HI-LUMI OPTICS: CHECKS AT LBDS PROTECTION DEVICES

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OVERVIEW

- Compared optics functions and beam sizes at the TCDQ and TCDS front faces for the different Hi-Lumi optics version found on afs:

  /afs/cern.ch/eng/lhc/optics/HLLHCV1.0/squeeze

- This time we included the squeeze and separated out horizontal and vertical beta functions previously presented as $\sqrt{\beta_x \beta_y}$.

- Our previous analysis was of the files named “collision” here:

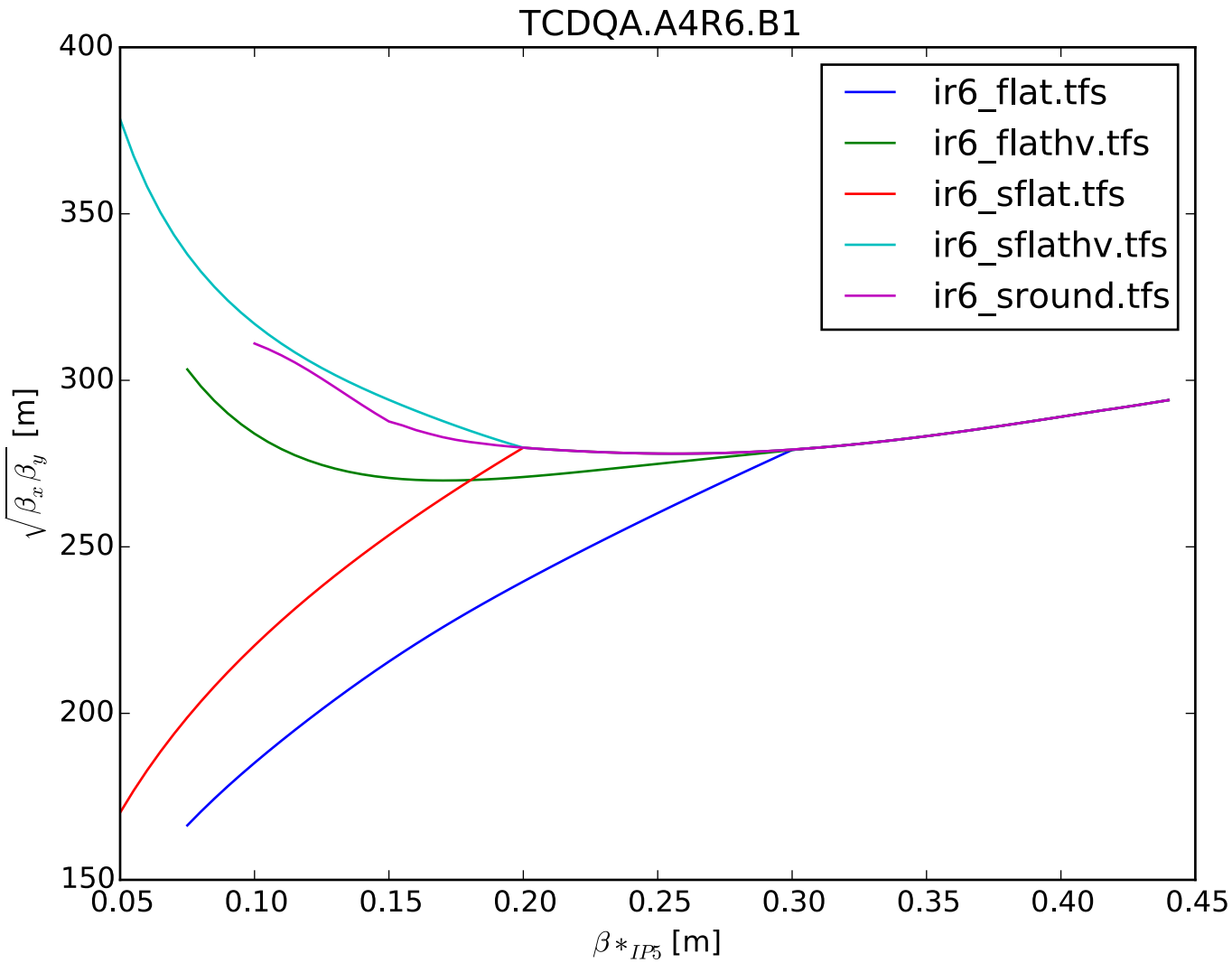
  http://lhc-optics.web.cern.ch/lhc-optics/www/hllhc10/index.html

(if I am not mistaken, these files correspond to somewhere on the squeeze and not necessarily at the end of the squeeze as we had assumed).

