DVCS collaboration meeting

16 January 2017

LHRS Optics Update

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Optics Matrix – short reminder

- Spring 2016 - 4 Q1 detune - 4 matrices:
  - Kin48_1: “100% detune”
  - Kin48_2: “62% detune”
  - Kin48_3: “85% detune”
  - Kin48_4: “74% detune”
- Fall 2016: “new Q1”,1 matrix

- I did the calibration only for Spring 2016.
- But Yang Wang (GMP) did for Fall 2016

$$\begin{bmatrix} \delta \\ \theta \\ y \\ \phi \end{bmatrix}_{tg} = \begin{bmatrix} \langle \delta | x \rangle & \langle \delta | \theta \rangle & 0 & 0 \\ \langle \theta | x \rangle & \langle \theta | \theta \rangle & 0 & 0 \\ 0 & 0 & \langle y | y \rangle & \langle y | \phi \rangle \\ 0 & 0 & \langle \phi | y \rangle & \langle \phi | \phi \rangle \end{bmatrix} \begin{bmatrix} x \\ \theta \\ y \\ \phi \end{bmatrix}_{fp}$$

Optics matrix (1st order approximation)

Optics Matrix – short reminder

$$y_{tg} = \sum_{j,k,l} Y_{jkl} \theta^{j}_{fp} y^{k}_{fp} \phi^{l}_{fp},$$

$$\theta_{tg} = \sum_{j,k,l} T_{jkl} \theta^{j}_{fp} y^{k}_{fp} \phi^{l}_{fp},$$

$$\phi_{tg} = \sum_{j,k,l} P_{jkl} \theta^{j}_{fp} y^{k}_{fp} \phi^{l}_{fp},$$

$$\delta = \sum_{j,k,l} D_{jkl} \theta^{j}_{fp} y^{k}_{fp} \phi^{l}_{fp},$$

$$Y_{jkl} = \sum_{i=1}^{m} C_i^{Y_{jkl}} x^{i}_{fp}$$

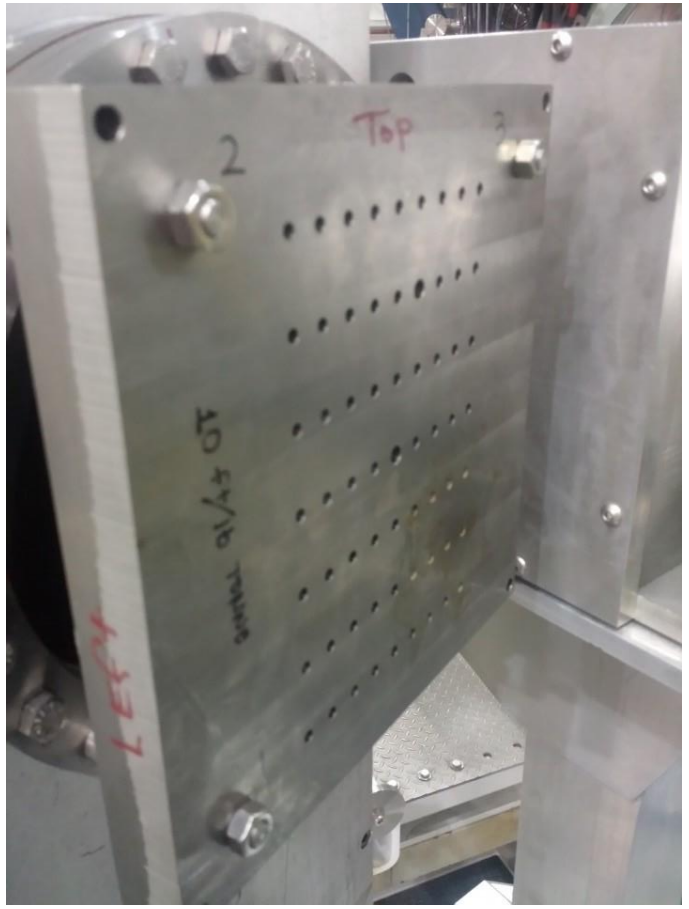
$$y_{tg} = \sum_{j,k,l} \sum_{i=1}^{m} C_i^{Y_{jkl}} x^{i}_{fp} \theta^{j}_{fp} y^{k}_{fp} \phi^{l}_{fp}$$

$C_i^{Y_{jkl}}$ “Optics matrix coefficients”

i + j + k + l ≤ 5

Optics Calibration process – short reminder

- Step 1: DIS on optics target + Sieve ON
  - Optimization of y_{tg}, θ_{tg} and ϕ_{tg} reconstruction
  - Optics target : 5 C foils during Spring 2016
    9 C foils during Fall 2016
- Step 2: Delta Scan Elastic on LH_2 target
  - Optimization of δ_{tg} reconstruction
  - Sieve ON helps but decreases statistics
  - Sieve was OFF during Spring, ON during Fall
  - New Sieve with more holes during Fall
- Fall 2016 calibration expected to be more accurate than Spring 2016



Corrections and limitations

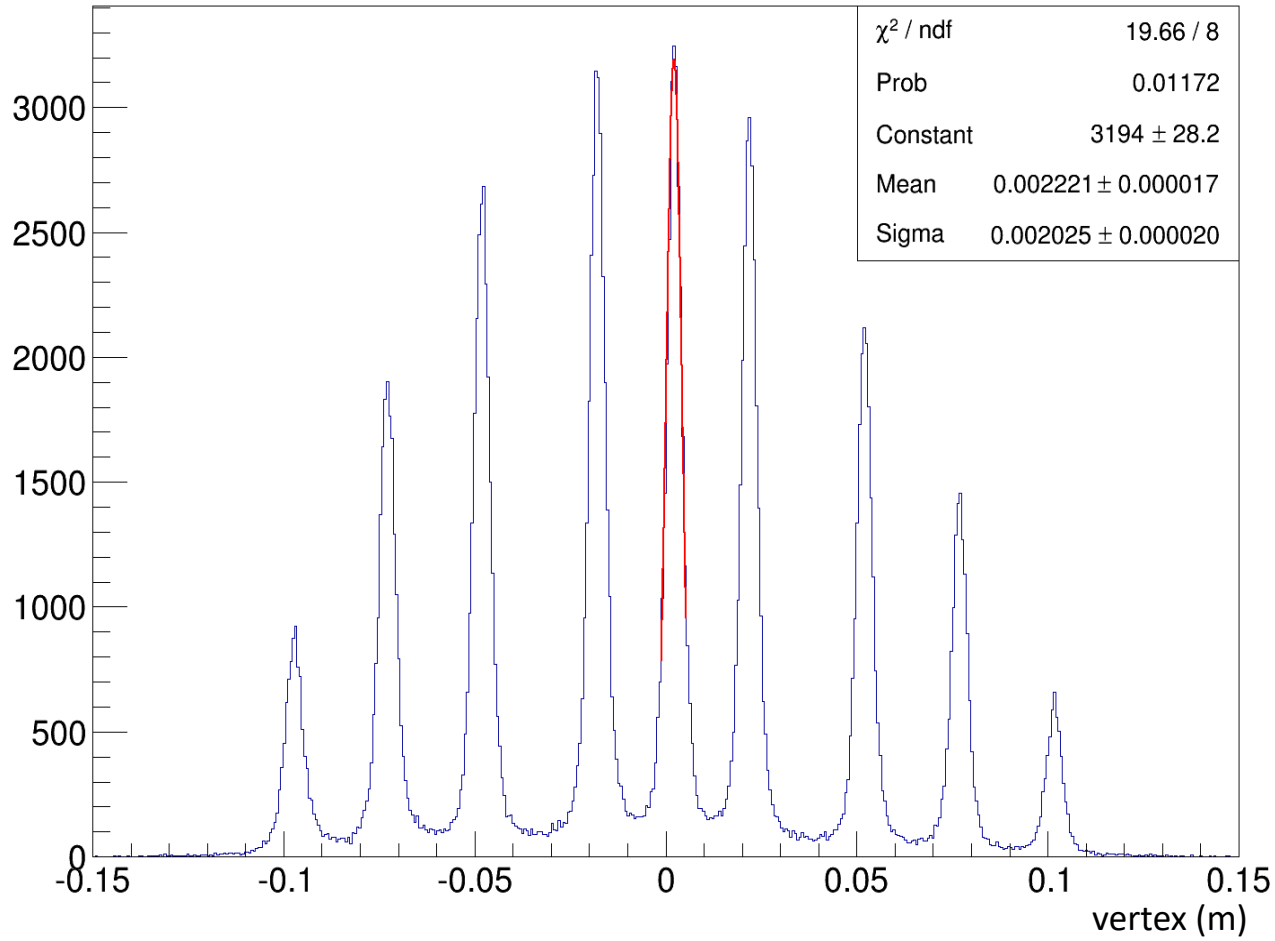
- Sieve position Offset:
  - Spring: Survey of 03/09/2015 used. No survey during Spring 2016.
  - Fall: Could not find any sieve survey for Fall 2016.
- LHRS pointing Offset and angle:
  - Spring: Survey of 02/26/2016 used.
  - Fall: Survey of 10/21/2016 used ?
- Raster (for Delta Scan):
  - LrbGmp beam class and variables used to take raster size into account.
- Energy loss corrections:
  - Spring: target specifications (LH_2 cell size, etc…) + PDG data used for computation.
  - Fall: taken into account ?
- Limitation on δ_{tg} optimization during Spring. No problem during Fall
  - Could only optimize for the dependences in x_{fp} and x_{fp}^2 and $x_{fp} * \theta_{fp}$.
  - $x_{fp} * \theta_{fp}$ is the dominating term.

