Dead Areas on GEM

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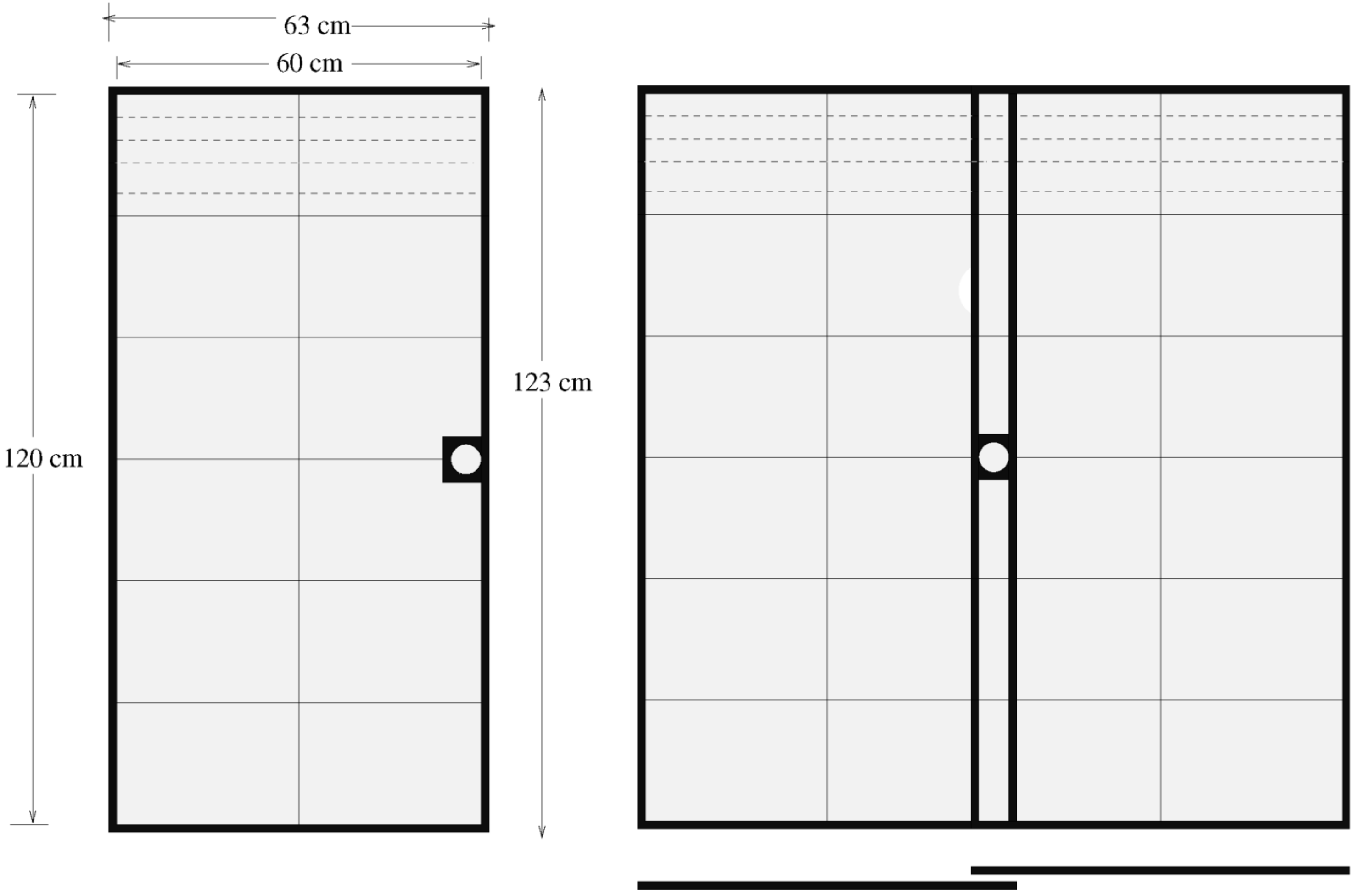
04/02/2014

Schematic of GEM

- Thin solid line
  - Spacers, 2 ~ 3 mm
- Dashed line
  - Sector boundaries, 0.5 mm



