Phase 2 accelerator physics results

Phase II Specification and Implementation Meeting

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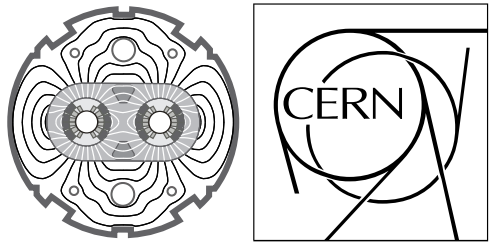
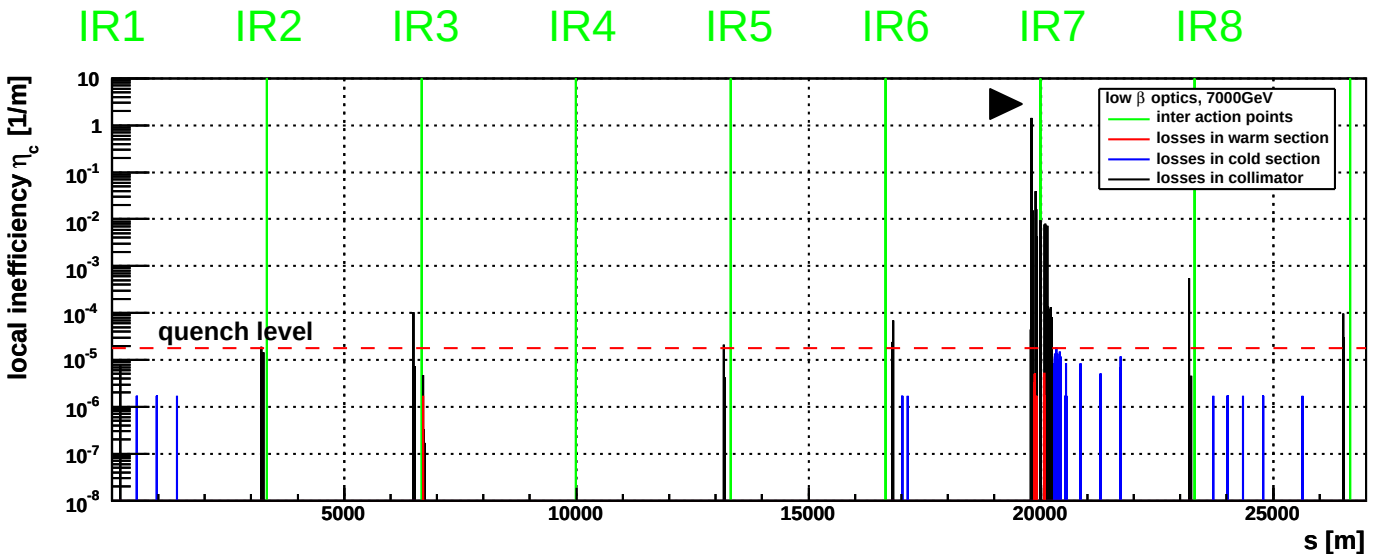
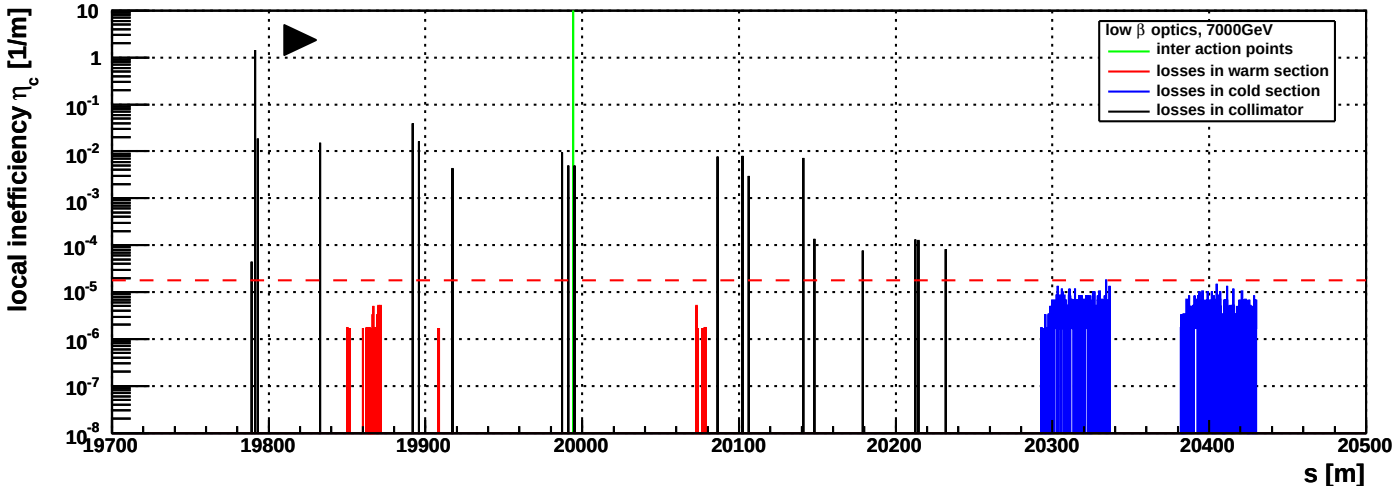


