

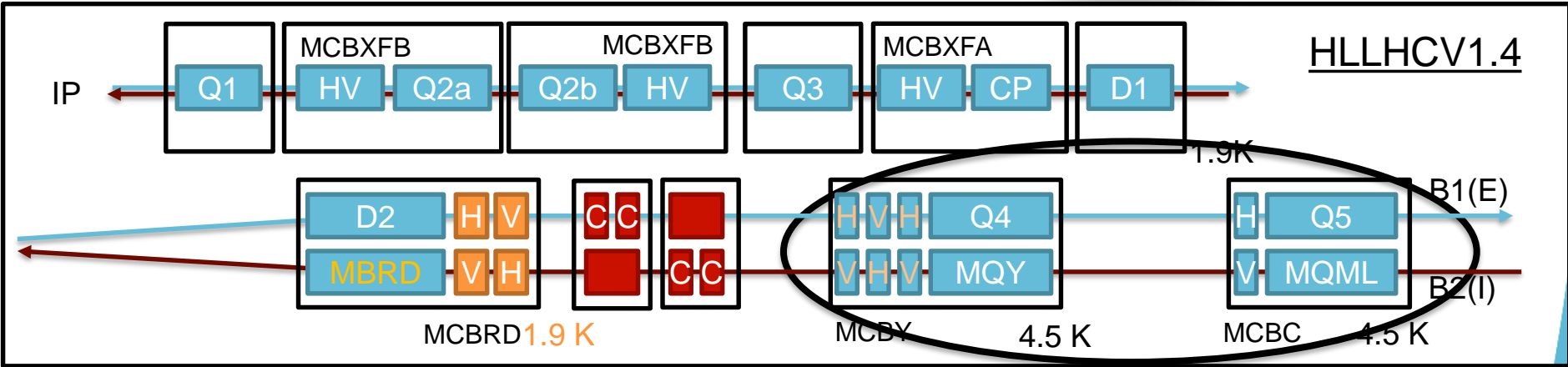
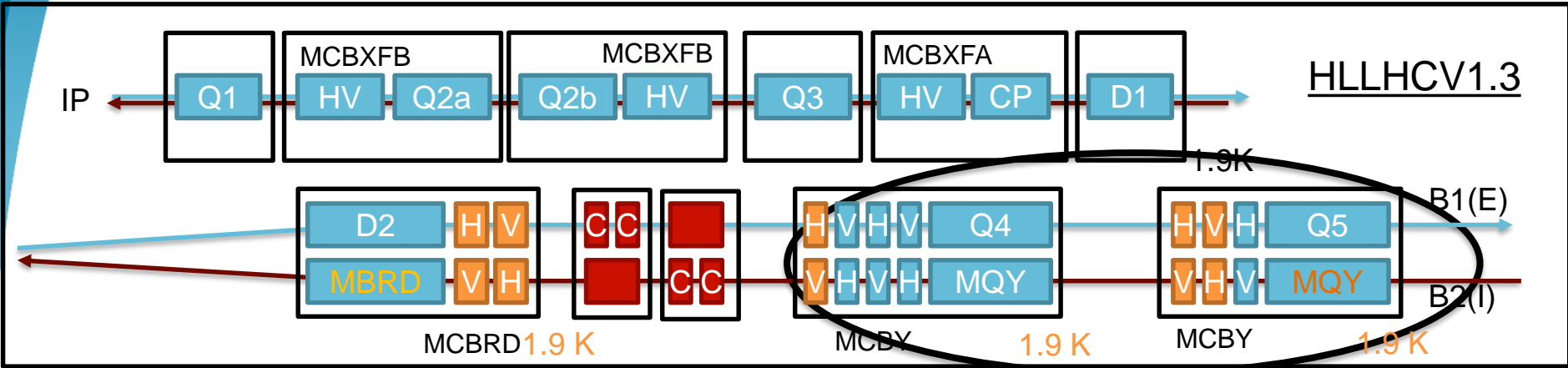


HL-LHCV1.4 (BI)

R. De Maria

WP13 meeting 3/9/2018

Layout changes



- Changes with respect to the baseline:
- Q4: reusing existing cold mass (3 correctors instead of 4), no need of 1.9 K.
 - Q5: reusing existing Q5 cold mass (1 corrector instead of 3), no need of 1.9 K.
 - Full deployment of remote alignment system to be used with safe beam.

Changes HLLHC1.3 → 1.4

Layout (IR1/5 when not specified):

- 2+2 crab cavities → 2 crab cavities only
- Q4: 4xMCBY+MQY 1.9K → 3xMCBY+MQY 4.5 K
- Q5: 3xMCBY+MQY 1.9K → 1xMCBC+MQML 4.5
- Q4, Q5 displaced towards the arc from 10.047 m, 11 m w.r.t LHC to 10.5 m w.r.t LHC
- Remote alignment system (i.e. machine can be realigned during beam commissioning)
- Extended D1 beam-screen
- New specification for TCTPV-TCTPH-TCLX stroke and apertures
- Changes length/position of correctors in CP
- IR7: MBH+TCLD, MQW (not the absorber)
- IR2: TCLD, TDIS
- IR8: TANB

Missing:

- Final positions of correctors in CP
- Comparison with mechanical drawings
- Agreement on design/nominal magnetic length on drawings
- ~~Possible displacement BPM from IP side D2 to arc side~~
- Small change MCBRD positions

Changes HLLHC1.3 → 1.4

Optics:

- Crossing bumps re-optimized thanks to remote alignment system
- Dedicated optics for 7 TeV (using 7.5 TeV equivalent currents where needed)
- IR4 optimized for instrumentation and e-lens
- IR6 reviewed and re-optimized for TCDQ gaps, Q5 strengths
- IR8 $\beta^*=1.5$ m
- New aperture estimates thanks to remote alignment system
- Decision on crossing plane for Point 1/5
- Squeeze sequence with/without ATS in the ramp
- Update MS10 branch and follow-up of the DA studies.
- Optics optimization for forward physics.

