Update on Cryogenic Collimators

Phase II Specification and Implementation Meeting

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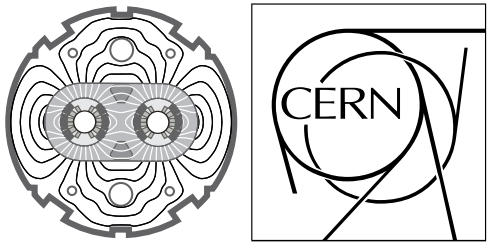
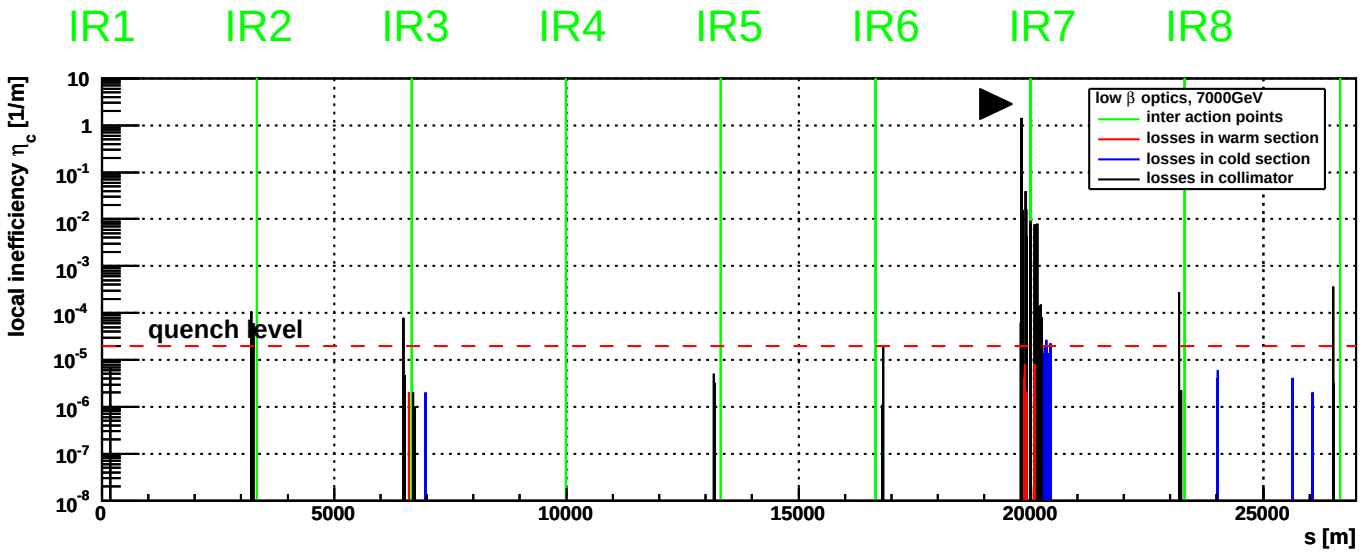
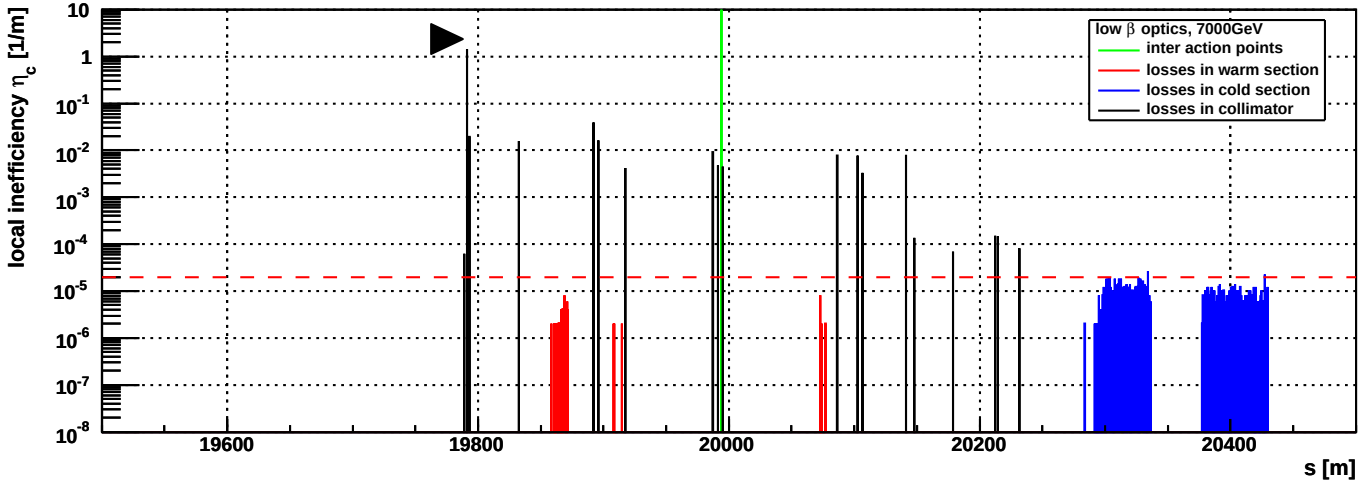


