Collimation During Ramp and Squeeze

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Acknowledgements to the colleagues in the
LHC Collimation Working Group and ABP, in particular:

C. Bracco, T. Weiler, S. Redaelli, R. Steinhagen, G. Robert-Demolaize
for providing data and plots.

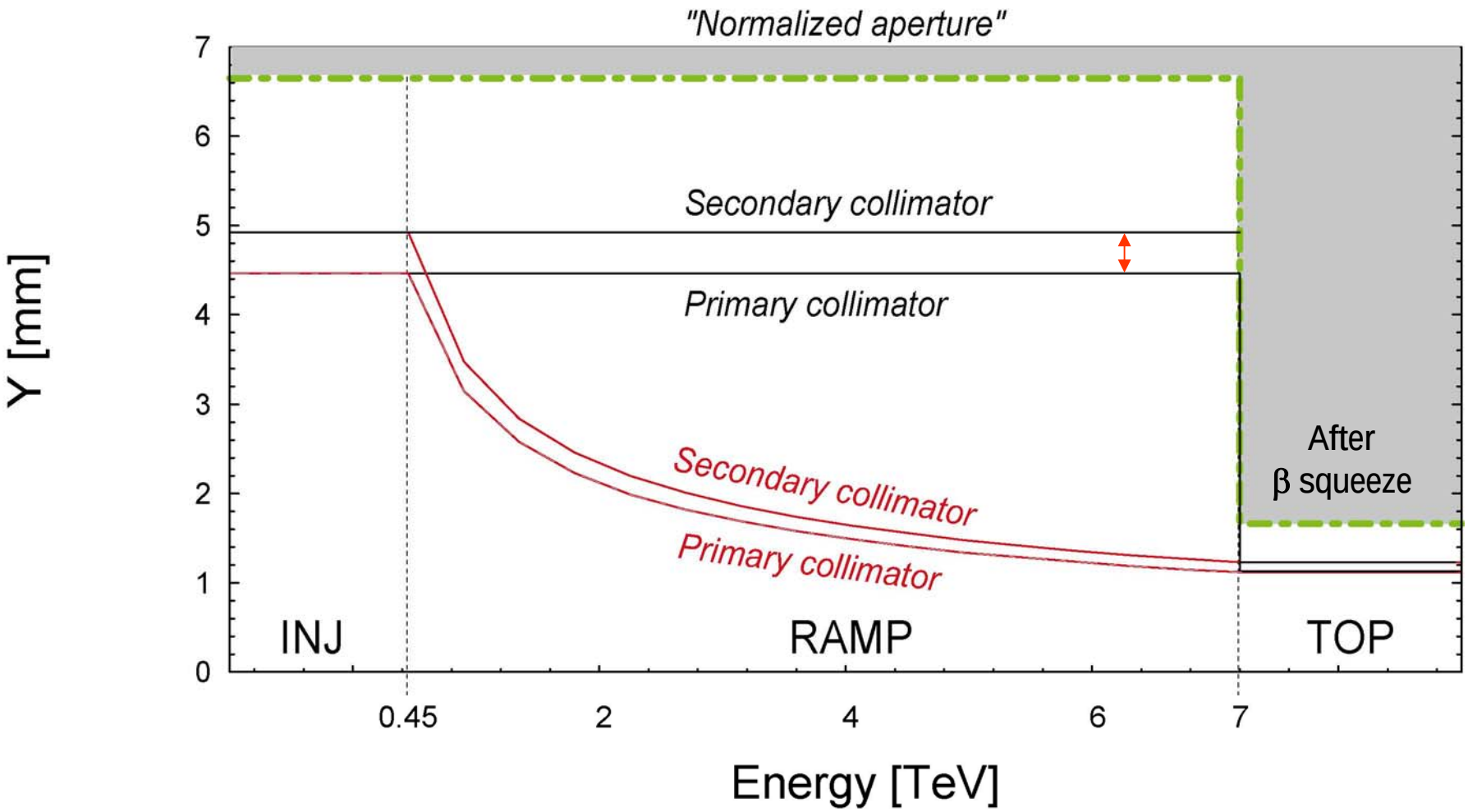
LHCCWG

November 28th, 2006

ABP Work on Collimation

- **Guillaume Robert-Demolaize** last week successfully defended his thesis at University of Grenoble:
  "Design and Performance Optimization of the LHC Collimation System" ➔ AB seminar this Thursday before starting job in BNL.
- **Chiara Bracco** performs her PhD on commissioning of the collimation system in collaboration with EPFL:
  "Commissioning Scenarios and Tests for the LHC Collimation System"
  ➔ Chiara will be happy to report on her results in some future meetings.
- **Valentina Previtali** will perform her PhD (starting Jan 1, 2007) on upgrade scenarios for the LHC collimation system (including crystals) in collaboration with EPFL. Valentina will participate in commissioning and analysis of phase 1 performance.
- **Thomas Weiler** (fellow) is preparing hardware commissioning paper. Will participate in HWC and is participating in collimation studies.

