Merlin simulations during squeeze at 4 TeV

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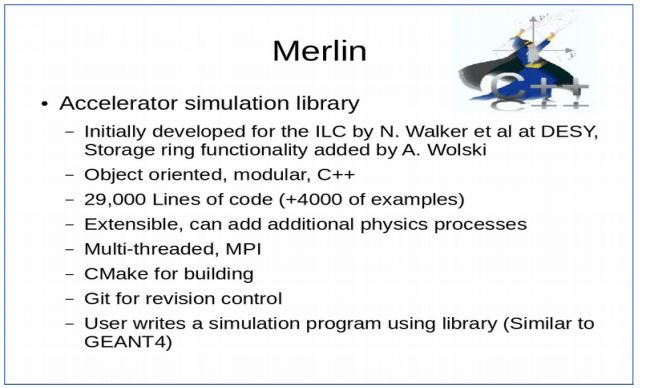
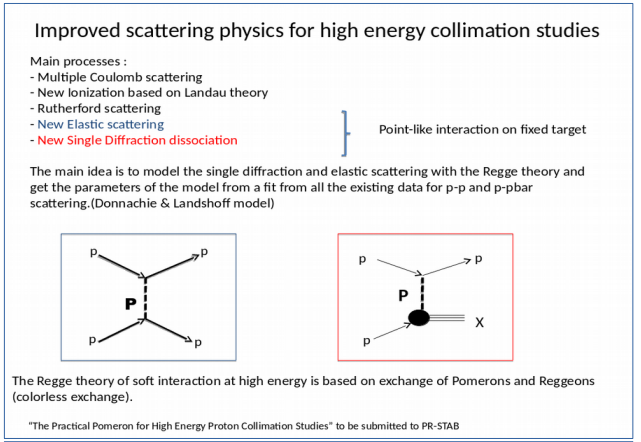
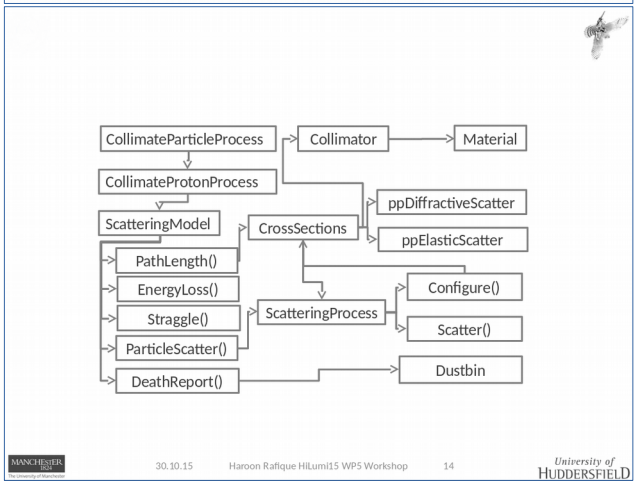
HiLumi 2015 CERN

Merlin

- Tracking code currently developed at Manchester and Huddersfield
- Many features, modular, scattering physics
- Already introduced in talks today and on Wednesday







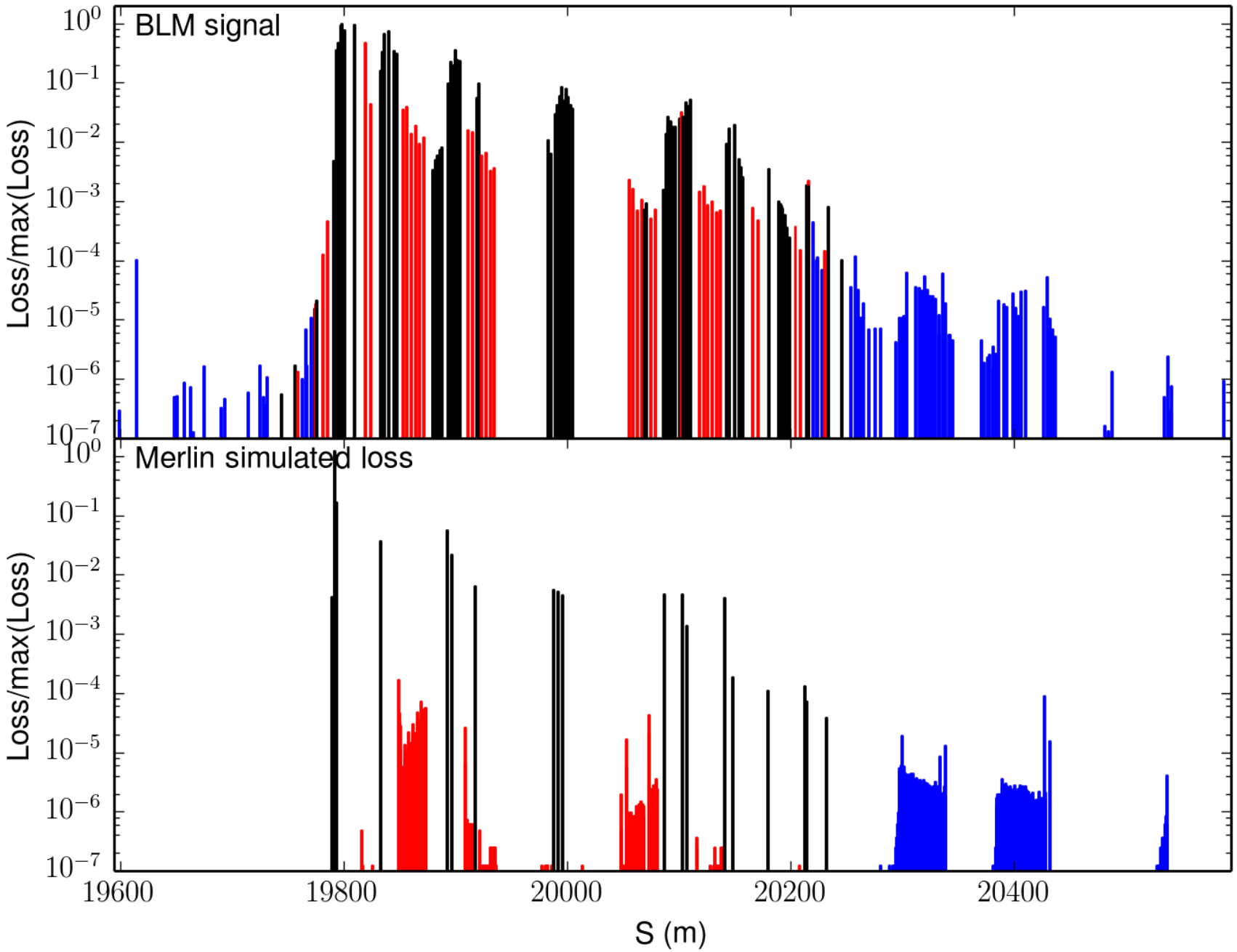
Validation

- Validation against data
  - Ideal test of code is to agree with real data
  - Beam loss monitors (BLM) are used to record loss maps in the LHC
- Validation against code
  - Test against code that does the same task
  - Sixtrack is the standard code for LHC collimation

