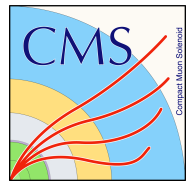
Track Reconstruction Performance for Semi-stable Charged Particles at CMS

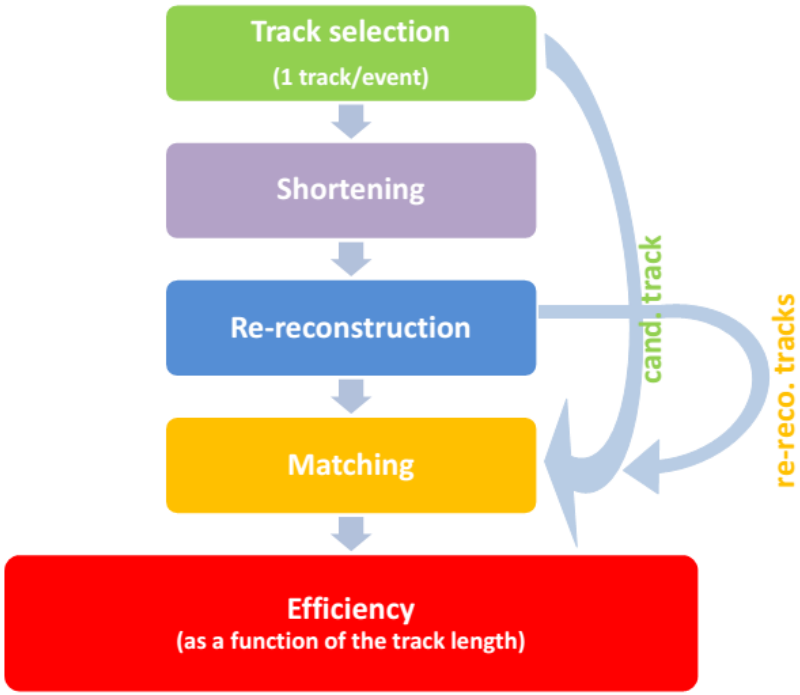
Samuel Bein, Viktor Kutzner, Peter Schleper, Georg Steinbrück,
Alexandra Tews, Benedikt Vormwald



