Updates from the D2 field quality studies

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HL-LHC WP2 Meeting, CERN

[1] CERN - BE-ABP

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General context

- Recent measurement results of the D2 field quality show that for most of the magnets, the b_3 is higher than anticipated.

- During a WP3 meeting (10/07/24), A. Pampaloni proposed 2 coil-coupling strategies to mitigate this observation.

- Numerous studies have been conducted to check the impact of the increased b_3 and to assess the performance of the nonlinear correction of the field quality of D2, such as a scan in b_{3S} from $-6\,\mathrm{u}$ to $6\,\mathrm{u}$.

Round Optics (v1.4)

$$Q_x = 62.31 \qquad Q_y = 60.32$$

$$Q' = 3 \qquad I_{MO} = 0\,\mathrm{A}$$

$$\tfrac{1}{2}\theta_c^{1,5} = 250\,\mathrm{\mu rad} \qquad d_{sep}^{1,5} = \pm 0.75\,\mathrm{mm}$$

$$\beta_{1,5}^* = 0.15\,\mathrm{m} \qquad \beta_2^* = 10\,\mathrm{m}$$

$$\beta_8^* = 1.5\,\mathrm{m} \qquad E = 7000\,\mathrm{GeV}$$
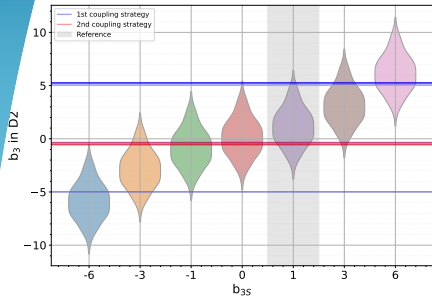
$$\epsilon_n = 2.5\,\mathrm{\mu m}$$

- Initial D2 field quality:
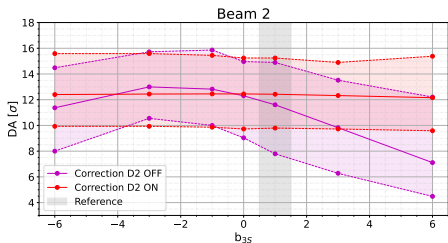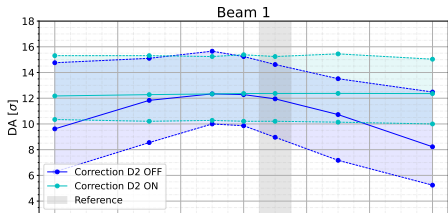 - $b_{3S} = 1.000$;
  - $b_{3M} = b_{3U} = 1.667$;

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Summary of previous results

The 1st coil-coupling strategy seems similar to the $b_{3S} = 0$ worst-case scenario, and the 2nd coil-coupling strategy is closer to a scenario with $b_{3S} = 1 - 3$.

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- Summary of previous results

- **Xdyna status and DA results**

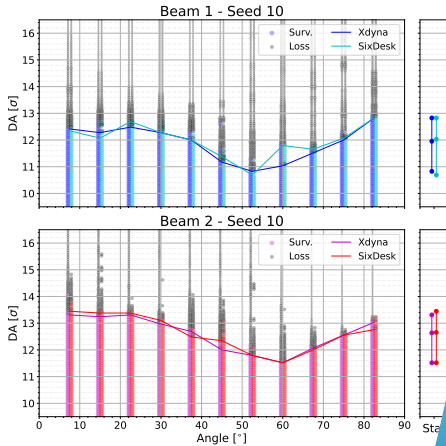- Conclusions

Xdyna
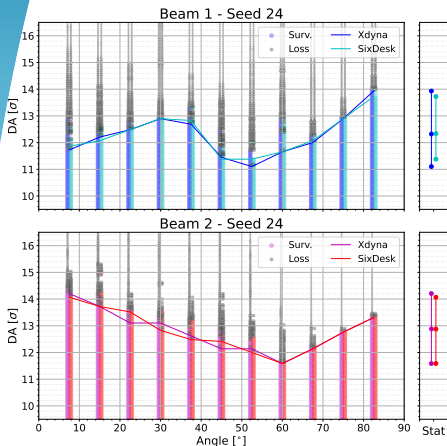
DA simulations are back with Xdyna!

Some bugs were fixed:

- Xdyna uses Xaux to manage the files in parallel processes. The lockfile corruption has been fixed and its management has been improved.

  ⇒ *Thanks again Frederik!*

- MAD-X script cannot contain undeclared variable when load with Xdyna. Those variables were set to 0 and MAD-X printed a warning. Now, this will generate an error.

- It is now possible for Xdyna to specify for Xline a different starting point when computing the CO.

  ⇒ *Thanks again Gianni and Riccardo!*

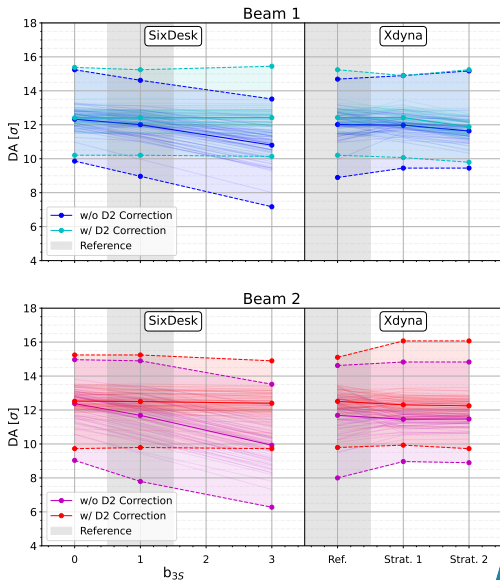# Comparison Xdyna vs SixDesk

Typical case

Worst case

Reference case with correction of b_3 within D2.

