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AB-ABP-LOC section meeting

Effect of crossing and separation schemes on the design of the TCT and TCLIA collimators

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Based on discussions with R. Assmann, W. Herr and T. Risselada

Contents:

Motivation:

The design of some collimators/protection devices placed in the experimental straight sections are affected by crossing and separation schemes.

⇒ We need to figure out the worst beam configurations at the collimator locations!

Element concerned:

TCT	Tertiary collimators (all IPs)	Tungsten	8.4 σ	7 TeV (inj?)
TCLI	Injection protection (IP2/IP8)	Carbon	6.8 σ	450 GeV

They are very similar to the secondary collimators but their design is not yet finalized.

Two design issues:

(A) Collimators between D2 and recombination (separate chambers)

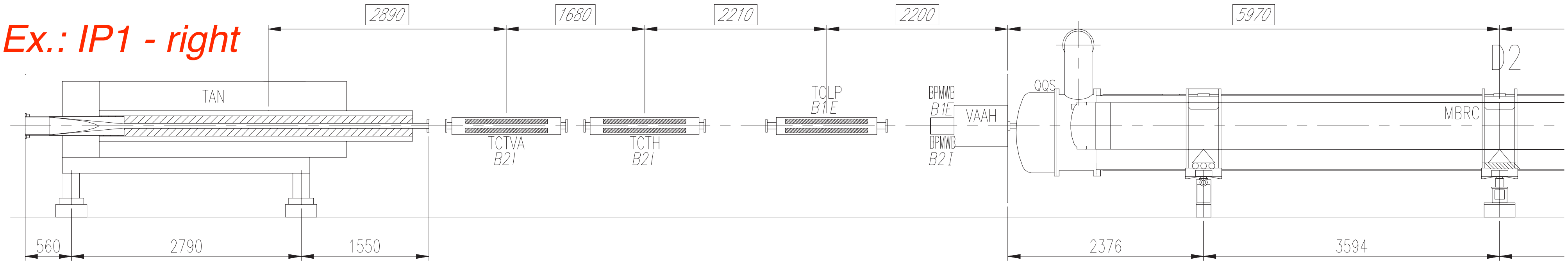
→ Additional beam offset w.r. to collimator centre from Xing - jaw must follow the beams!

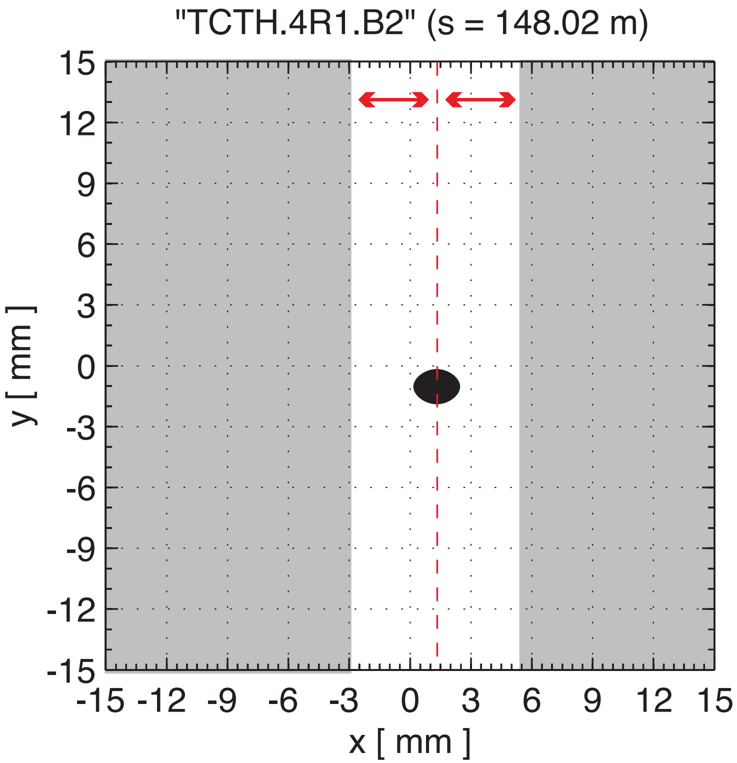
(B) Collimators close to D1 (common chamber for B1 and B2)

