

Merlin simulations during squeeze at 4 TeV

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Merlin

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



Merlin

- Accelerator simulation library
 - Initially developed for the ILC by N. Walker et al at DESY, Storage ring functionality added by A. Wolski
 - Object oriented, modular, C++
 - 29,000 Lines of code (+4000 of examples)
 - Extensible, can add additional physics processes
 - Multi-threaded, MPI
 - CMake for building
 - Git for revision control
 - User writes a simulation program using library (Similar to GEANT4)

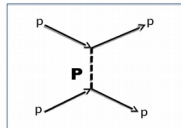
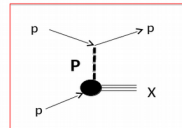
Improved scattering physics for high energy collimation studies

Main processes :

- Multiple Coulomb scattering
- New Ionization based on Landau theory
- Rutherford scattering
- New Elastic scattering
- **New Single Diffraction dissociation**

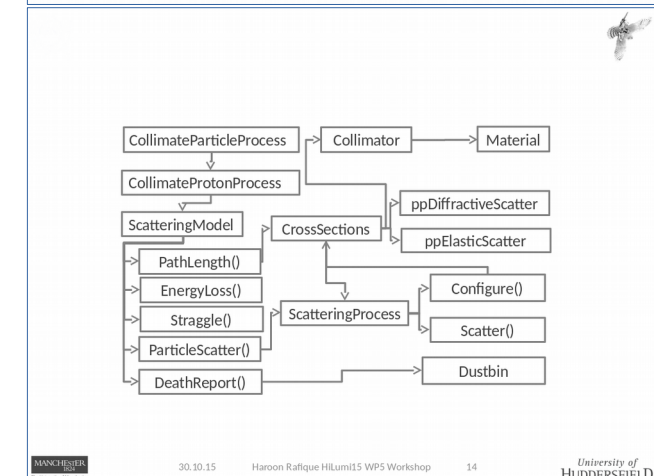
} Point-like interaction on fixed target

The main idea is to model the single diffraction and elastic scattering with the Regge theory and get the parameters of the model from a fit from all the existing data for p-p and p-pbar scattering. (Donnachie & Landshoff model)

The Regge theory of soft interaction at high energy is based on exchange of Pomerons and Reggeons (colorless exchange).

"The Practical Pomeron for High Energy Proton Collimation Studies" to be submitted to PR-STAB



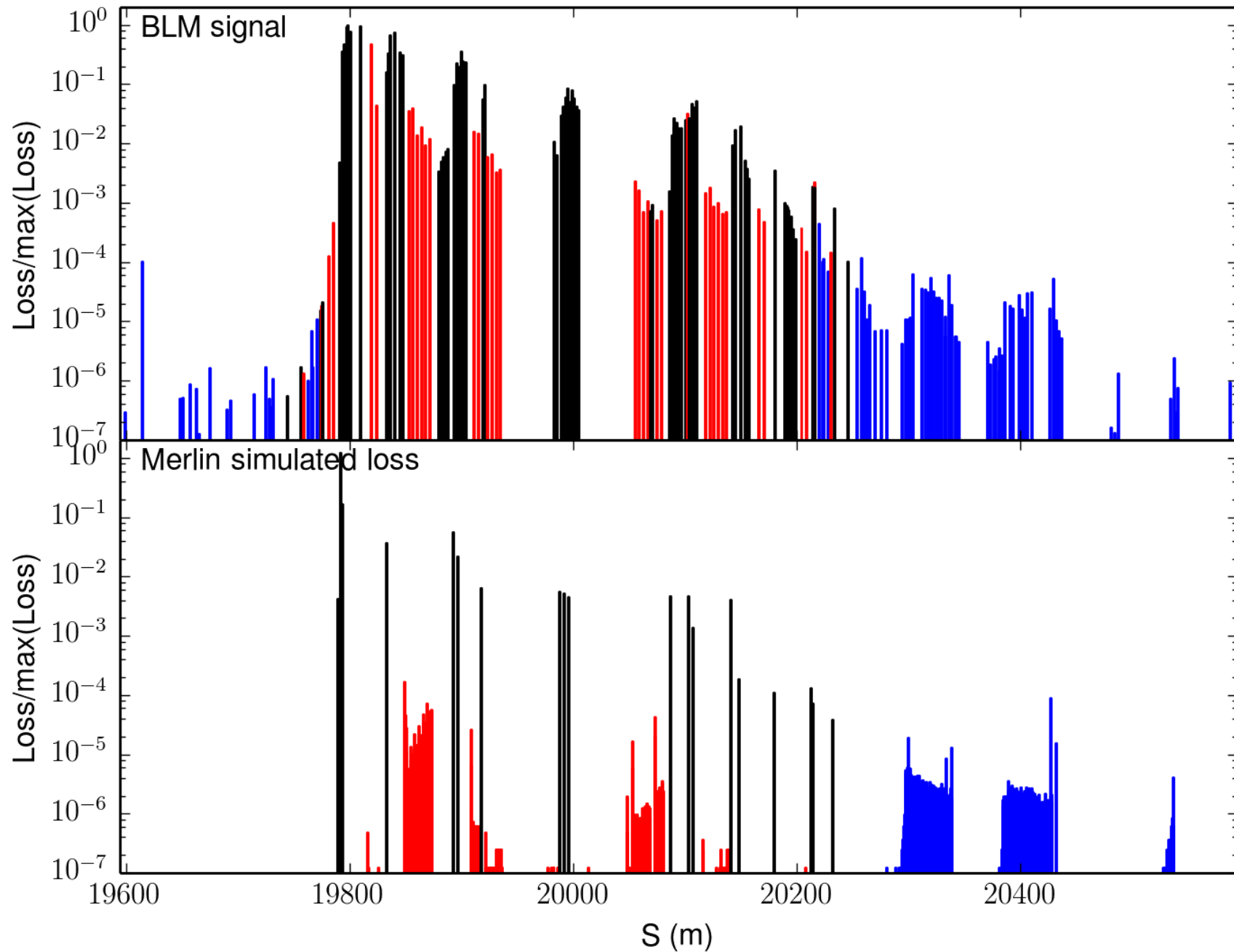
Validation

- 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 \rightarrow 0.6m	0
IP 5	11 \rightarrow 0.6m	145 H
IP 2	10 \rightarrow 3 m	220 V
IP 8	10 \rightarrow 3 m	90 V

