Loss maps for new IR7 optics

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On behalf of
the LHC Collimation Team

Introduction

Re-cabling of IR7 and possibility to power down an MQW lead to a new proposed LHC optics for the post-LS1 restart of the machine

Studies of the influence of this new possible optics on the LHC Collimation cleaning required to validate the new solution
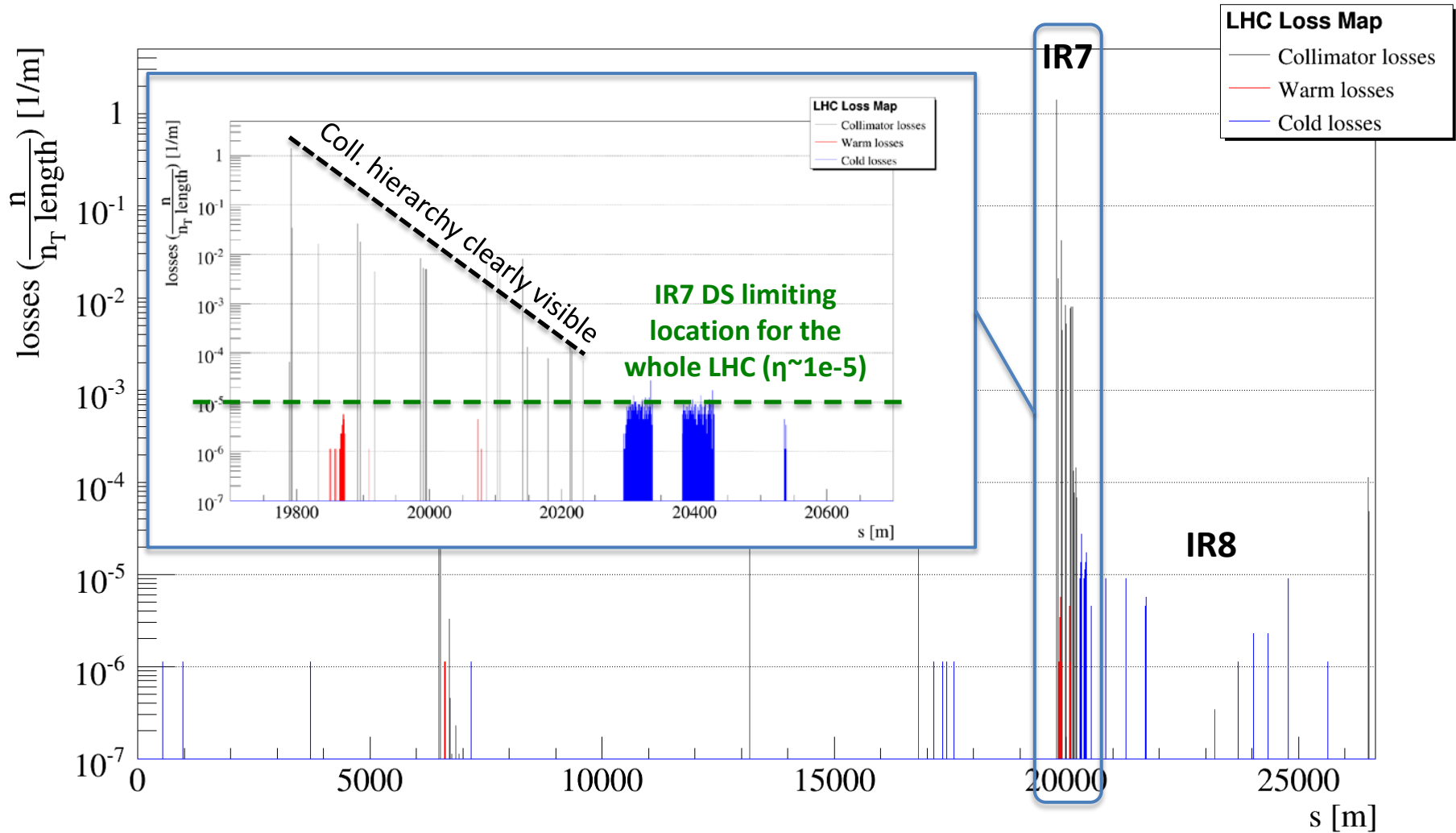
- Simulations made for beam 1 and beam 2 with 7 TeV nominal collision settings. (β*=55cm)