BEAM 1

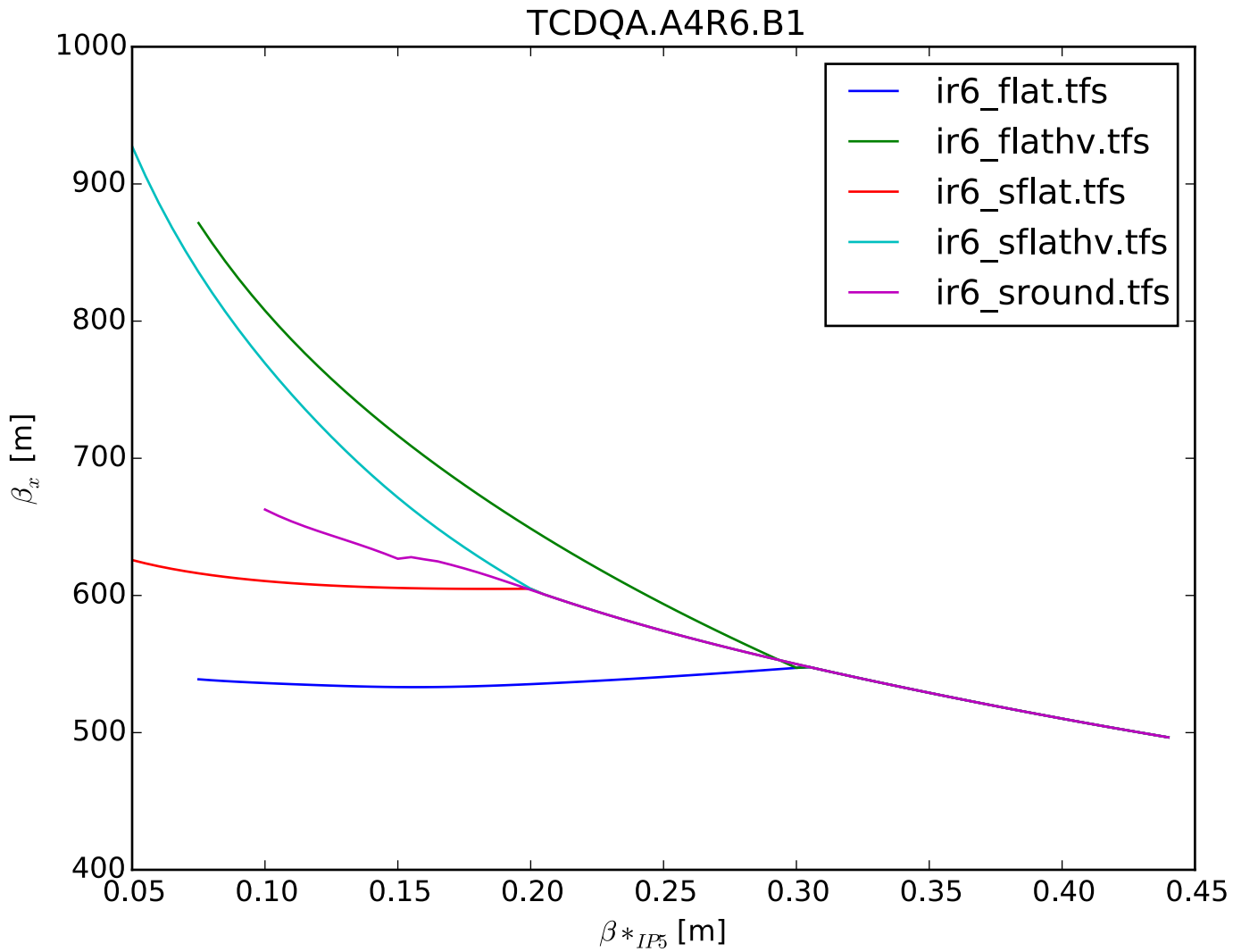
TCDQA.A4R6.B1: $\sqrt{\beta_x \beta_y}$

- Compares nicely to Riccardo's HL-LHC optics presentation.



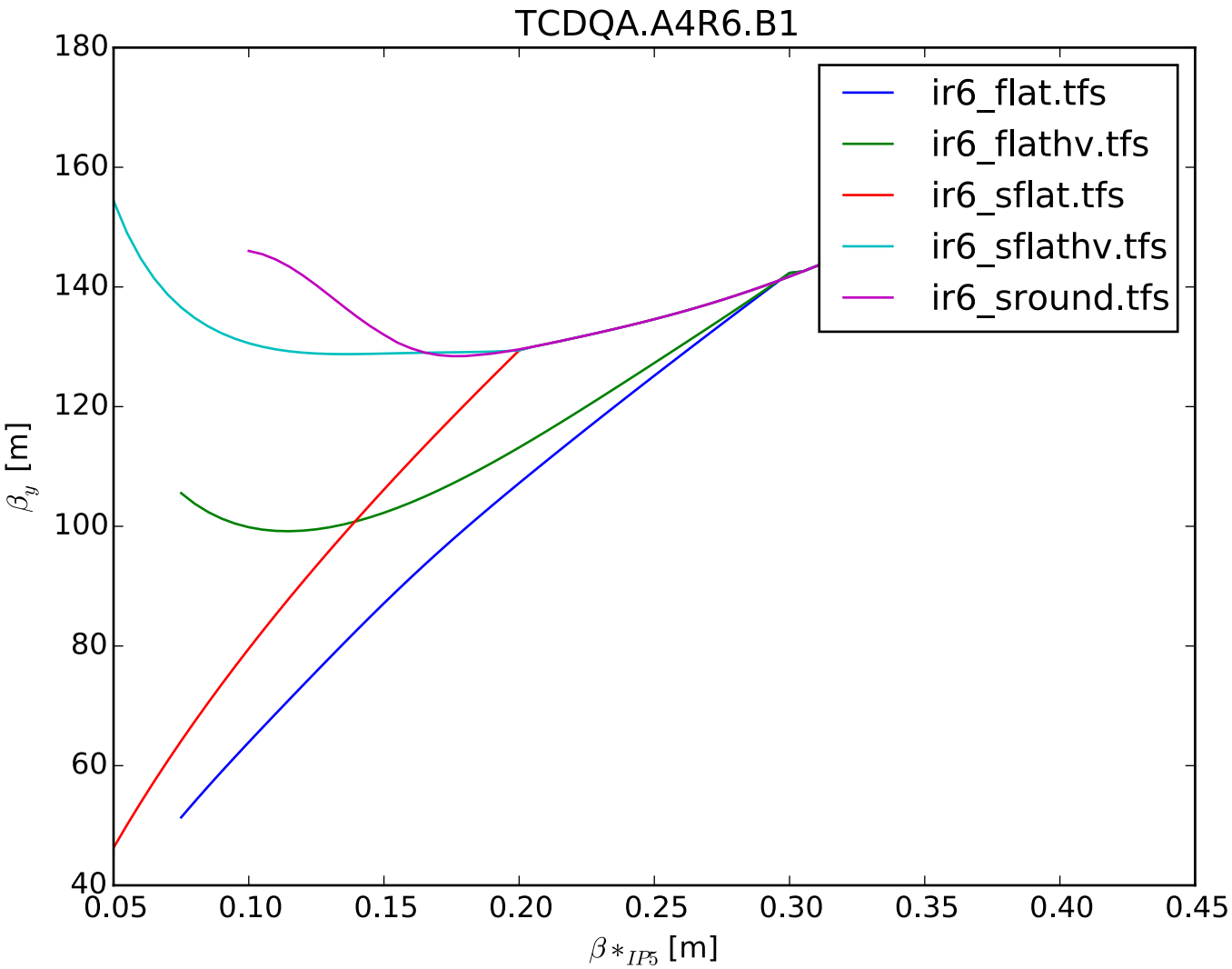
TCDQA.A4R6.B1: β_x

- Minimum β_x constant for all optics at 500 m before squeeze.