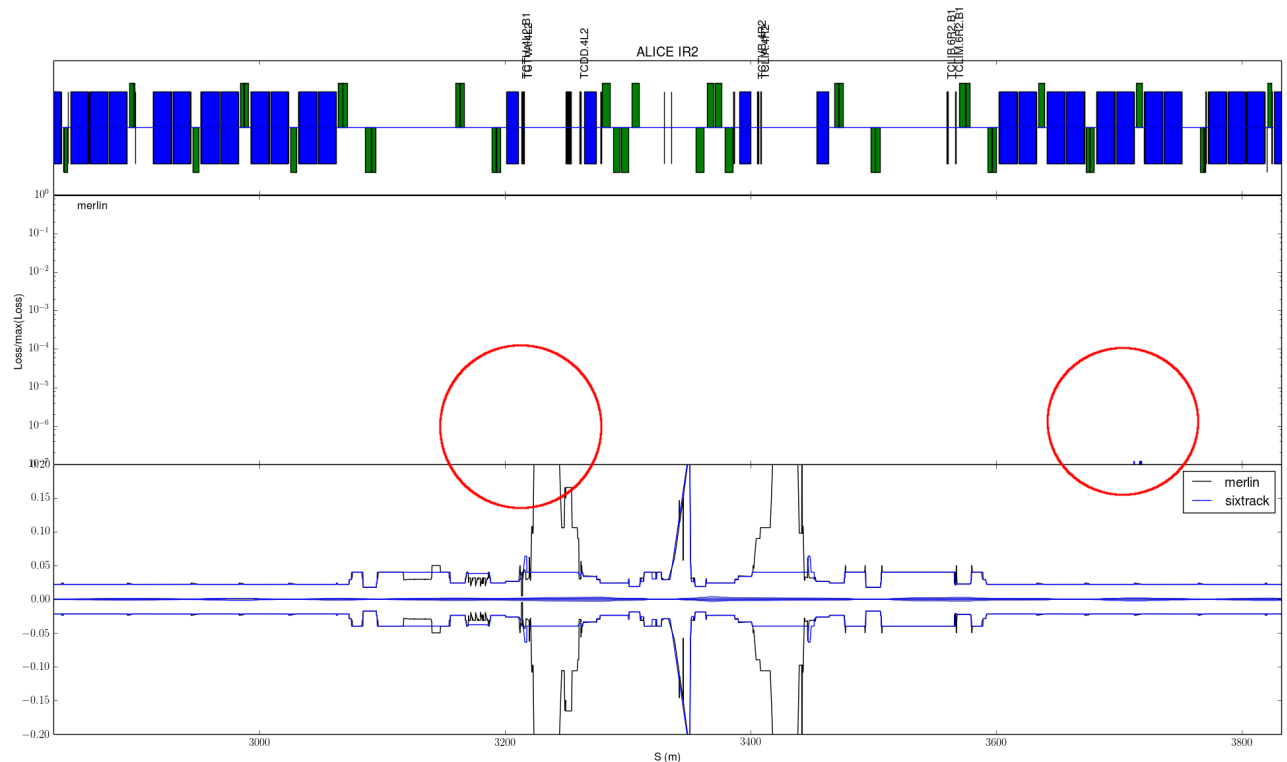
- 64 million particles
- New merlin merged physics

	IP	Gap (σ)
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 \rightarrow 9
	2,8	26 \rightarrow 12

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

Improving comparison

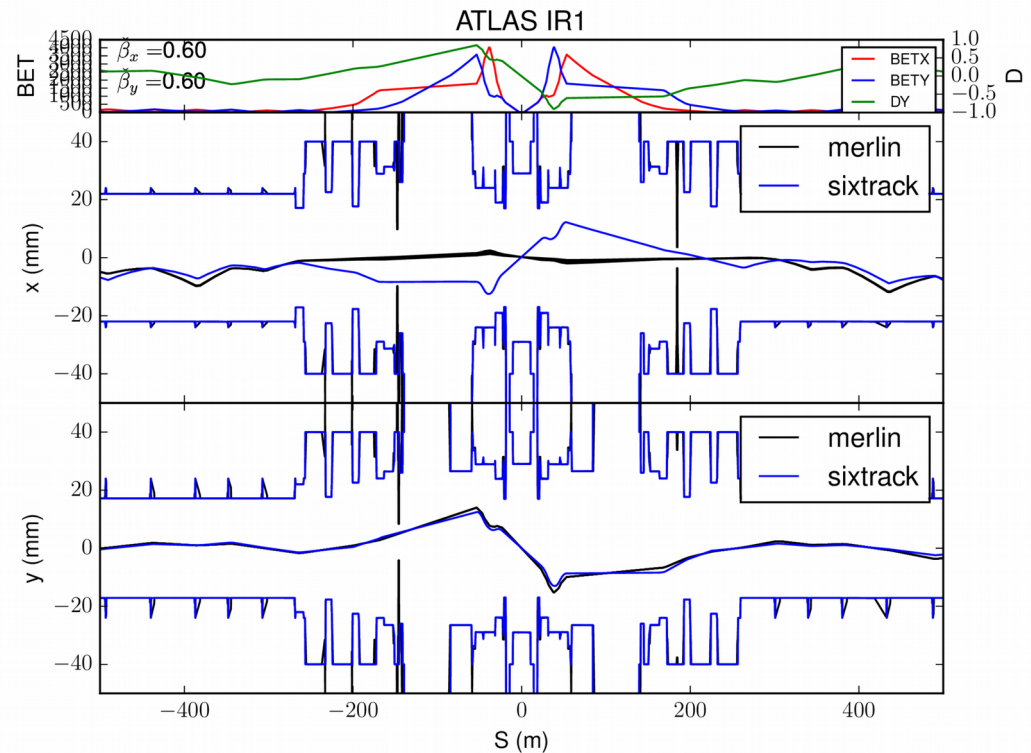
- Initially had some disagreements in the IPs compared to SixTrack
- Apertures
- Optics
- Tracking