- Compared the system performance using the original optics, with respect to the new optics proposed.
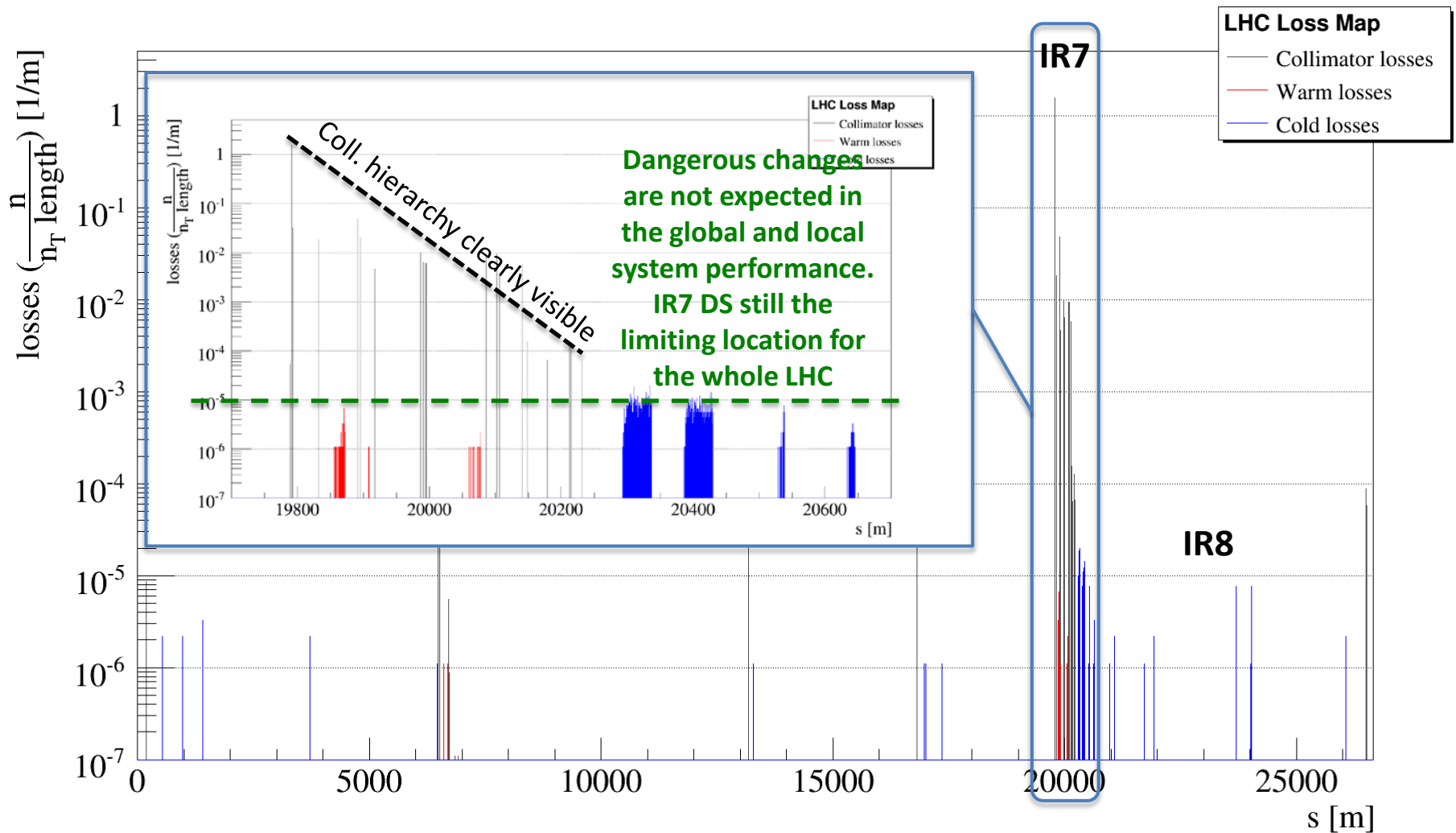
Beam 1

Beam 1 H reference loss map

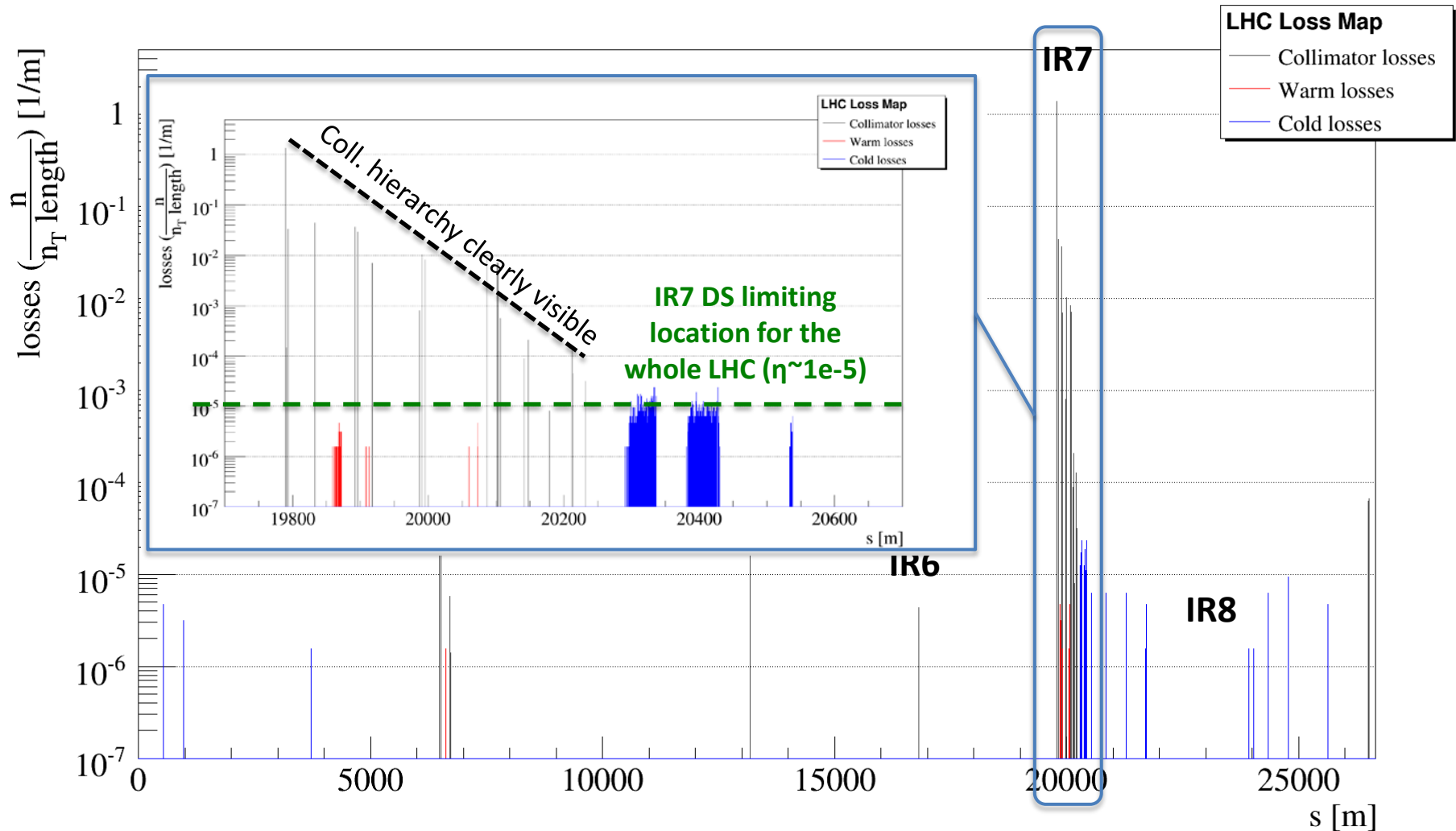*Expected performance of the collimation system with original optics*

