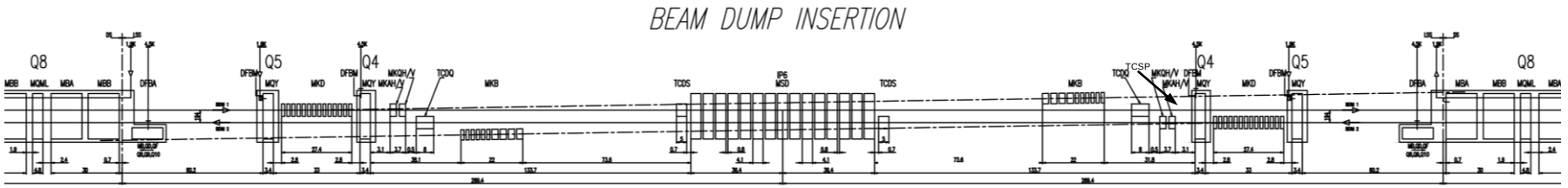
IR6 Dump size optimization

R. De Maria

WP2 Meeting 25/11/2019

IR6 optics constraints



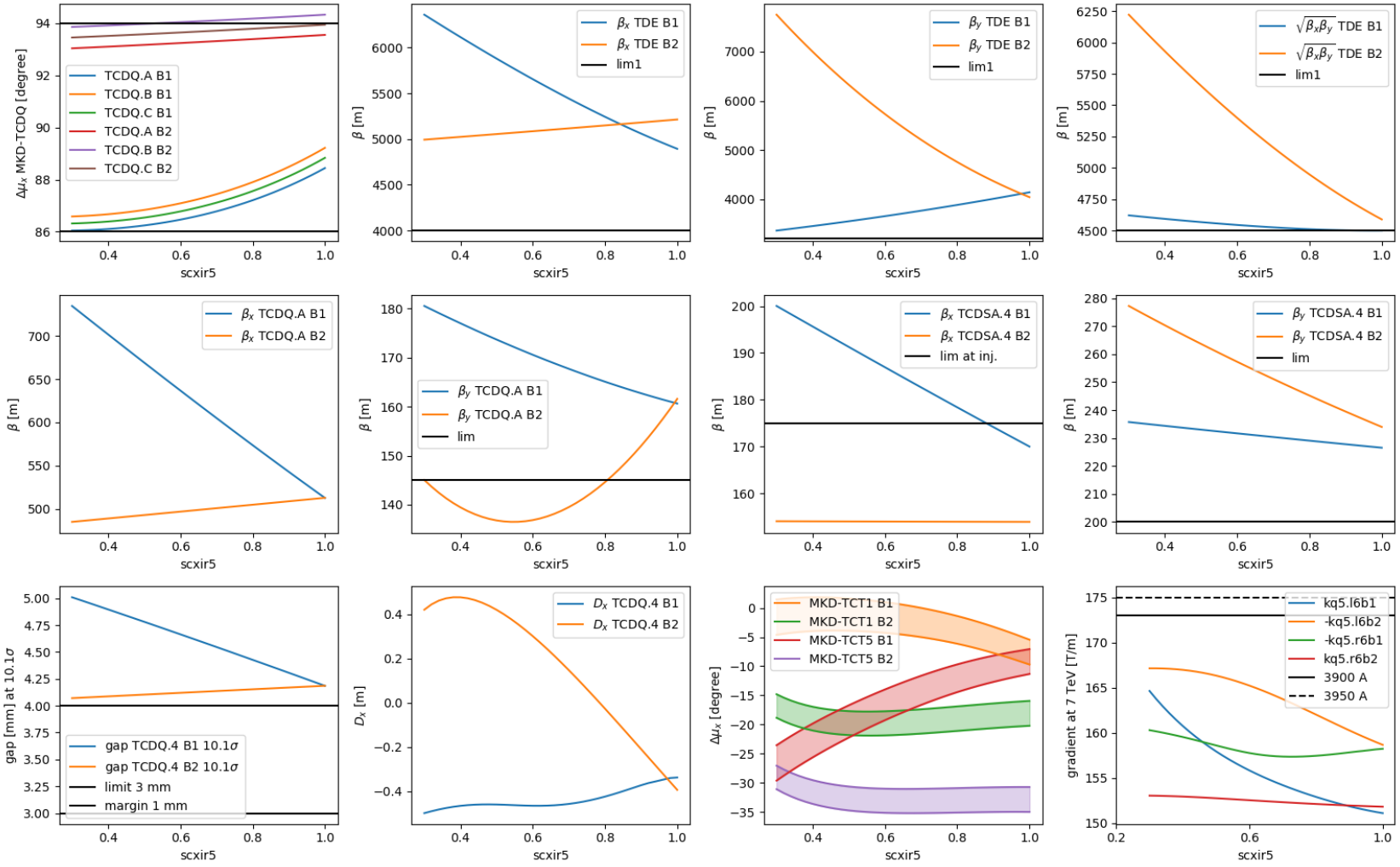
Optics knobs: in Q13L to Q13R: 16 quadrupoles

