Collimator setup for 450GeV and 3.5TeV - Results

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Overview - Collimator setup and verification for 450GeV

- setup of ring collimators for both beams (~ 86)
- 10h two teams (2x2) beam 1 and beam 2 in parallel following a formalized procedure
- full beam scraping with all TCPs and the reference TCLAs
- grazing events for Atlas
- 3-4h verification of setup with slow losses (Q_h, Q_v and $\frac{\Delta p}{p}$)
- grazing events for CMS

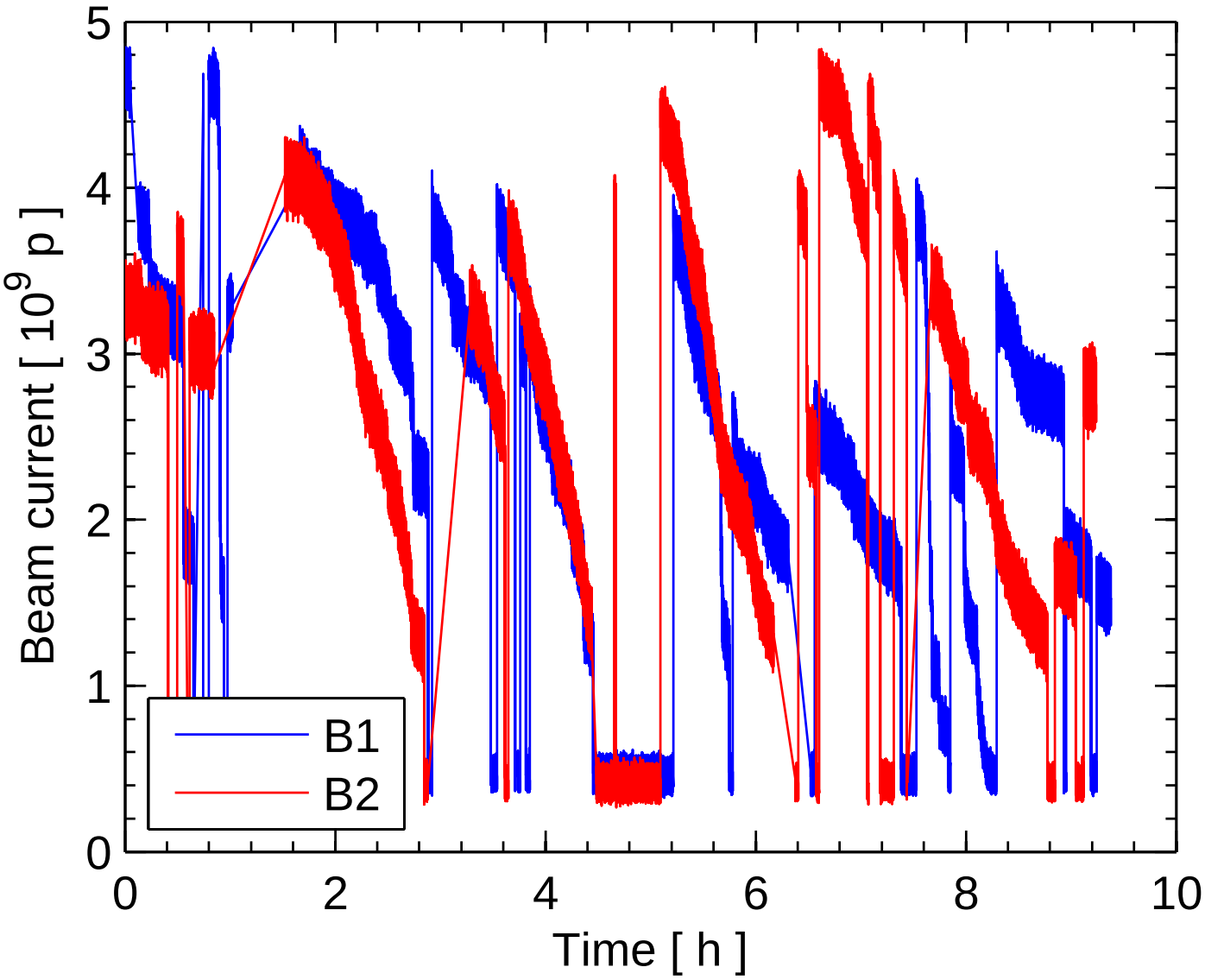
Procedure - Collimator setup for 450GeV

- creating a reference beam edge at $4.5\sigma_{nom}$ with final tertiary absorbers at the end of IR7 (TCLA.A7R7.B1, TCLA.C6R7.B1, TCLA.A7L7.B2, TCLA.C6L7.B2)
- centering the other collimators with respect to the tertiaries from back to front (as seen from the beam) and opening them to nominal settings
- B1: starting in IR7
- B2: starting in IR3