Reminder: Phase1 System



beam 1

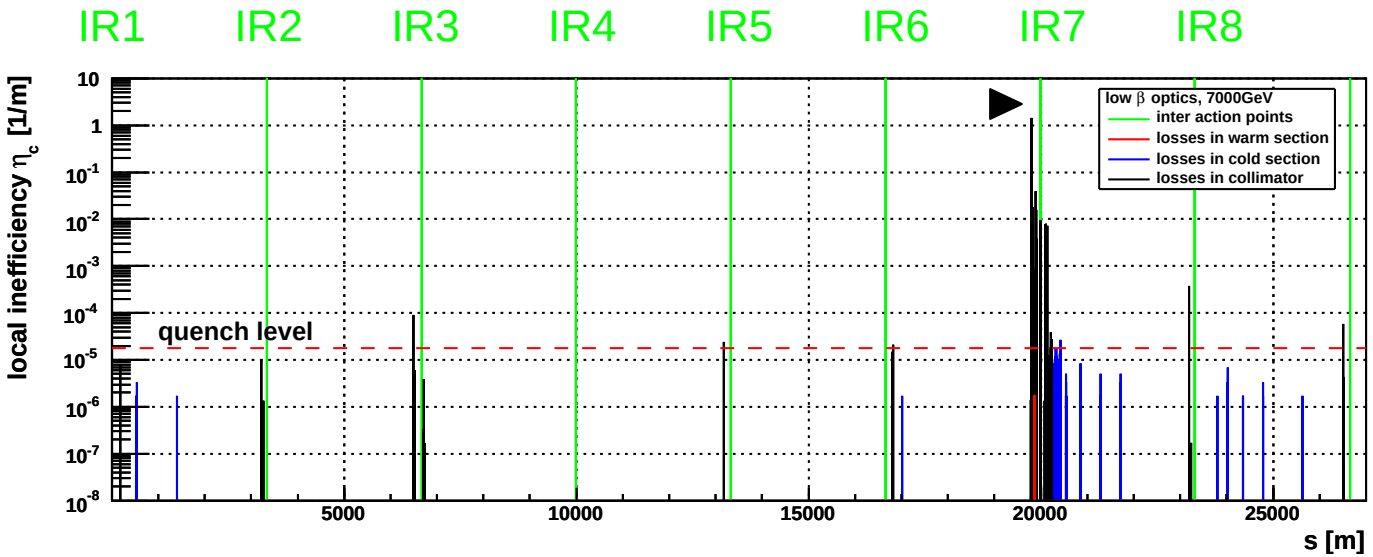
- V6.503 / 7 TeV
- horizontal betatron halo
- standard settings
- ideal machine



beam 1

- V6.503 / 7 TeV
- zoom in IR7

Reminder: Phase2 System



beam 1

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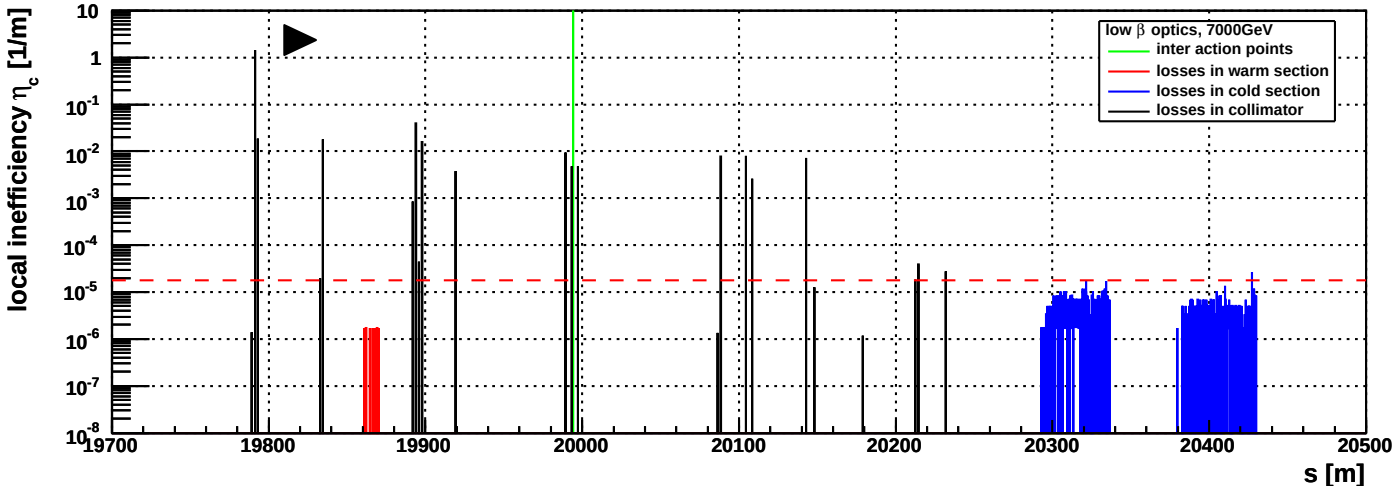
- standard settings
- ideal machine



beam 1

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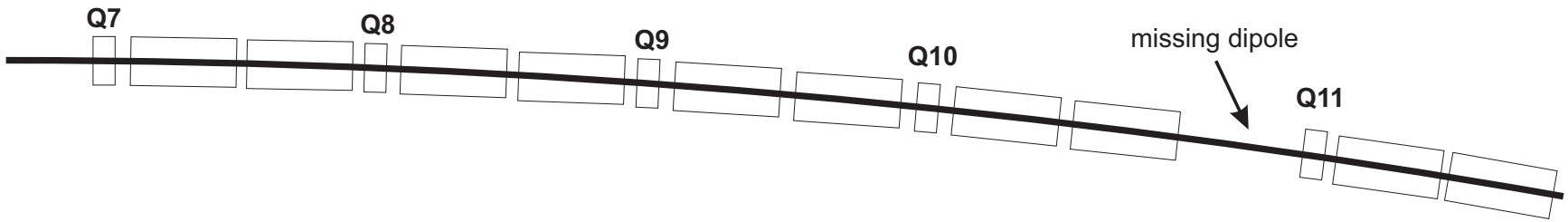
- zoom in IR7

Proposal for Phase2 Efficiency Improvement

Problem from the cleaning efficiency side of view of Phase1 and Phase2 system are the losses in the dispersion suppressor after the cleaning insertions.

Idea for a possible Phase2 system is to add additional collimators in the dispersion suppressor at the location of the loss peaks seen.