BLM data

- BLM measure radiation levels outside the magnets and collimators
- Deliberate loss maps made by exciting the beam with transverse dampers
- Imperfect comparison
  - Merlin records position of proton losses from beam pipe
  - BLM records shower
  - Shows can be many meters long
  - Detailed comparison would require interfacing with a shower code

BLM compare IR7



Sixtrack Comparison

- Merlin and Sixtrack model lossmaps in similar ways
- A halo distribution with a small impact parameter on the TCP is generated
- Particles are tracked until they hit an aperture
  - At collimators scattering is modelled
  - At other elements proton is stopped
- Should give very similar results
- Sixtrack vs BLM comparisons are quite advanced
- Subtle differences from thin vs thick and scattering physics

4TeV 2012 Settings

	Betastar	Crossing angle [μrad]
IP 1	11→0.6m	0
IP 5	11→0.6m	145 H
IP 2	10 → 3 m	220 V
IP 8	10 → 3 m	90 V

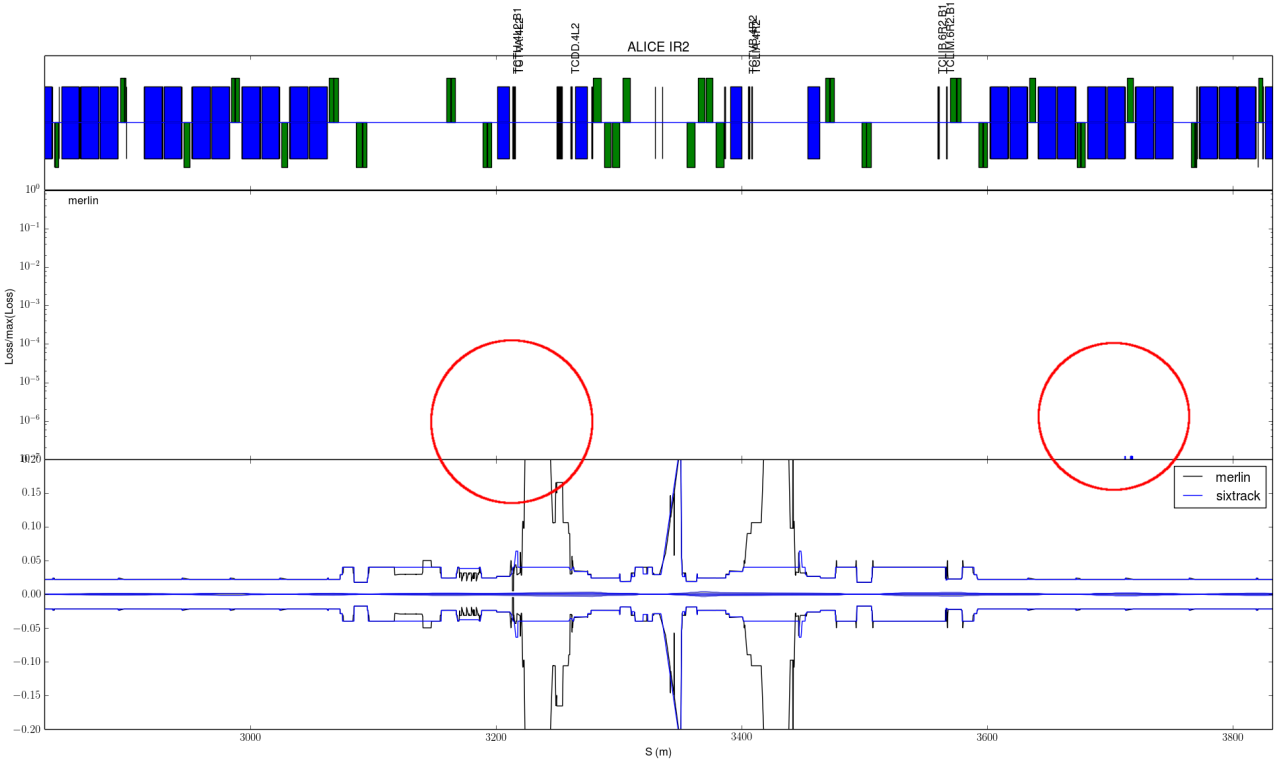
- 64 million particles
- New merlin merged physics

	IP	Gap (sgima)
TCP	7	4.3
	3	12
TCSG	7	6.3
	3	15.6
	6	9.8
TCL	1	10
	3	17.6
	5	10
	7	8.3
TCT	1,5	26 → 9
	2,8	26 → 12

IP TCT set by linear scaling from 26 σ → 9/12 σ for β* 11/10m → 0.6/3m

Improving comparison

- Initially had some disagreements in the IPs compared to SixTrack
- Apertures
- Optics
- Tracking



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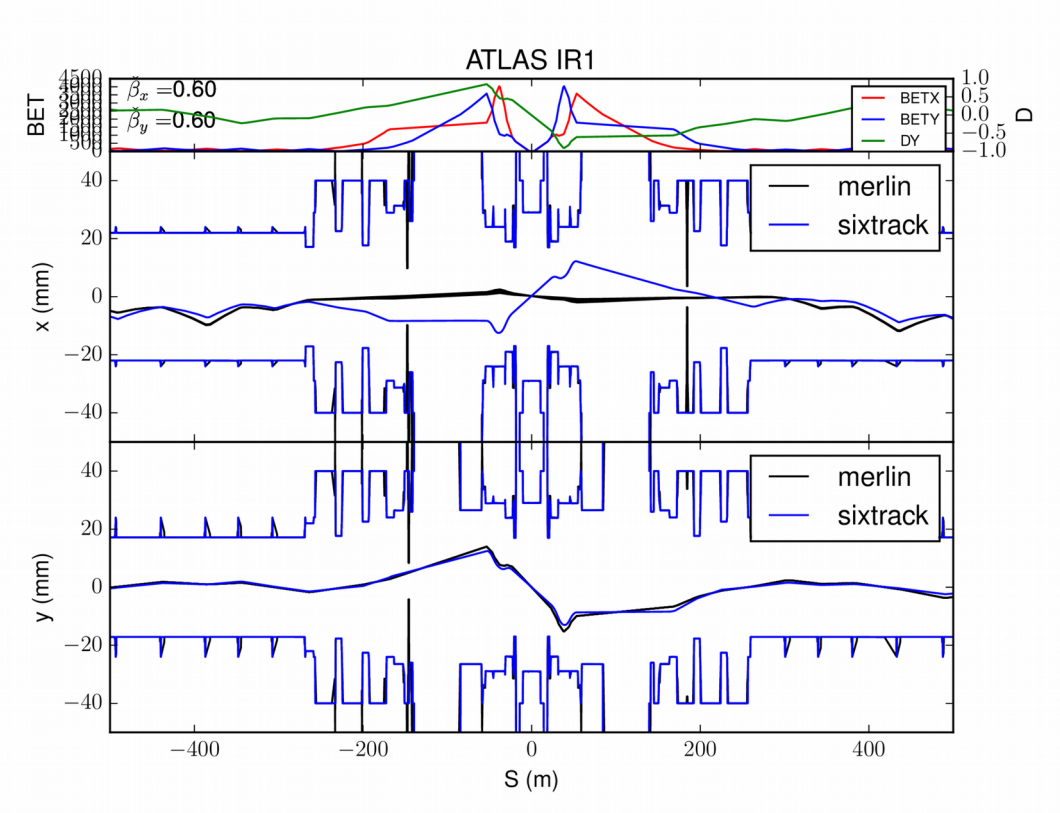

