Collimation in the experimental IRs

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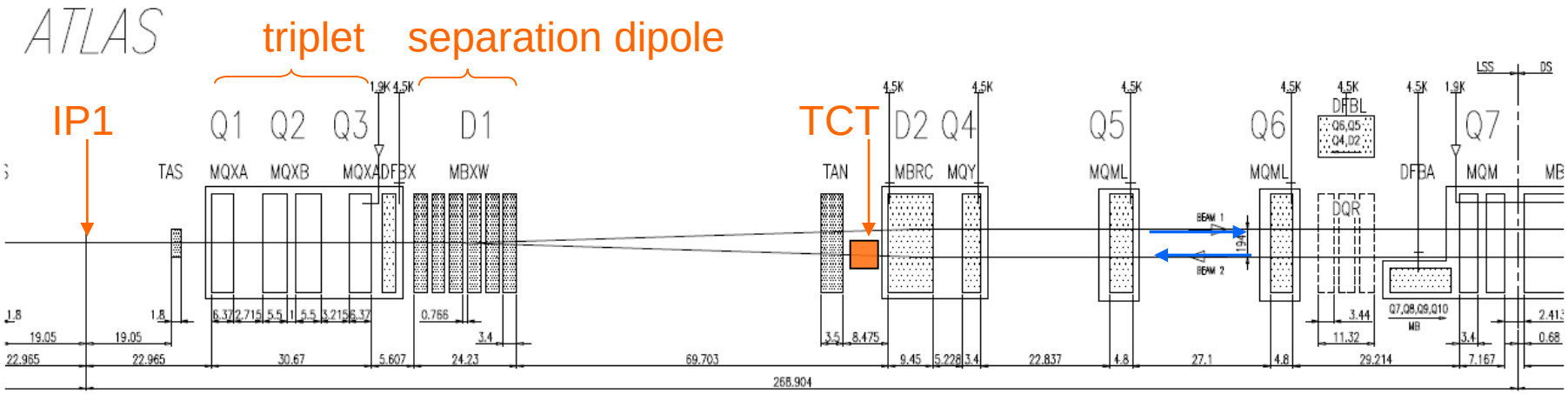
Acknowledgement: B. Goddard and team

