Preliminary studies of the beam spot width

DESY/ Uni-HH alignment meeting

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Motivation

- Primary vertex, impact parameter, etc. are essential elements of CMS analysis
  - in particular heavy flavor physics, b tagging, ...
- Beam line serves as an essential input
  - track selection
  - primary vertex computation
  - impact parameter computation

$\Rightarrow$ beam line parameters must be known very accurately

- especially need to know the beam line width
  - $\rightarrow$ less trivial to compute in transverse direction
  - $\rightarrow$ enters computation of important observables (e.g. heavy flavor-related significance estimators)
- beam line gives an excellent reference point for studying tracking performance
- main focus: investigation of systematic errors in beam spot measurements (especially beam spot width)

Data set

- first some tests on Monte Carlo data
- /store/mc/Spring10/MinBias/ALCARECO /START3X_V26_S09_TkAlMinBias-v1/0005 /F813AAFC-A54D-DF11-B953-003048678BB8.root
- first 122516 tracks

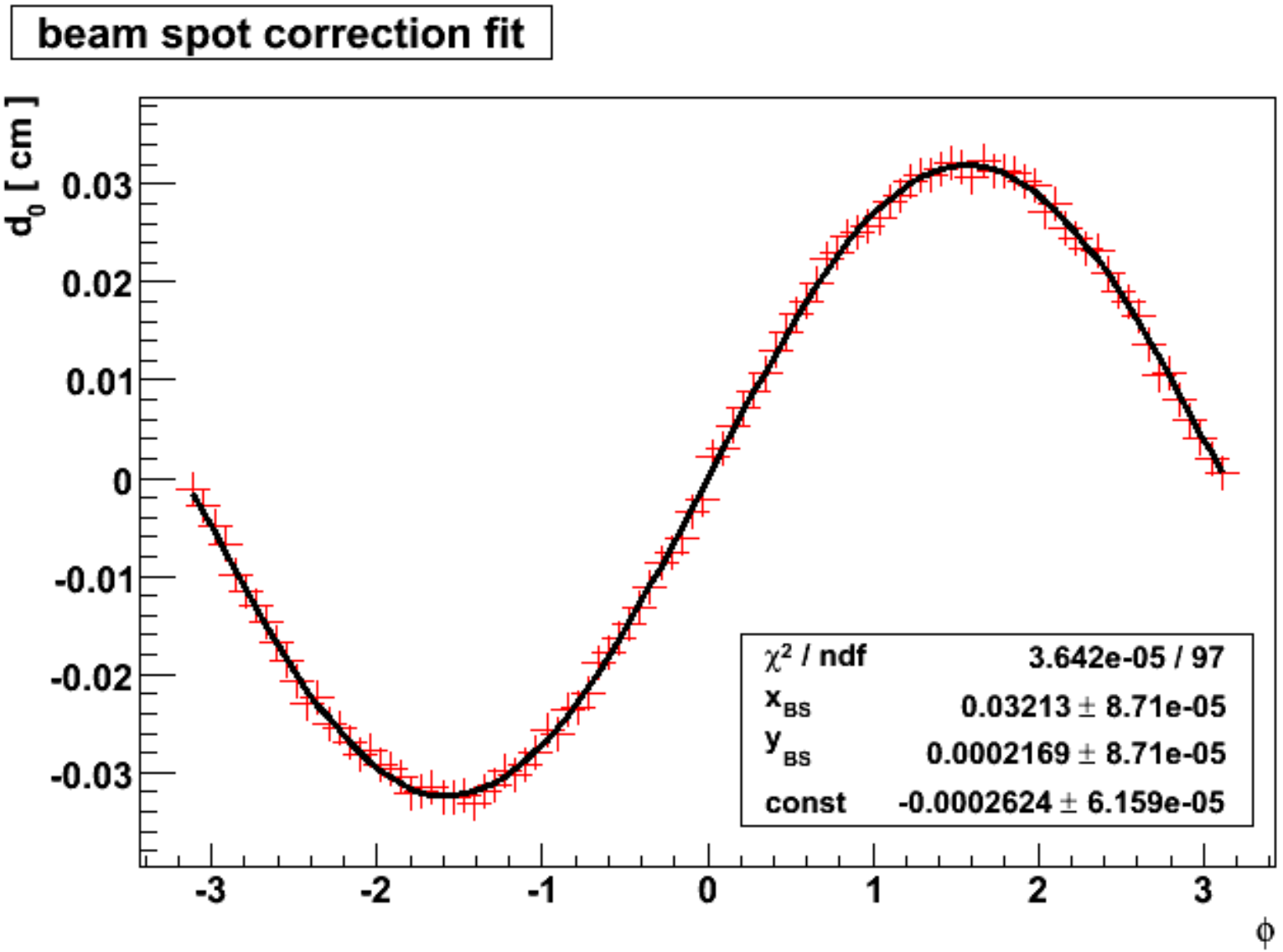
Beam spot correction of d_0

- d_0: impact parameter, defined as distance between a reference point and the point of closest approach of the track to the reference point
- correction is needed for a statement about d_0-distribution wrt beam spot (not wrt reference point)
- d_0-histogram for each interval
- fit each with Gauss function (less sensitive to background)

  $\Rightarrow$ $\langle d_0 \rangle$ as a function of ϕ
- fit with:

$$
\begin{aligned}
f(\phi) &= r_{BS} \cdot \sin(\phi - \phi_{BS}) + const \\
&= \underbrace{r_{BS} \cdot \cos\phi_{BS}}_{x_{BS}} \cdot \sin\phi - \underbrace{r_{BS} \cdot \sin\phi_{BS}}_{y_{BS}} \cdot \cos\phi + const \\
&= x_{BS} \cdot \sin\phi - y_{BS} \cdot \cos\phi + const
\end{aligned}
$$