Repository:

- Move LS2 changes from HL-LHC to RunIII repository
- Error tables, macros and script (e.g.. CP update)

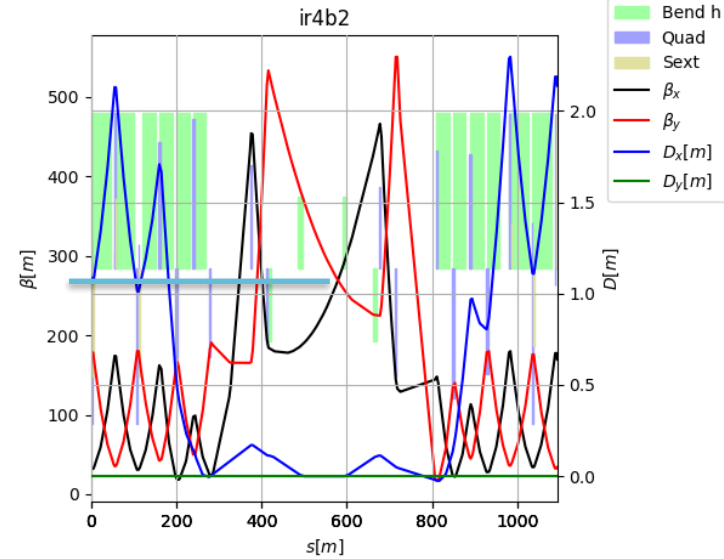
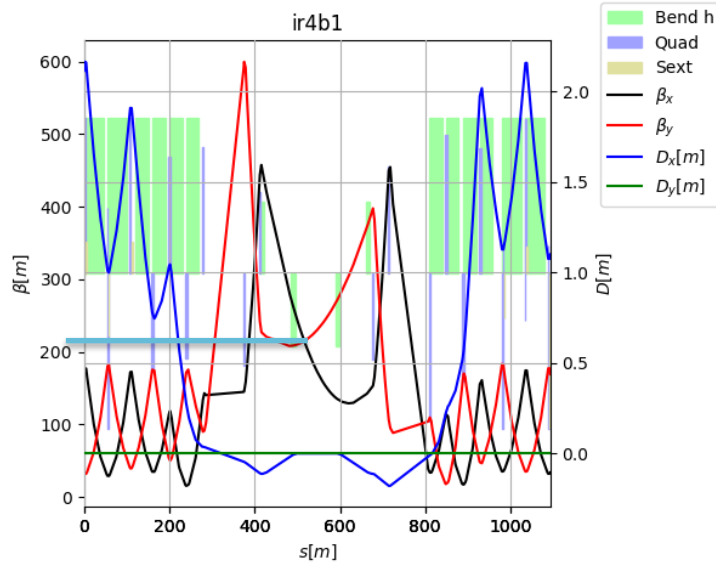
IR4 optics actions from BI

Follow-up from [115th WP2 meeting](#):

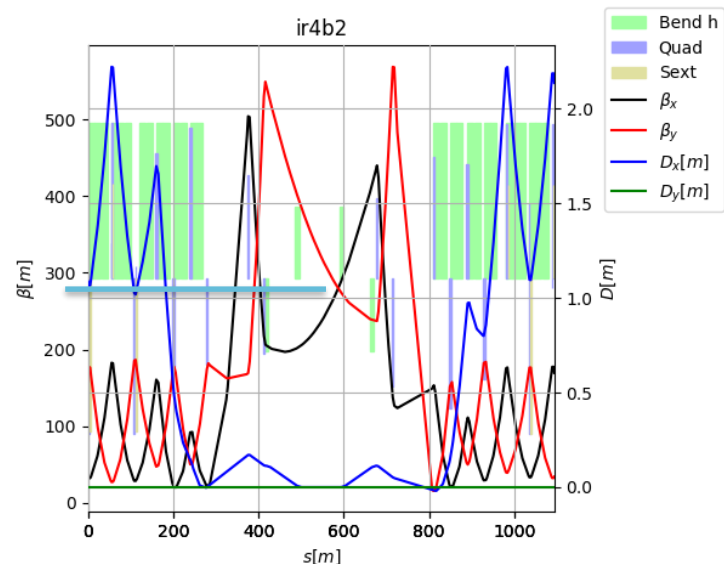
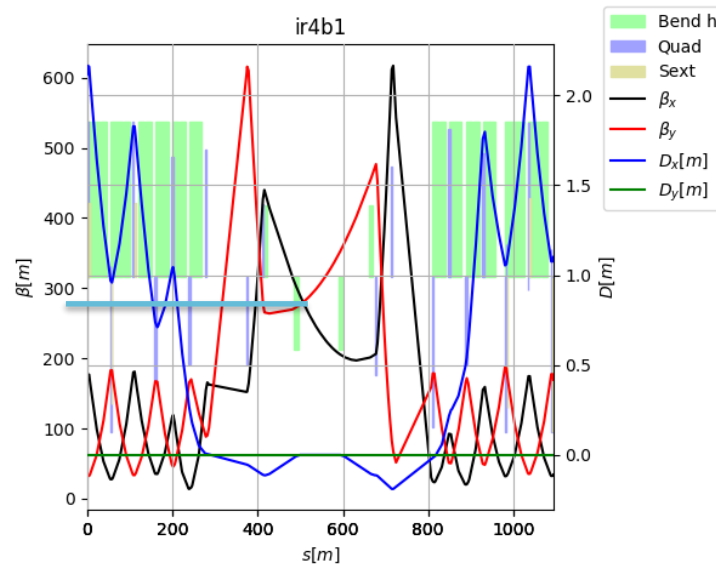
- Use improved injection optics without optics change during the ramp (for the time being)
- Increase the minimum beta at the BSRT above 200 m while keeping the beta at HEL bigger than 250 m.
- Reduce β -ratio between for Shottky monitors
- Study reducing the aperture of the HEL (below 50 mm)
- Optics parameters should be estimated at the location of BGV and new BSRT using the light from D4
- Implications of the issue with imbalance of currents on Q8.L4.B1
- Review BQK
- Provide dispersion correction in IR4 (on-going)