$\Rightarrow$ make use of space from missing dipole

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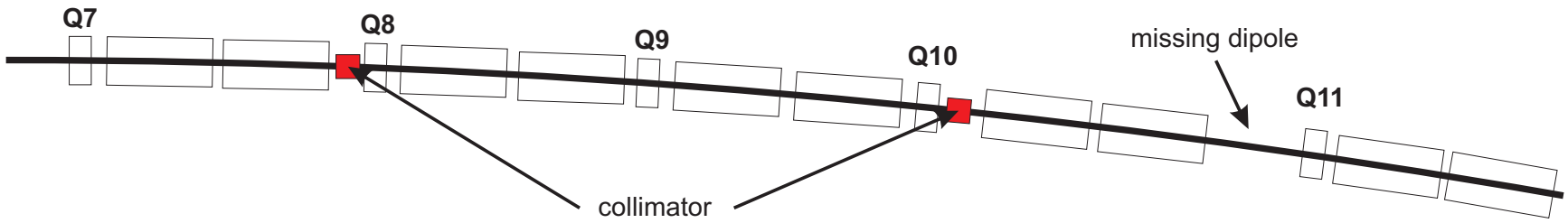
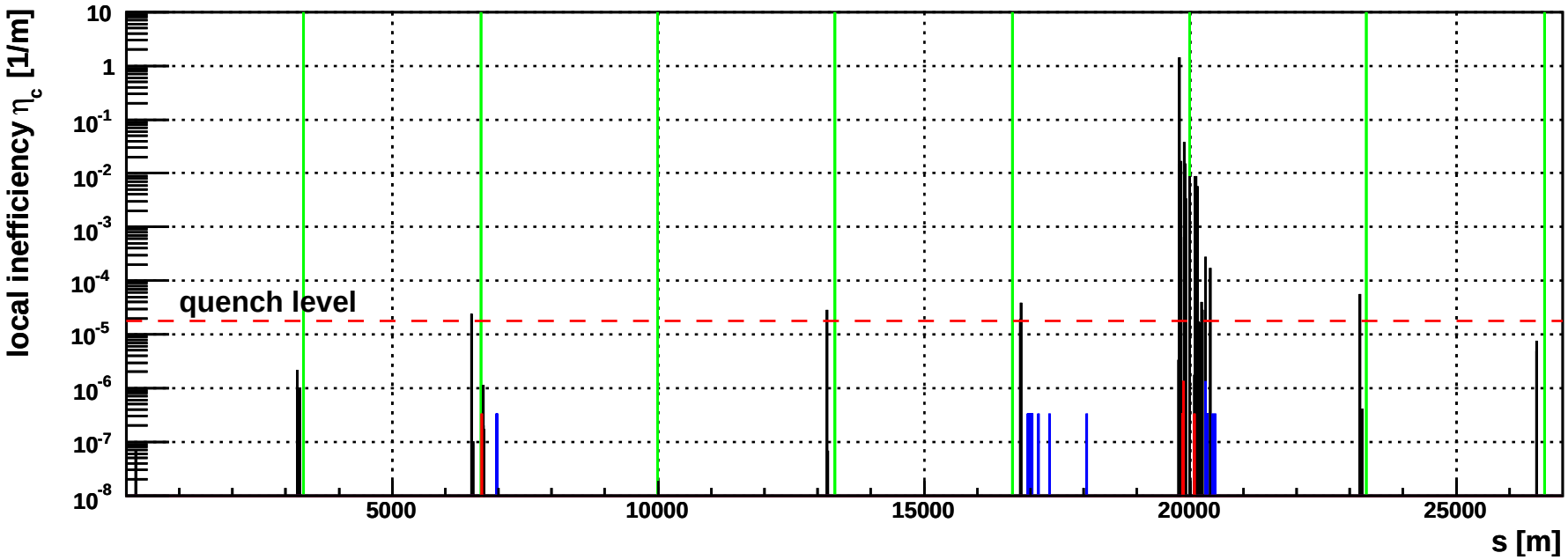


symmetric shift of two dipoles at the beginning and end of the dispersion suppressor by $3\,\mathrm{m}$.

Performance Phase 2 & Optics V6.503

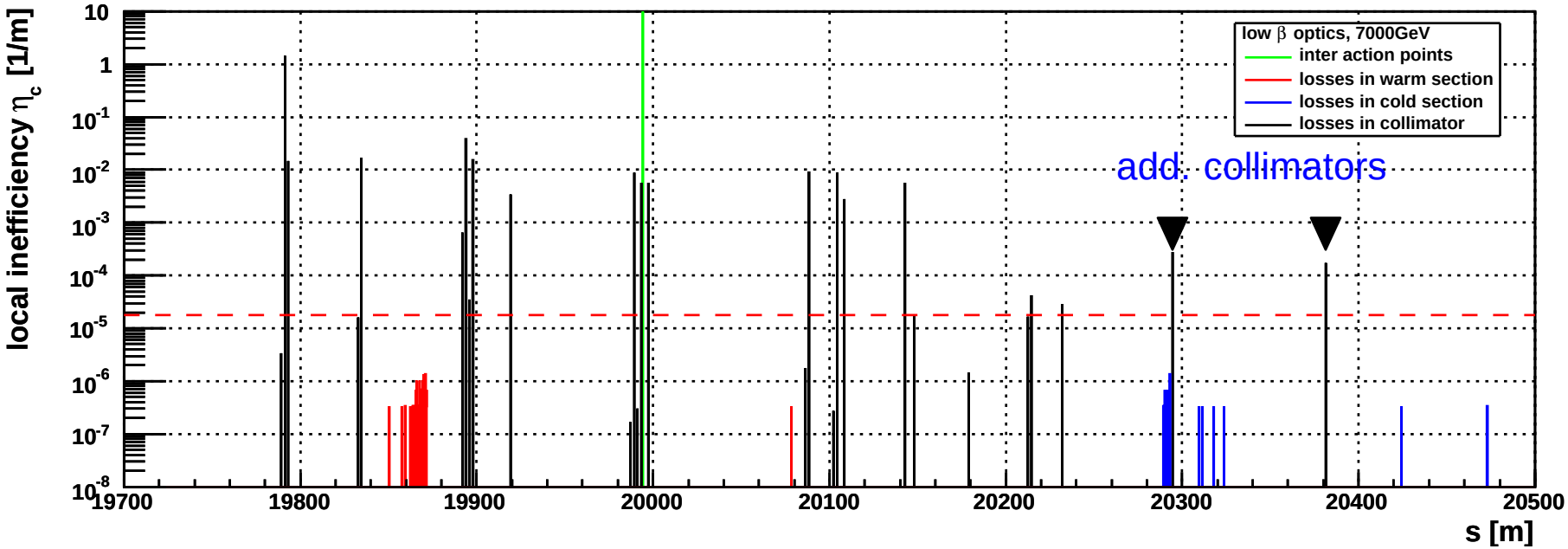
Loss-map around LHC for beam 1 (for 29.0M particles)



Copper secondaries set to nominal settings, carbon secondaries set to relaxed opening (26.5σ), cryogenic collimators (material copper, length 1 m) placed at 298.89 m and 388.44 m from IR7 at 15σ.