Beam spot correction of d_0



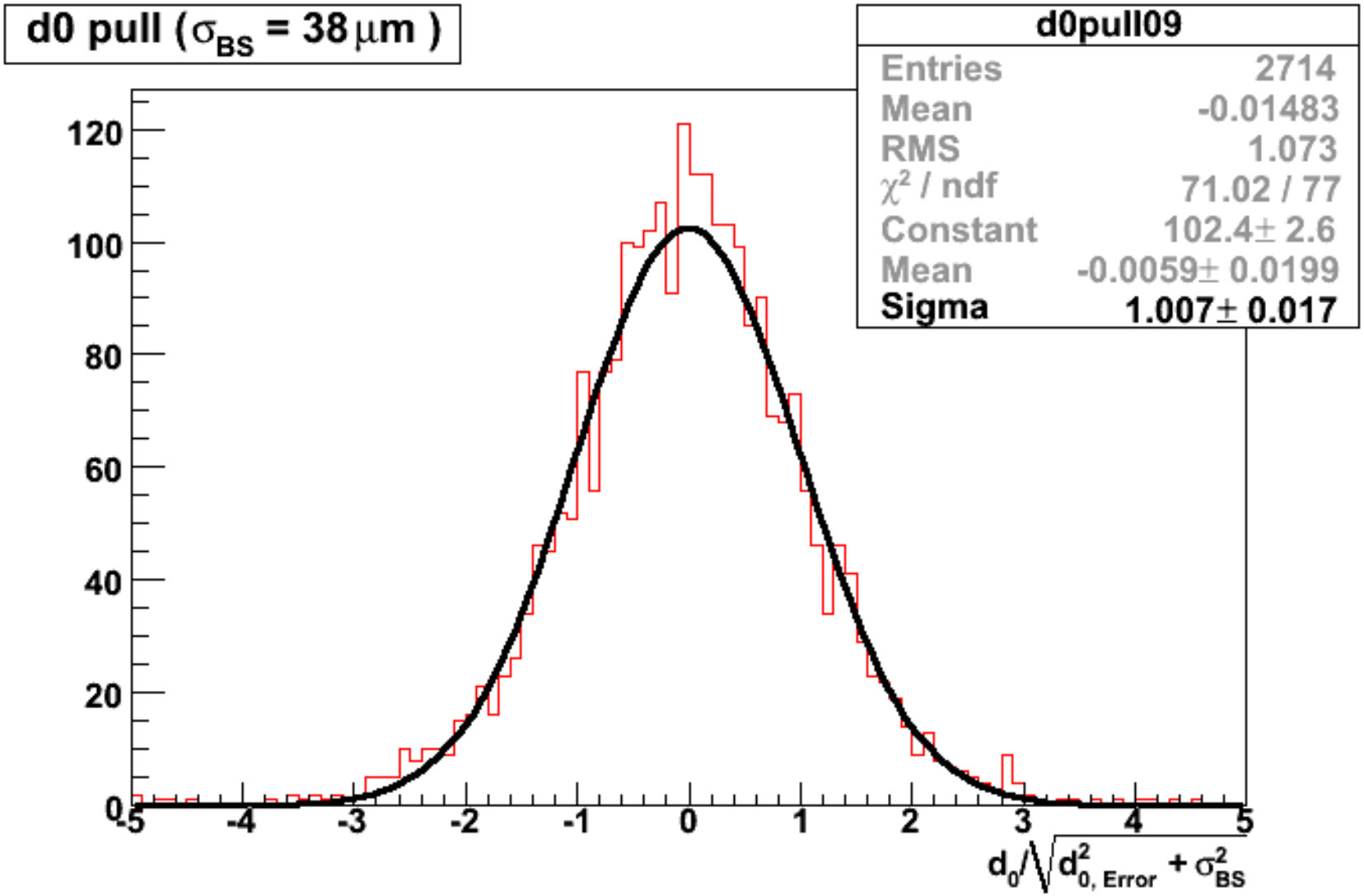
Beam spot correction of d_0

- fit results:
  $x_{BS} = (321.3 \pm 0.9)\ \mu\text{m}$
  $y_{BS} = (2.2 \pm 0.9)\ \mu\text{m}$
- beam spot correction for d_0-pull histogram:
  $y_{BS} \approx 0$
  $\Rightarrow\ d_0 \rightarrow d_0 - x_{BS} \cdot \sin(\phi)$