- Final agreement not perfect, but considered good enough to continue

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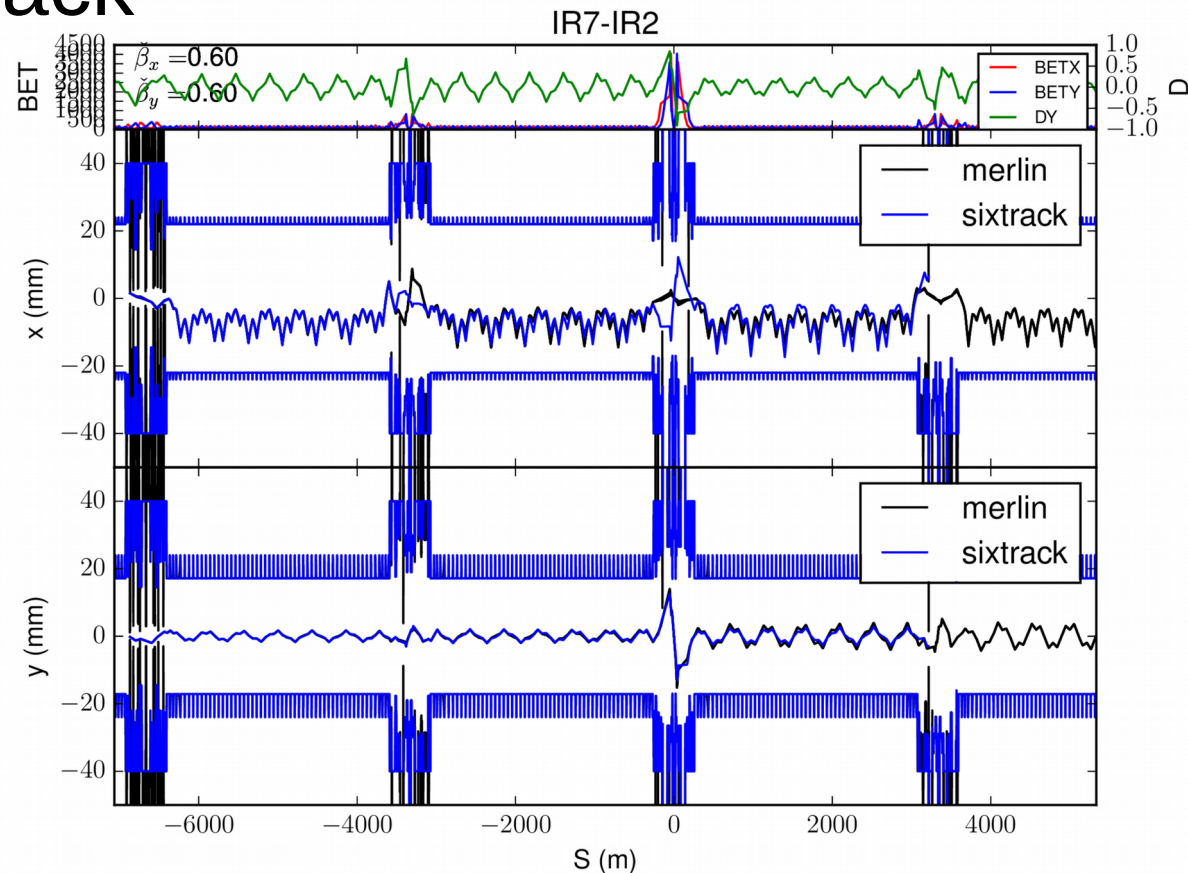