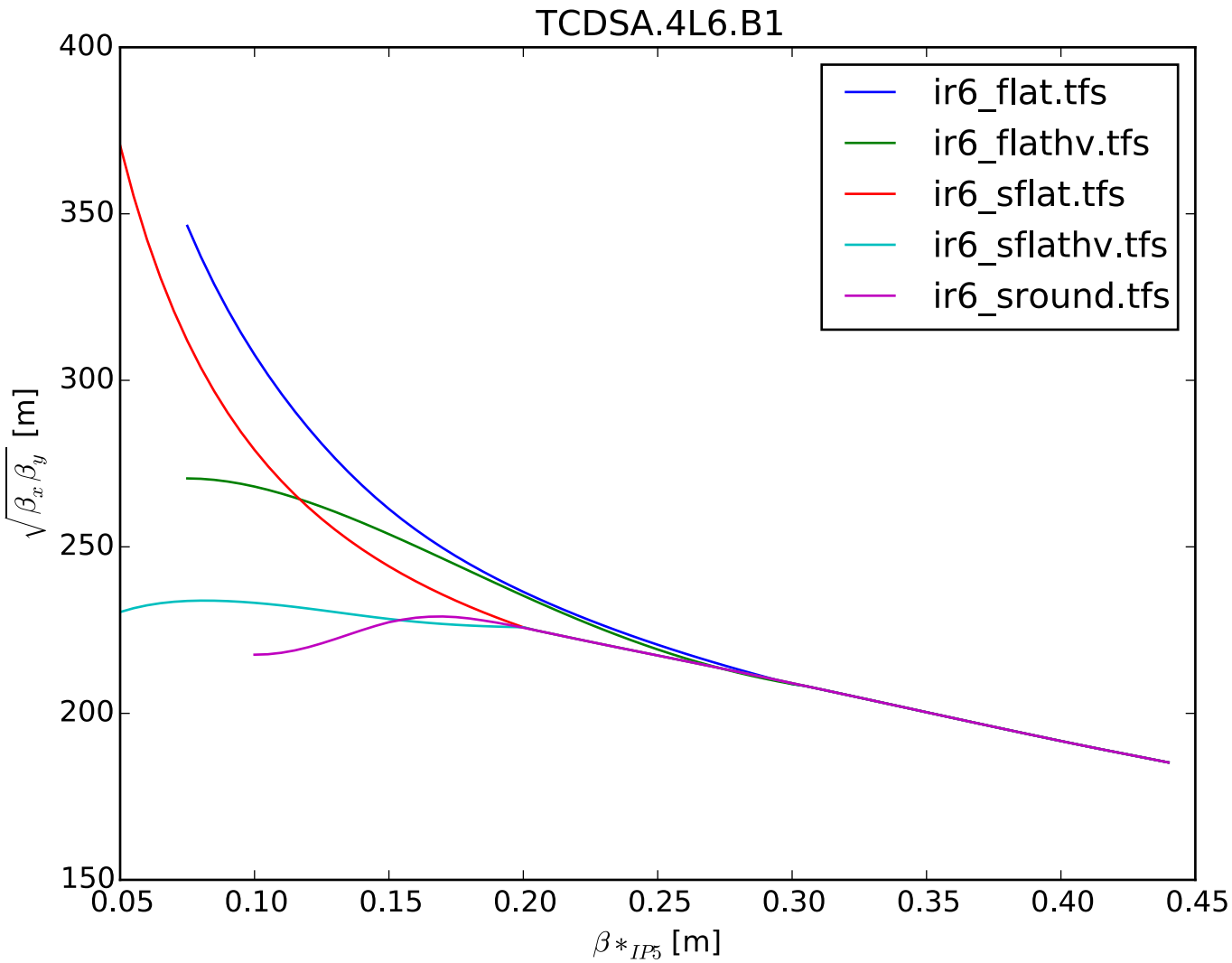
TCDQA.A4R6.B1: β_y

- Minimum β_y worryingly small at 50 m after squeeze for *sflat* and *flat* optics.



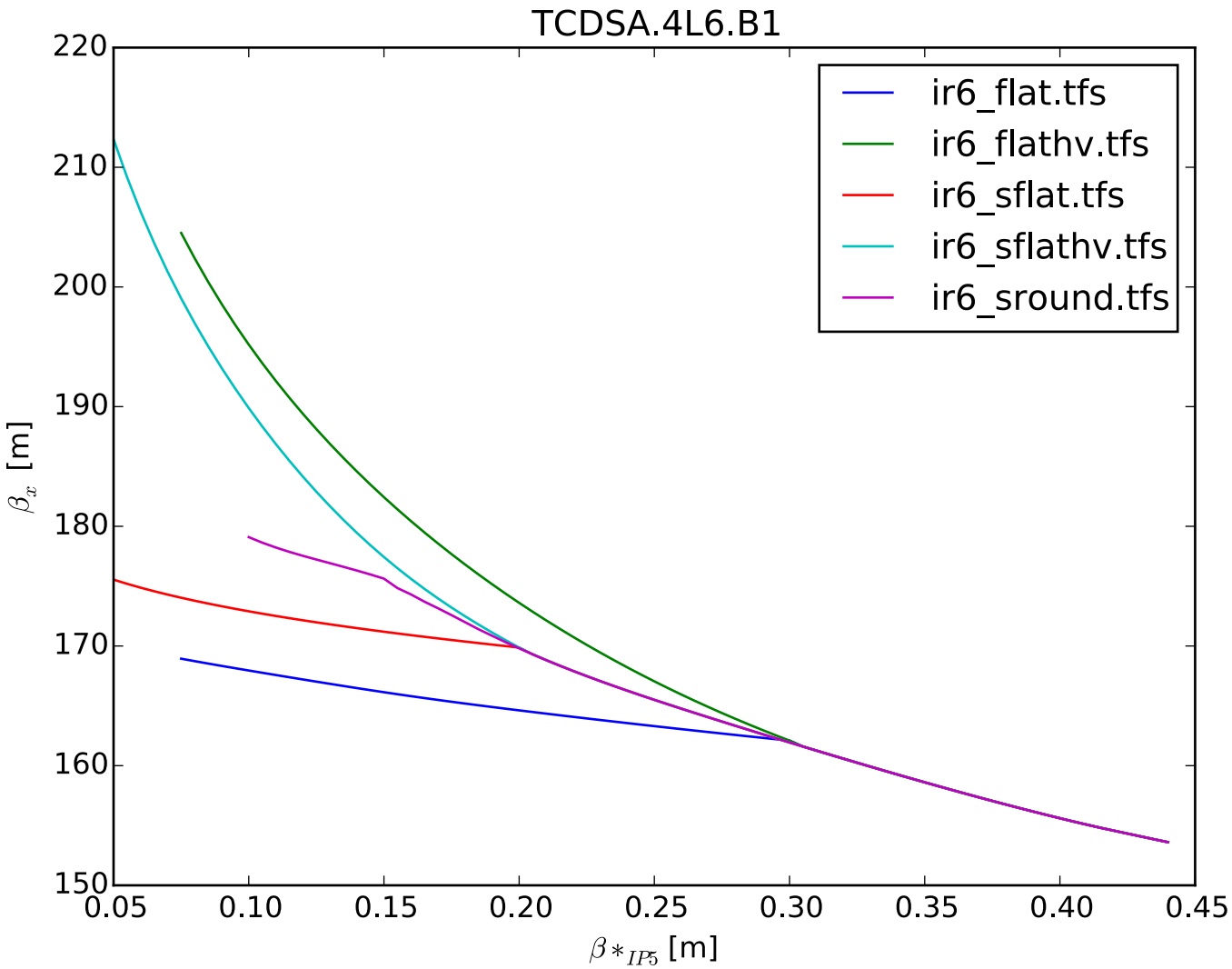
TCDSA.4L6.B1: $\sqrt{\beta_x \beta_y}$

- Compares nicely to Riccardo's HL-LHC optics presentation.