Layout of IR1

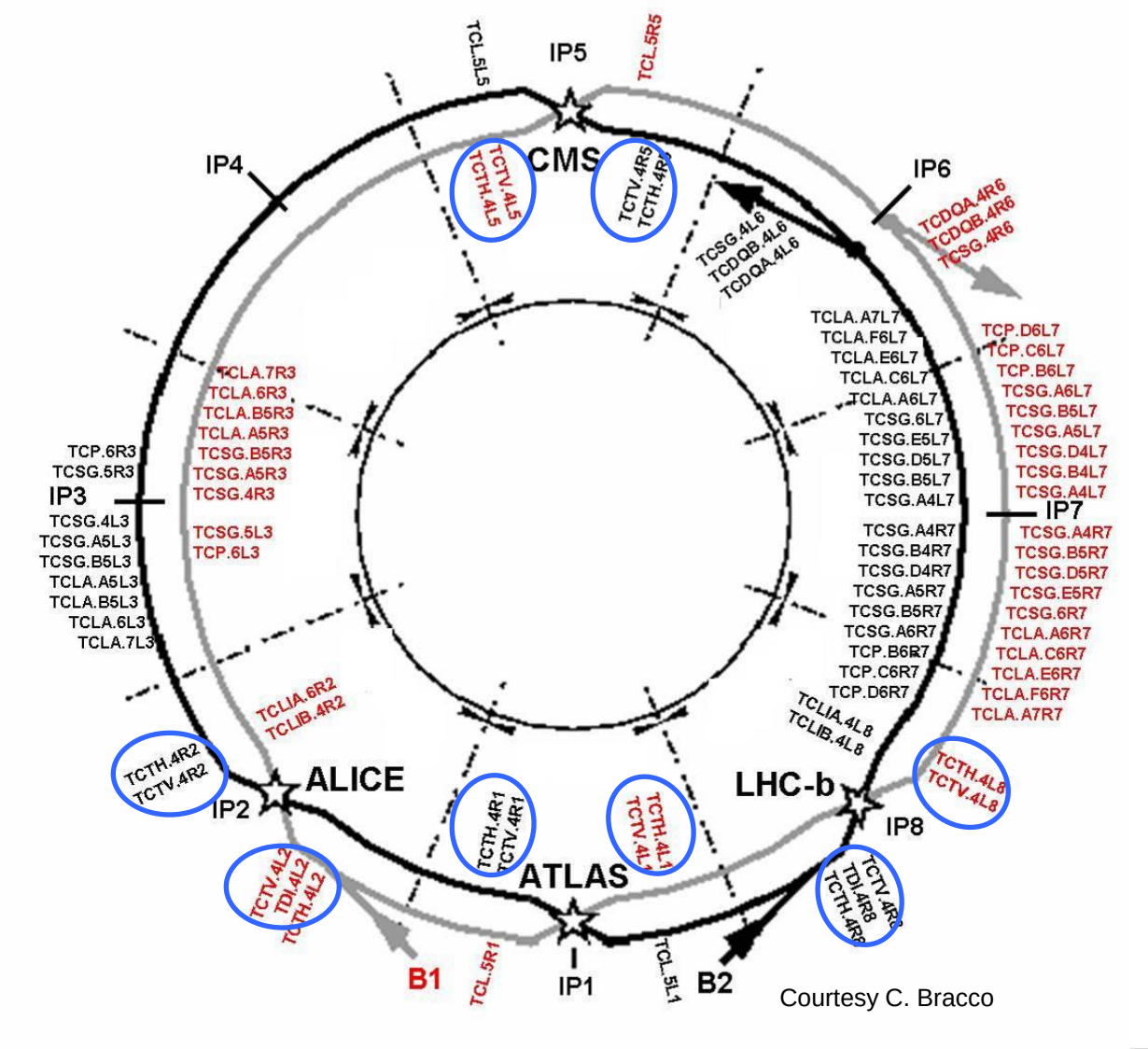


- Passive absorbers (TAS and TAN) intercept outcoming debris from collisions

- Tertiary collimators (TCTs) on *incoming* beam

Layout of TCTs in ring

- One tertiary collimator per plane on the incoming beam in front of each IP



Courtesy C. Bracco

Tertiary collimators

- Tertiary collimators (TCTs) provide third (now fourth step) step in cleaning hierarchy
- Installed in the experimental IRs
- Made of tungsten
- Why we need TCTs:
  - protect cold aperture in IR, in particular bottleneck in triplet from particles leaking out of upstream collimation insertions
  - Passive machine protection: to protect against losses caused by equipment failures or erraneous operation
  - Minimization of collimation-related background at the experiments

Constraints for safe operation

- We need sufficient margin between the TCTs and the triplet aperture bottleneck
- We need sufficient margin in the collimator hierarchy so that it remains valid
- Minimum margins depend on machine reproducibility and stability
  - Coherent analysis of margins is ongoing with colleagues in TE-ABT.

Movement of TCT during ramp and squeeze

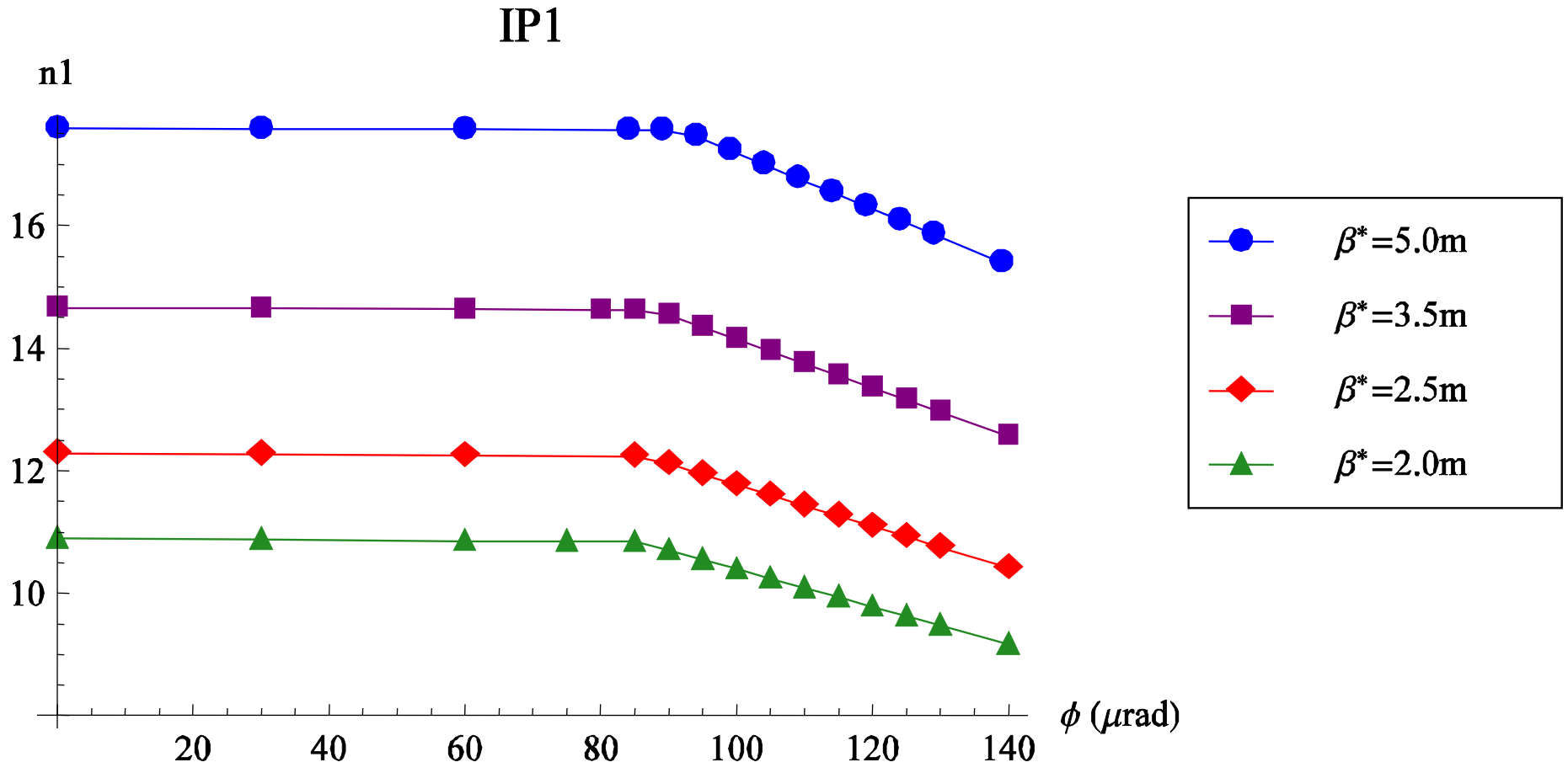
	Inj. Optics, 450 GeV	Inj. Optics, 3.5 TeV	β*=3.5m, separated, no crossing	β*=3.5m, collapsed, 100 μrad half angle
TCT setting (σ)	15-25	40-70	15	15
Margin to triplet (σ)			2.5	2.5
Margin to dump protection			4.4	4.4

