LHC Collimation Project - HL-LHC Design Study: WP5

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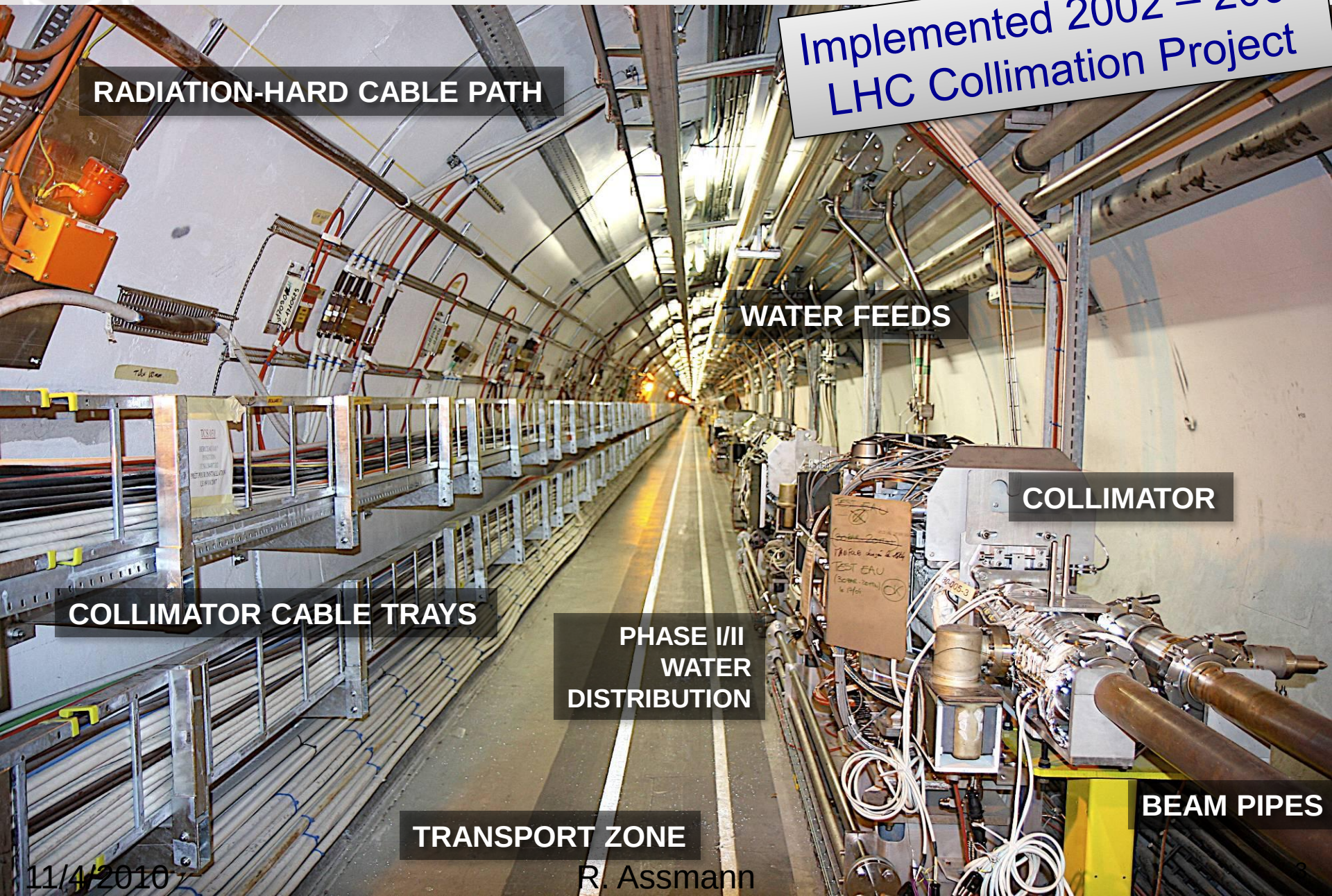
LARP CM15, 1.11.2010