Performance Phase 2 & Optics V6.503

Zoom in IR7 and dispersion suppressor



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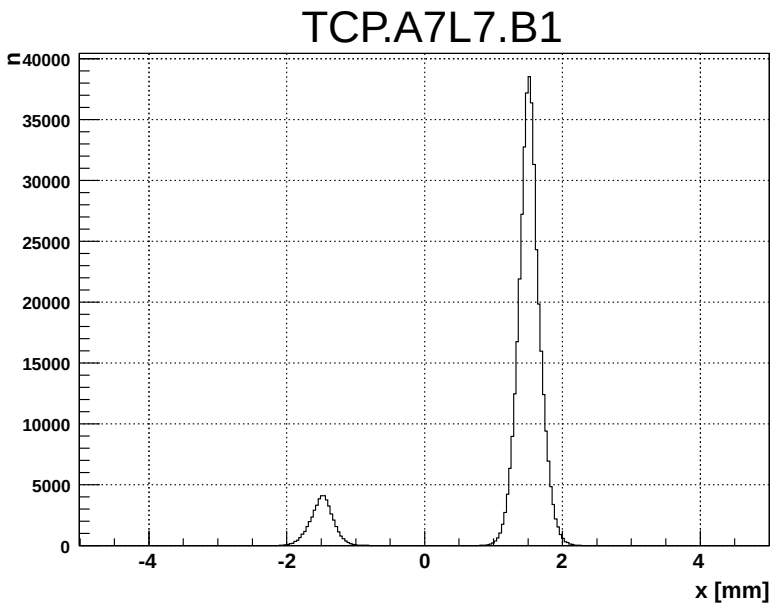
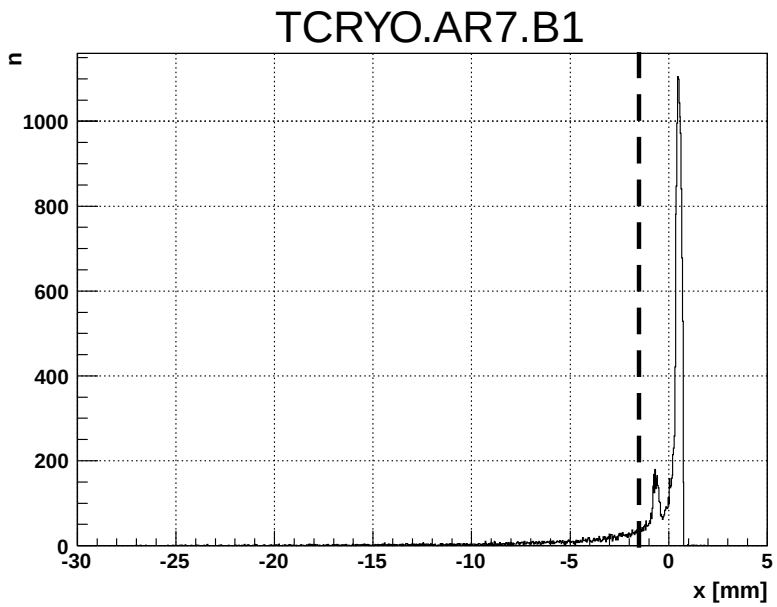
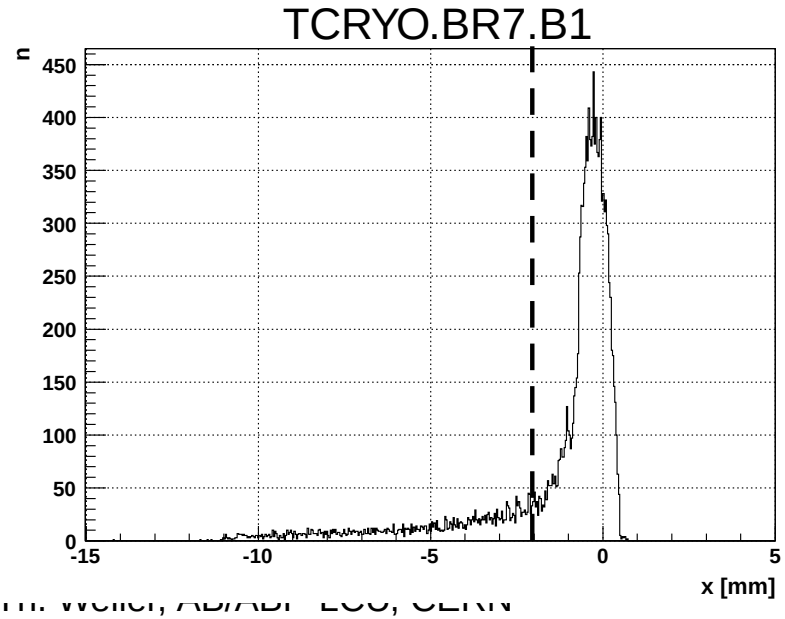
Single Diffractive Particles

