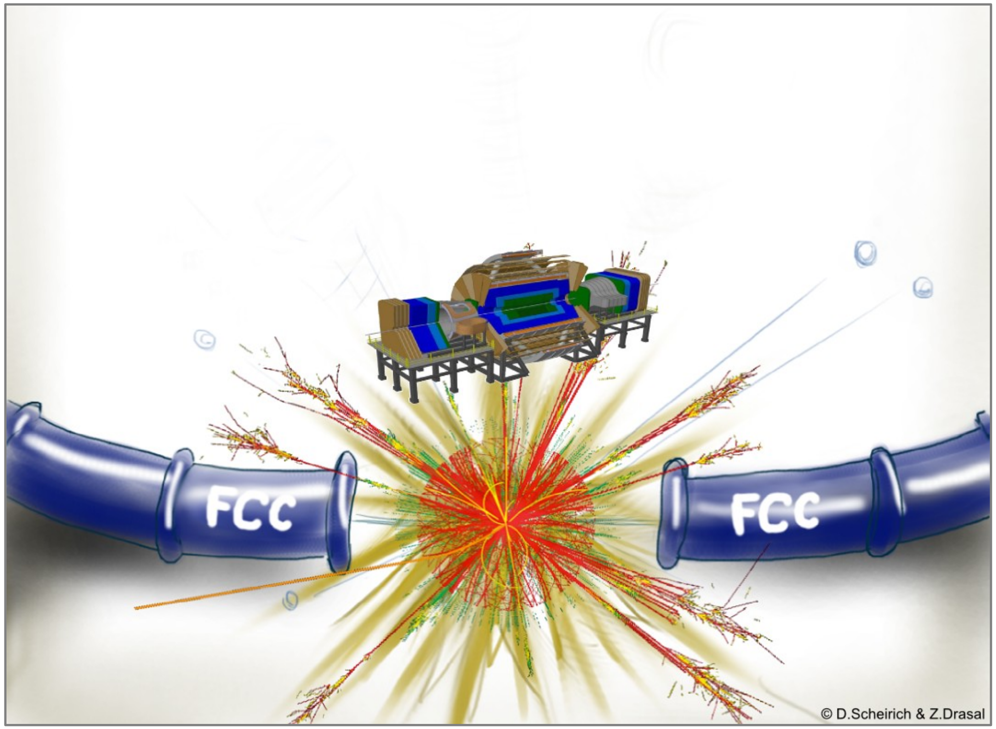
Conclusion on Non-uniform B Field Effects



W. Riegler, Z. Drásal
CERN

With M. Mannelli

Introduction

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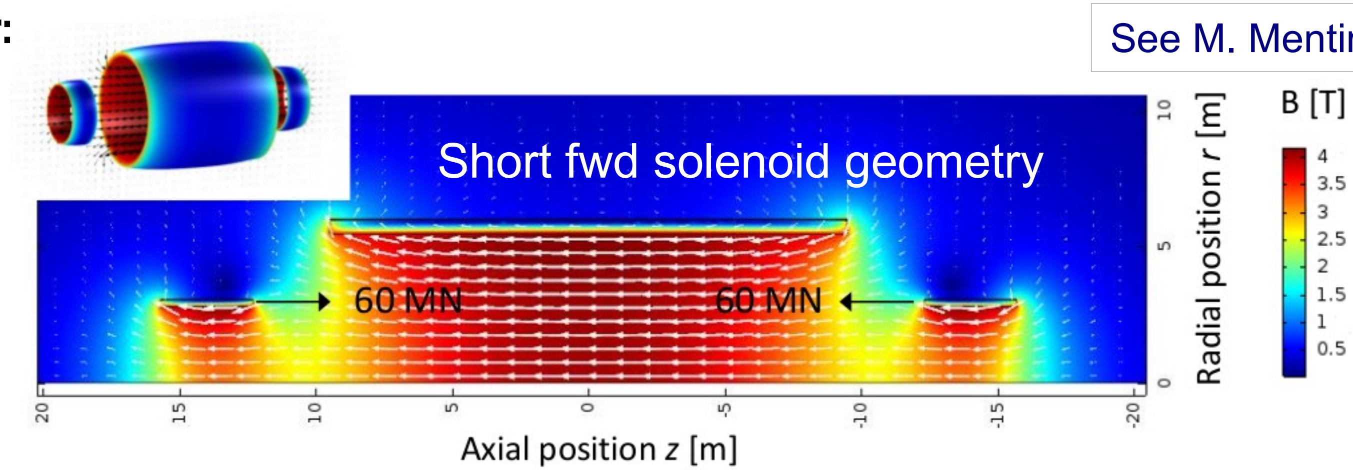

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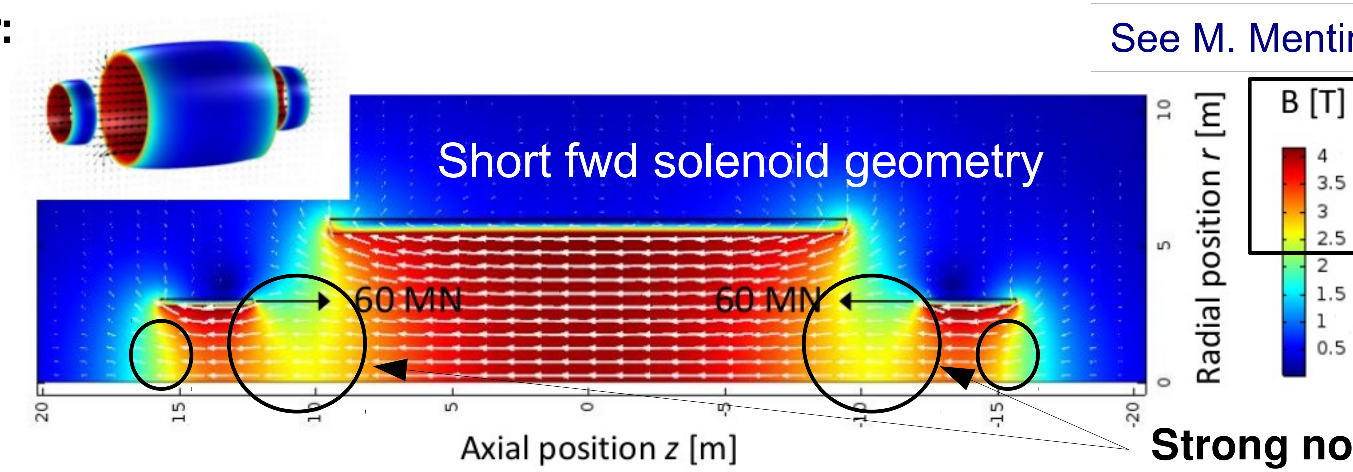