Optics constraints:

(12 strict)	Matching to arcs and squeeze IP5 ($\beta_{x,y}$, $\alpha_{x,y}$, D_x, D'_x)
(2 strict)	Strength Q4.L6B1, Q4.R6B2 fixed by the transfer line
(2)	MKD-TCT phase advance $\Delta\mu_x$ depends on available H aperture
(4)	beam size beam dump (TDE) β_x>4 km, β_y>3.2 km, $\beta_x\beta_y$> (4.5 km)^2
(2)	$\Delta\mu_{x,\ MKD\text{-}TCDQ}$, $\Delta\mu_{x,\ MKD\text{-}TCSP}$ <90 ±4°
(4)	beam size TCDQ β_x>430 m, β_y>145 m
(4)	minimum gap TCDQ > 3mm, 1 mm margin, constant gap at flat top (β_x, D_x)
(8)	Peak β in the insertion during squeeze <1.5 km
(2)	Beam size TCDS β_y>200 m
(4)	Strength Q5, non-conform MQTL.11
(20)	Aperture at injection (peak beta and dispersion at focusing quads)

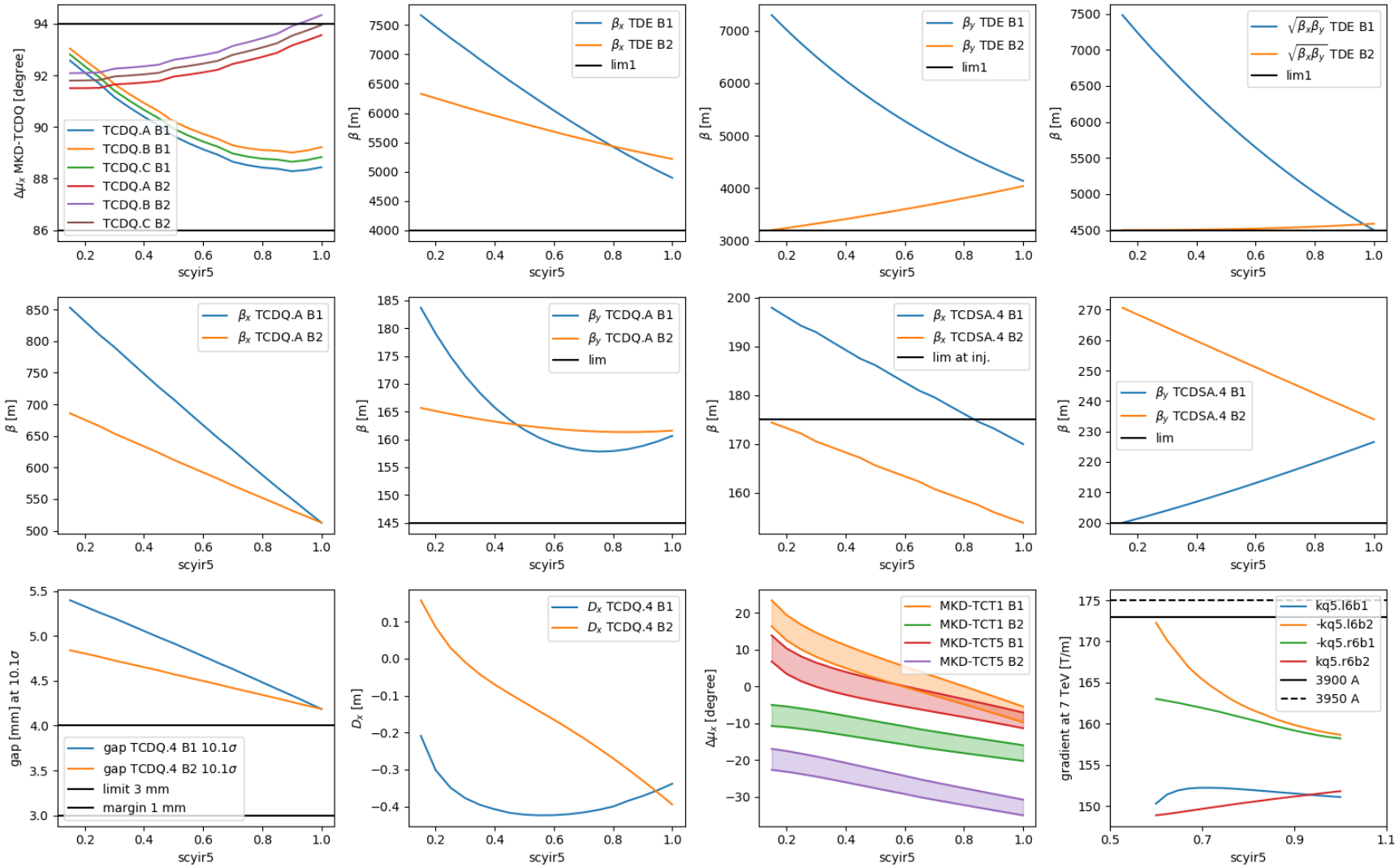
Optics constraints Round squeeze

Each type ATS factor in point 5 (Round $\beta^*_x=\beta^*_y$, Flat $\beta^*_x>\beta^*_y$, FlatCC $\beta^*_x<\beta^*_y$) and noMS14 variants requires different optics.