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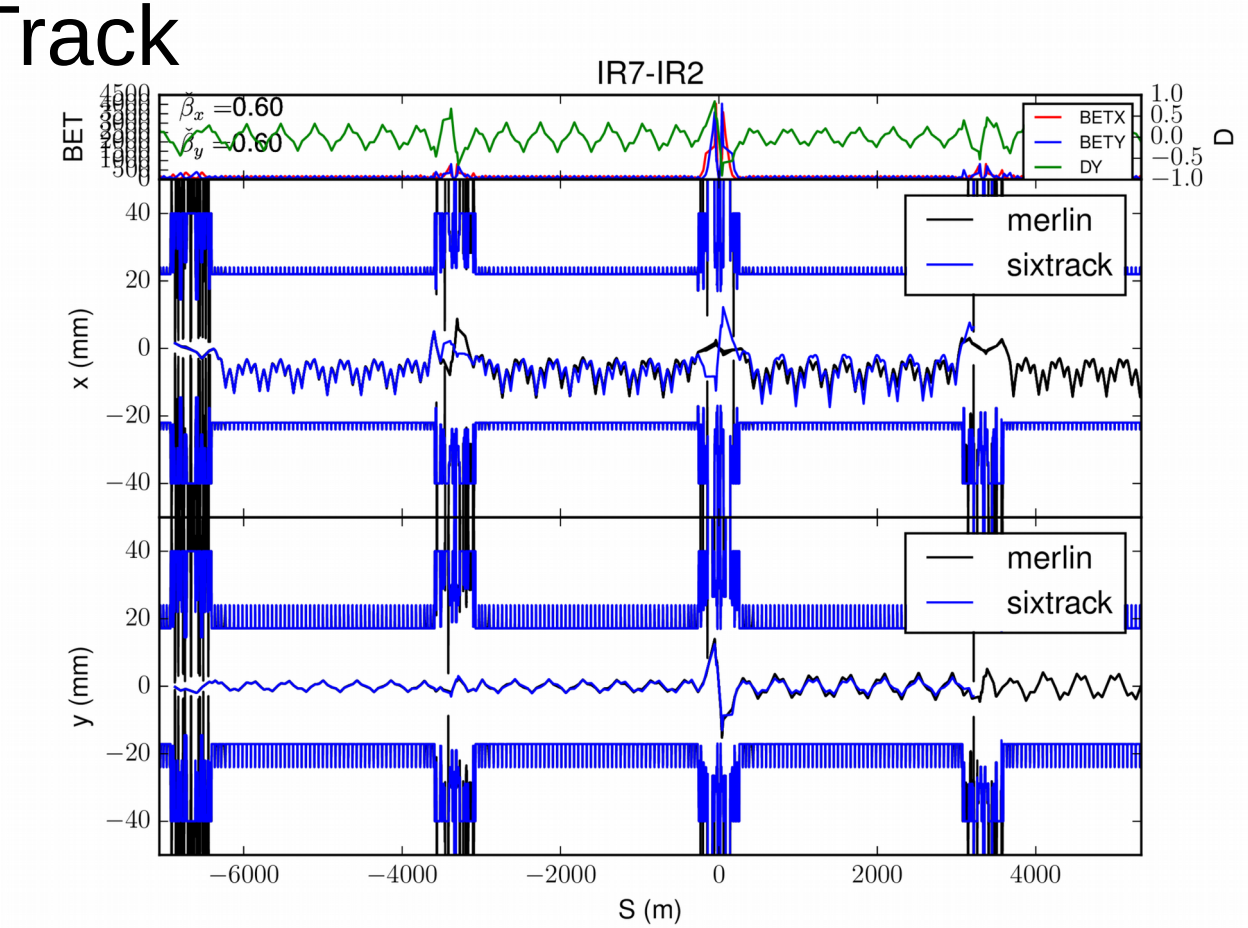