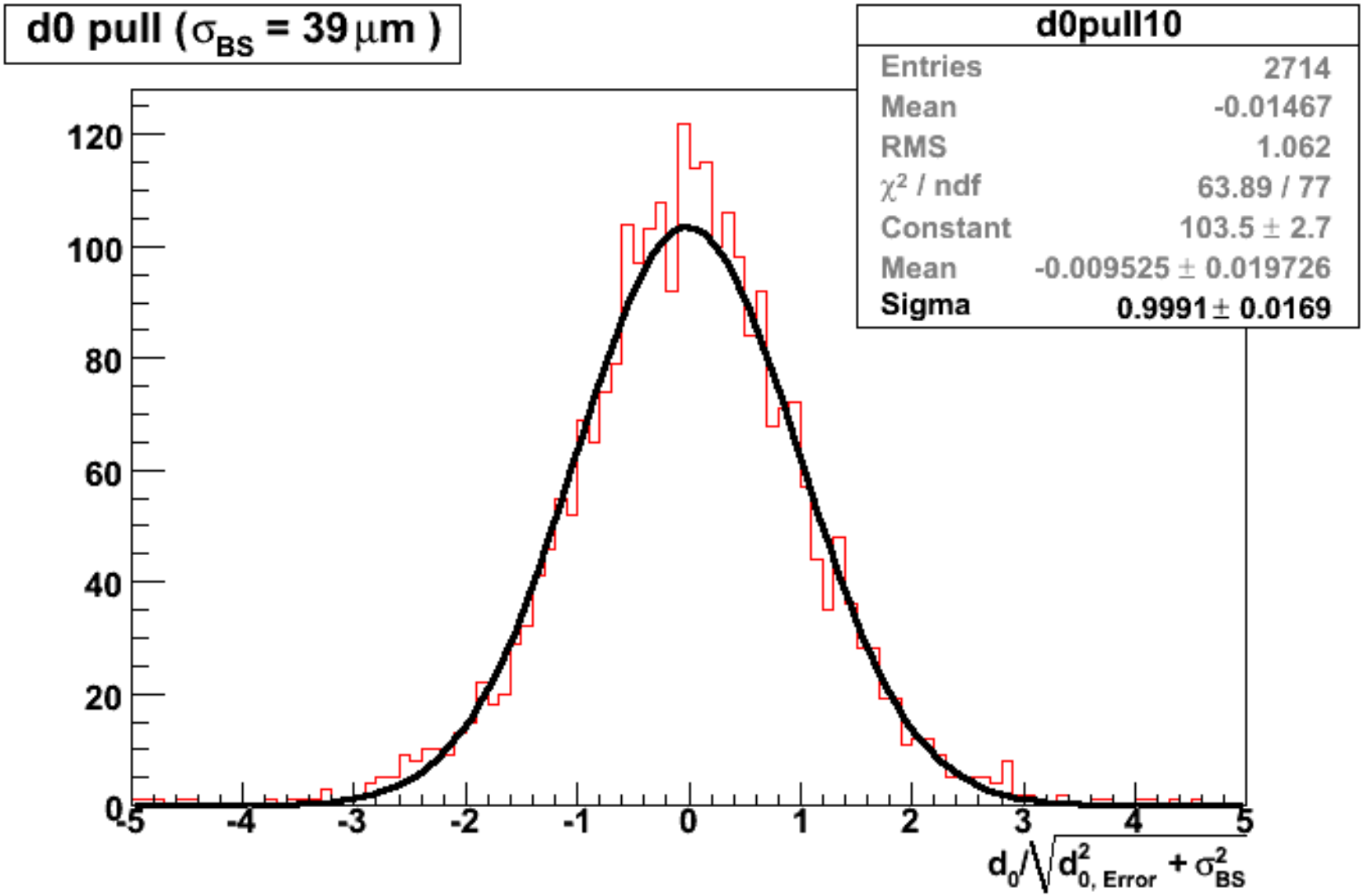
Beam spot width measurement

- cuts: $pt > 3$ GeV, $numberOfValidHits > 10$, $abs(eta) < 1.5$, $d0Error < 0.01$
  - $\Rightarrow$ avoid background (tracks originated from beam spot)
    each track should have a good d_0-resolution
- fit of d_0-pull histogram $\left(\frac{d_0}{\sqrt{d_{0,Error}^2 + \sigma_{BS}^2}} \right)$ with Gauss function
- plot σ of the fit and the RMS of the histogram against σ_{BS}
- compare value of σ_{BS} at which $\sigma /$ RMS $= 1$ with MC input ($\sigma_{BS}^{MC} = 46\ \mu$m)