TCT & triplet shadowed by arc

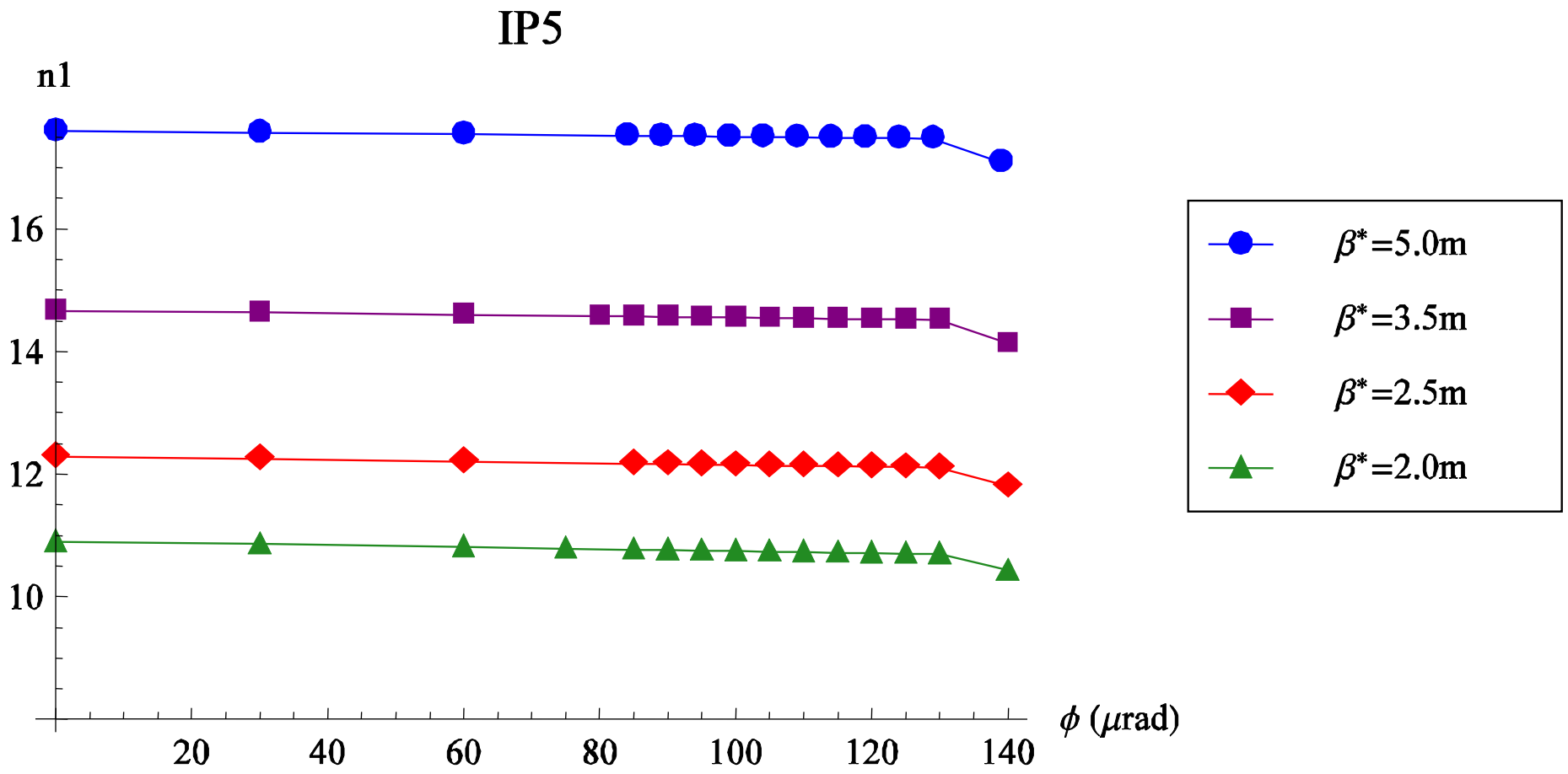
See talk by S. Redaelli

- TCTs moved in to squeezed position at β*=7m

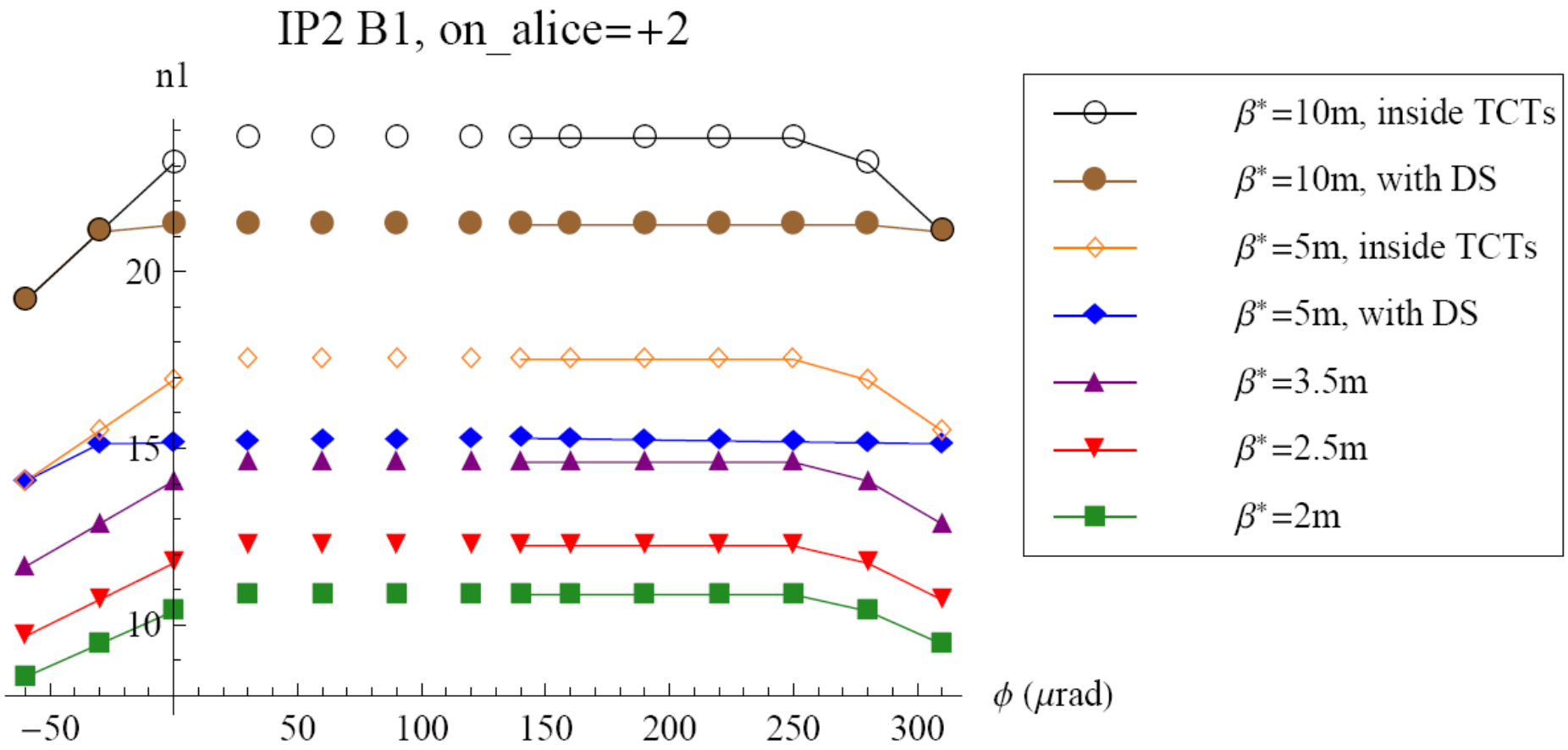
Available margins for crossing angles



Available margins for crossing angles



Available margins for crossing angles

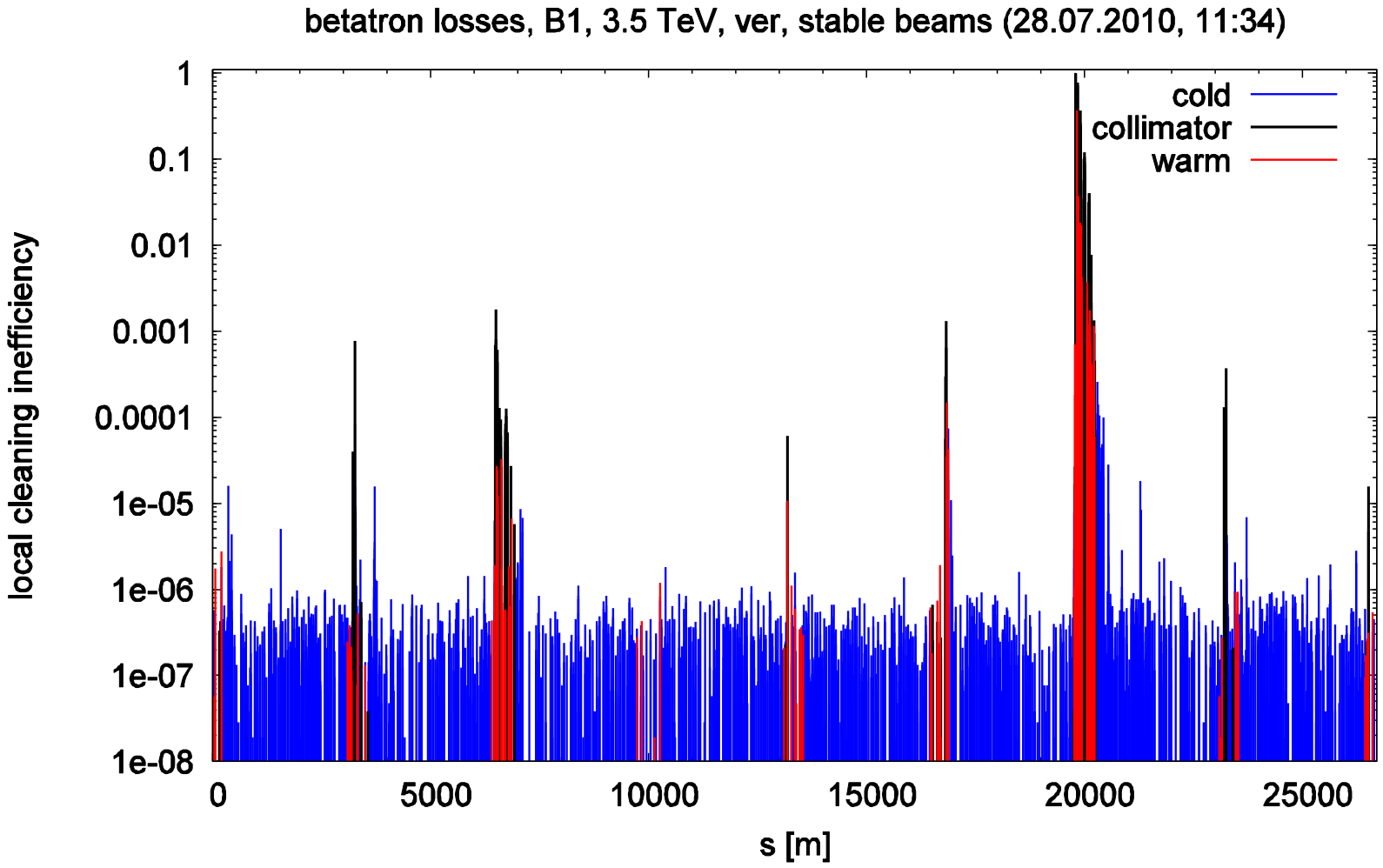


Available margins for lumi scans