T. PUGNAT   Updates from the D2 FQ studies

DA simulations

- The reference case was reproduced to benchmark Xdyna, and the results are almost identical to the one from SixDesk.

- Alessandra only provided the field quality for three D2. The remaining one (in R5) follows the Initial field quality specification.

- The DA for both coils coupling strategies is really good. Even without correction of the average b_3 between apertures, the DA is above $9\,\sigma$ for both beam. With it, the minimum DA is about $10\,\sigma$.

Beam 1

SixDesk   Xdyna

- w/o D2 Correction
- w/ D2 Correction
- Reference

Beam 2

SixDesk   Xdyna

- w/o D2 Correction
- w/ D2 Correction
- Reference

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Conclusions

- The production of DA simulation can now resume with Xdyna and at a faster space.

- The DA is very good for both coil-coupling strategies. Even without correction of the average b_3 within D2, the DA is expected to be higher than $9\,\sigma$ for both beam. With correction, it is possible to reach $10\,\sigma$ for both beam.
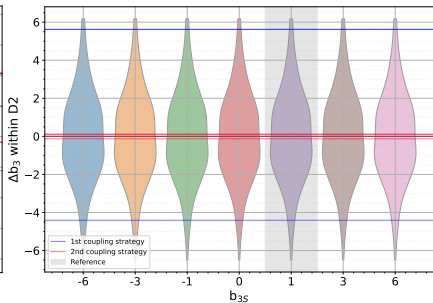
Thank you very much!

Extra: $\langle b_3 \rangle$ and $\triangle b_3$ within D2

Average b_3 between aperture
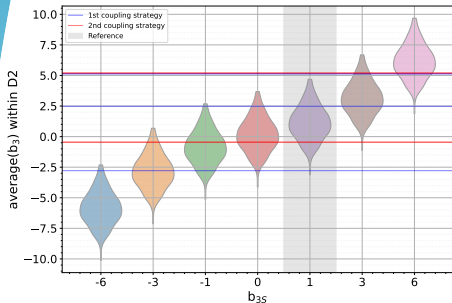
$\triangle b_3$ between aperture

Extra: 1st plots definition

- **All OFF:**

  For this simulation, all LHC magnetic errors are included, but the HL-LHC magnetic errors are turned off.

- **Individual Family:**

  For these simulations, all LHC magnetic errors are included, and the errors of one HL-LHC magnet family are included each time.

- **All ON:**

  For these simulations, all LHC and HL-LHC magnetic errors are switched ON except:

  - □ **no NLC:** NLC magnetic errors are switched OFF
  - □ **no NLC no MCBXF:** NLC and MCBXF errors are switched OFF
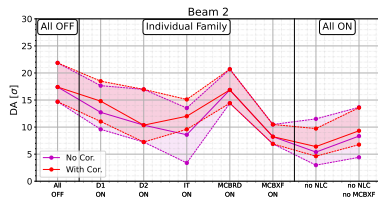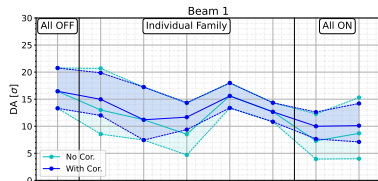
- **No Cor.:** Correction of the field quality of IT and D1 is switched OFF.

- **With Cor.:** Correction of the field quality of IT and D1 is switched ON.
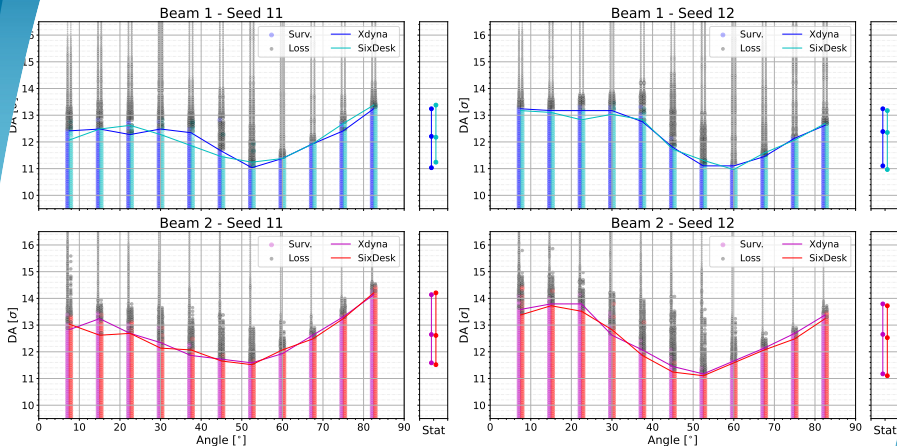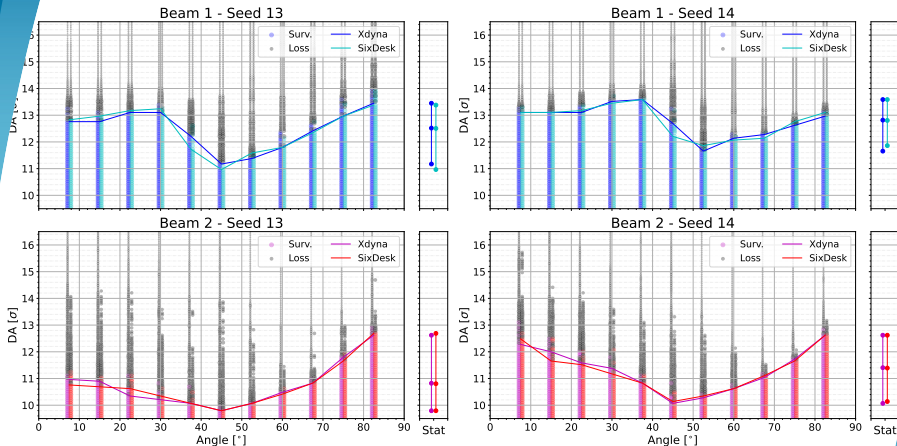
Extra: Comp. Xdyna vs SixDesk