GEFÖRDERT VOM
Bundesministerium
für Bildung
und Forschung

Weekly Shorttracks Meeting
April 13th, 2018

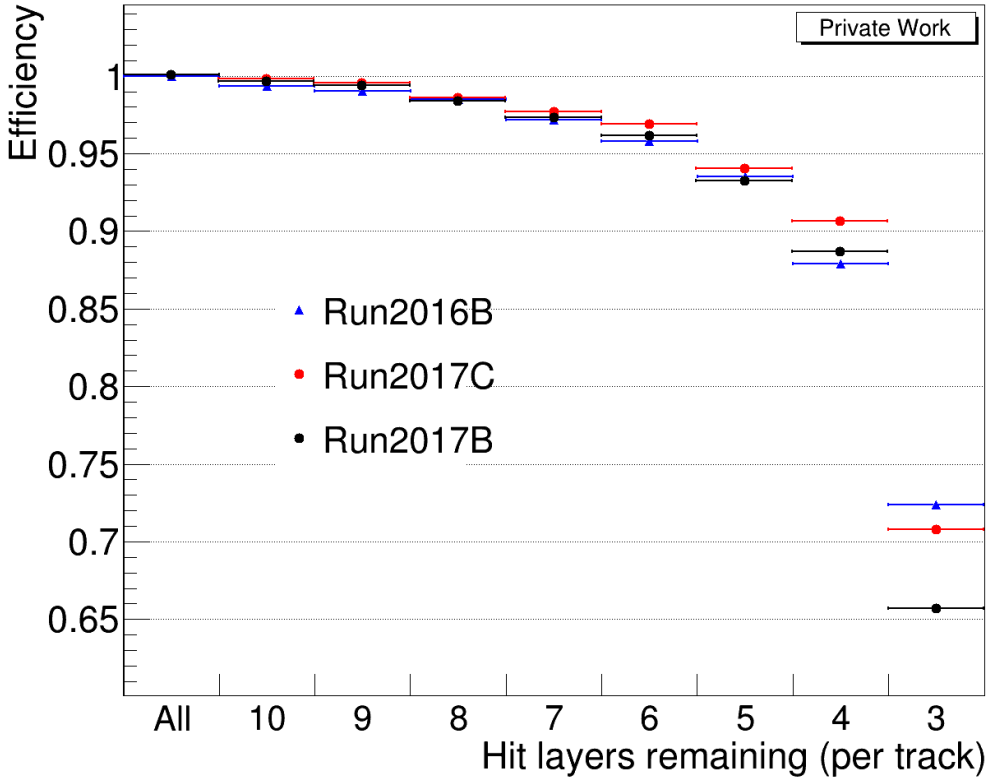
Tracking Efficiency for Short Tracks



- ***New method: tracking efficiency for short tracks***
- Determined in-situ ***from data***
- Shorten one long track per event to a certain length
- Shortening on the basis of clusters
- ***Full re-reconstruction*** of the track remains i.e. seeding, pattern recognition, ...
- Matching of reco. track to sel. track: $\Delta R < 0.01$

Tracking Efficiency for Short Tracks

Which track length is still efficiently reconstructed ?



Efficiency at track length $l = x$:

$$\epsilon^{total}_{l=x} = \epsilon^{reco.}_{l=all\ \ lengths} \times \epsilon^{reco.}_{l=x},$$

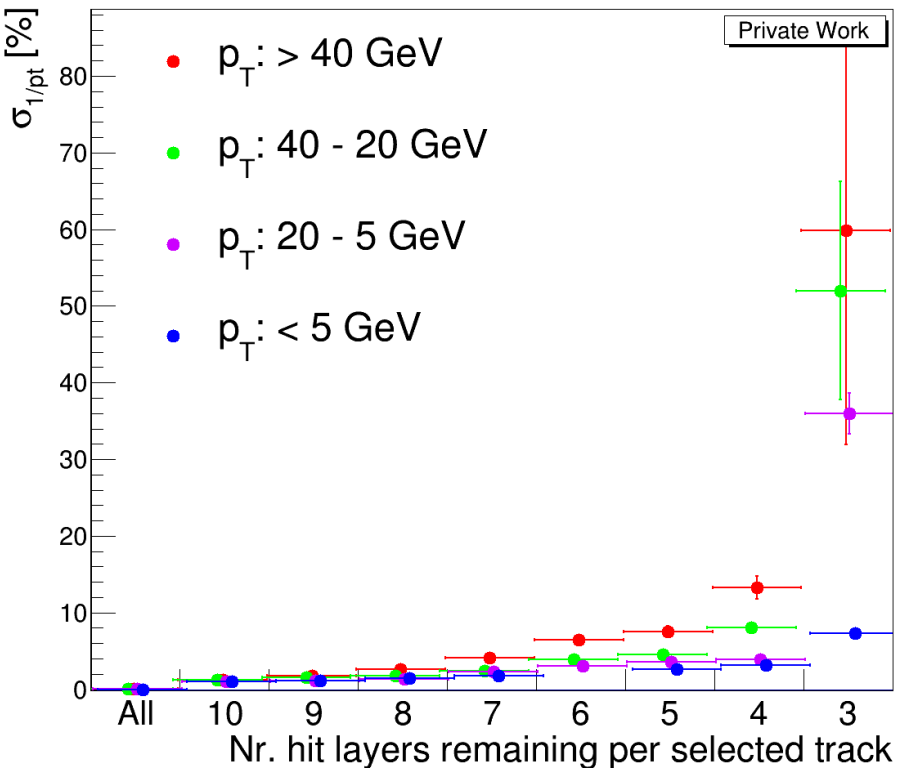
$$\epsilon^{reco.}_{l=x} = \frac{N^{re-reco.}_{l=x}}{N_{l=x}},\ N = \text{no. of tracks}$$

- 2016 and 2017 pp-collision data, $\sqrt{s} = 13$ TeV, 4M events each
- *SingleMuon* trigger events with ≥ 1 candidate track

Even tracks with only 3 hit layers can still be reconstructed with an efficiency of $\epsilon^{reco.}_{l=3} = 66$ - 72 %, [l] = hit layers

Impact of Decreasing Track Length on Momentum Resolution

5 track parameters (track helix) retrieved from reconstruction $\rightarrow$ **resolutions**