Beam 1 H new opt. loss map

Expected performance of the collimation system with proposed new optics
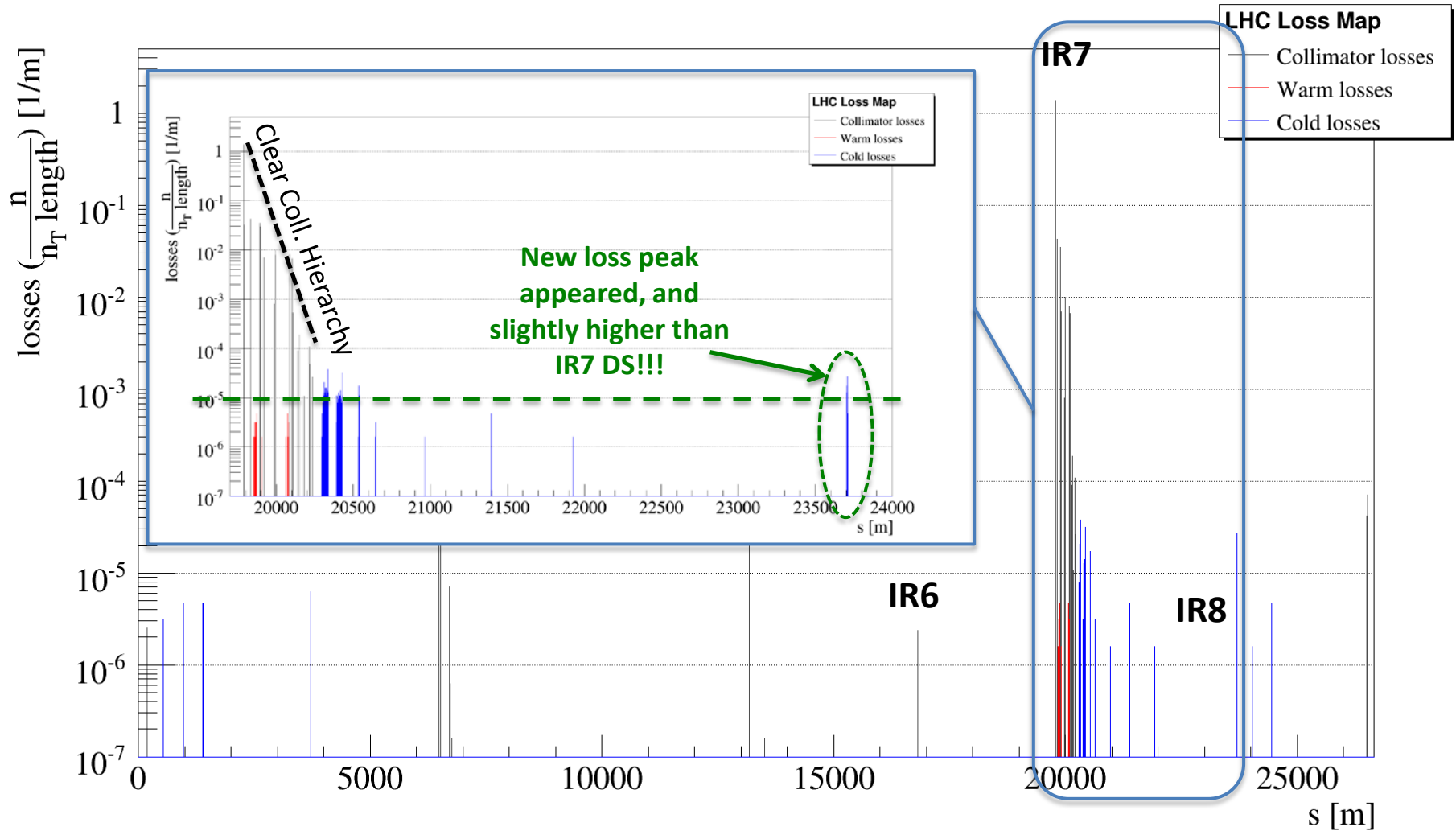
Beam 1 V reference loss map

*Expected performance of the collimation system with original optics*

Beam 1 V new opt. loss map

Expected performance of the collimation system with proposed new optics

Considerations on Beam 1-V

To what it is due this new peak higher than IR7 DS?

➢ Particle by particle analysis on simulations output shows that this peak is due to halo protons which experienced single diffractive interaction in the vertical TCP jaw acquiring a $\delta p/p \sim$ 1e-2.

  ➢ This particles are then lost mainly at the first passage to that s location.
     (where $D_x \sim$ 2m, and H aperture of ~2cm)