- During scans, orbit is moving closer one of the TCT jaws =>
  - margin decreases between TCT and IR6 collimators in case of asynchronous dump
  - The cleaning hierarchy could be violated, causing more losses in the insertions
- As long as n1 is constant, margin to triplet aperture is preserved
- If n1 decreases significantly, new TCT settings must be applied
- The danger is thus a violated hierarchy for cleaning or failures
  - Need to define minimum margin
  - Work ongoing in collaboration with B. Goddard et al.
- During larger scans, we would like the TCTs to follow orbit - not the case now

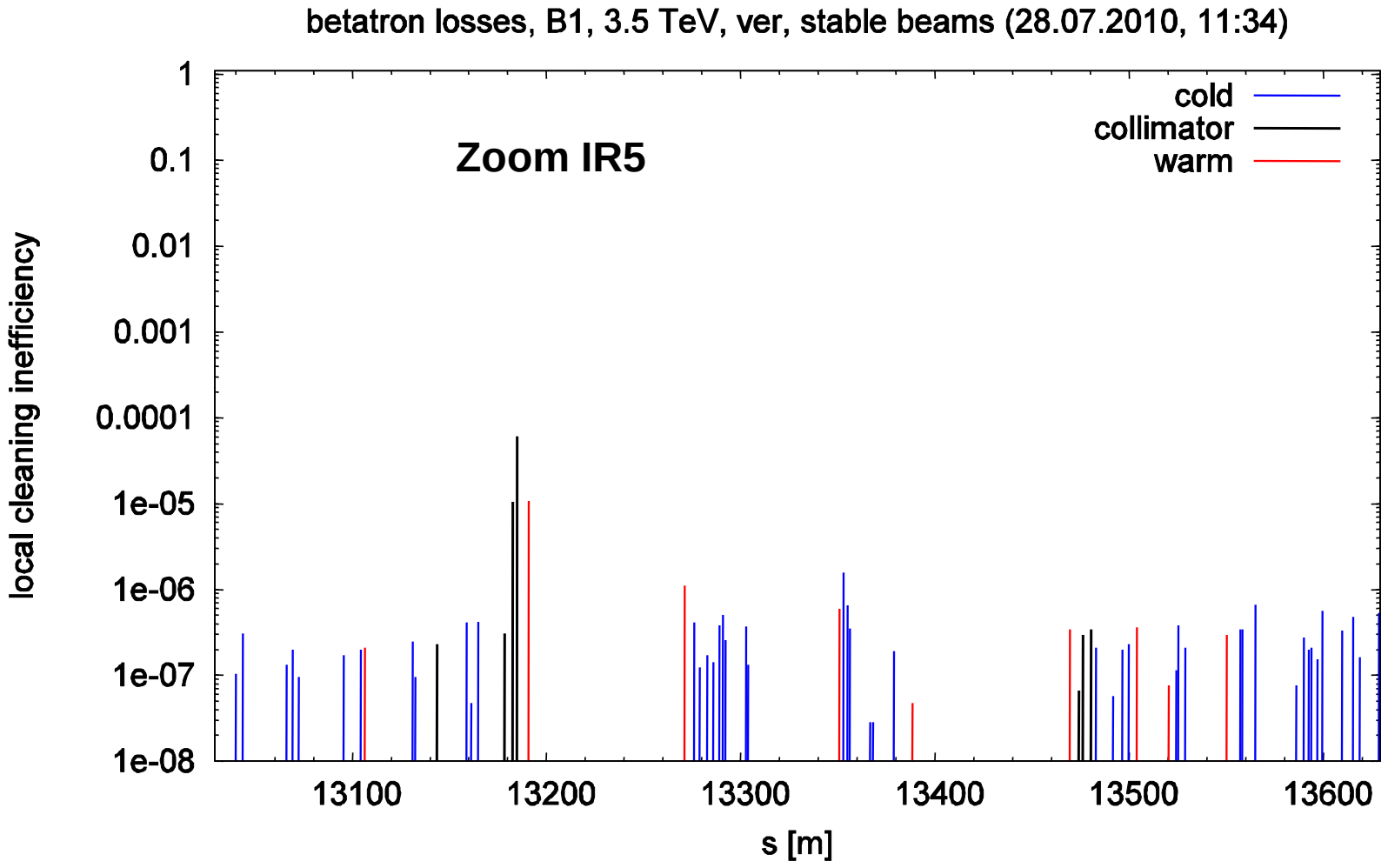
Measured loss map

Verification of cleaning hierarchy: loss map (see talk D. Wollmann)