→ Additional offset + perturbation of outgoing beam + impedance (TCLI)

(A) Collimators between D2 and recombination (H and V)

Ex.: IP1 - right



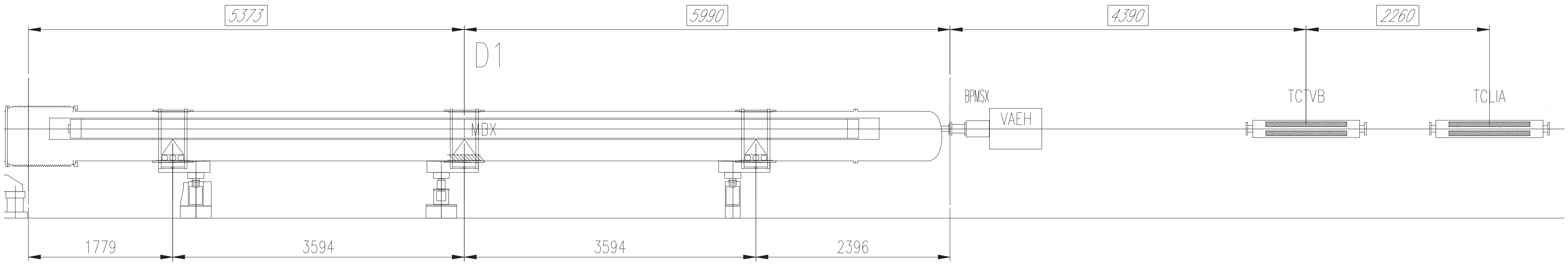


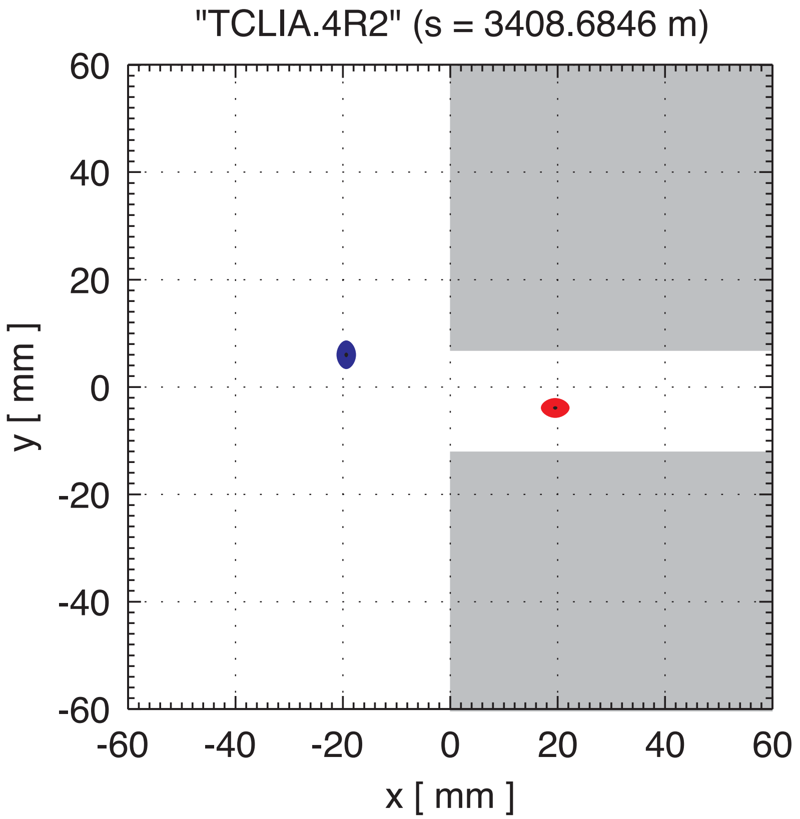
During operation, the jaws must be centred around the beam.