Reference case with correction of b_3 within D2.

Extra: Comp. Xdyna vs SixDesk

Reference case with correction of b_3 within D2.
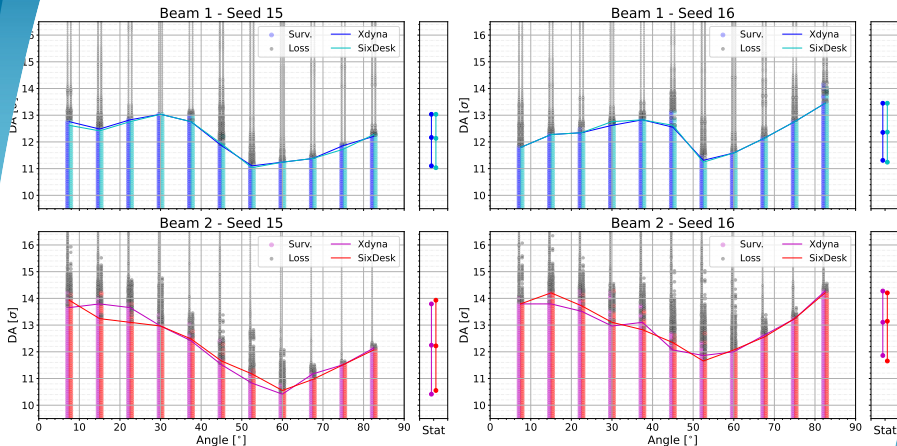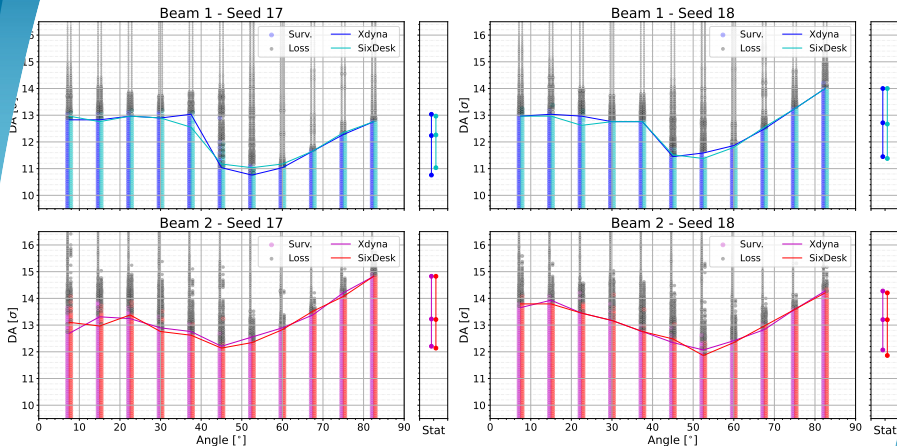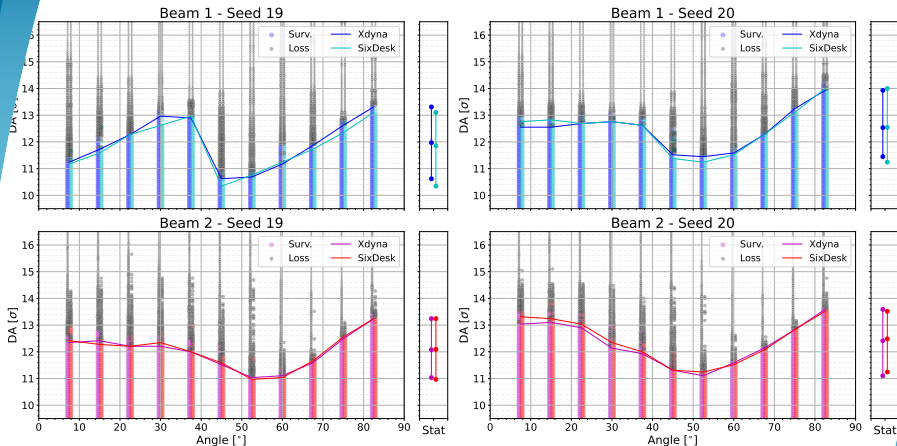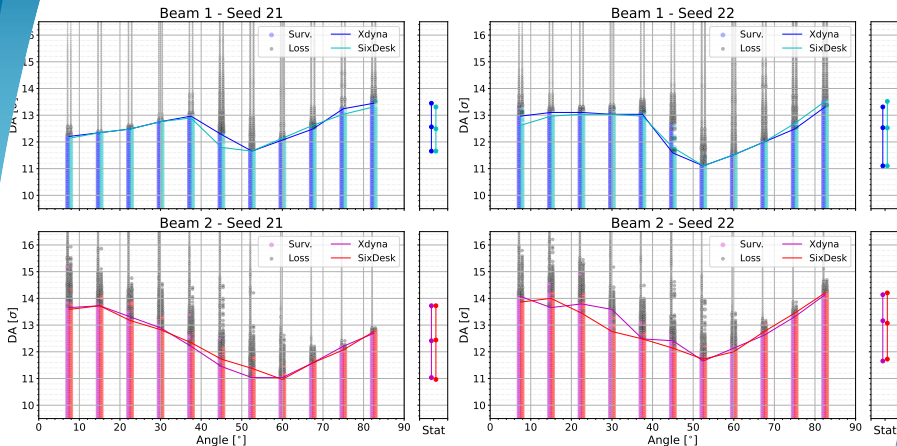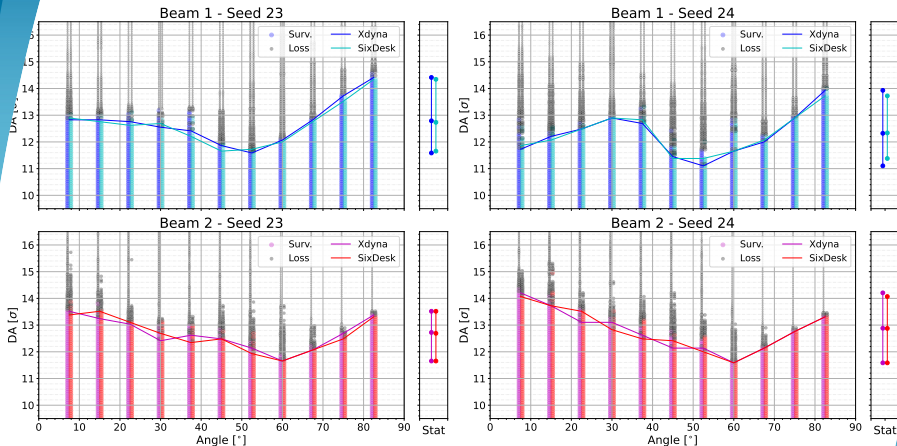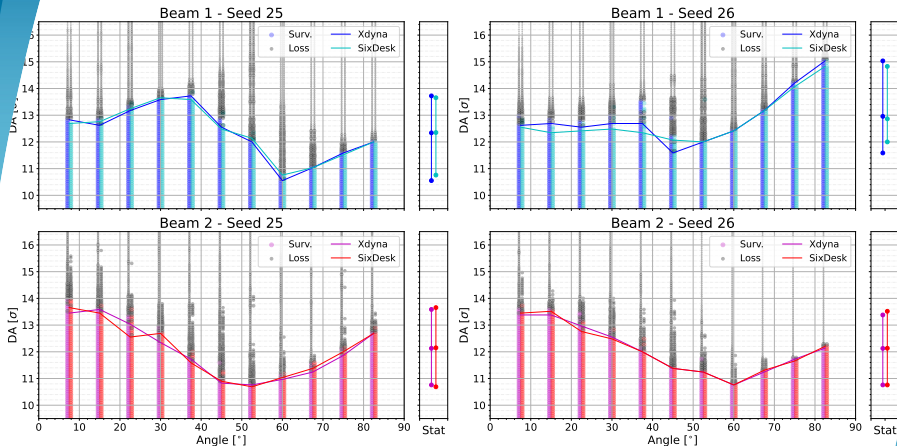