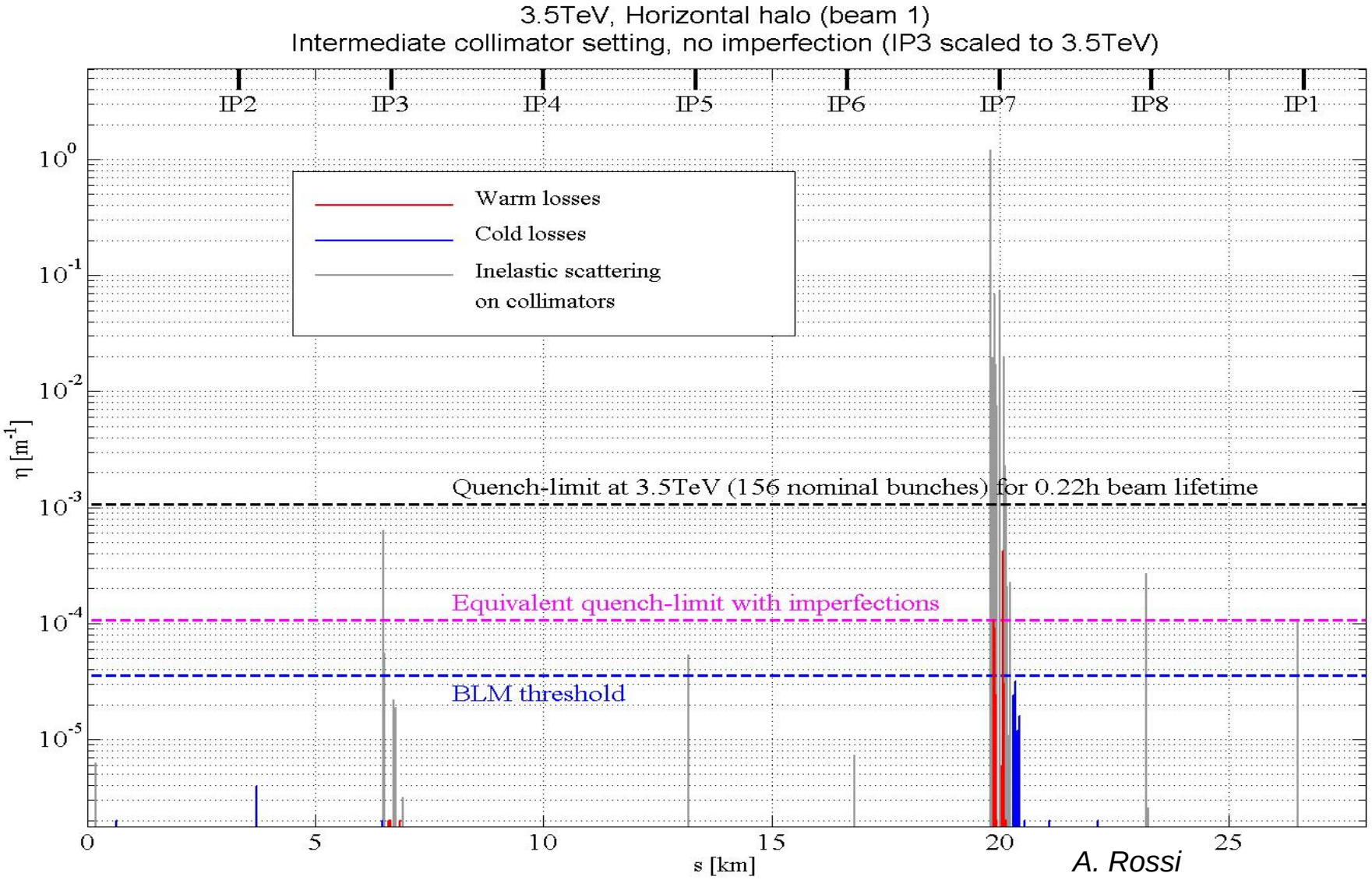


Measured loss map

Verification of cleaning hierarchy: loss map (see talk D. Wollmann)

