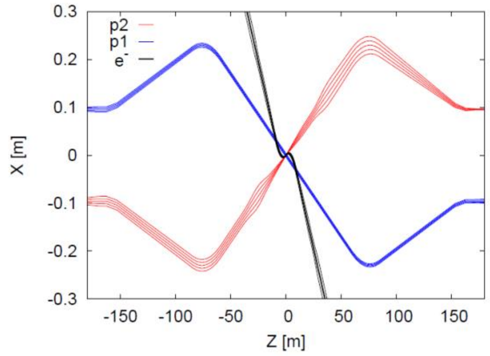
LHeC IR design recap

E. Cruz-Alaniz

16th May, 2018

LHeC IR

- Aim of the design: Focus one of the proton beams and collide it with the electron beam while the other proton beam bypasses the interaction.



- Installation on IR2: Original design β*=10 m and L*=23 m.

- In order to reach Luminosity reach:
  - 10^{33} $cm^{-2}s^{-1}$, β*=10 cm (LHeC CDR)
  - 10^{34} $cm^{-2}s^{-1}$, β*=5 cm (Post LHeC CDR)

- Move L* to 10 m to improve chromaticity correction

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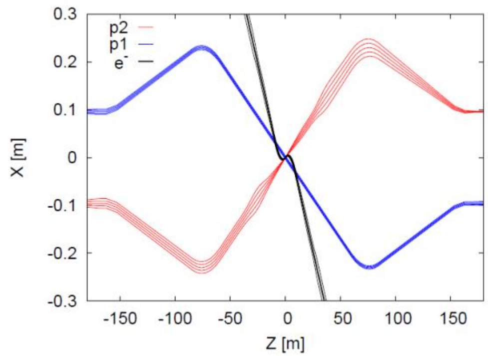

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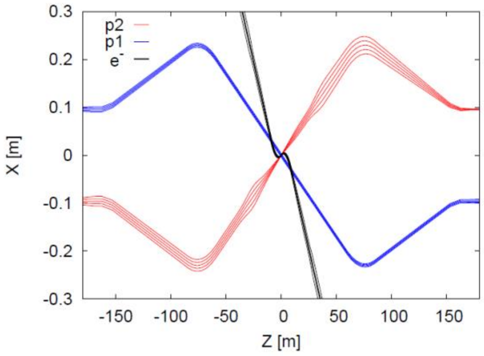

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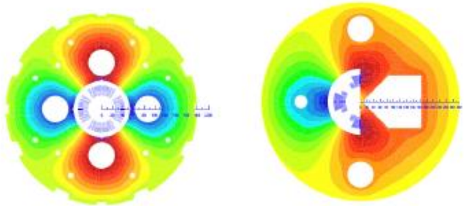
Changes to the IR

- Installation of new quadrupoles of IT: Free-field regions for the non-colliding proton beam and the electron beam.



LHeC CDR design S. Russenschuck

Name	Gradient (T/m)	Length (m)	Radius of aperture (mm)	p1-p2 Separation (mm)	"Radius" of field-free aperture (mm)
Q1	187	9	22	63	40
Q2	308	9	30	87	26
Q3	185	9	32	-	-

- Change dipole strength to direct beams to corresponding apertures.

- Limits on strengths of the quads and chromaticity correction.

- Following example of HL-LHC. Extend ATS scheme into IR2.
  - Pre-squeeze: β*=30 cm
  - Squeeze: β*=10 cm

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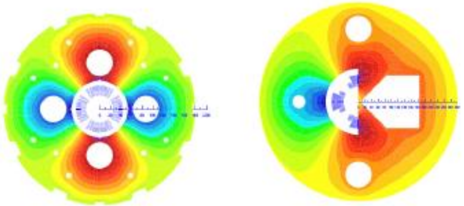

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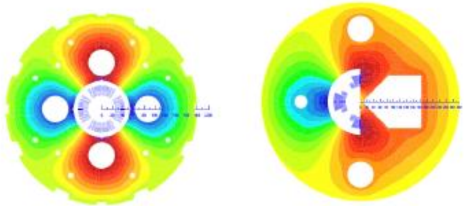