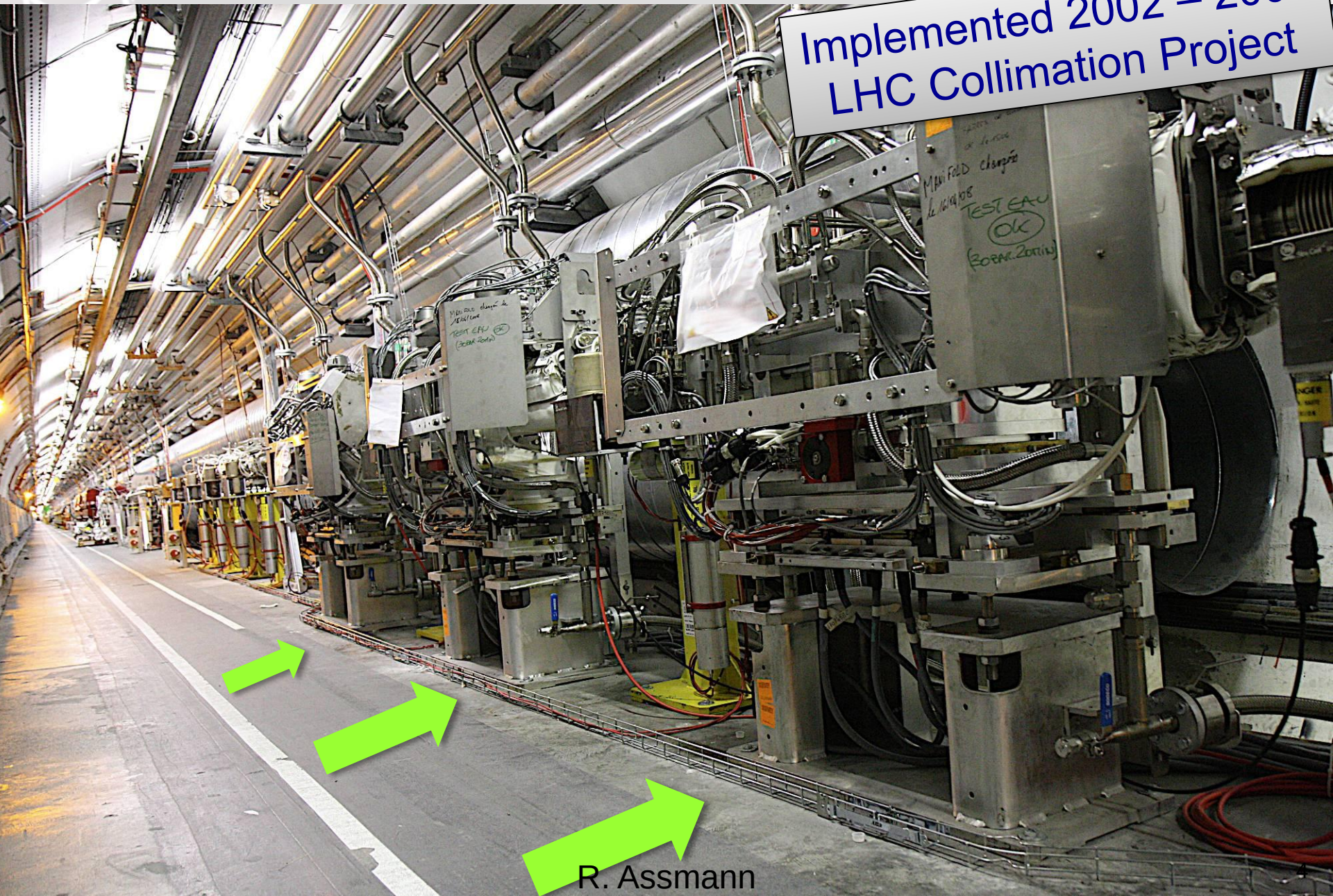
LHC Collimation Works Well…

- With already very high LHC beam intensity we see unavoidable beam losses constantly (see example for lifetime > 75 hours).
- We can characterize losses. E.g. losses for beam 1 mostly in momentum cleaning → had a few RF cavity trips. Losses for beam 2 mostly in betatron cleaning → no RF trips for beam 2.
- **Essentially all losses intercepted at primary collimators in betatron and momentum cleaning insertions!**
- Small leakage to outside cleaning insertions. **High efficiency!**
- Some local losses occur in the experimental insertions (visible on logarithmic scale): luminosity-driven losses, p-p collisions.
- In addition: rare beam dumps due to tiny, fast losses in middle of arc (10 events so far → rare dust particles?). Not discussed here…

Phase I in Tunnel (Radiation-Optimized)