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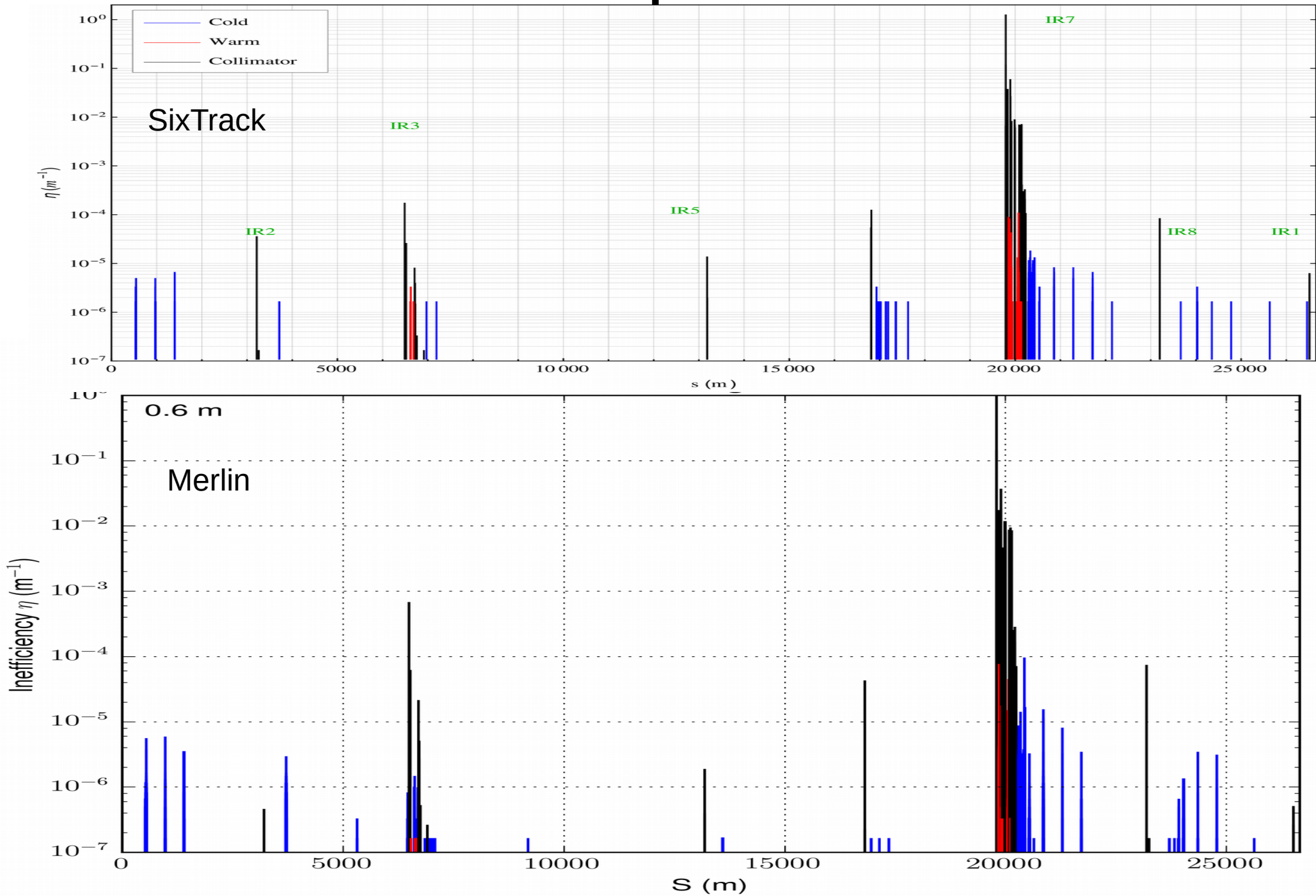
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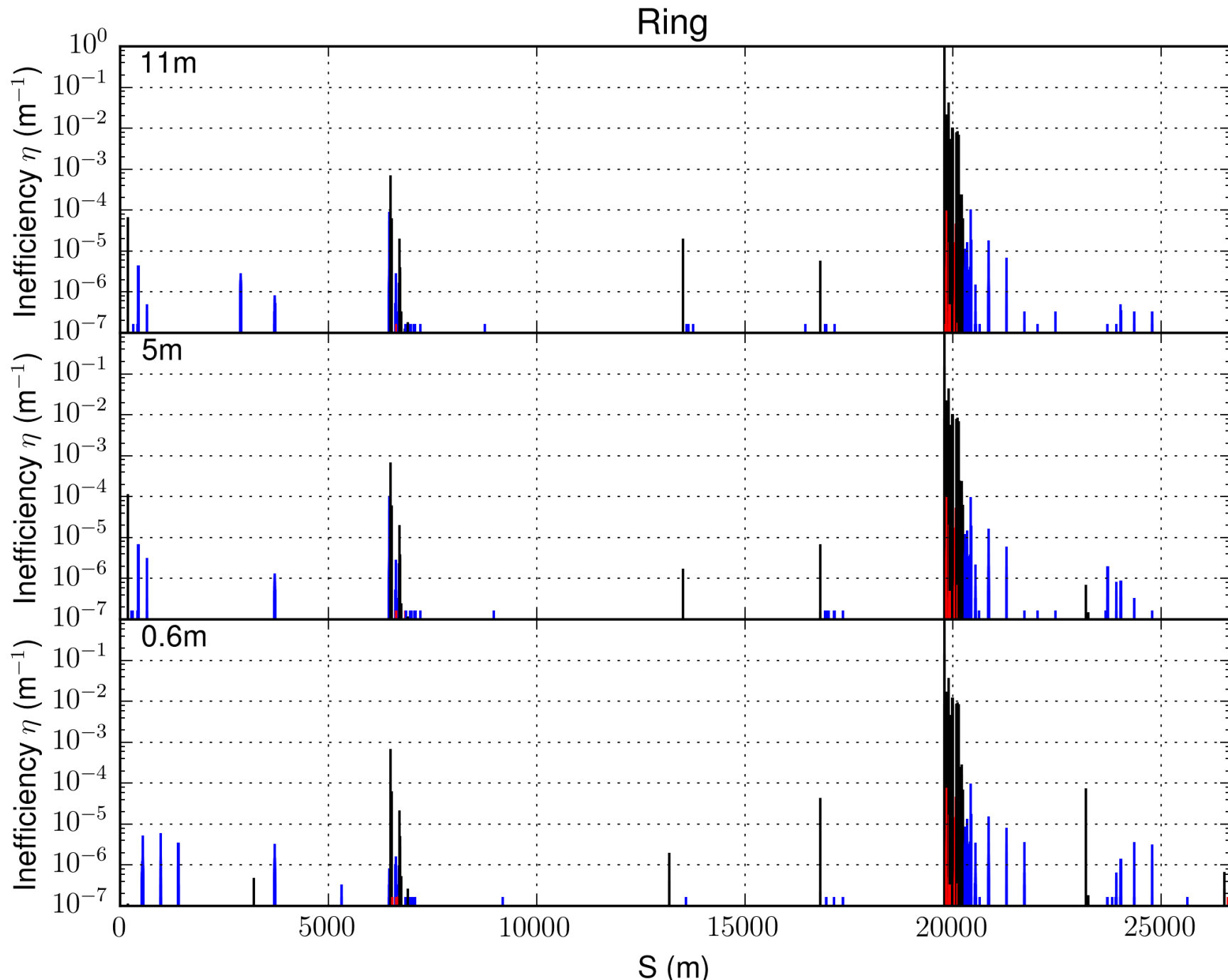


