligibly affects multiple scattering
4. Scintilators increase multiple scattering spread by factor 1.5

Less distance – better

Geometry Update for resolution test

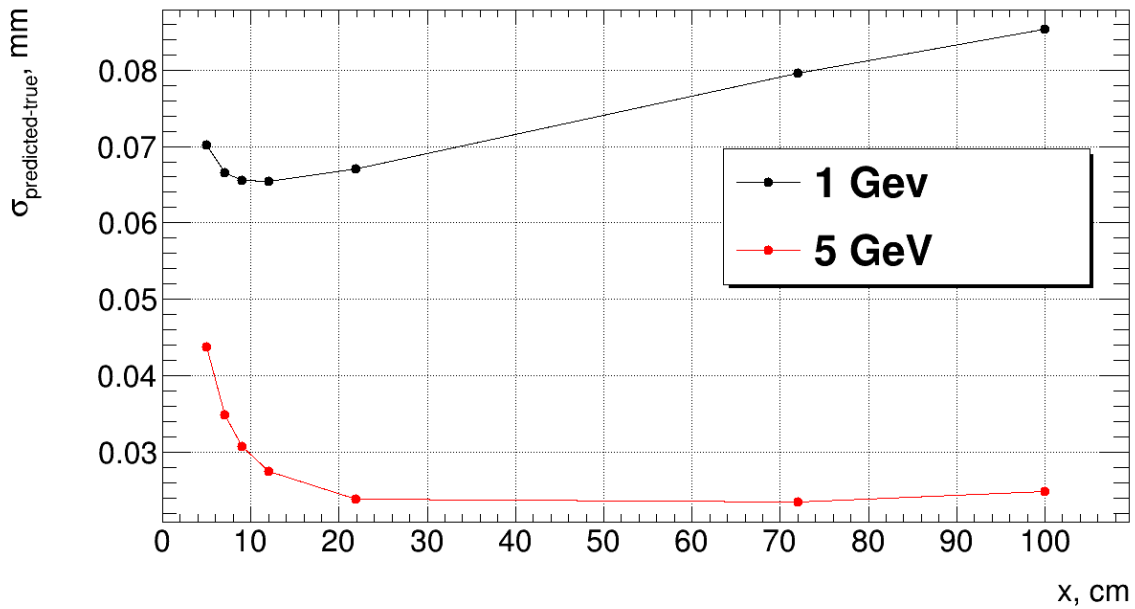


Changes:

- Only 2 ALPIDE planes
- Vary distance between them
- Added beam size: 5×5 mm square

Check: How precisely telescope can predict impact point in the dummy $\sigma(y_{true} - y_{predict})$

Results on resolution test



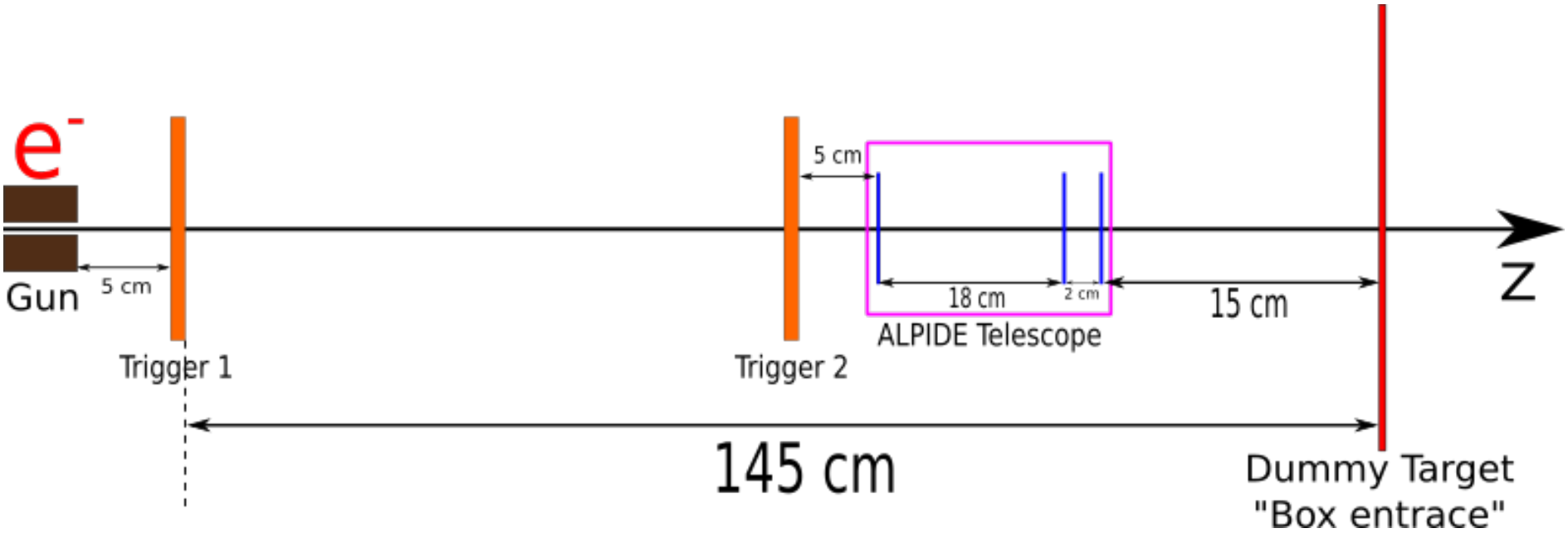
Limitations:

Activated pixel is calculated by true hit coordinates. Therefore only 1 pixel per plane is activated. In reality multiple pixels can be activated which influence resolution

Conclusion:

- 20 cm between planes is good for both energies
- Multiple scattering prohibit improving for larger distances

Resolution with 3 planes?



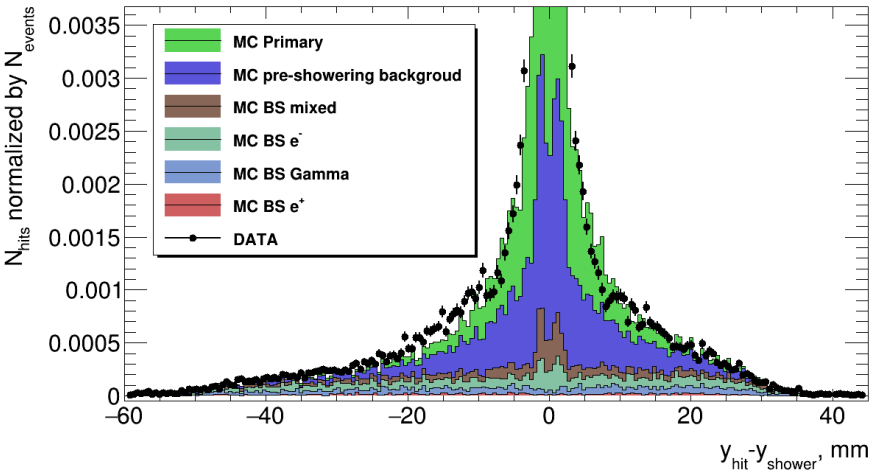
Note: 3rd plane is added with 14 μm staging to improve resolution

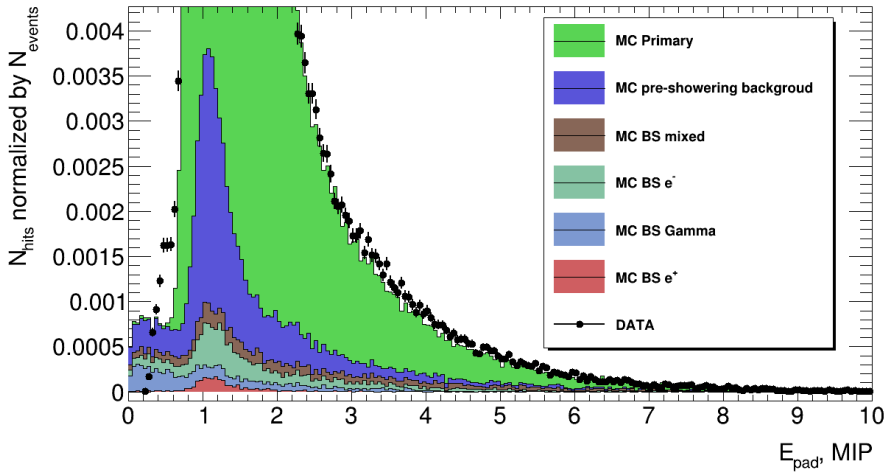
$\sigma^{5GeV}_{2planes} = 0.02423$ mm

$\sigma^{5GeV}_{3planes} = 0.02481$ mm

No improvement is seen. But additional planes can help to fight background

Pre-showering in TB16





Pre-showering is superior and shadows studying back-scattering signals