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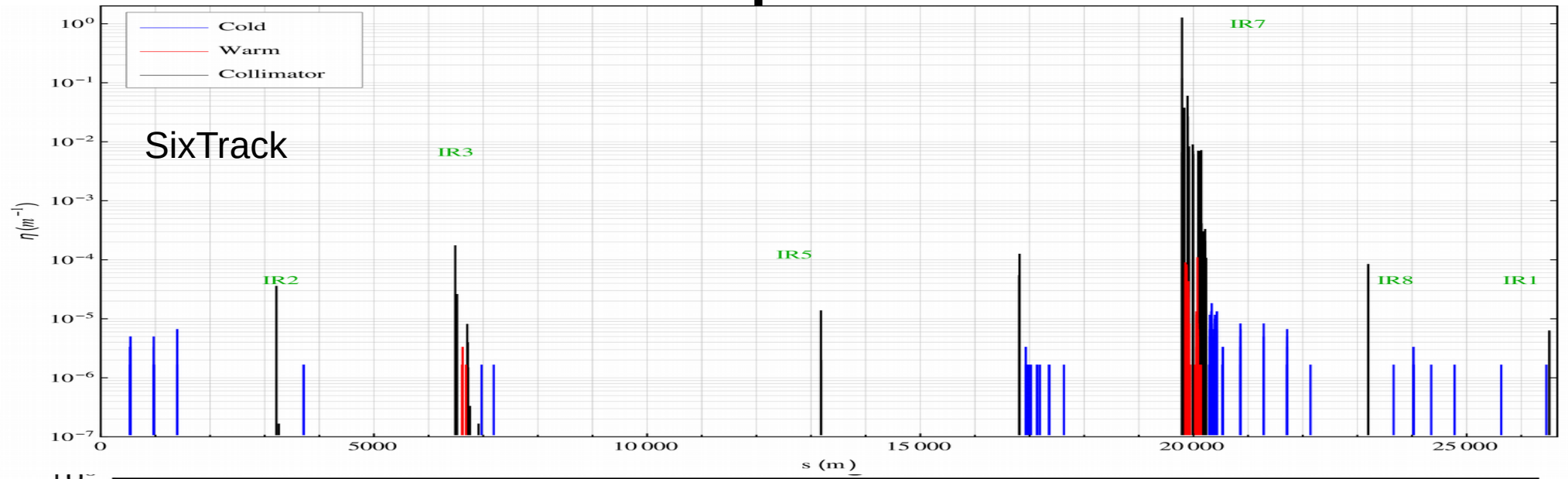
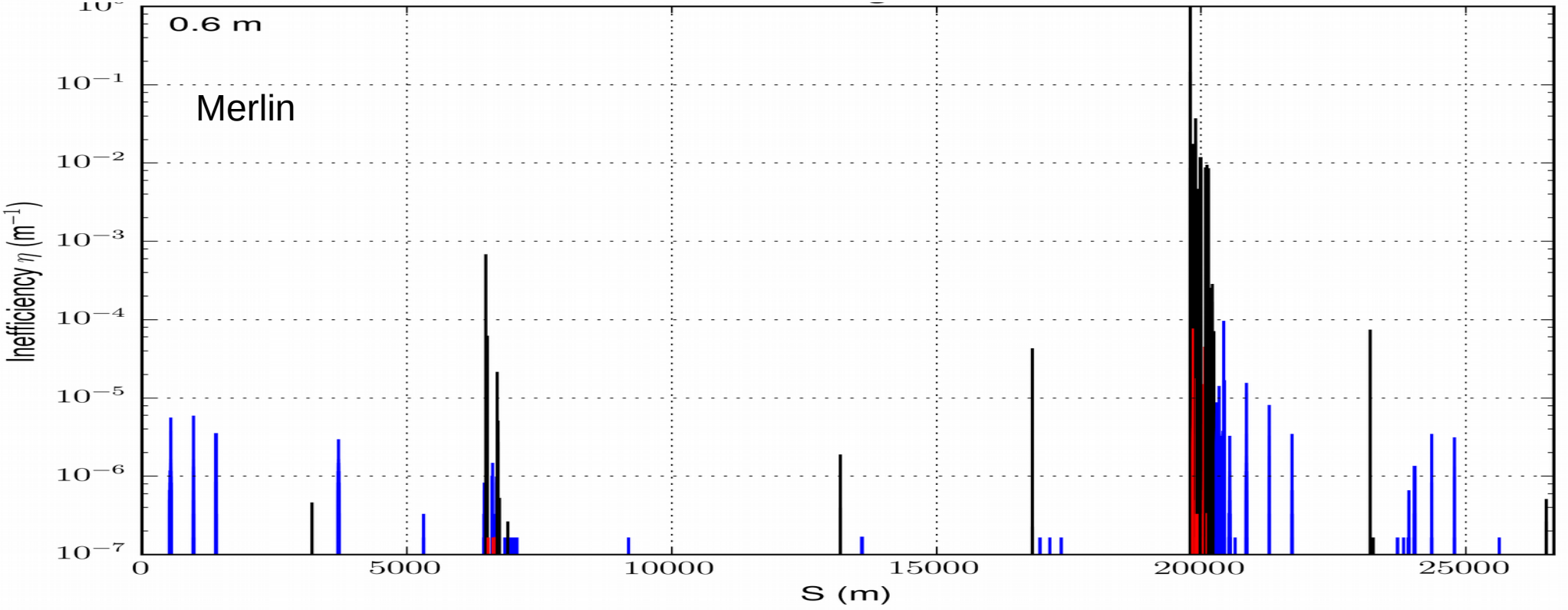
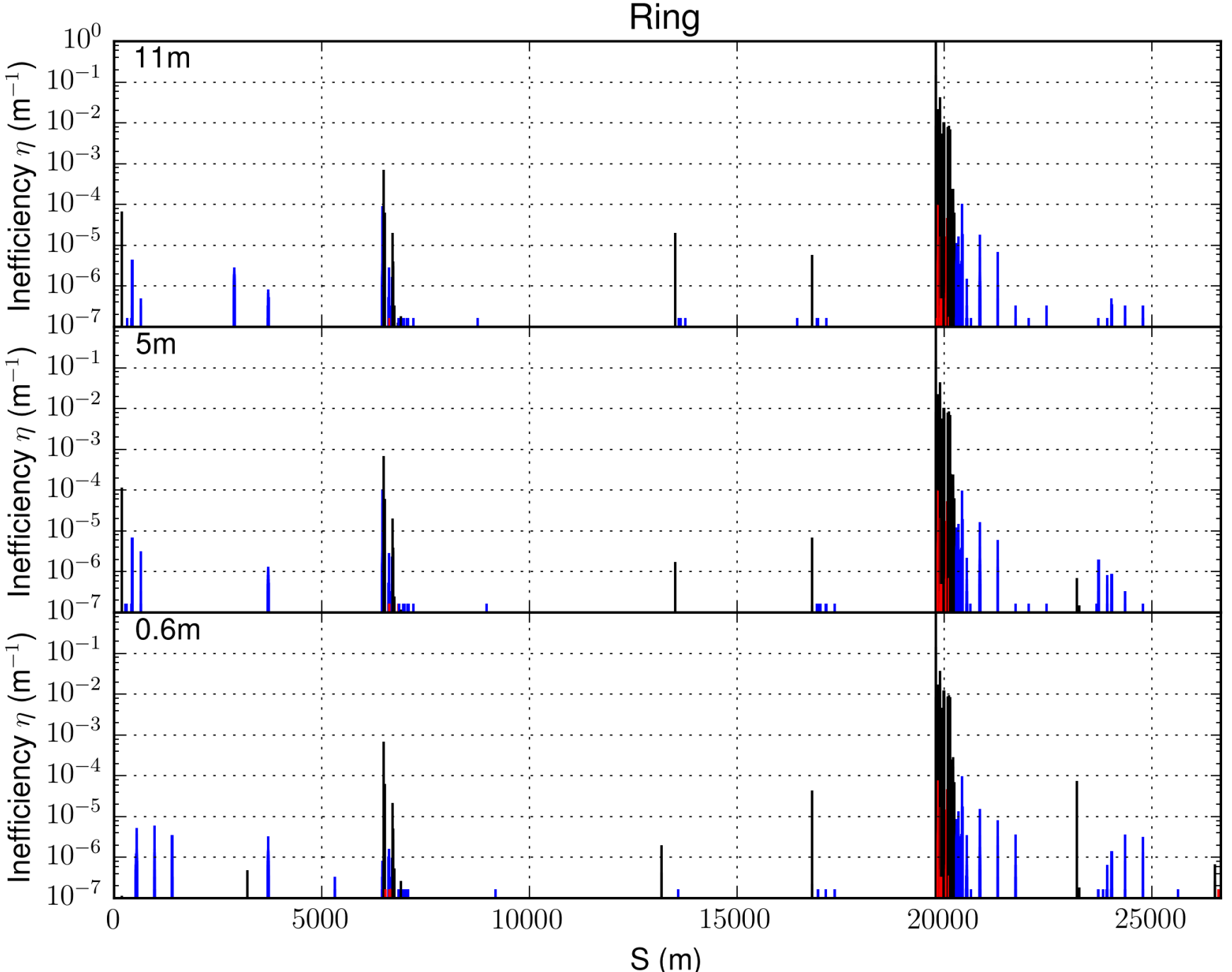
Sixtrack comparison 60cm