IR4 Injection Optics: 1.3 -> 1.4

HL1.3

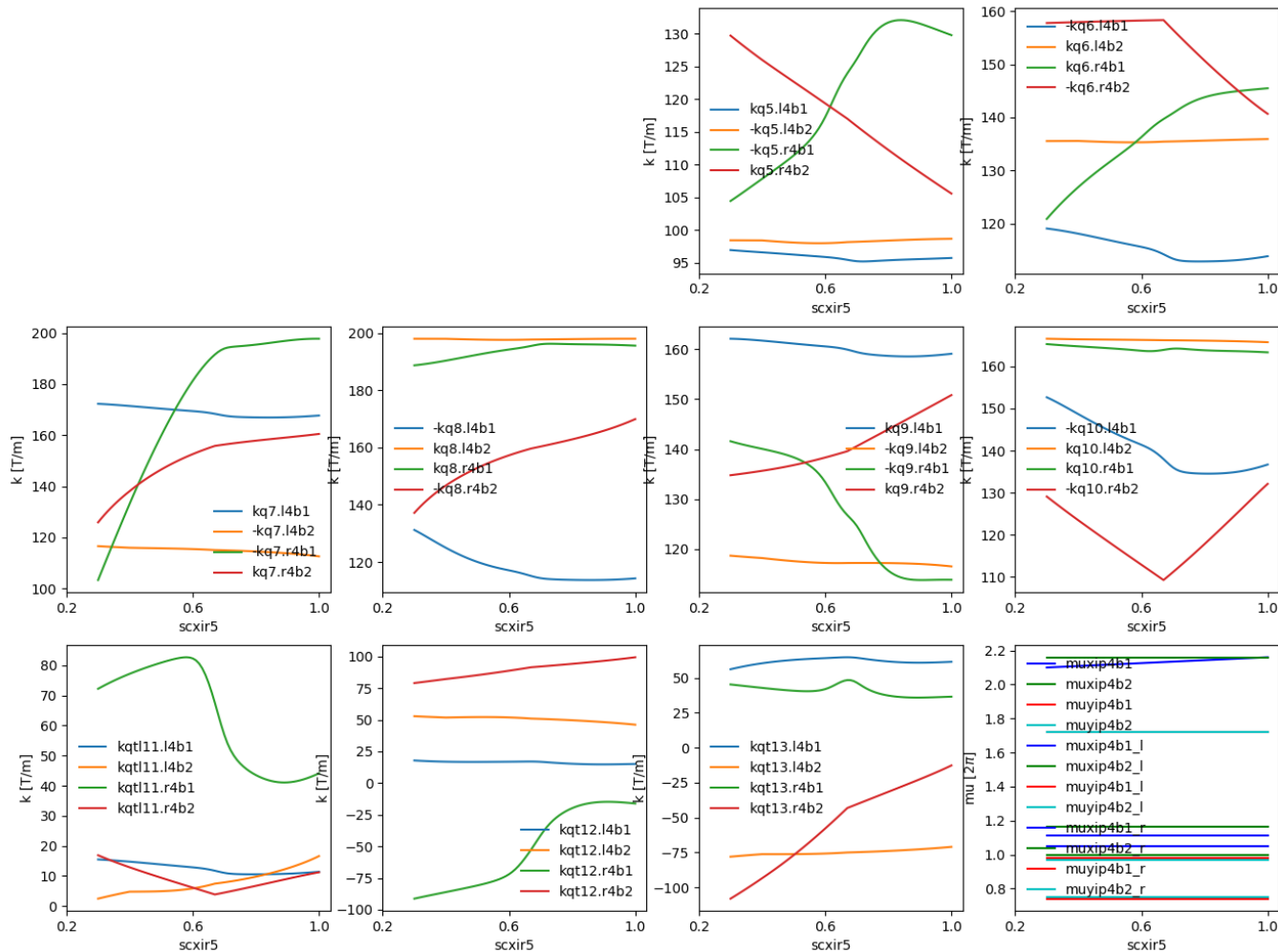


HL1.4



Increased beta and rounded in B1, more round in B2. No optics transitions to enhance β further.

Round optics transition



ATS scaling factor 1 \rightarrow 0.3 to squeeze Point 5:

- β^* : 50 cm \rightarrow 15 cm during levelling
- β^* : 2 m \rightarrow 60 cm during ramp&squeeze

Instrumentation Markers

Label	Beam 1	At [m]	Beam 2	At [m]
e-lens	ELENS.5L4.B1	-40.000	ELENS.5R4.B2	40.000
BSRTD3	MU.A5R4.B1	45.701	MU.A5L4.B2	-45.561
BSRTD4	BSRTD4.5L4.B1	-117.114	BSRTD4.5R4.B2	117.114
BGI	BGIH.5L4.B1	-64.186	BGIH.5R4.B2	64.186
WS	BWS.5R4.B1	84.876	BWS.5L4.B2	-84.876
BQSH	BQSH.7R4.B1	174.902	BQSH.5R4.B2	114.409
BQSV	BQSV.5R4.B1	116.109	BQSV.7R4.B2	176.702
BPLH1	BPLH.A6R4.B1	163.088	BPLH.6R4.B2	136.952
BPLH2	BPLH.7R4.B1	177.952	BPLH.A7L4.B2	-173.952
BPLV	BPLV.B6R4.B1	138.552	BPLV.B5L4.B2	-116.559
BQLV2	-	-	BPLV.7R4.B2	178.752
BPLX	BPLX.H6R4.B1	149.662	BPLX.D6R4.B2	148.872
BGV	BGV.7R4.B1	200.000	BGV.7L4.B2	-200.000
MKQ	MKQA.6L4.B1	-150.137	MKQA.6L4.B2	-152.337