Reminder: Phase1 System



beam 1

- 7 TeV
- horizontal betatron halo
- standard settings
- ideal machine



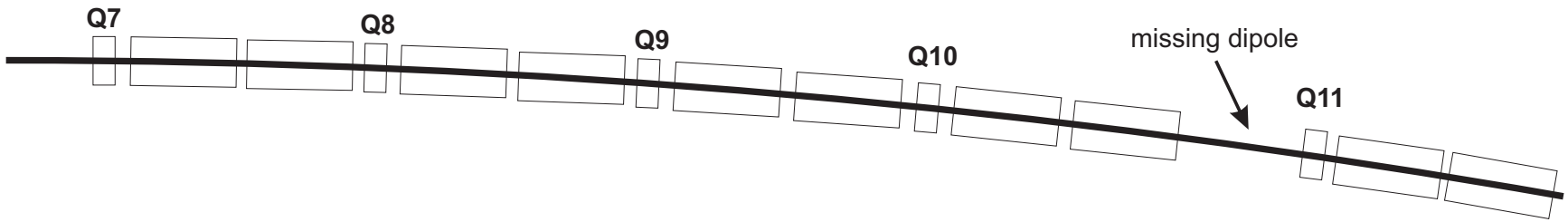
beam 1

- 7 TeV
- 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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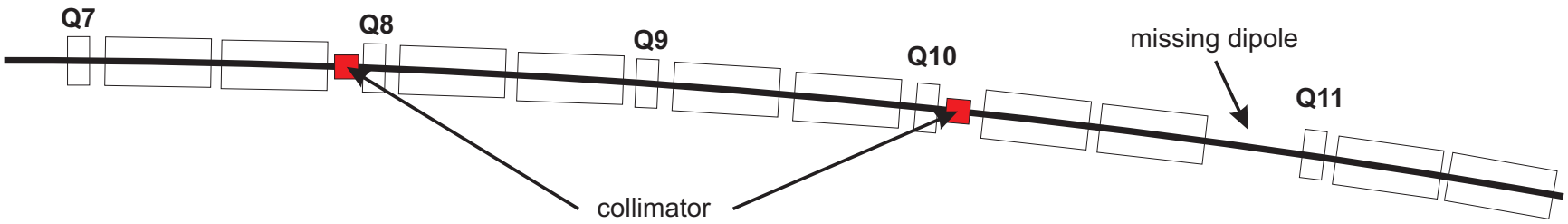
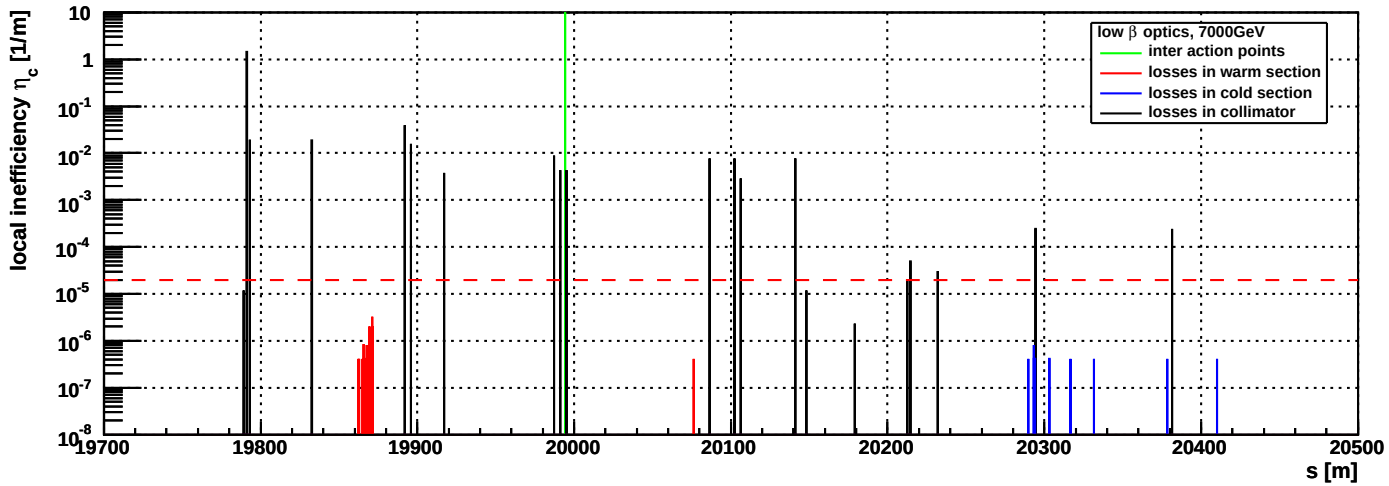
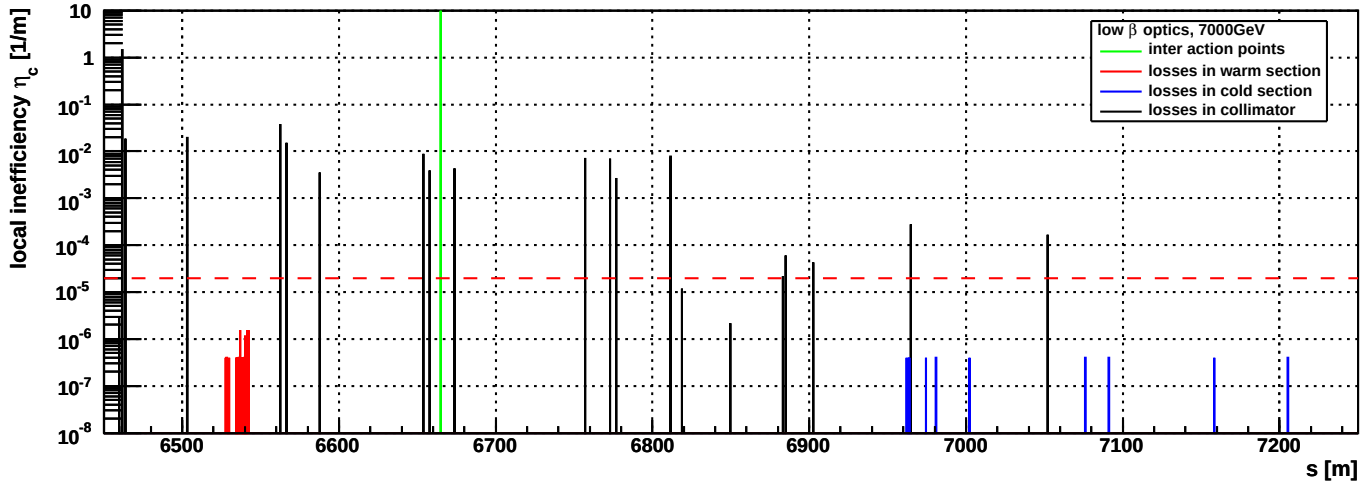


symmetric shift of two dipoles at the beginning and end of the dispersion suppressor by $3\,\mathrm{m}$.