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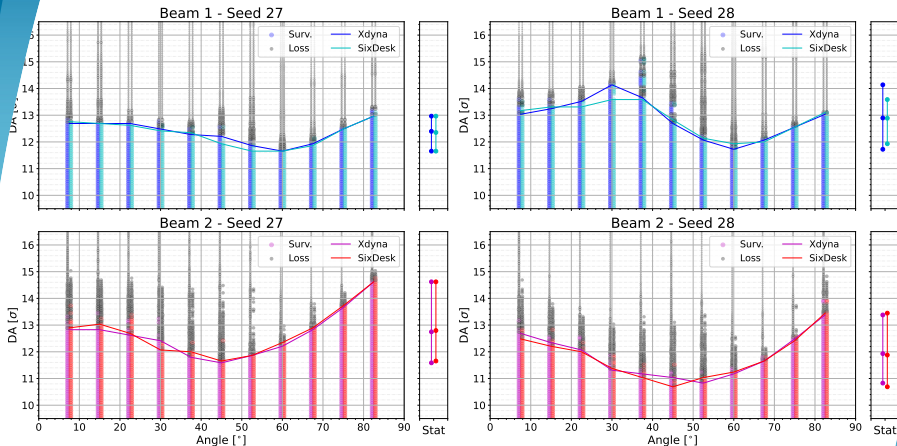
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Reference case with correction of b_3 within D2.
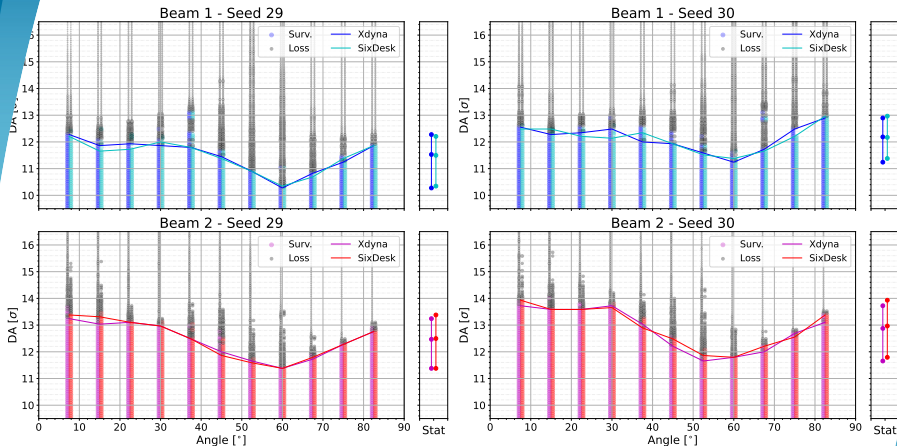
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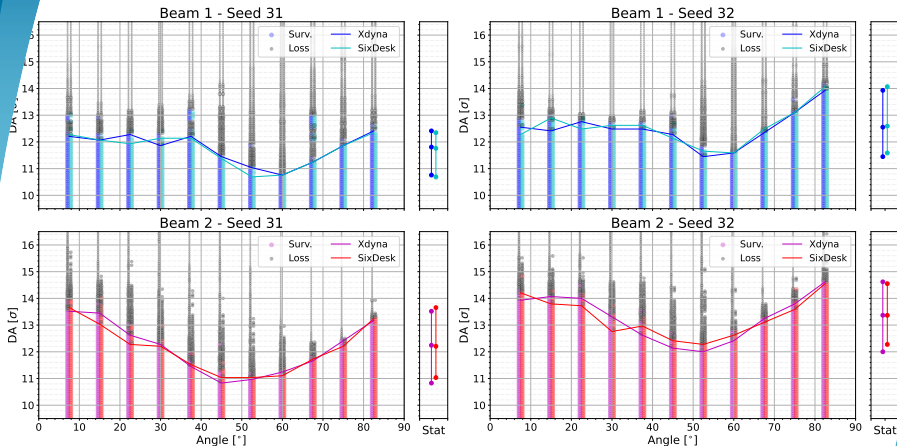
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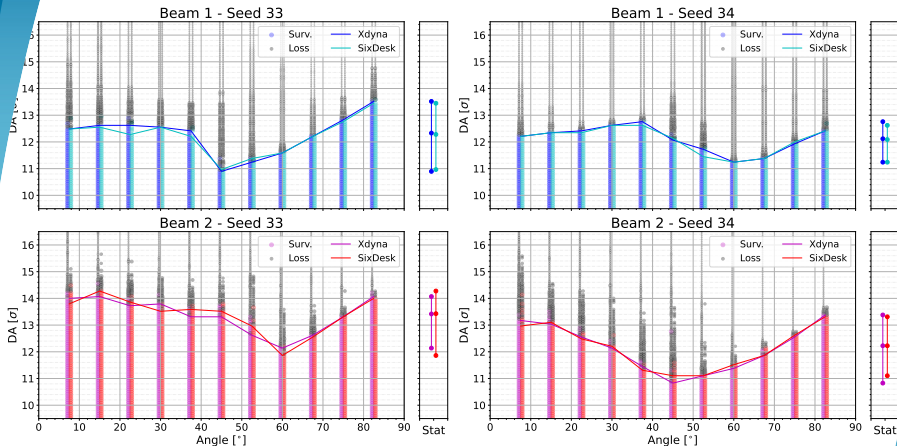