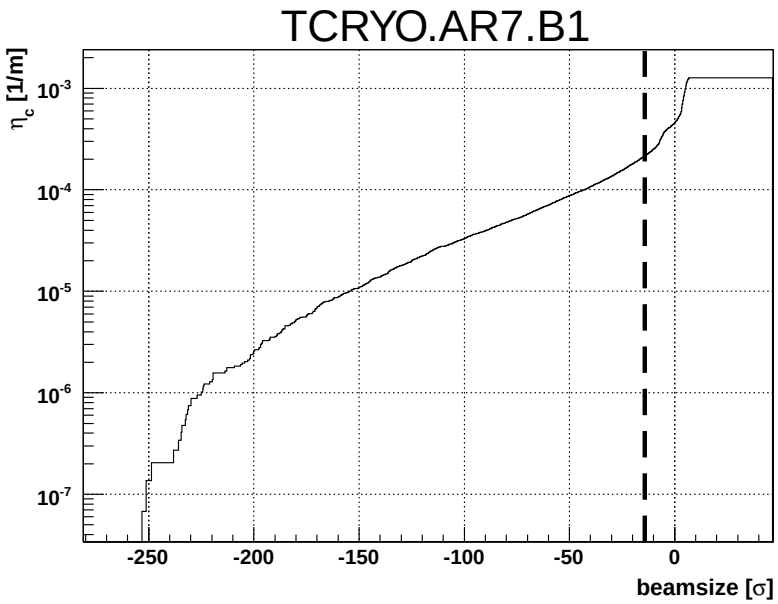


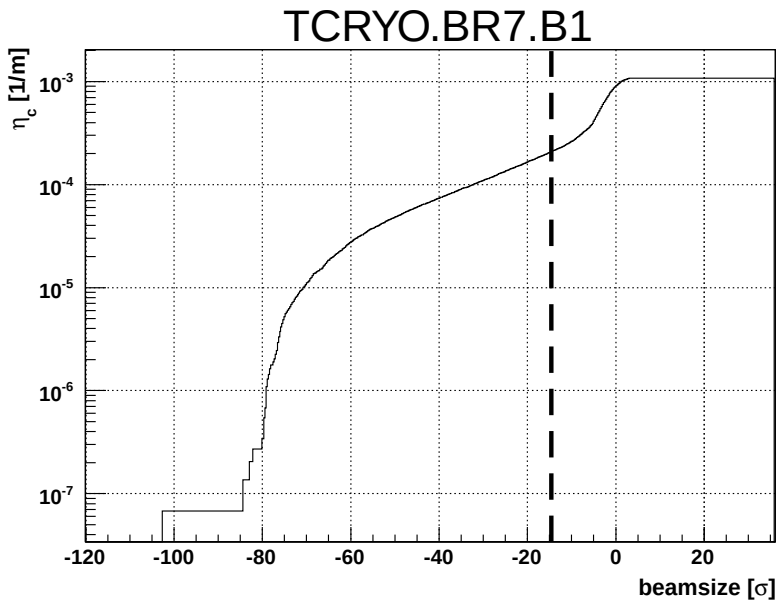


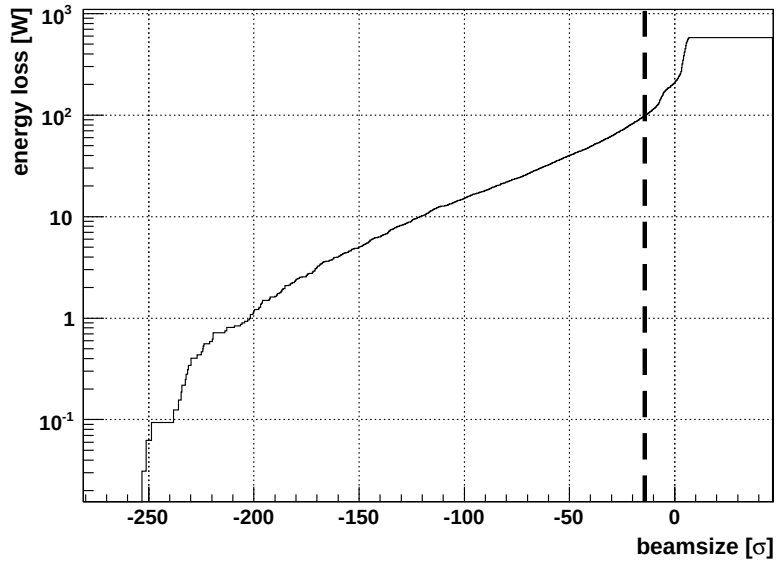


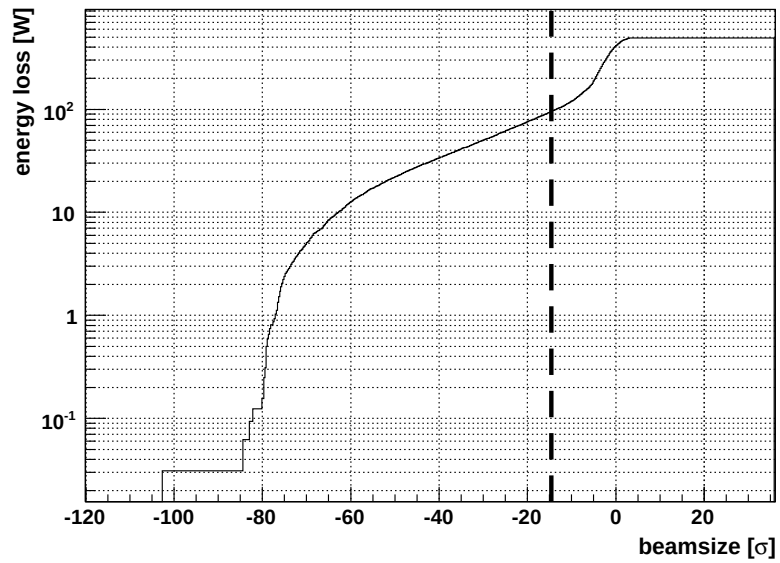
Particle distribution due to single diffractive events close to the primary collimator and the cryogenic collimtators.