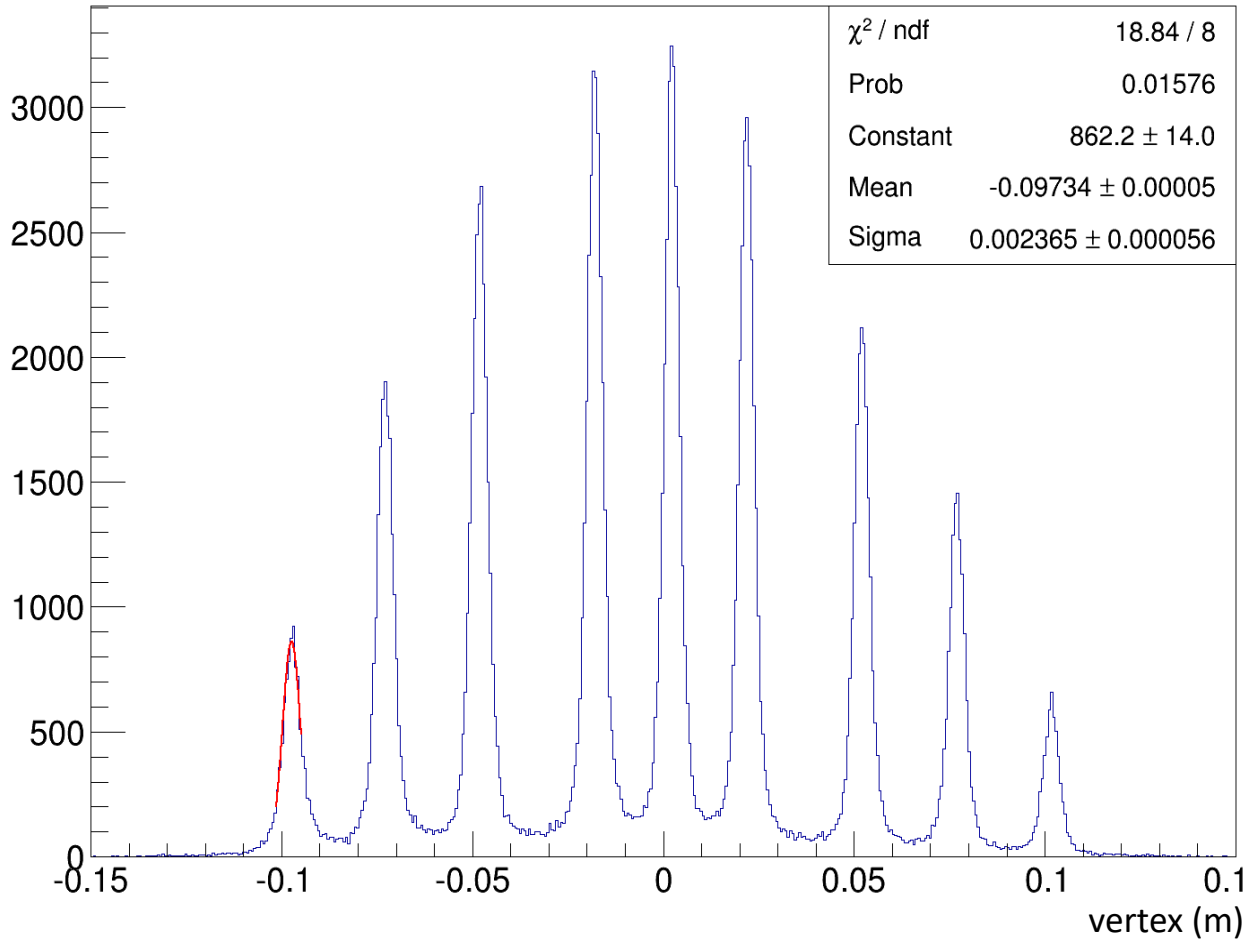
Spring 2016 – Final results

Optics target					Delta Scan
detune Q1	mean position central peak (mm)	sigma central peak (mm)	mean position left peak (mm)	sigma left peak (mm)	resolution dp/p (x 10^{-3})
100%	4.866	7.2	-67.81	6.717	0.9593
85%	5.097	7.169	-67.58	6.818	0.9891
74%	5.011	7.591	-67.48	6.612	1.074
62%	5.142	7.79	-67.58	6.681	1.098

LHRS angle: 16.629 deg
7.2 * Sin(LHRS angle) = 2.06 mm
6.7 * Sin(LHRS angle) = 1.92 mm