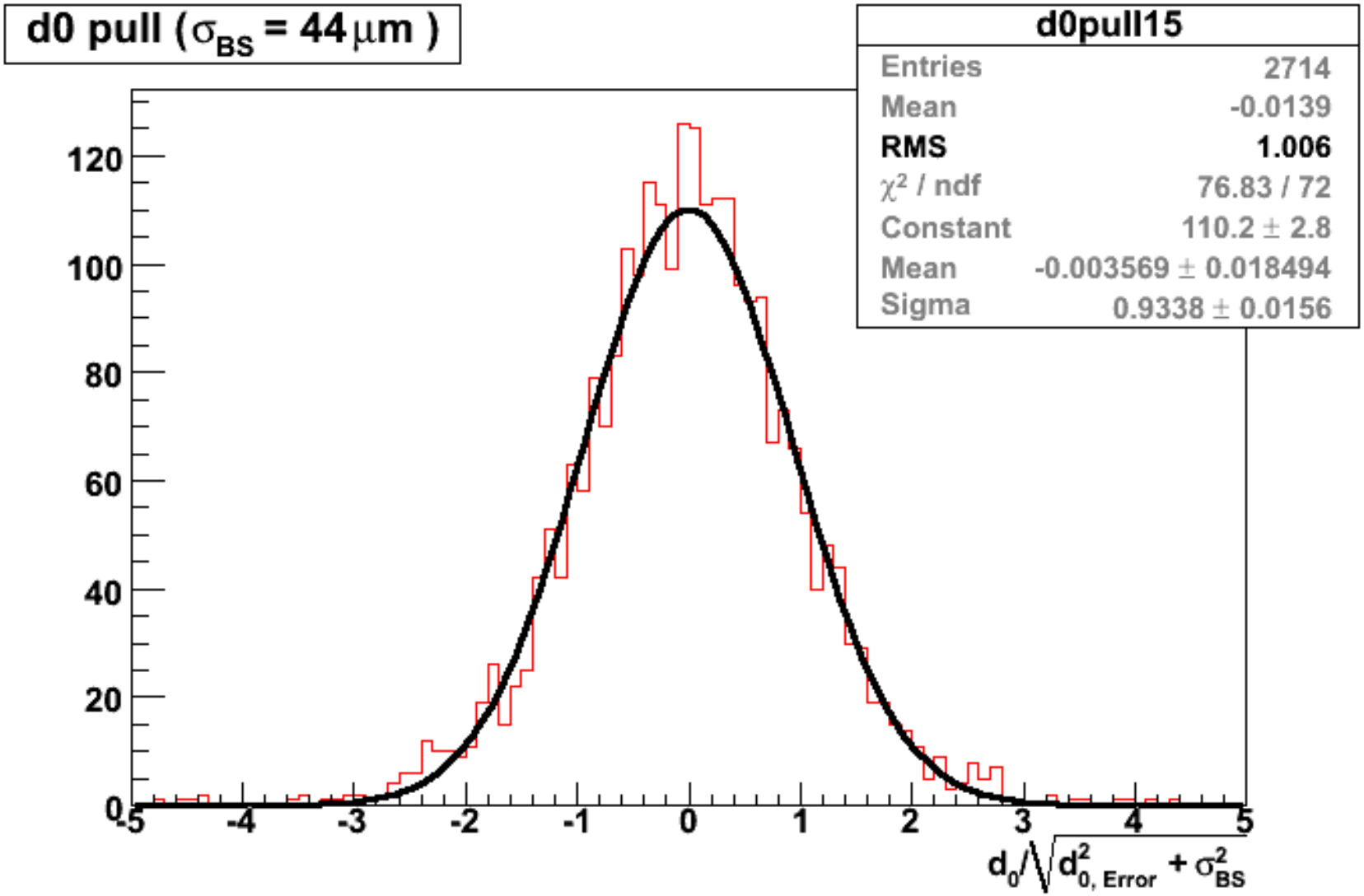
Beam spot width measurement



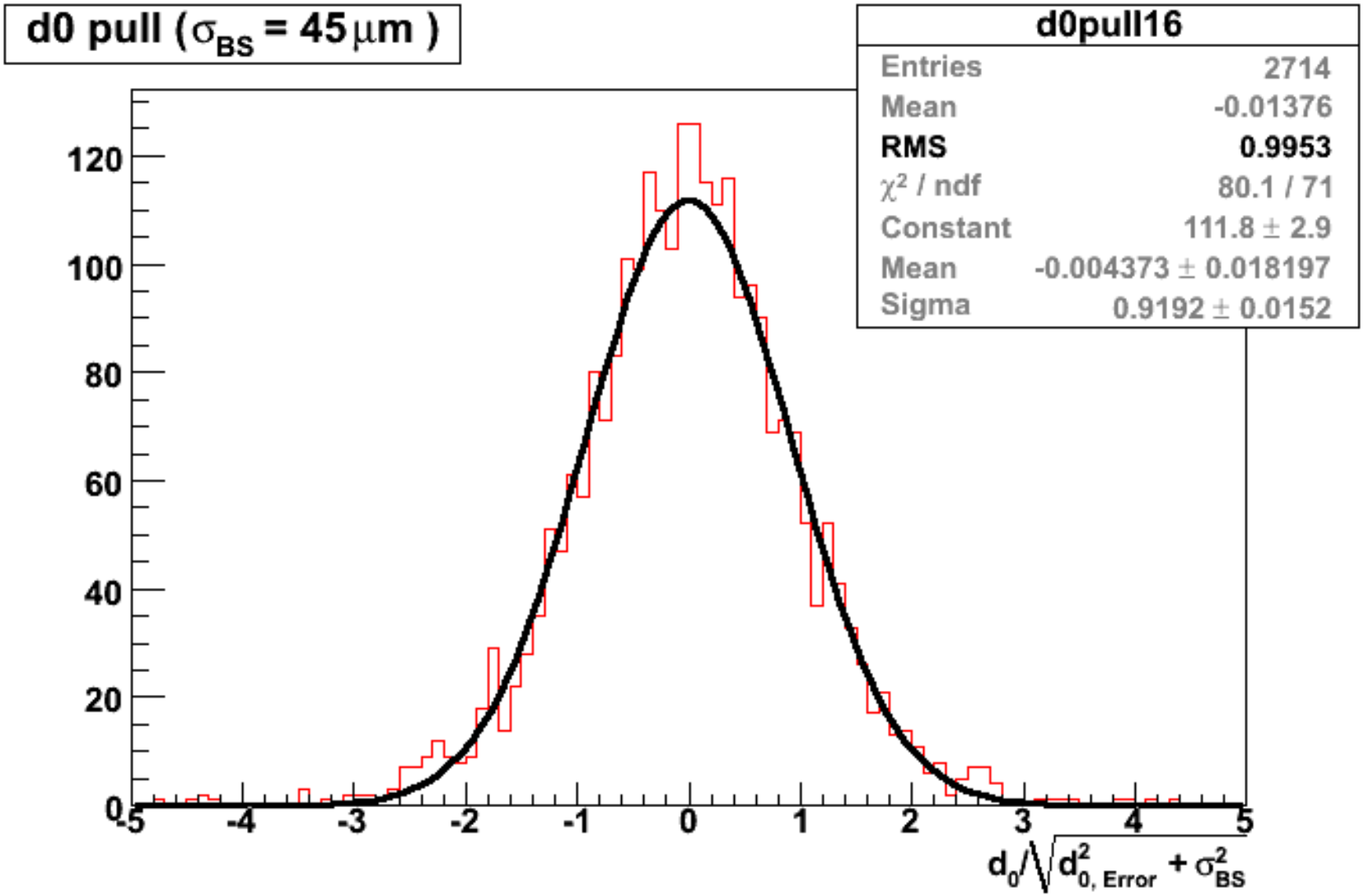
Beam spot width measurement



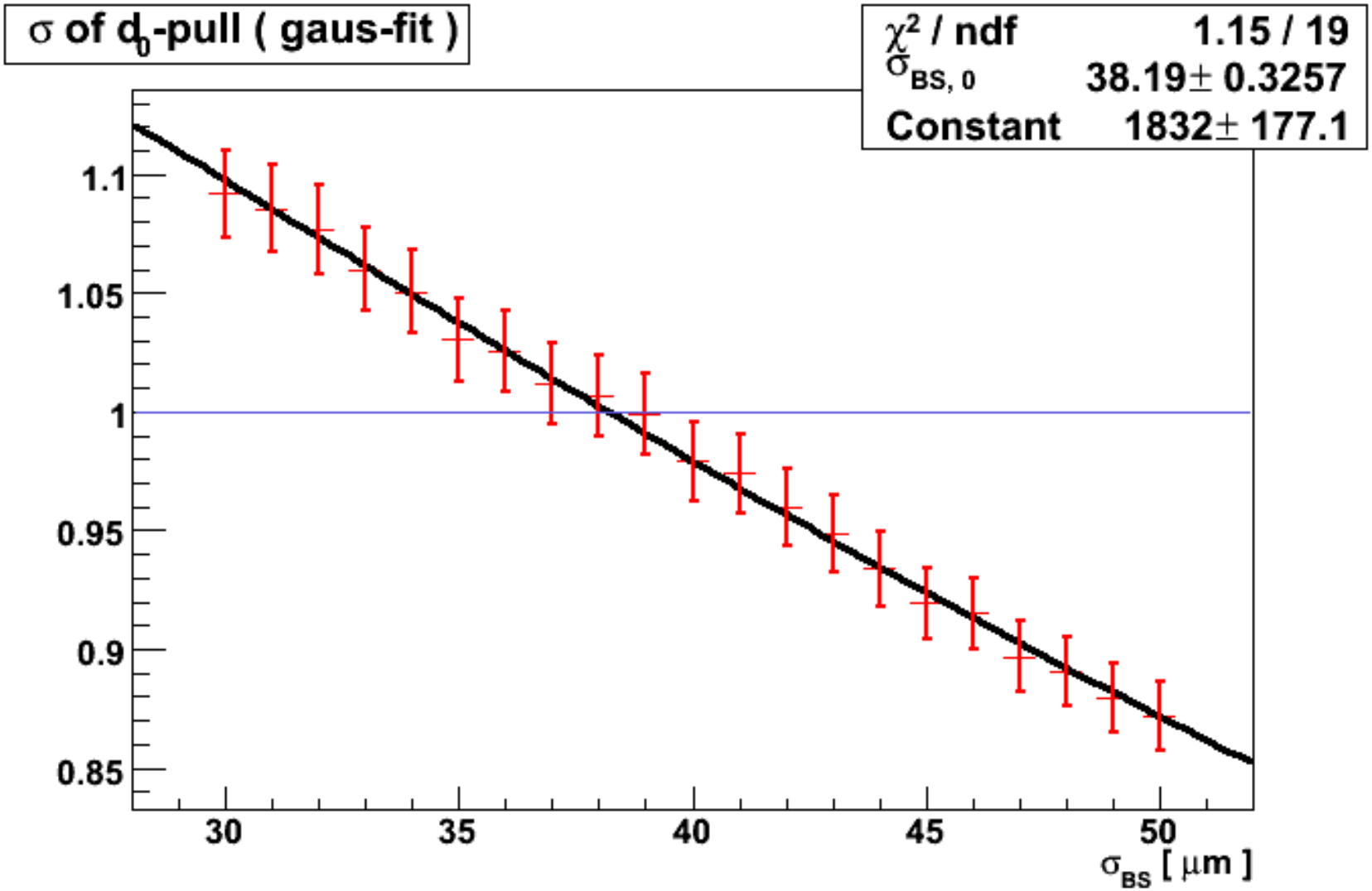