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Sixtrack comparison 60cm

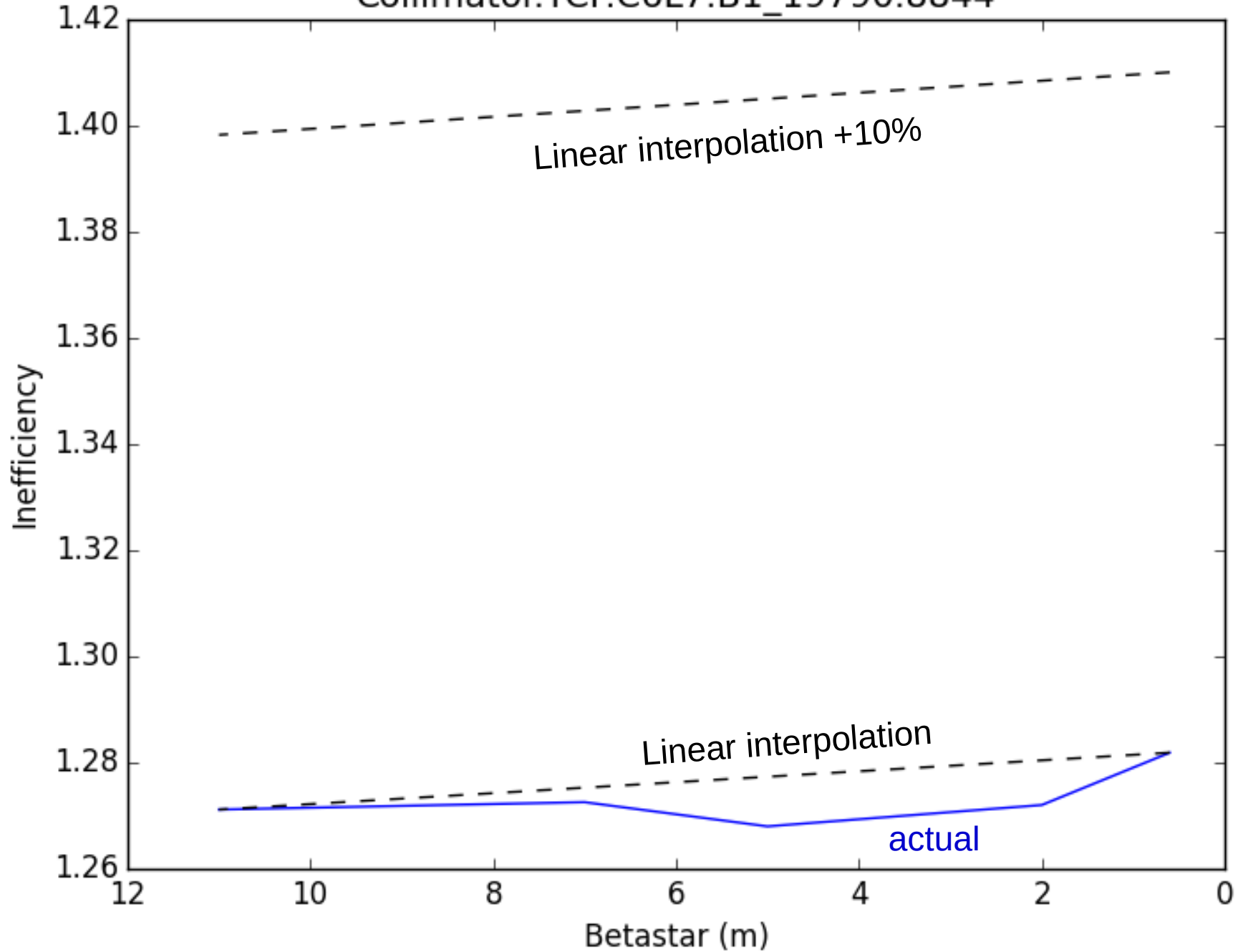


Loss maps during squeeze



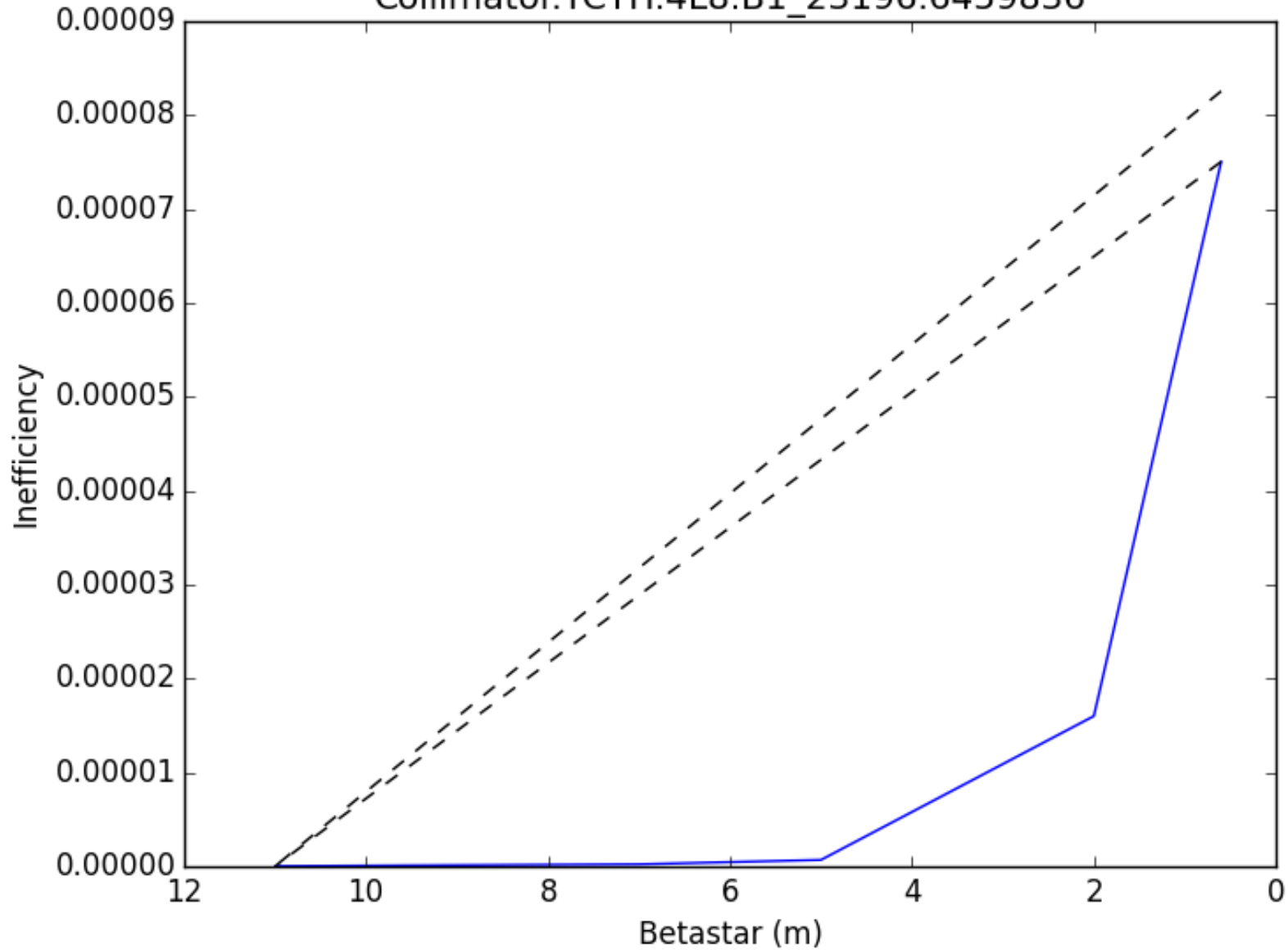
TCP

Collimator.TCP.C6L7.B1_19790.8844



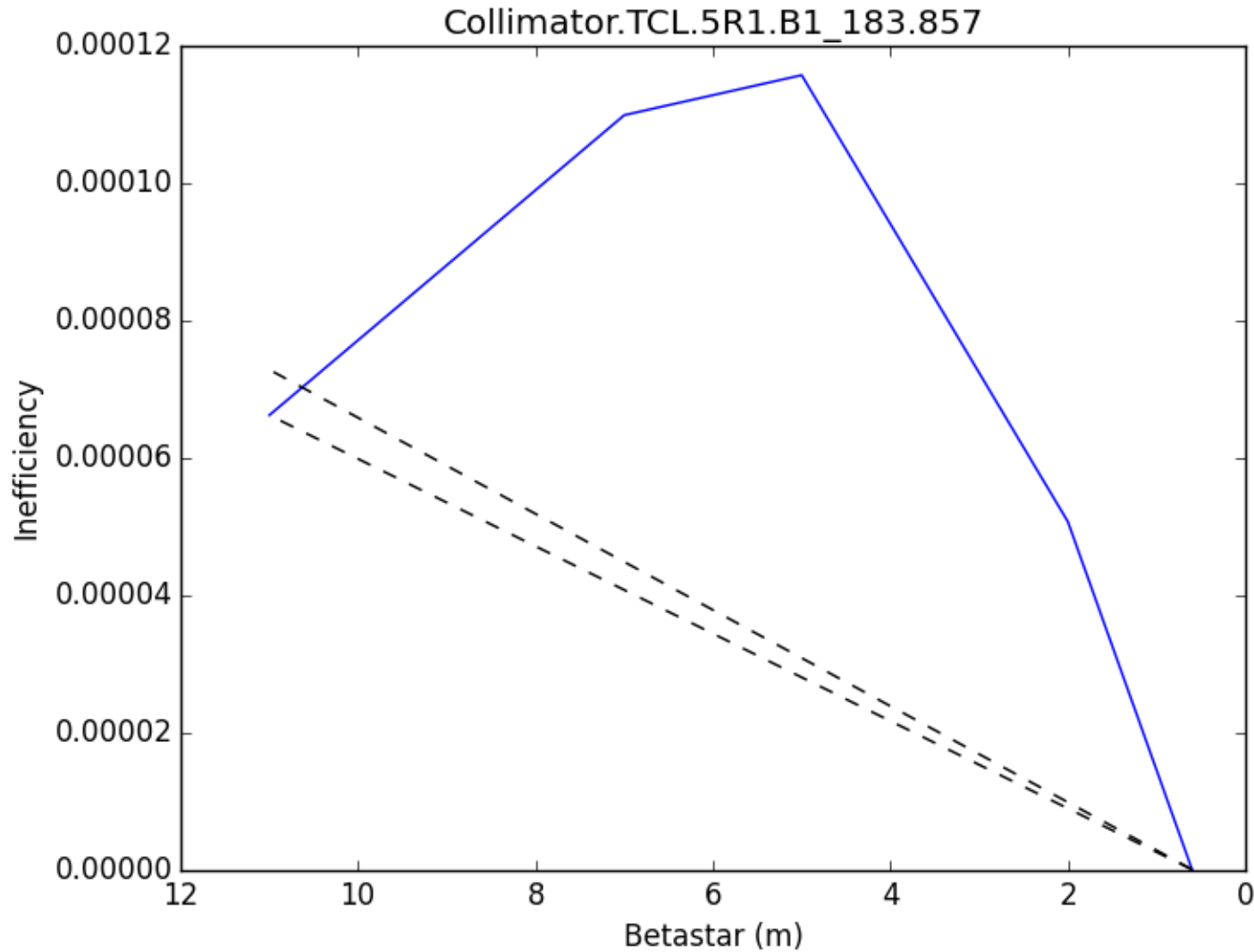
TCTH.4L8