Strong non-uniformities

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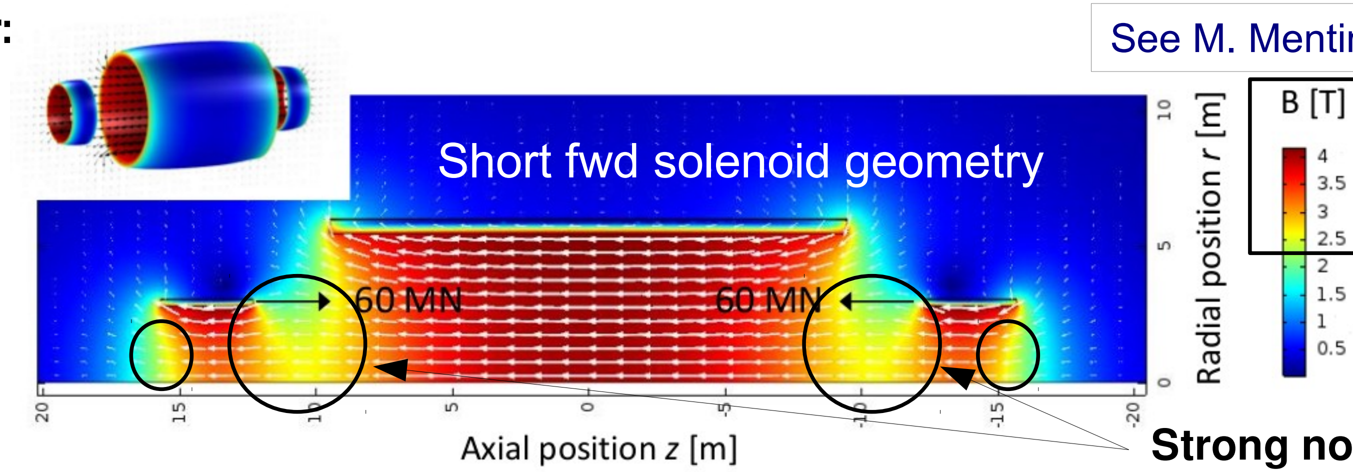

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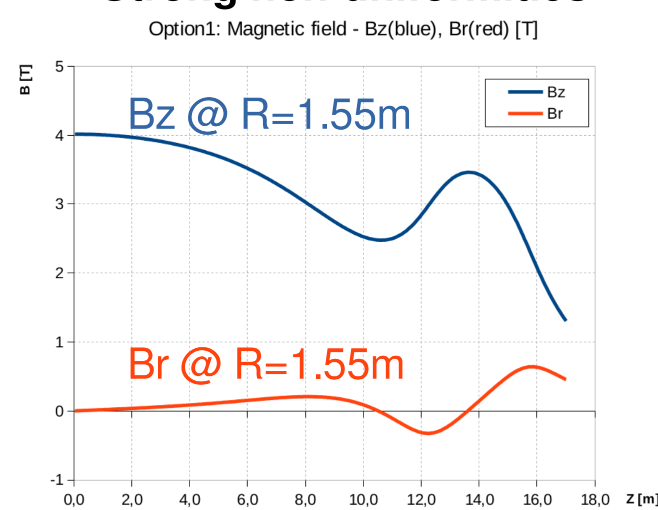

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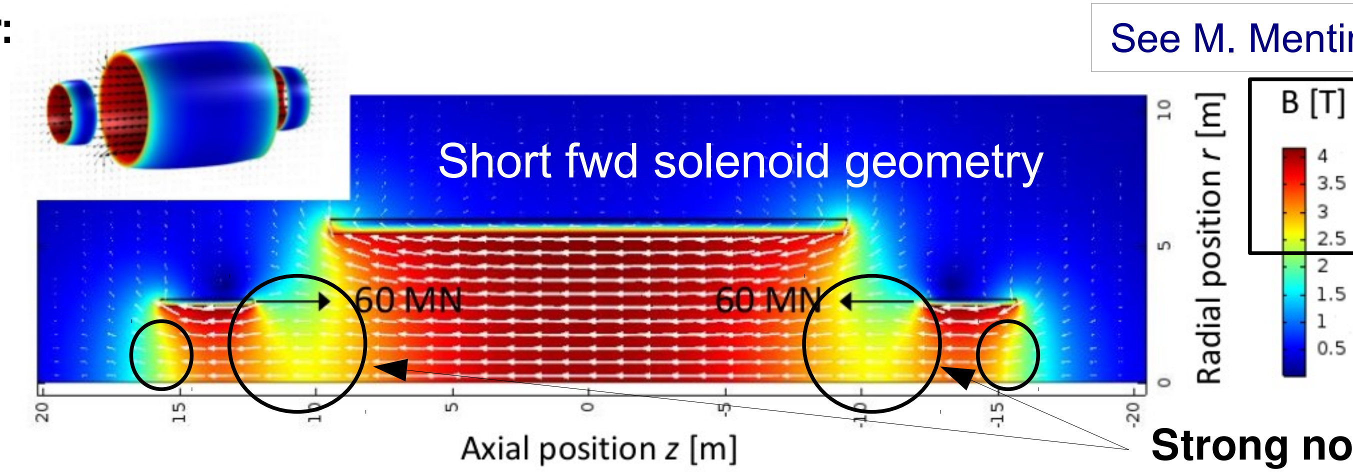

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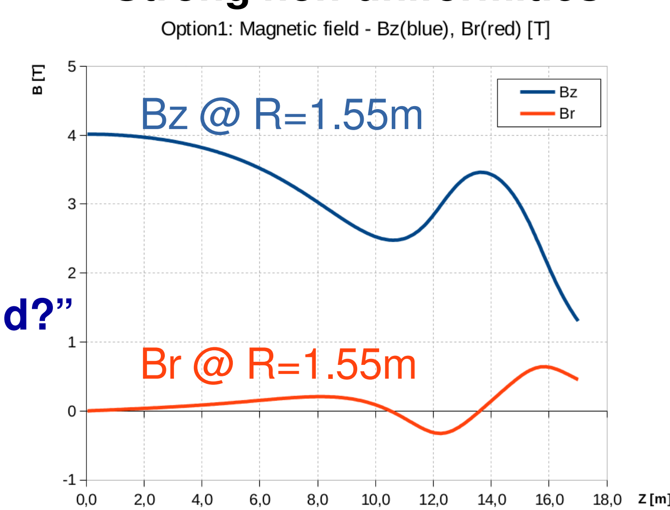
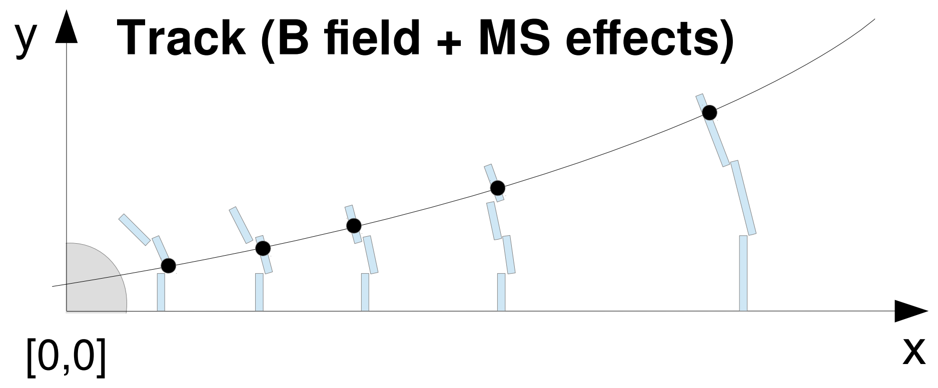


  - **So, the question was: “How much does one lose with a non-uniform B field in the FWD region compared to a const. B field?”**