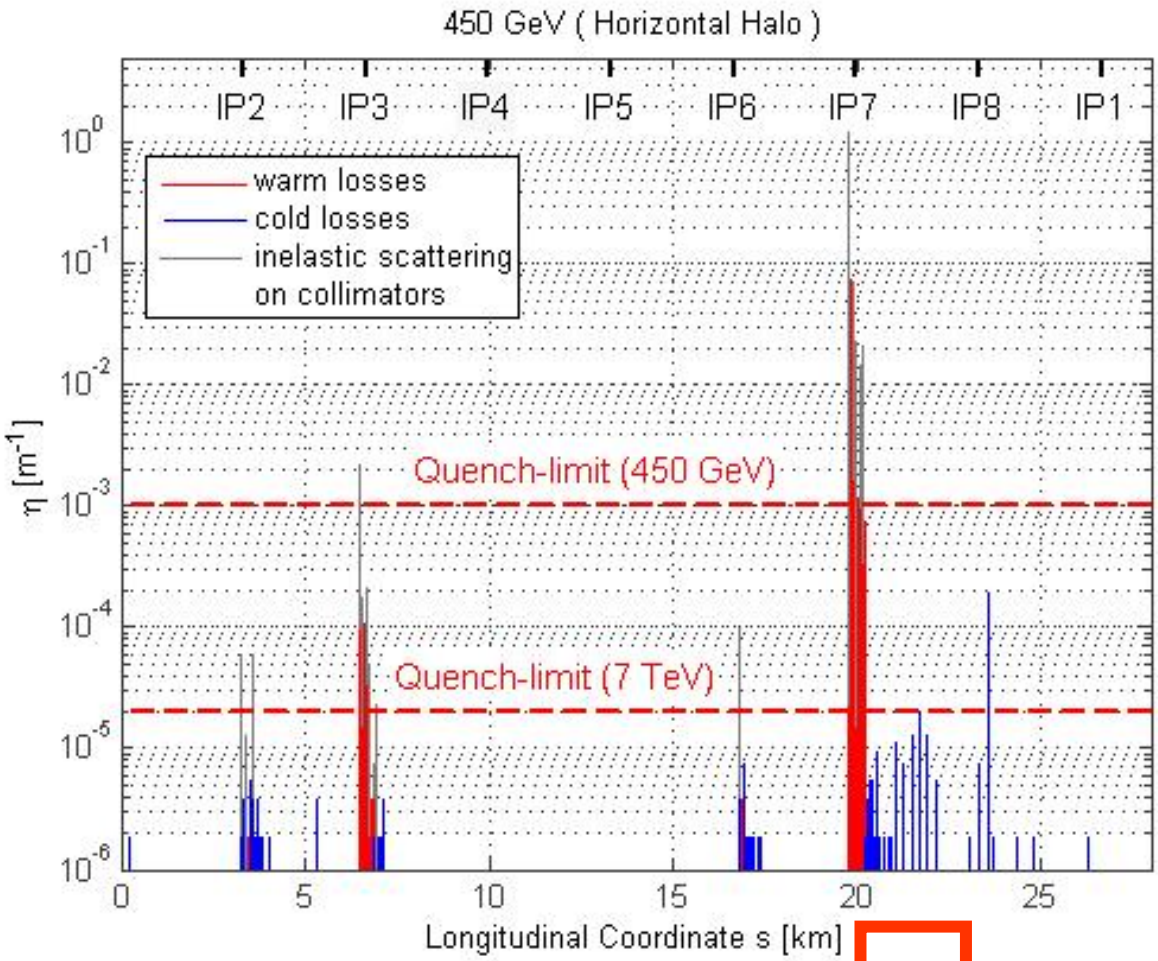
Possible Vertical Collimator Settings

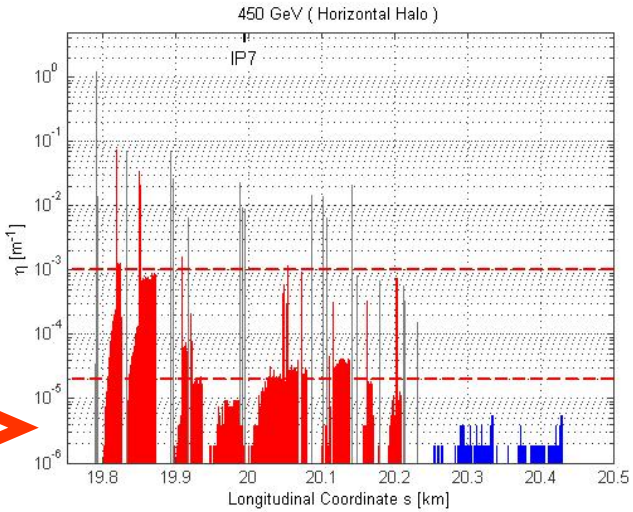


➔ *Consider very different values for retraction primary – secondary collimators…*

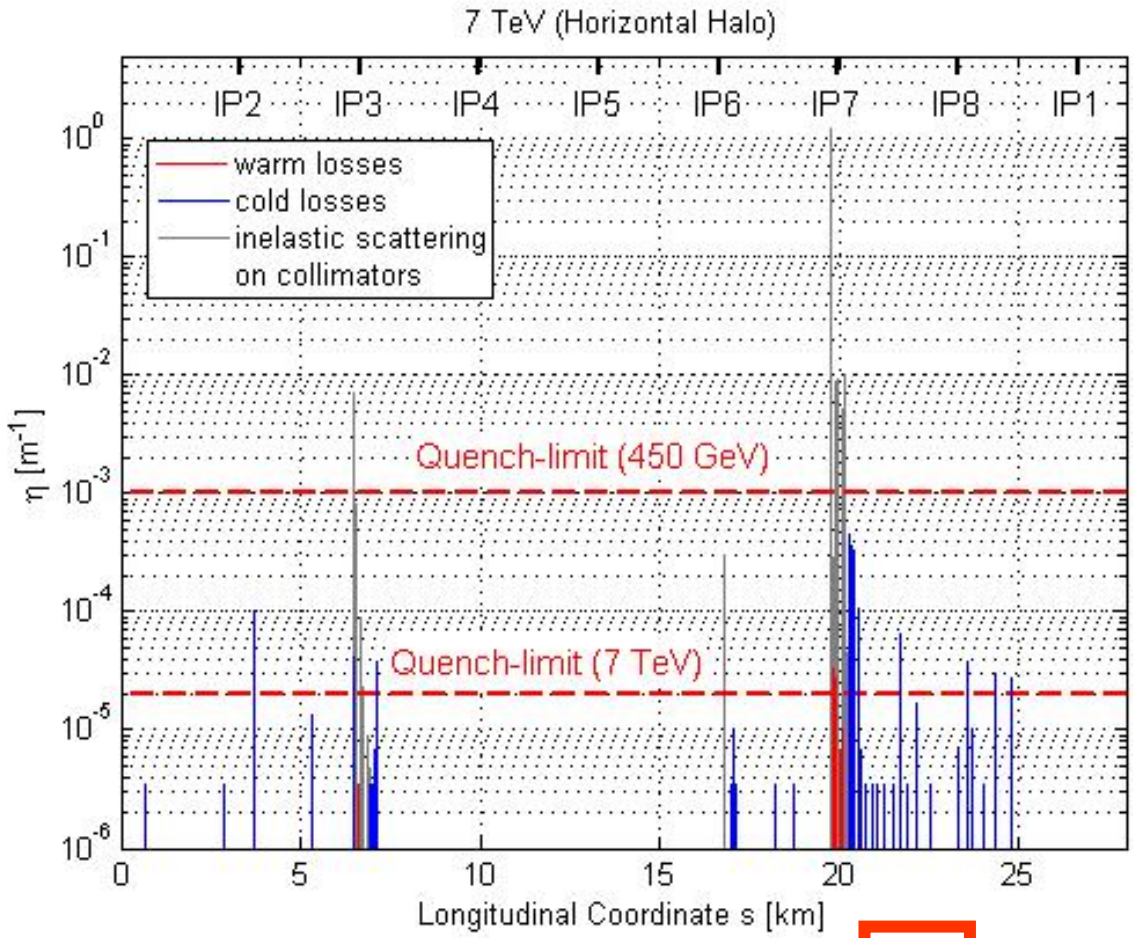
Loss Map at Start of Ramp

C. Bracco

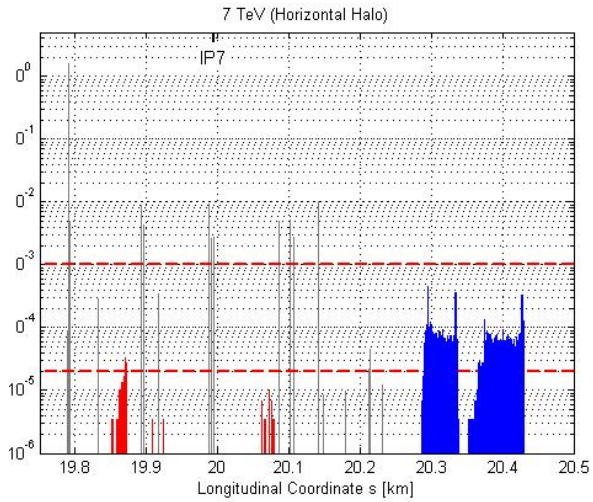




Loss Map End of Ramp (Collimators at Injection Settings)