Collimator.TCTH.4L8.B1_23196.6459836



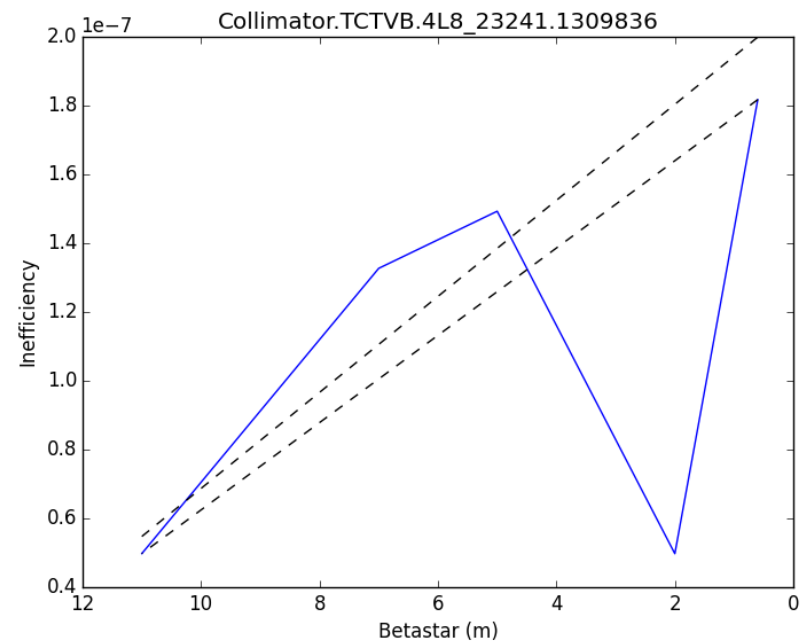
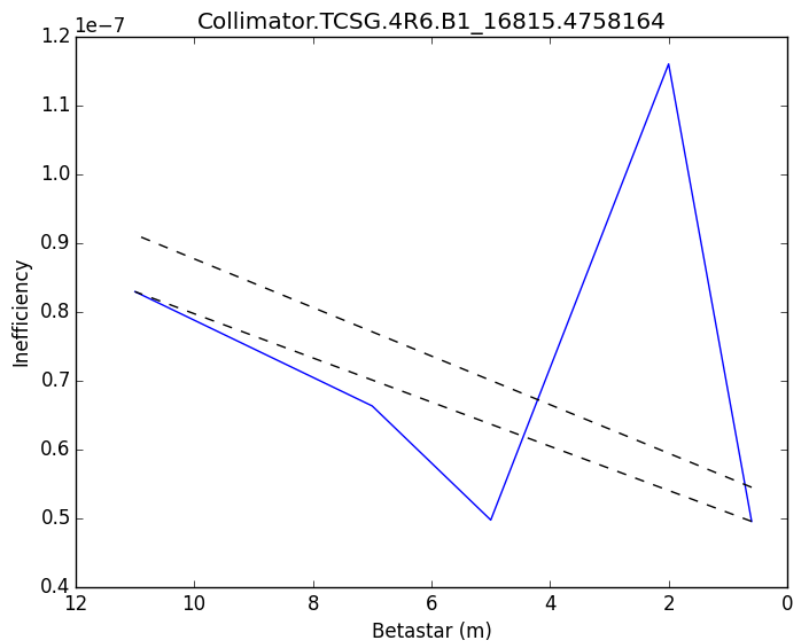
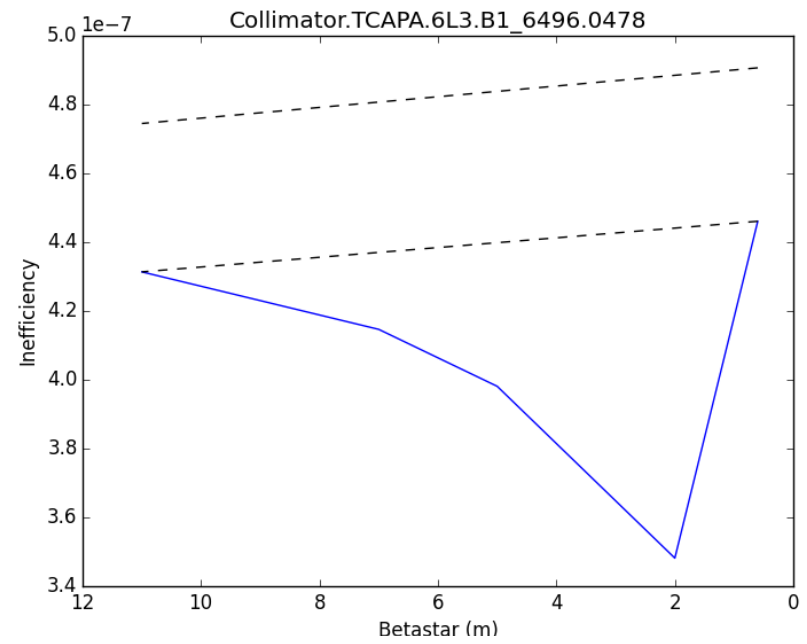
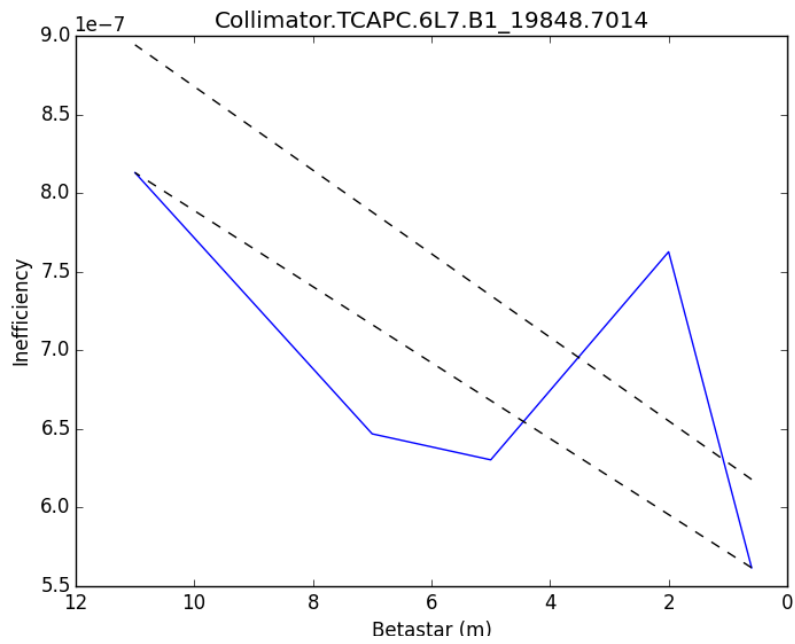
Losses do not occur until small betastar

TCL.5R1



- Mid squeeze loss is double of end point