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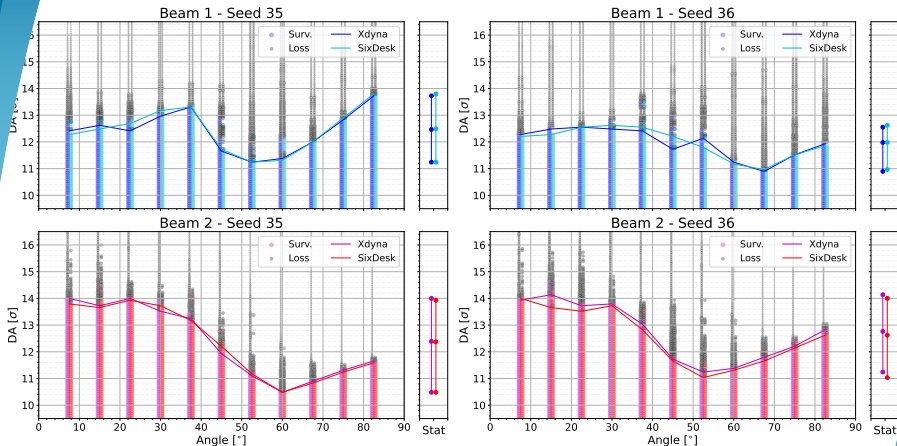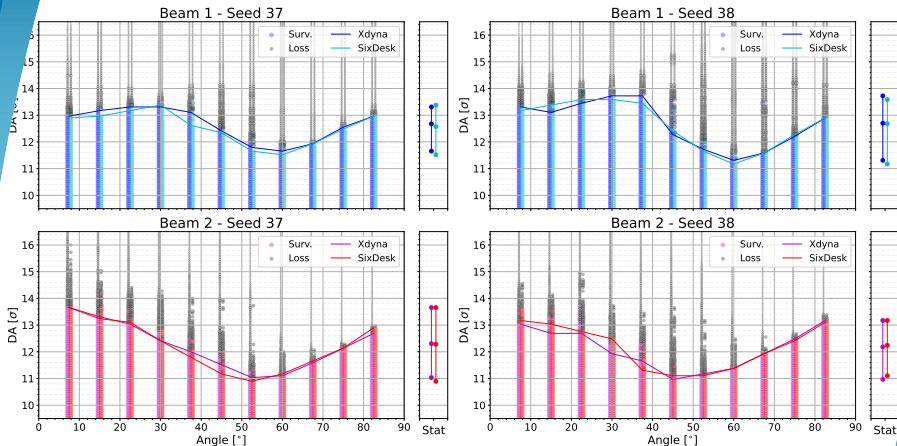