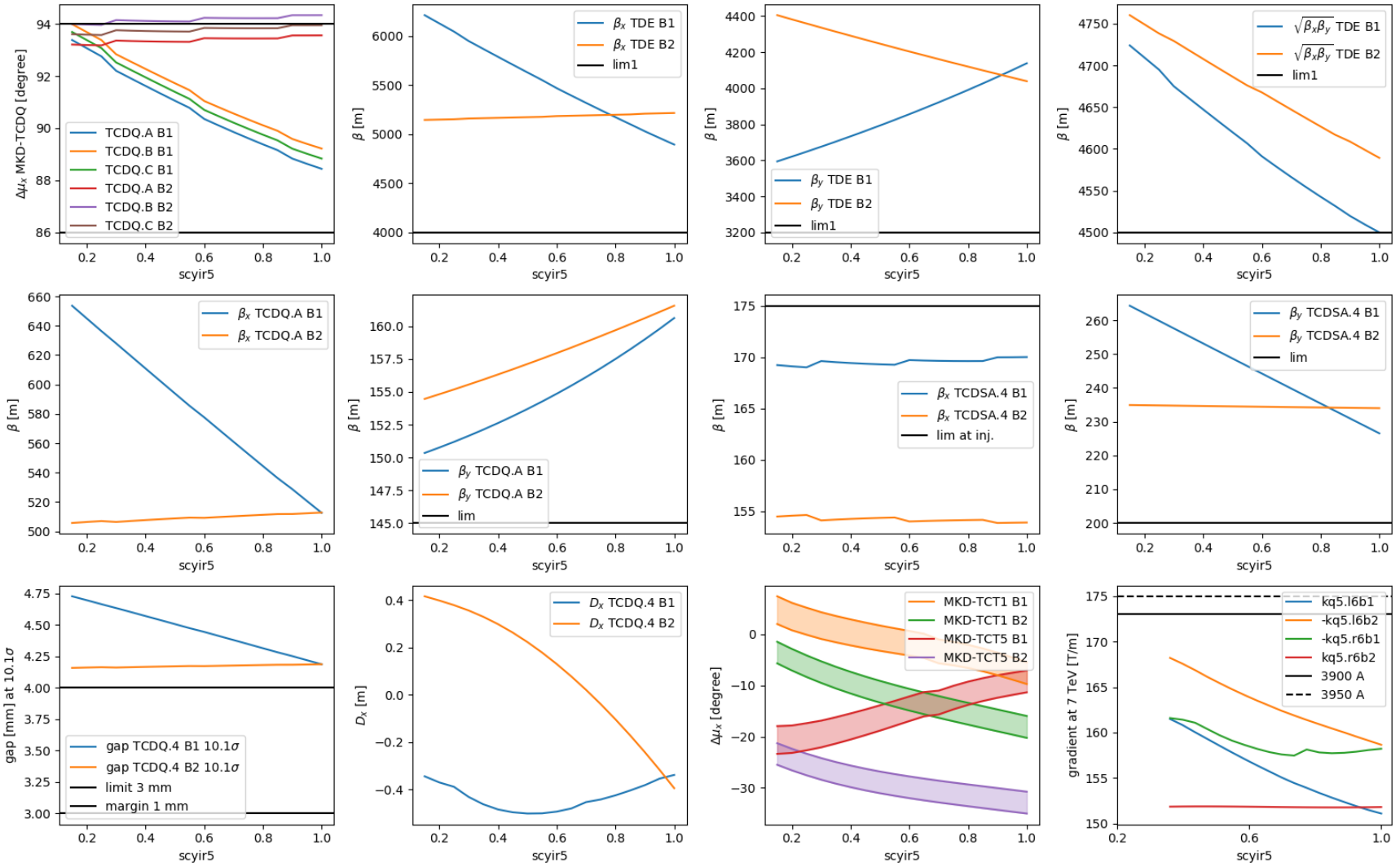
Optics constraints Flat squeeze

Each type ATS factor in point 5 (Round $\beta^*_x=\beta^*_y$, Flat $\beta^*_x>\beta^*_y$, FlatCC $\beta^*_x<\beta^*_y$) and noMS14 variants requires different optics.



Optics constraints FlatCC squeeze

Each type ATS factor in point 5 (Round $\beta^*_x=\beta^*_y$, Flat $\beta^*_x>\beta^*_y$, FlatCC $\beta^*_x<\beta^*_y$) and noMS14 variants requires different optics.



Optics, aperture, crossing plane

	Round	Flat	FlatCC	FlatCCHV	FlatCCHV
β* Xing/Sep [cm]	15/15	30/7.5	18/7.5	18/9	18/7.5
Xing angle [μrad]	±250	±245	±240	±240	±240
Crossing plane IP5	V (or H)	H	H	V	V
Aperture Xing plane [σ]	13.1	15.6	14.2	14.2	14.2
Aperture Sep plane [σ]	16.5	12.7	12.7	13.9	12.7
H Aperture Point 1/5	13.1/16.5	12.7/15.6	12.7/14.2	14.2/13.9	14.2/12.7
MKD-TCT [°] IP1 [B1/B2]	5/19	23/10	4/6	13/22	8/22
MKD-TCT [°] IP5 [B1/B2]	30/31	14/22	27/25	40/45	51/54
H Ap. Protected IP1 W/Cu	11.2/11.2	11.4/11.2	11.2/11.2	11.3/11.2	11.3/11.2
H Ap. Protected IP5 W/Cu	11.9/11.2	11.3/11.2	11.7/11.2	13.3/12.3	14.1/13.1
Ap. Margin W [σ]	1.9 (or 1.2)	1.3	1.5	0.6	-1.4
Ap. Margin CuCD [σ]	1.9 (or 1.9)	1.5	1.5	1.6	-0.4