Fall 2016 – using Yang Wang's (GMP) matrix



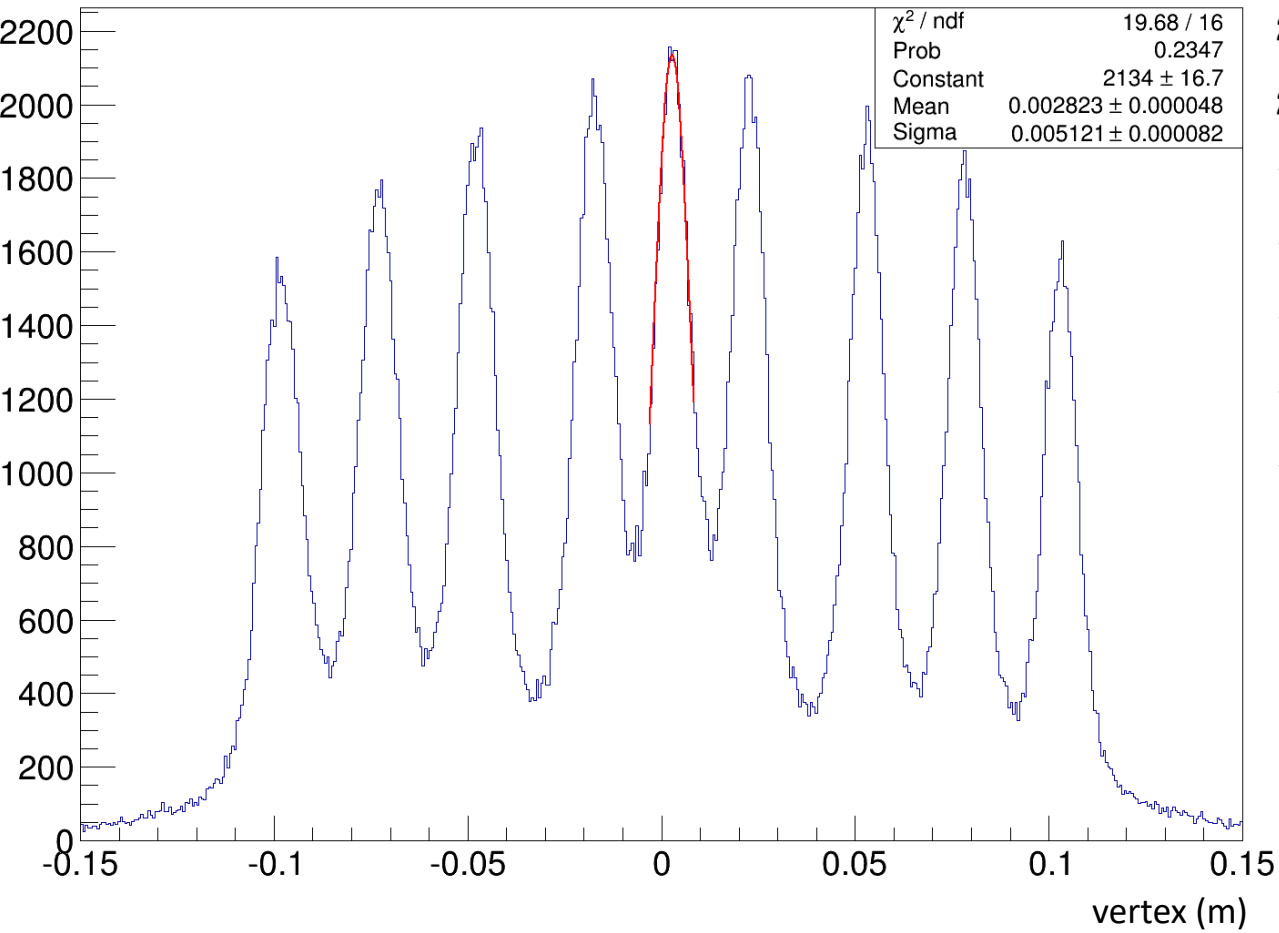


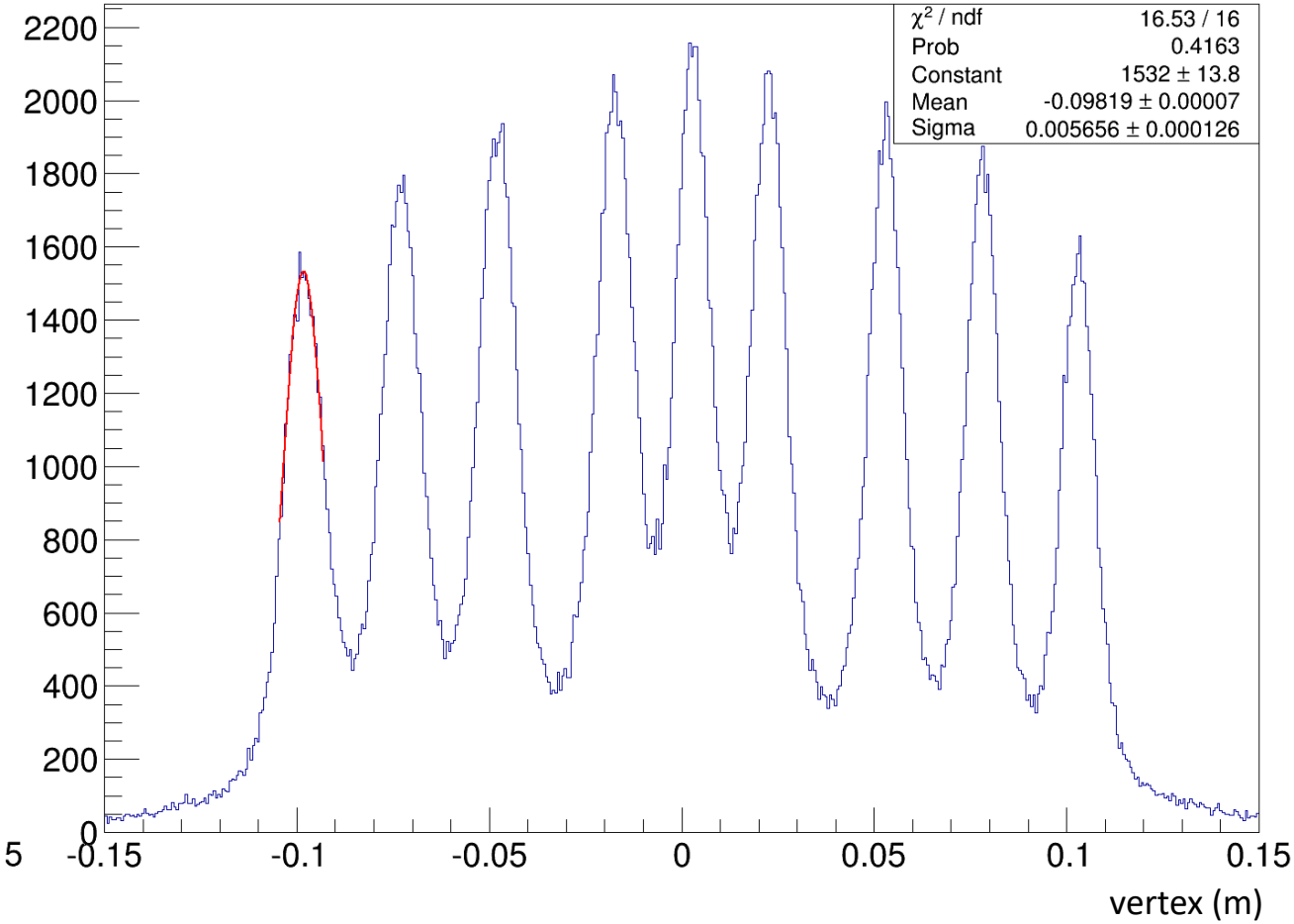
LHRS angle: 42.005 deg

$Sigma_{center}$ = 2.025 mm ; $Sigma_{center}$ * Sin(LHRS angle) = 1.355 mm

$Sigma_{left}$ = 2.365 mm ; $Sigma_{left}$ * Sin(LHRS angle) = 1.583 mm

Fall 2016 – using Yang Wang's (GMP) matrix



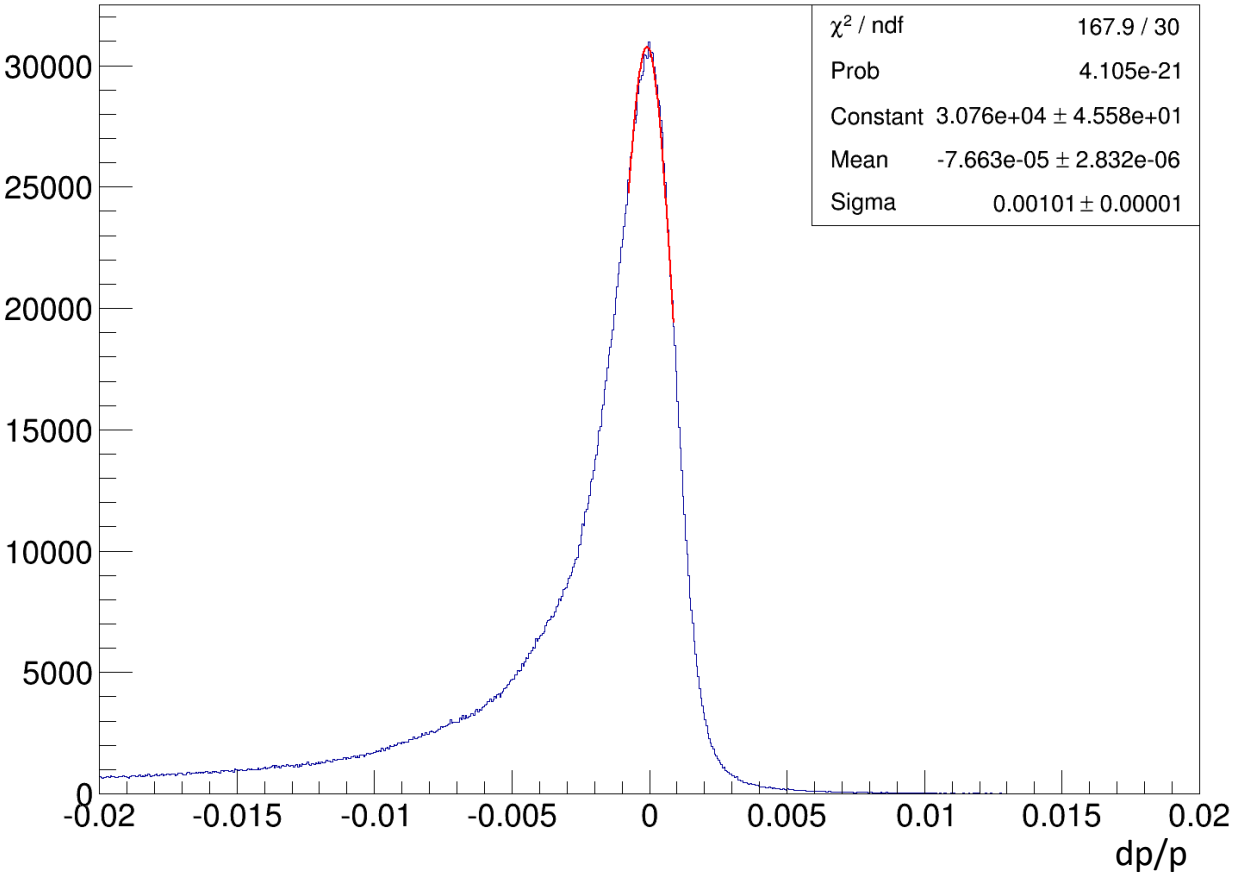


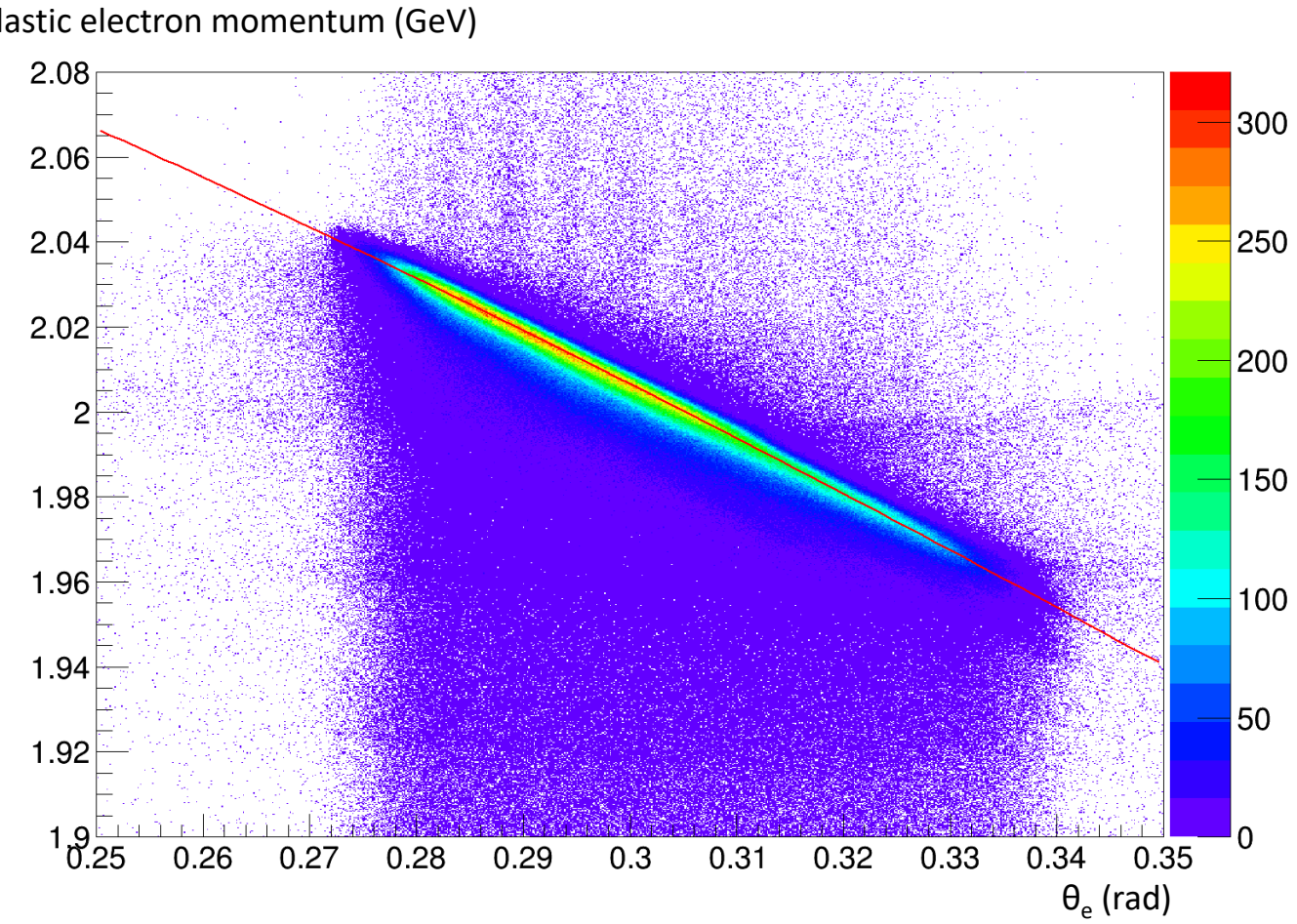
LHRS angle: 17.513 deg

$Sigma_{center}$ = 5.121 mm ; $Sigma_{center}$ * Sin(LHRS angle) = 1.541 mm

$Sigma_{left}$ = 5.656 mm ; $Sigma_{left}$ * Sin(LHRS angle) = 1.702 mm → Better than Spring