Beam spot width measurement



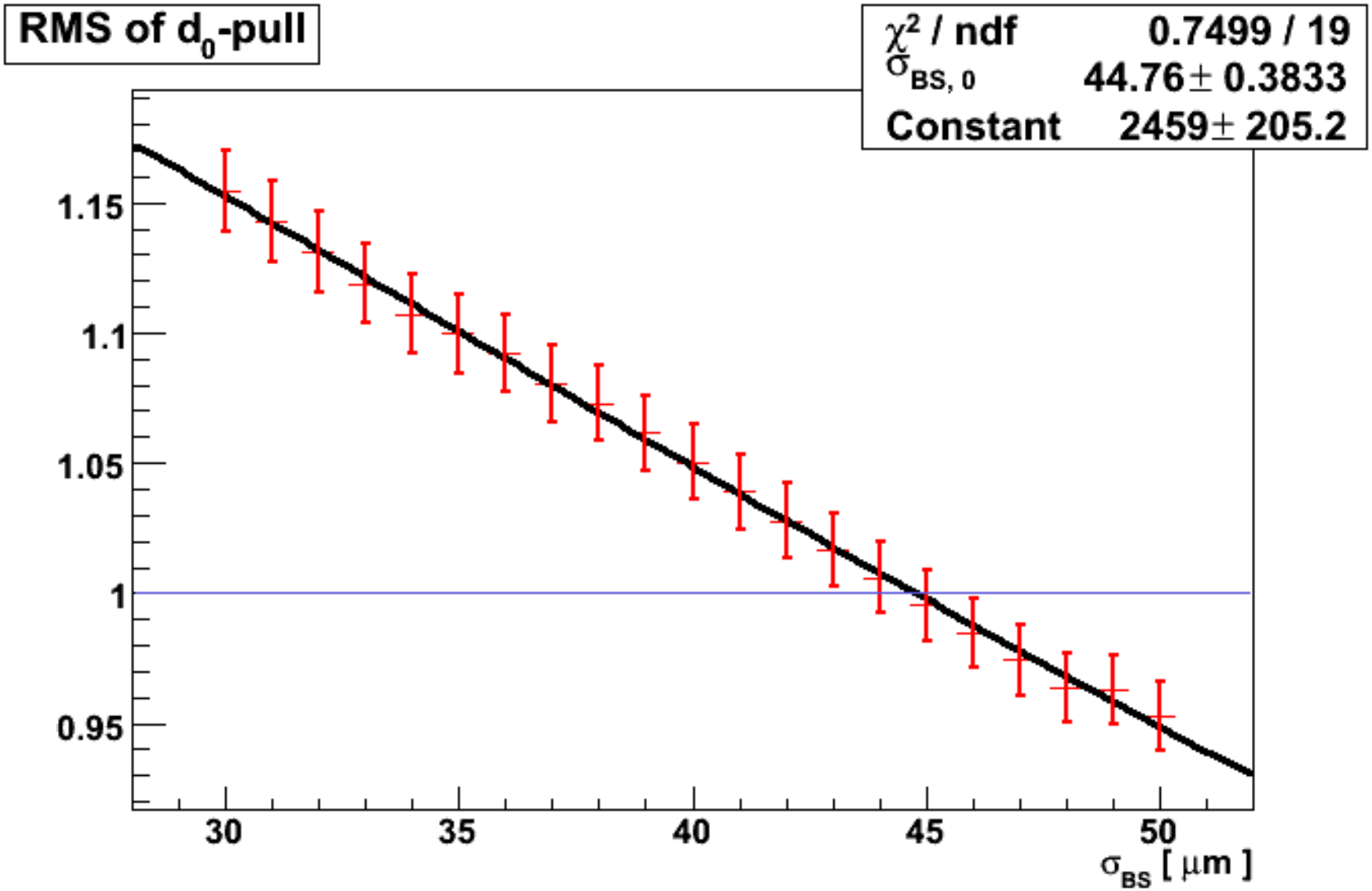
Beam spot width measurement



Beam spot width measurement



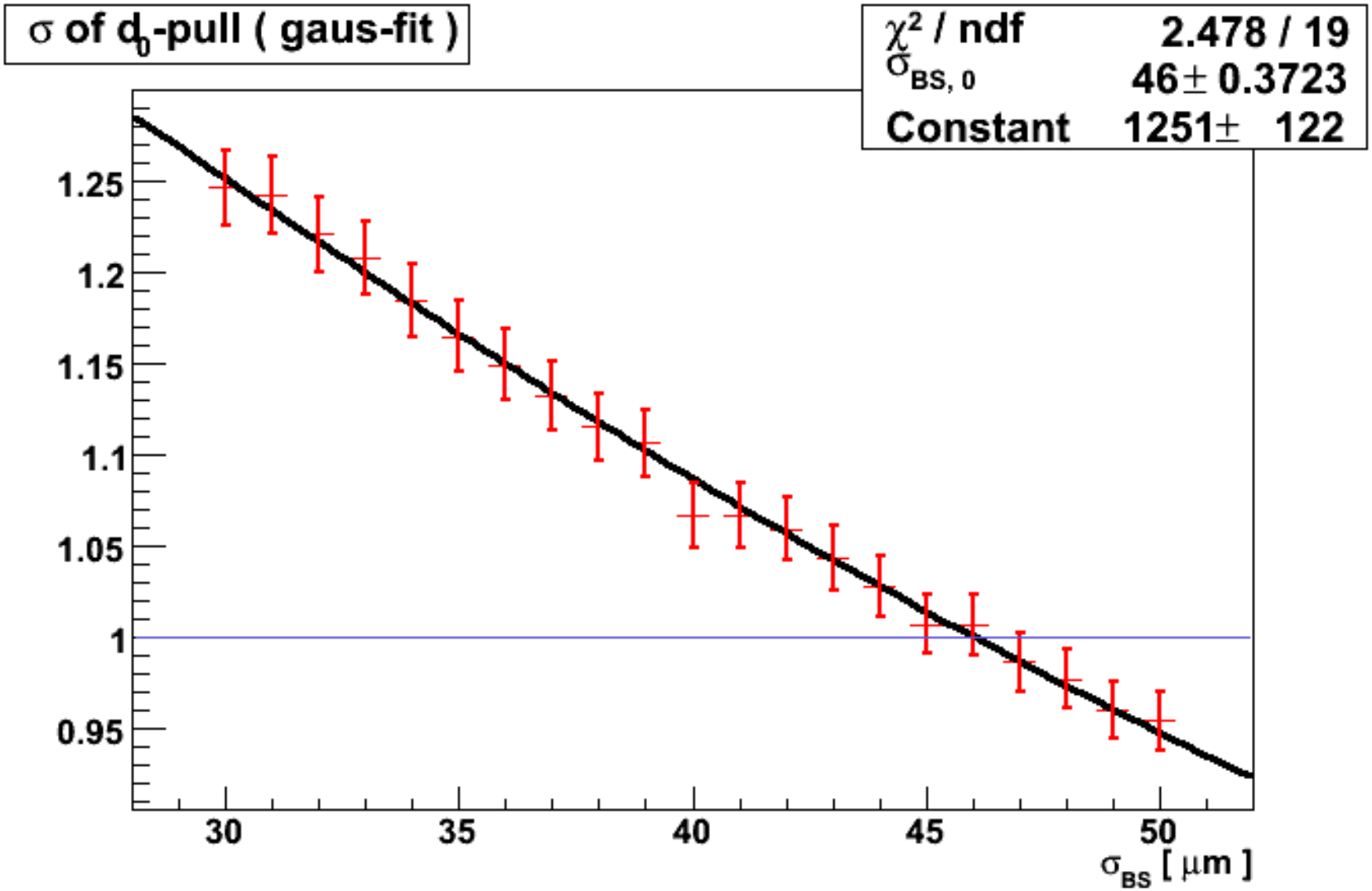
Beam spot width measurement



Beam spot width measurement

- measured value is in both cases (σ^{Gauss} and σ^{RMS}) smaller than MC input
- some freedom in definition of tracking errors/ calibration of method
  $\Rightarrow$ calibration factor C for $d_{0,Error}$ to get the right effective value for σ_{BS}
- use of Gauss fit method although σ_{BS}^{RMS} is closer to σ_{BS}^{MC}
  $\Rightarrow$ less sensitive to outliers
  $\Rightarrow$ $C = 0.804781$

Beam spot width measurement



Outlook

- apply the calibrated method on real data
- use of **I**mpact **P**arameter **C**orrelation method