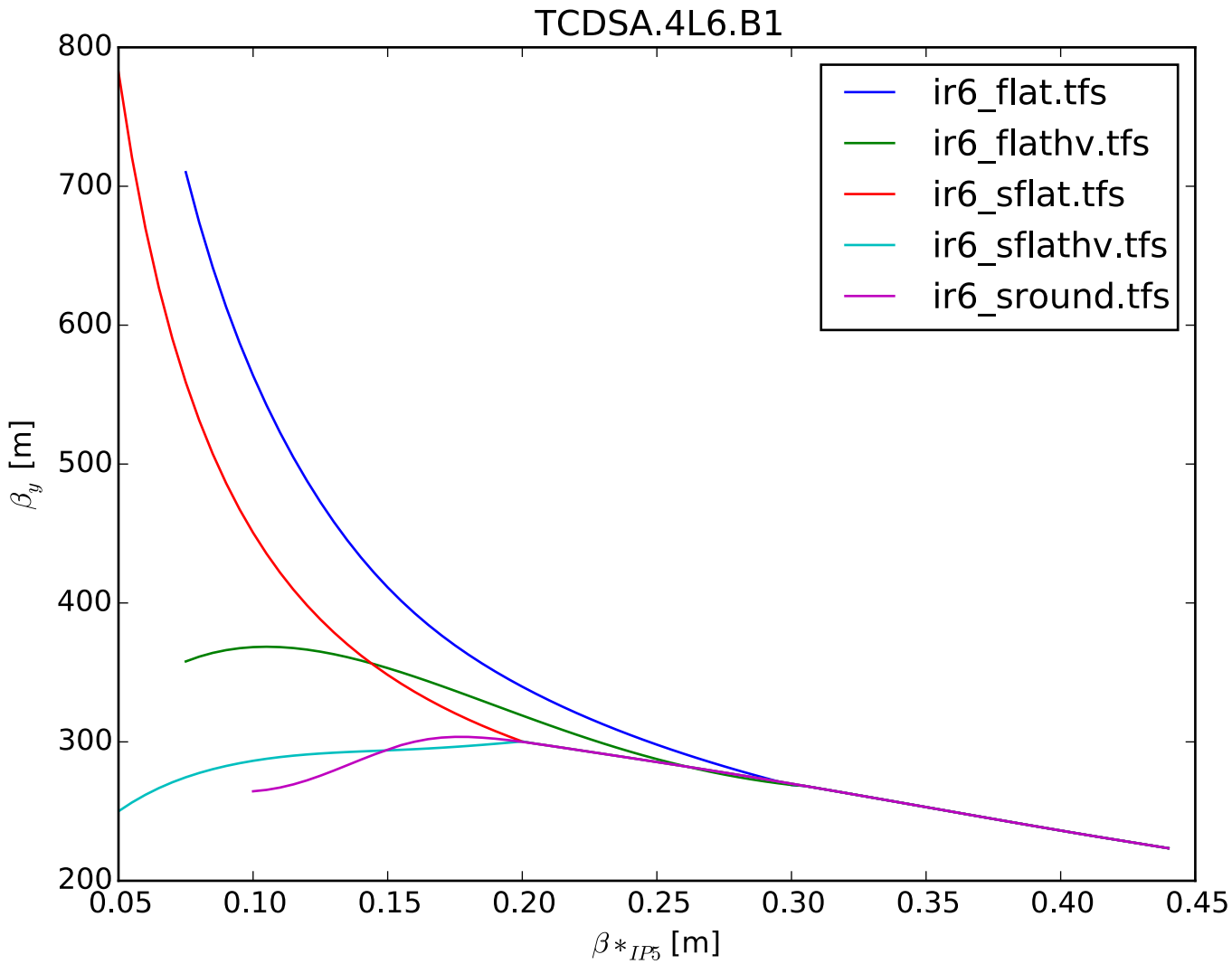
TCDSA.4L6.B1: β_x

- Minimum β_x constant for all optics at 150 m before squeeze.



TCDQA.A4R6.B1: β_y

- Minimum β_y constant for all optics at 220 m before squeeze.



BEAM 1: TCDQ SUMMARY

Optics Version	Configuration (including squeeze)	Energy [TeV]	Relativistic Gamma	Norm. RMS Emittance [m]	TCDQA.A4L6.B2			
					minimum betx [m]	sigx [mm]	minimum bety [m]	sigy [mm]
Run 2	Collision	7	7460.523175	2.60E-06	4.88E+02	0.41	1.62E+02	0.24
HL	Flat	7	7460.523175	2.60E-06	499.5	0.42	107.5	0.19
HL	Flat HV	7	7460.523175	2.60E-06	499.5	0.42	138.1	0.22
HL	sRound	7	7460.523175	2.60E-06	499.5	0.42	165.4	0.24
HL	sFlat	7	7460.523175	2.60E-06	499.5	0.42	119.4	0.20
HL	sFlat HV	7	7460.523175	2.60E-06	499.5	0.42	131.1	0.21

BEAM 1: TCDS SUMMARY

Optics Version	Configuration (including squeeze)	Energy [TeV]	Relativistic Gamma	Norm. RMS Emittance [m]	TCDSA.4L6.B1			
					minimum betx [m]	sigx [mm]	minimum bety [m]	sigy [mm]
Run 2*	Collision	7	7460.523175	2.60E-06	1.55E+02	0.23	2.31E+02	0.28
HL	Flat	7	7460.523175	2.60E-06	153.6	0.23	223.4	0.28
HL	Flat HV	7	7460.523175	2.60E-06	153.6	0.23	223.4	0.28
HL	sRound	7	7460.523175	2.60E-06	153.6	0.23	223.4	0.28
HL	sFlat	7	7460.523175	2.60E-06	153.6	0.23	223.4	0.28
HL	sFlat HV	7	7460.523175	2.60E-06	153.6	0.23	223.4	0.28

*We didn't check before or during the squeeze for Run 2.

BEAM 1: TCDQ SUMMARY

Factor 2 reduction in vertical beam size at TCDQ for Beam 1 for certain optics!!!