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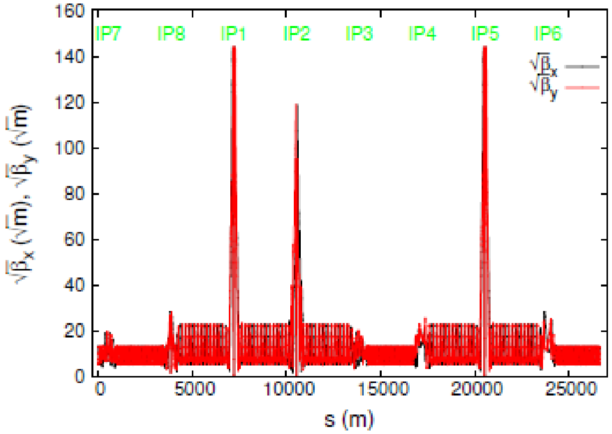

Flexibility of the design

Explore flexibility of the design:

- **Increase L***
  - **Advantages**: Minimize synchrotron radiation
  - **Disadvantages**: Increase chromatic aberrations
  - Cases: L*=10-20 m and β* fixed at 10 cm.

- **Minimize β***
  - **Advantages**: Increase Luminosity (in particular β*=5 cm)
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Further Studies

- **Chromaticity correction.**
  - Tried three different schemes: LHC-like (all families varying the same), LHeC-like (families varying independently), HL-LHC-like (strong/weak families).
  - LHeC-like works the best, but has limit in $L^*=19$ m and $\beta^*=8$ cm.
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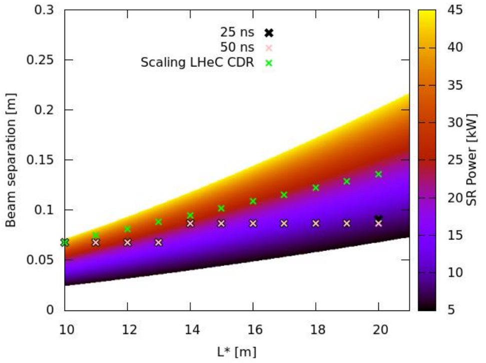
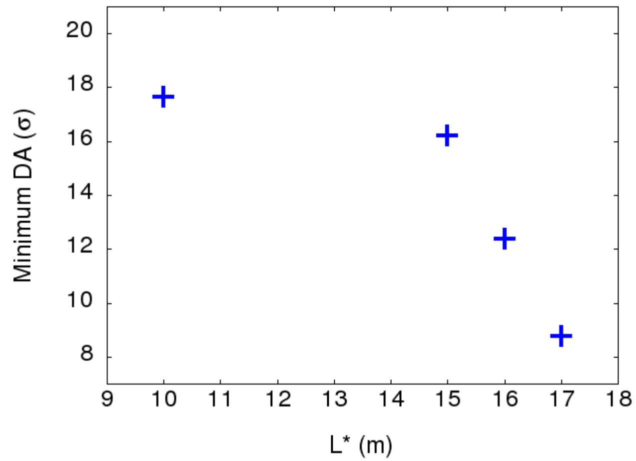
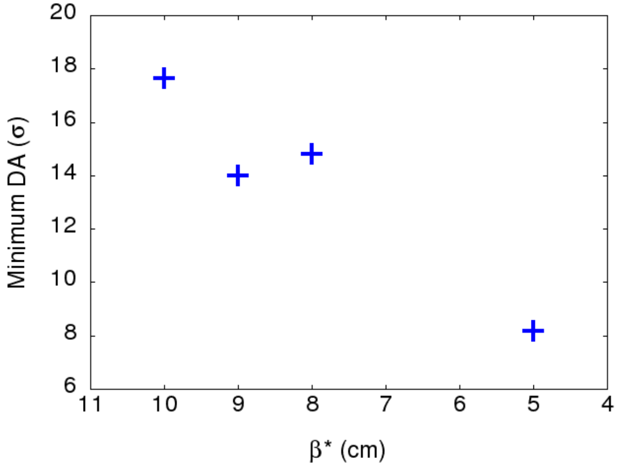
- **Synchrotron radiation:**
  - Original design with L*=10 m, β*=10 cm -> 49 kW
  - Increasing L* -> 25 kW
  - Minimizing aperture in quads -> 9 kW