Study on the dead areas

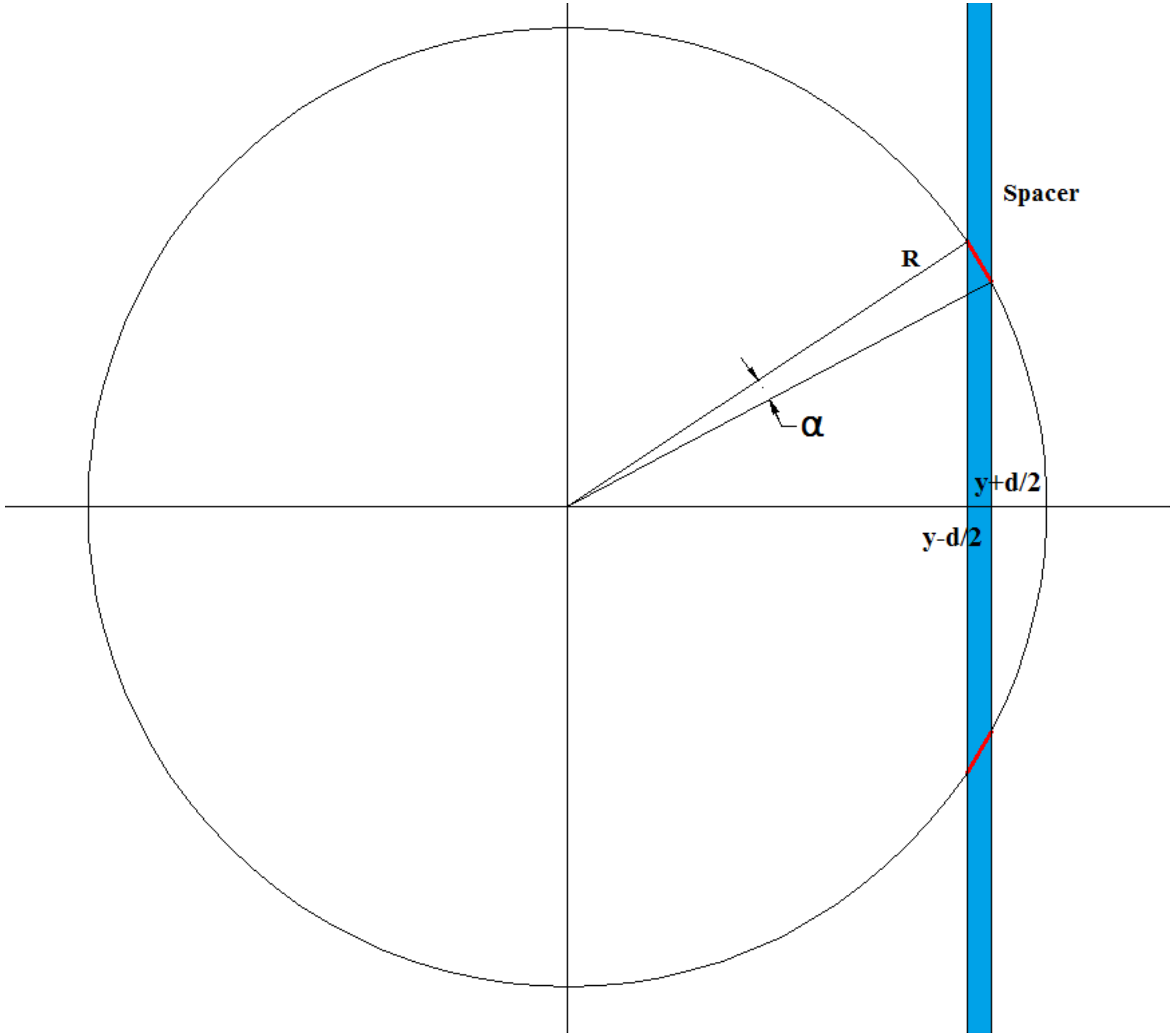
- The spacers are studied (thin solid line at page 2)
  - Assuming a width of 2 mm
  - Located at y = 0, ±20 cm, ±40 cm, and x = ±30 cm
- Loss of acceptance
  - The dead strip will cause a loss of acceptance, need corrections on the acceptance to obtain the cross section
- Introduced uncertainties
  - Slightly worse statistics
  - Uncertainties on the corrections: from uncertainties of the location and width of spacers and position resolutions