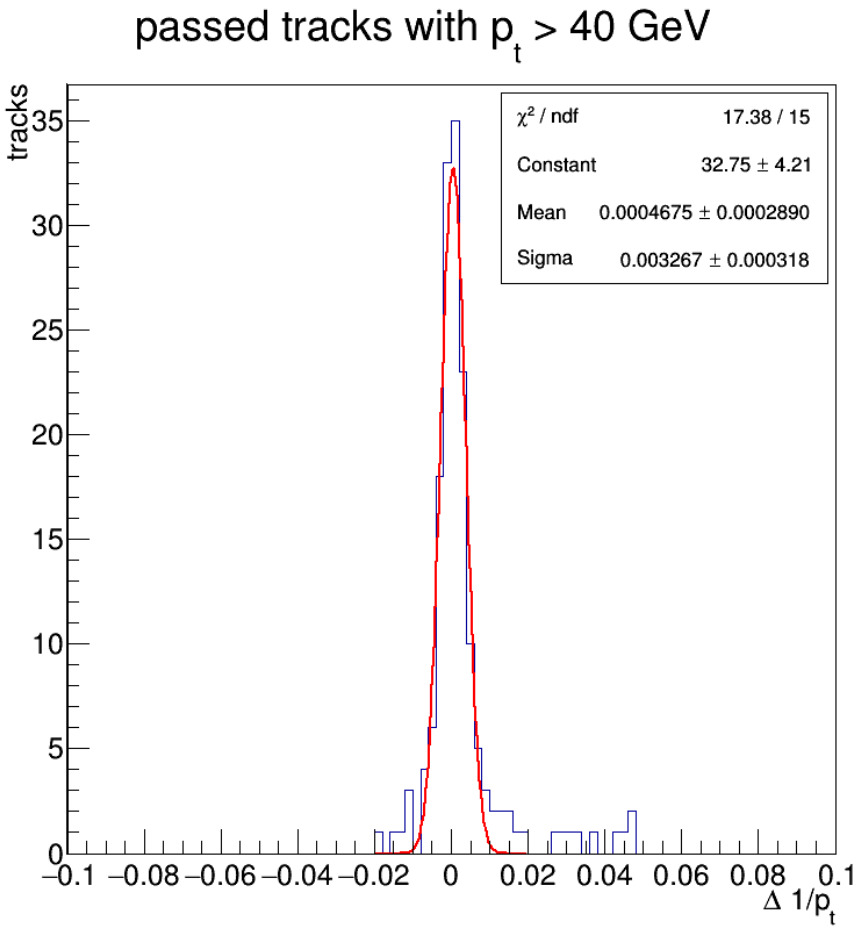
Momentum resolution determined from MC for tracks with average length:

- Difference between reco. tracks' and gen. particles' parameters
- **Momentum resolution for muons with $p_t \approx$ 100 GeV, $|\eta| <$ 1.4 : 2.8 %**

Studied deviation in momentum resolutions for short tracks:

- In bins of p_t, $|\eta|$ and ϕ
- **2016** RunB, 1079 sel. tracks,

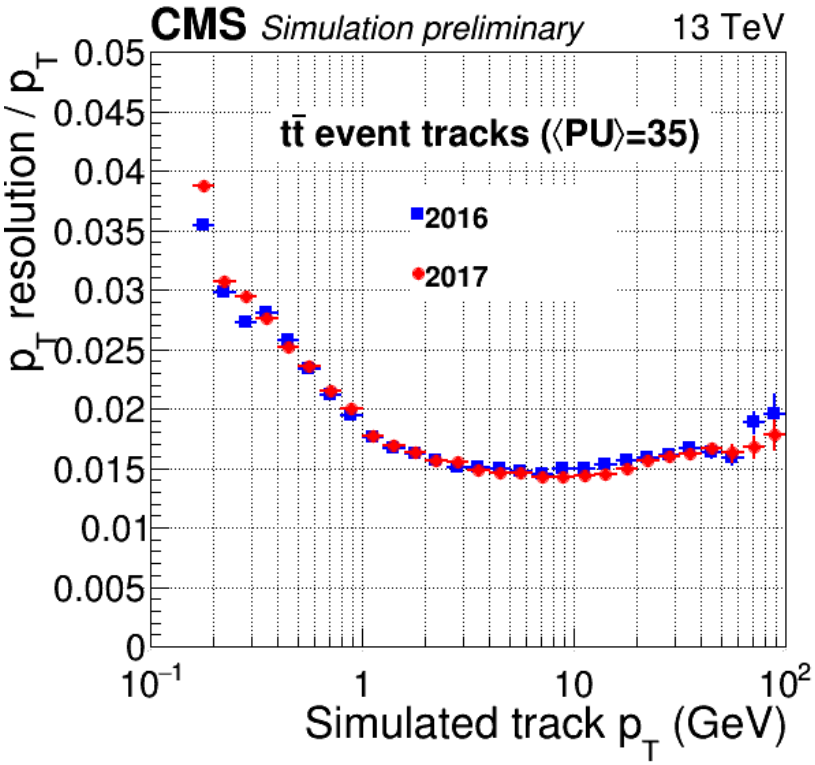
Fitting Procedure for Resolution Residuals