Dynamic Aperture

- DA studies: 10^5 turns, 60 seeds, 5 angles.
- Errors in the arcs but NOT in the new IRs: IR1, IR5 and IR2. (Error tables for IR1 and IR5 were on-going work at the time)





- DA looks good with L* up to 15 m, very similar than for 10 m. For minimizing β* DA decays more rapidly.
- Case for β*=5 cm looks challenging. Try with new chromatic correction.
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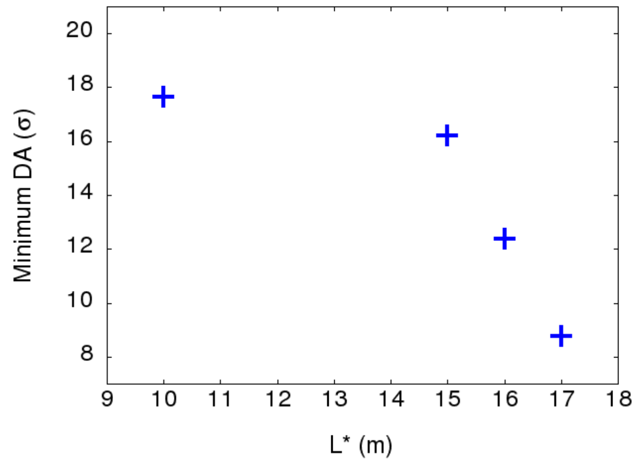

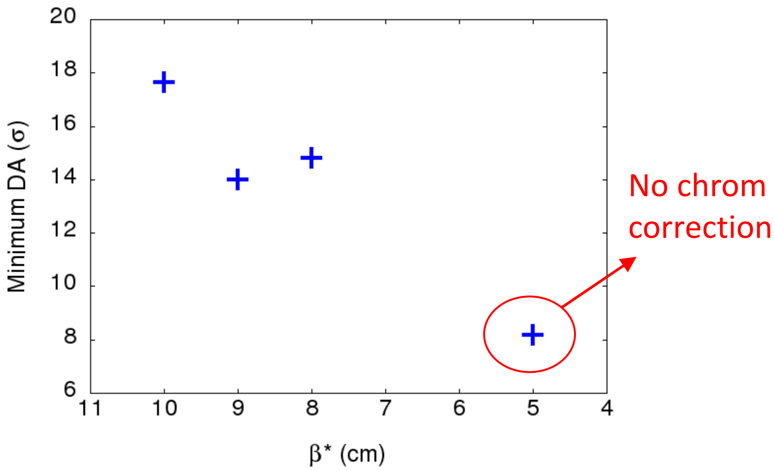

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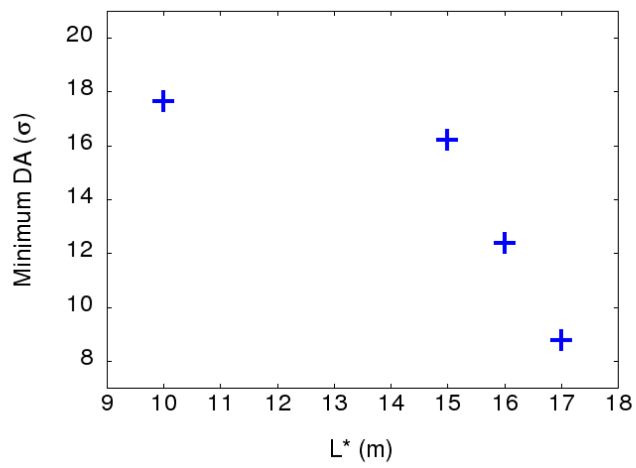