“N-parabolas” Approach: Non-uniform B Field

- Mathematical concept applied in tkLayout:



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  - x-y plane → circle
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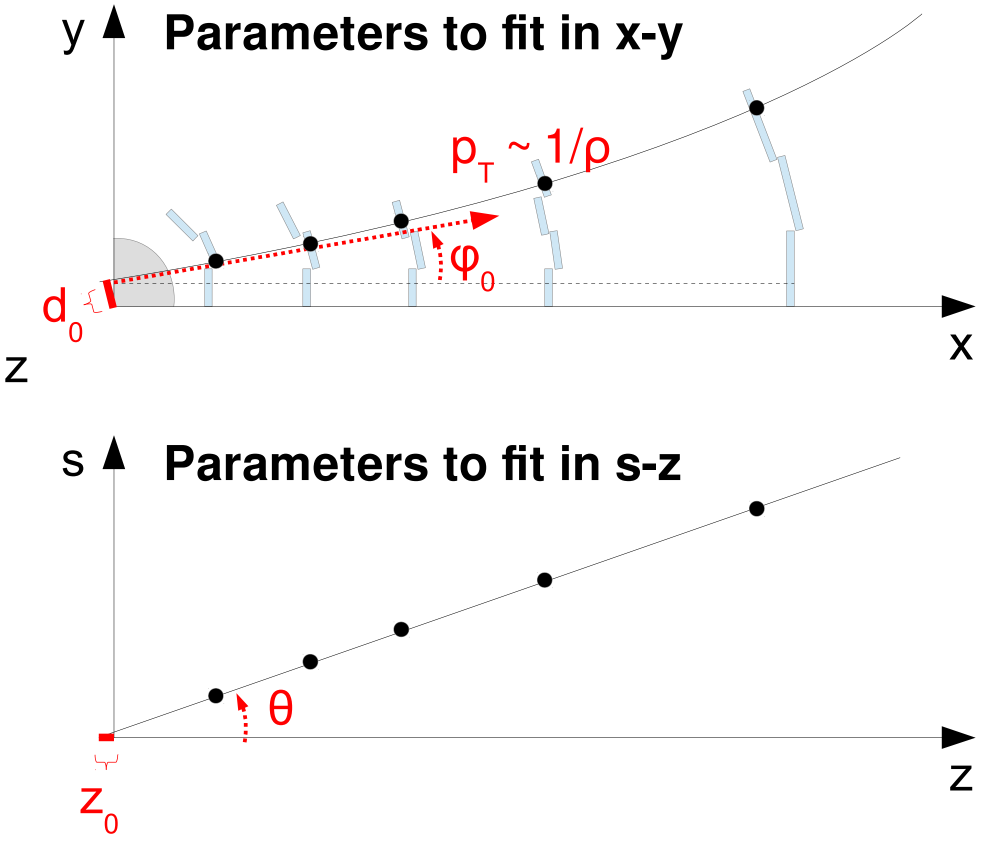
  Global χ^2 fit



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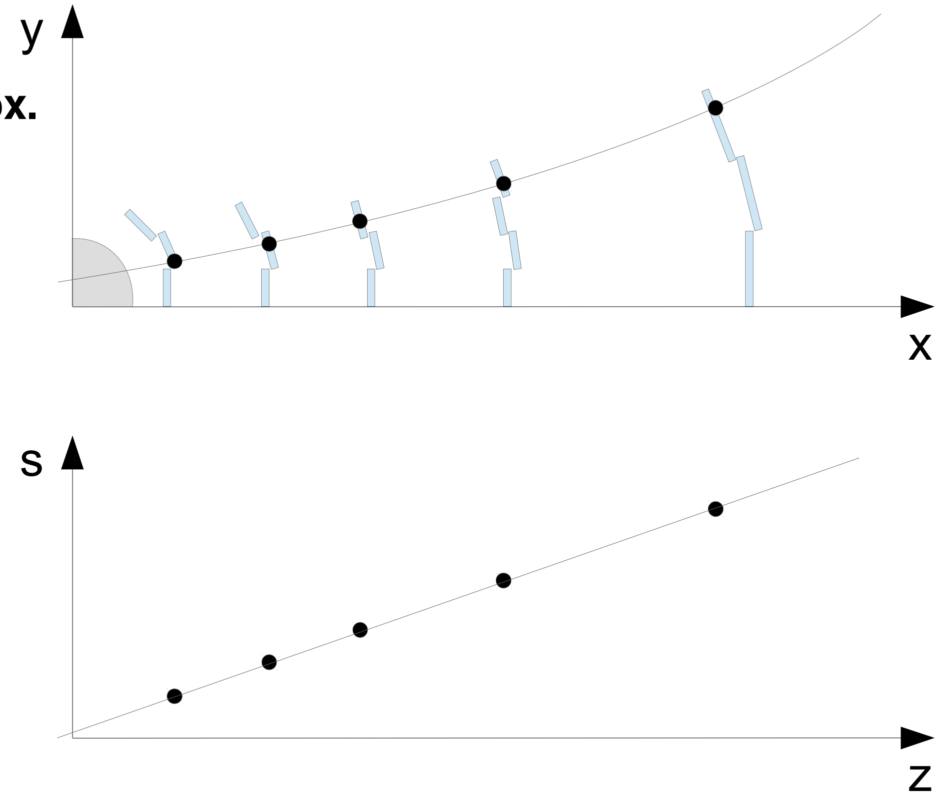

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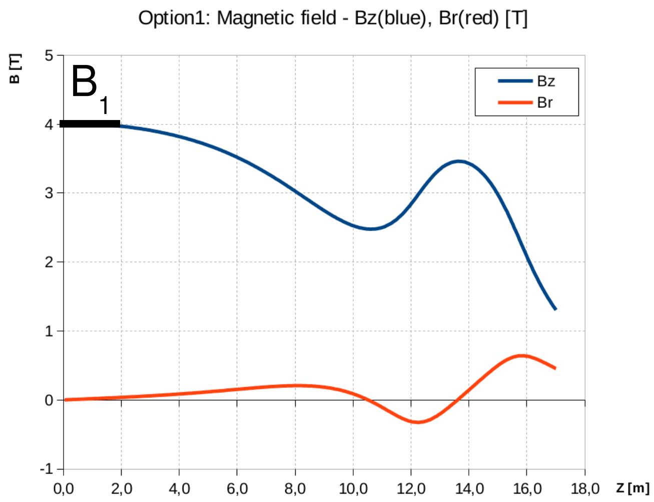