Reminder: Optics V6.500

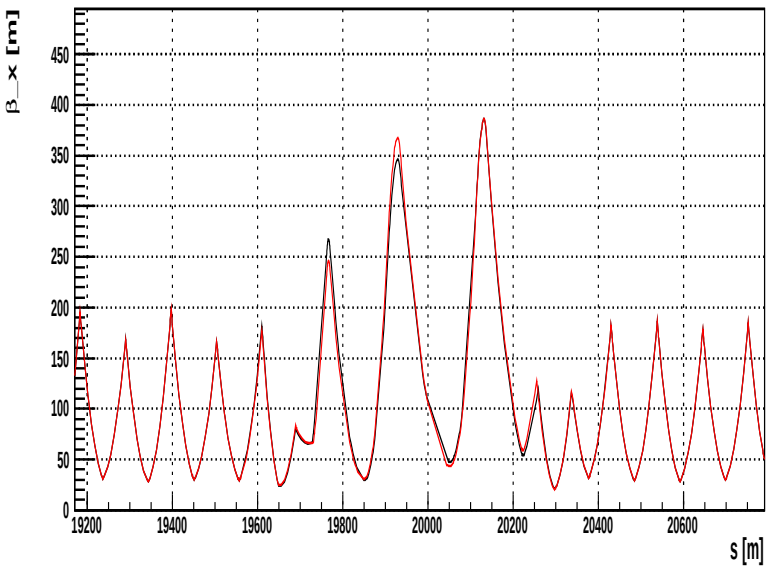


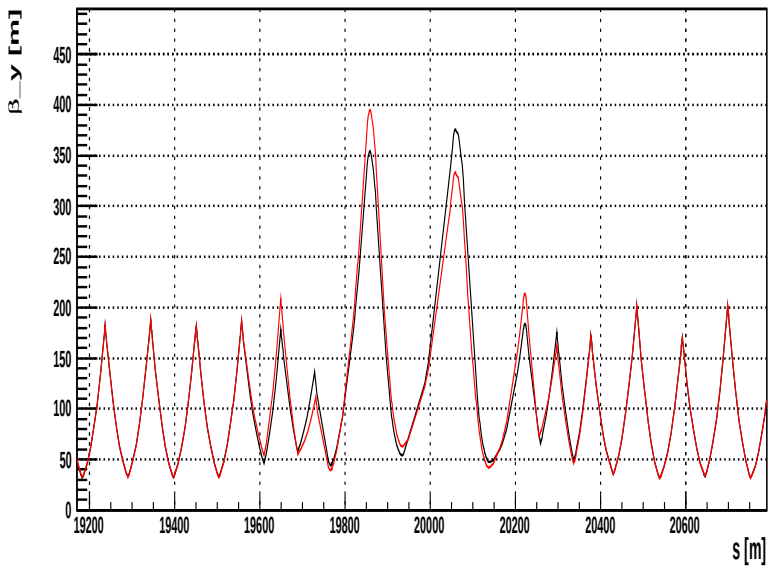


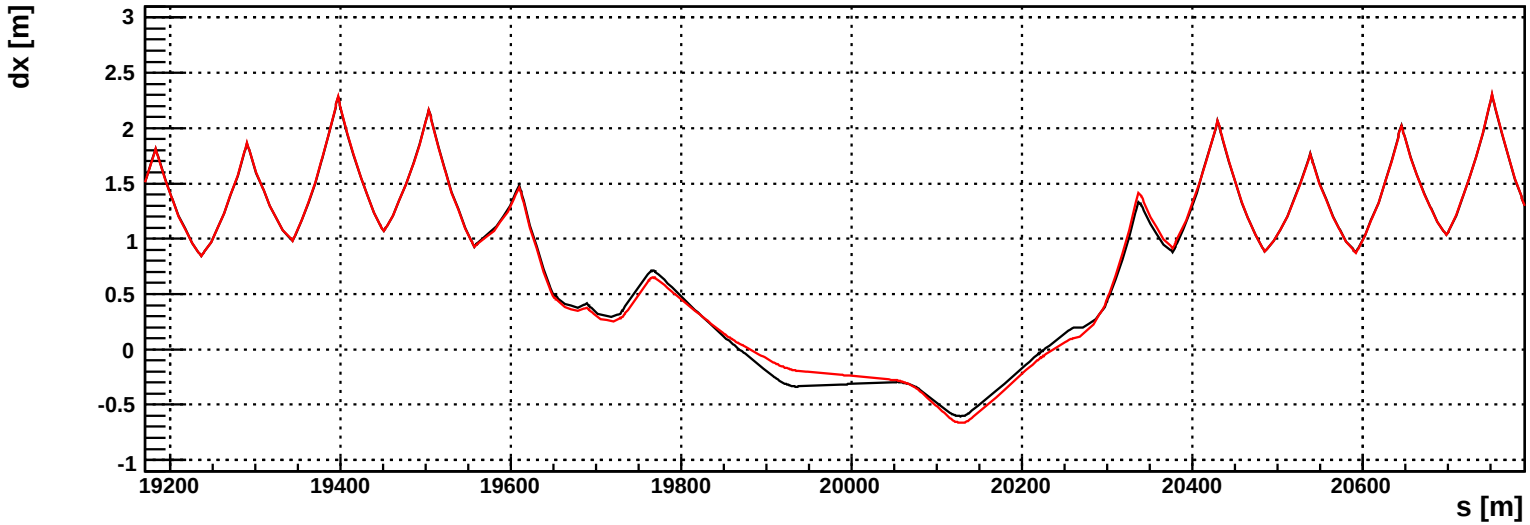
Zoom in IR7 for beam 1 and beam 2

- optcis V6.500
- thin lens,
- no shift of elements
- cryogenic collimators at $300m$ m and 387 m from IR7
- ≈ 30 M protons simulated
- gain of factor 30 in cleaning efficiency