Collimator type	σ_{nom}
TCP IR3	8
TCSG IR3	9.3
TCLA IR3	10
TCP IR7	5.7
TCSG IR7	6.7
TCLA IR7	10

Collimator type	σ_{nom}
(TCDQ IR6	8)
TCSG IR6	7
TCLI IR2/IR8	6.8
TCT IR8	25
TCT IR1	15
TCL IR1	20

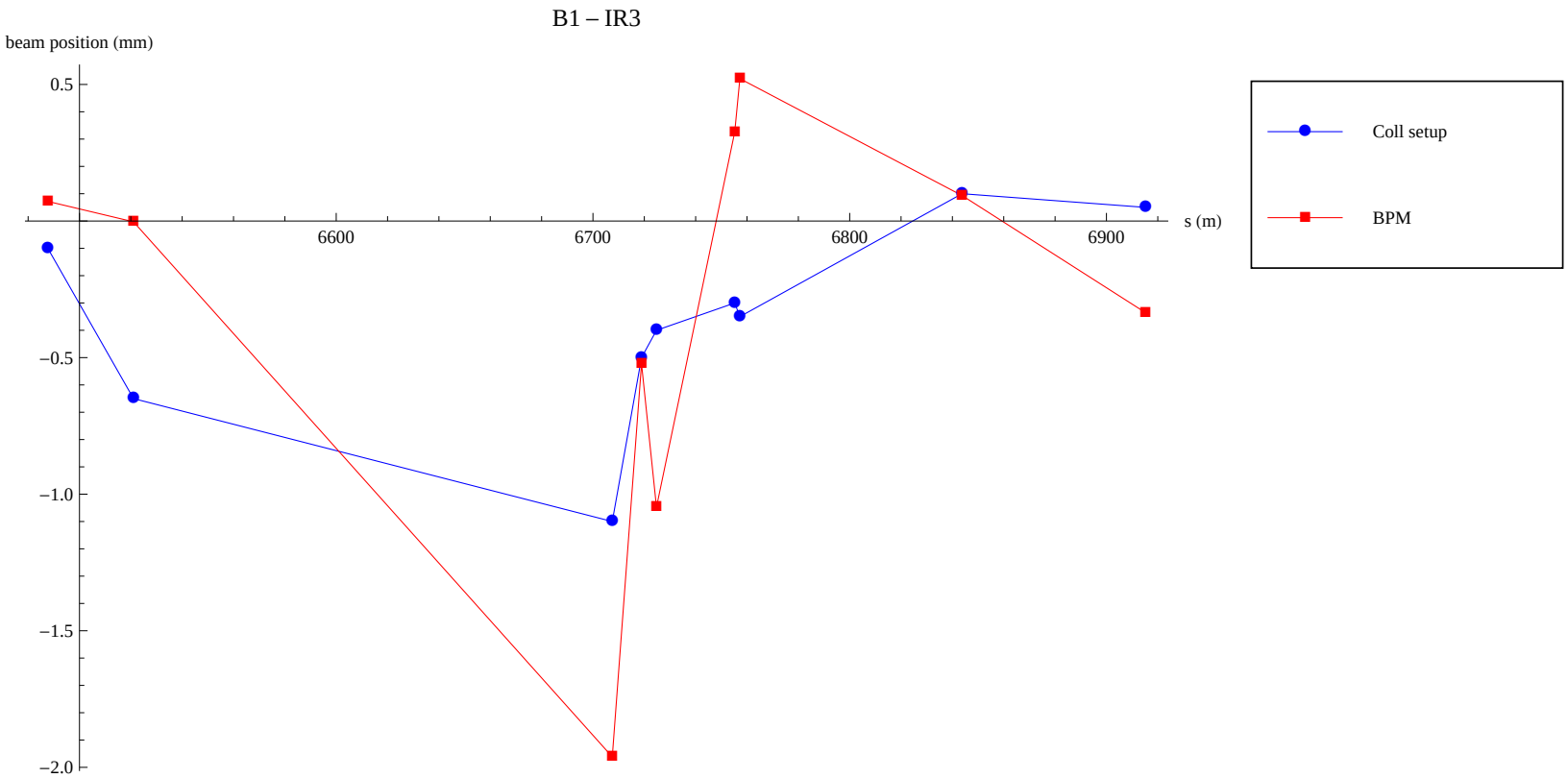
Collimator setup for 450GeV - Beam current versus time