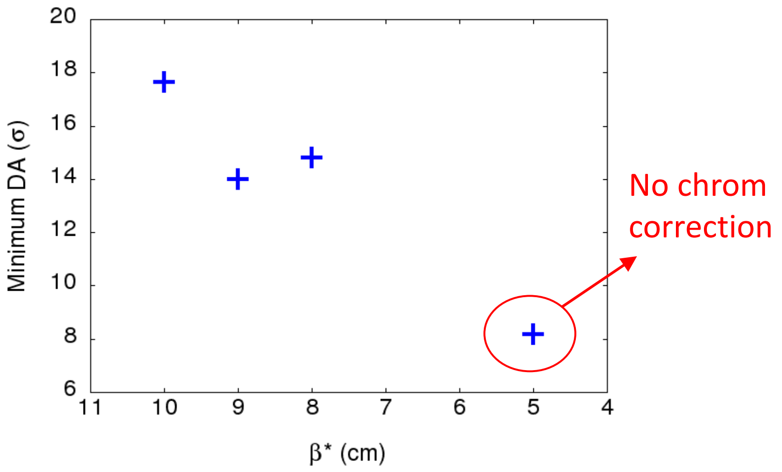

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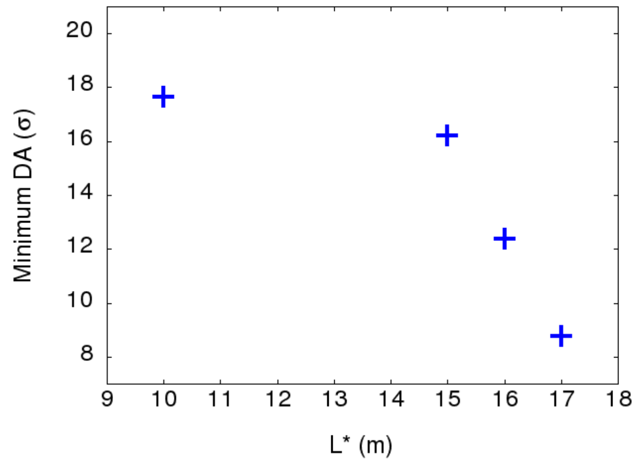

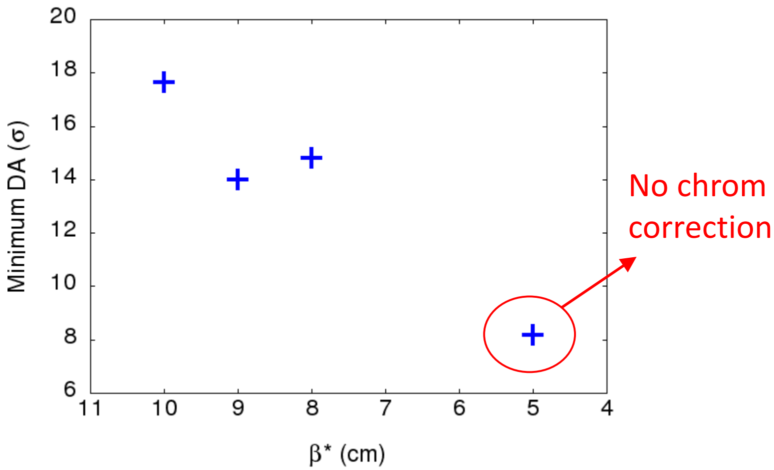

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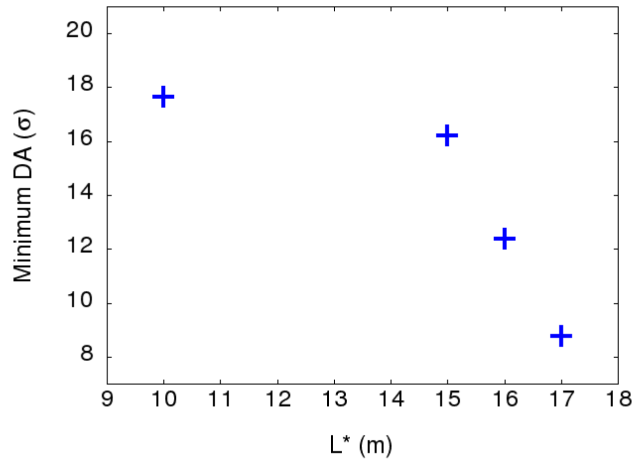