Fall 2016 – using Yang Wang's (GMP) matrix





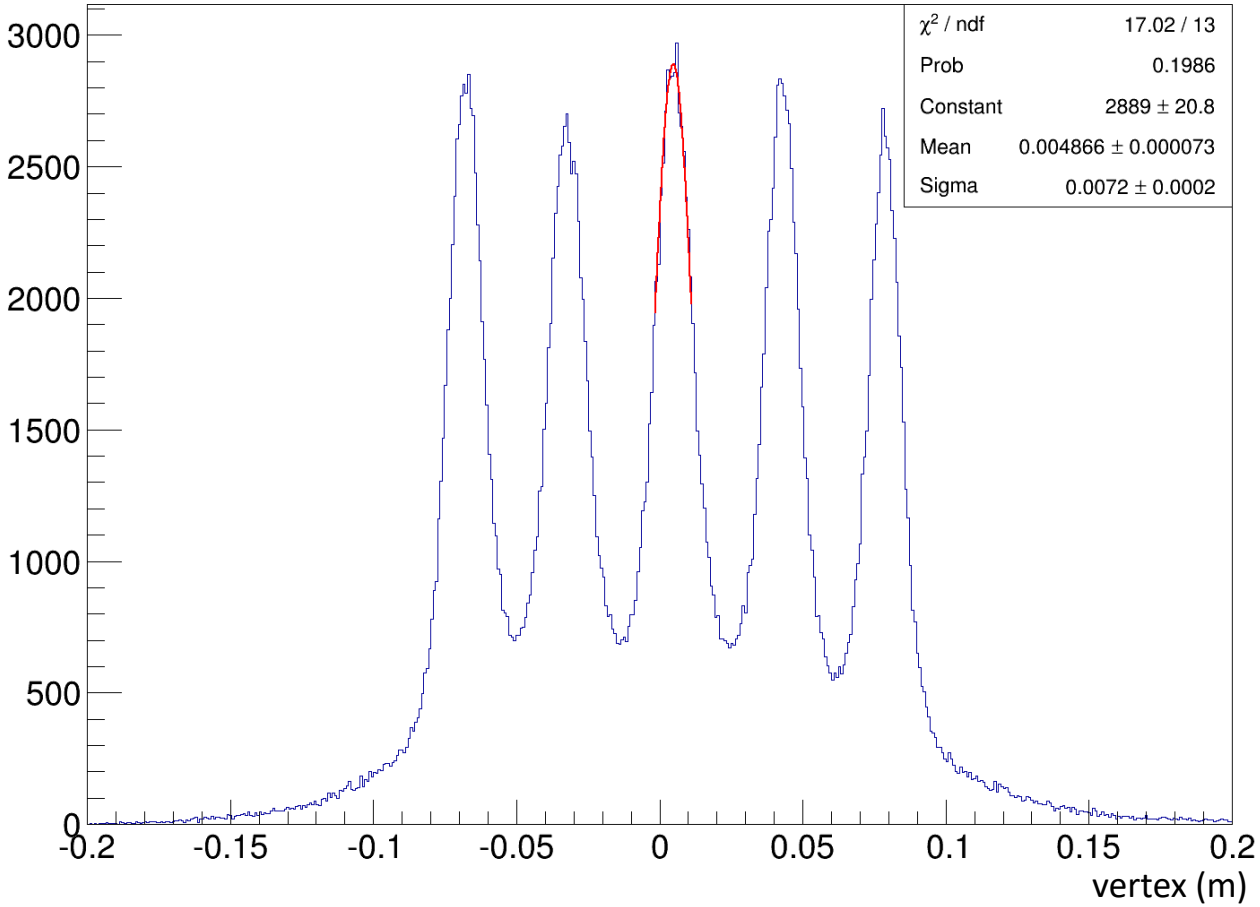
dp/p sigma: 0.00101 ⟶ Same as Spring

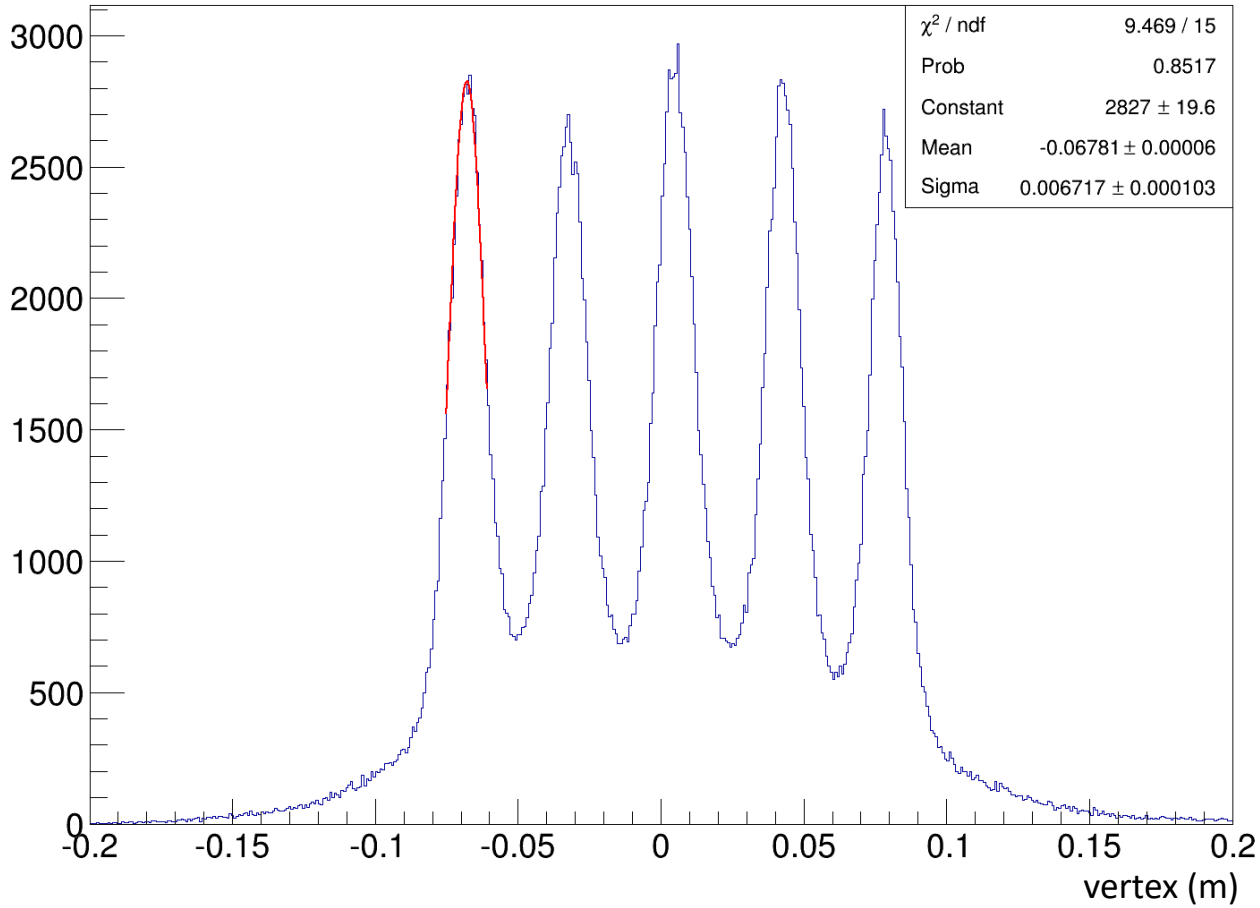
Status - Conclusion

- Spring 2016: Optics calibration complete
- Fall 2016: We can use GMP's optics matrix (calibration complete)

- Optional: We can cross check GMP's matrix with Q1 100% detune setting from Spring
- (Optional: We can try to do the optics calibration for Fall 2016 and cross check with GMP)