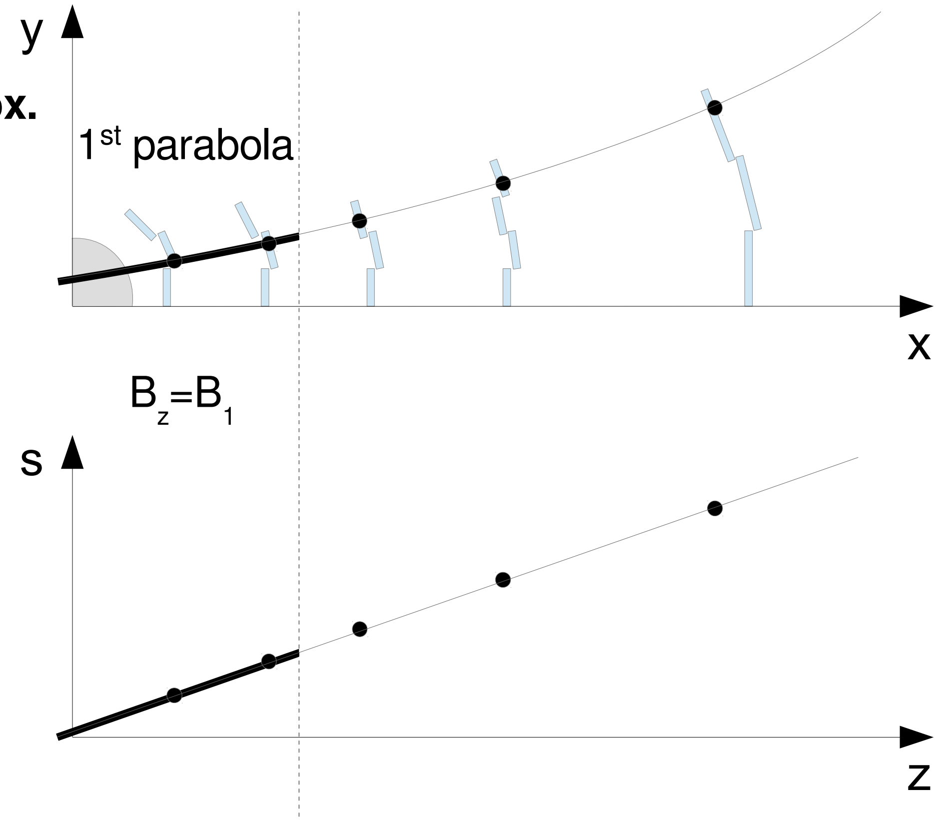

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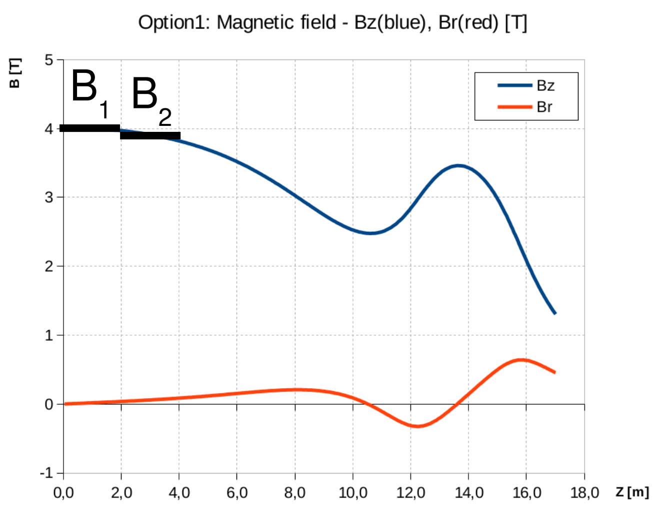

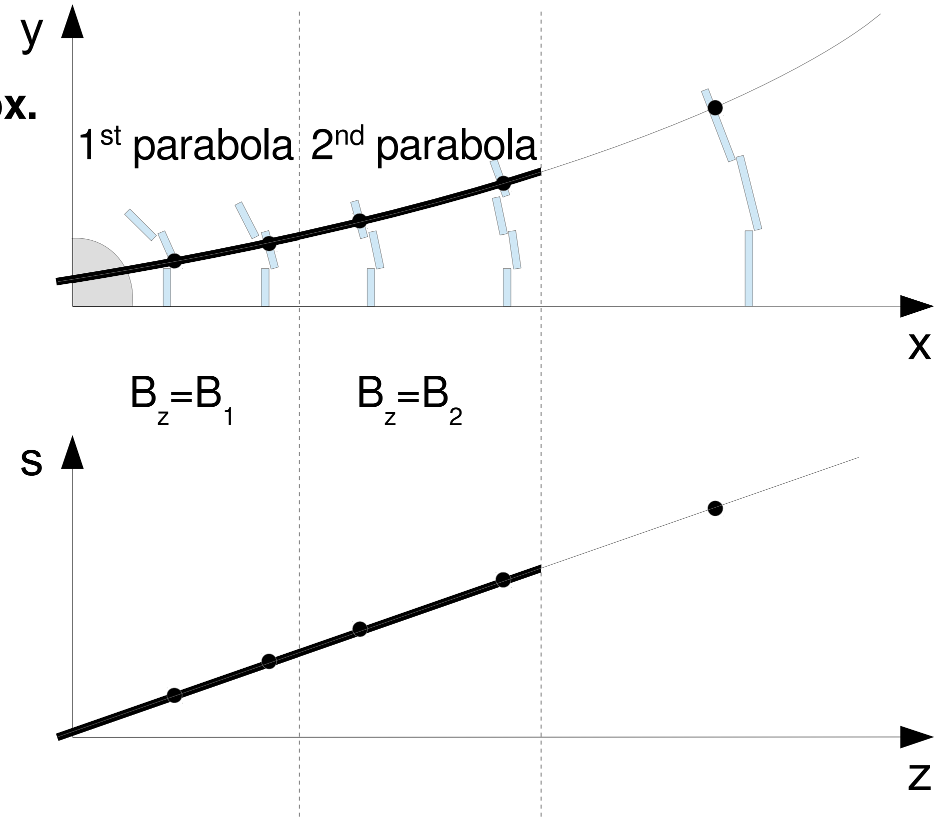

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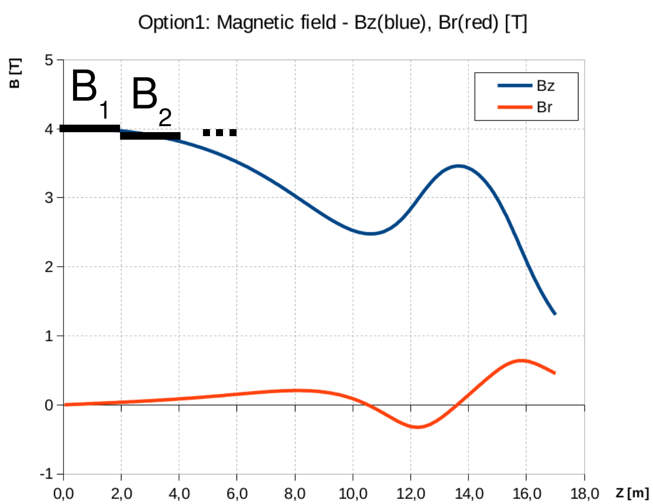