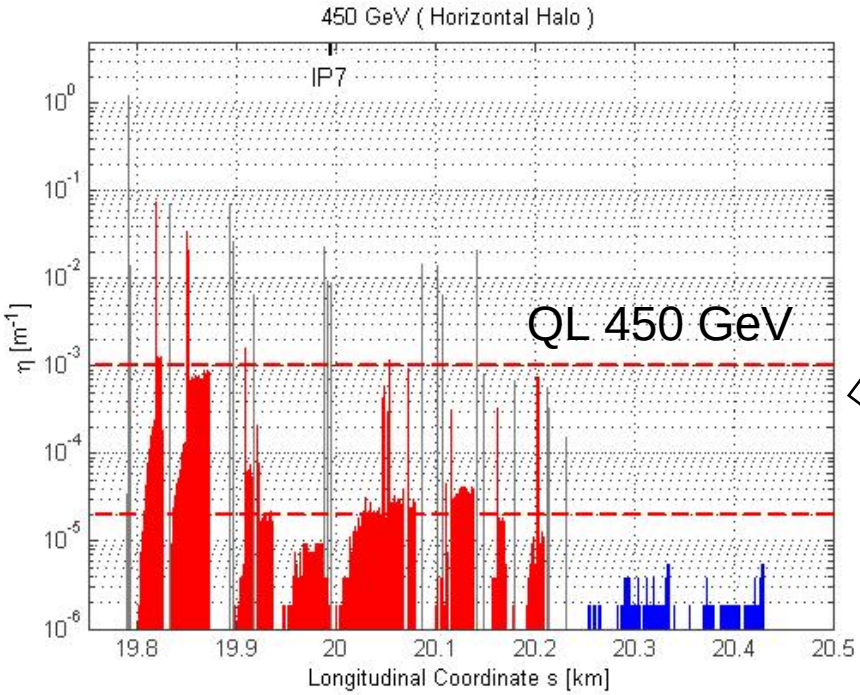


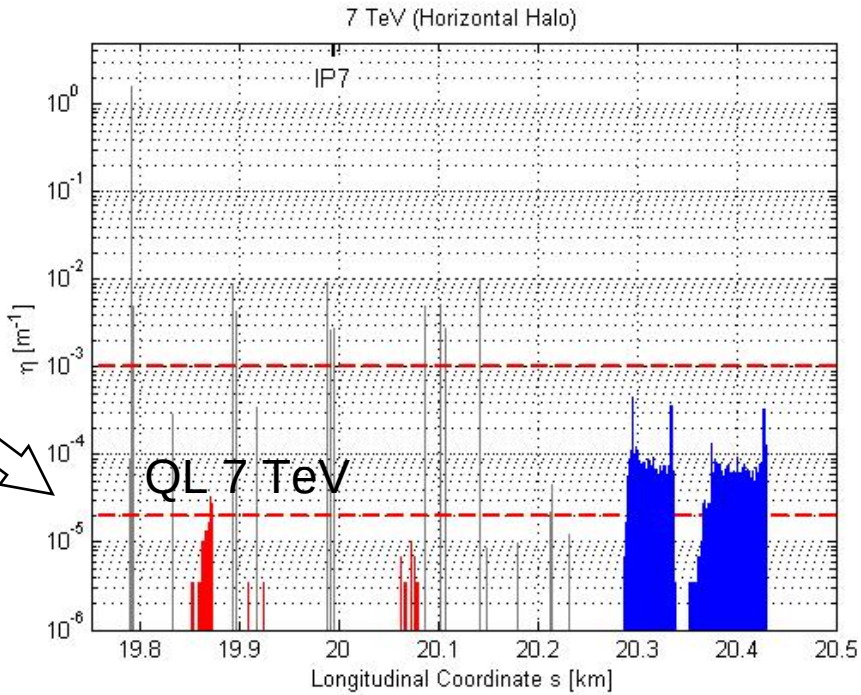
C. Bracco



Ramp without Closing Collimators

C. Bracco

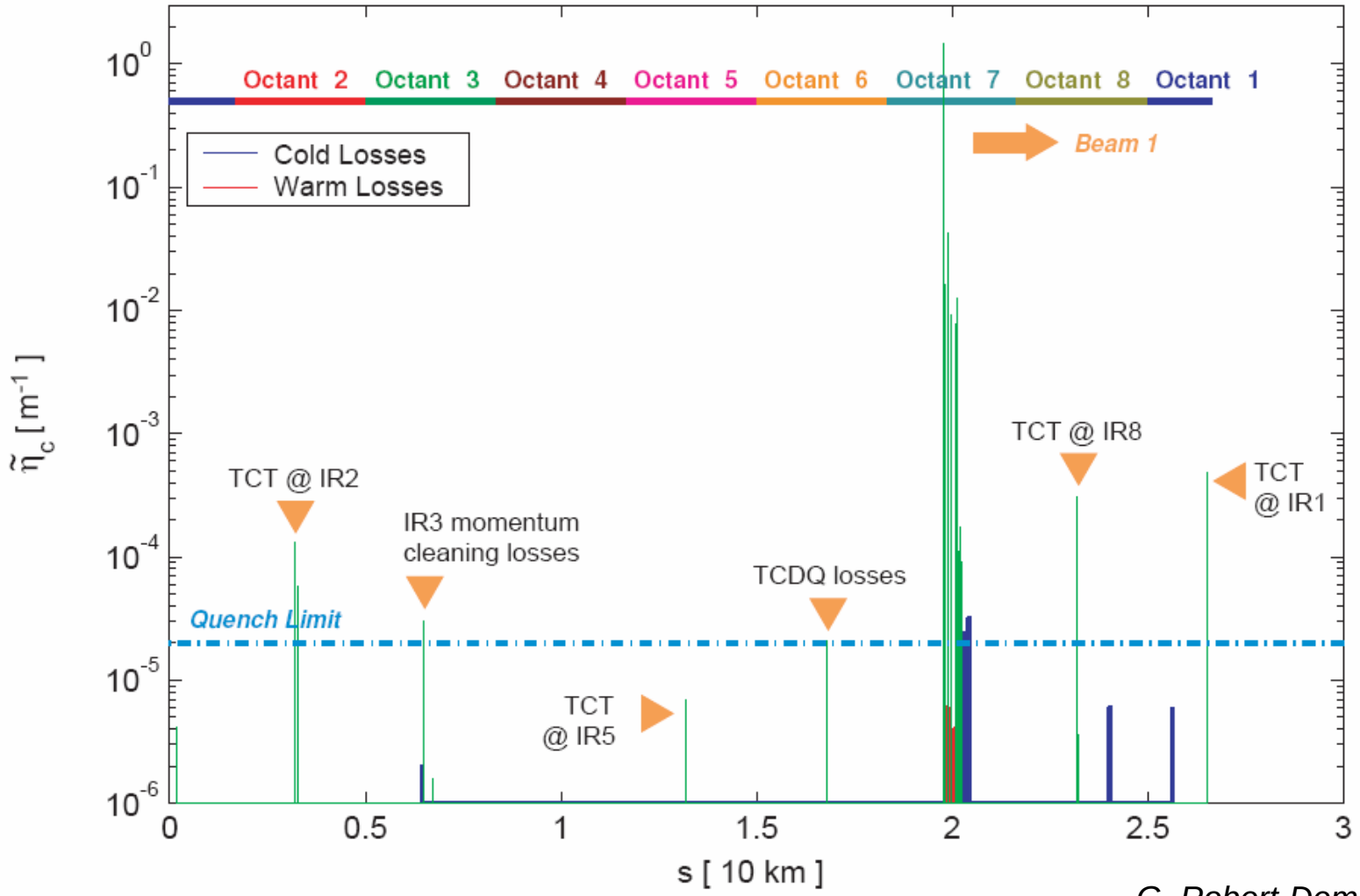




Two observations: 1) Quench limits go down.

2) Local losses in DS go up because collimator not closed!

Collision: Collimators Closed (0.55m)



G. Robert-Demolaize

Optimized Setting during Ramp

Primary closing with energy (remains at 5.7σ)!

Absolute distance from secondary collimator to primary kept constant:

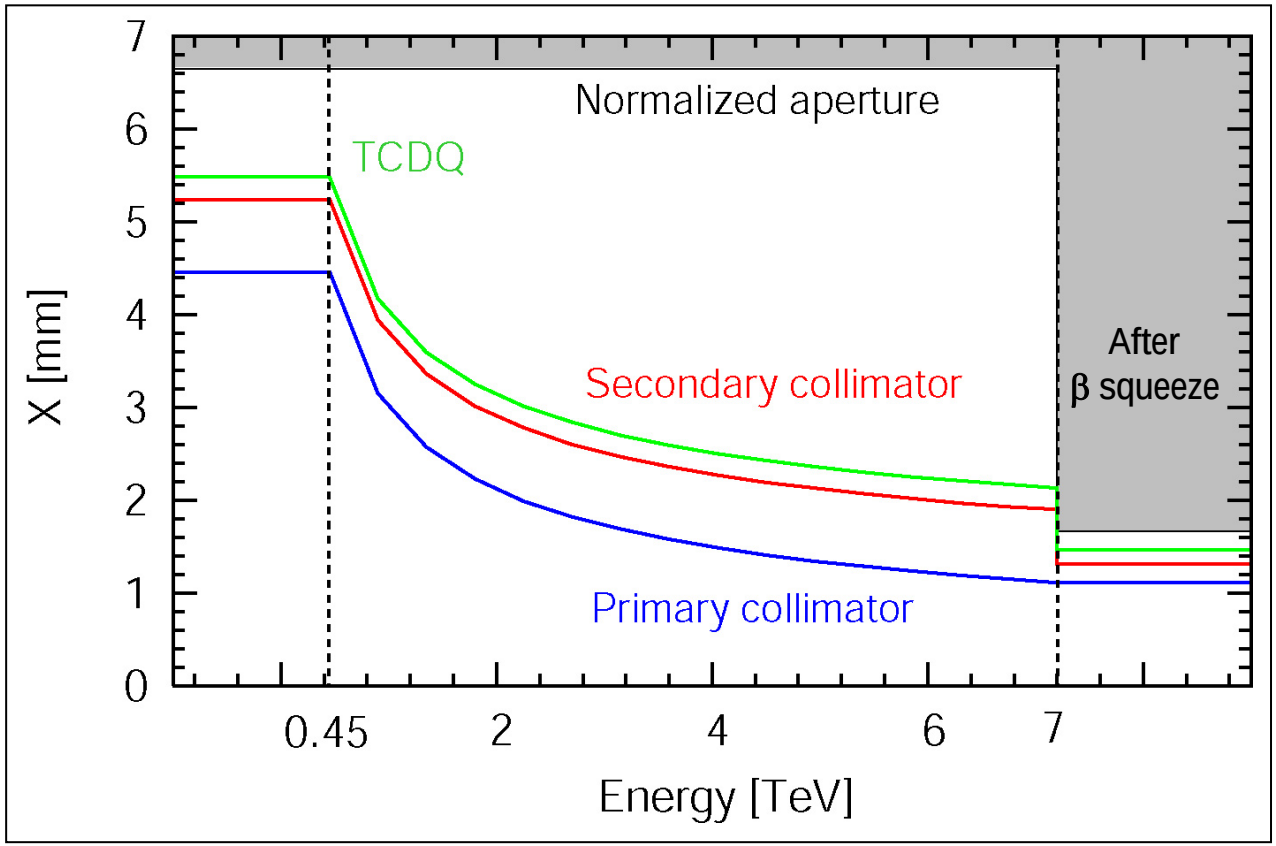
➔ Increased setting in σ.

➔ Constant orbit and beta beat tolerances from collimation!

➔ Better cleaning efficiency!

TCDQ follows secondary collimators with constant absolute distance:

➔ Increased setting in σ.



X normalized to location of primary collimator

Open phase space shrinks during ramp:

➔ Improved safety against emittance blow-up

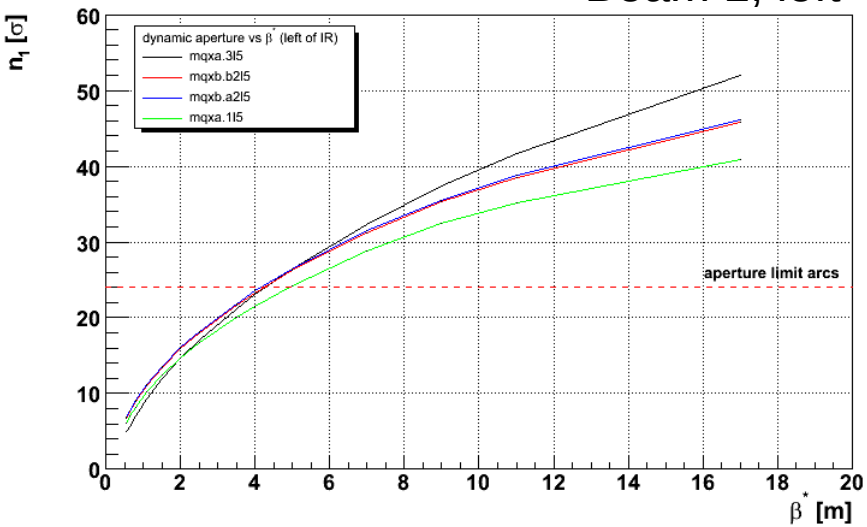
➔ Orbit errors caught earlier

➔ dI/dt is not as steep when beam loss is seen

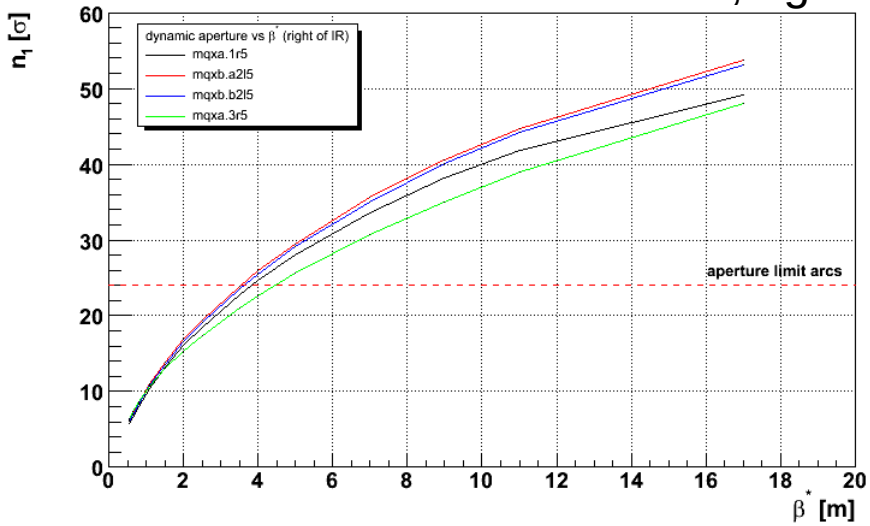
IP1 Triplet Aperture During Squeeze

T. Weiler

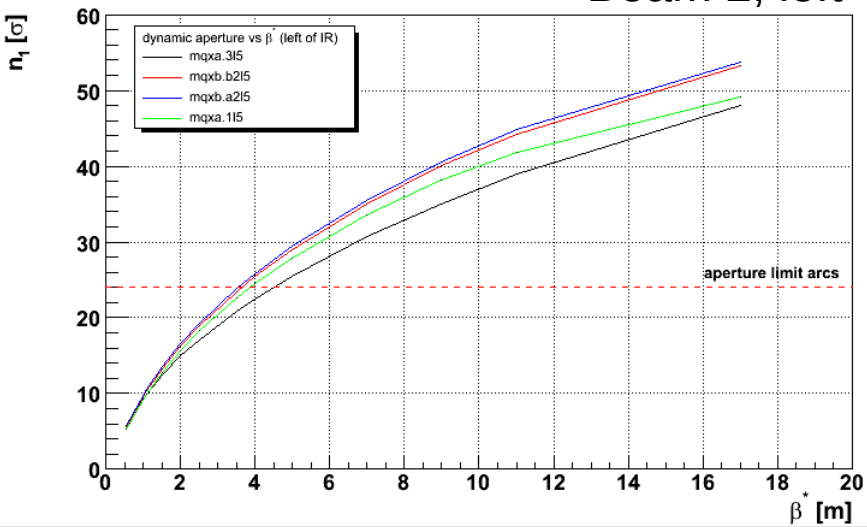
Beam 1, left