courtesy S. Redaelli

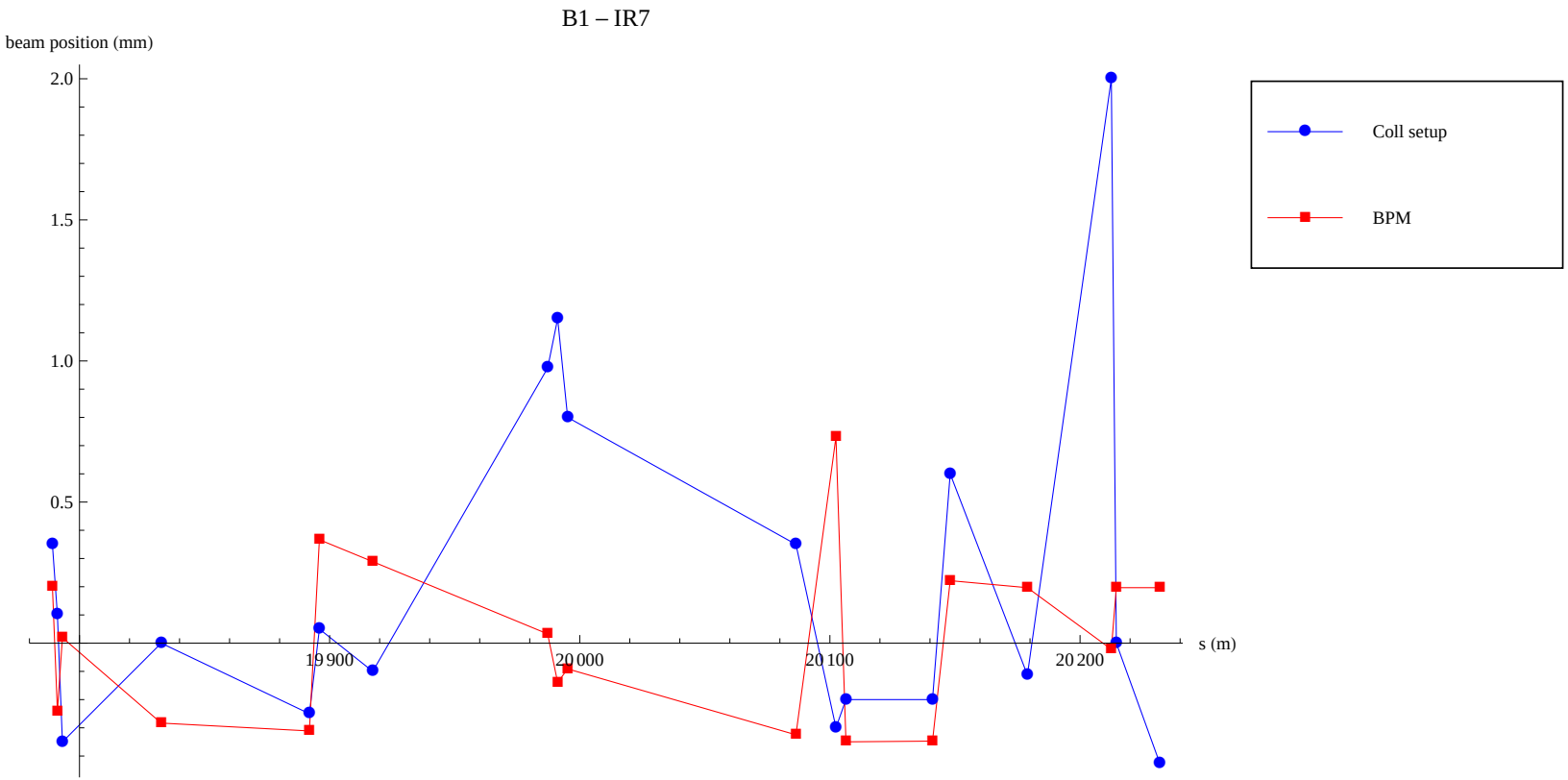
Results - Collimator setup B1

Measured beam offsets IR3