Reference case with correction of b_3 within D2.

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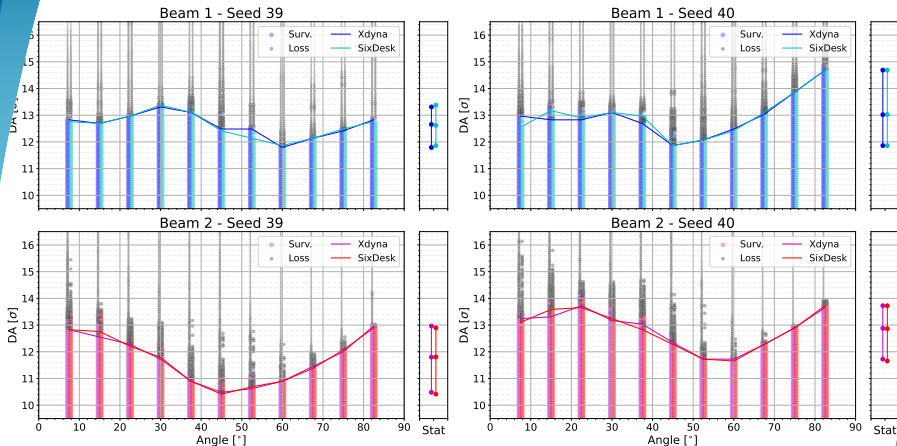*Reference case with correction of b_3 within D2.*

Extra: Comp. Xdyna vs SixDesk

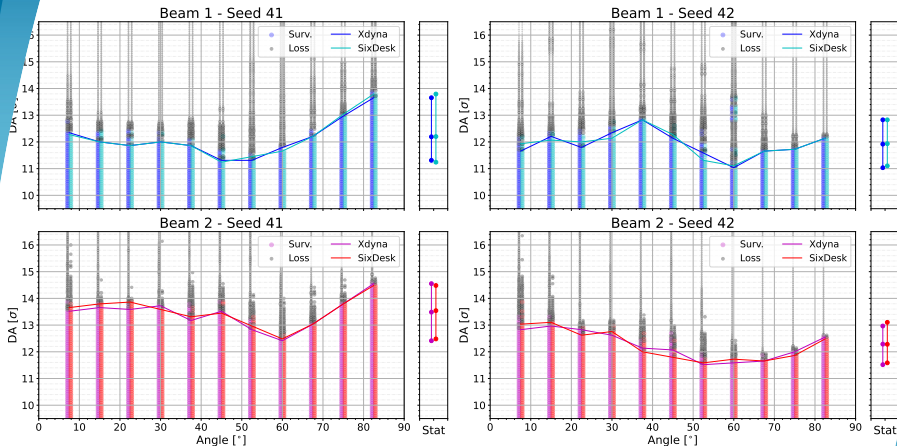*Reference case with correction of b_3 within D2.*