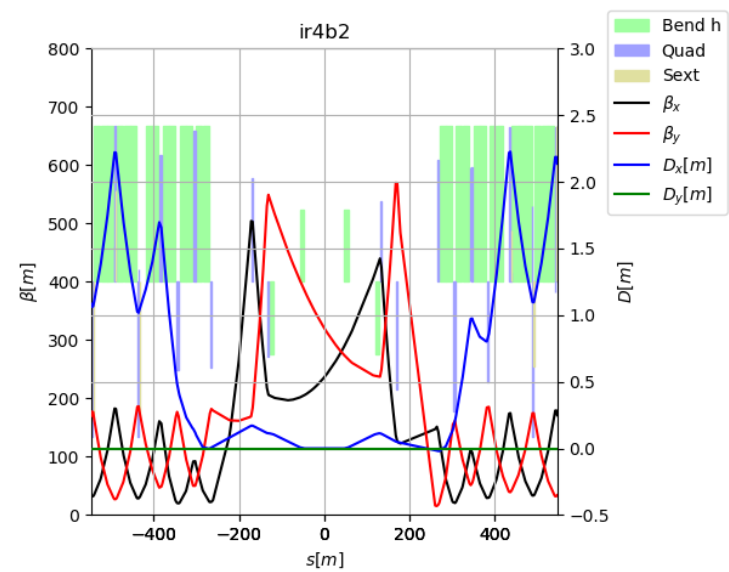
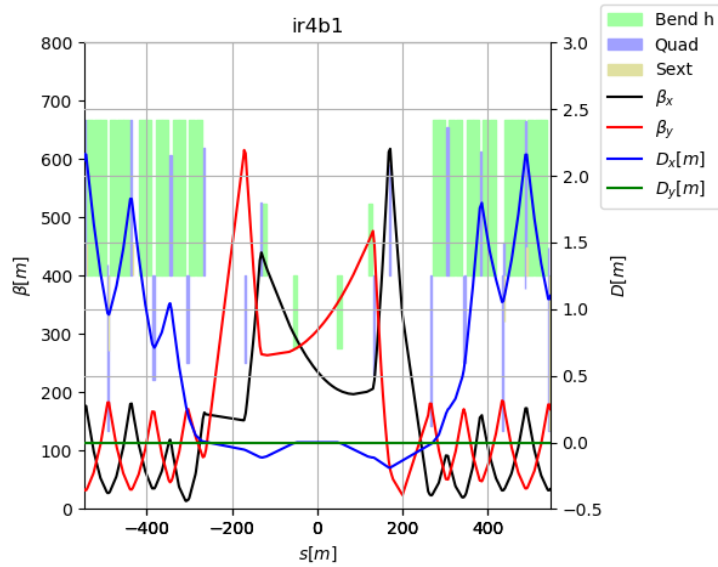
New IR4: Values

β_{xB1}/β_{yB1} β_{xB2}/β_{yB2} [m]	Pos.	HLLHC 1.4 Injection	LHC 1.4 Round 15cm
e-lens	D3	280/280/280/280	280/280/280/280
BSRTD3	D3	206/351/206/384	206/351/206/384
BSRTD4	D4	410/264/410/239	410/264/410/239
BGI	D3-4	314/270/314/262	314/270/314/262
WS	D3-4	197/402/197/453	197/402/197/453
BQSH	Q5-7	577/ 58/405/240	504/119/405/240
BQSV	Q5-7	201/451/123/507	201/451/ 61/584
BPLH1	Q5-7	544/117/396/270	472/173/384/278
BPLH2	Q5-7	544/ 51/479/168	482/114/479/169
BPLV	Q5-7	260/389/201/517	250/408/201/517
BQLV2	Q5-7	/ /123/484	/ / 58/555
BPLX	Q5-7	375/245/279/372	341/288/242/407
BGV	Q5-7	332/ 24/266/162	339/ 87/267/163
MKQ	Q5-7	286/418/356/320	284/421/355/321