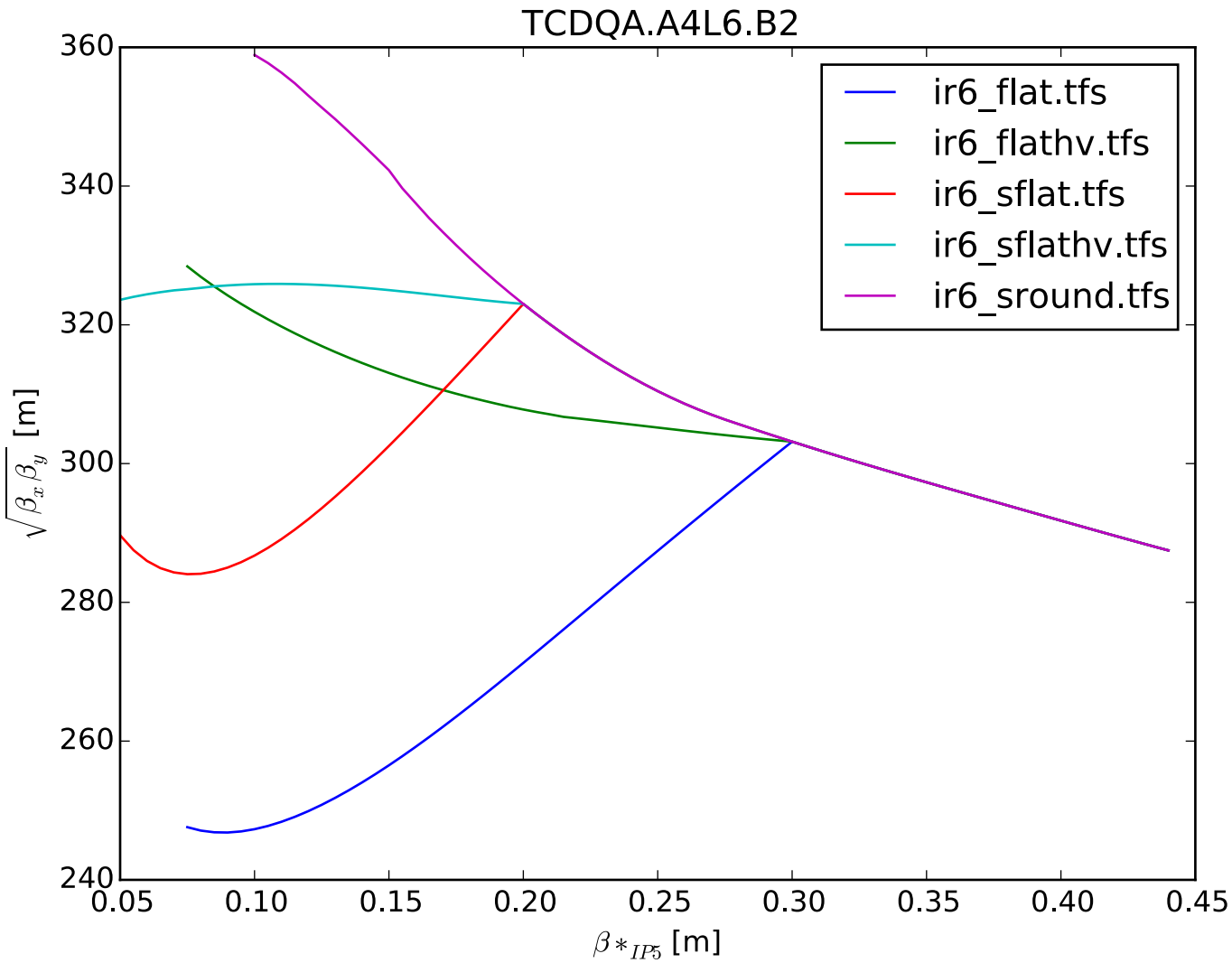
Optics Version	Configuration (including squeeze)	Energy [TeV]	Relativistic Gamma	Norm. RMS Emittance [m]	TCDQA.A4R6.B1			
					minimum betx [m]	sigx [mm]	minimum bety [m]	sigy [m]
Run 2*	Collision	7	7460.523175	2.60E-06	4.84E+02	0.41	1.61E+02	0.24
HL	Flat	7	7460.523175	2.60E-06	496.55	0.42	51.4	**0.13**
HL	Flat HV	7	7460.523175	2.60E-06	496.55	0.42	99.2	0.19
HL	sRound	7	7460.523175	2.60E-06	496.55	0.42	128.4	0.21
HL	sFlat	7	7460.523175	2.60E-06	496.55	0.42	46.3	**0.13**
HL	sFlat HV	7	7460.523175	2.60E-06	496.55	0.42	128.8	0.21

*We didn't check before or during the squeeze for Run 2.