Spring 2016 – Optics plots – Q1 100%



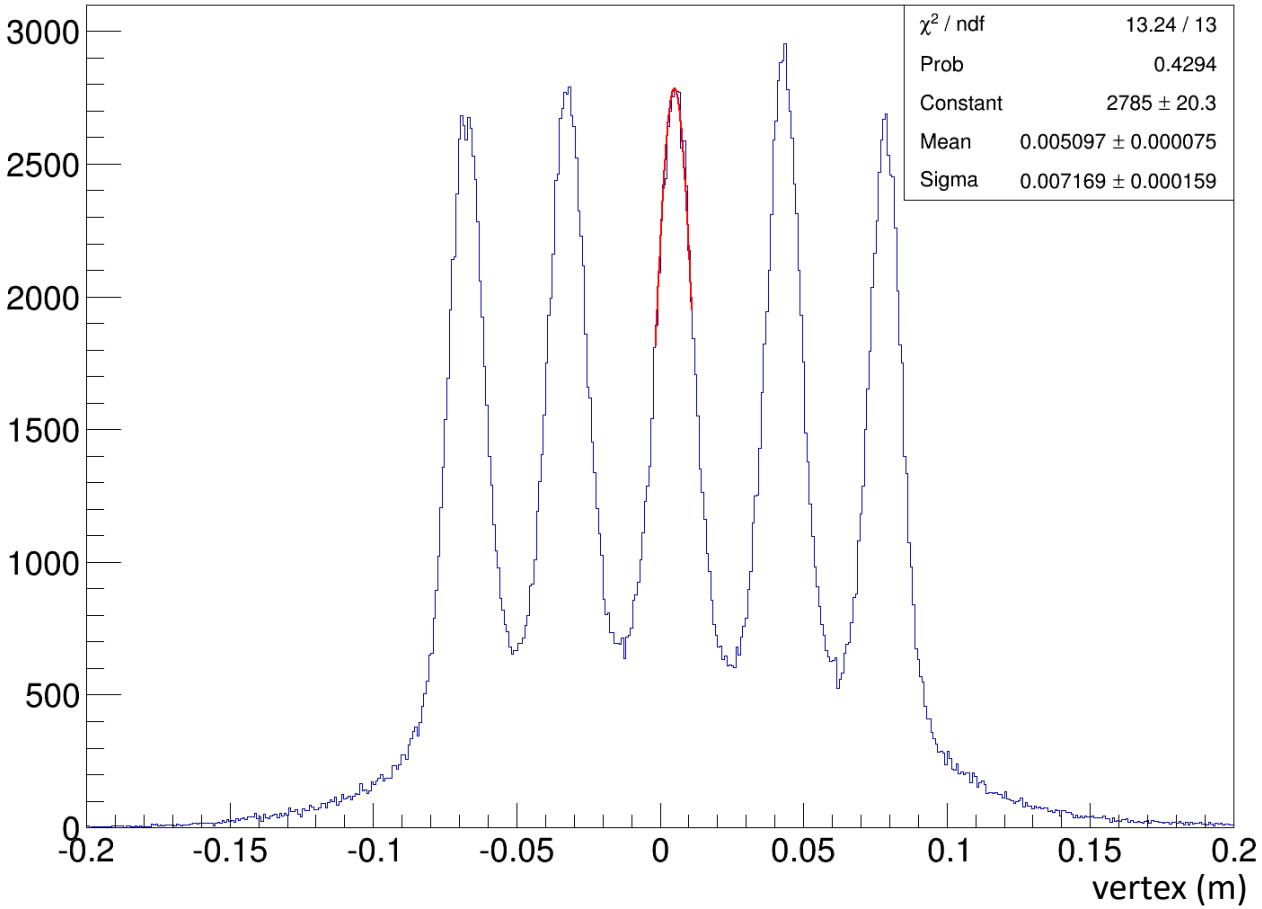


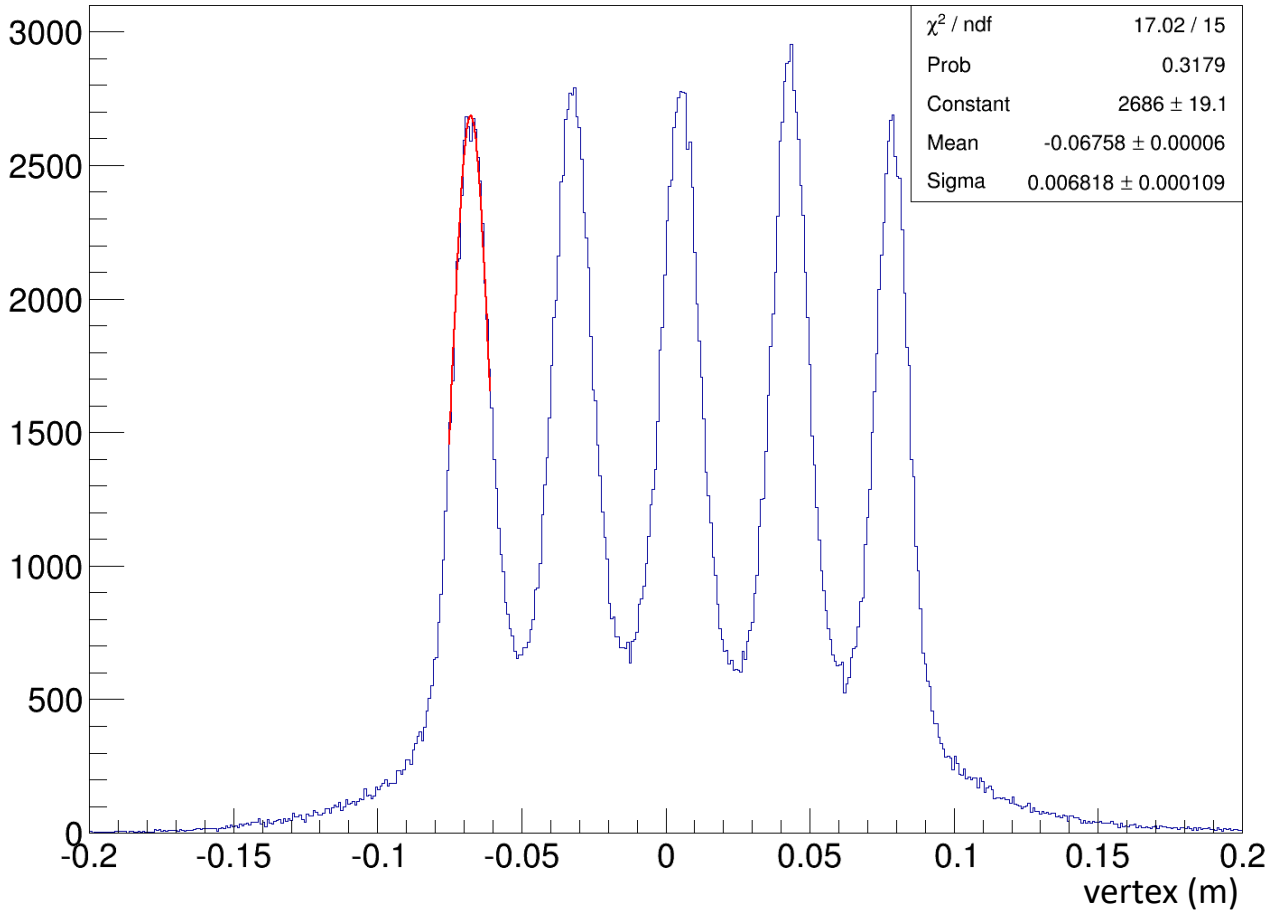
LHRS angle: 16.629 deg

$Sigma_{center}$ = 7.2 mm

$Sigma_{left}$ = 6.717 mm

Spring 2016 – Optics plots – Q1 85%



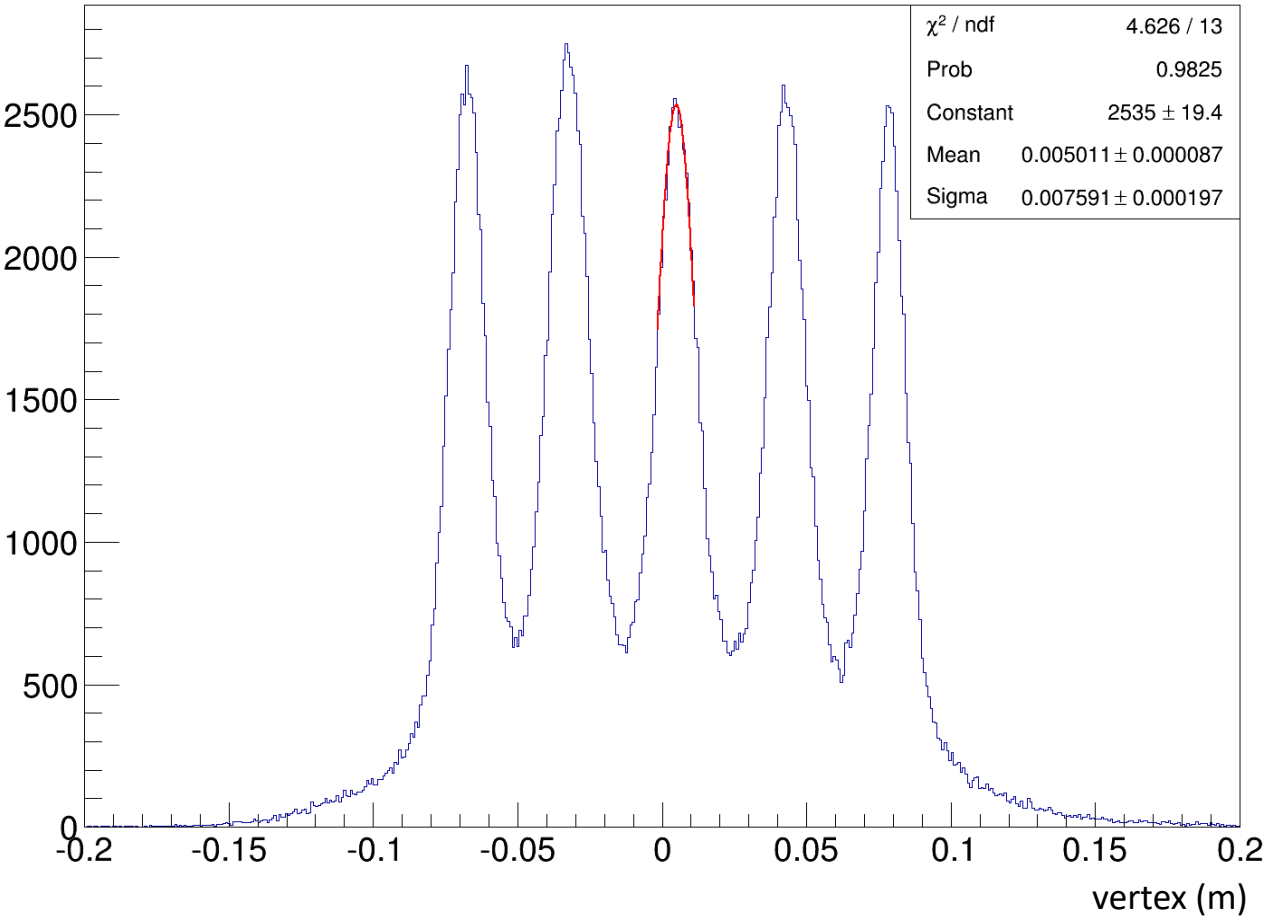