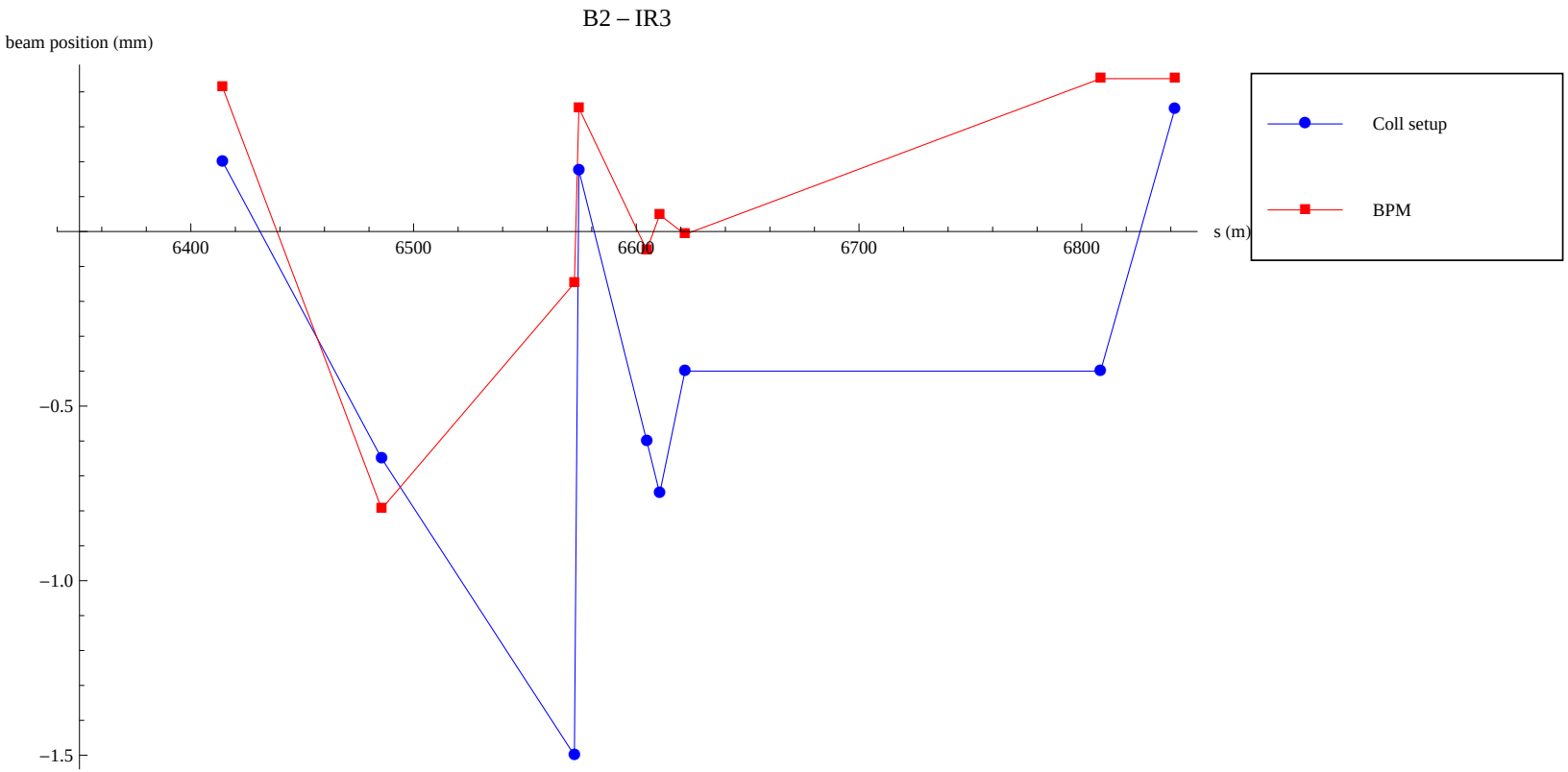
Results - Collimator setup B1

Measured beam offsets IR7