  ➢ Impact points on the beam pipe fits with the topology off-momentum losses,
     i.e. all protons are lost on the H plane and internal side of the machine.
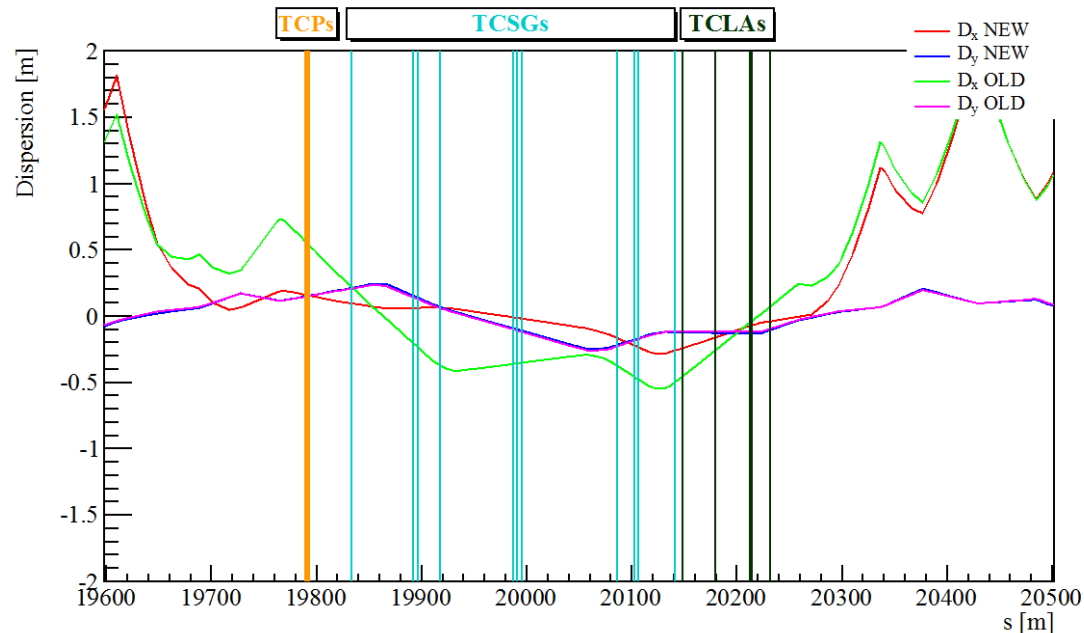
Main difference between old and new optics:
**Local Horizontal Dispersion in IR7
and phase advance**

*Everything else is comparable between
the two optics in the whole LHC ring*

Considerations on Beam 1-V

Summary table of interesting parameters playing a key role on such off-momentum losses

H-Coll. ID	D_x [m]		halfgap [m]		$\delta p/p$ cut	
	Old	New	Old	New	Old	New
TCP.C6L7	0.55	0.15	1.65e-3	1.65e-3	3.0e-3	1.1e-2
TCSG.B4L7	-0.36	-0.01	1.85e-3	1.88e-3	5.1e-3	1.9e-1
TCSG.6R7	-0.50	-0.26	2.88e-3	2.71e-3	5.8e-3	1.0e-2

Used the periodic dispersion to identify possible sources of differences in loss maps.
Did not calculate yet the difference of what the particle sees on single passage

The hypothesis it is then:

The new loss peak it is due to off-momentum particles created in the interaction with the vertical primary collimator and then no longer intercepted by the horizontal secondary collimators, due to the reduced dispersion at their location (i.e. reduced $\delta p/p$ cut performed)
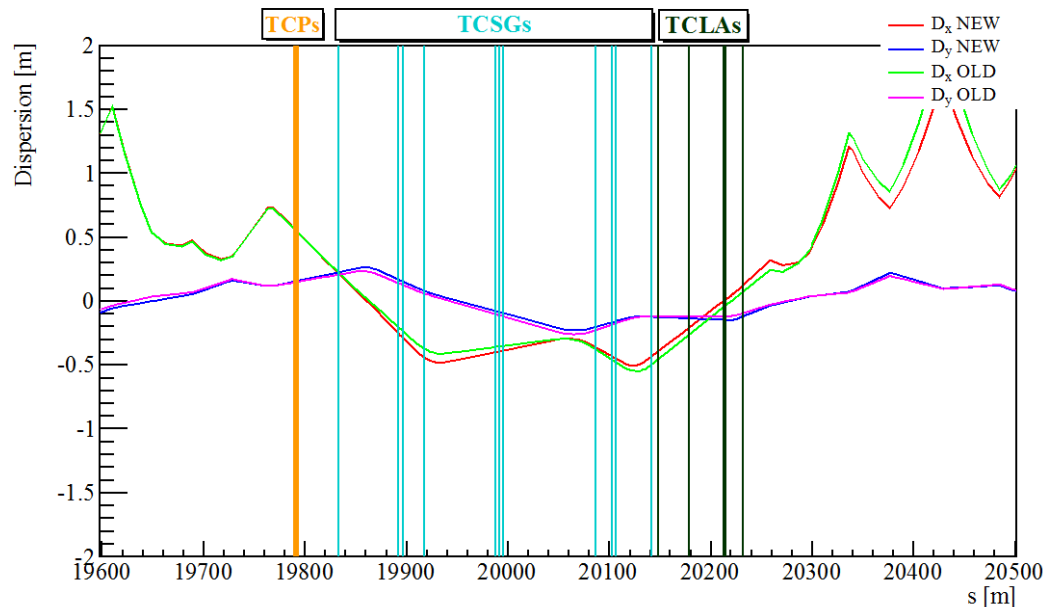
Checked if bringing back the local dispersion function to the old values cure this new loss peak (not possible to bring back the phase advance too, due to problems at injection)

Modified proposed new opt.

Modified local dispersion in IR7

everything else unchanged with respect to new proposed optics (Thanks to R. De Maria)

| H-Coll. ID	D_x [m]			halfgap [m]			$\delta p/p$ cut		
	Old	New	Mod	Old	New	Mod	Old	New	Mod
TCP.C6L7	0.55	0.15	0.55	1.65e-3	1.65e-3	1.65e-3	3.0e-3	1.1e-2	3.0e-3
TCSG.B4L7	-0.36	-0.01	-0.40	1.85e-3	1.88e-3	1.88e-3	5.1e-3	1.9e-1	4.7e-3
TCSG.6R7	-0.50	-0.26	-0.44	2.88e-3	2.71e-3	2.71e-3	5.8e-3	1.0e-2	6.2e-3