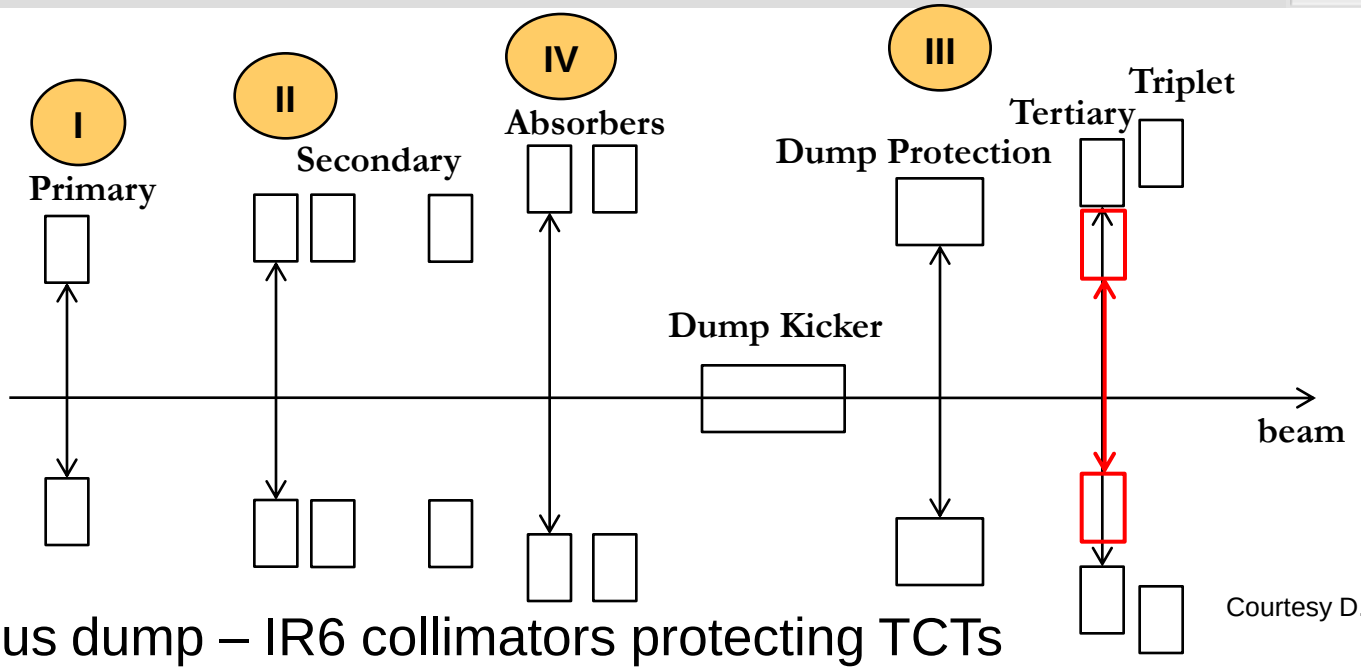


Simulated loss map SixTrack (β*=2m)