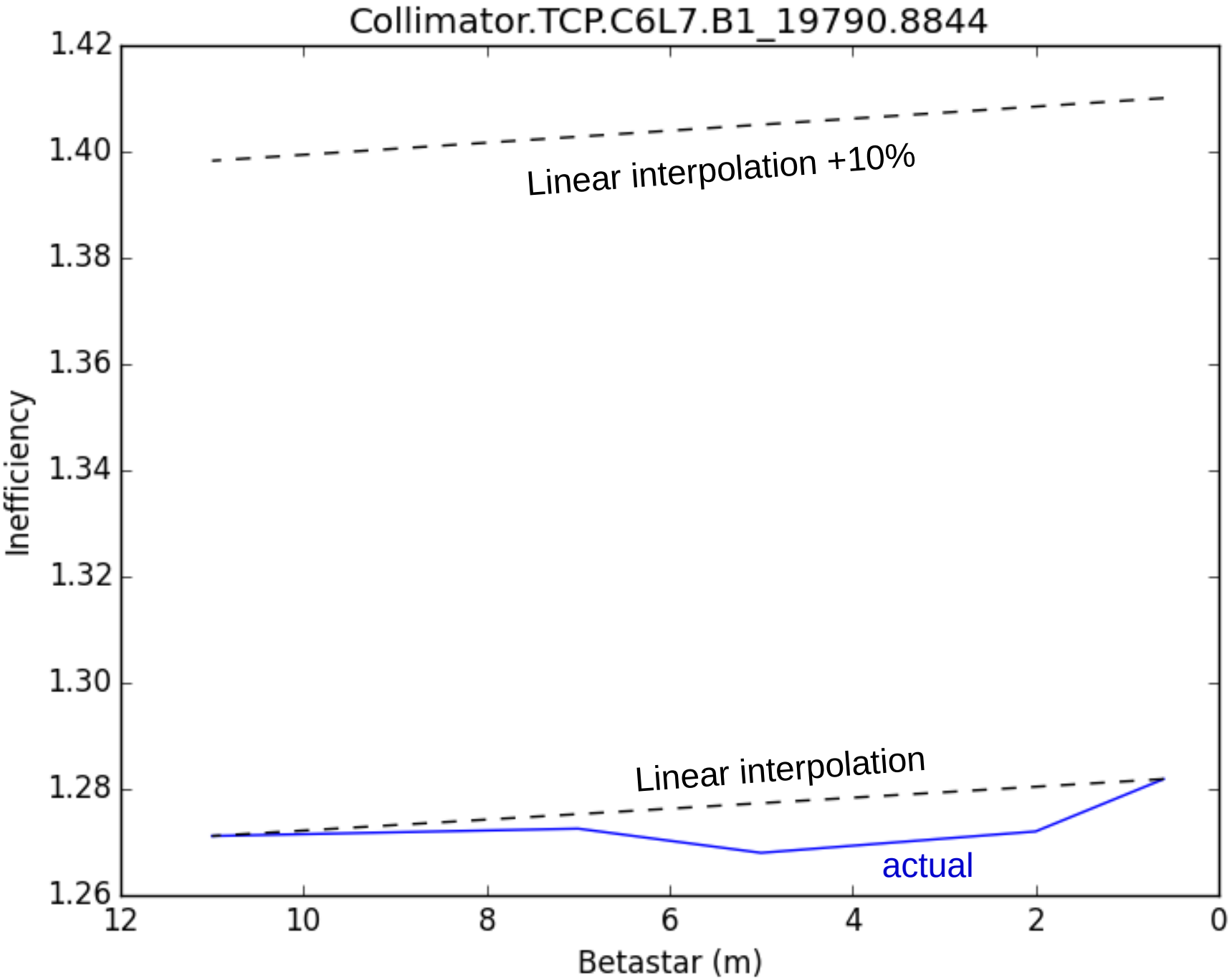




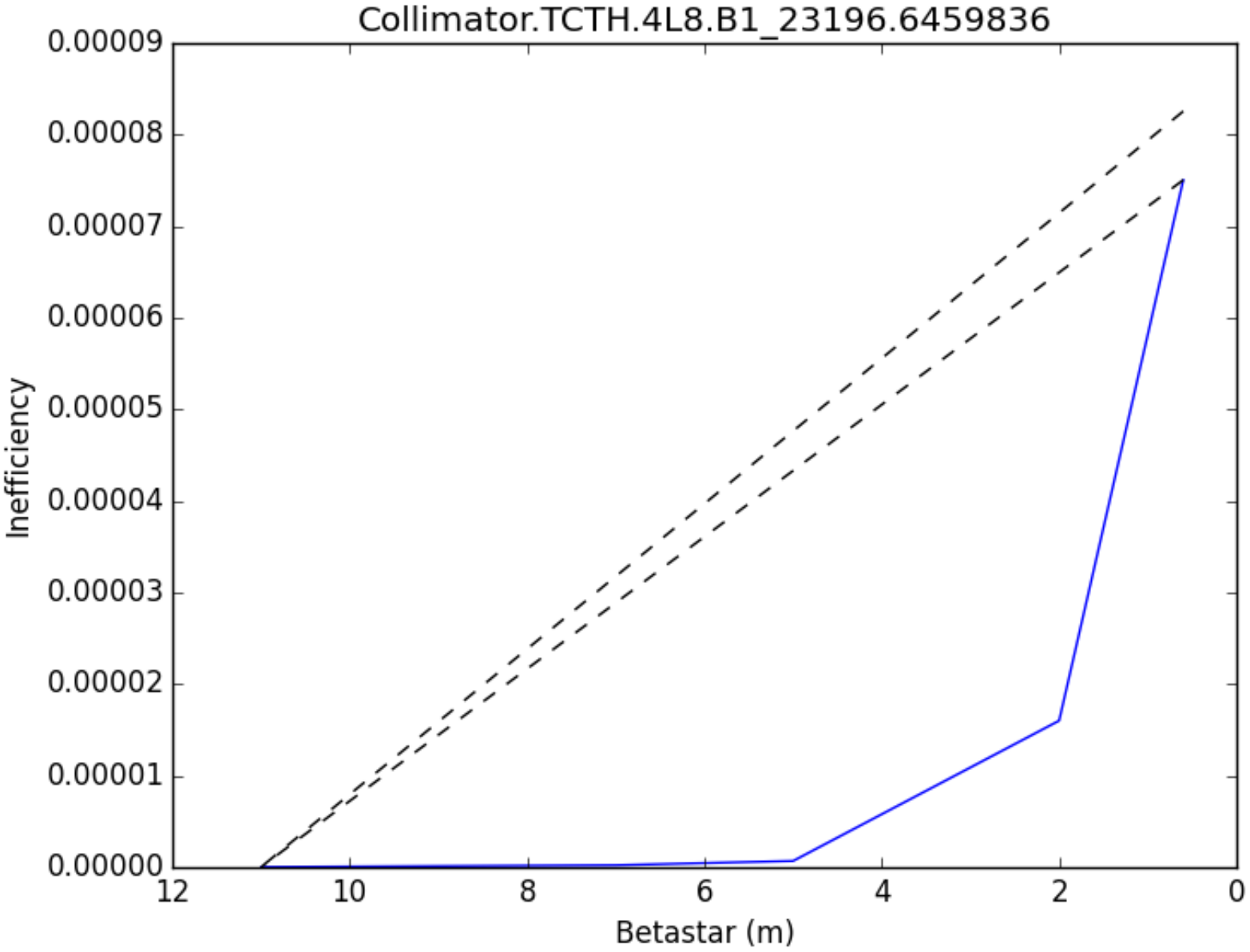
Loss maps during squeeze



TCP

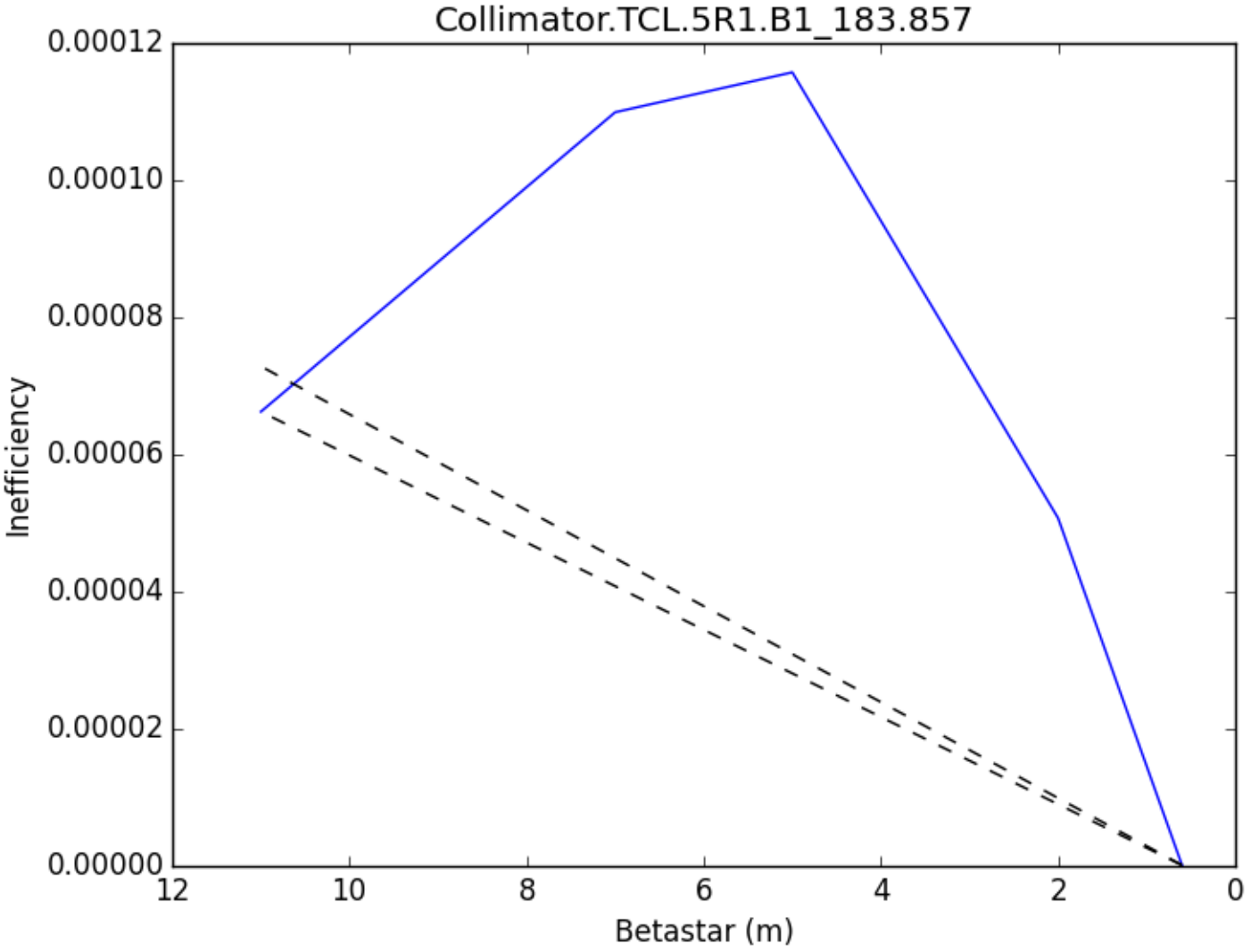

Collimator.TCP.C6L7.B1_19790.8844
Linear interpolation +10%