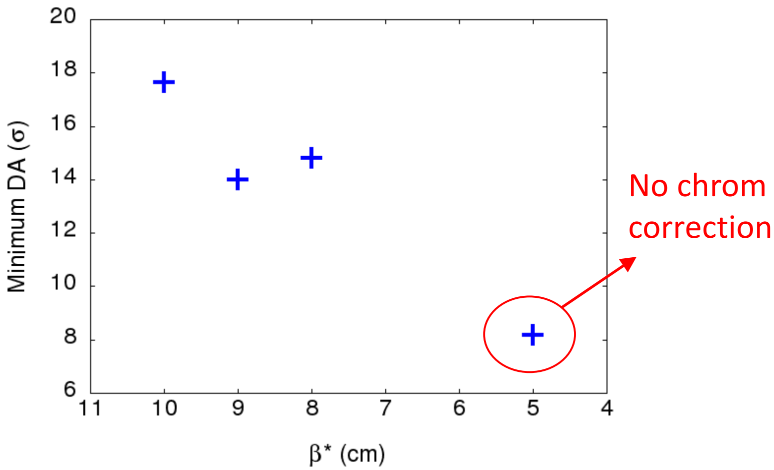

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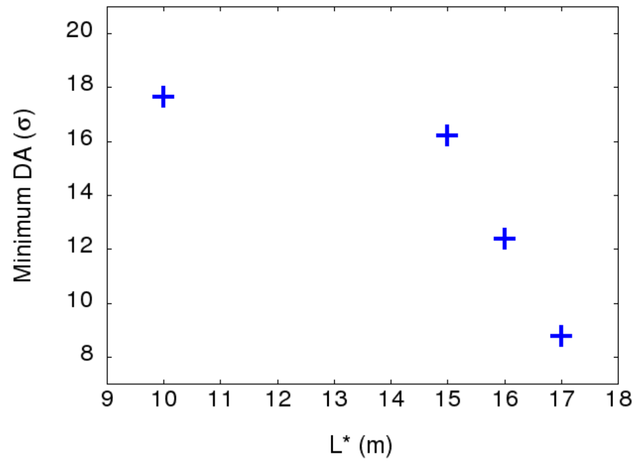

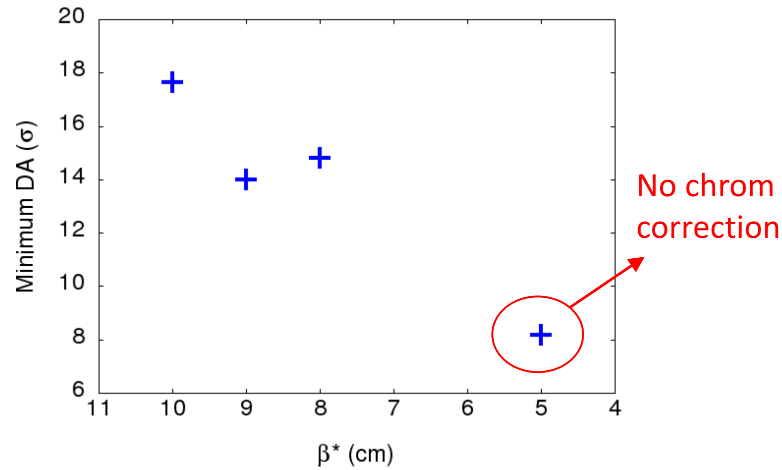

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- **SR load-limits and distance between apertures**

  → 1. Define minimum L*

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2. Once L* is defined, choose β*
3. Get optics (if there's not one yet)
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- Suggestions?

- In the mid time. Work for workshop:
  - DA with IT errors in HL IRs (IR1 and IR5)
  - Explore new chromaticity correction
  - Give more defined limits for L*, β* options.

Magnet Input

- **SR load-limits and distance between apertures**

1. Define minimum L* → Start with L*=15 m
2. Once L* is defined, choose β* → Start with β* =10 cm

Start with current design -> necessary apertures
Magnet design (Brett)
Back to optics -> Fulfil necessary apertures?