Interesting interactions?



Conclusion

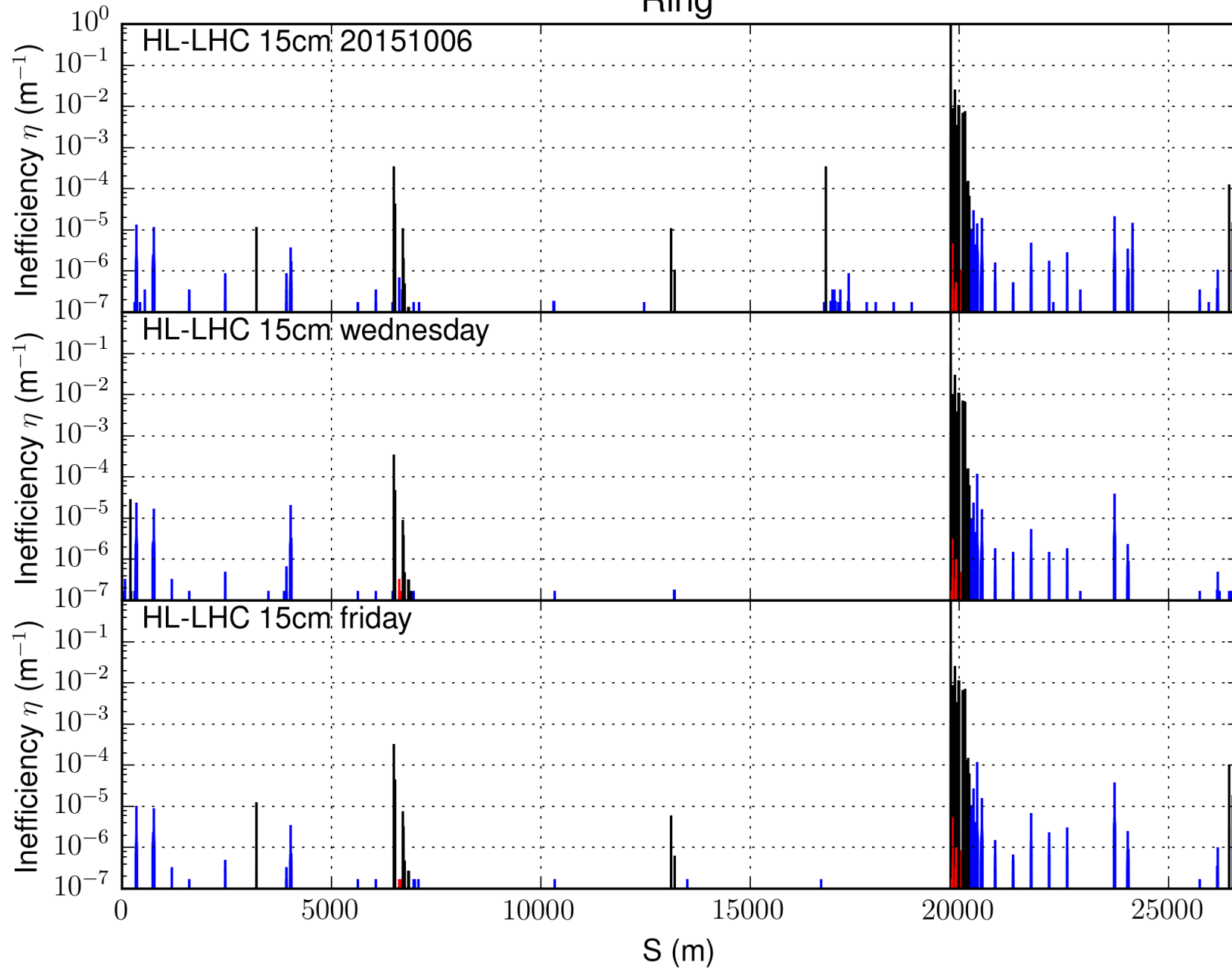
- Can use Merlin to simulate intermediate squeeze optics
- Some interesting effects
 - Some higher losses mid squeeze (TCL)
 - Some interesting interactions (needs more checking)
- Lots to analyse