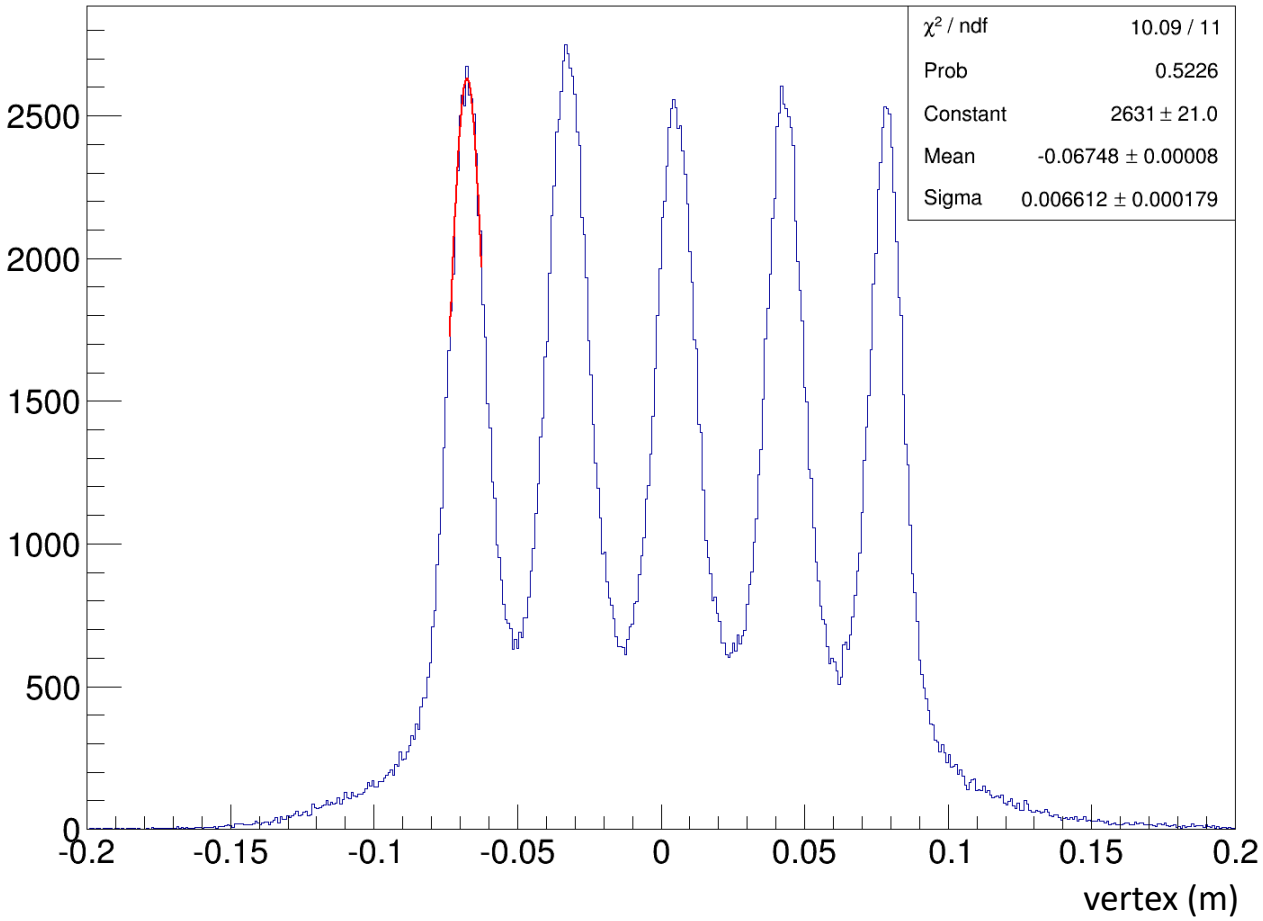
LHRS angle: 16.629 deg

$Sigma_{center}$ = 7.169 mm

$Sigma_{left}$ = 6.818 mm

Spring 2016 – Optics plots – Q1 74%



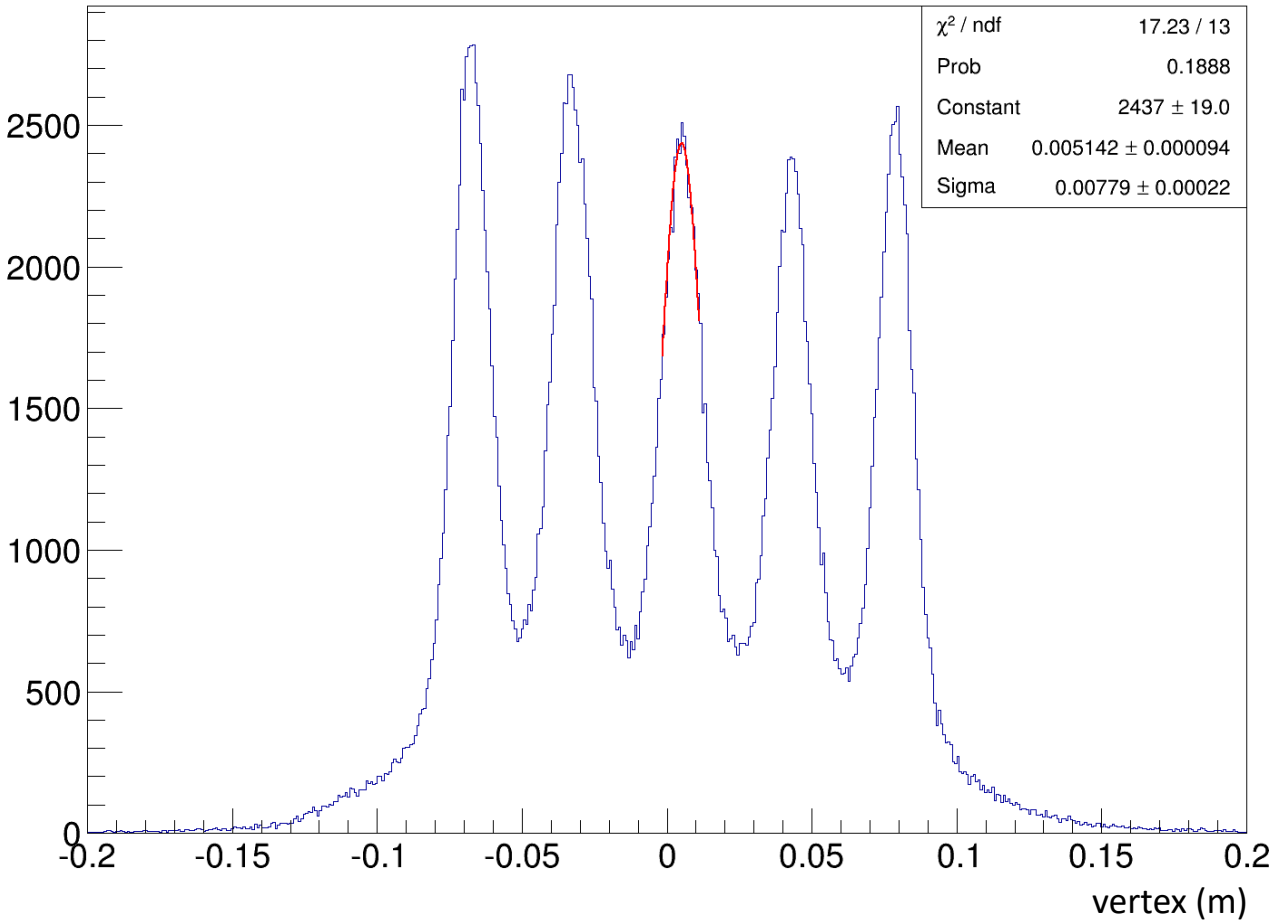


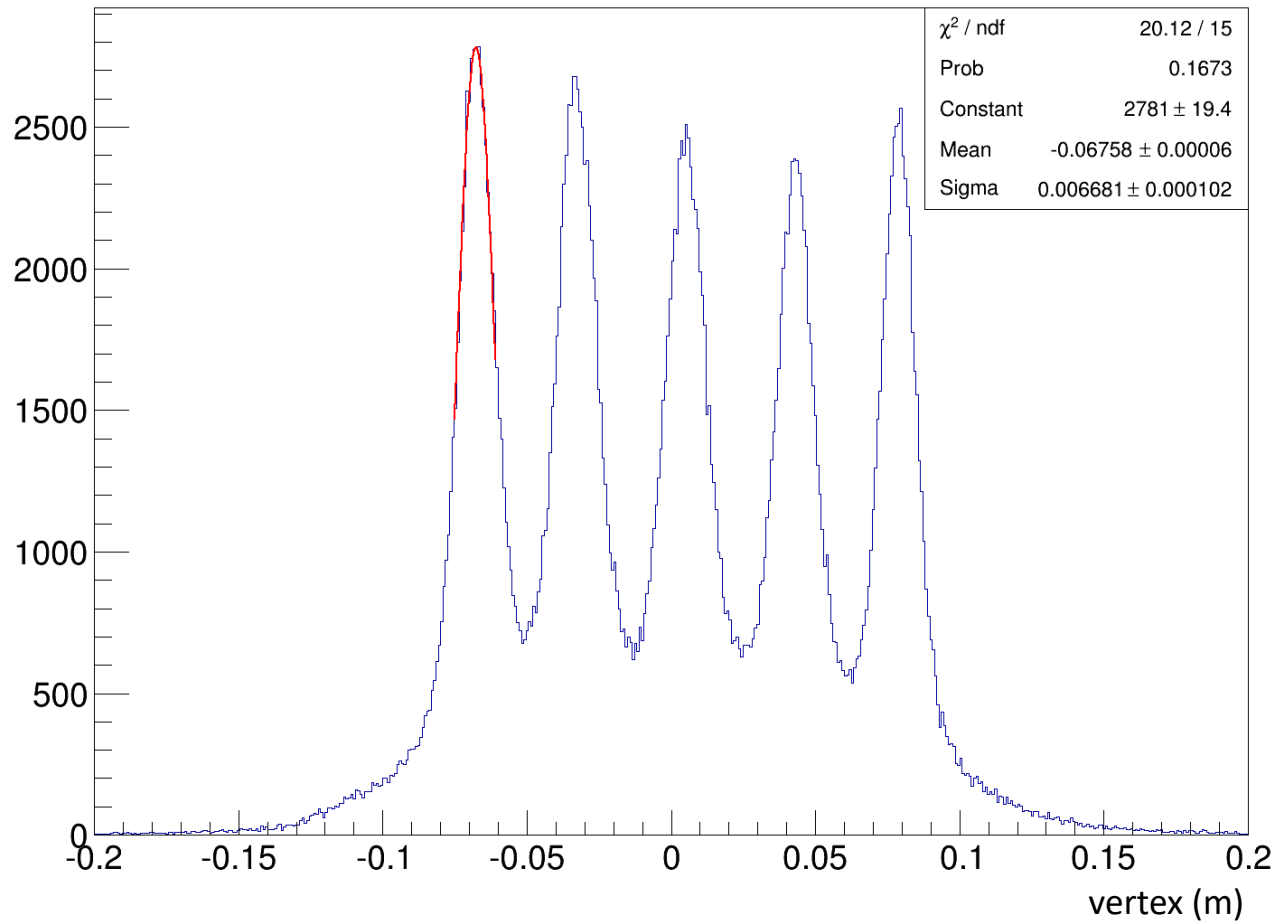
LHRS angle: 16.629 deg

$Sigma_{center}$ = 7.591 mm

$Sigma_{left}$ = 6.612 mm