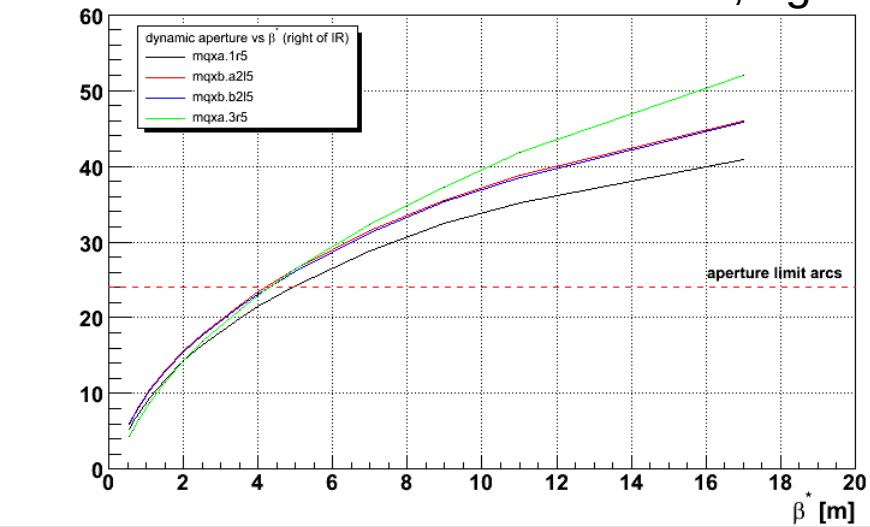
Beam 1, right



Beam 2, left



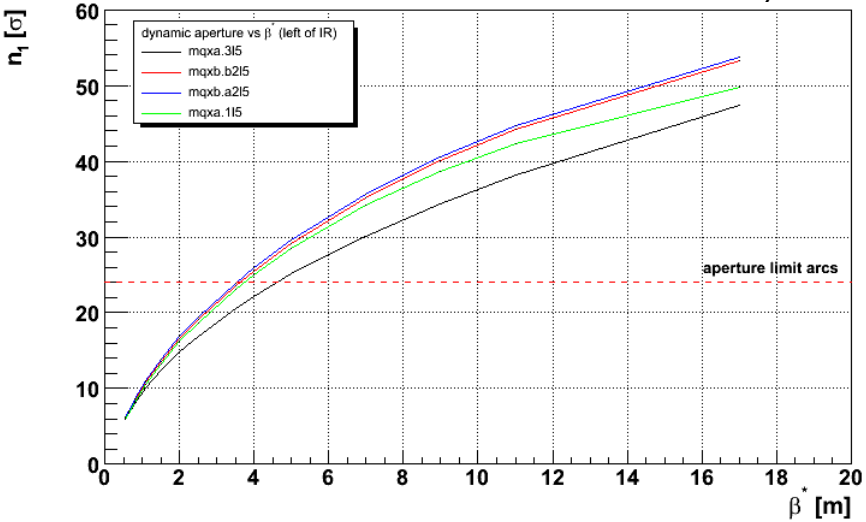
Beam 2, right



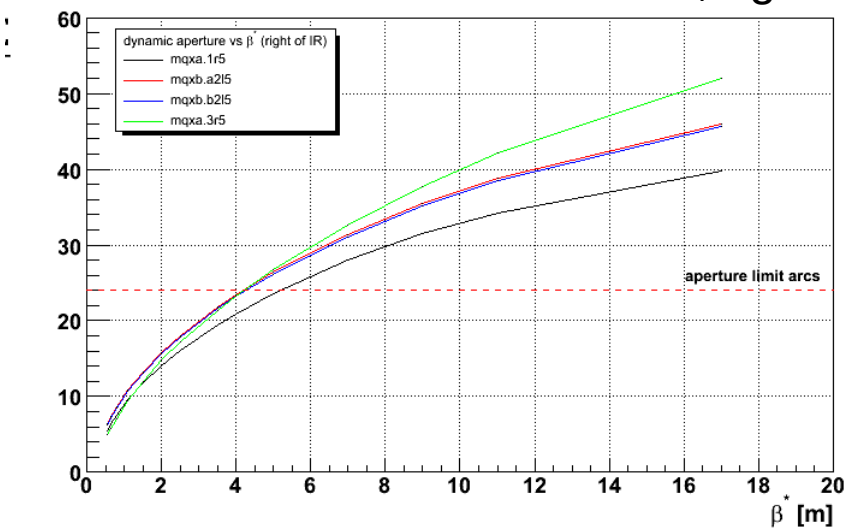
IP5 Triplet Aperture During Squeeze

T. Weiler

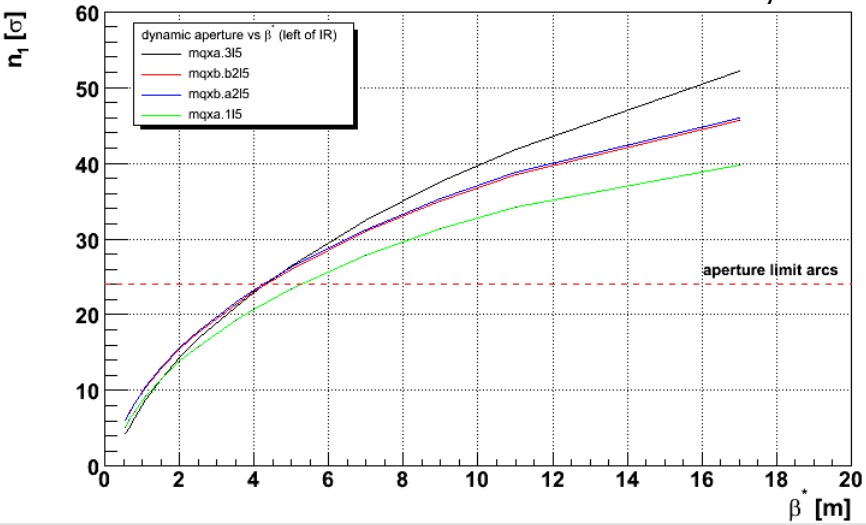
Beam 1, left



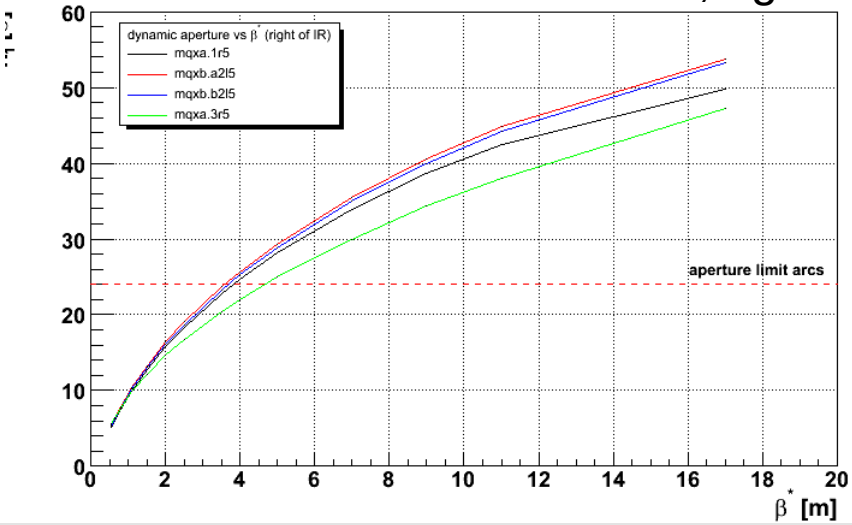