Beam 1 H mod. opt. loss map

Expected performance of the collimation system with proposed new optics
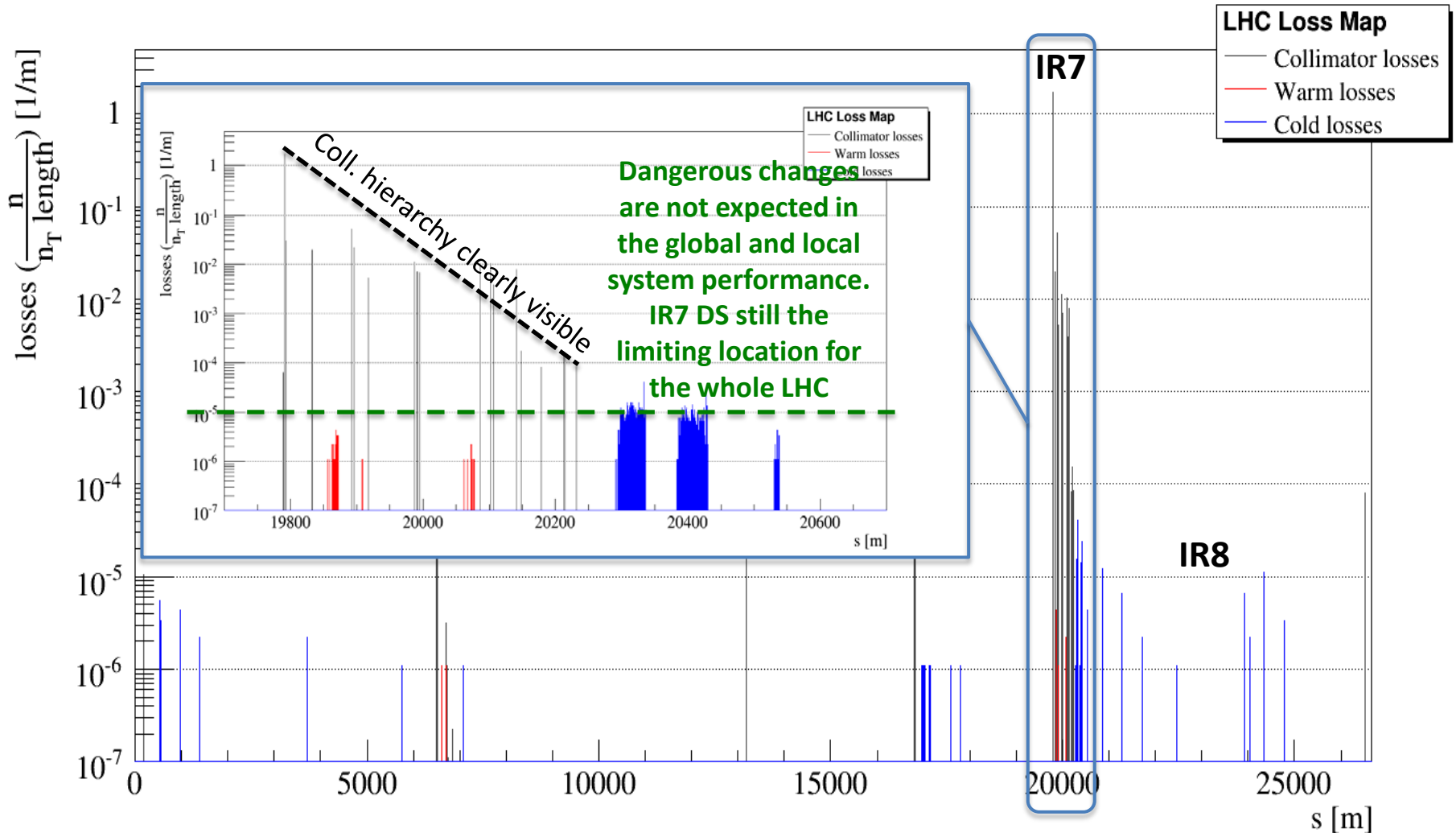
Beam 1 V mod.opt. loss map