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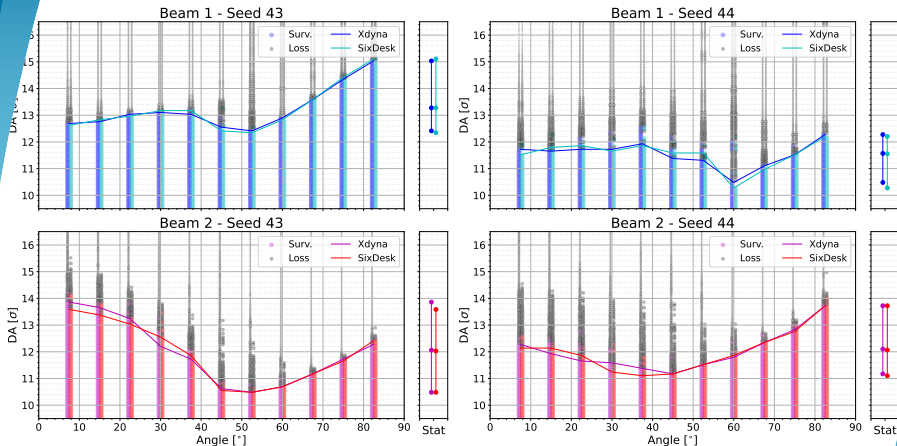
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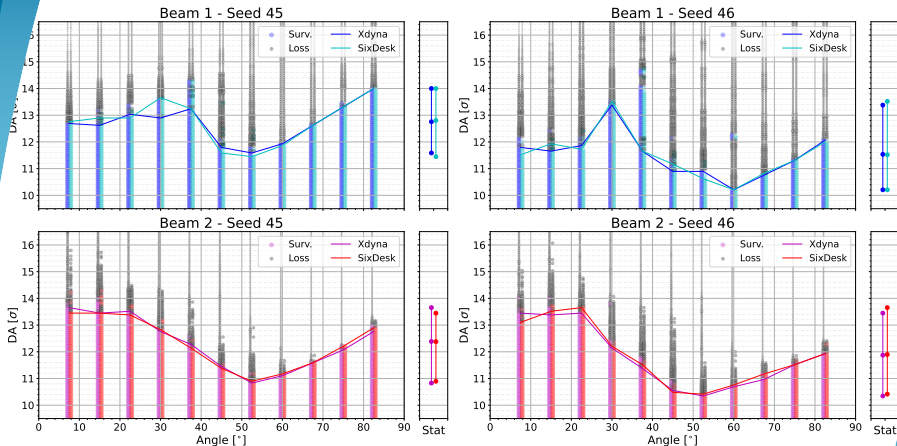
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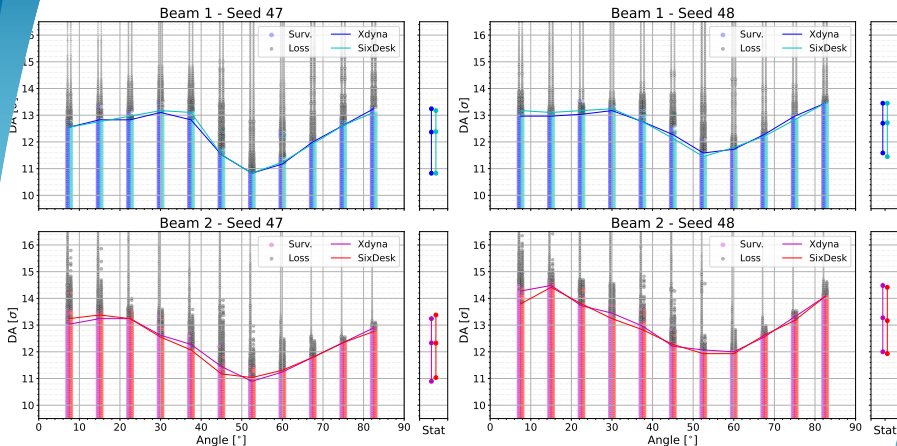
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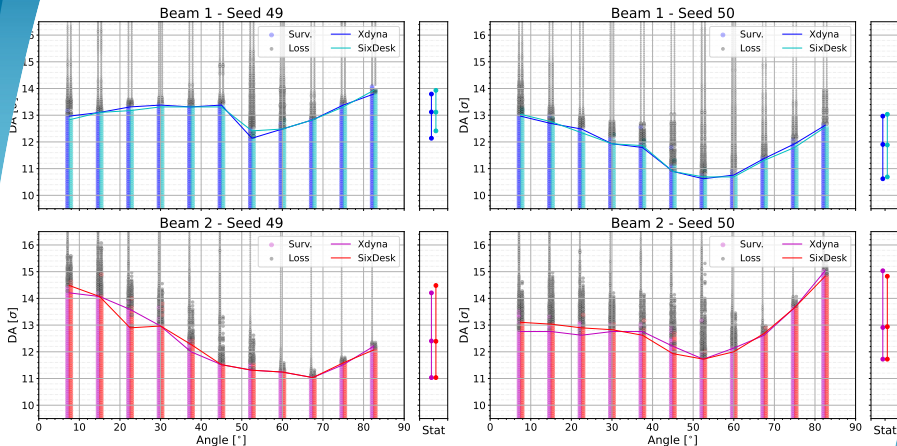
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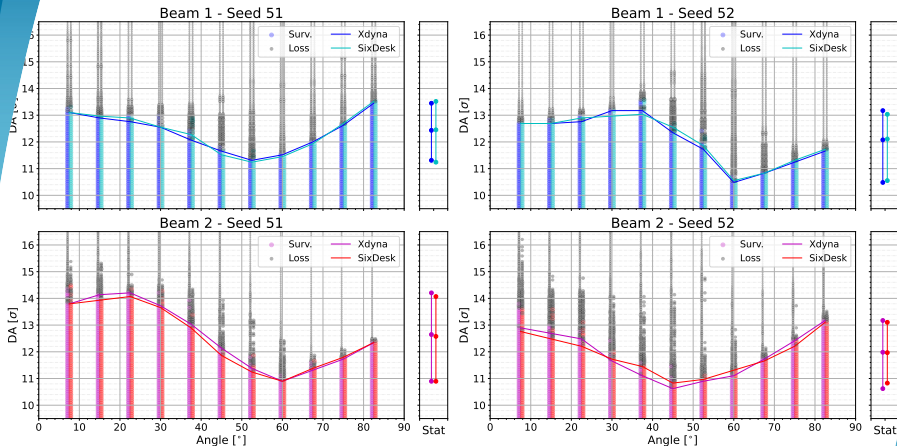
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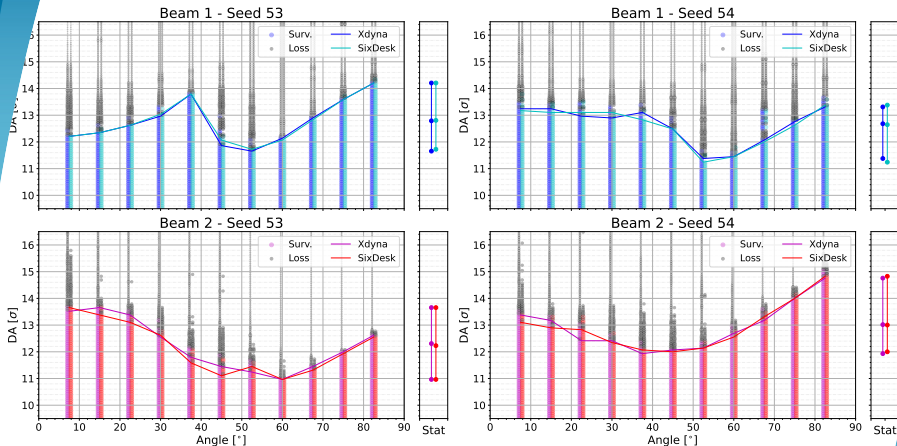
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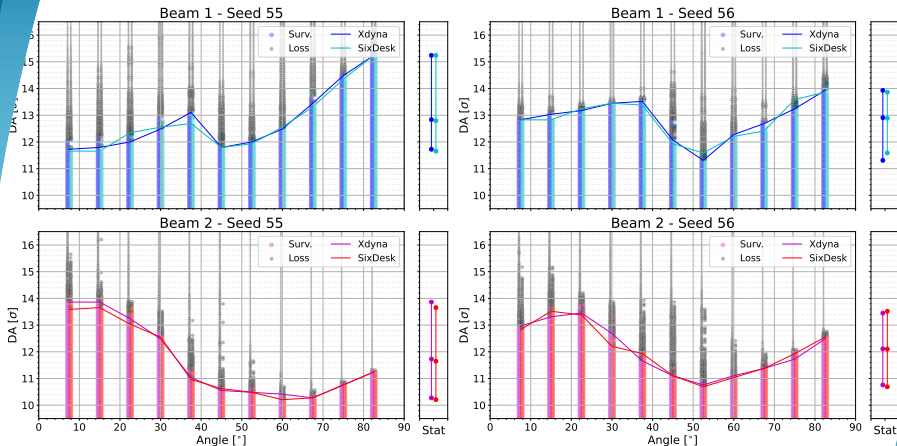*Reference case with correction of b_3 within D2.*