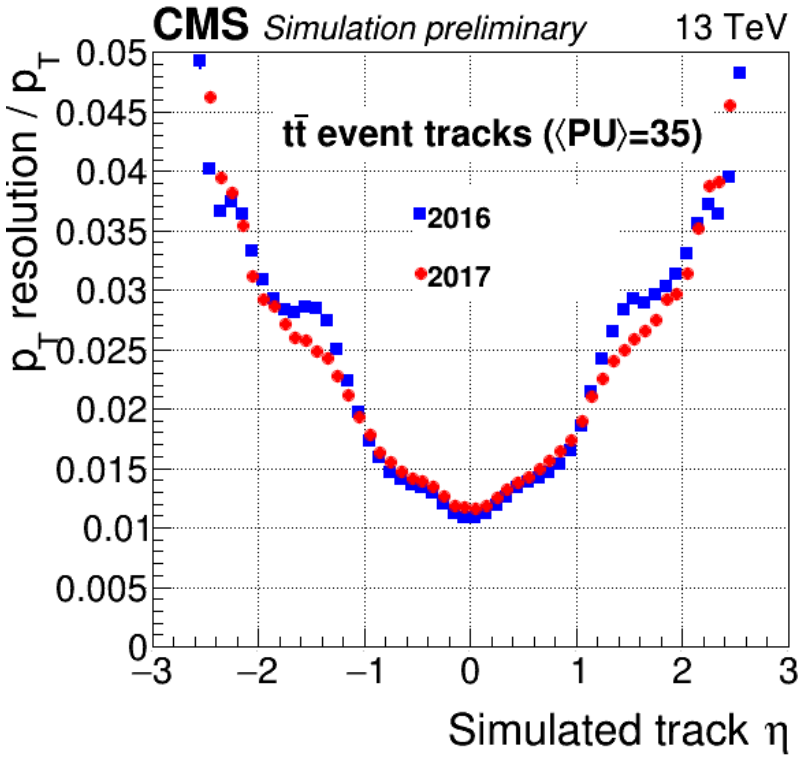


1. Distribution of $\Delta(\frac{1}{p_t}) = \frac{1}{p_t^{true}} - \frac{1}{p_t^{reReco}}$
2. 'true' $\leftrightarrow$ from pre-selection, before removal and reRECO
3. Fit with gaus function $\rightarrow$ problem: Distribution of $\Delta(\frac{1}{p_t})$ broadens with decreasing amount of hit layers, Statistics decrease (massively)
4. Rebin distribution until 65 % of all entries lie in the peak (Peak := mean $\pm$ 1 stdv.)
5. Fit in a range of mean* $\pm$ 1 stdv.
6. $\sigma_{\frac{1}{p_t}} = \sigma_{gaus}$ (+ error)