What is the additional offset from crossing and separation? Can the jaws follow the beam?

Present design of secondary collimators: overshoot of **5 mm** beyond the collimator centre to follow the closed orbit (tolerance: < 4mm).

(B) Collimators close to D1 (only vertical)





- Can the jaws follow the beam?
- Is the other beam perturbed (aperture)?
- Is there any impedance issue (TCLI)?

Design criteria:

- Minimize the number of different collimator designs.

  ⇒ Find the *worst* case!

- Do not constrain aperture if TCT's are not used.

  ⇒ In fully open configuration, jaws should be outside of the local aperture

What determines the *worst case* for the beam centre position?

- Take closed-orbit tolerance into account (always worst sign!).
- Take simultaneously separation and crossing, also at 7 TeV ("pre-collision")
- Take into account 0.05% $\delta p/p$ for chromatic sweeps.
- *Figure out the optics configurations with largest crossing angles*.

Considered optics scenarios

Nominal scenarios as of
LHC design report (V1, Ch 4)

State	$\beta^*_{x,y}$ (m)	horizontal crossing angle (μrad)	vertical orbit (mm)
Injection	18.0	+ 160.0	+ 2.50
Ramp	18.0	+ 40.0	+ 0.625
Pre-collision	0.55	+ 142.5	+ 0.50
Collision	0.55	+ 142.5	+ 0.0

State	SPEC (ALICE) (μrad)	$\beta^*_{x,y}$ (m)	half external angle α_{ext} (μrad)	half crossing angle α (μrad)	horizontal orbit separation (mm)
Injection	0.0	10.0	$\pm$ 170.0	$\pm$ 170.0	+ 2.00
Injection	+ 70.0	10.0	+ 170.0	+ 240.0	+ 2.00
Injection	- 70.0	10.0	- 170.0	- 240.0	+ 2.00
Collision	+ 70.0	10.0	+ 80.0	+ 150.0	0.18
Collision	- 70.0	10.0	- 80.0	- 150.0	0.18

State	SPEC (LHCb) (μrad)	$\beta^*_{x,y}$ (m)	half external angle α_{ext} (μrad)	half crossing angle α (μrad)	horizontal orbit separation (mm)
Injection	0.0	10.0	- 170.0	- 170.0	- 2.00
Injection	+ 135.0	10.0	- 170.0	- 35.0	- 2.00
Injection	- 135.0	10.0	- 165.0	- 300.0	- 2.00
Collision	+ 135.0	10.0	- 210.0	- 75.0	0.0
Collision	- 135.0	10.0	- 65.0	- 200.0	0.0