Loss of acceptance

- Mathematically determine the acceptance loss

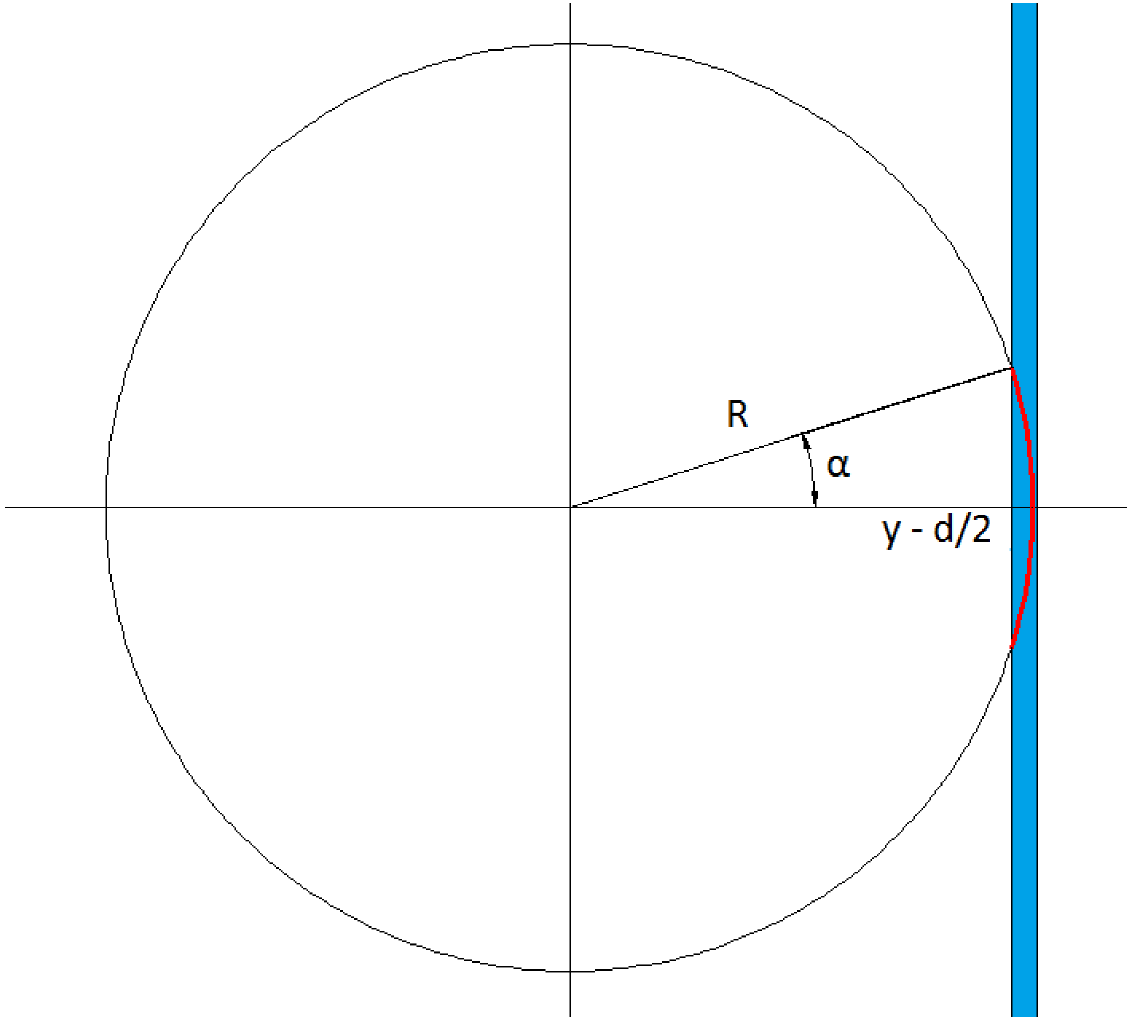
- If the dead strip is full crossed by the θ ring
  - $R = Z \cdot \tan(\theta)$, $Z = 5000\, mm$
  - The center of the spacer is at y, its width is d

- The loss is the red arc shown in the picture, its corresponding angle is α
  - $\alpha = \arccos(\frac{y-d/2}{R})$ - $\arccos(\frac{y+d/2}{R})$
  - The loss is $2\alpha/2\pi$



Loss of acceptance

- If the dead strip is partly crossed by the θ ring
- The loss is the red arc shown in the picture, its corresponding angle is α
  - $\alpha = \arccos(\frac{y-d/2}{R})$
  - The loss is $2\alpha/2\pi$



Loss of acceptance

- For GEM located at z = 5000 mm, with the 2 mm dead strips at y = 0, ±200 mm, ±400 mm, and x = ±300 mm, the loss vs. theta is (R is the radius of the theta ring on GEM)