Optcis V6.503 Thin Lens

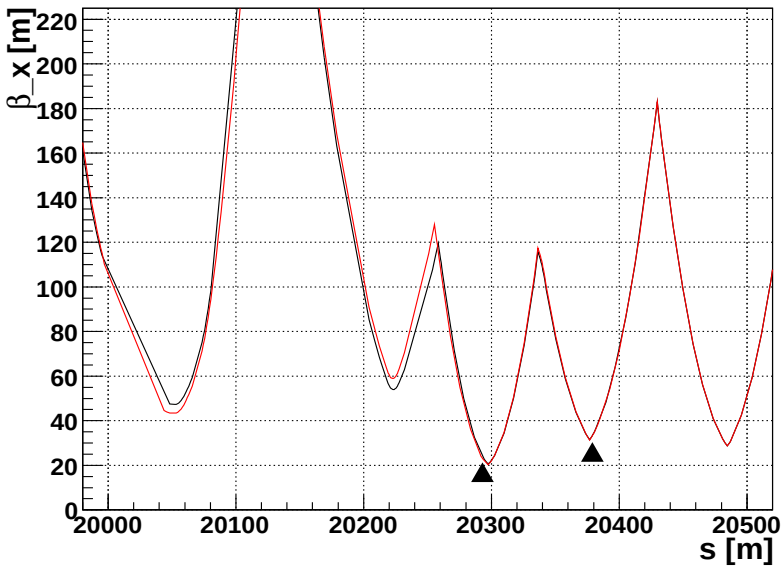


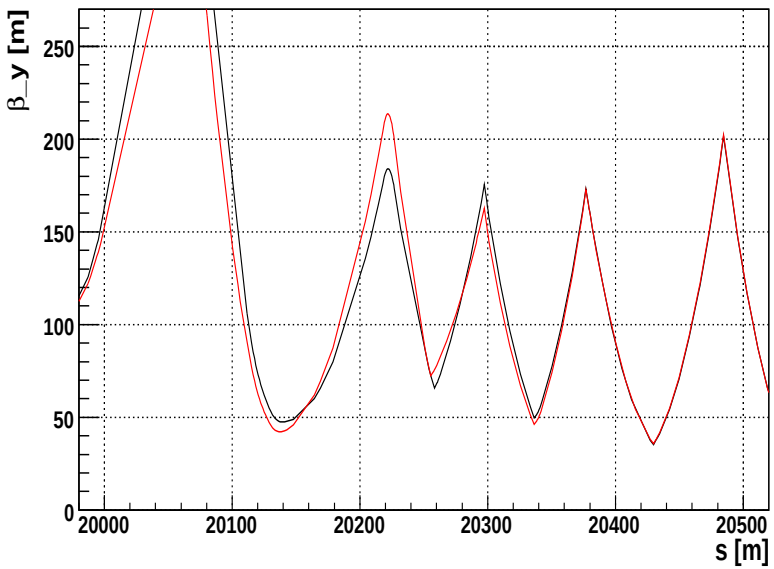


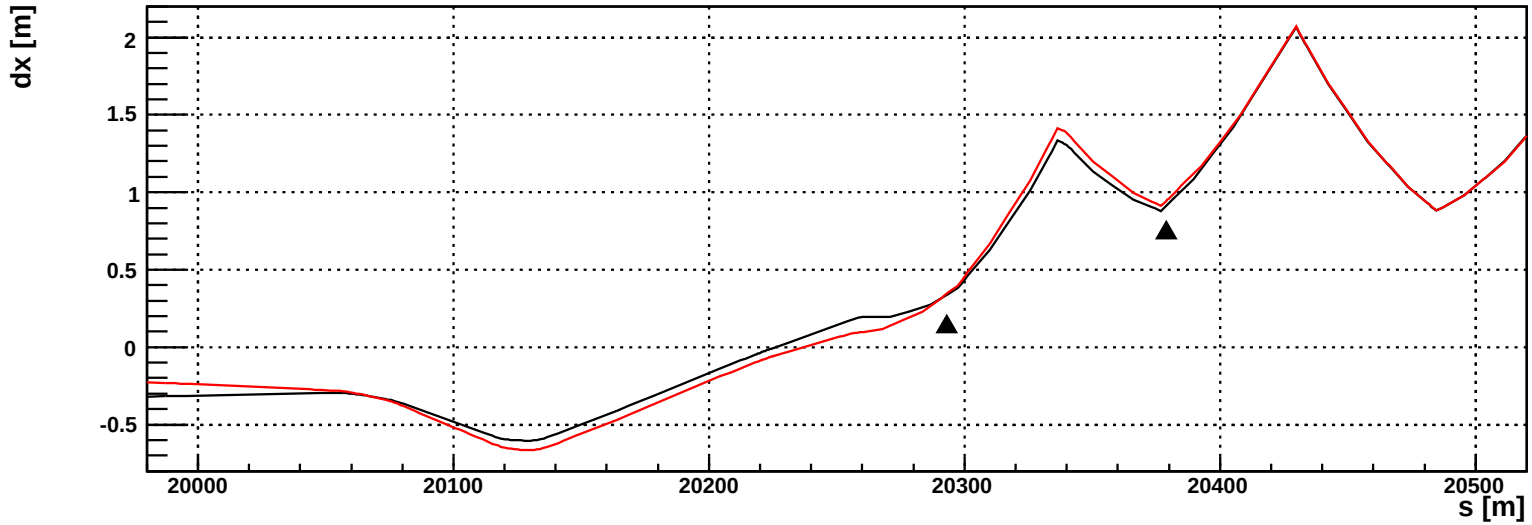


nominal optics, shifted and rematched optics

Optcis V6.503 Thin Lens



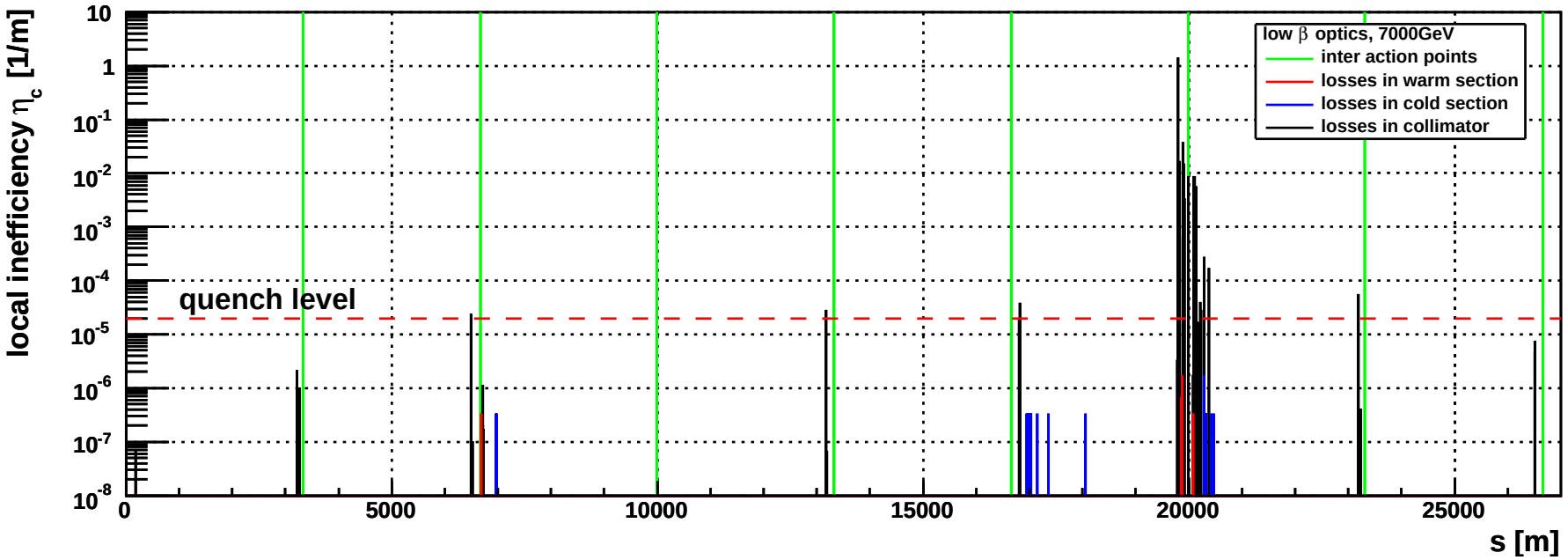




nominal optics, shifted and rematched optics

Performance Phase 2 & Optics V6.503

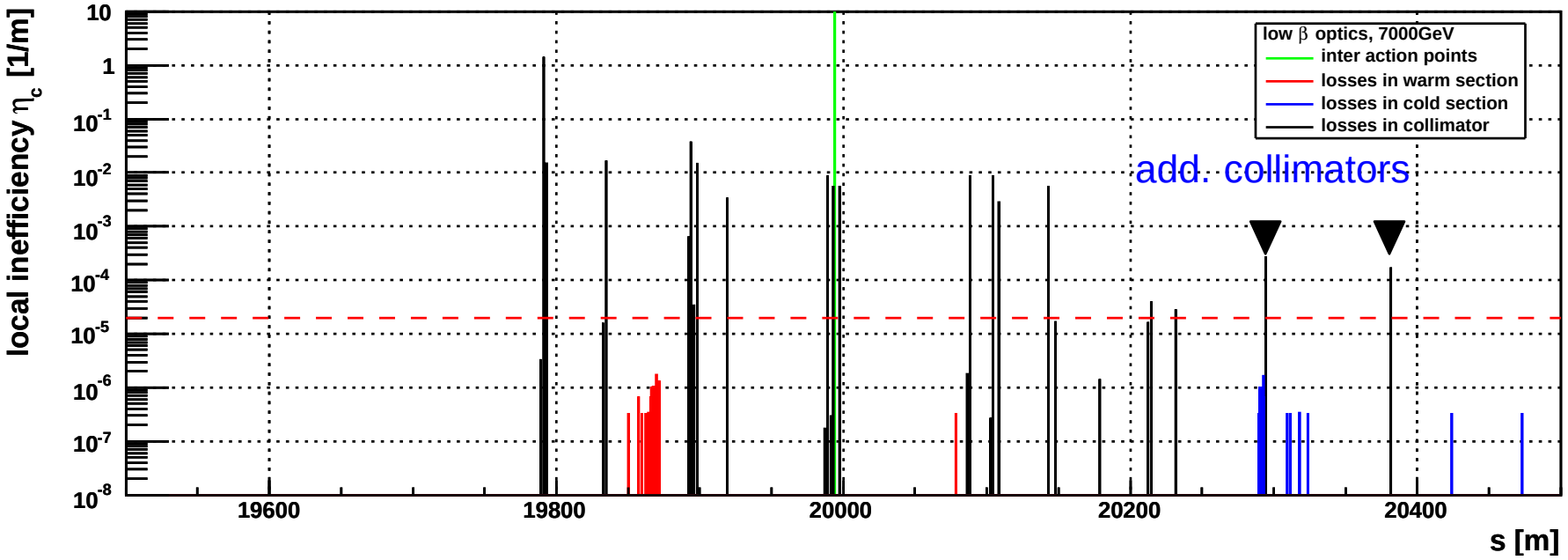
Loss-map around LHC for beam 1 (for 29.0M particles)



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



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.