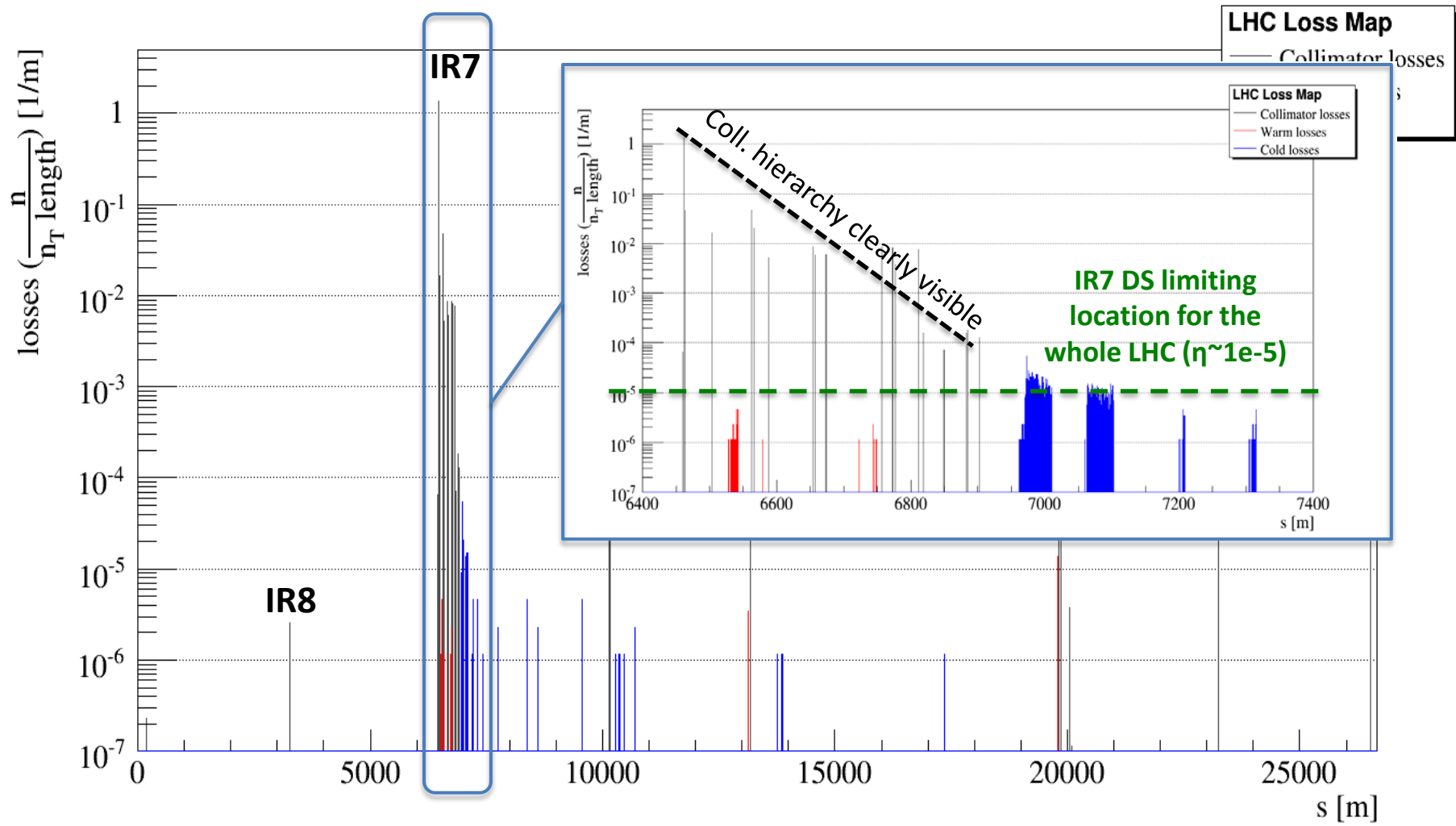*Expected performance of the collimation system with proposed new optics*
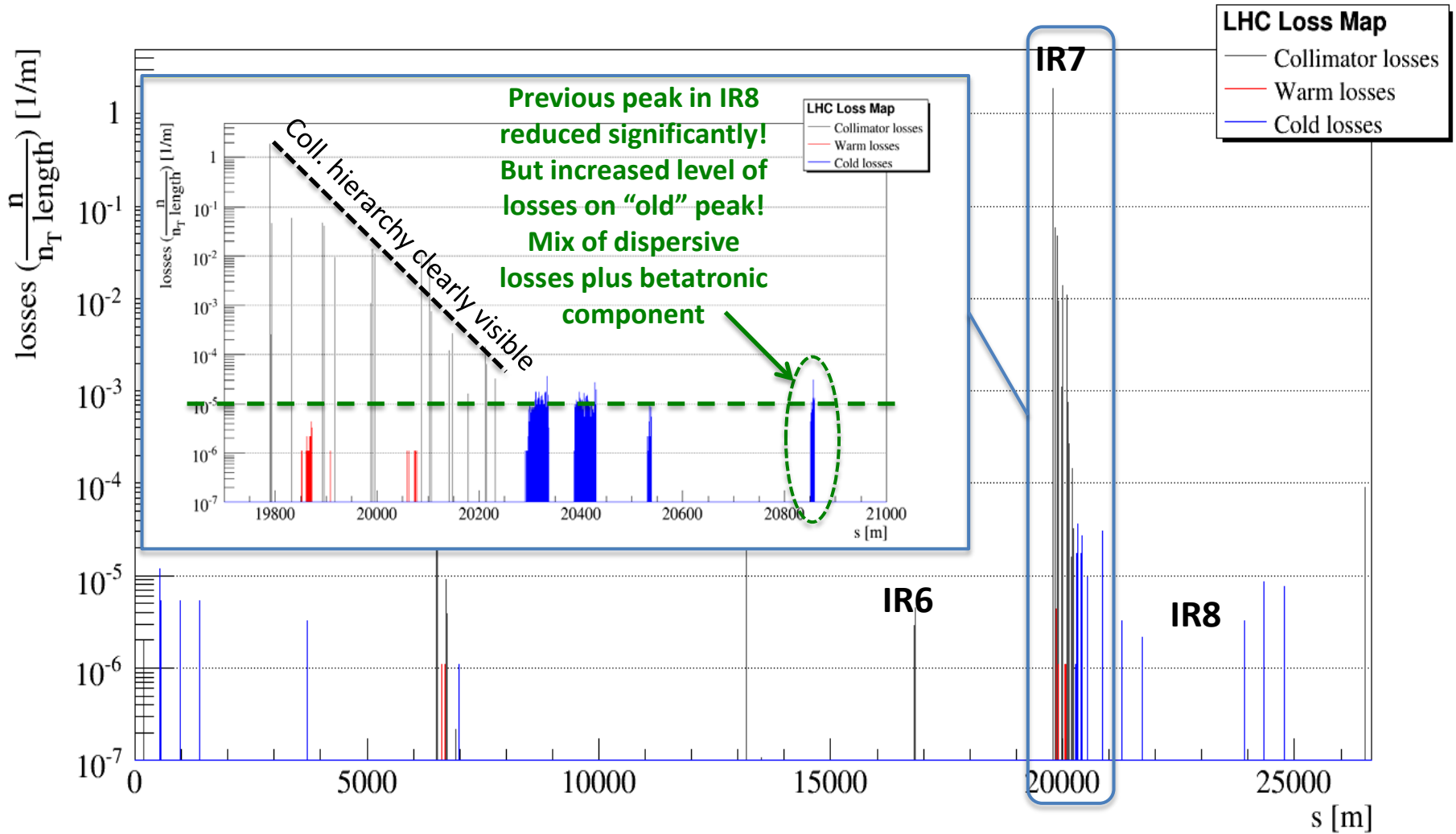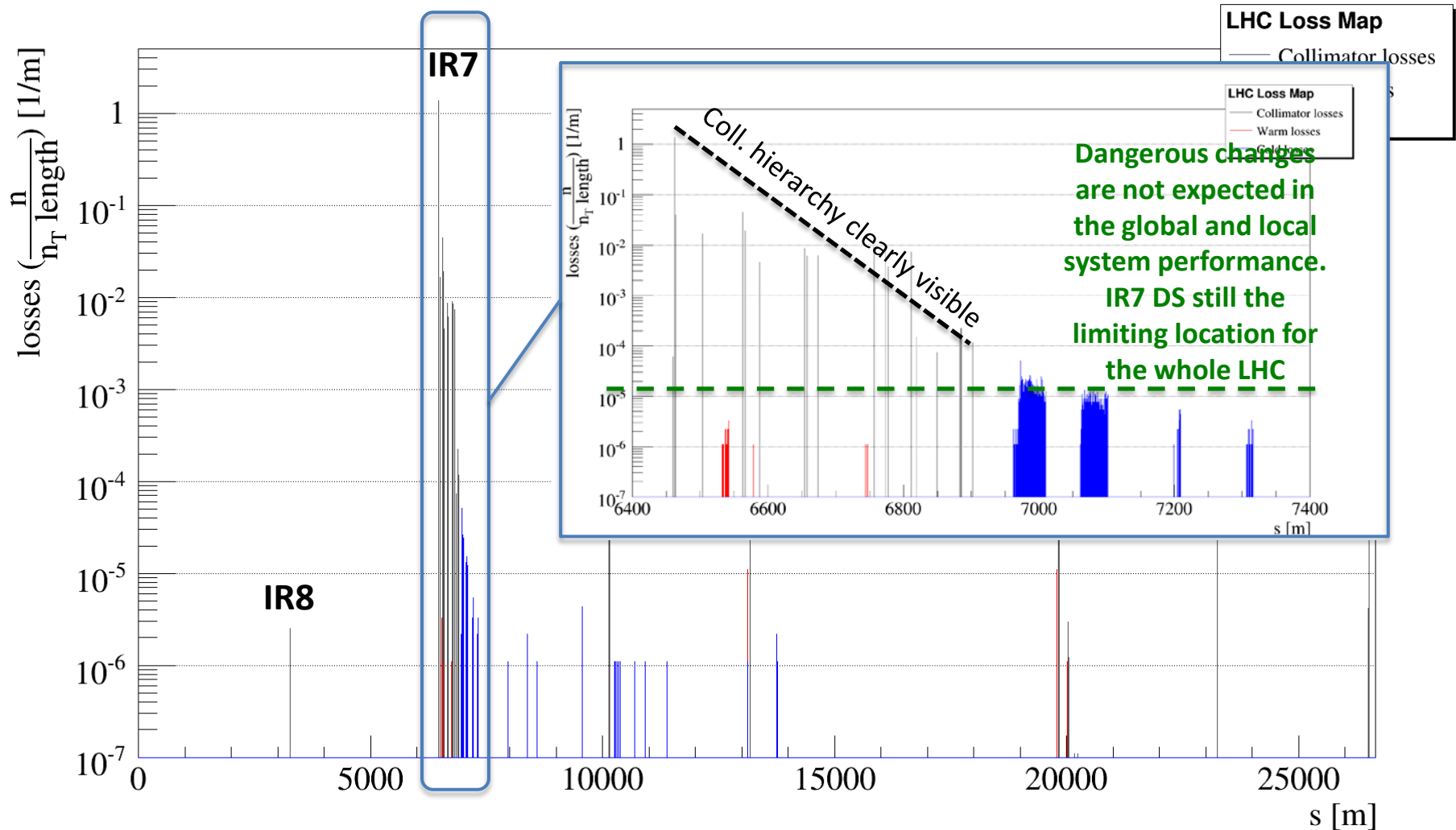
Beam 2