BEAM 2

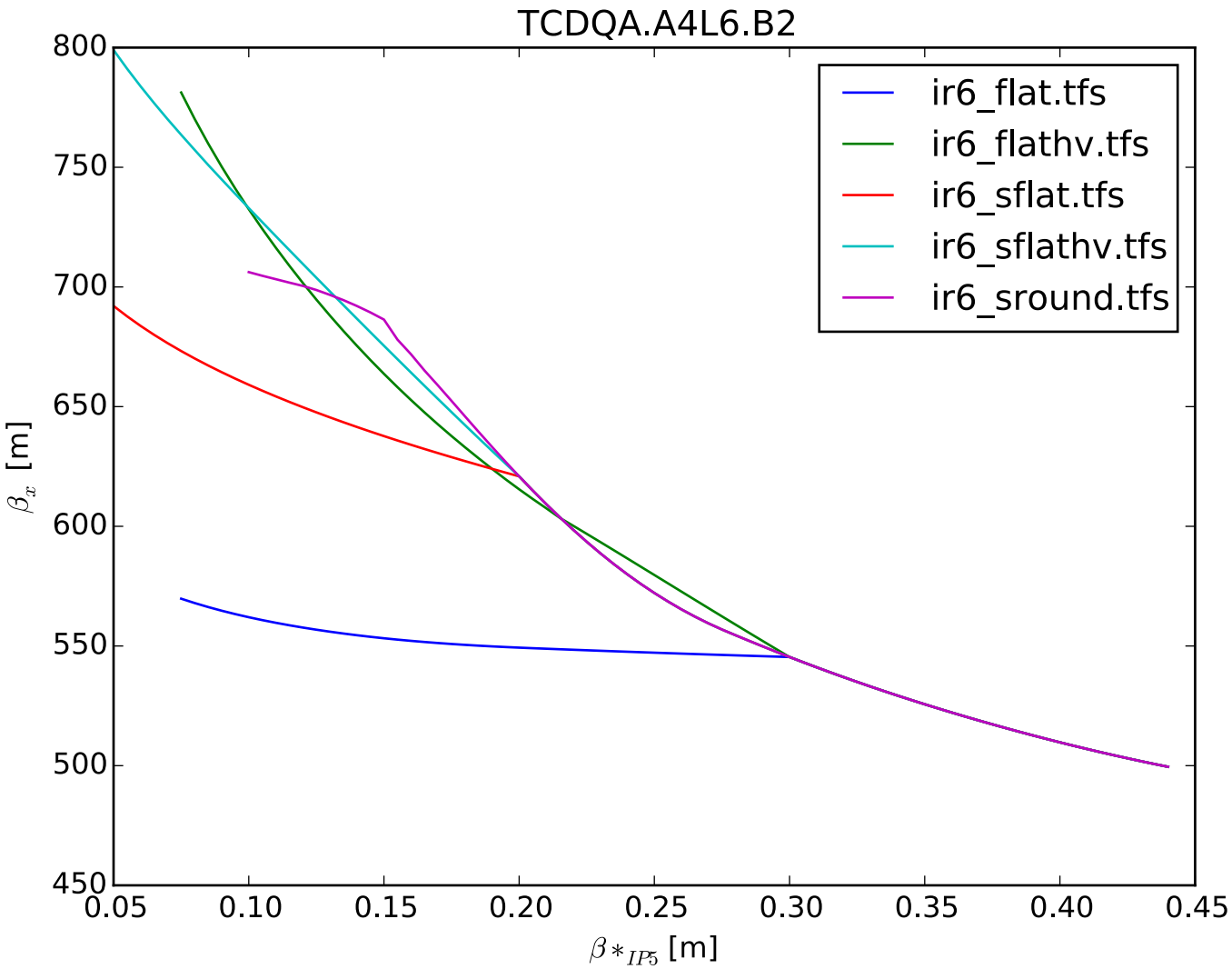
TCDQA.A4L6.B2: $\sqrt{\beta_x \beta_y}$

- Compares nicely to Riccardo's HL-LHC optics presentation.



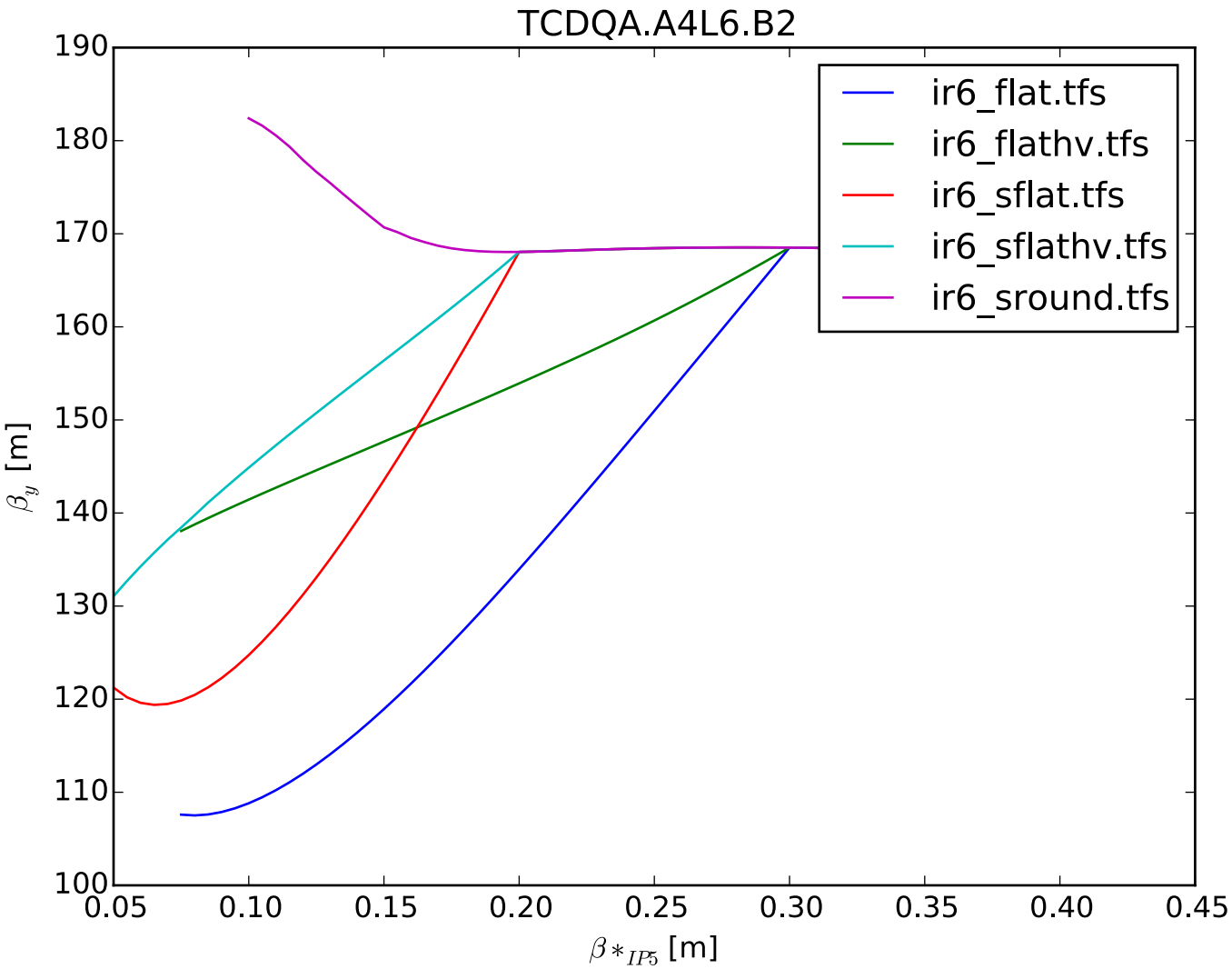
TCDQA.A4L6.B2: β_x

- Minimum β_x constant for all optics at 500 m before squeeze.