Spring 2016 – Optics plots – Q1 62%



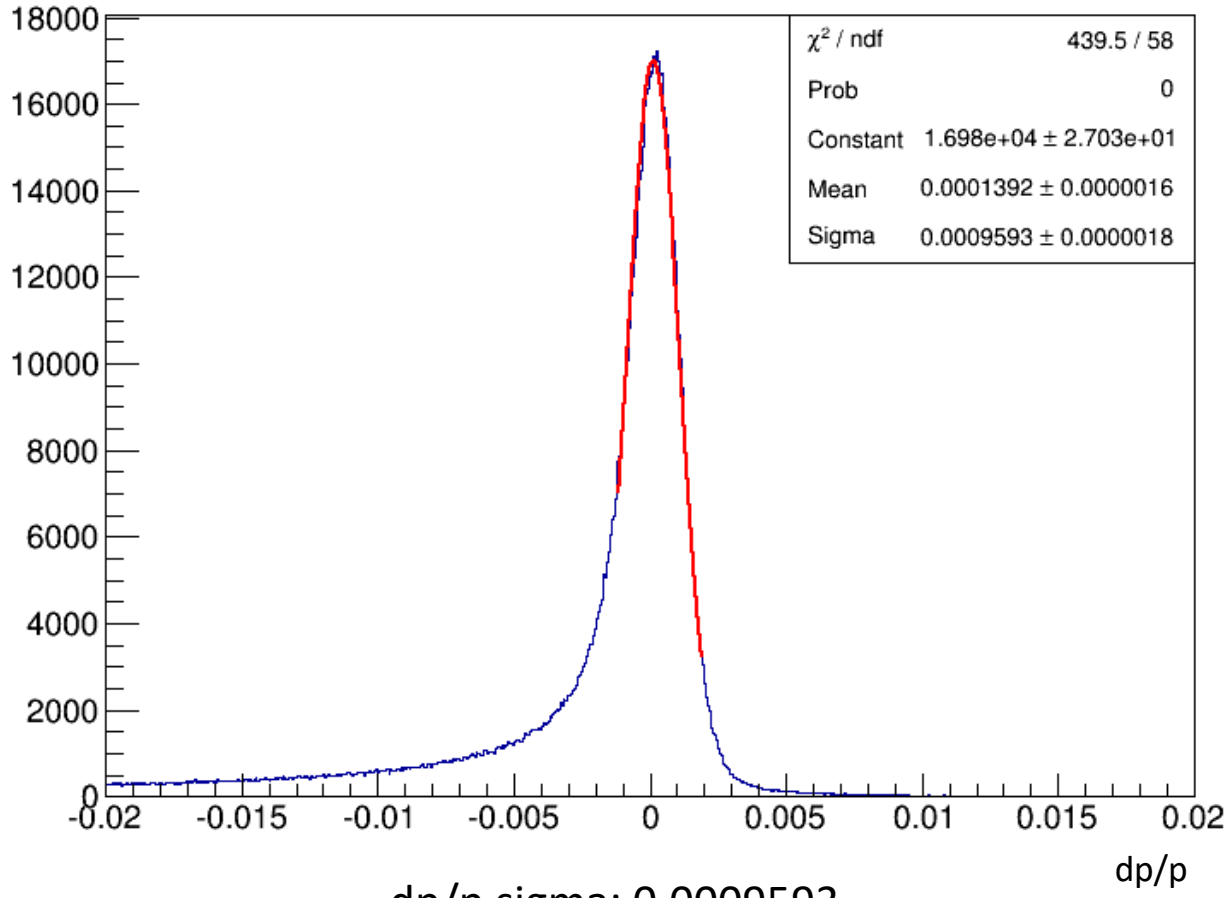


LHRS angle: 16.629 deg

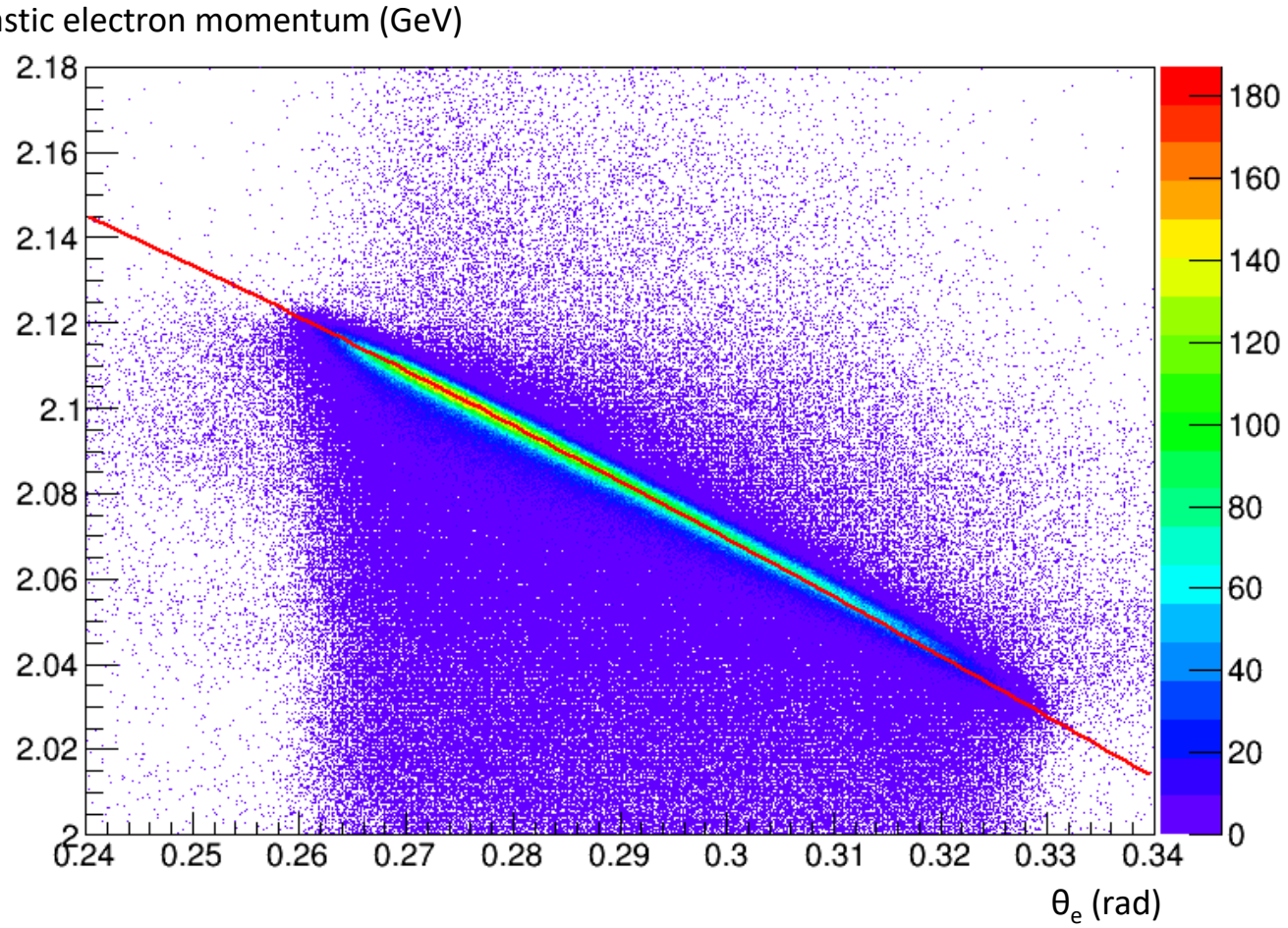
$Sigma_{center}$ = 7.79 mm

$Sigma_{left}$ = 6.681 mm

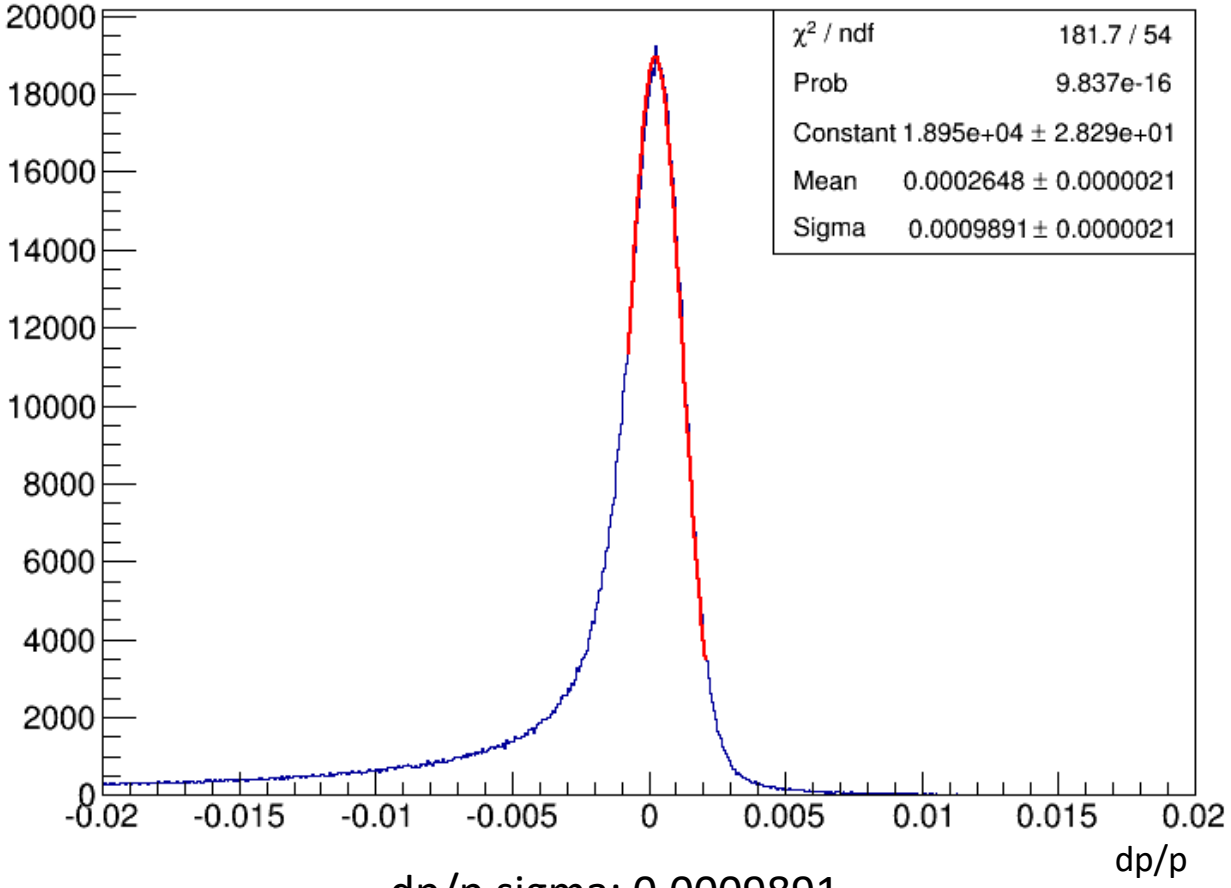
Spring 2016 – Delta Scan plots – Q1 100%