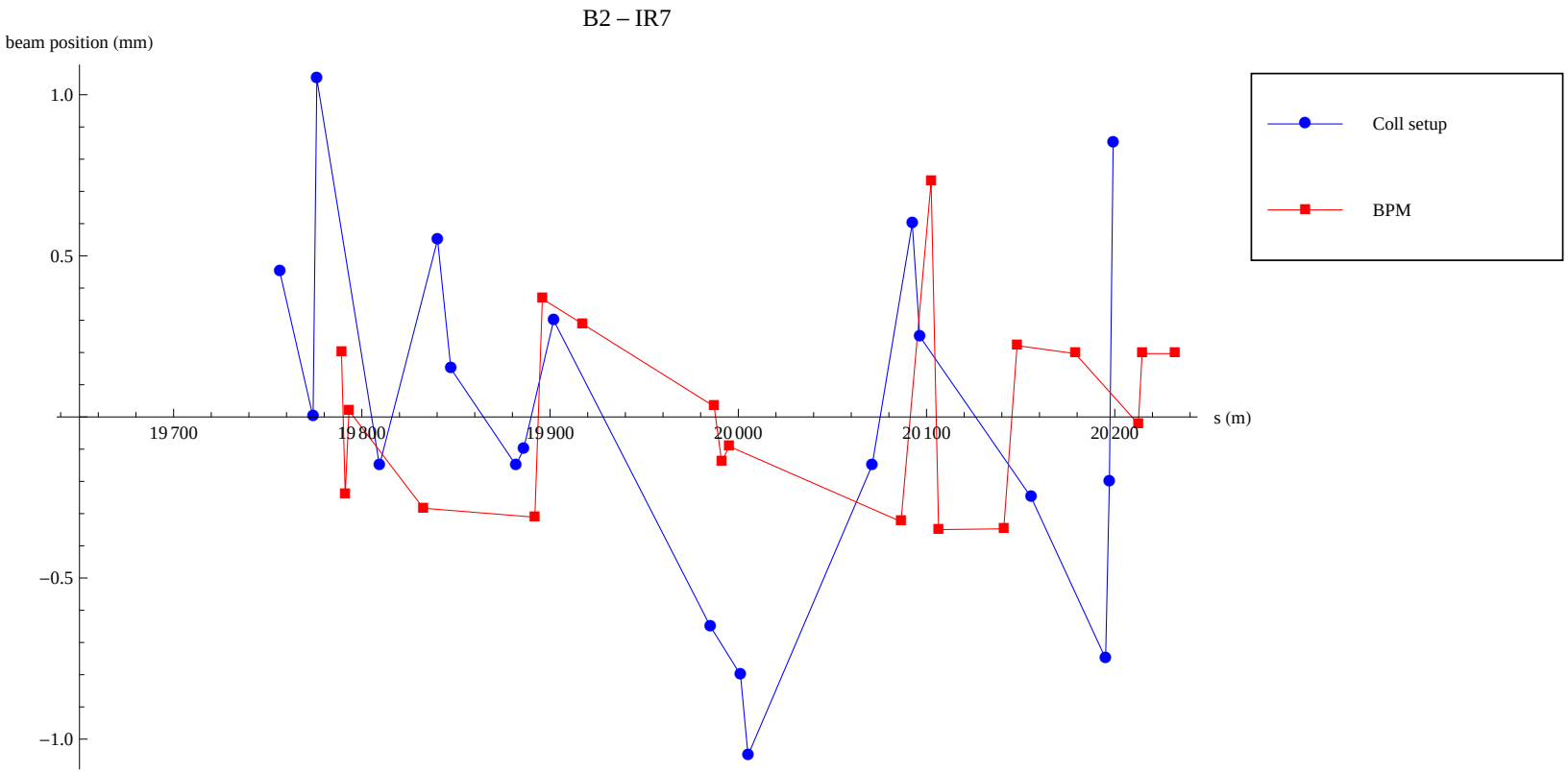
Results - Collimator setup B2

Measured beam offsets IR3