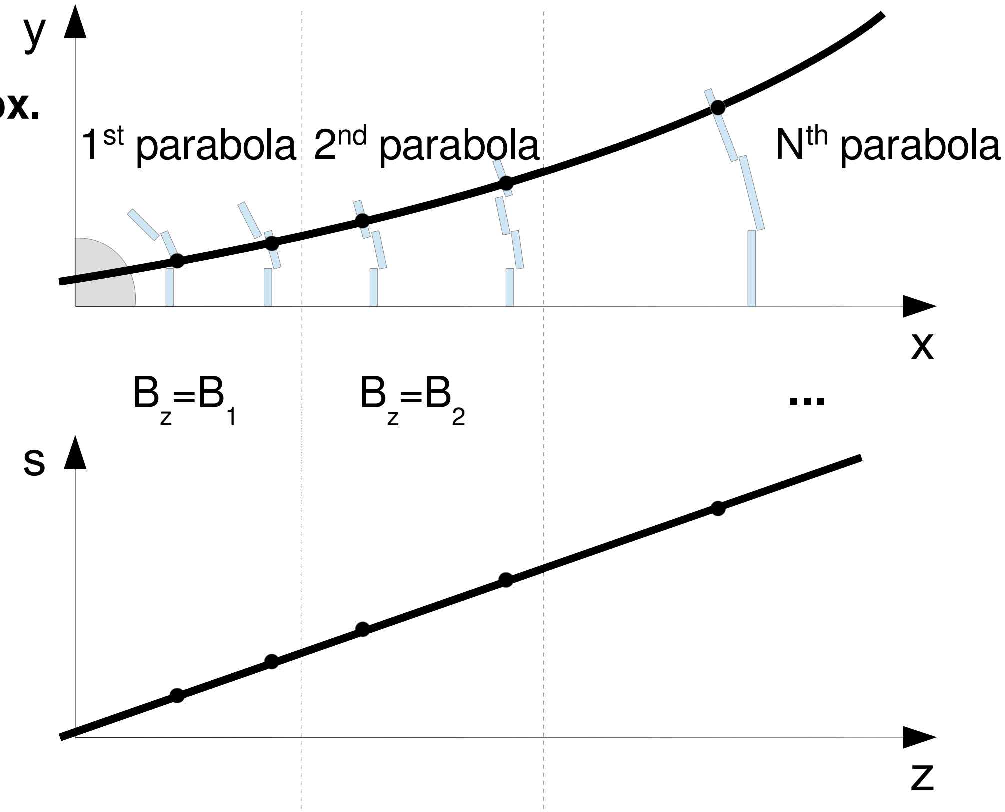

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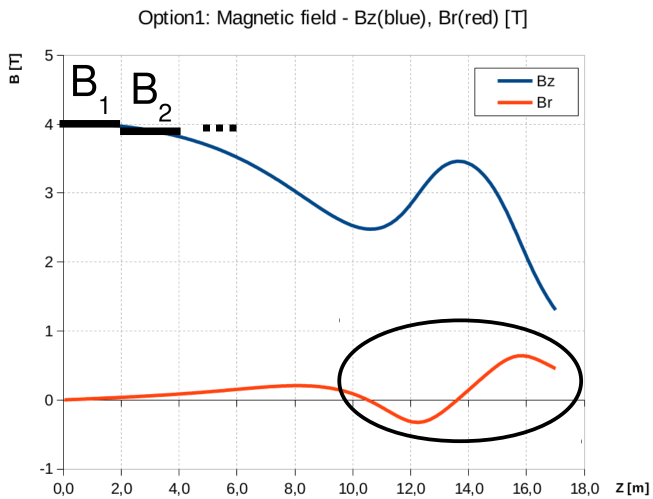

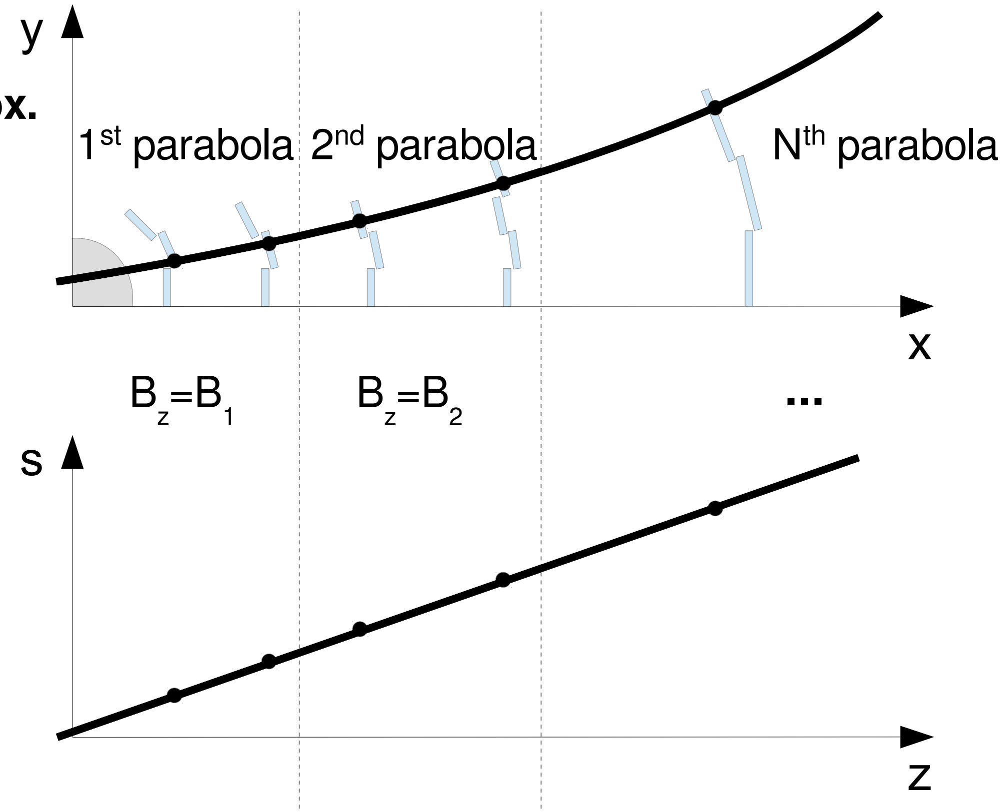

  - **But several assumptions were applied in this technique:**
    - $B = B_z(z)$ → function of z only → p_T const. along the path **s**
    - $B_r(r,z) \sim 0$

Is it reasonable?

Full Approach: Non-uniform B Field

- Full approach (by W.Riegler) → solve numerically equation of motion in Mathematica SW:

$$\frac{d^2\vec{x}(s)}{ds^2} = \underbrace{\frac{0.3}{p}}\frac{d\vec{x}(s)}{ds} \times \vec{B}(\vec{x}(s))$$