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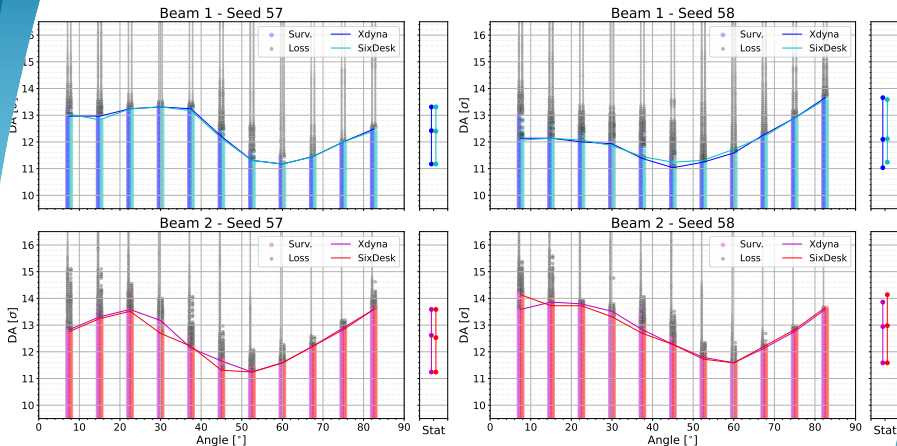*Reference case with correction of b_3 within D2.*

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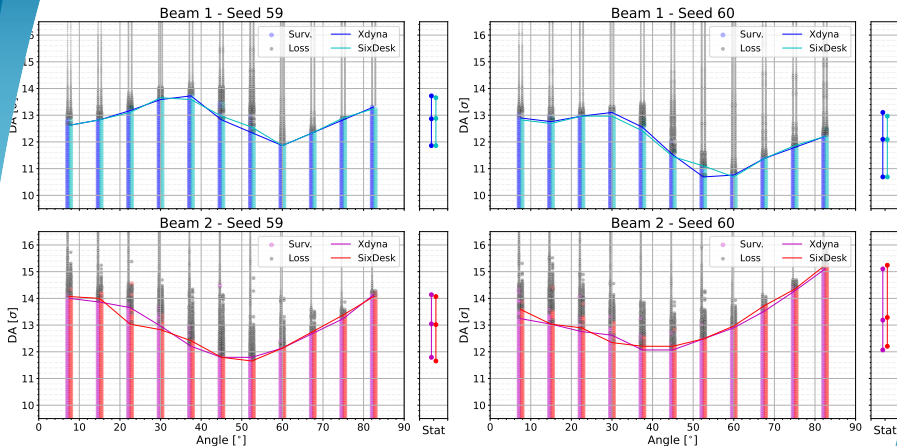

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