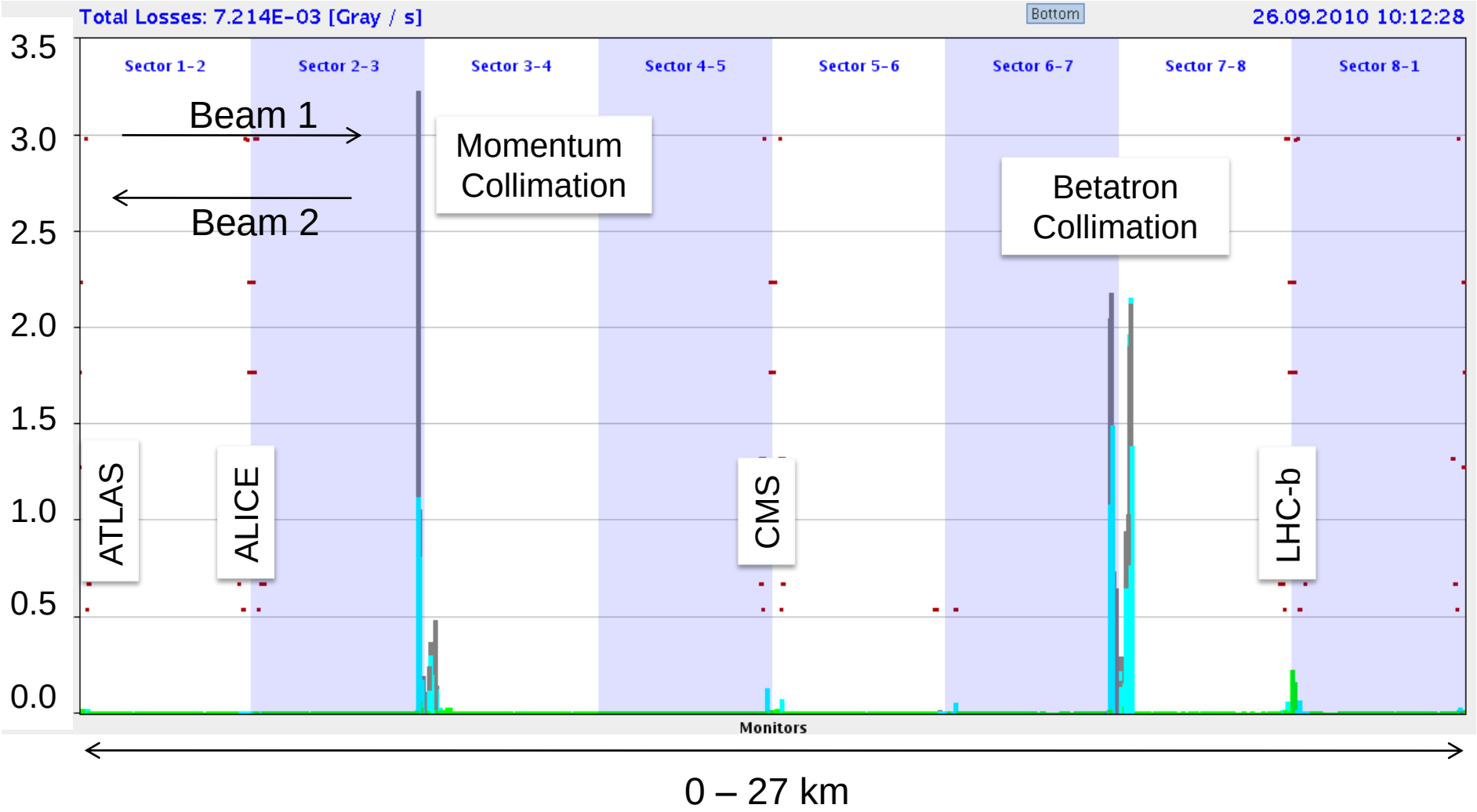


Tunnel: 3 Primary Betatron Collimators



Losses Around the Ring

(3.5 TeV, End Record Fill 26.9.2010, $\tau > 75$ h)