Linear interpolation
actual
Inefficiency
Betastar (m)
1.42
1.40
1.38
1.36
1.34
1.32
1.30
1.28
1.26
12
10
8
6
4
2
0

TCTH.4L8



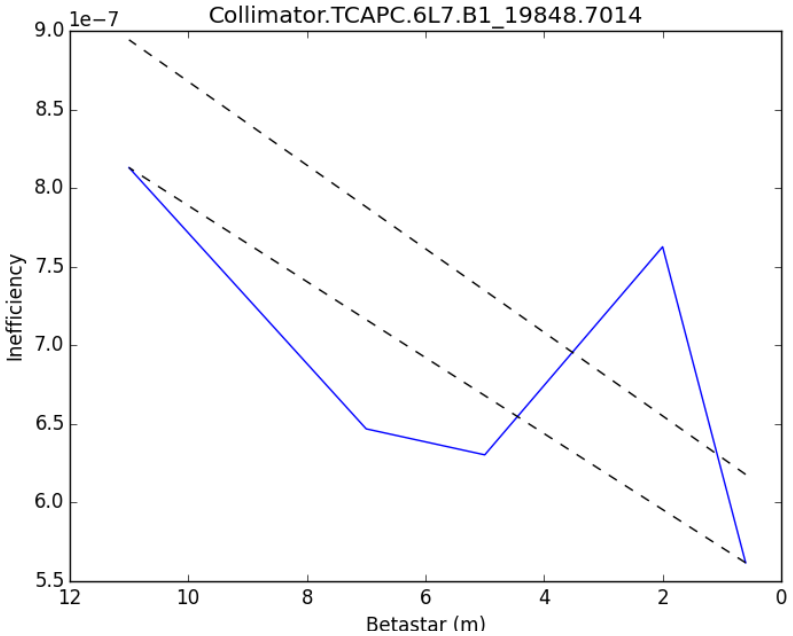
Losses do not occur until small betastar