Single Diffractive Particles

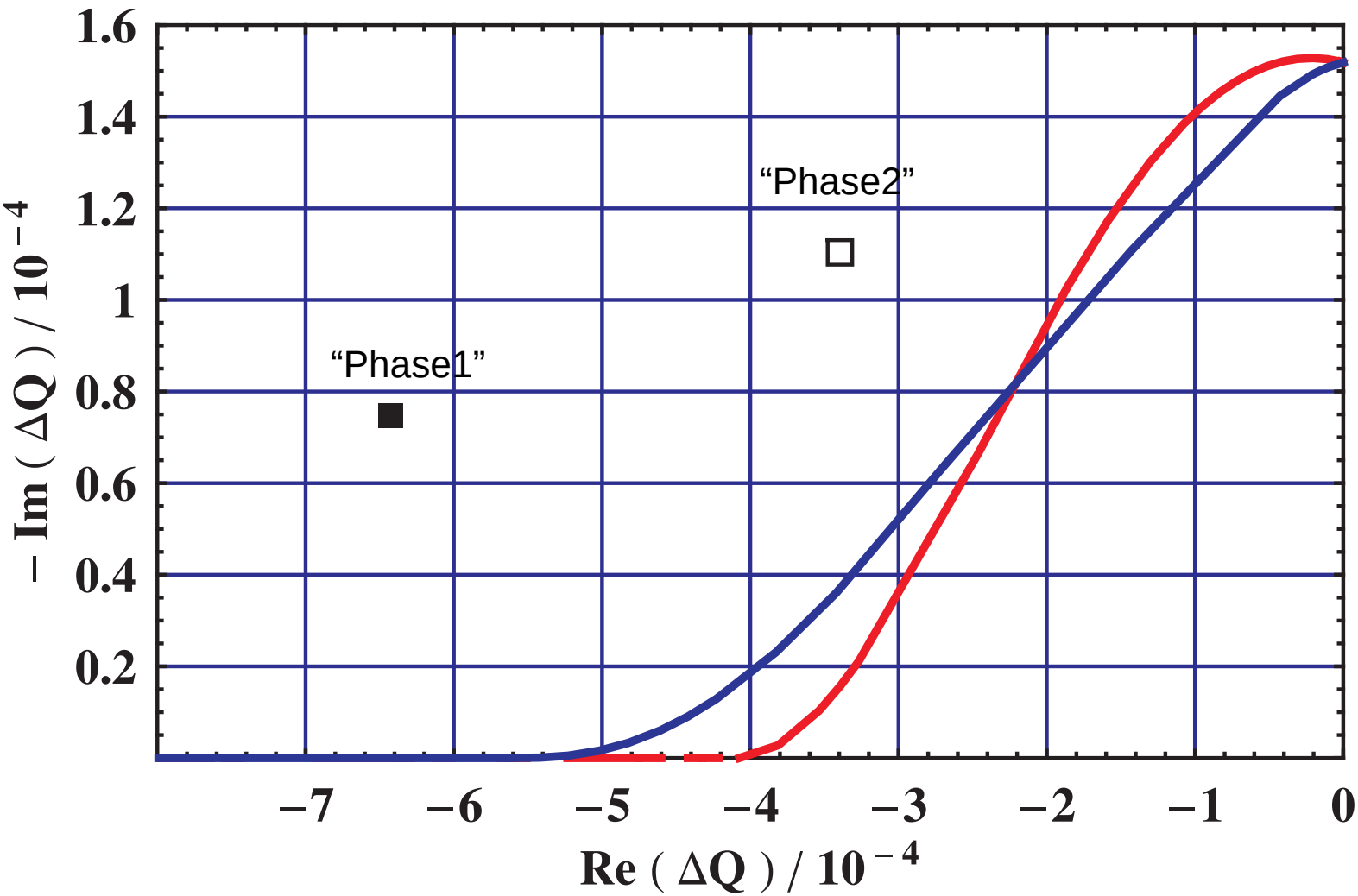








Impedance



E. Metral

Phase 1 and Phase 2 system are both outside the stability region (provided by Landau octupoles)

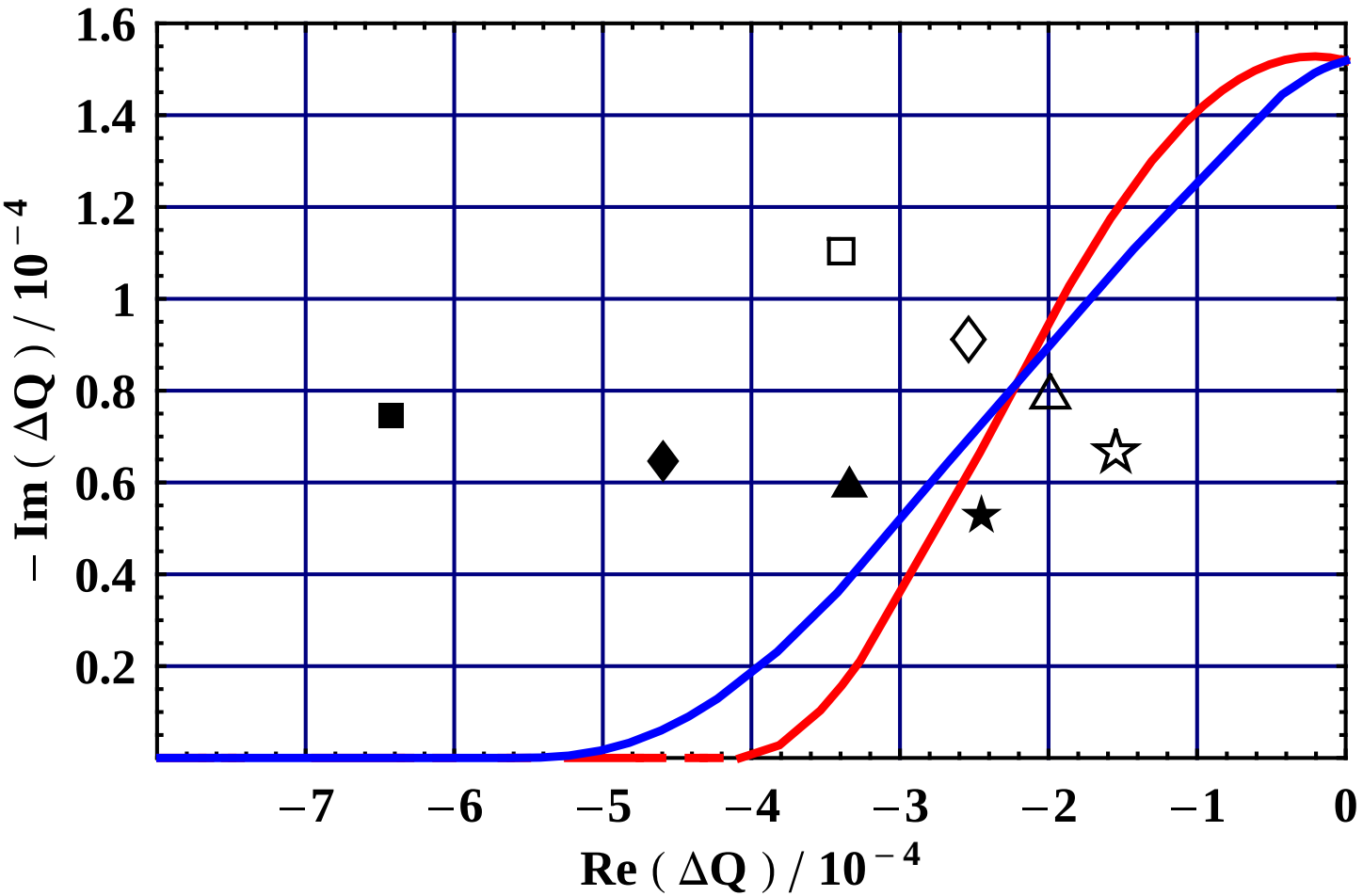
Further Studies

- look at cleaning inefficiency for increased gap size (momentum cleaning collimators kept at nominal settings)
- impact on impedance ($\Rightarrow$ E. Metral)

Collimator group	**nominal** $[\sigma]$	**step1** ($\approx \times 1.2$) $[\sigma]$	**step2** ($\approx \times 1.5$) $[\sigma]$	**step3** ($\approx \times 2.0$) $[\sigma]$
TCP IR7	6.0	7.2	9.0	12.0
TCS IR7	7.0	8.4	10.5	14.0
TCLA IR7	10.0	12.0	13.0	16.0
TCLP	10.0	12.0	13.0	16.0
TCT	8.3	10.0	12.5	16.6
TCDQ IR6	8.0	9.6	12.0	16.0
TCSG IR6	7.5	9.0	11.25	15.0
TCRYO	15.0	15.0	15.0	17.0

$\Rightarrow$ IR3 collimators kept at nominal settings.