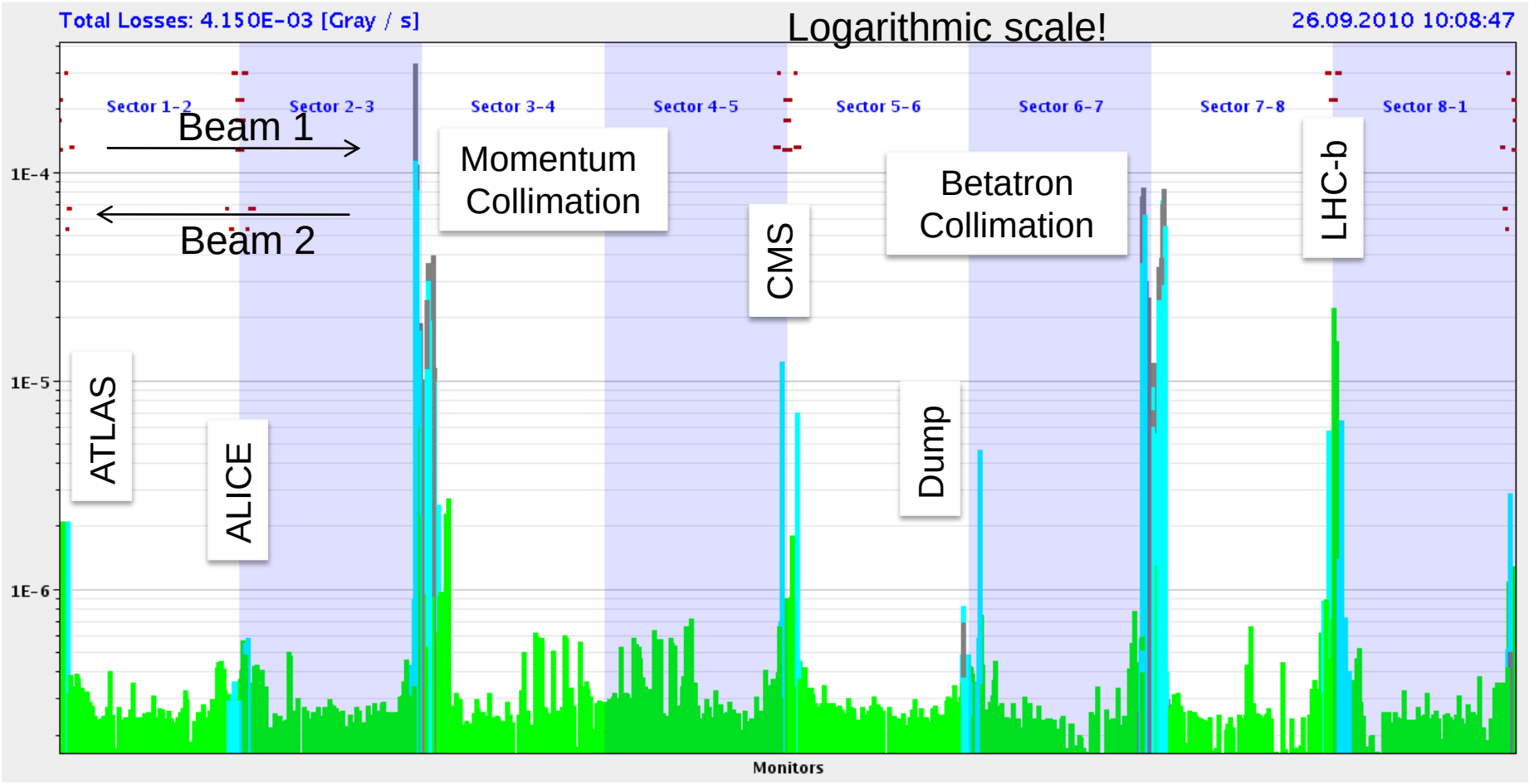


0 – 27 km

Essentially all losses at collimators → No quench!

Losses Around the Ring

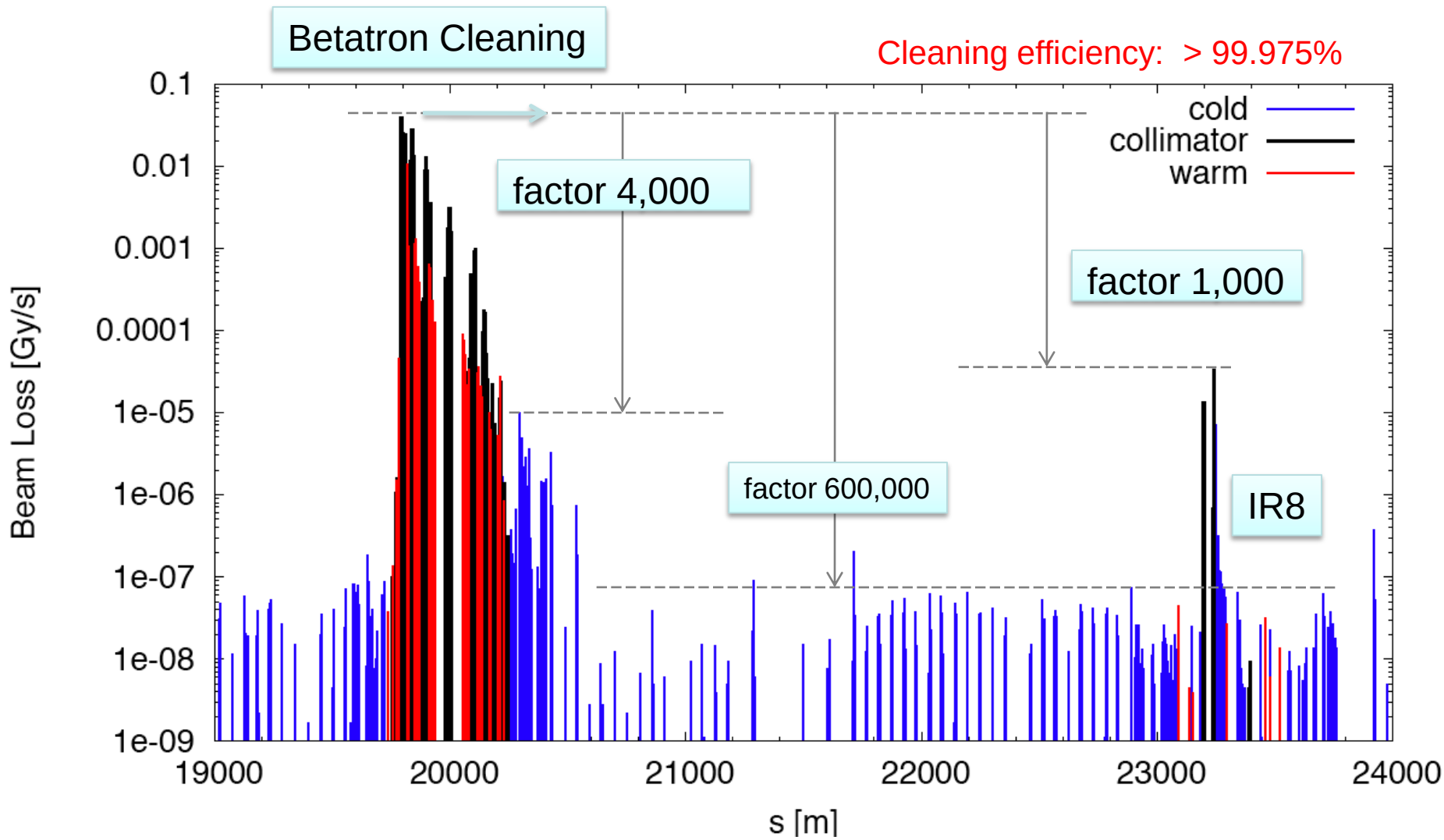
(3.5 TeV, End Record Fill 26.9.2010, $\tau > 75$ h)