Further Studies

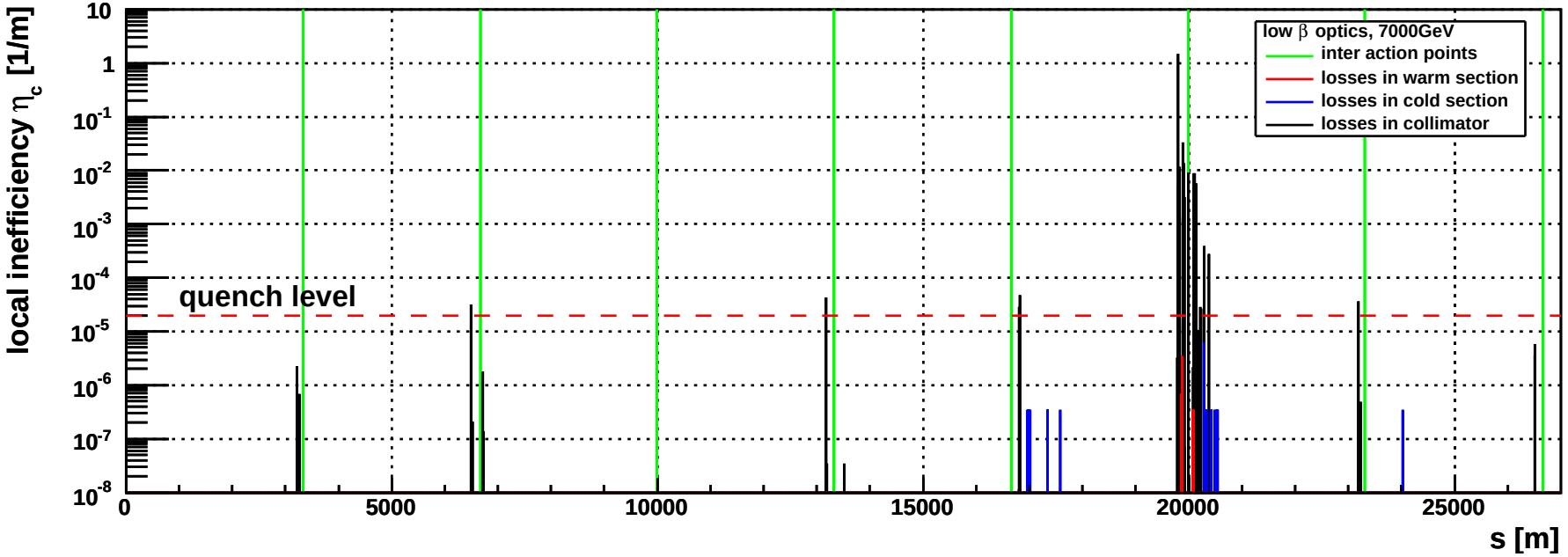
- look at cleaning inefficiency for increased gap size (momentum cleaning collimators kept at nominal settings)
- impact on impedance ($\Rightarrow$ E. Metral)

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.

Performance Step 1 & Optics V6.503

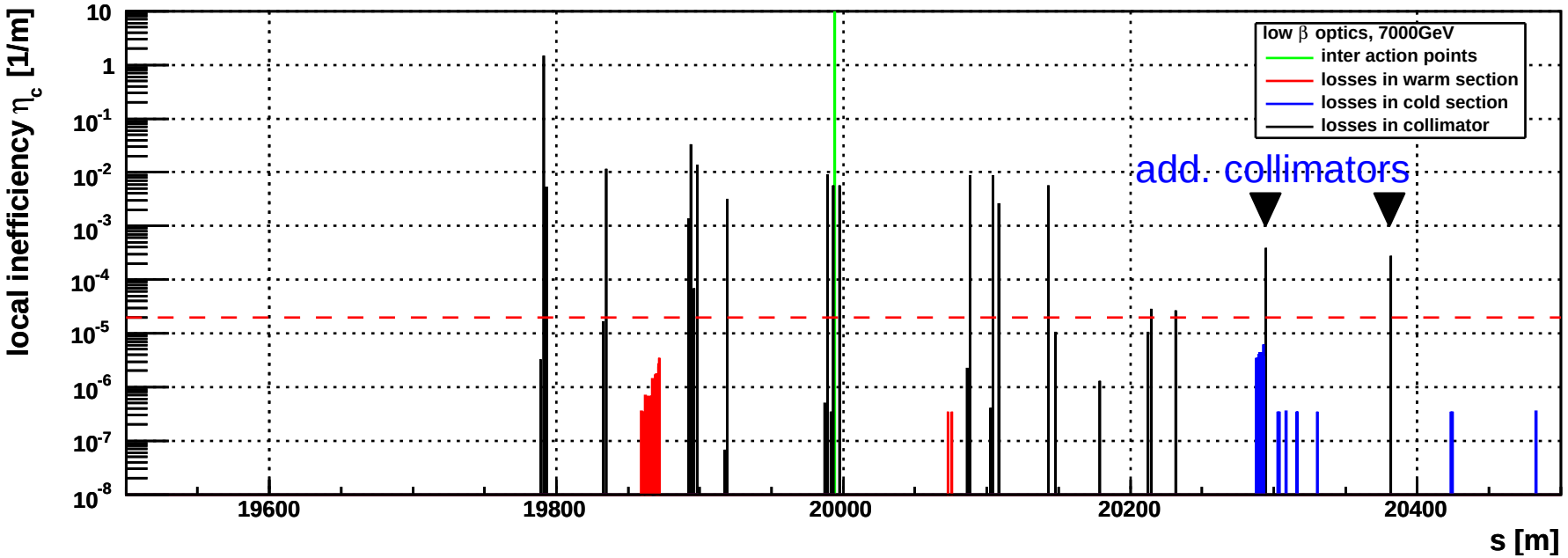
Loss-map around LHC for beam 1 (for 29.0M particles)



CFC primaries at 7.2σ, Cu secondaries at 8.4σ, CFC secondaries set to relaxed opening (26.5σ), cryogenic collimators (material Cu, length 1 m) placed at 298.89 m and 388.44 m from IR7 at 15σ.