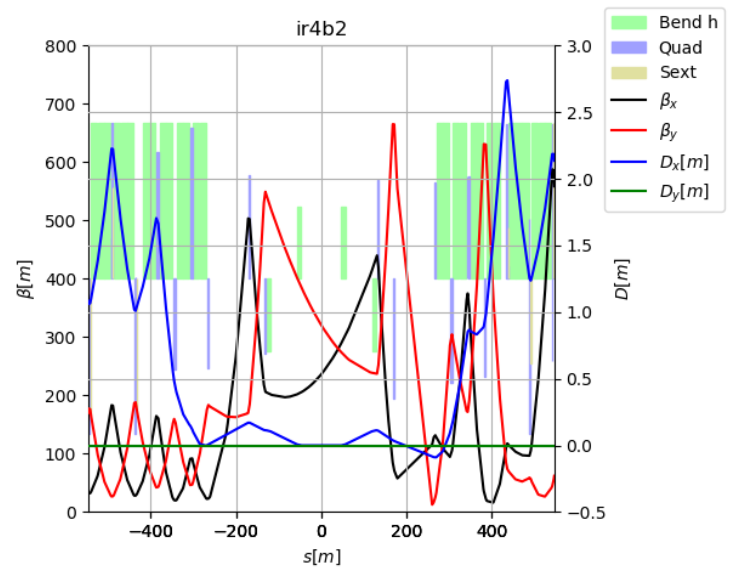
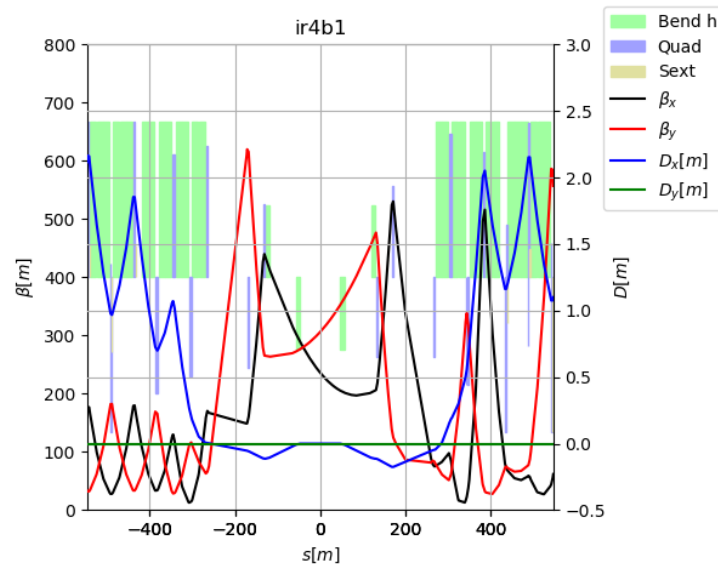
Flat 30/7.5 cm and 18/7.5 cm optics are also possible.

IR4 HLLHCV1.4: Injection to squeeze optics

Injection



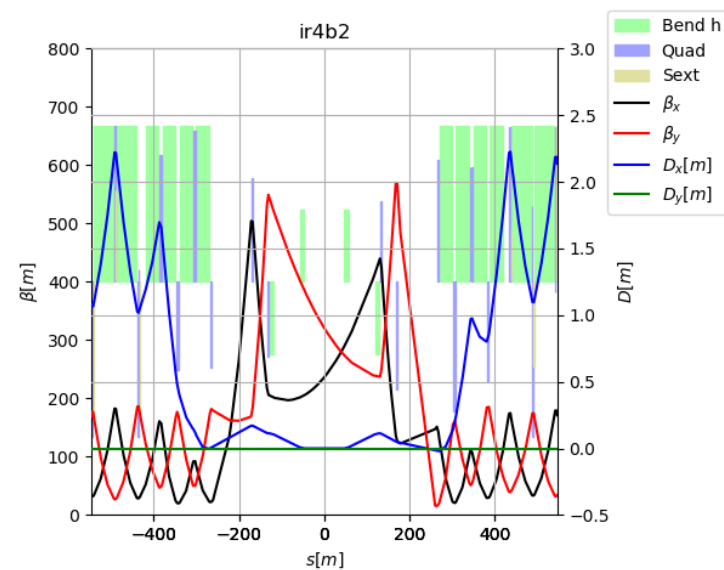
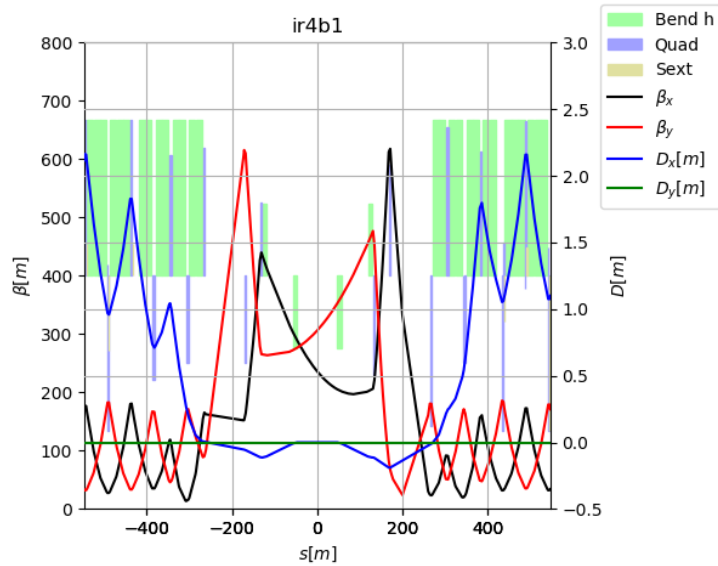
Squeezed round



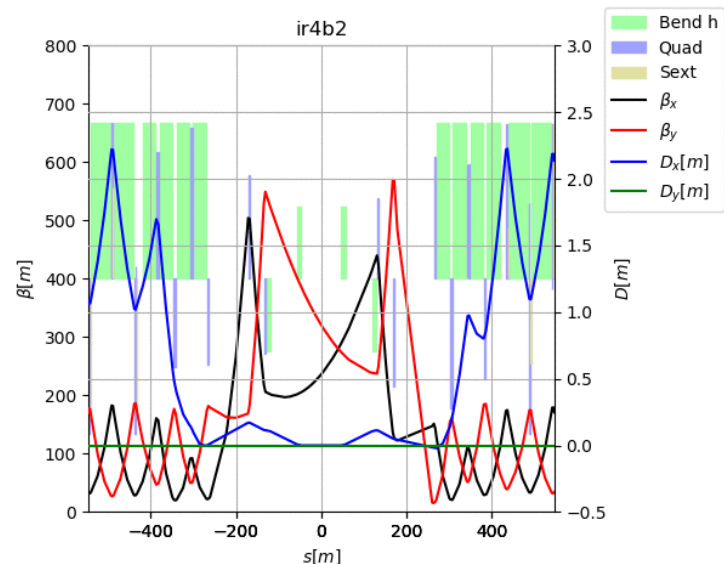
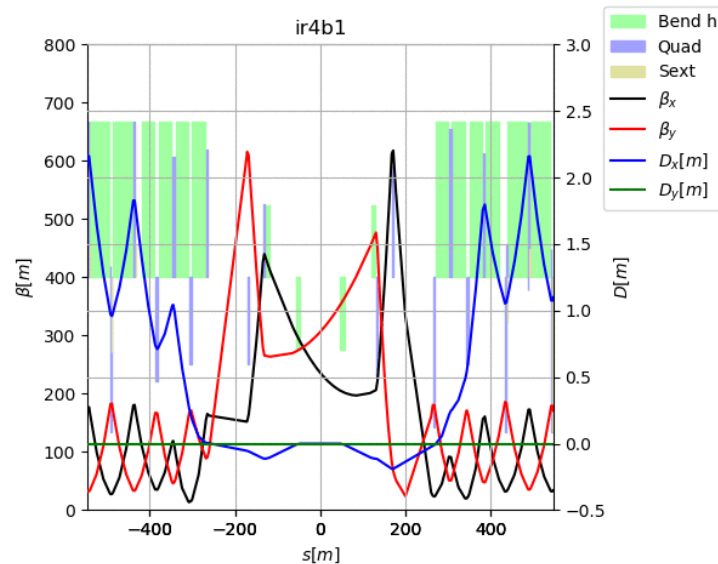
Constant optics from Q5 to Q5. Right part important optics changes due to ATS