dp/p sigma: 0.0009593

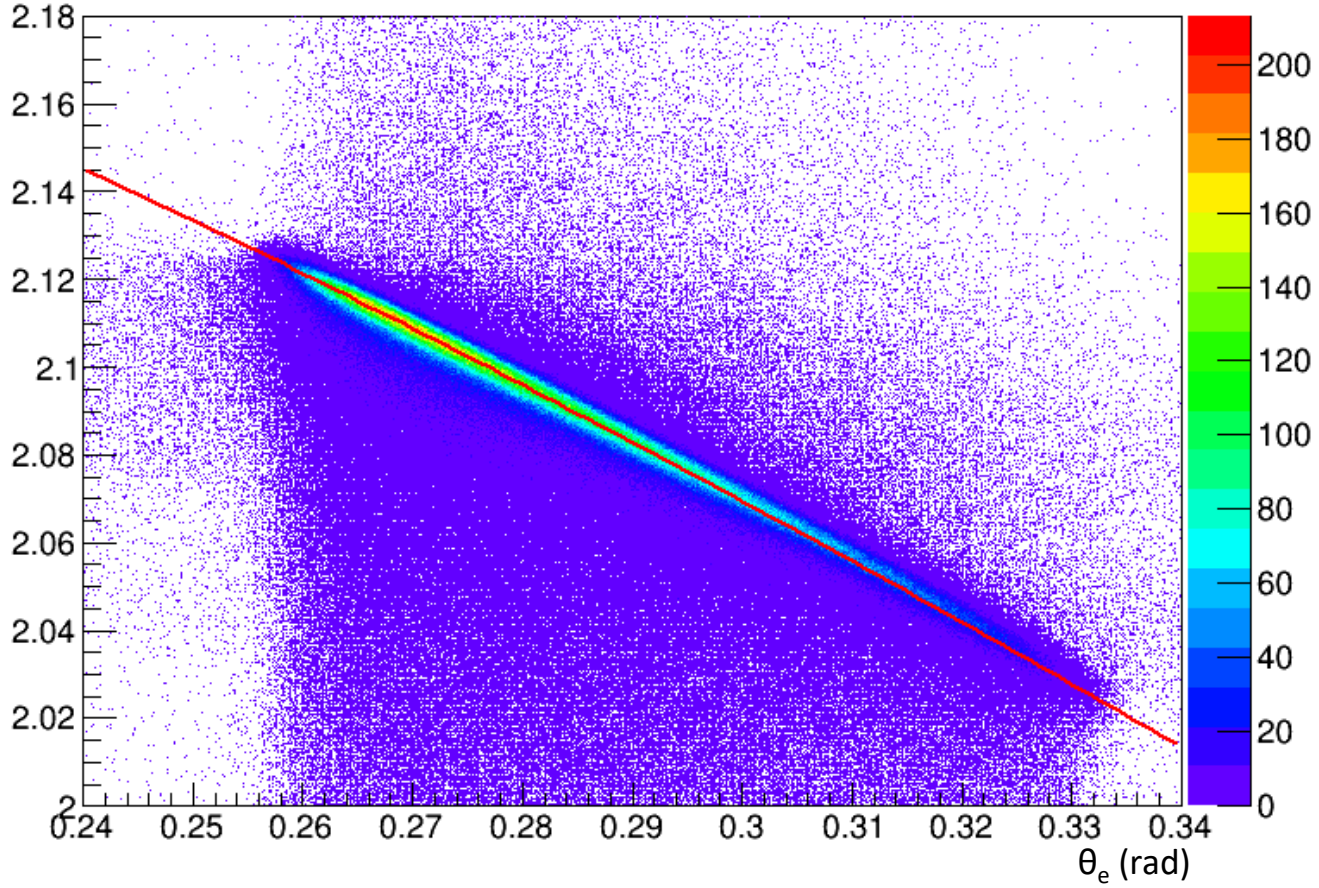


Spring 2016 – Delta Scan plots – Q1 85%

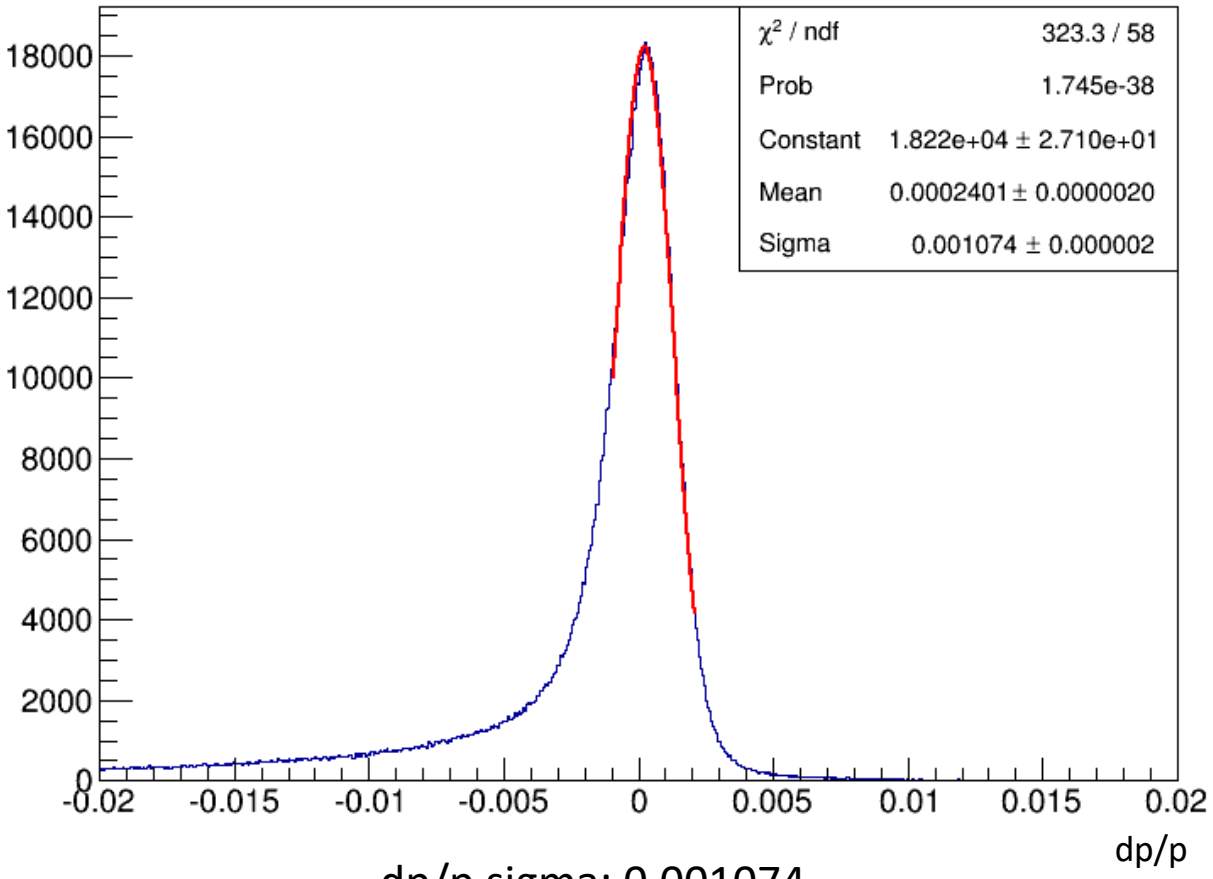


dp/p sigma: 0.0009891

elastic electron momentum (GeV)

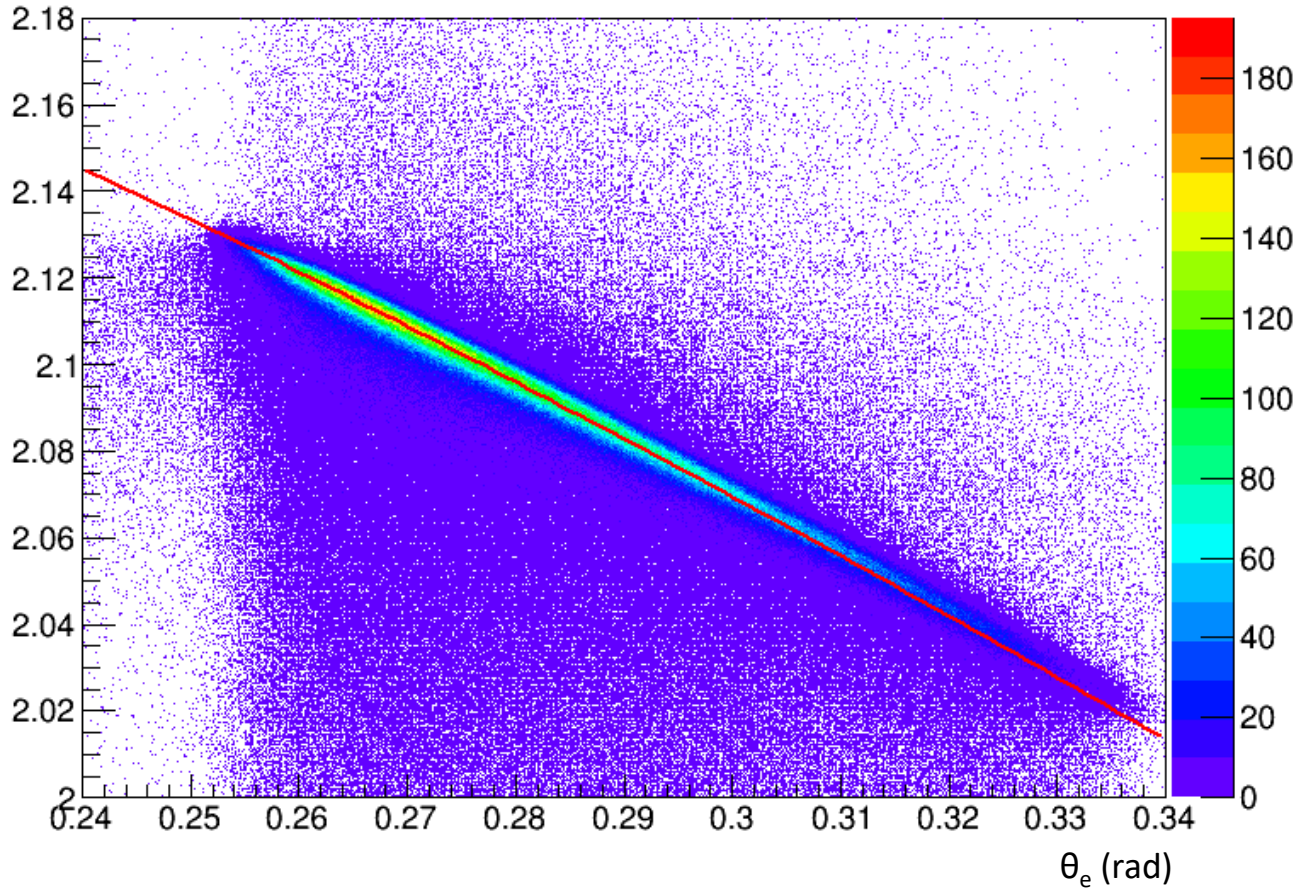


Spring 2016 – Delta Scan plots – Q1 74%

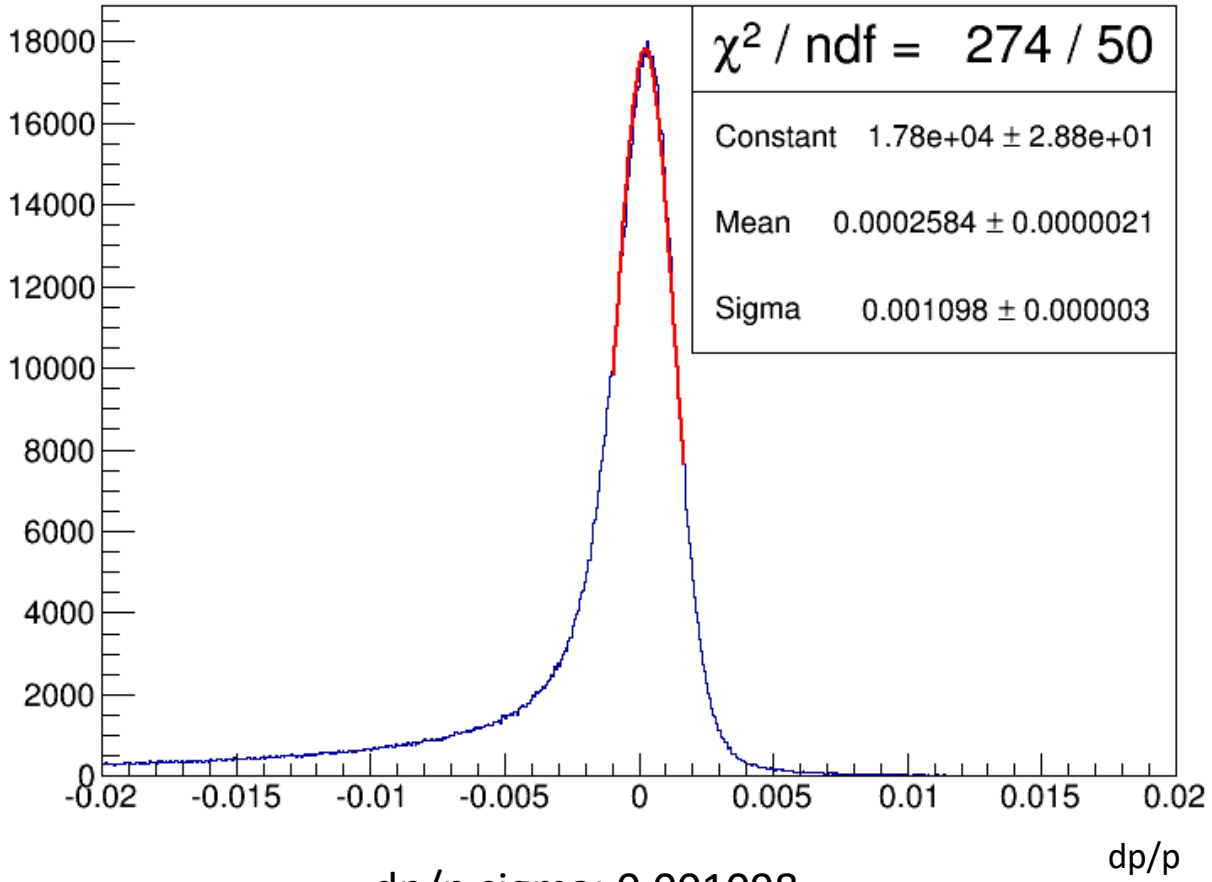


dp/p sigma: 0.001074

elastic electron momentum (GeV)



Spring 2016 – Delta Scan plots – Q1 62%



dp/p sigma: 0.001098

elastic electron momentum (GeV)