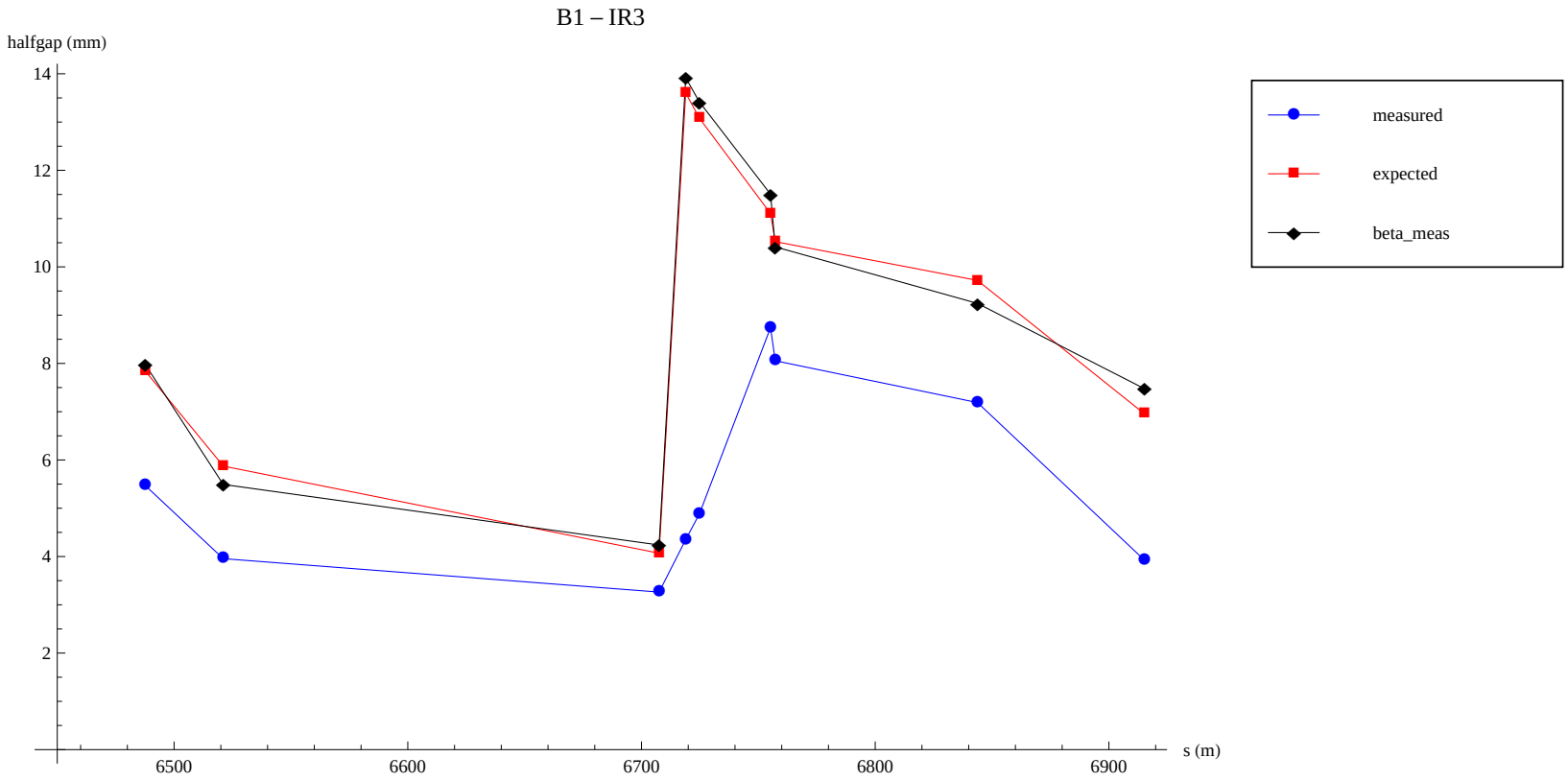
Results - Collimator setup B2

Measured beam offsets IR7