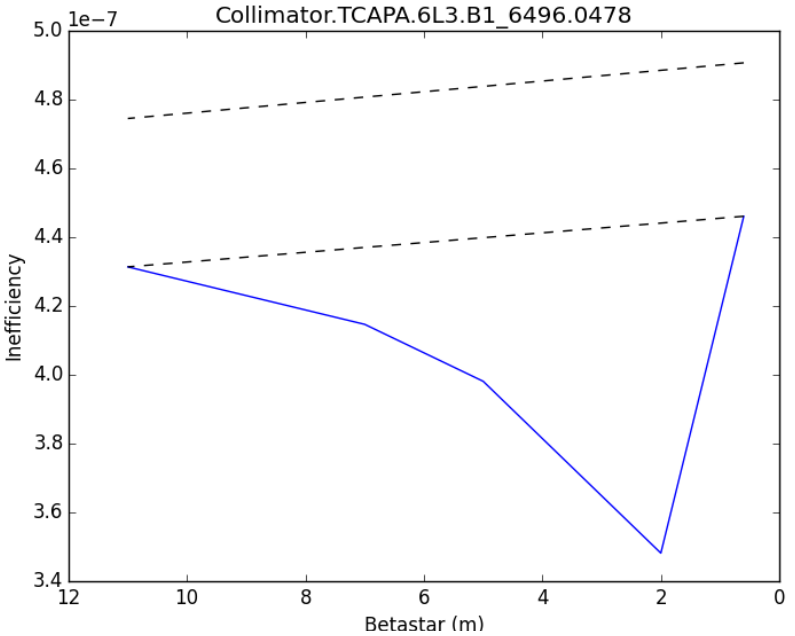
TCL.5R1

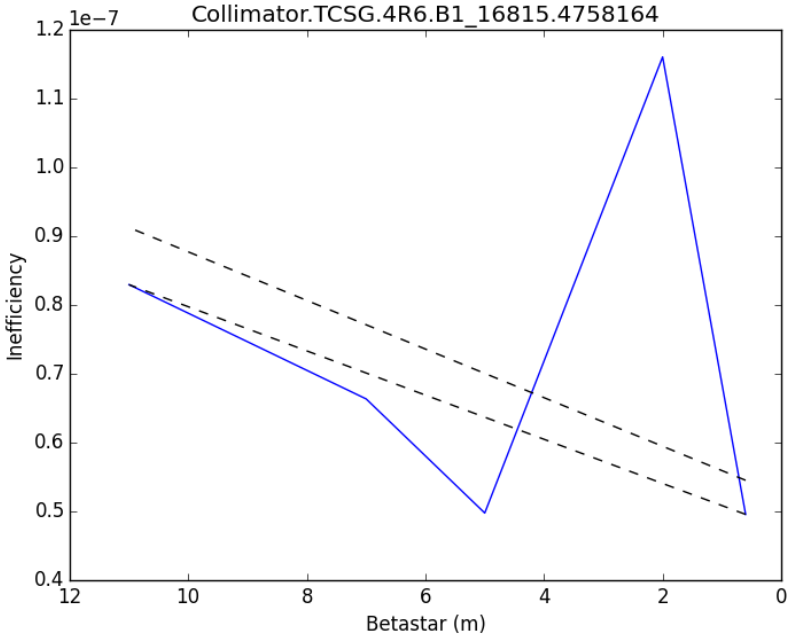


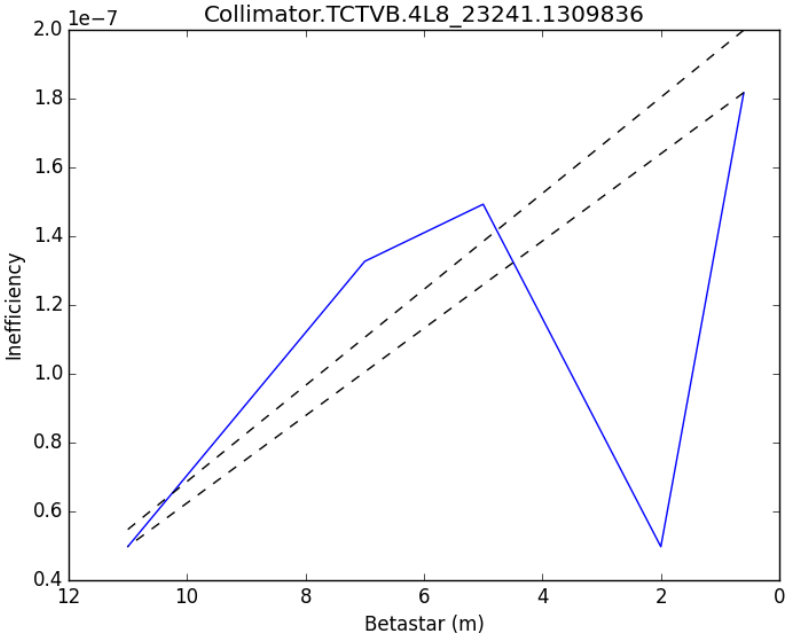
- Mid squeeze loss is double of end point

Interesting interactions?