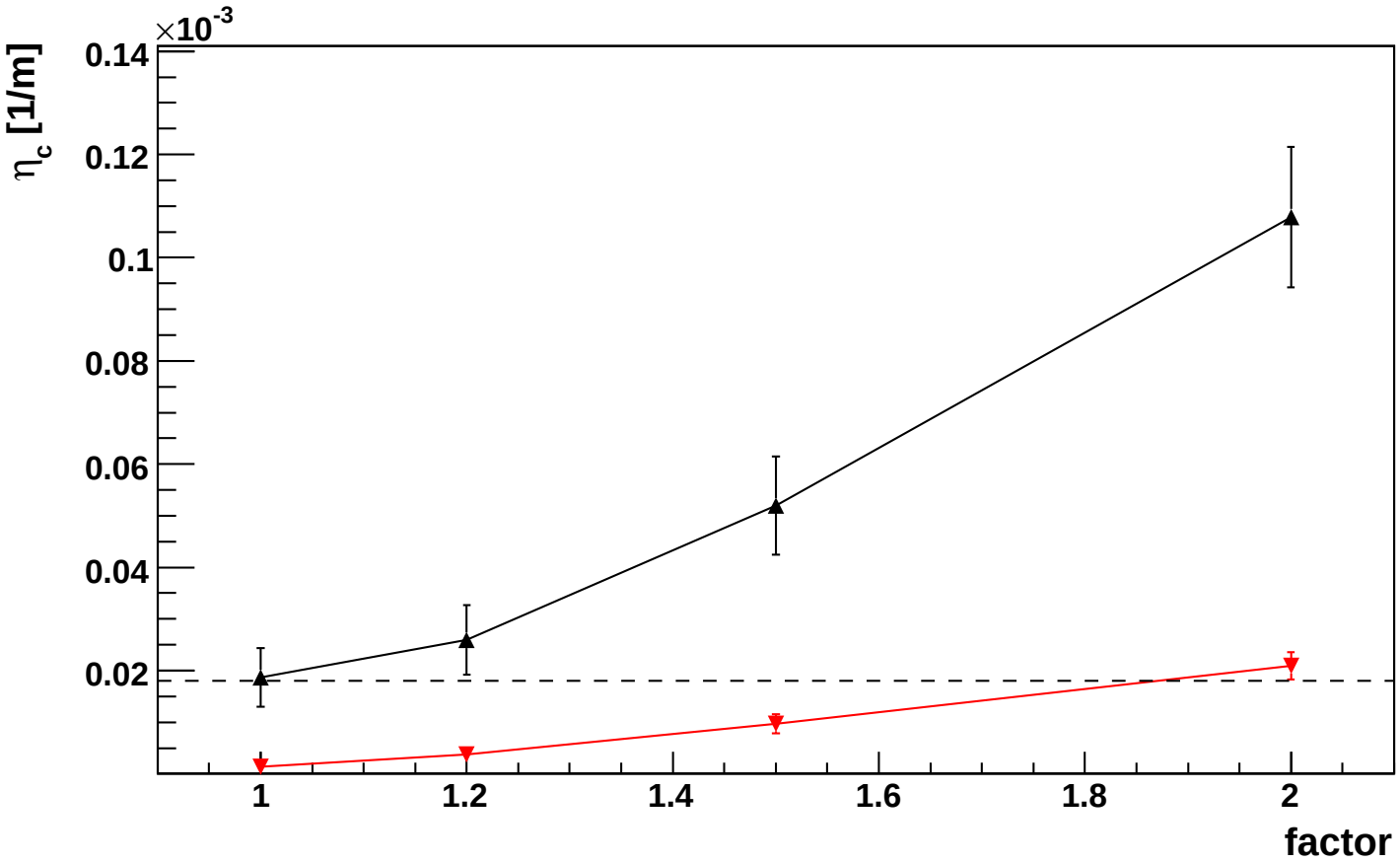
Impedance



E. Metral

Filled symbol phase 1, unfilled symbols phase 2 with cryogenic collimators.
$\square = \text{nominal}, \lozenge \approx 1.2, \triangle \approx 1.5, \ldots$ (see table on previous slide)