Beam 2 H reference loss map

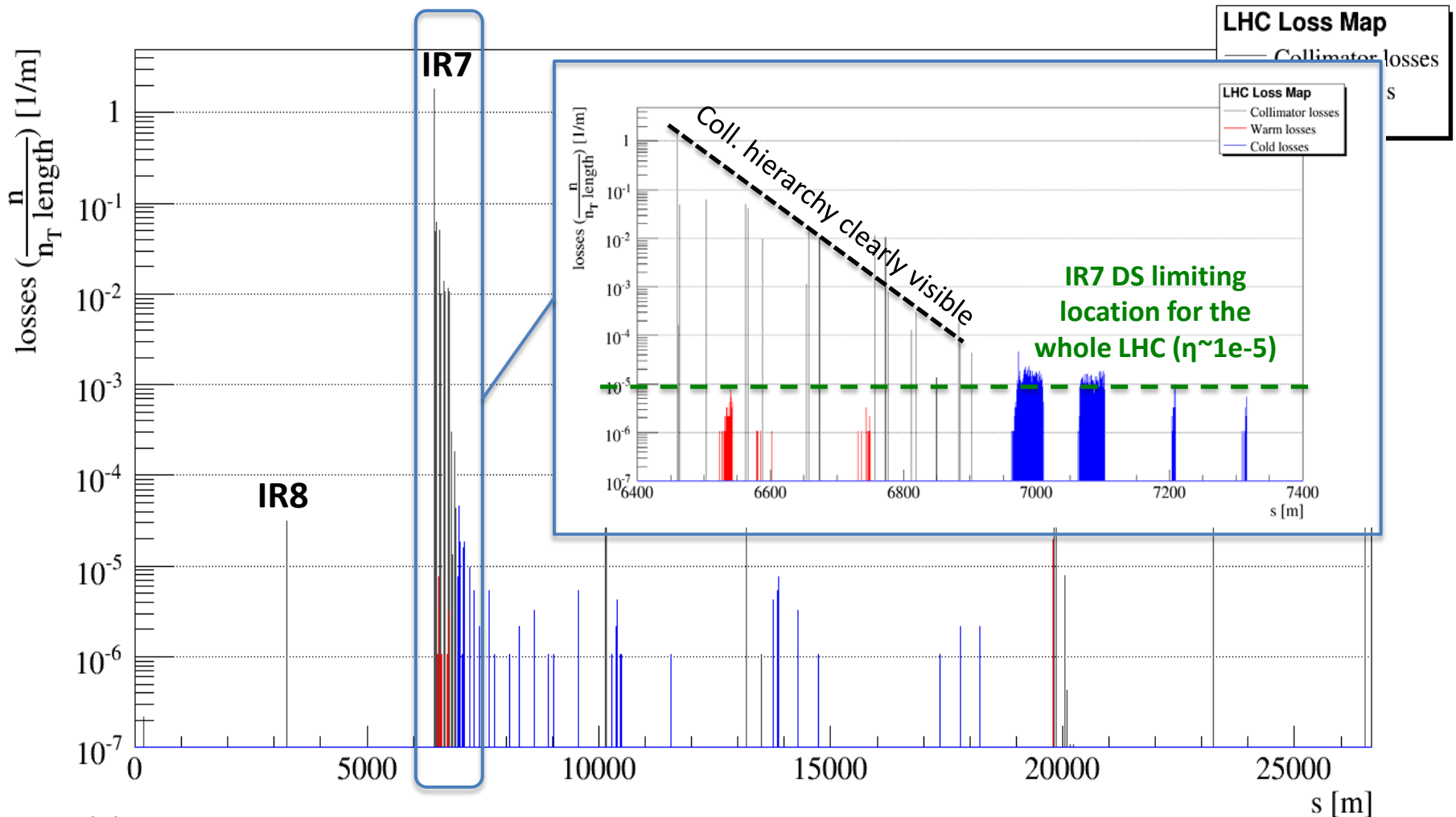*Expected performance of the collimation system with original optics*