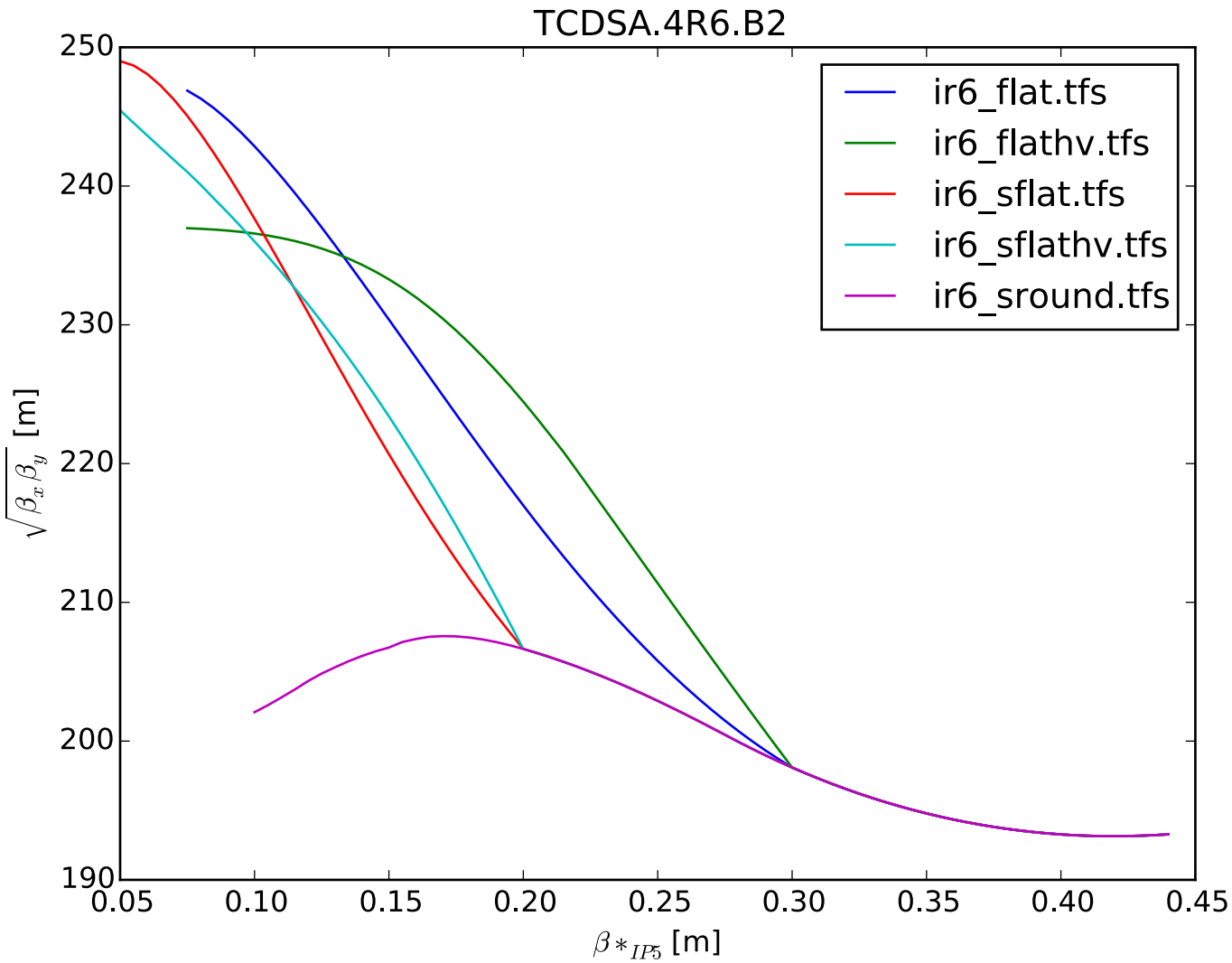
TCDQA.4L6.B2: β_y

- Minimum β_y small at 110 m and 120 m after squeeze for *sflat* and *flat* optics.



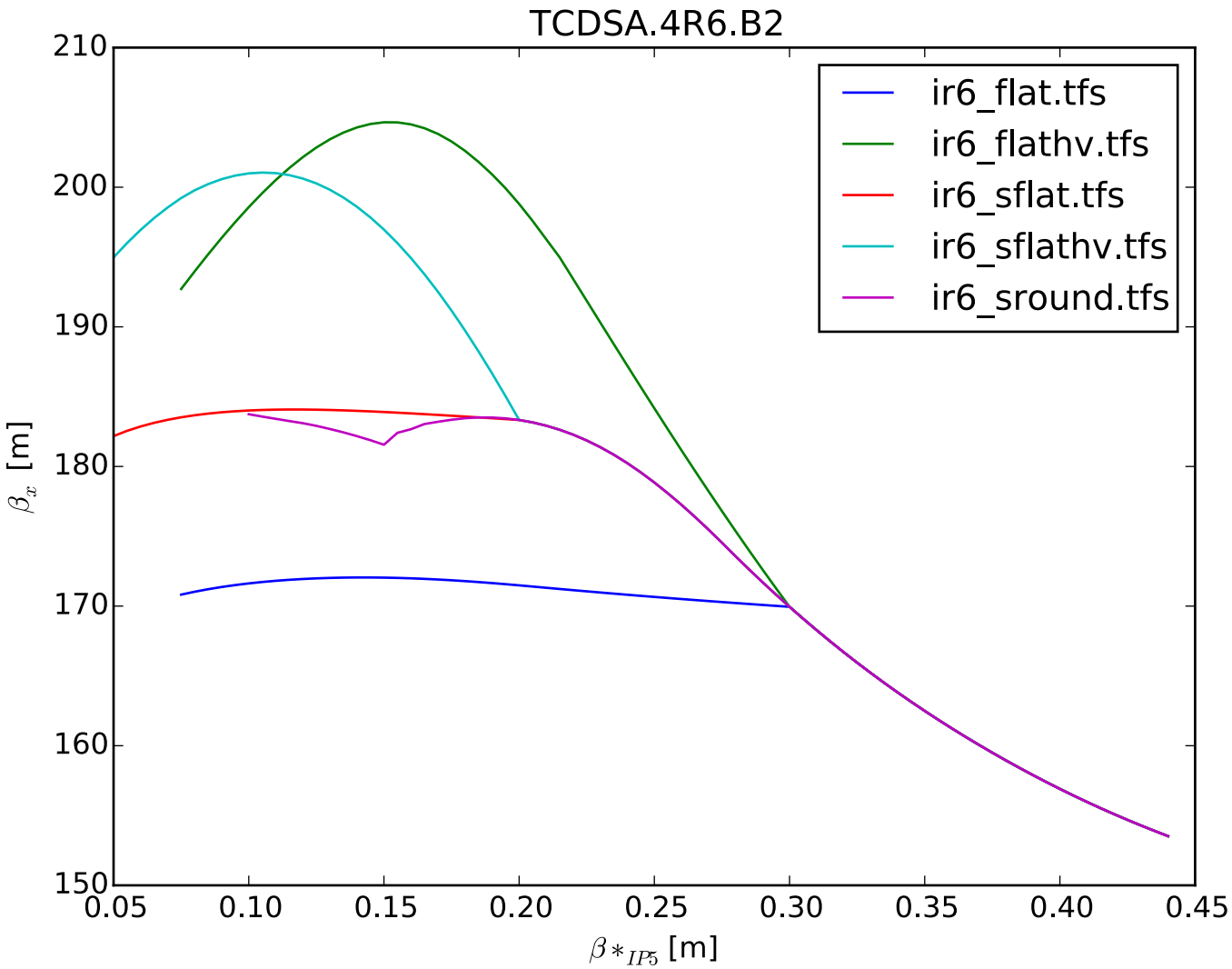
TCDSA.4R6.B2: $\sqrt{\beta_x \beta_y}$

- Compares nicely to Riccardo's HL-LHC optics presentation.