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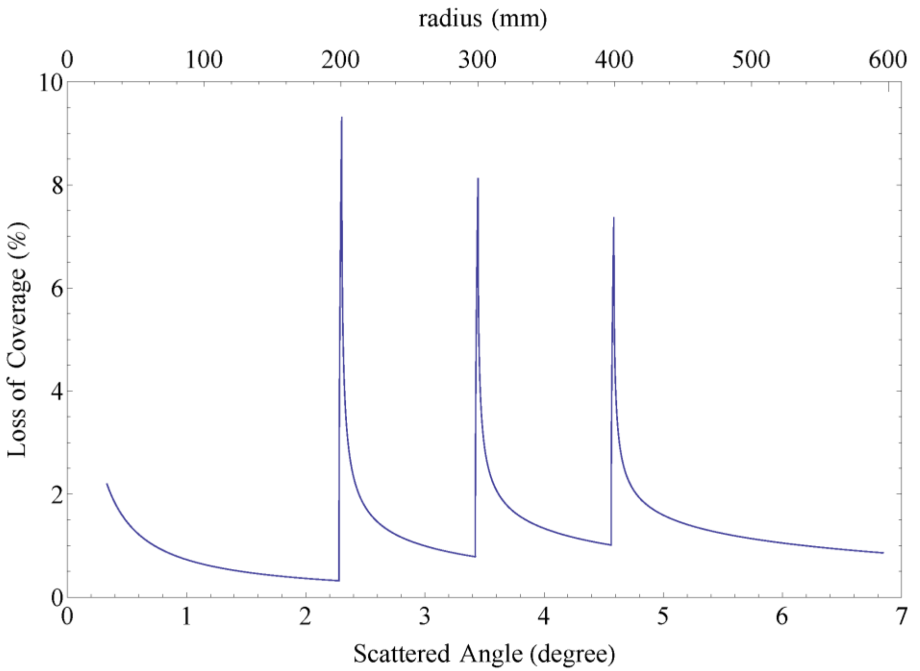
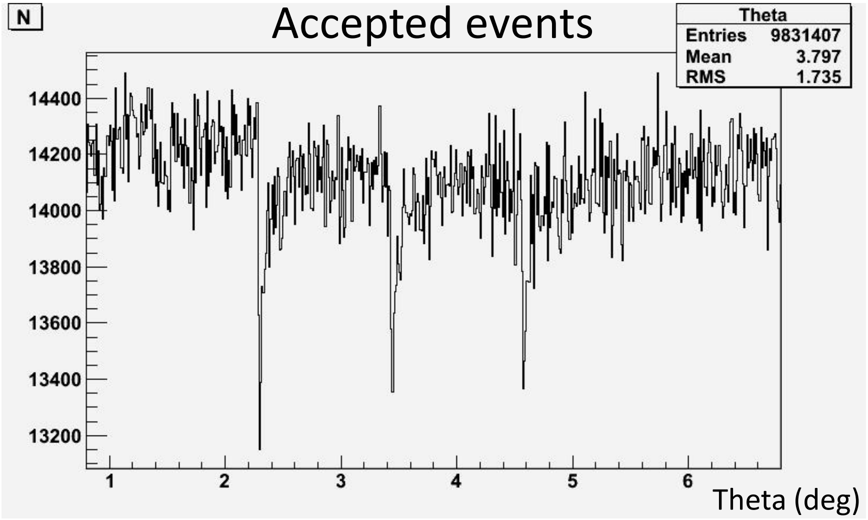
{{Abs[ArcCos[1/R] - ArcCos[-1/R]] / Pi,
 R ≤ 199},
{(Abs[ArcCos[1/R] - ArcCos[-1/R]] + 2 * Abs[ArcCos[199/R]]) / Pi,
 199 < R ≤ 201},
{(Abs[ArcCos[1/R] - ArcCos[-1/R]] + 2 * Abs[ArcCos[(200 + 1) / R] - ArcCos[(200 - 1) / R]]) / Pi,
 201 < R ≤ 299},
{(Abs[ArcCos[1/R] - ArcCos[-1/R]] + 2 * Abs[ArcCos[(200 + 1) / R] - ArcCos[(200 - 1) / R]] + 2 * Abs[ArcCos[299/R]]) / Pi,
 299 < R ≤ 301},
{(Abs[ArcCos[1/R] - ArcCos[-1/R]] + 2 * Abs[ArcCos[(200 + 1) / R] - ArcCos[(200 - 1) / R]] + 2 * Abs[ArcCos[(300 + 1) / R] - ArcCos[(300 - 1) / R]]) / Pi,
 301 < R ≤ 399},
{(Abs[ArcCos[1/R] - ArcCos[-1/R]] + 2 * Abs[ArcCos[(200 + 1) / R] - ArcCos[(200 - 1) / R]] + 2 * Abs[ArcCos[(300 + 1) / R] - ArcCos[(300 - 1) / R]] + 2 * Abs[ArcCos[399/R]]) / Pi,
 399 < R ≤ 401},
{(Abs[ArcCos[1/R] - ArcCos[-1/R]] + 2 * Abs[ArcCos[(200 + 1) / R] - ArcCos[(200 - 1) / R]] + 2 * Abs[ArcCos[(300 + 1) / R] - ArcCos[(300 - 1) / R]] + 2 * Abs[ArcCos[(400 + 1) / R] - ArcCos[(400 - 1) / R]]) / Pi,
 401 < R}}]
```

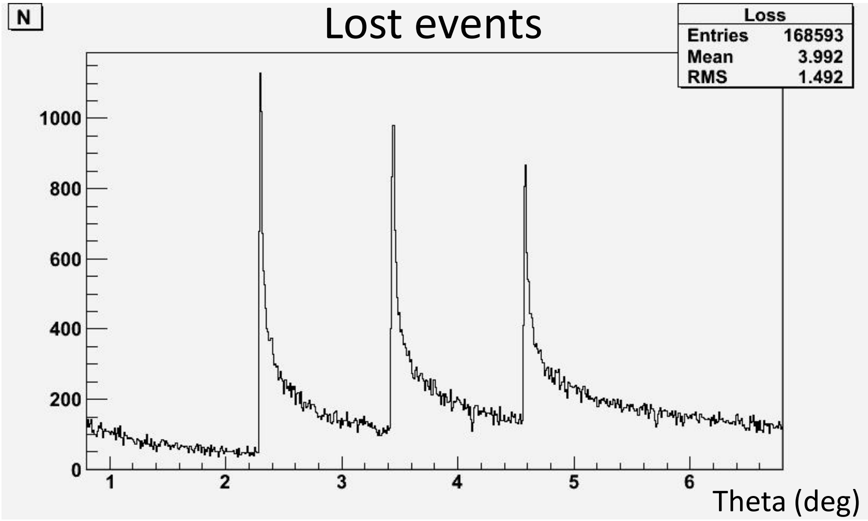
Loss of acceptance

- The result is verified by MC simulation (events are generated uniformly in theta)