Beam 2 H new opt. loss map

Expected performance of the collimation system with proposed new optics

Dangerous changes are not expected in the global and local system performance. IR7 DS still the limiting location for the whole LHC
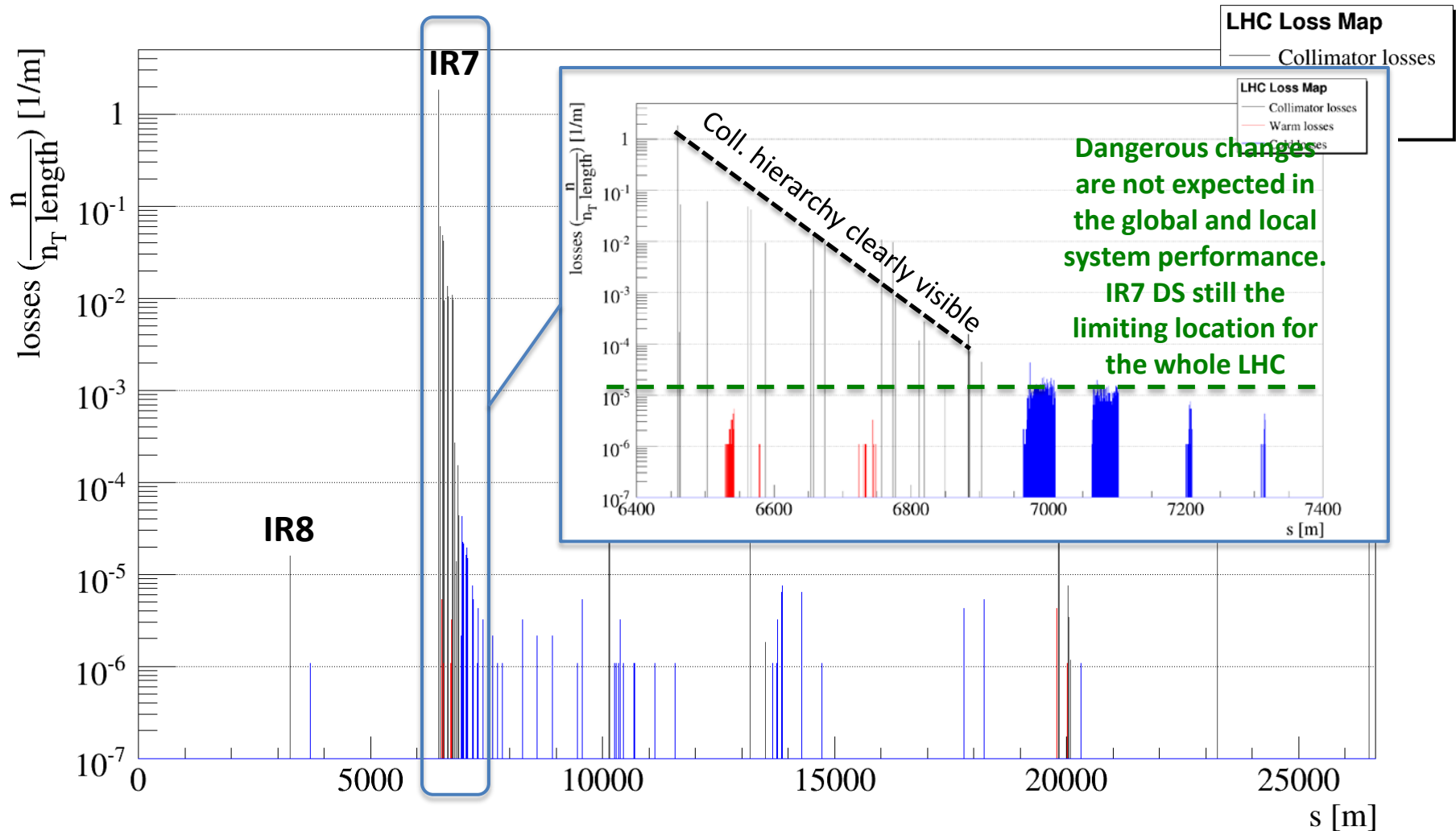
Beam 2 V reference loss map

Expected performance of the collimation system with original optics

Beam 2 V new opt. loss map

Expected performance of the collimation system with proposed new optics

Conclusions

Beam 1

Horizontal:

✓ Similar performance of the collimation system are expected with the proposed new optics, with respect to the original optics

Vertical:

✓ New dangerous peak (higher than IR7 DS) appeared in IR8!

✓ Details of the single-pass dispersion are ongoing. Based on the periodic dispersion changes, we suggested to re-match the optics to get the same local optics

Still not identical loss maps, but acceptable

Beam 2

✓ Optics functions almost identical to the original optics
(only minor changes on the beta values at the collimators in the IR7)

✓ Similar performance of the collimation system are expected with the proposed new optics, with respect to the original optics, in both collimation planes