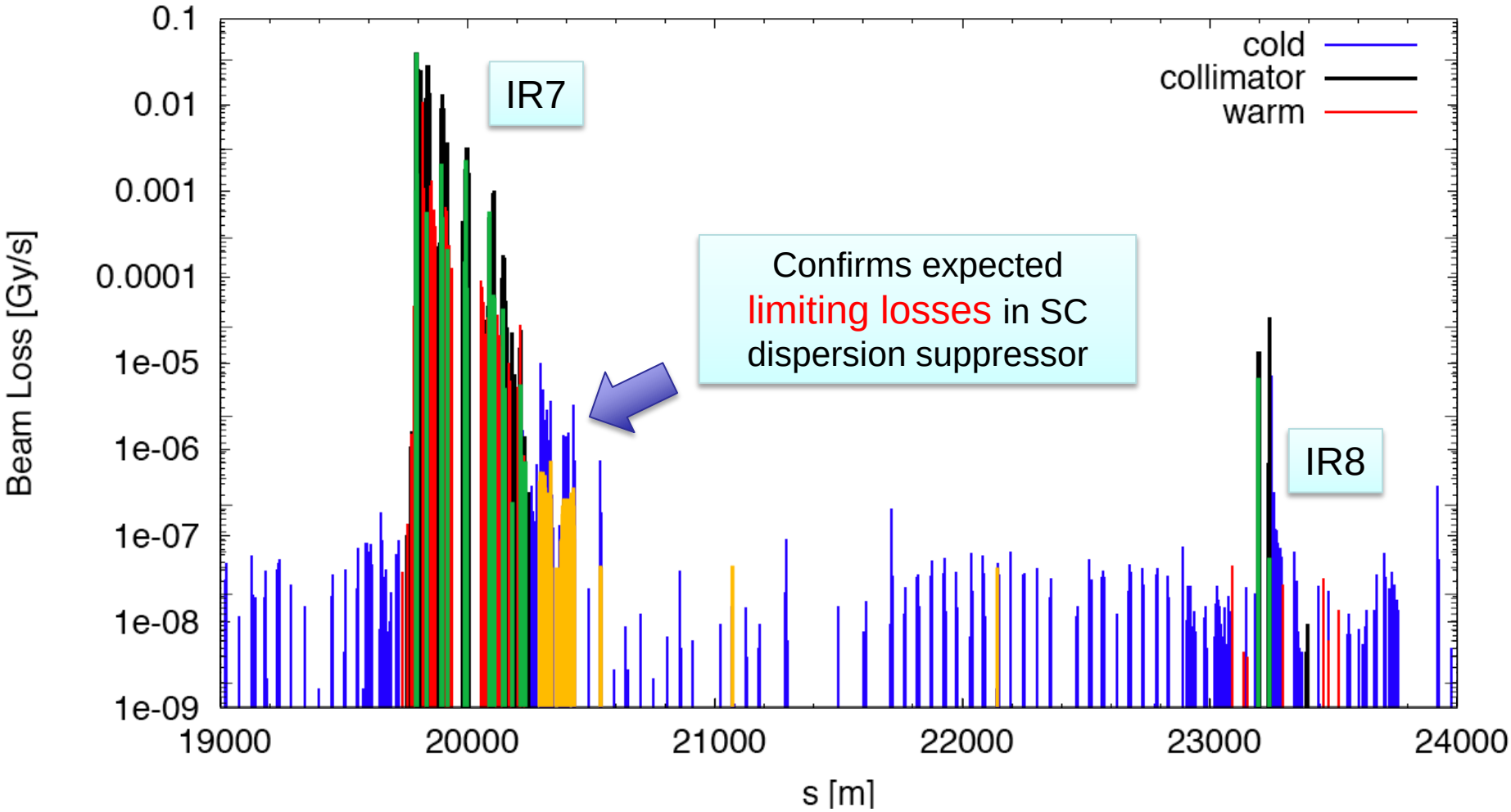
0 – 27 km

Details can be seen in logarithmic scale!