Performance Step 1 & Optics V6.503

Zoom in IR7 and dispersion suppressor

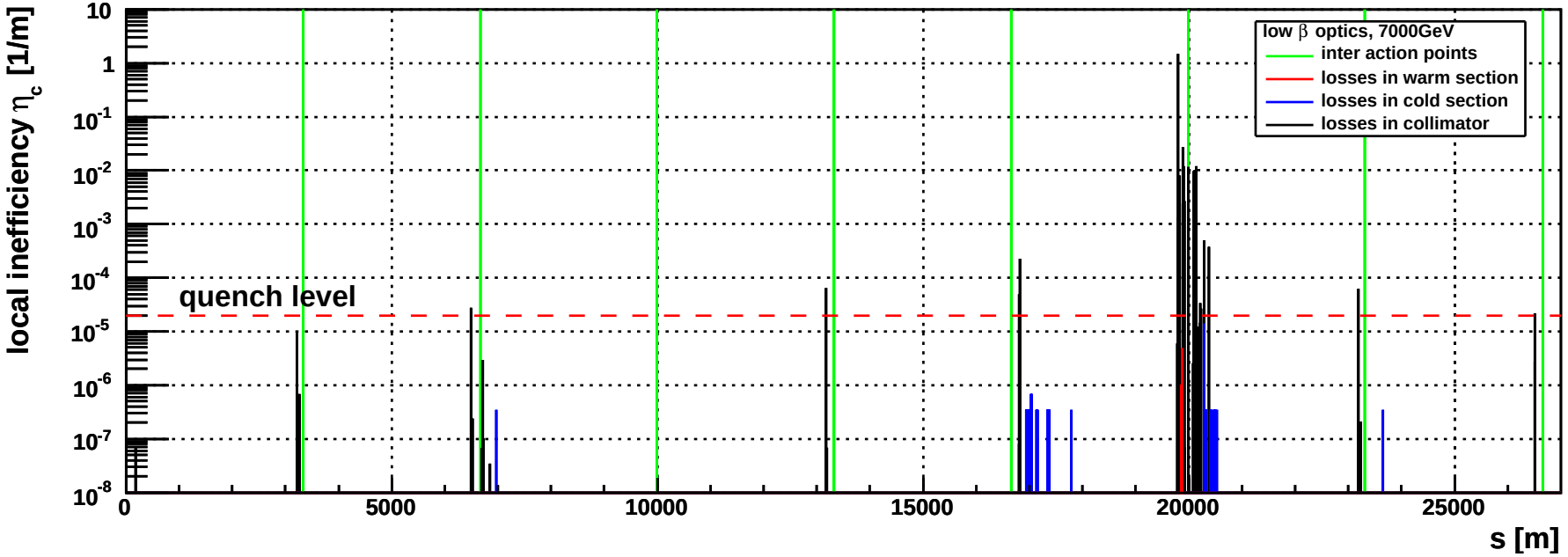


CFC primaries at 7.2σ, Cu secondaries at 8.4σ, CFC secondaries set to relaxed opening (26.5σ), cryogenic collimators (material Cu, length 1 m) placed at 298.89 m and 388.44 m from IR7 at 15σ.

$\eta_c = 6.22 \times 10^{-6}\,\mathrm{m}^{-1}$ in dispersion suppressor.

Performance Step 2 & Optics V6.503

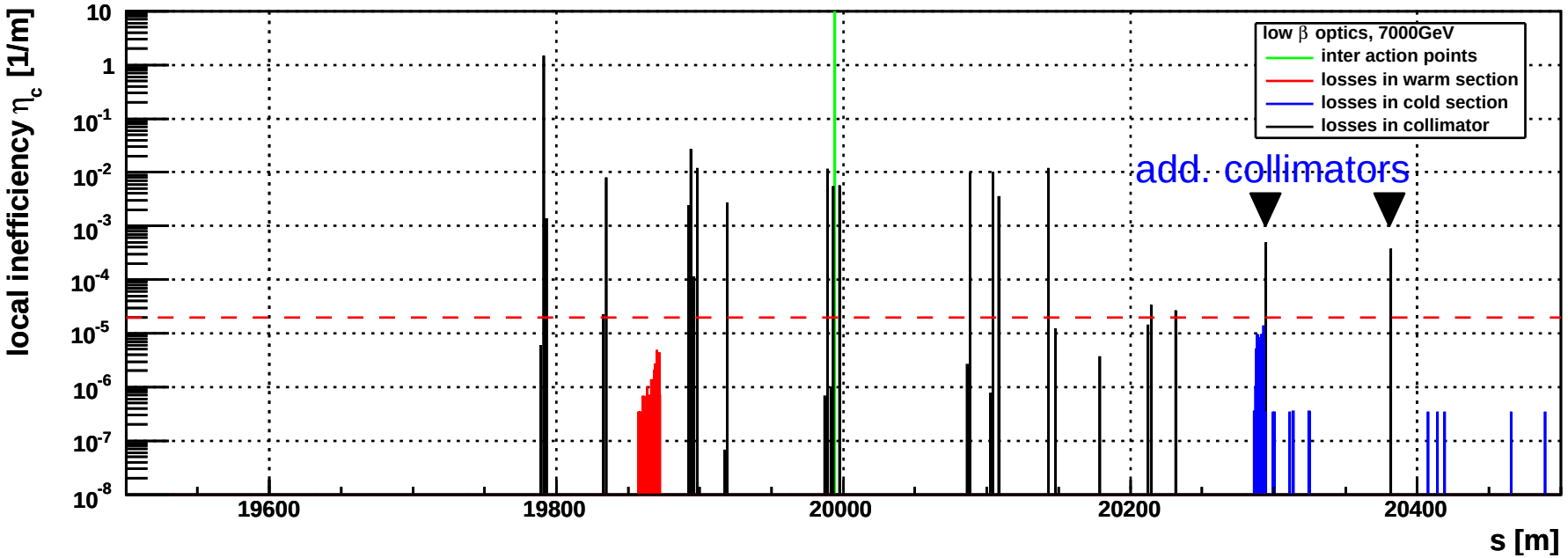
Loss-map around LHC for beam 1 (for 29.0M particles)



CFC primaries at 9.0σ, Cu secondaries at 10.5σ, CFC secondaries set to relaxed opening (26.5σ), cryogenic collimators (material Cu, length 1 m) placed at 298.89 m and 388.44 m from IR7 at 15σ.