Assuming different settings for TCTH and TCTV (R. Bruce)
Present aperture margins are being considered to be used for:

1) Increase collimators gaps to reduce impedance (this also can relax TCDQ gaps and interlocks)
2) Introduce IP offset in the crossing plane to reduce radiation deposited in the triplets
3) Reduce further β* (if extra margin in DA)

IR6 Dump size optimization

- Increase spot size at the beam dump by relaxing MKD-TCT phase advance or other constraints
- Spot size cannot be increased at injection due to aperture constraints, but can be done during ramp&squeeze. Below the results for β*=15 cm.

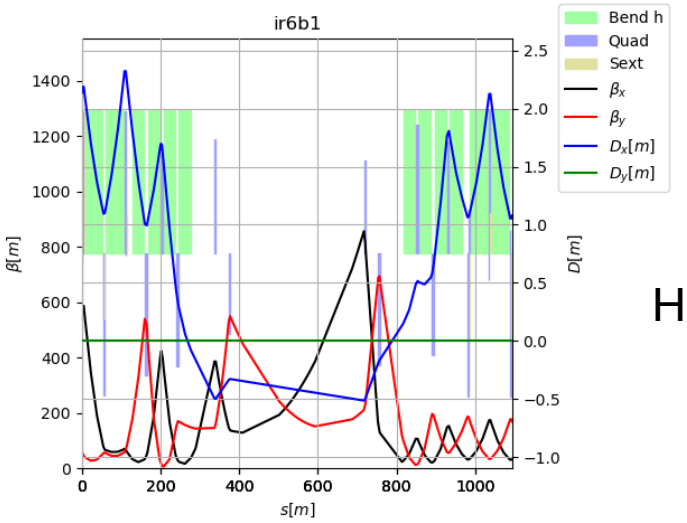
B1/B2	Request [km]	V1.4 round [km]	Limited by MQTL11.R6B1 β_y in Q4.R6B2	MQTL11.R6B1 at 400 A
β_x	>4	6.3/5.0	9.0/5.0	9.3/5.0
β_y	>3.2	3.8/7.8	5.4/9.9	5.9/9.9
$(\beta_x\beta_y)^{1/2}$	>4.5	4.6/6.2	7.0/7.0	7.4/7.0

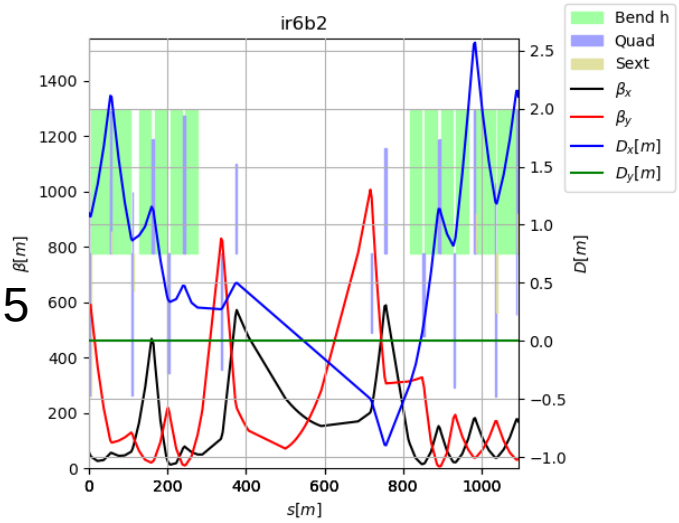
General limits: RQTL11.R6B1, RQ8.R6B1, RQ8.L6B2, peak β.
MKD-TCT still below 20 °