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

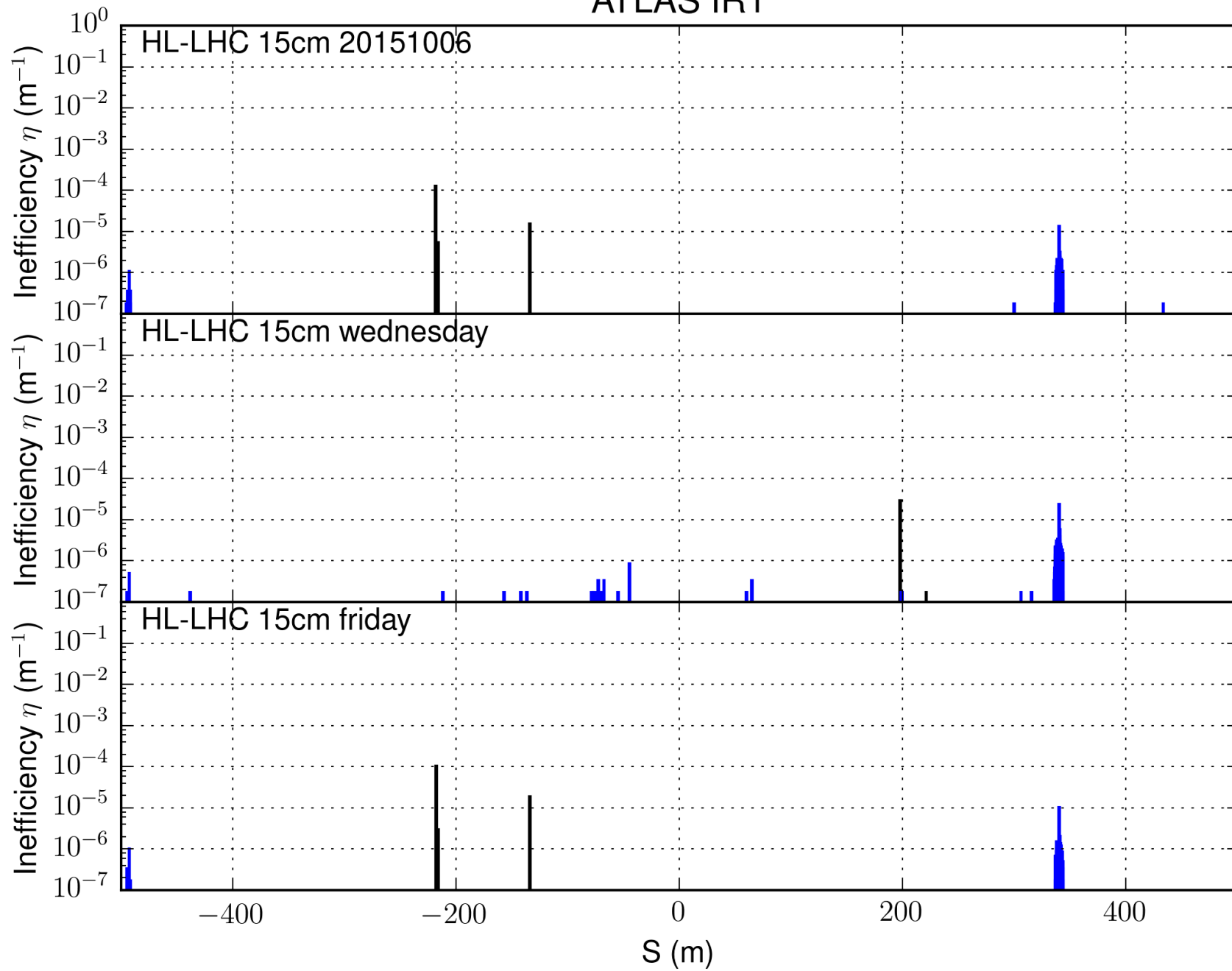
HL squeeze

Ring



HL squeeze

ATLAS IR1



THIS IS GIT. IT TRACKS COLLABORATIVE WORK
ON PROJECTS THROUGH A BEAUTIFUL
DISTRIBUTED GRAPH THEORY TREE MODEL.

COOL. HOW DO WE USE IT?

NO IDEA. JUST MEMORIZE THESE SHELL
COMMANDS AND TYPE THEM TO SYNC UP.
IF YOU GET ERRORS, SAVE YOUR WORK
ELSEWHERE, DELETE THE PROJECT,
AND DOWNLOAD A FRESH COPY.