IR4 HLLHCV1.4: Injection to squeeze optics

Injection

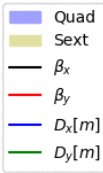
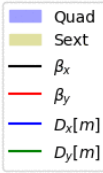
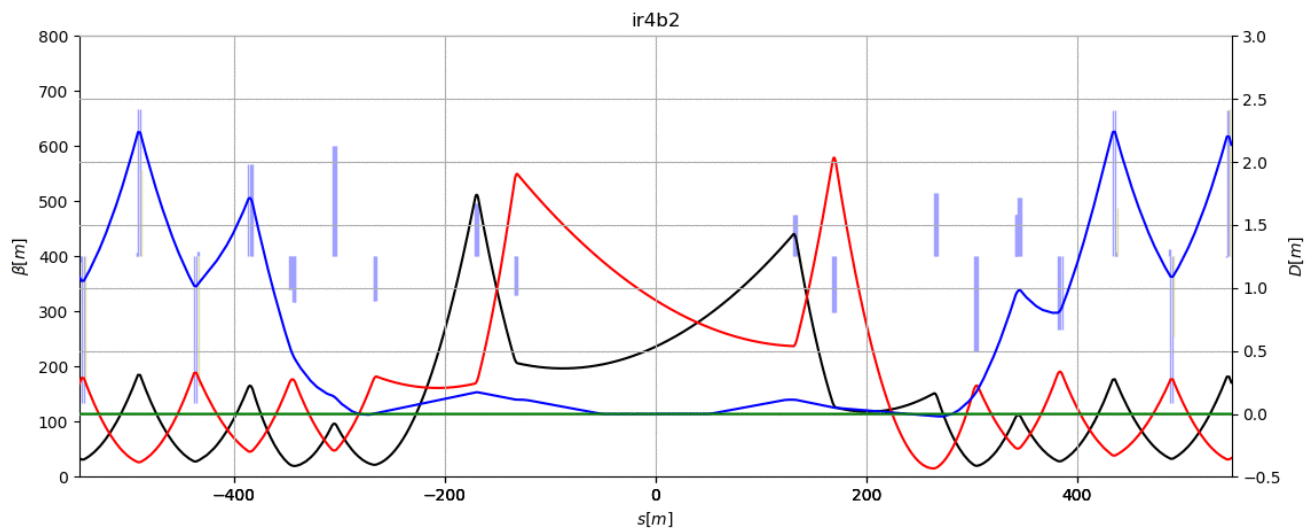
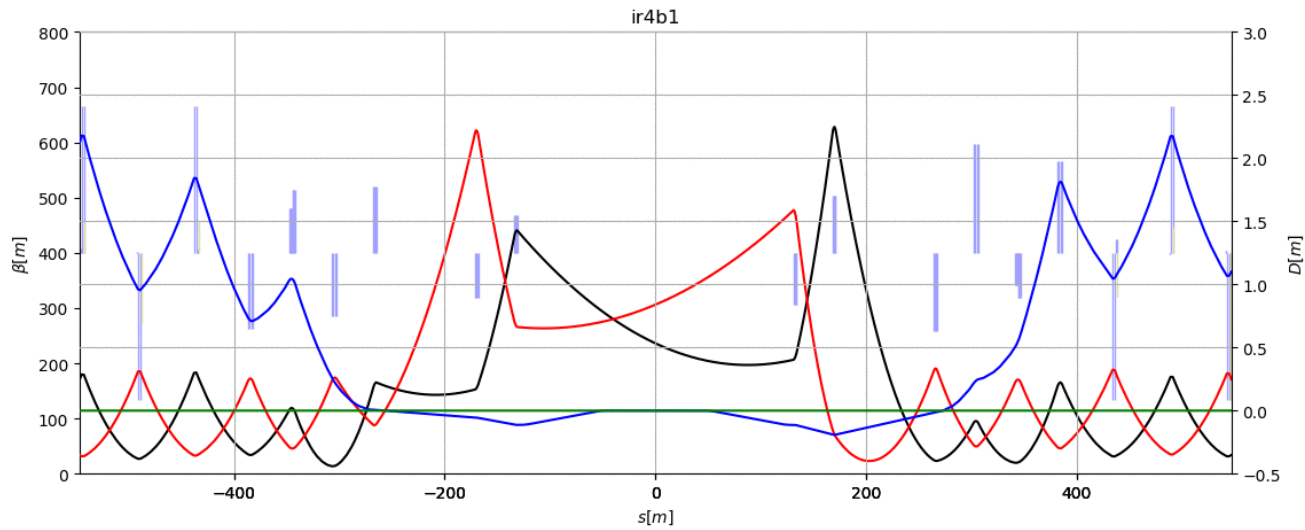