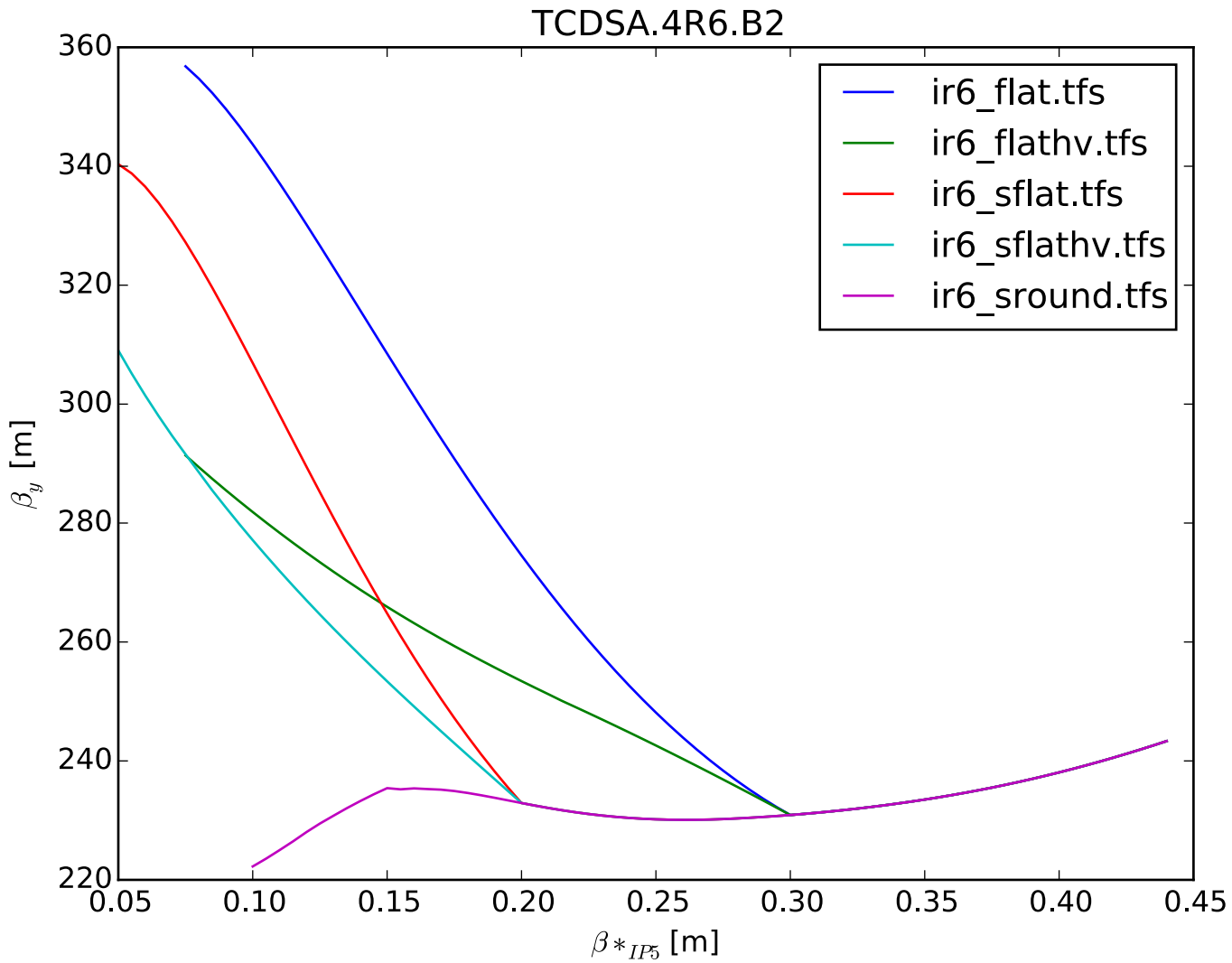
TCDSA.4R6.B2: β_x

- Minimum β_x constant for all optics at 150 m before squeeze.



TCDSA.4R6.B2: β_y

- Minimum β_y after squeeze at 220 m after squeeze for *sround* optics.



BEAM 2: TCDS SUMMARY

Optics Version	Configuration (including squeeze)	Energy [TeV]	Relativistic Gamma	Norm. RMS Emittance [m]	TCDSA.4R6.B2			
					minimum betx [m]	sigx [mm]	minimum bety [m]	sigy [mm]
Run 2*	Collision	7	7460.523175	2.60E-06	1.53E+02	0.23	2.46E+02	0.29
HL	Flat	7	7460.523175	2.60E-06	153.5	0.23	230.9	0.28
HL	Flat HV	7	7460.523175	2.60E-06	153.5	0.23	230.9	0.28
HL	sRound	7	7460.523175	2.60E-06	153.5	0.23	222.3	0.28
HL	sFlat	7	7460.523175	2.60E-06	153.5	0.23	230.1	0.28
HL	sFlat HV	7	7460.523175	2.60E-06	153.5	0.23	230.1	0.28

*We didn't check before or during the squeeze for Run 2.

BEAM 2: TCDQ SUMMARY

Optics Version	Configuration (including squeeze)	Energy [TeV]	Relativistic Gamma	Norm. RMS Emittance [m]	TCDQA.A4L6.B2			
					minimum betx [m]	sigx [mm]	minimum bety [m]	sigy [mm]
Run 2*	Collision	7	7460.523175	2.60E-06	4.88E+02	0.41	1.62E+02	0.24
HL	Flat	7	7460.523175	2.60E-06	499.5	0.42	107.5	0.19
HL	Flat HV	7	7460.523175	2.60E-06	499.5	0.42	138.1	0.22
HL	sRound	7	7460.523175	2.60E-06	499.5	0.42	165.4	0.24
HL	sFlat	7	7460.523175	2.60E-06	499.5	0.42	119.4	0.20
HL	sFlat HV	7	7460.523175	2.60E-06	499.5	0.42	131.1	0.21

*We didn't check before or during the squeeze for Run 2.

CONCLUSION

- TCDS beam size looks fine.
- TCDQ beam size in the vertical plane is reduced in general, and by a factor of 2 for certain optics (*sflat* and *flat*) for Beam 1.
- These results are to be verified by Riccardo… I drifted the beam to where we wanted to make the checks so acted on the data on afs. I checked $\sqrt{\beta_x \beta_y}$ was consistent with Riccardo.
- I note that the "Collision" optics that we used for our first checks do not correspond to the same optics as found in the files showing the squeeze. To be checked with Riccardo.
- We should check Run 2 optics before the squeeze.