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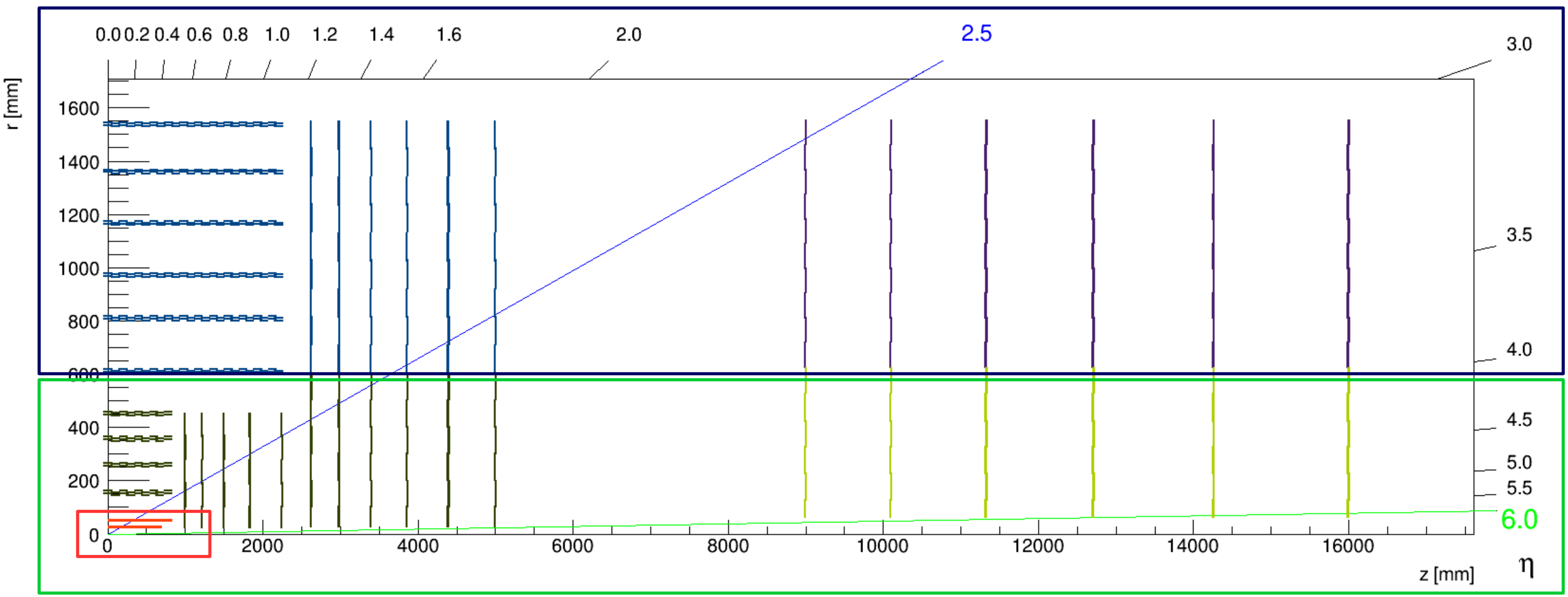
$$\Delta c = \frac{\Delta p}{p} \approx \frac{\Delta p_T}{p_T}$$

FCC-hh Tracker Geometry

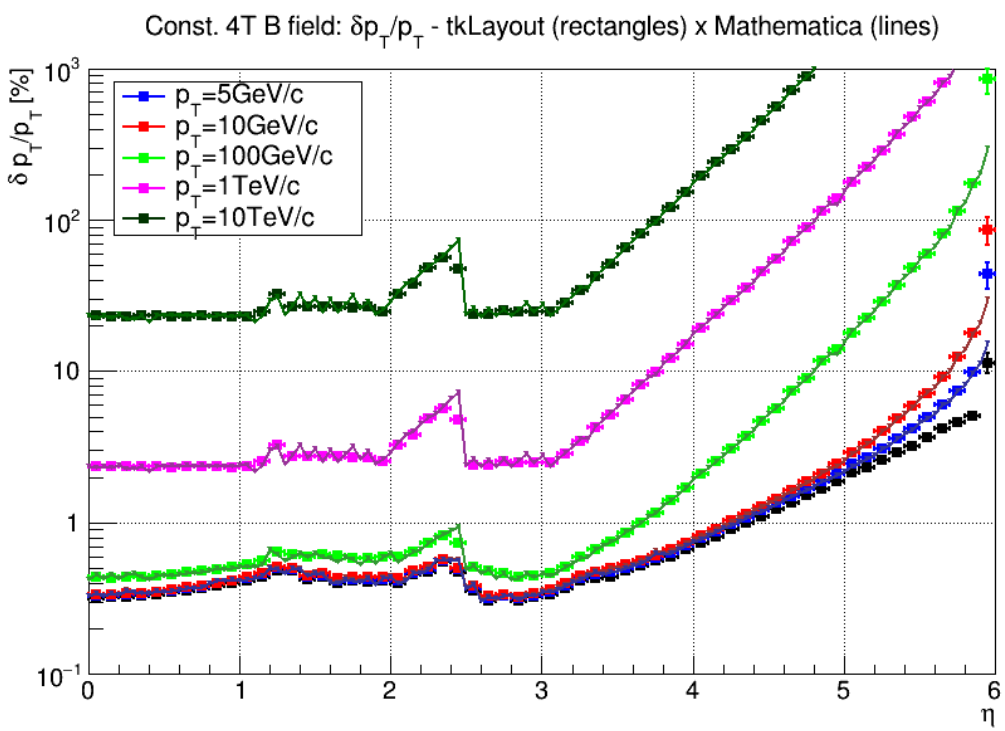
- Studied tracker geometry:
  - For details see: http://fcc-tklayout.web.cern.ch/fcc-tklayout/FCChh_Option3.v01/index.html



  - Resolution:
    - **10x15µm^2** (0.5% x/x_0 BRL only, EC 1.5% x/x_0),
    - **10x30µm^2** (1.5% x/x_0), **10x100µm^2** (3.0% x/x_0)

Short Fwd Solenoid: Methods Cross-check

- Let's first cross-check both approaches → study of **geometry with short fwd solenoid** & ideal **const. 4T mag. field**:



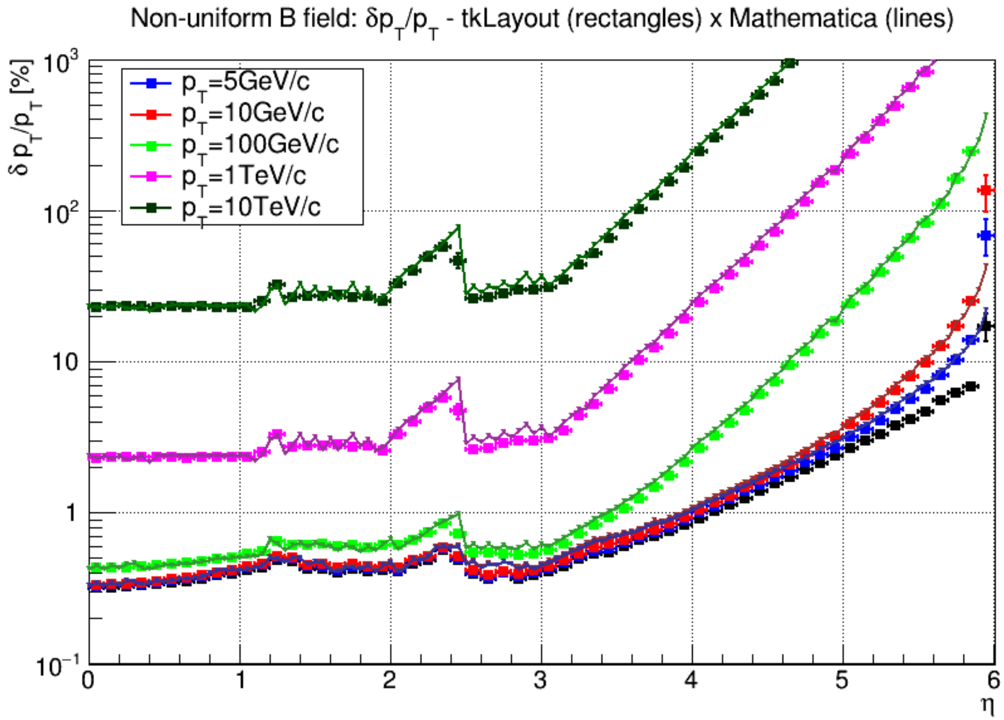
Lines → Mathematica SW

Rectangles → tkLayout

OK → fully consistent results

Short Fwd Solenoid: Non-uniform B Field

- Study of **geometry with short fwd solenoid** with realistic **non-uniform mag. field**:



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Small inconsistency from η=2.5, **why?**

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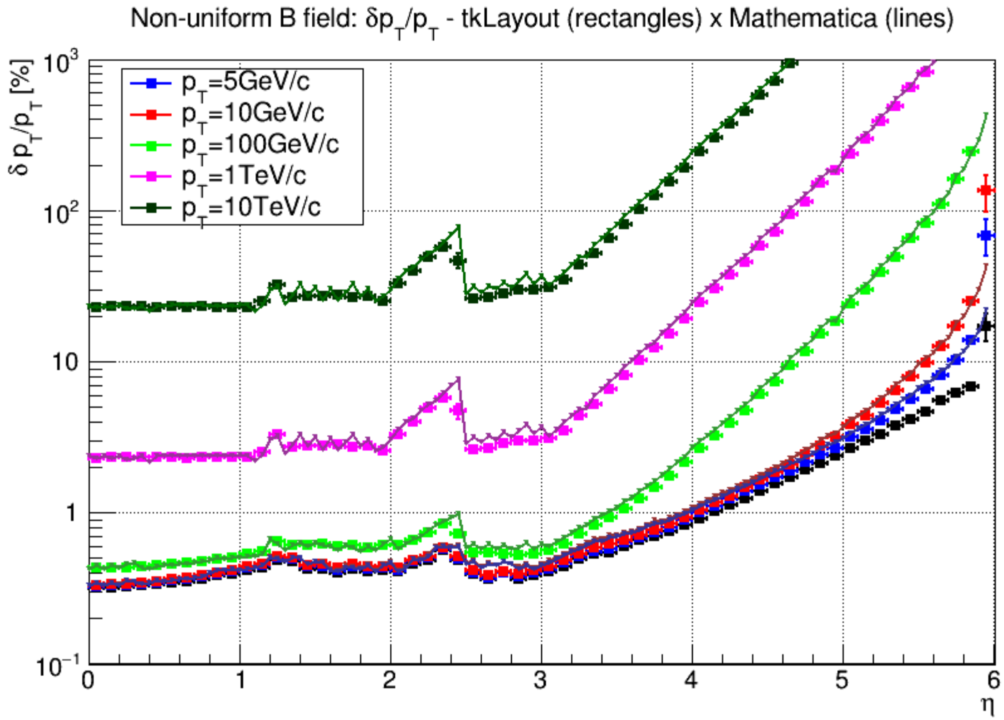

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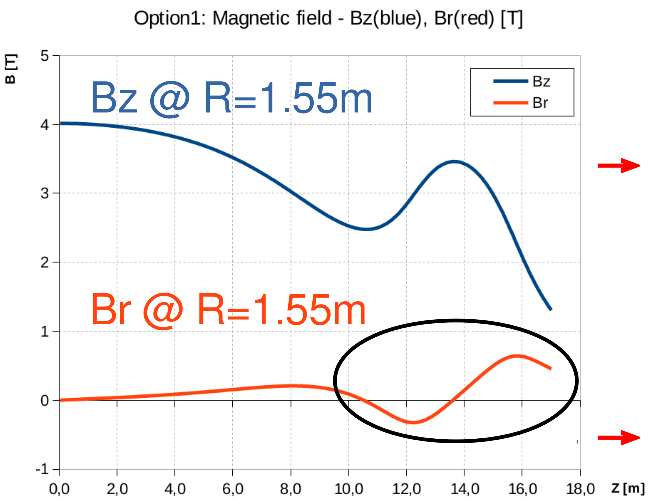
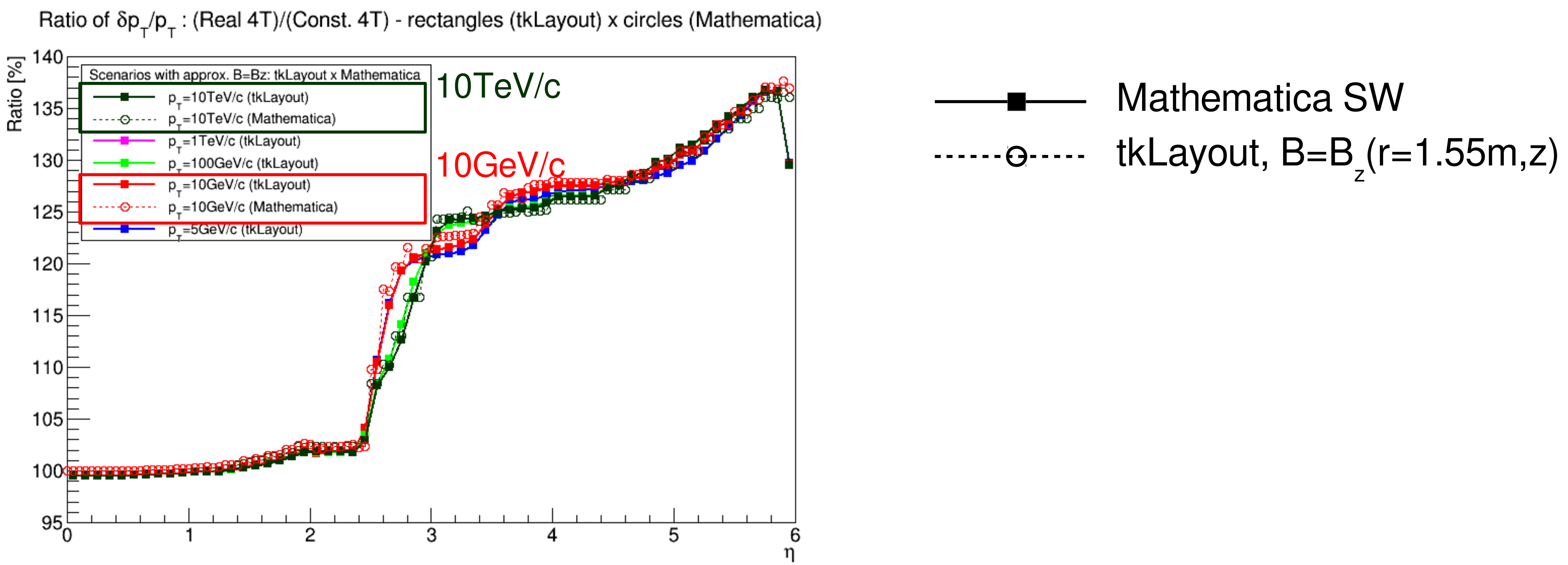


B_z**(r & z)** → minor r-dep.**!**

B_r**(r,z) ≠ 0** → not negligible**!**

Short Fwd Solenoid: Non-uniform B Field

- Let's “switch off” the $B_r(r,z)$ component in full approach (Mathematica SW):