Performance Step 2 & Optics V6.503

Zoom in IR7 and dispersion suppressor

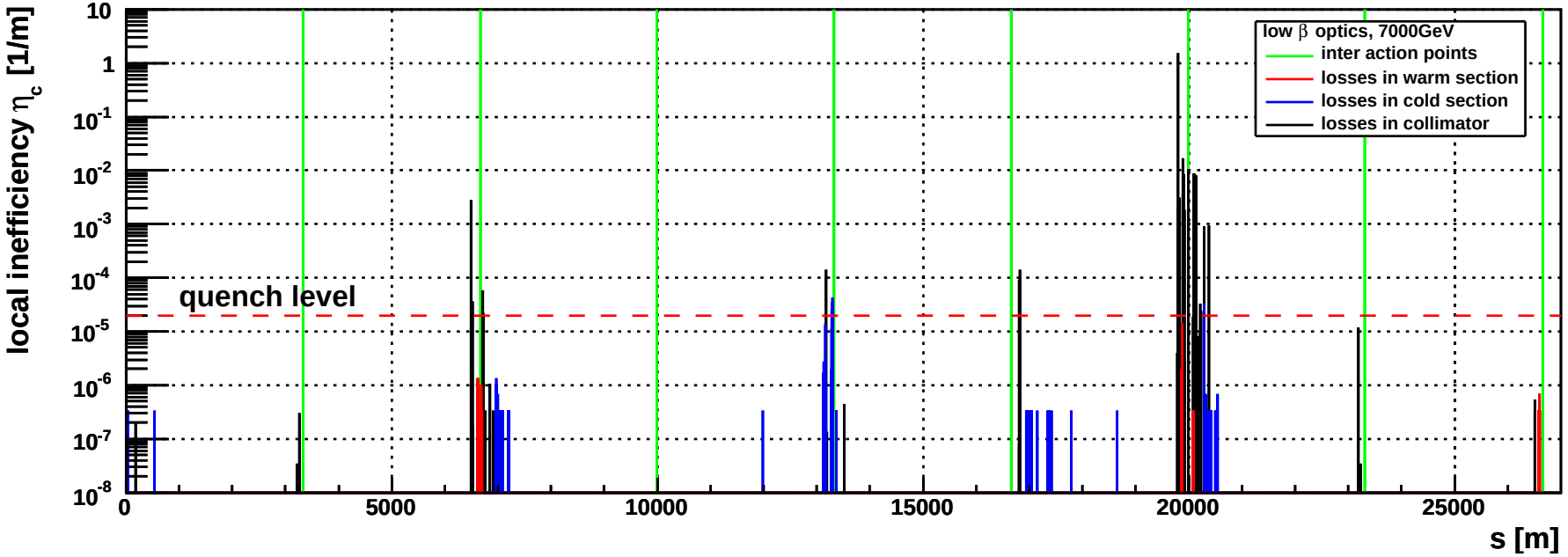


CFC primaries at 9.0σ, Cu secondaries at 10.5σ, CFC secondaries set to relaxed opening (26.5σ), cryogenic collimators (material Cu, length 1 m) placed at 298.89 m and 388.44 m from IR7 at 15σ.

$\eta_c = 1.42 \times 10^{-5}\,\mathrm{m}^{-1}$ in dispersion suppressor.

Performance Step 3 & Optics V6.503

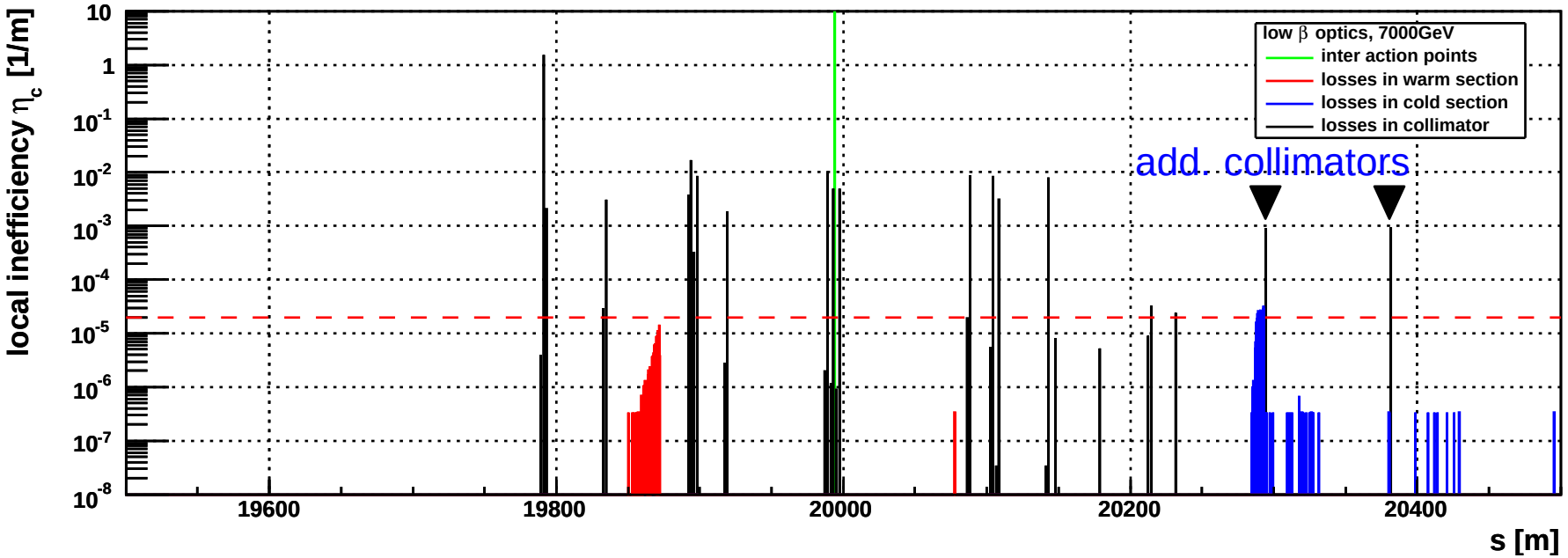
Loss-map around LHC for beam 1 (for 29.0M particles)



CFC primaries at 12.0σ, Cu secondaries at 14.0σ, CFC secondaries set to relaxed opening (26.5σ), cryogenic collimators (material Cu, length 1 m) placed at 298.89 m and 388.44 m from IR7 at 17σ.