R. Bruce, 2010.09.02

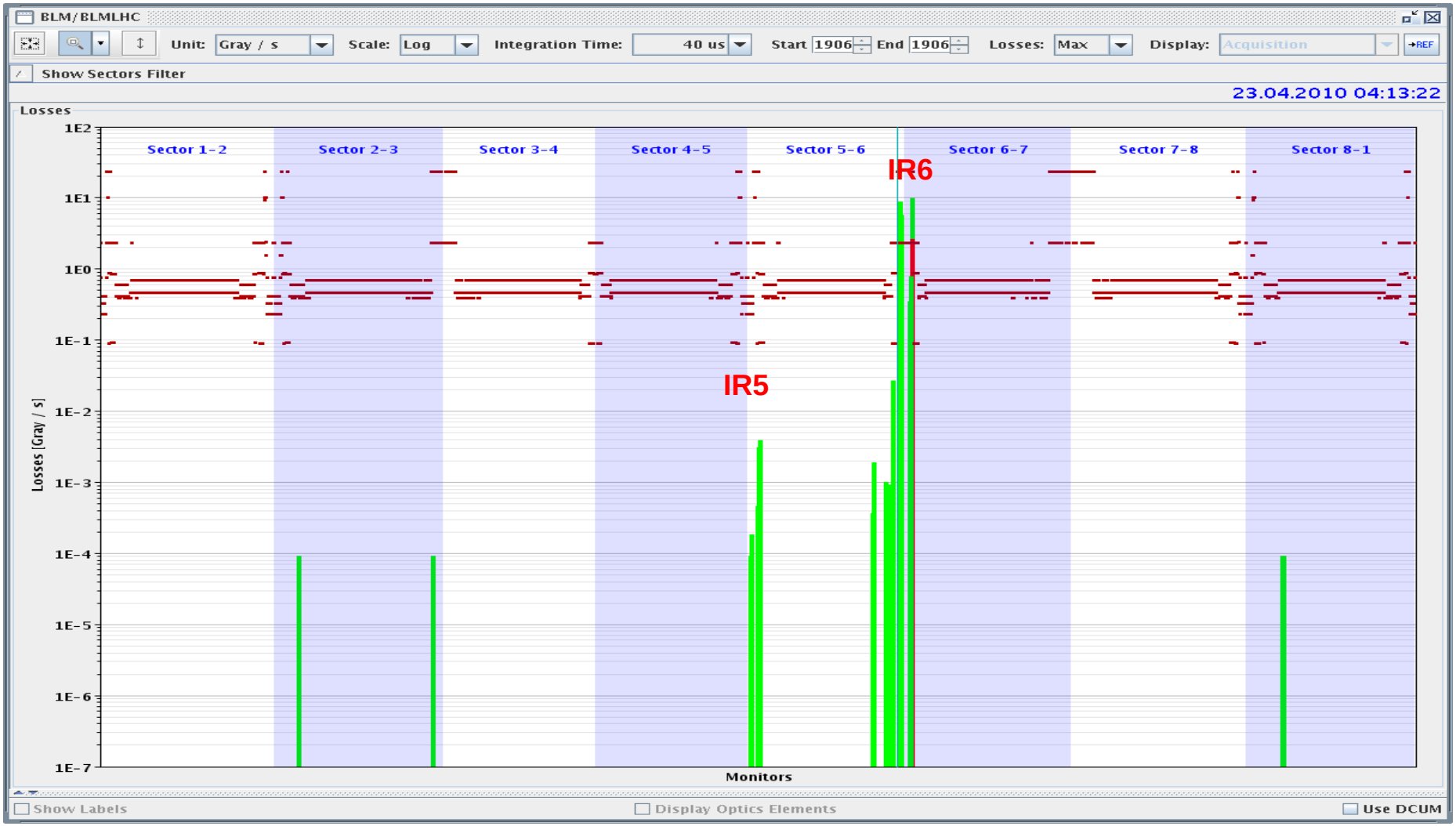
Failure scenarios



Courtesy D. Wollmann

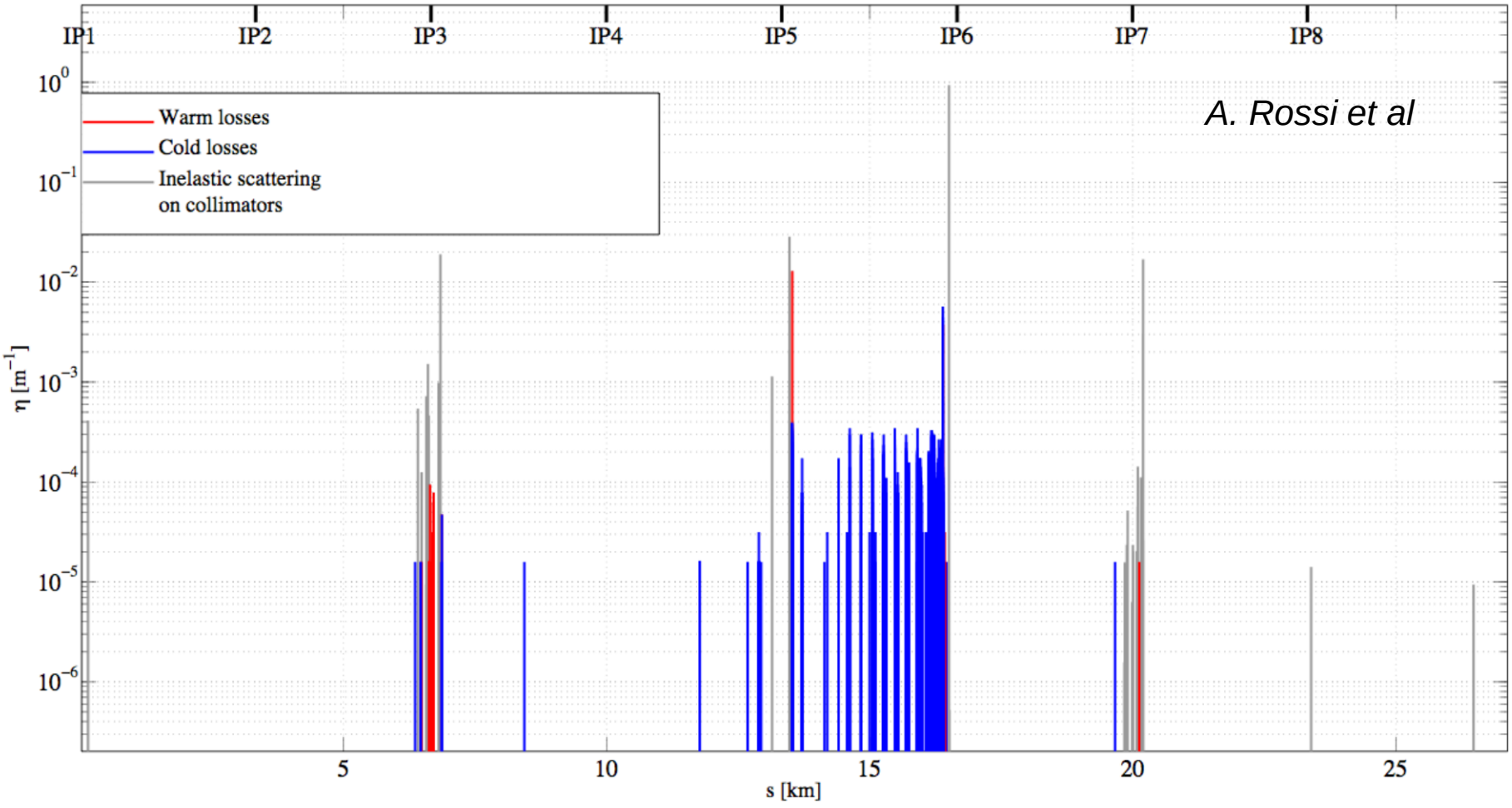
- Asynchronous dump – IR6 collimators protecting TCTs
- Failures during setup: TCTs have to act as primary for beam-based centering during a short time
  - Violation of hierarchy.
  - Possible damage in case of asynchronous dump during setup (very small risk though!)
  - Studies of shockwave damage in case of accident ongoing

Asynchronous dump test



Courtesy B. Goddard et al.

Simulation of leakage in IR5 from IR6



Leakage of 2% with 1.5 cm rms beam size => not worried for TCTs if below this level

Conclusions

- Tertiary collimators (TCTs) on incoming beam around all experimental IRs
- Should protect cold aperture in triplet against losses during regular and irregular operation
- Sufficient margins have to be kept to the triplet aperture and the IR6 dump protection
- TCTs kept constant during ramp and moved in at β*=7m before triplet goes out of the shadow of the arc
- When changing crossing angle, changes in available aperture have to be checked
- Orbit variations during lumi scans must be sufficiently small so that hierarchy is not validated
- Cleaning efficiency verified by loss maps – consistent with expectations
- Leakage to TCTs during asynchronous dump observed to be sufficiently small