Plot of the acceptance loss in percentage





Loss of acceptance

- The table shows the integrated acceptance loss for each bin (bins with scattered angle > 6.8 is not listed here, because the phi coverage is not complete due to the size of HyCal)

- The Differential Cross Section (DCS) of elastic ep and Møller scatterings are under one photon exchange approximation

Angular bin (Degree)	Acceptance loss (%)	Weighted by ep DCS (%)	Weighted by ee DCS (%)
0.80 - 1.05	0.793	0.813	0.809
1.05 - 1.30	0.623	0.633	0.629
1.30 - 1.55	0.513	0.518	0.516
1.55 - 1.80	0.436	0.439	0.437
1.80 - 2.05	0.379	0.382	0.380
2.05 - 2.30	0.813	0.72	0.813
2.30 - 2.55	2.572	2.694	2.564
2.55 - 2.80	1.343	1.356	1.341
2.80 - 3.05	1.055	1.06	1.053
3.05 - 3.30	0.894	0.898	0.893
3.30 - 3.55	2.297	2.213	2.322
3.55 - 3.80	1.861	1.878	1.855
3.80 - 4.30	1.311	1.328	1.304
4.30 - 4.80	1.931	1.856	1.960
4.80 - 5.30	1.568	1.587	1.560
5.30 - 5.80	1.219	1.226	1.216
5.80 - 6.30	1.040	1.044	1.038
6.30 - 6.80	0.918	0.921	0.917

Study on the uncertainties

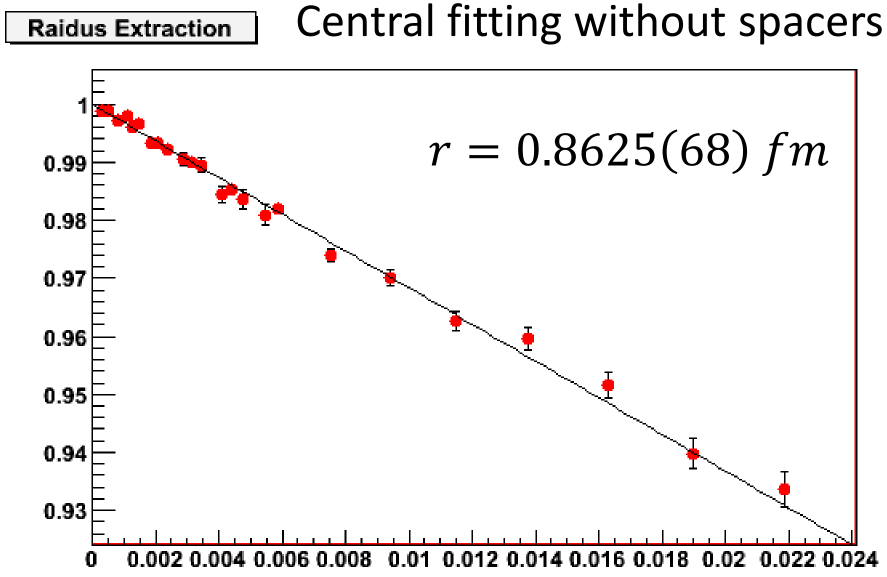
- Worse statistics
  - According to the acceptance loss

- Uncertainties due to the acceptance corrections
  - Position resolutions
  - Uncertainties of the location and width of spacers

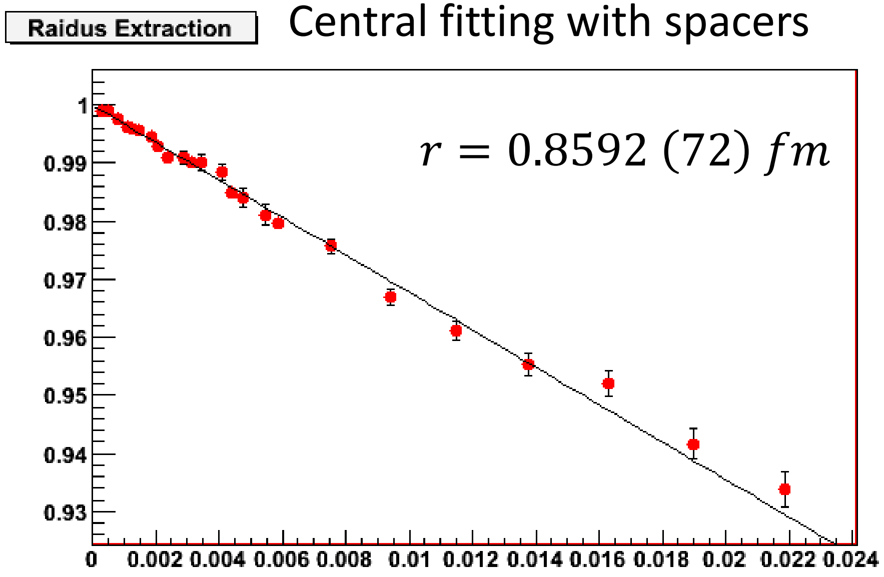