Performance Step 3 & Optics V6.503

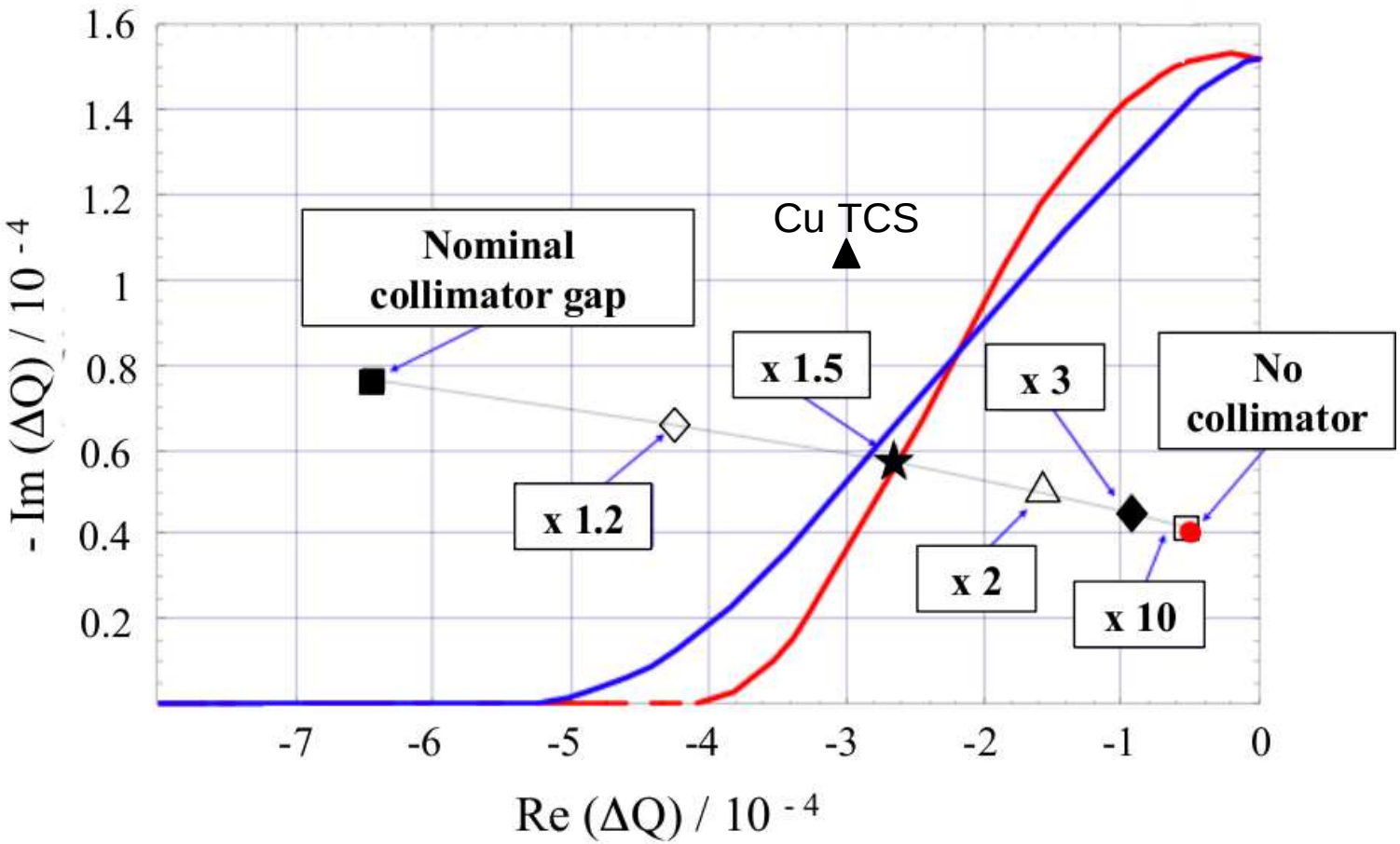
Zoom in IR7 and dispersion suppressor



CFC primaries at 12.0σ, Cu secondaries at 14.0σ, CFC secondaries set to relaxed opening (26.5σ), cryogenic collimators (material Cu, length 1 m) placed at 298.89 m and 388.44 m from IR7 at 17σ.

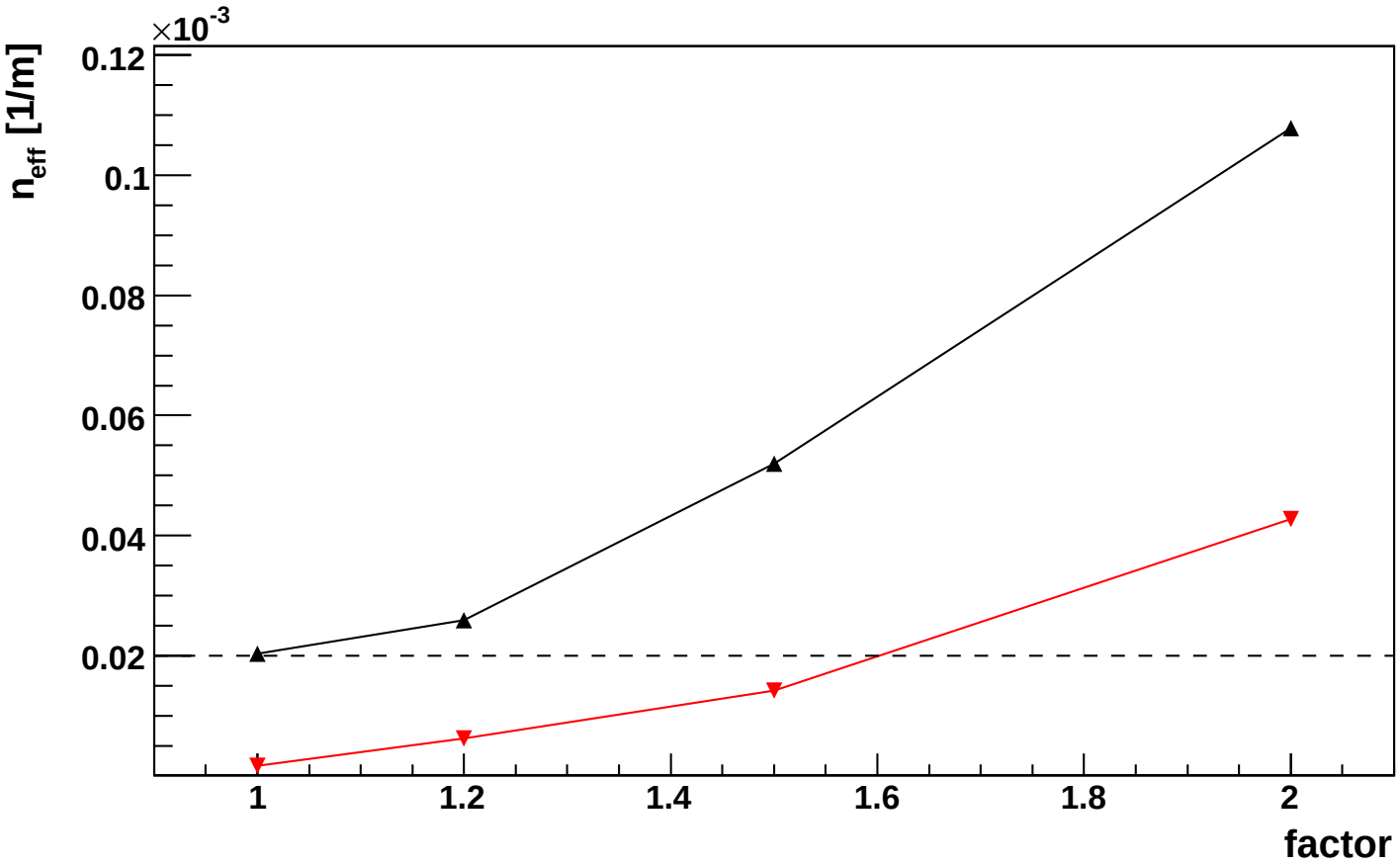
$\eta_c = 4.28 \times 10^{-5}$ m^{-1} in dispersion suppressor.

Impedance and Gap Size



Input files for the setting of the Phase 1 and Phase 2 system provided to E. Metral, calculation in preparation.

Gap Size and Cleaning Ineffiency



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.

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)
- 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 studies needed to see energy deposition on the downstream magnets.
  - Impedance calculation for the different cases in preparation.
  - New collimator design for dispersion suppressor needed.