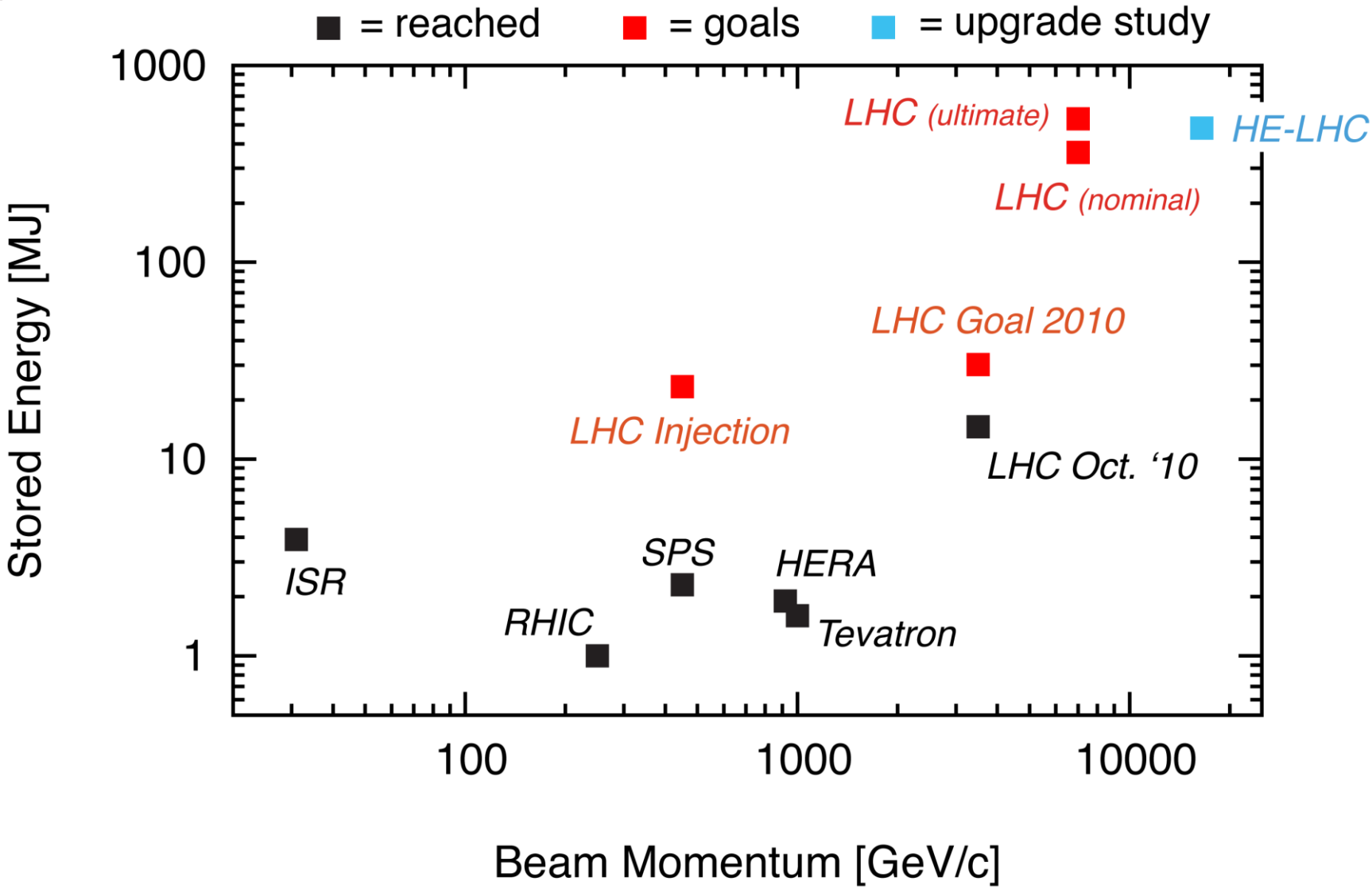
Measured Cleaning at 3.5 TeV
(beam1, vertical beam loss, intermediate settings)