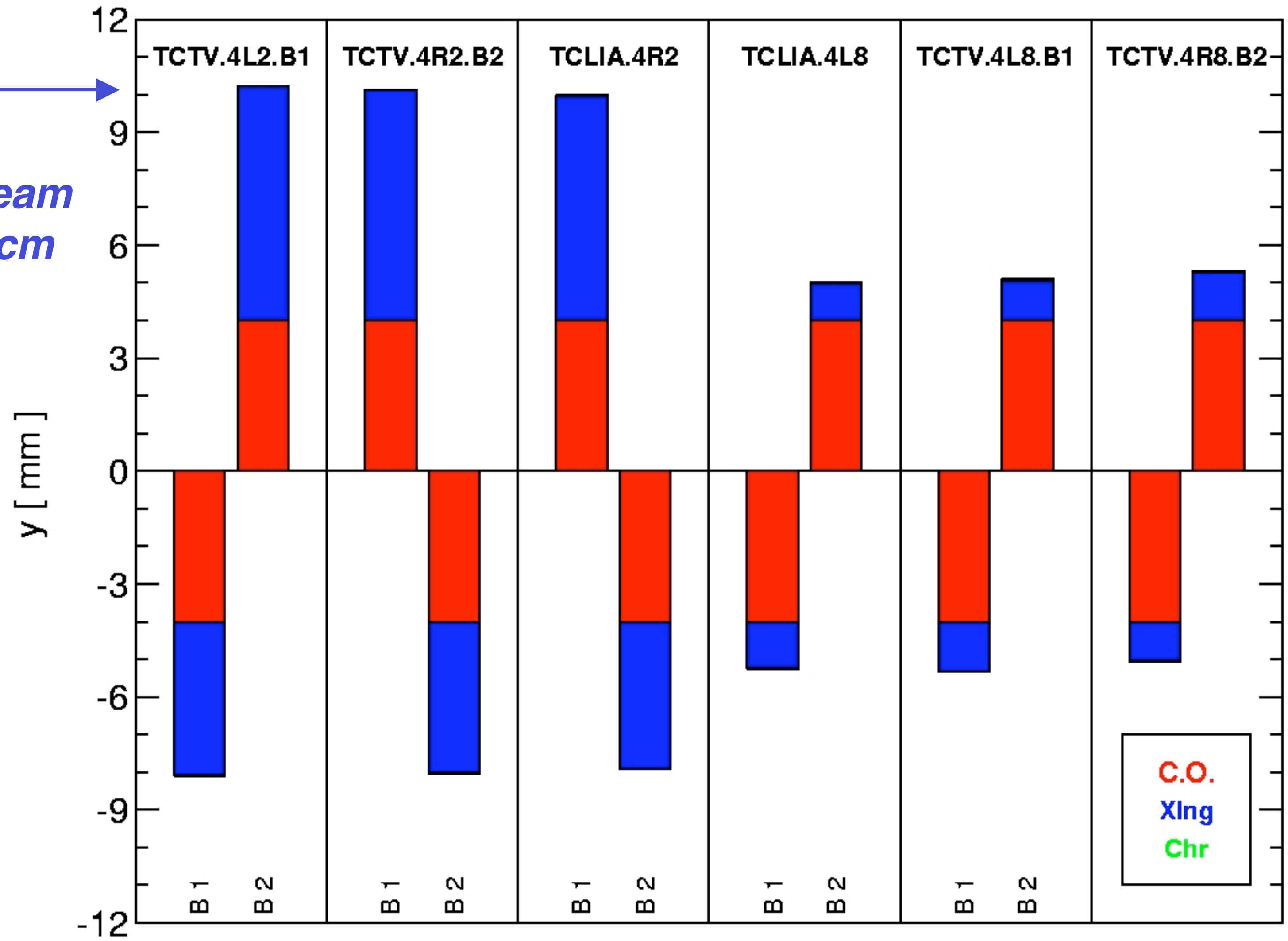
Table of used optics:

NAME	S	BETX	BETY	DX	DY	X	PX	Y	PY
"IP1"	0.000000	0.55	0.55	0.006356	0.018974	-0.000500	-0.000000	-0.000500	0.000143
"IP2"	3332.436584	10.00	10.00	0.014722	-0.006509	0.001999	-0.000000	-0.000000	0.000150
"IP5"	13329.289233	0.55	0.55	-0.006953	0.010795	0.000500	0.000142	0.000500	-0.000000
"IP8"	23315.378984	10.00	10.00	-0.024535	0.012994	-0.000000	-0.000210	-0.001999	0.000000

Simulation results - Elements close to D1 (common pipe)