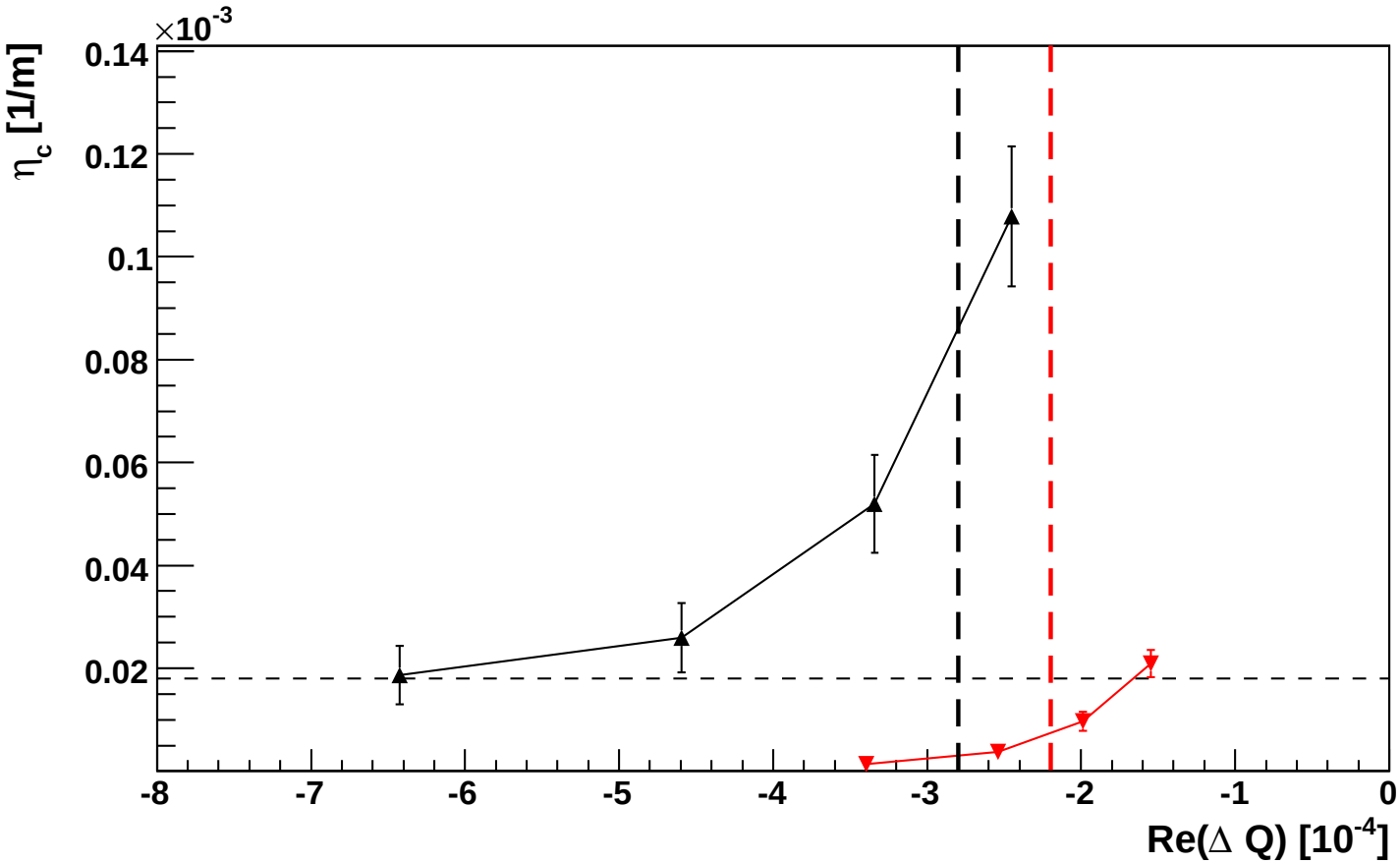
Gap Size and η_c



Reminder: mutliplication “factor” is only true for TCP and TCS collimators.

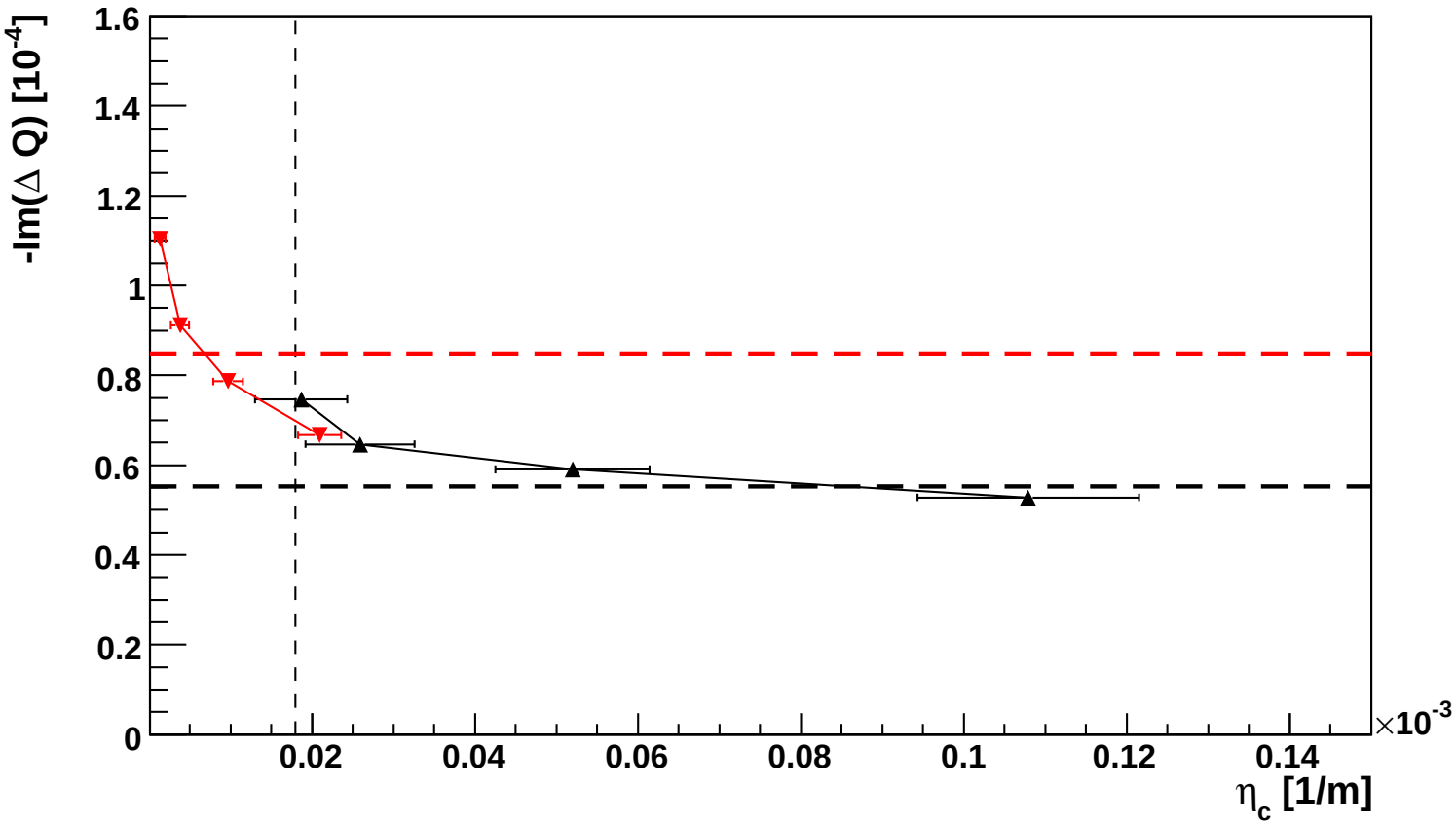
For phase 2 and ideal machine opening gaps upto a “factor” 1.5 possible.

Re Impedance and η_c



Only for phase 2 with cryogenic collimators one finds settings to stay below the required η_c and withing the stable region.

Im Impedance and η_c



Summary and Outlook

- Simulation for shifted and re-matched optics (V6.503).
- Gain ≈ 10 in cleaning efficiency. Reminder: first simulation with unchanged thin lens optics showed a gain of ≈ 30.
- Different sets of collimator opening study to reduce impedance. (TCP and TCS opened by a factor 1.2, 1.5 and 2.0, other collimators opened to keep hierarchy and machine protection), this can solve impedance problem and stay within required cleaning inefficiency.
- To do:
  - Check feasibility and space availability in tunnel.
  - Studies for beam 2 with optics V6.503.
  - Sensitivity to errors (orbit, beta beat, ...) has to be studied.
  - FLUKA ongoing, preliminary results (only single diffractive) TCRYO.AR7.B1 55 W (total), TCRYO.BR7.B1 64 W (total), MB.A9R7.B1 0.2 mW/cm3 MB.A11R7.B1 0.7 mW/cm3
  - New collimator design for dispersion suppressor needed.