First improvement 25% in beam size at the end of the squeeze

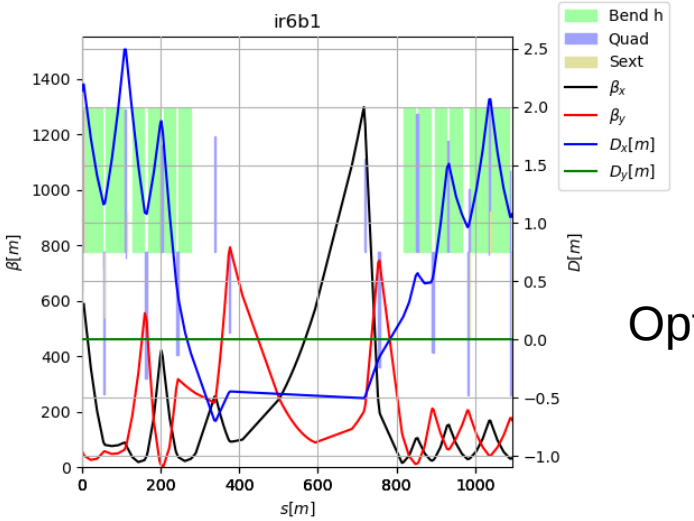
HiLumi HL-LHC PROJECT

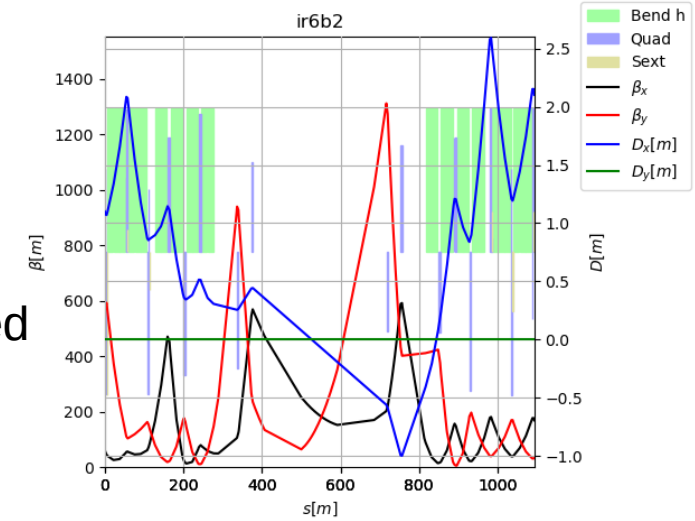
Optics plots





HL1.4/1.5





Optimized

Conclusion

- IR6 optics has many conflicting constraints
- It possible to increase the beam size at the dump by about 25% at the expenses of a peak beta of 1.5 km in Q4/Q5 at the end of the squeeze.
- Some RQ8, RQTL, peak β limiting factor
- Intermediate values should confirmed by studying new optics transitions during the ramp

Backup

Optics, aperture, crossing plane

	Round	Flat	FlatCC	FlatCCHV	FlatCCHV
β* Xing/Sep [cm]	15/15	30/7.5	18/7.5	18/9	18/7.5
Xing angle [μrad]	±250	±245	±240	±240	±240
Crossing plane IP5	V (or H)	H	H	V	V
Aperture Xing plane [σ]	13.1	15.6	14.2	14.2	14.2
Aperture Sep plane [σ]	16.5	12.7	12.7	13.9	12.7
H Aperture Point 1/5	13.1/16.5	12.7/15.6	12.7/14.2	14.2/13.9	14.2/12.7
MKD-TCT [°] IP1 [B1/B2]	5/19	23/10	4/6	13/22	8/22
MKD-TCT [°] IP5 [B1/B2]	30/31	14/22	27/25	40/45	51/54
H Ap. Protected IP1 W/Cu	11.2/11.2	11.4/11.2	11.2/11.2	11.3/11.2	11.3/11.2
H Ap. Protected IP5 W/Cu	11.9/11.2	11.3/11.2	11.7/11.2	13.3/12.3	14.1/13.1
Ap. Margin W [σ]	1.9 (or 1.2)	1.3	1.5	0.6	-1.4
Ap. Margin CuCD [σ]	1.9 (or 1.9)	1.5	1.5	1.6	-0.4

Assuming different settings for TCTH and TCTV (R. Bruce):