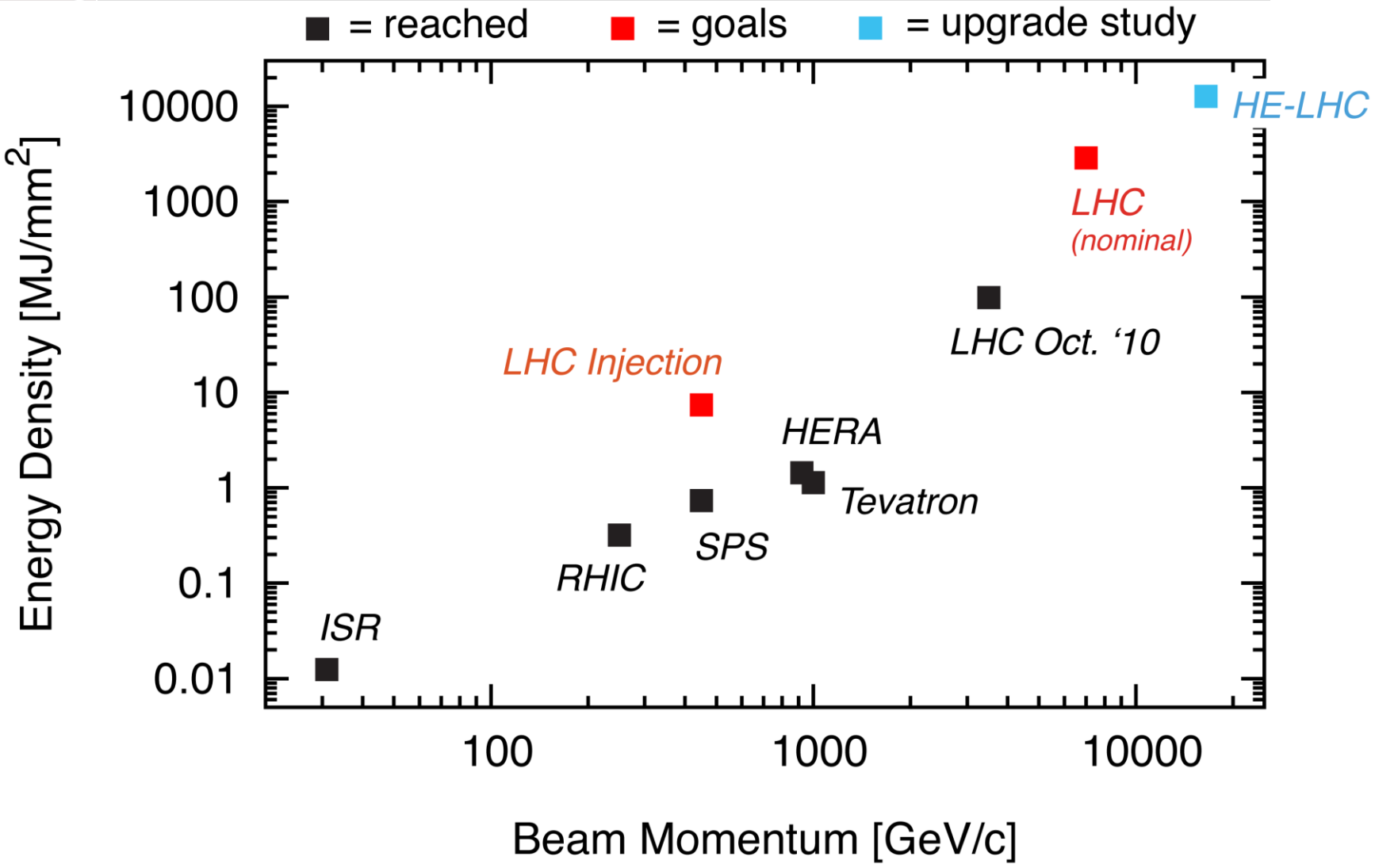
Meas. & Sim. Cleaning at 3.5 TeV
(beam1, vertical beam loss, intermediate settings)