3. Get new optics (in progress)
4. Run DA (**errortables for magnets**?)

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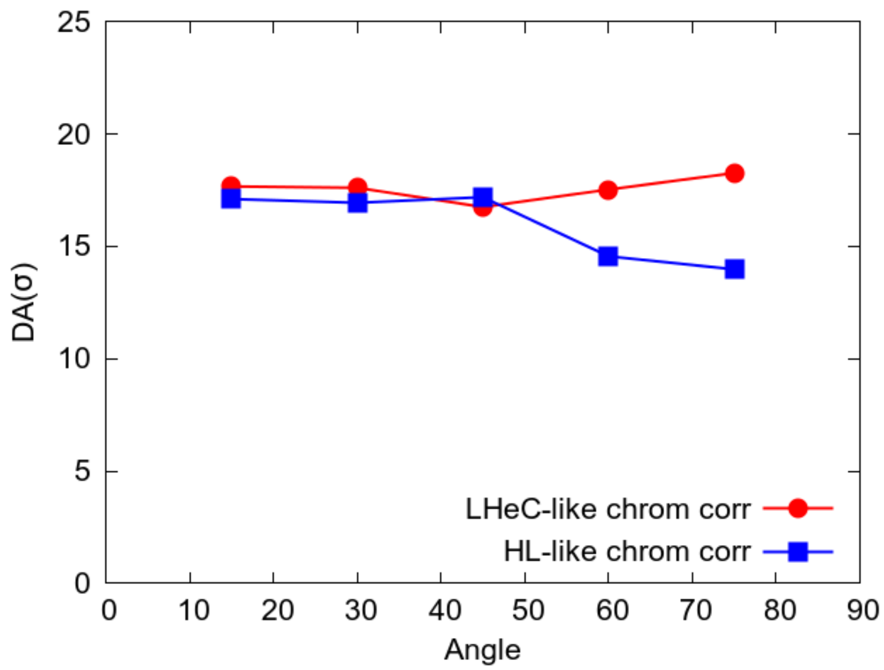
DA studies

- New chromaticity correction.
  Works for more cases (matched for β*=5 cm)
  DA for baseline case L*=10m and β*=10 cm looks worst

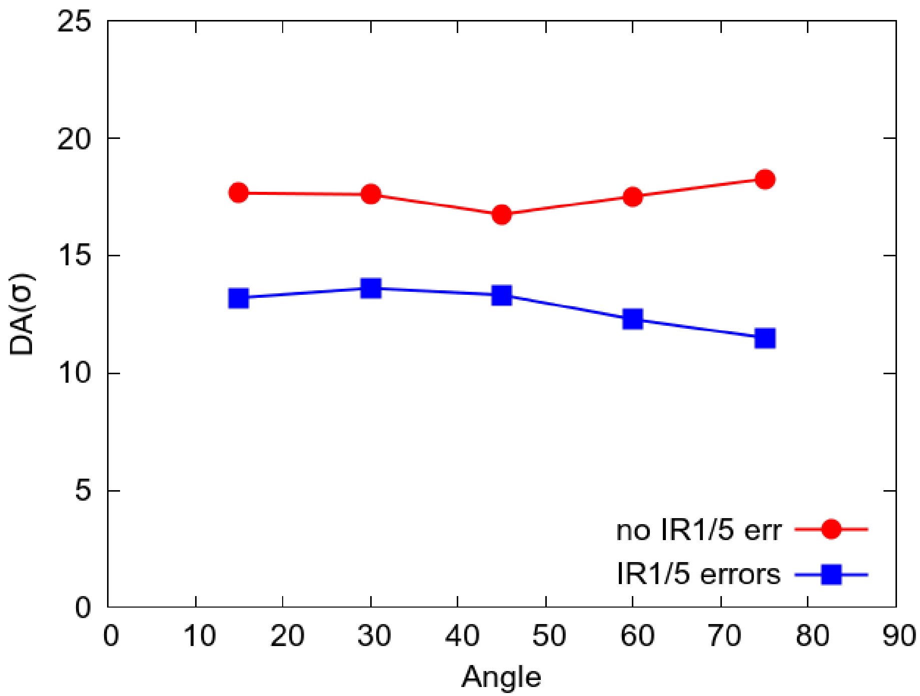


Min DA 16.7σ vs 14σ

- Check both options for each case.
- Useful for cases when LHeC correction non-possible

DA studies

- Errors in IR1 and IR5
- Using non-linear correctors in IR1 and IR5.



Min DA 16.7σ vs 11.5σ

Get new values with updated optics.
See how it impacts on L*=15 m. (non-error case) loss of around 1.5σ
Fixing L*=15 m to get results-> This will get updated with new triplet

DA studies

- Work for June

  - Updated DA for colliding beam 2 L*=15 m, β*=10 cm
  - Errors on the triplet IR1/IR5
  - Effect of non-linear correctors on DA
  - DA for non-colliding beam?
  - Alternative options?