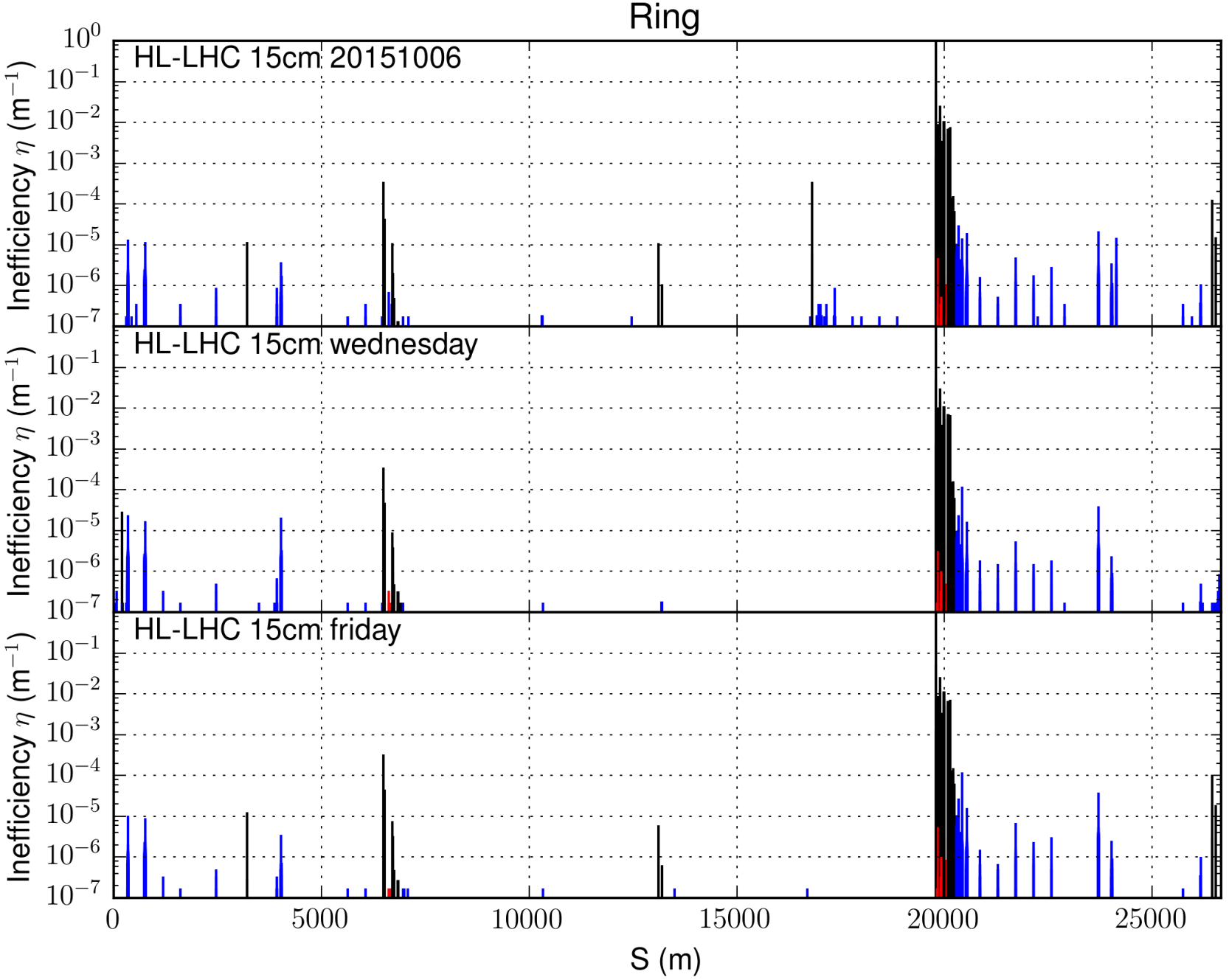
Conclusion

- Can use Merlin to simulate intermediate squeeze optics
- Some interesting effects
  - Some higher losses mid squeeze (TCL)
  - Some interesting interactions (needs more checking)
- Lots to analyse

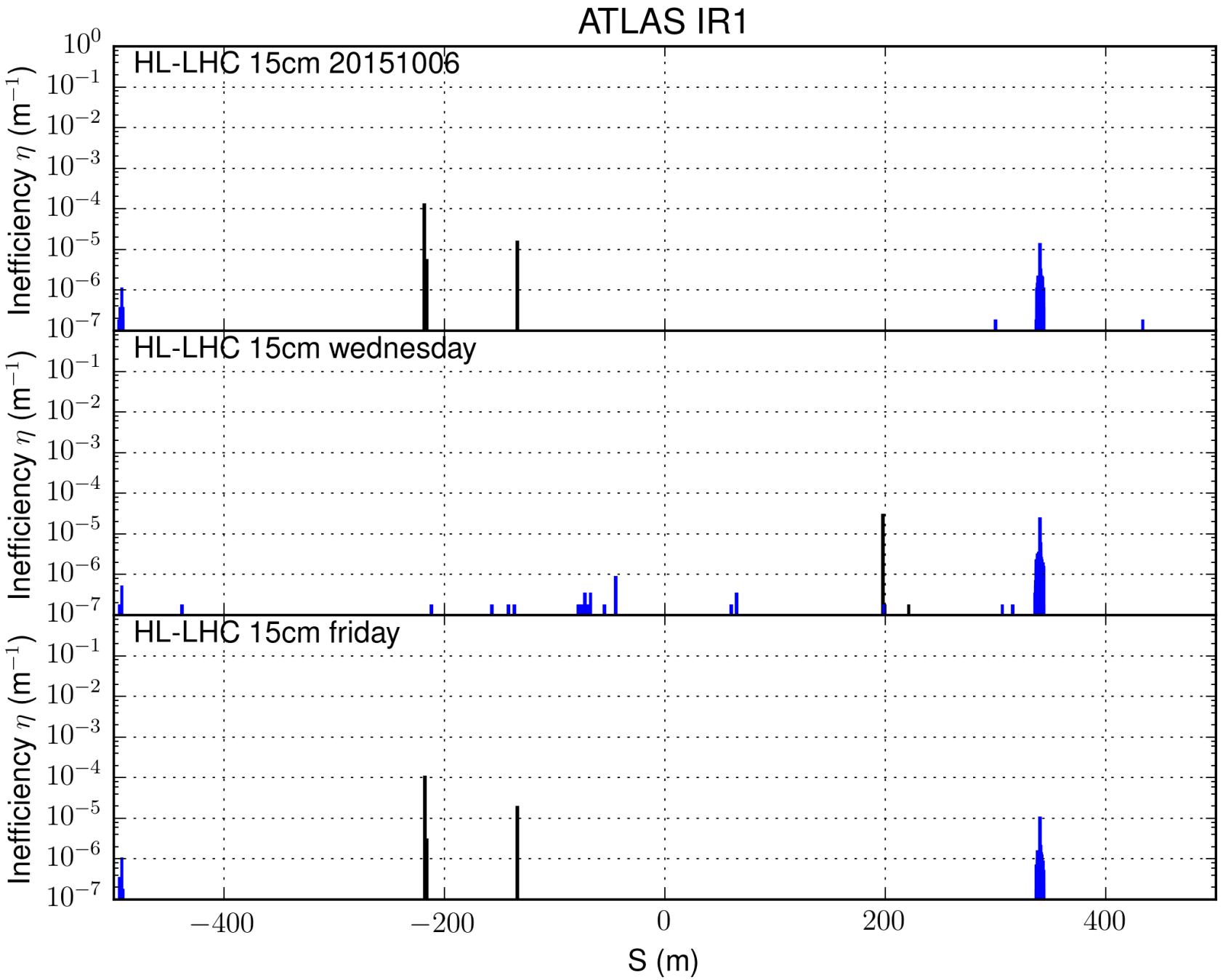
HL squeeze

- In my wednesday talk, I showed some issues I was having with the HL squeeze
- Roderik and Miriam helped me track down the problem
- I had not noticed a change in the TCT names (TCTH.4L2.B1 → TCTPH.4L2.B1)
- So TCT apertures were not being set properly
- This fixes lack of losses at IP1,2,5
- Still a difference at IR6, due to optics changes
- Agreement with sixtrack for 15cm HLLHC1.2 is good

HL squeeze


Ring
HL-LHC 15cm 20151006
HL-LHC 15cm wednesday
HL-LHC 15cm friday
Inefficiency η (m^{-1})
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
0
5000
10000
15000
20000
25000
S (m)

HL squeeze


ATLAS IR1
HL-LHC 15cm 20151006
HL-LHC 15cm wednesday
HL-LHC 15cm friday
Inefficiency η (m^{-1})
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
−400
−200
0
200
400
S (m)

http://xkcd.com/1597/