Example: production with *4 hit layers remaining per track*

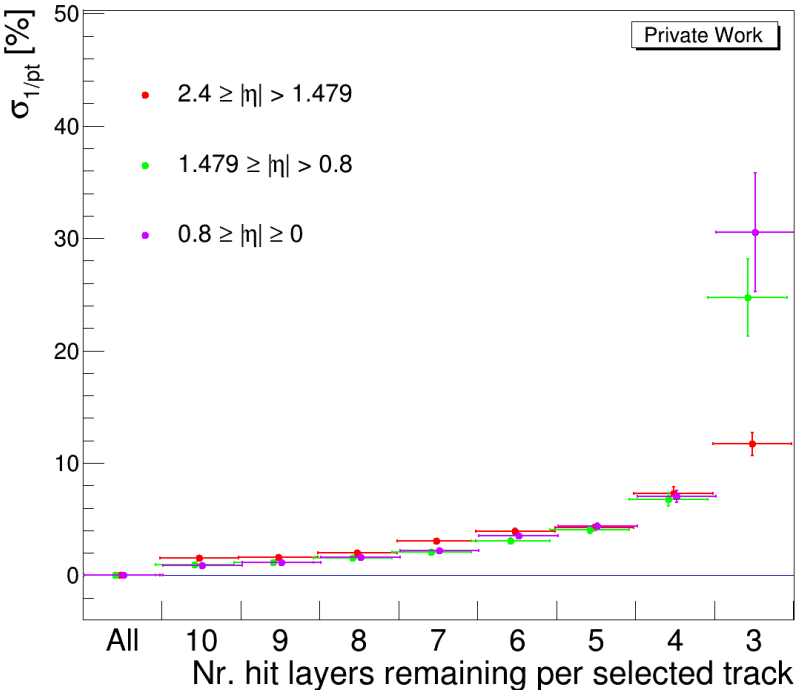
Nominal Track Momentum Resolution

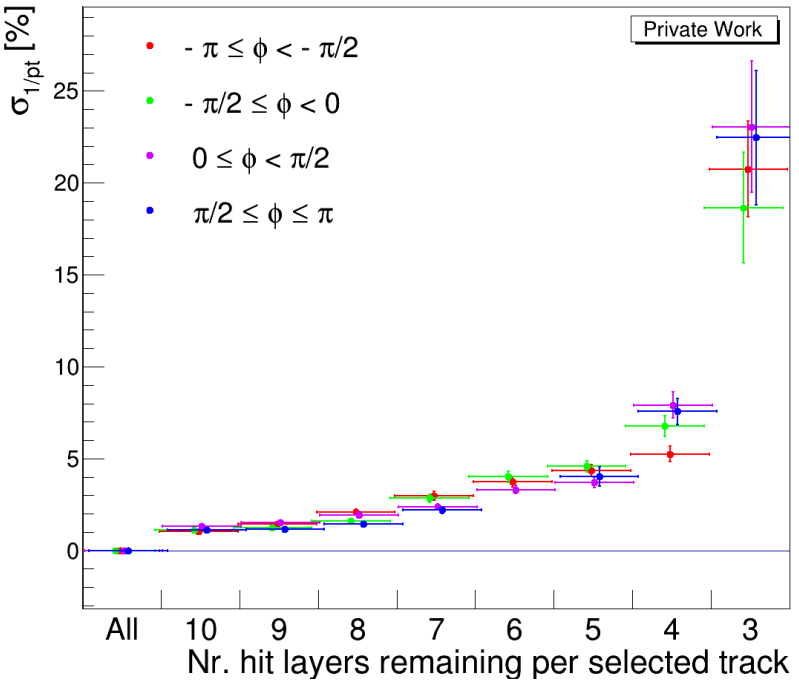




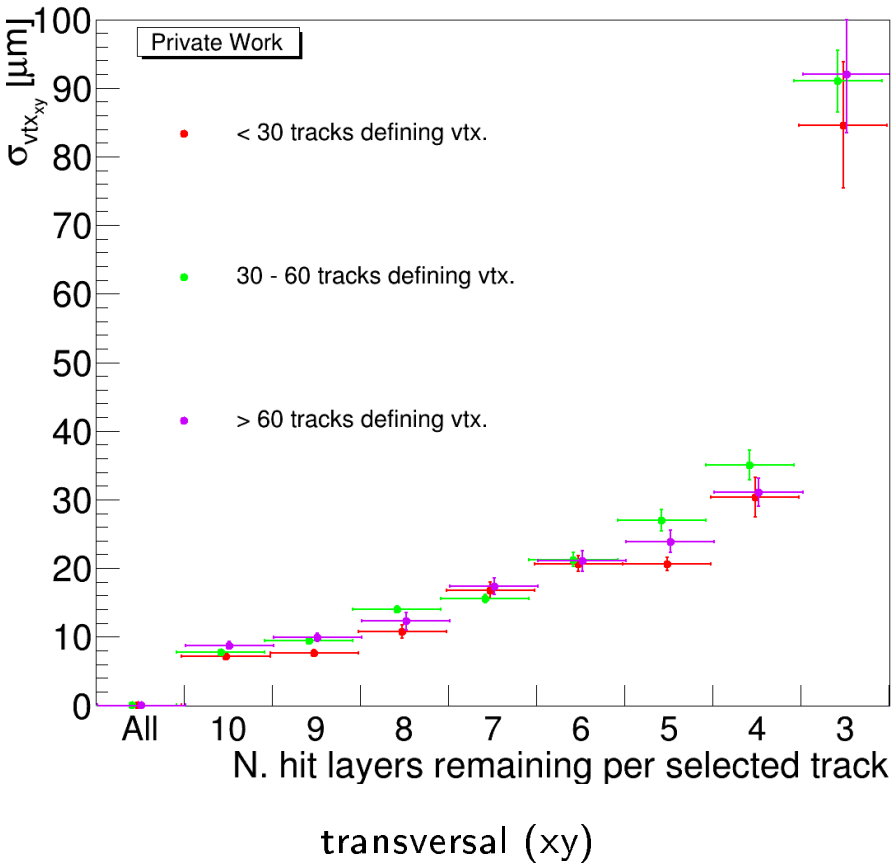
https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsTRK

Impact of Decreasing Track Length on Momentum Resolution in Bins of $|\eta|$ and ϕ





Impact of Decreasing Track Length on Vertex Resolution



transversal (xy)

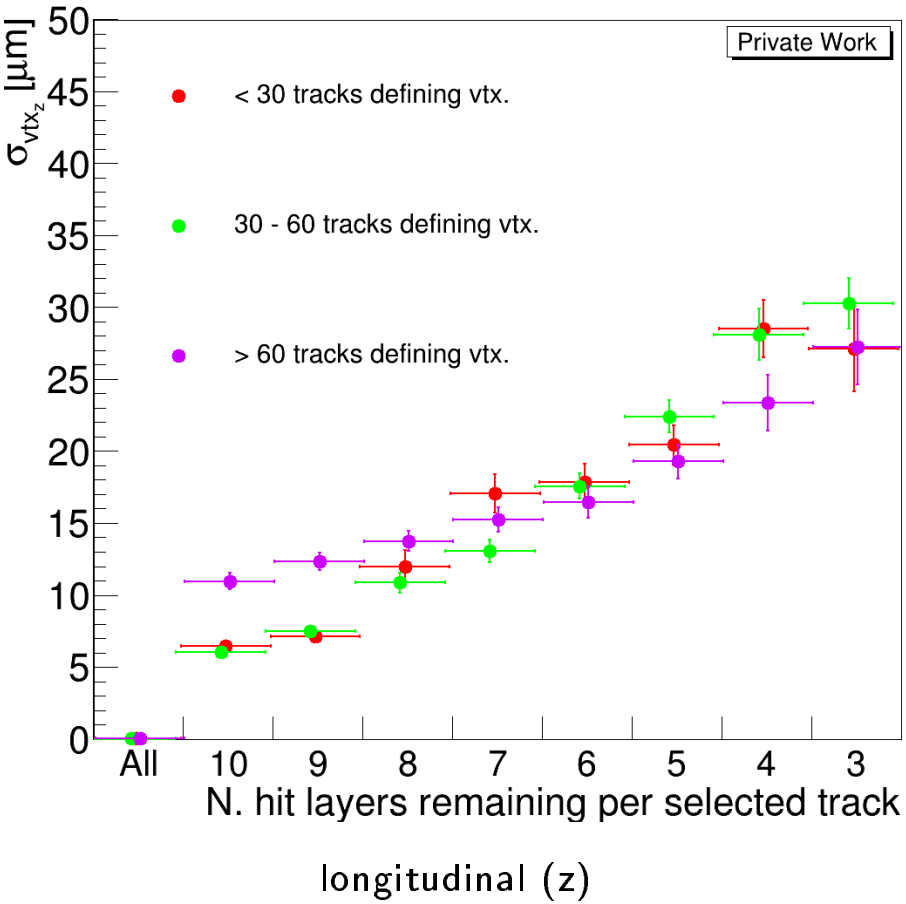
Vertex resolution determined from MC for tracks with average length:

- Difference between reco. tracks' and gen. particles' parameters
- **Vertex resolution for muons with $p_t \approx$ 100 GeV, $|\eta| < 1.4$: 10 μm (trans.), 30 μm (long.)**

Studied deviation in vertex resolution for short tracks:

- In bins of nr. of tracks defining the vertex
- Bins of p_t and $|\eta|$ planned with more statistics
- **2016** RunB, 1079 sel. tracks,

Impact of Decreasing Track Length on Vertex Resolution



Vertex resolution determined from MC for tracks with average length:

- Difference between reco. tracks' and gen. particles' parameters
- **Vertex resolution for muons with $p_t \approx$ 100 GeV, $|\eta| < 1.4$: 10 μm (trans.), 30 μm (long.)**

Studied deviation in vertex resolution for short tracks:

- In bins of nr. of tracks defining the vertex
- Bins of p_t and $|\eta|$ planned with more statistics
- 2016 RunB, 1079 sel. tracks,