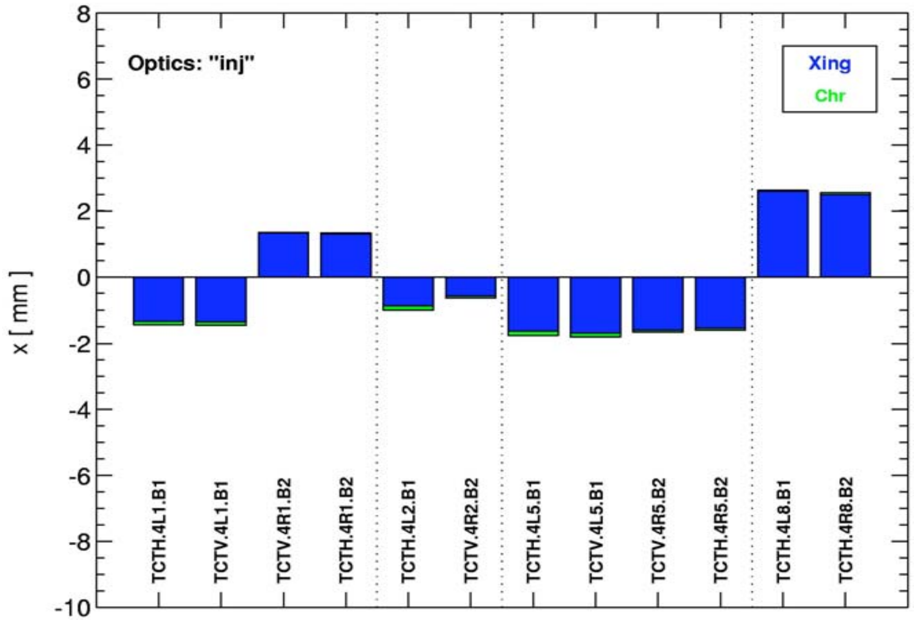
Worst case: injection optics (4 mm closed orbit!)