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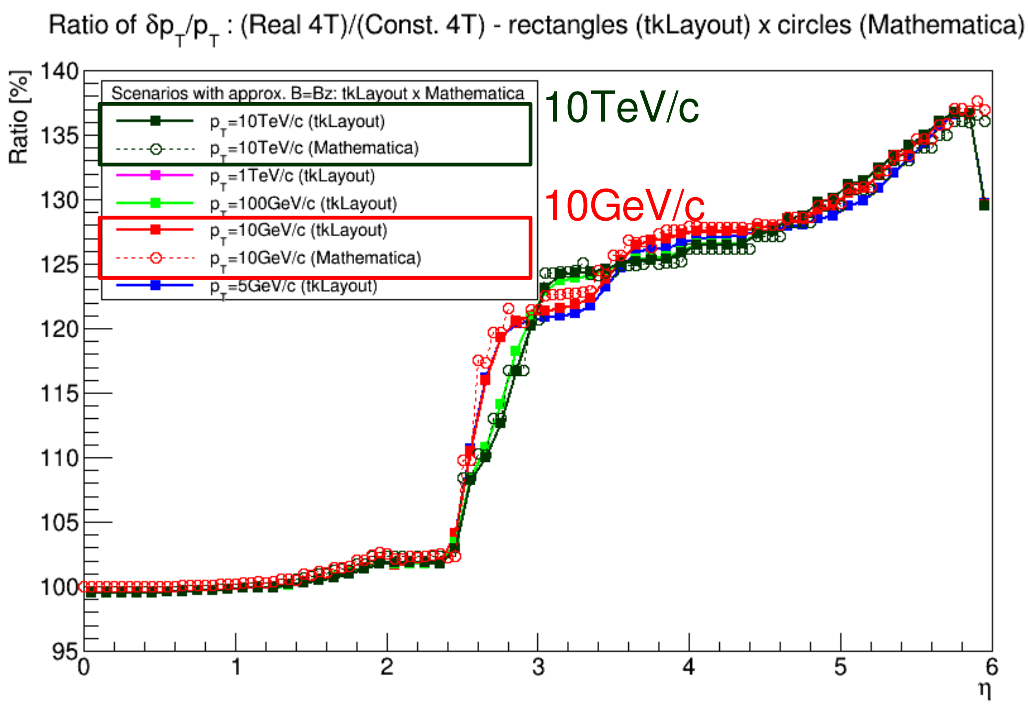


Mathematica SW

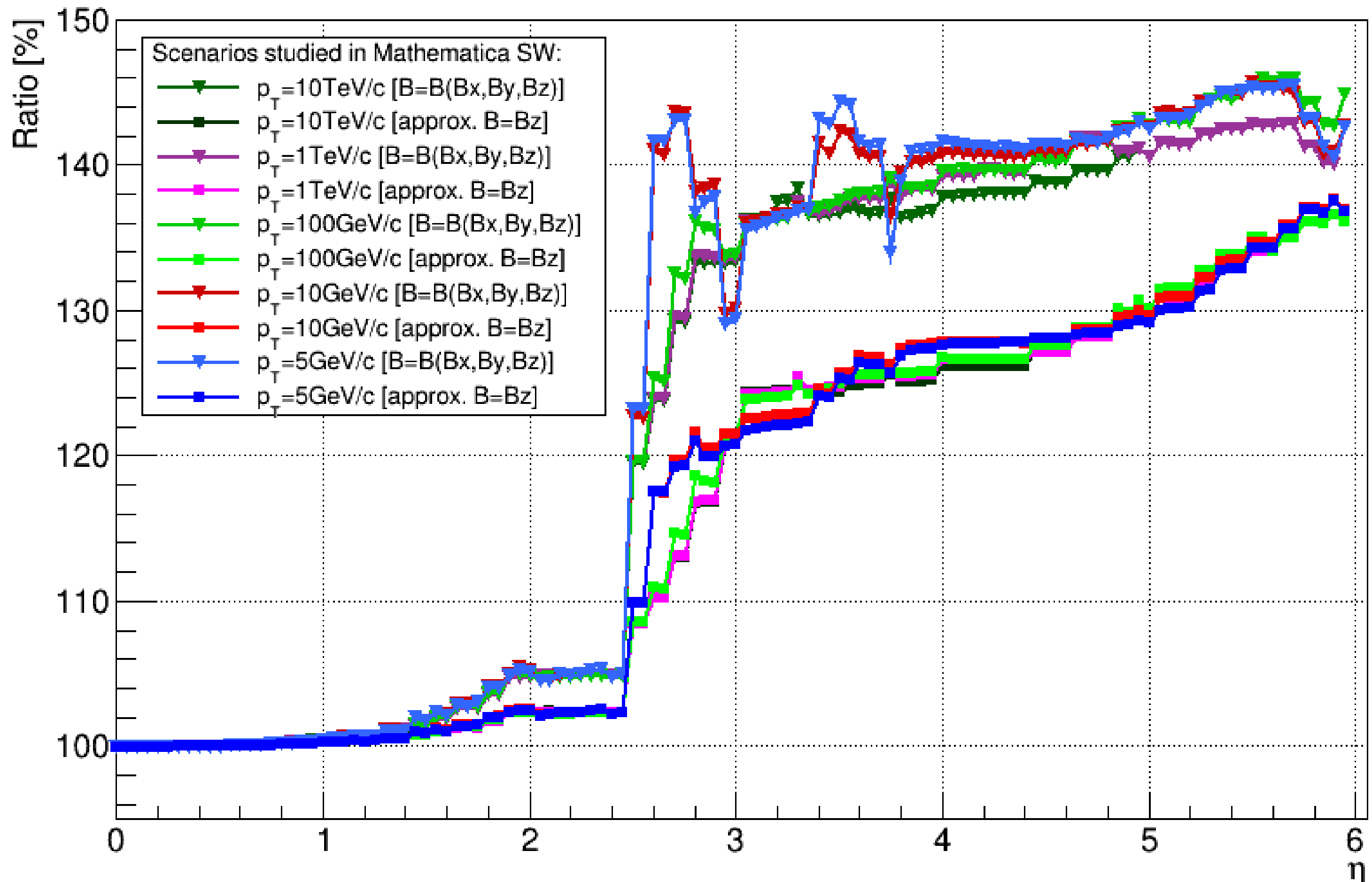
tkLayout, $B=B_z(r=1.55m,z)$

OK → Consistent results, if $B_r(r,z)=0$

→ Deterioration due to $B_z(r,z)$ ~**25-35%** compared to const. 4T B scenario

Final Results

Ratio of $\delta p_T/p_T$: (Real 4T)/(Const. 4T) - triangles [B=B(Bx,By,Bz)] x rectangles [B=B(0,0,Bz)]



B=B(Bx,By,Bz)

B=B(0,0,Bz), i.e. B_r=0

→ Total deterioration in $\delta p_T/p_T$ due to non-uniformity of B field ~ **35-45% @ η=2.5 or higher**

Conclusions & Outlook

- With true magnet system in a configuration with **short FWD solenoid** ("baseline") one gets ~ **35-45% worse performance in $\delta p_T/p_T$** from **η=2.5 up-to 6** compared to an ideal case with const. 4T B field

  → Deterioration by ~ **25-35% due to Bz(r,z)** component of the B field

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  - → So, approximately **half of the detector η coverage** is going to be **influenced by the FWD solenoid & overall B field non-uniformity!**
- **Outlook:**
  - → The same mathematical method(s) may be used to **fully assess the dipole option & compare its performance with solenoid field for the CDR!**