Squeezed round

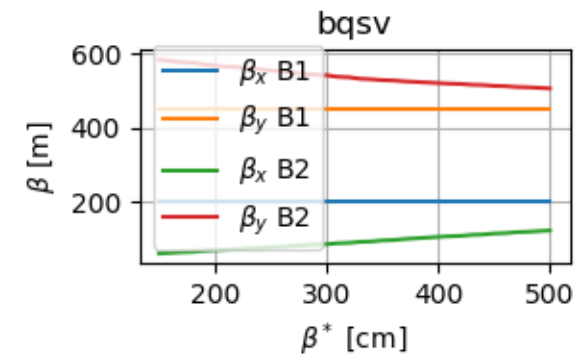
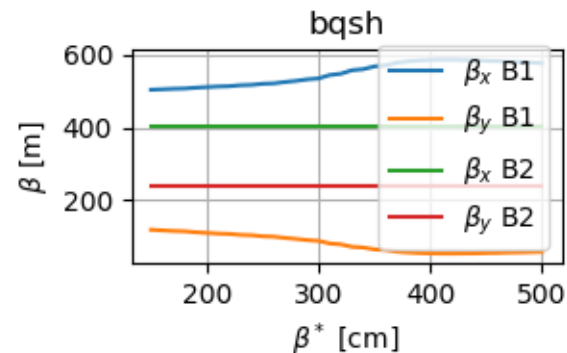
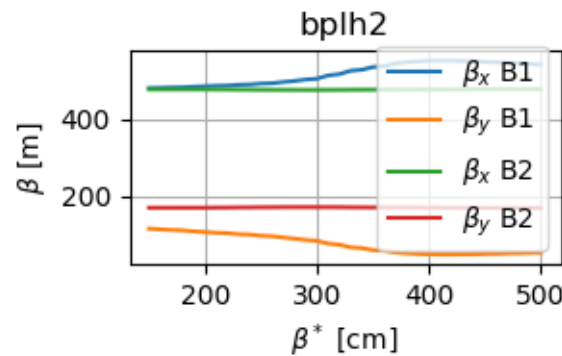
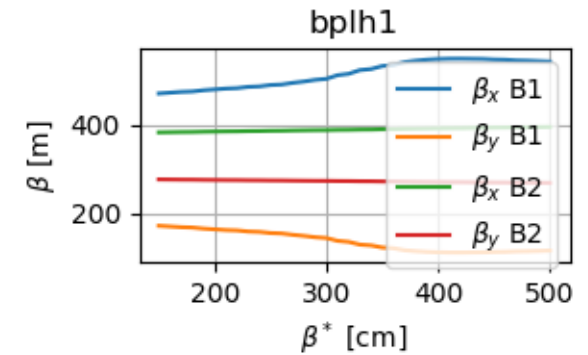
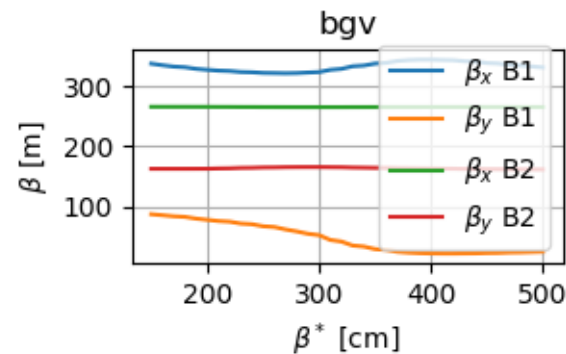
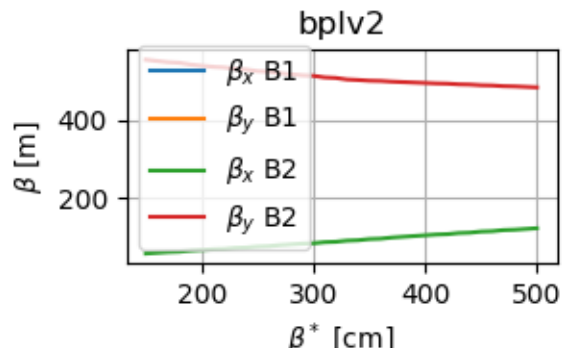
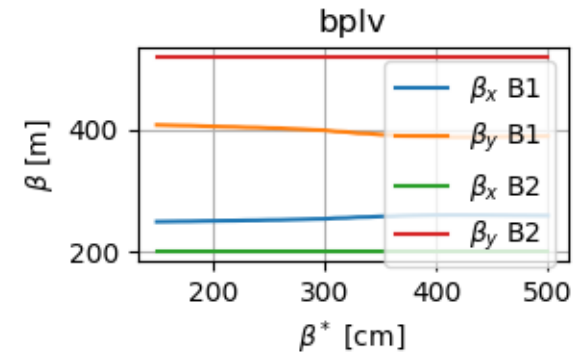
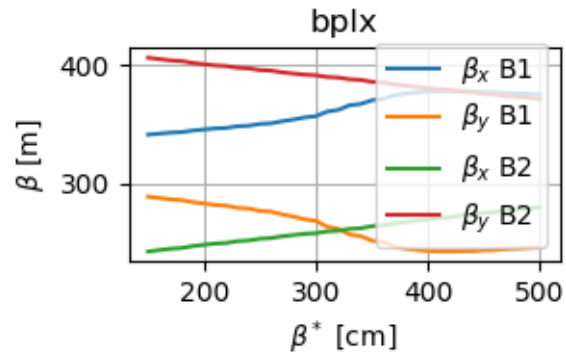
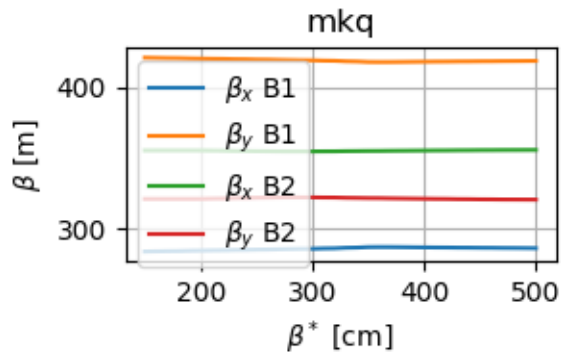


Optics transitions can occur during the squeeze at flat top or during the ramp&squeeze depending on the operational scenario.