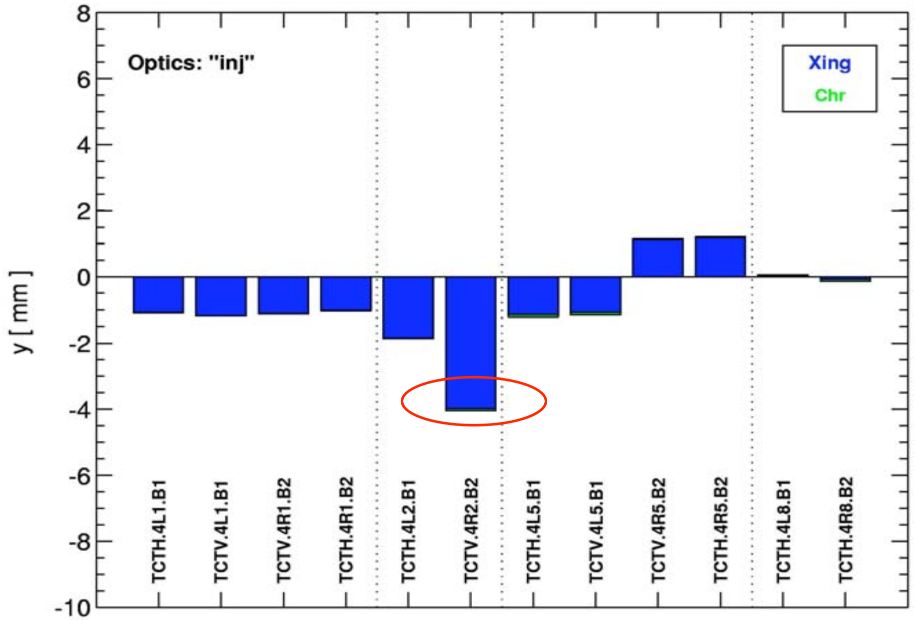
Maximum beam offset of ~ 1cm

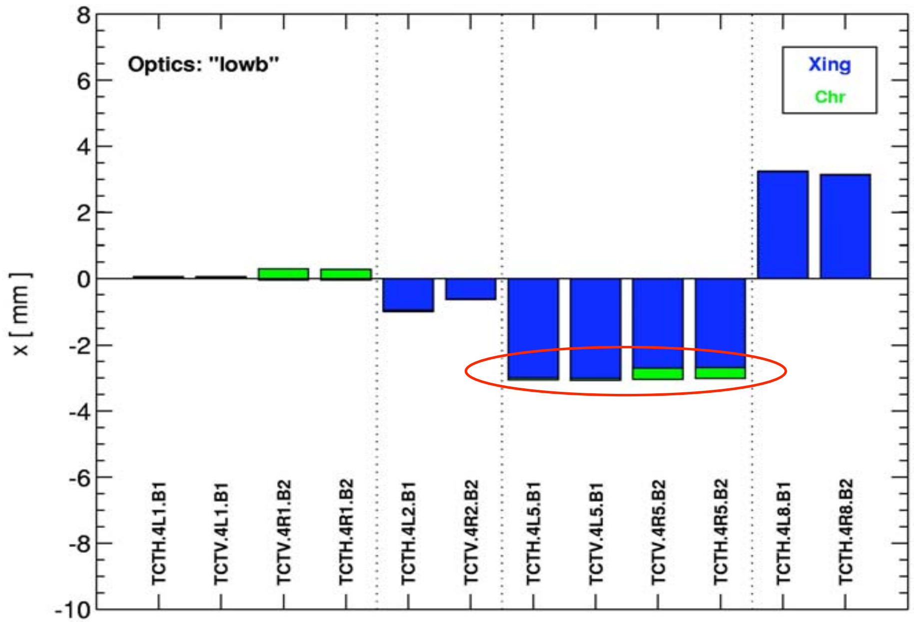


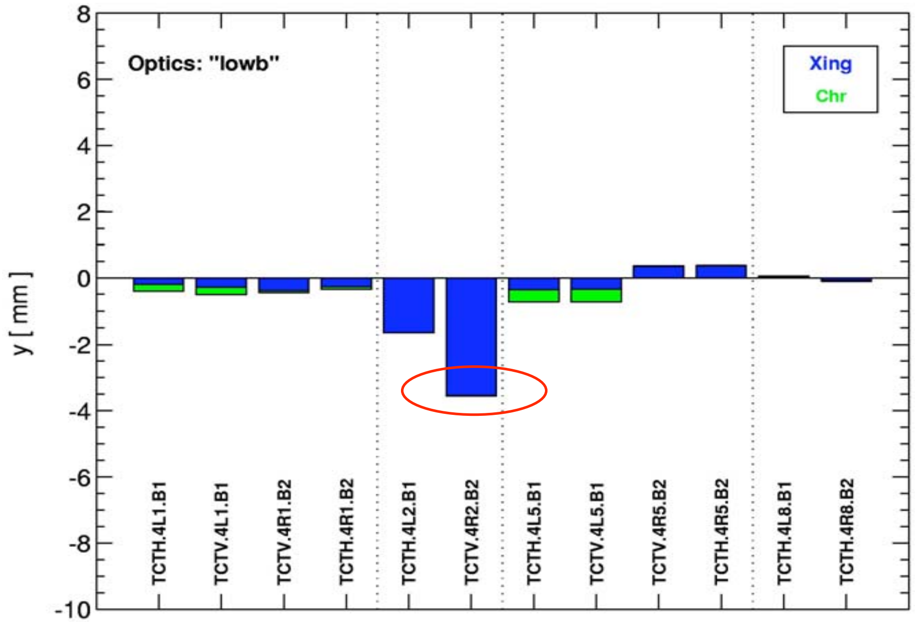
4 mm for closed-orbit

Simulation results - Design for separate beam pipe close to D2









Conclusion - Summary of worst cases

(A) **TCT's between D2 and recombination** (can the jaws follow the beam centre?)

Maximum horizontal offset	→	**~ 3.5 mm**	*"Small" design changes*
Maximum vertical offset	→	**~ 4.0 mm**	

(B) **TCT's and TCLI's close to D1** (can jaws follow the beam? Is impedance ok?)

Maximum excursion with CO	→	**~ 10.0 mm**
Maximum vertical B1-B2 offset with CO	→	**~ 20.0 mm**
Typical horizontal B1-B2 separation	→	**~ 30 to 50 mm**

Comments from LOC are welcome! Is there any missing scenario?