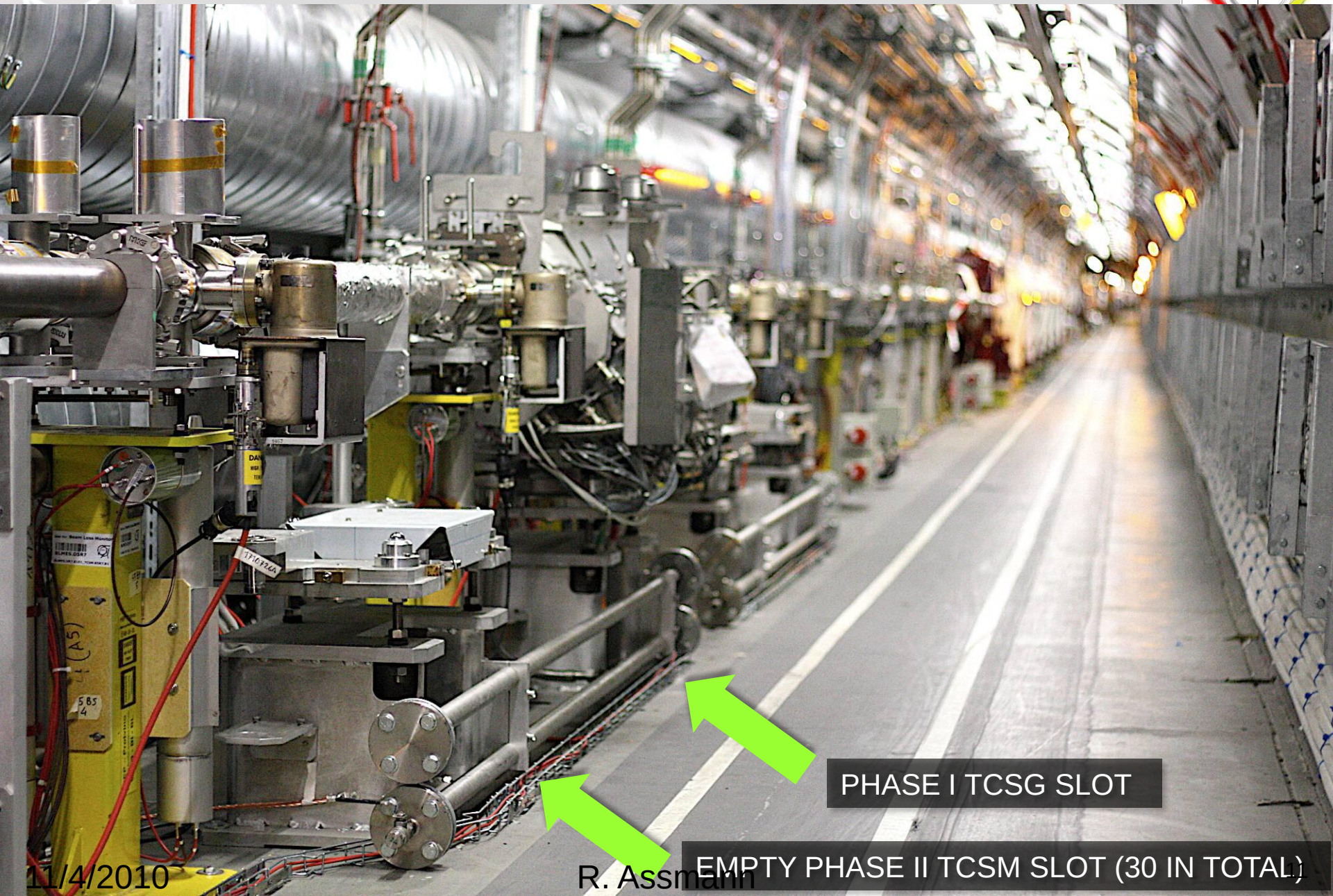
Status LHC Stored Energy



LHC Status Energy Density



Collimation is Designed for Upgrades!



LHC Collimation Upgrade Work

Work is defined in three stages:

I. 2010 – 2013: Upgrade part 1

II. 2013 – 2017: Upgrade part 2

III. 2020: Upgrade part 3.

Collimation Upgrade Part 1 (2010 – 2013)

- Start date of work: **1.7.2010**
- End date of work: **31.12.2013**
- Deliverables:
  - **Improve collimation efficiency by factor 5-10.**
  - **Implement flexibility in loss location (IR3 or IR7).**

Collimation Upgrade Part 2 (2013 - 2017)

– to be approved in 2011

- Start date of project: **1.1.2013**
- End date of project: **31.12.2017**
- Deliverables:
  - **Improve collimation efficiency by factor 2-3.**
  - **Reduce setup time by factor 100.**
  - **Implement radiation handling for highest intensities.**

Collimation Upgrade Part 3 (2020)

→ *WP5 in FP7 HL-LHC Design Study*

- Deliverables:
  - **Same or better loss situation than before the IR upgrade *(lower beta* with the same or better intensity reach)*.**
  - **Adapt IR collimation to the new IR layout and optics.**
  - **Design report, build hardware, implement modified IR collimation.**

WP5

WP Structure I

- WP 5.1: Coordination and Communication
- WP 5.2: IR Simulations of Halo Loss
  - Collimation Sixtrack: CERN ABP, Valencia
  - Collimation Merlin: Uni Manchester
  - Collimation Geant: Royal Holloway
- WP 5.3: IR Simulations of Energy Deposition
  - Mars: FNAL
  - FLUKA: CERN STI, Uni Manchester
  - Geant: Royal Holloway

WP Structure II

- WP 5.4: Design of IR Collimation
  - CERN ABP
  - Uni Valencia
  - SLAC

Objectives I

- WP 5.1: Coordination & Communication
  - To coordinate and schedule work package tasks
  - To monitor work progress and inform the project management and work package participants
  - To follow up the WP budget and use of resources
  - To prepare internal and deliverable reports
- WP 5.2: IR Simulations of Halo Loss
  - Assess locations and magnitudes of beam loss in the experimental IR's for various upgrade scenarios.
  - Study impact of imperfections on beam loss.
  - Explore interplay of IR beam losses with machine parameters (beta*, crossing angle).
  - Specify operational tolerances related to collimation and the IR upgrade.
  - Define beam impact scenarios for energy depositions studies and collimator design.
  - Prepare input for energy deposition studies.

Objectives II

- WP 5.3: IR Simulations of Energy Deposition
  - Assess locations and magnitude of energy deposition in the IR's for various upgrade scenarios including imperfections.
  - Investigate any possibly required shielding requirements.
  - Provide input to collimator design.
  - Prepare input for background simulations.
- WP 5.4: Design of IR Collimation
  - Study required collimation to keep losses at the same level or below before the IR upgrade.
  - Specification of collimator requirements.
  - Integration of collimators, new layout and optics.
  - Feed forward to simulation WP's.

Milestones (After Start of Design Study)

- M12: Set up of models and implementation of upgrade optics.
- M24: Assessment of beam halo losses in various upgrade scenarios.
- M36: Definition of new IR collimation solution.
- M42: Verification of new IR collimation solution in simulations. Possible iteration in design.
- M48: Final report.

Conclusion

- LHC collimation delivers promised performance, allowing LHC to already reach 28 MJ in stored energy.
- Performance reach will be reviewed in the Chamonix workshop, January 2011.
- The first phase of the LHC upgrade is ongoing in full speed.
- Two more phases have been defined up to 2020.
- The upgrade of IR collimation is foreseen for 2020 and is WP5 of the HL-LHC FP7 design study.