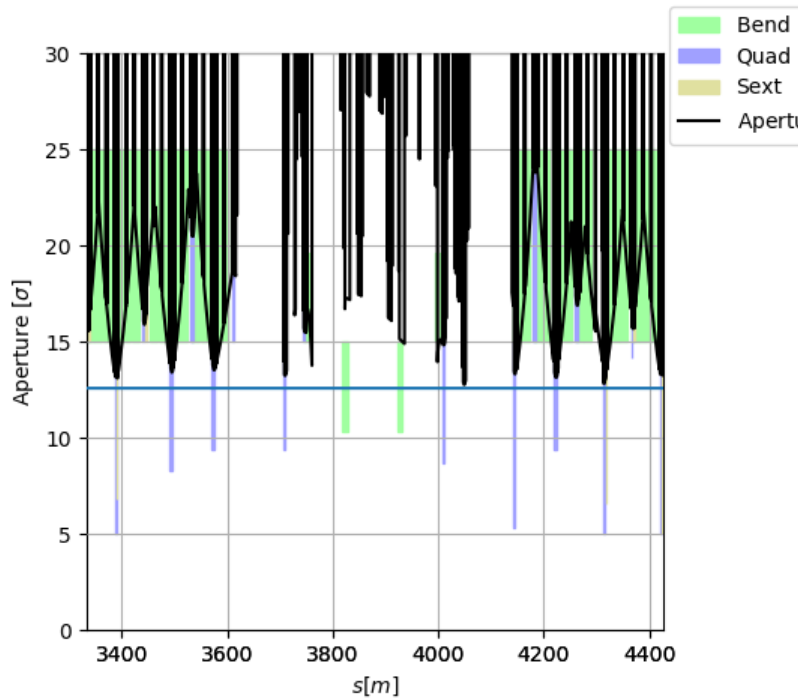
IR4 HLLHC V1.4: Injection to squeeze optics



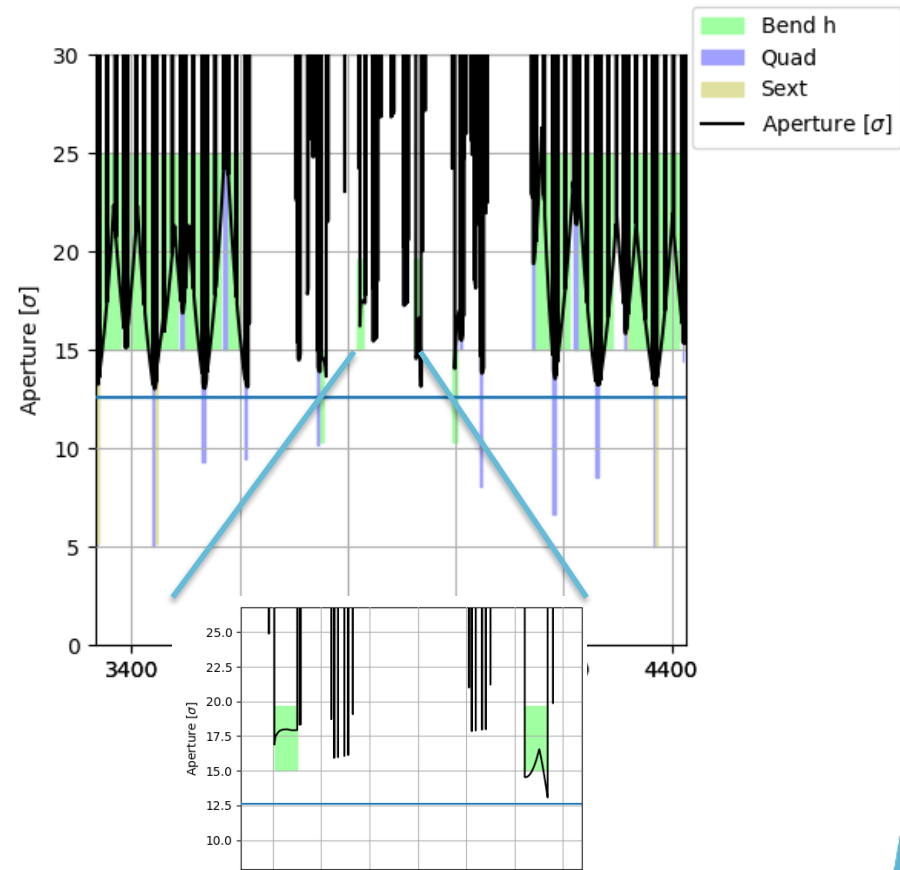
Transitions



New IR4 Injection Optics



Aperture at injection above the target of 12.6σ using HL-LHC aperture tolerances.



Aperture margin for e-lens available, to be evaluate with detailed drawings

Conclusion

- IR4 optics has been updated with larger beta
- A detailed optics transition shows stable and unstable optics locations.
- Iteration needed to find optimal location of each instrument.
- Next step:
 - Review IP1/5 instrumentation phase advances