Beam 1, right



Beam 2, left

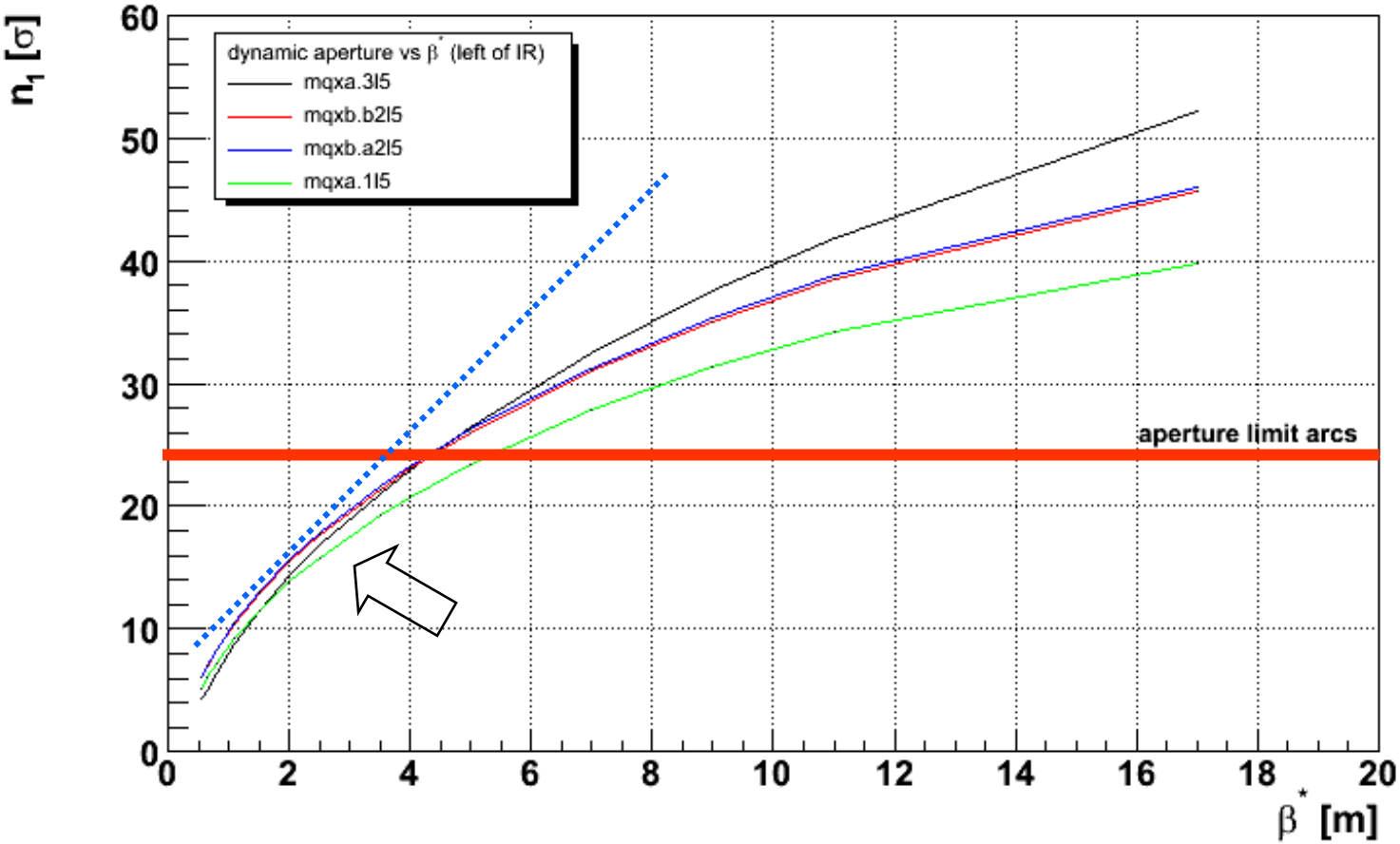


Beam 2, right



Limit at IP5

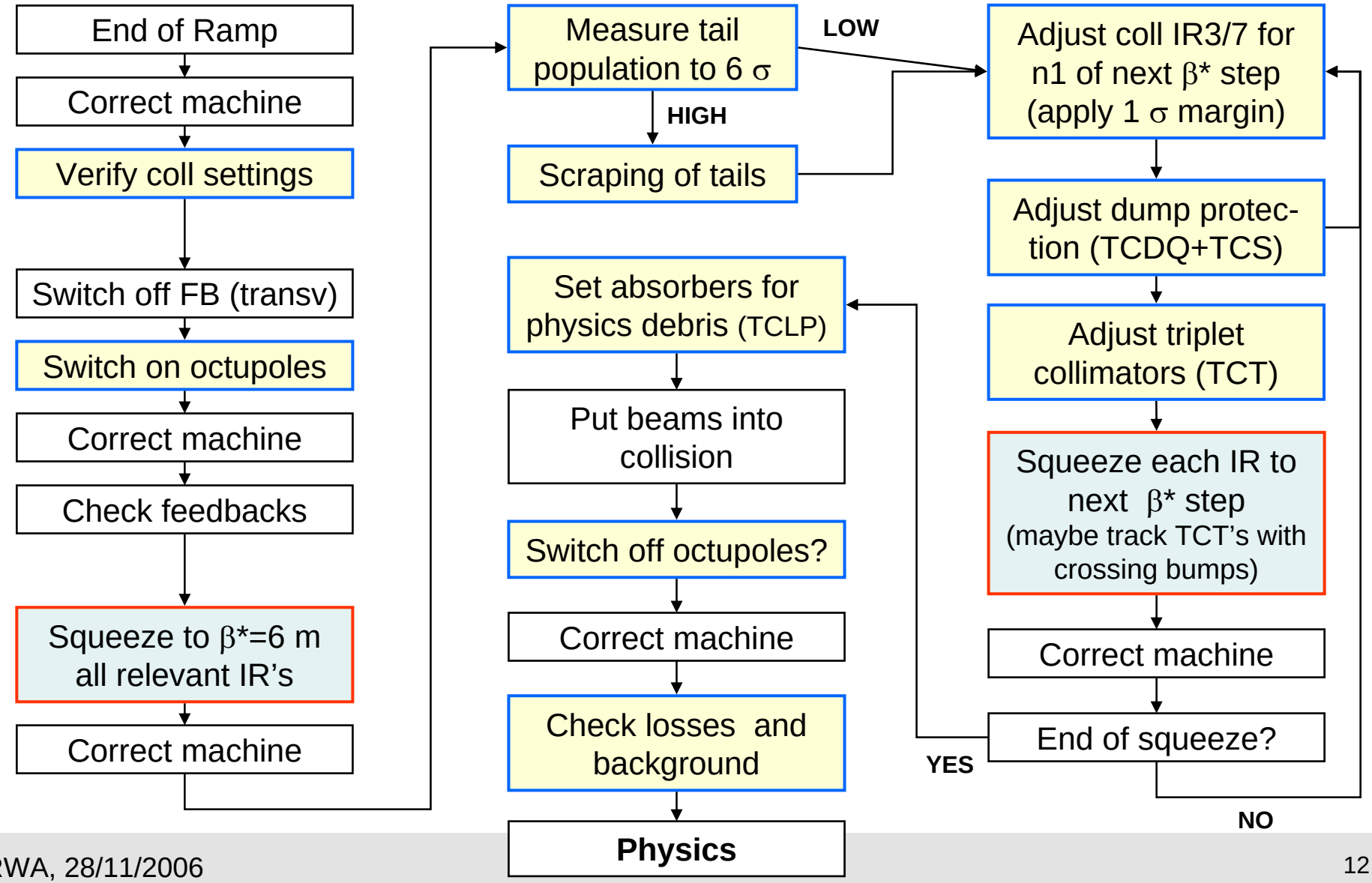
T. Weiler



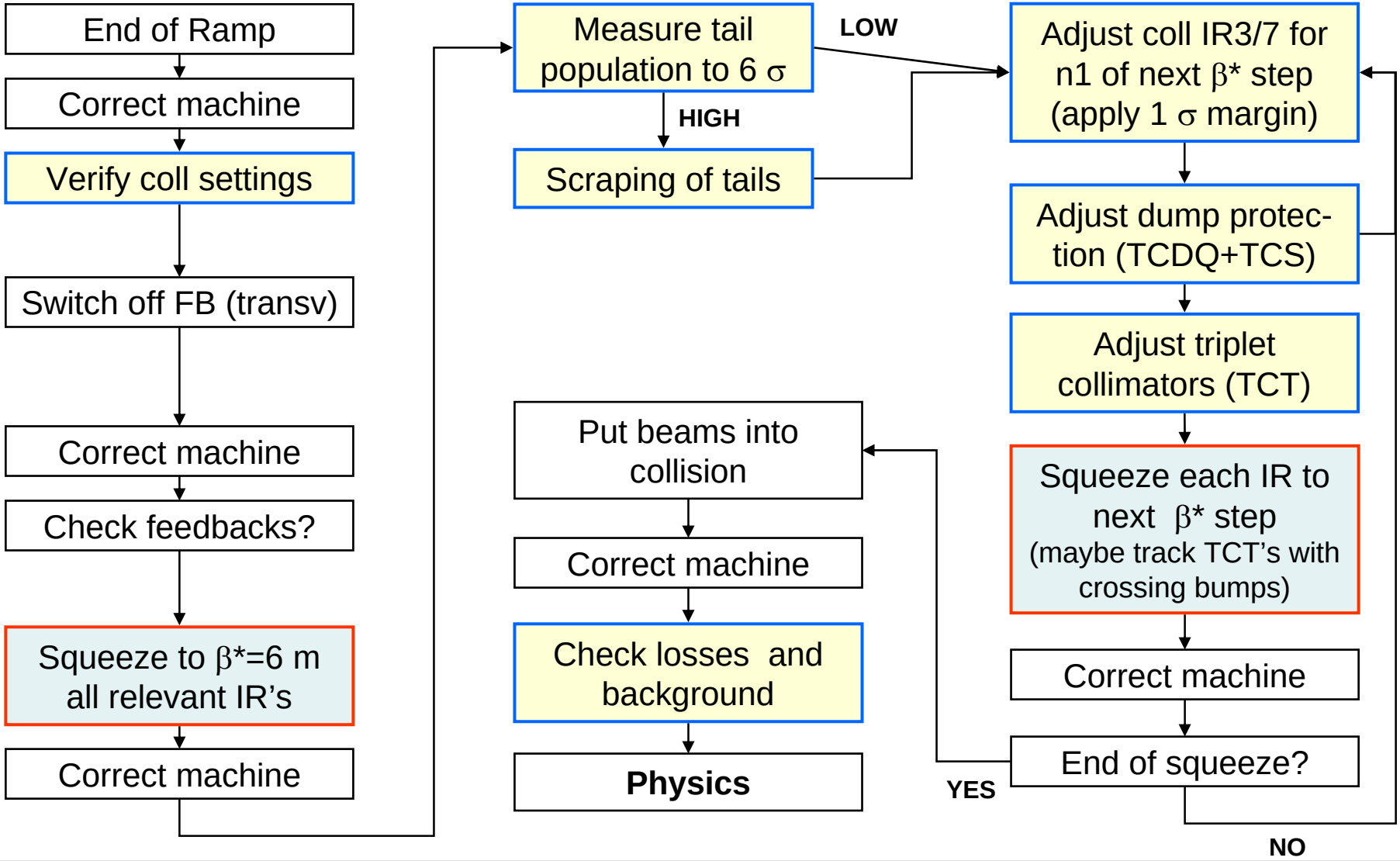
Obliged to close collimators below β* of ~6 m!

Change in n1: about 2.5 σ per m in β* in relevant range!