Statistics and position resolution

- The correction is affected by the position resolution, but it is almost negligible (< 0.1 % for all bins) because of the binning effect and GEM's good resolution (0.1 mm)
- The right plot shows the radius extraction if we considered the corrections and worse statistics in simulation (scatters due to statistics are implemented)

Central fitting without spacers



Central fitting with spacers



Uncertainties of the location and width

- Assuming a 0.2 mm uncertainty on the location of the spacer at 200 mm and a 0.1 mm uncertainty on the width of it.
- Check the correction factor for the angular bin of 2.30 – 2.55 degree. The largest error on ep CS would be $\left(1 - \frac{100-2.694}{100-2.892}\right) = -0.20\%$
- Normalizing to Møller would reduce the error, but not much because of its relatively uniform distribution

Position (mm)	Width (mm)	Acceptance Loss (%)	Weighted by ep DCS (%)	Weighted by Moller DCS (%)
200	2	2.572	2.694	2.564
200 + 0.2	2 + 0.1	2.754	2.892	2.744
200 + 0.2	2 – 0.1	2.517	2.642	2.508
200 – 0.2	2 + 0.1	2.622	2.739	2.613
200 – 0.2	2 – 0.1	2.391	2.495	2.383

Summary

- The loss of acceptance due to the spacers is acceptable

- However, we need precise information on the width and the position of the spacers to do corrections