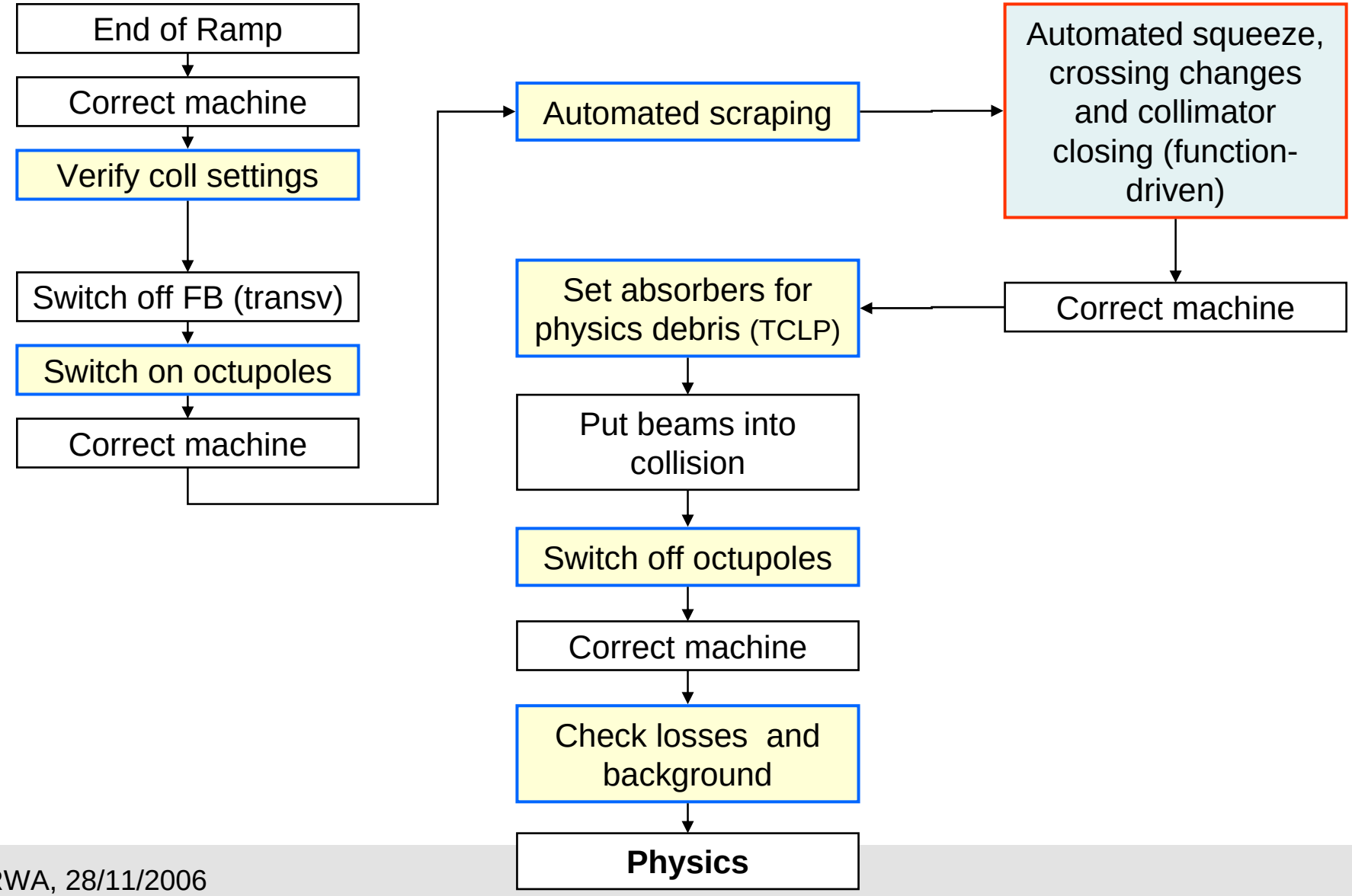
Draft Squeeze Procedure



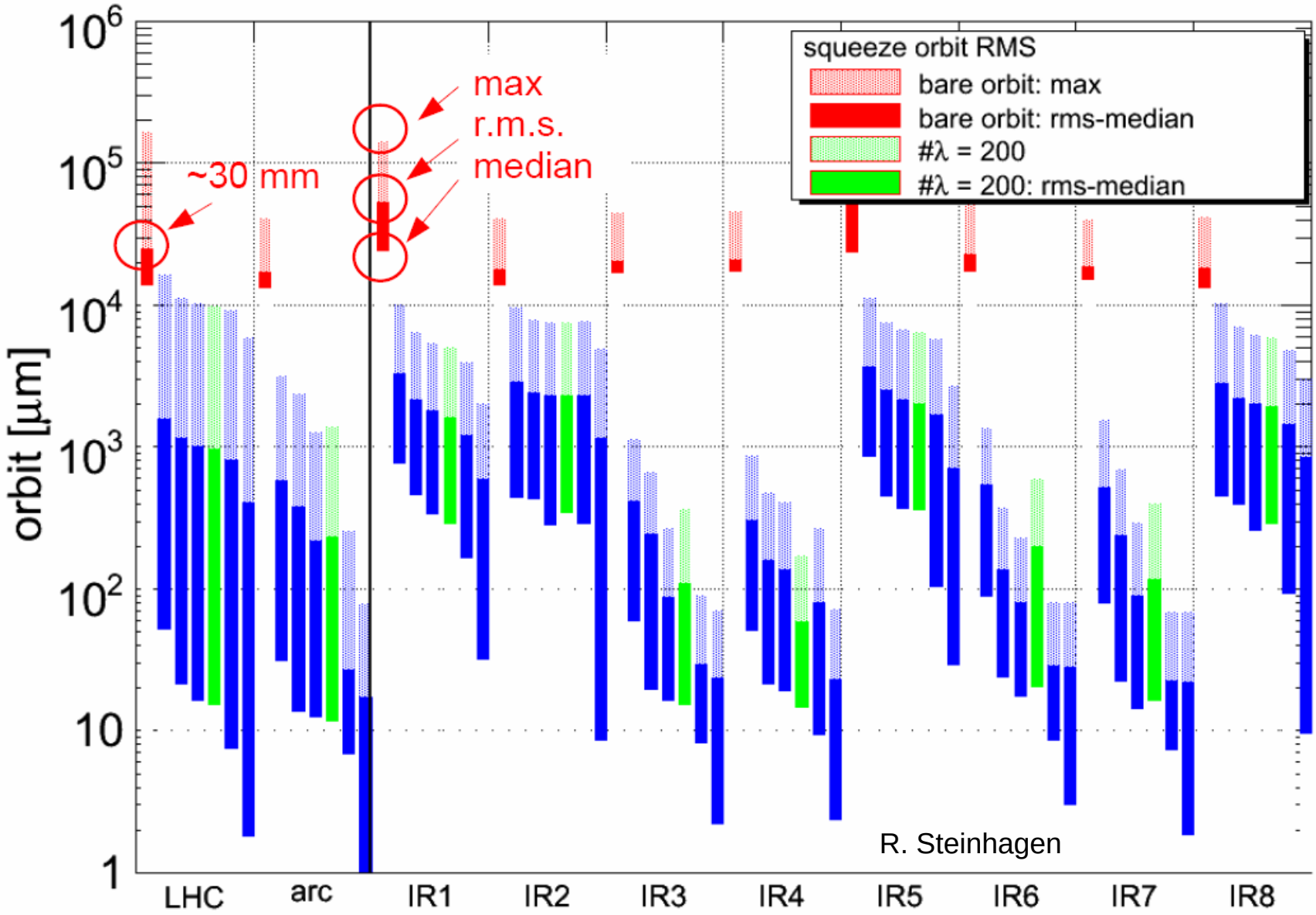
Reduced Procedure for Low Intensity



Production Procedure?



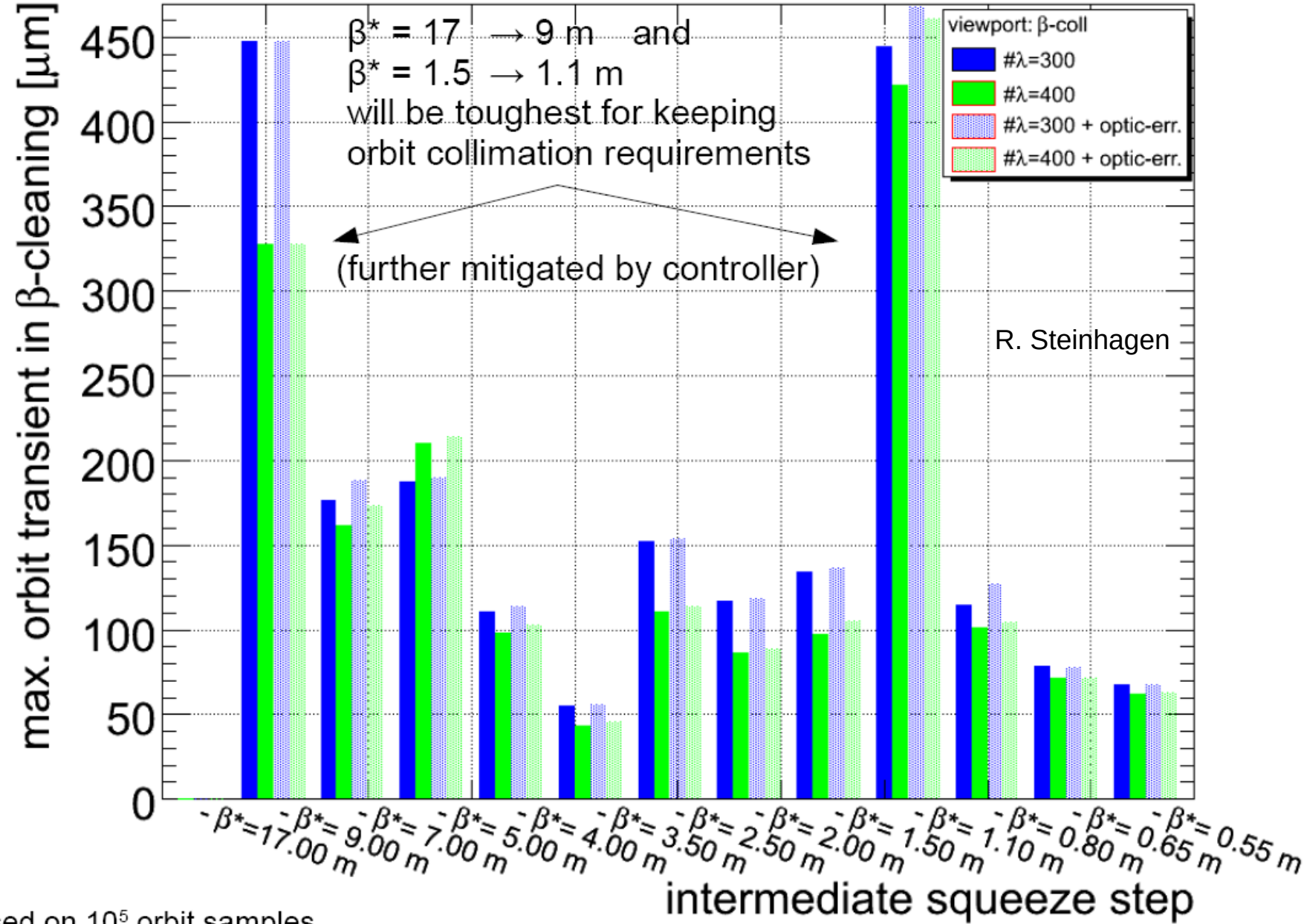
Transient due to low beta Squeeze: Overview LHC



based on 10^5 orbit samples

bars: $\#\lambda_{svd}$ = 50, 100, 150, 200, 250, 270 (B1 only)

Transient in Collimation Insertion vs. Squeeze Step - moderate global orbit correction only (commissioning)



based on 10^5 orbit samples

Squeeze During Ramp

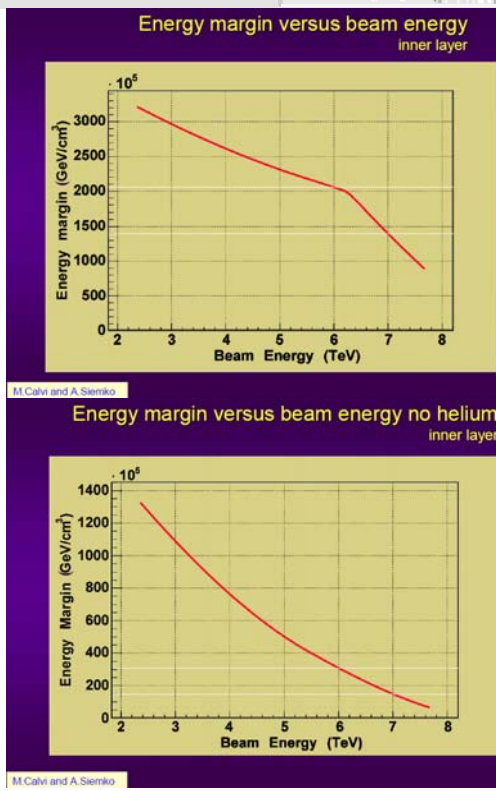
Power loss

$$P_{loss} \propto \frac{N_p^{tot}}{\tau} \cdot E_b$$

Power for quench

$$P_q \propto \frac{1}{E_b^r} \quad (r \geq 1)$$

$$\frac{P_{loss}}{P_q} \propto \frac{N_p^{tot} \cdot E_b^r}{\tau} < 1 \quad (r \geq 2)$$



- Beam losses are much less dangerous in terms of quenches at lower beam energy. Win factor >2 if squeeze is done at 5 TeV.
- Clear preference for squeeze at lowest possible beam energy, for example β^*=1 m (or 2 m) at 5 TeV!