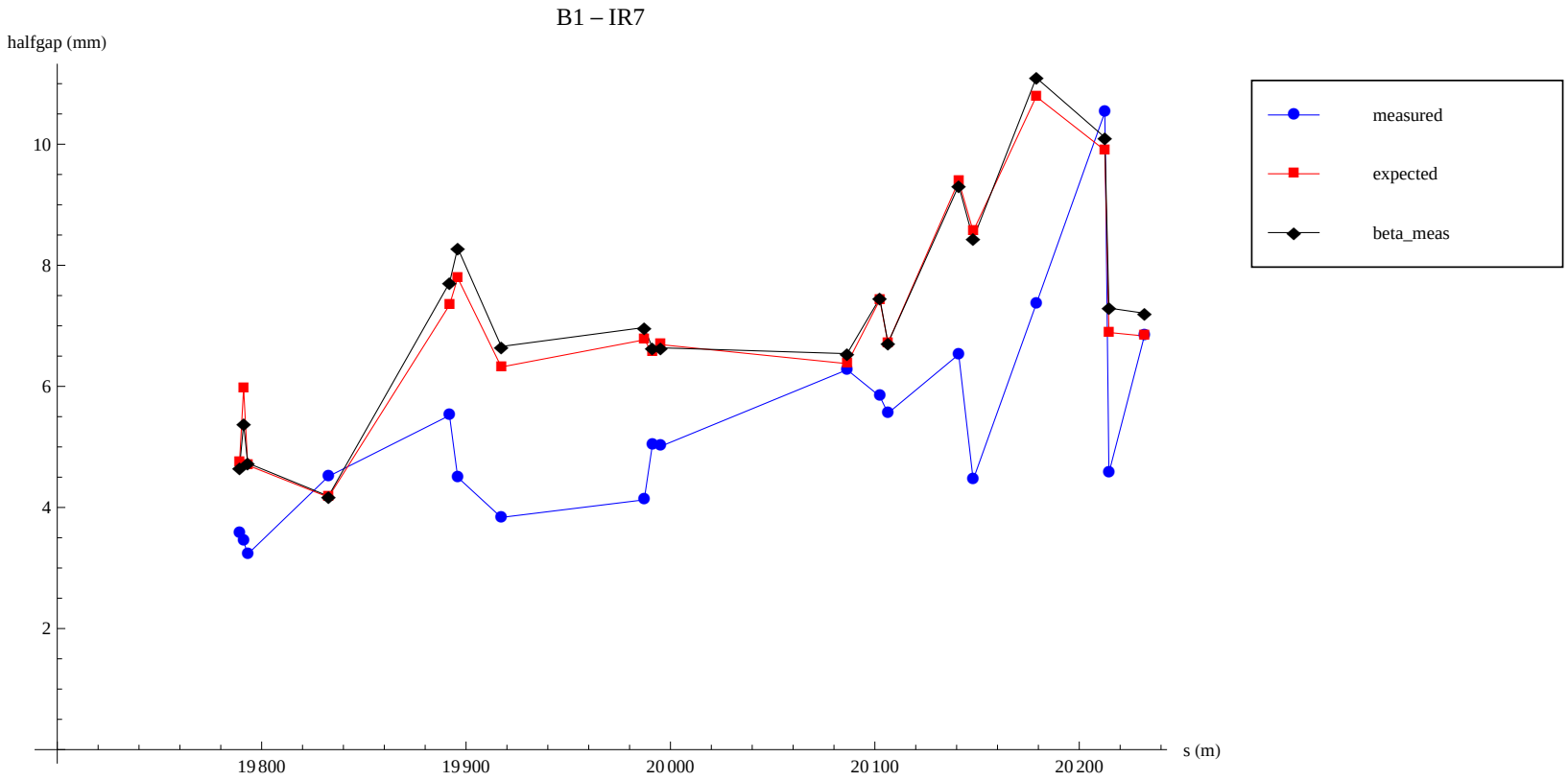
Results - Collimator setup B1

Measurend halfgaps versus expected halfgaps gaps IR3



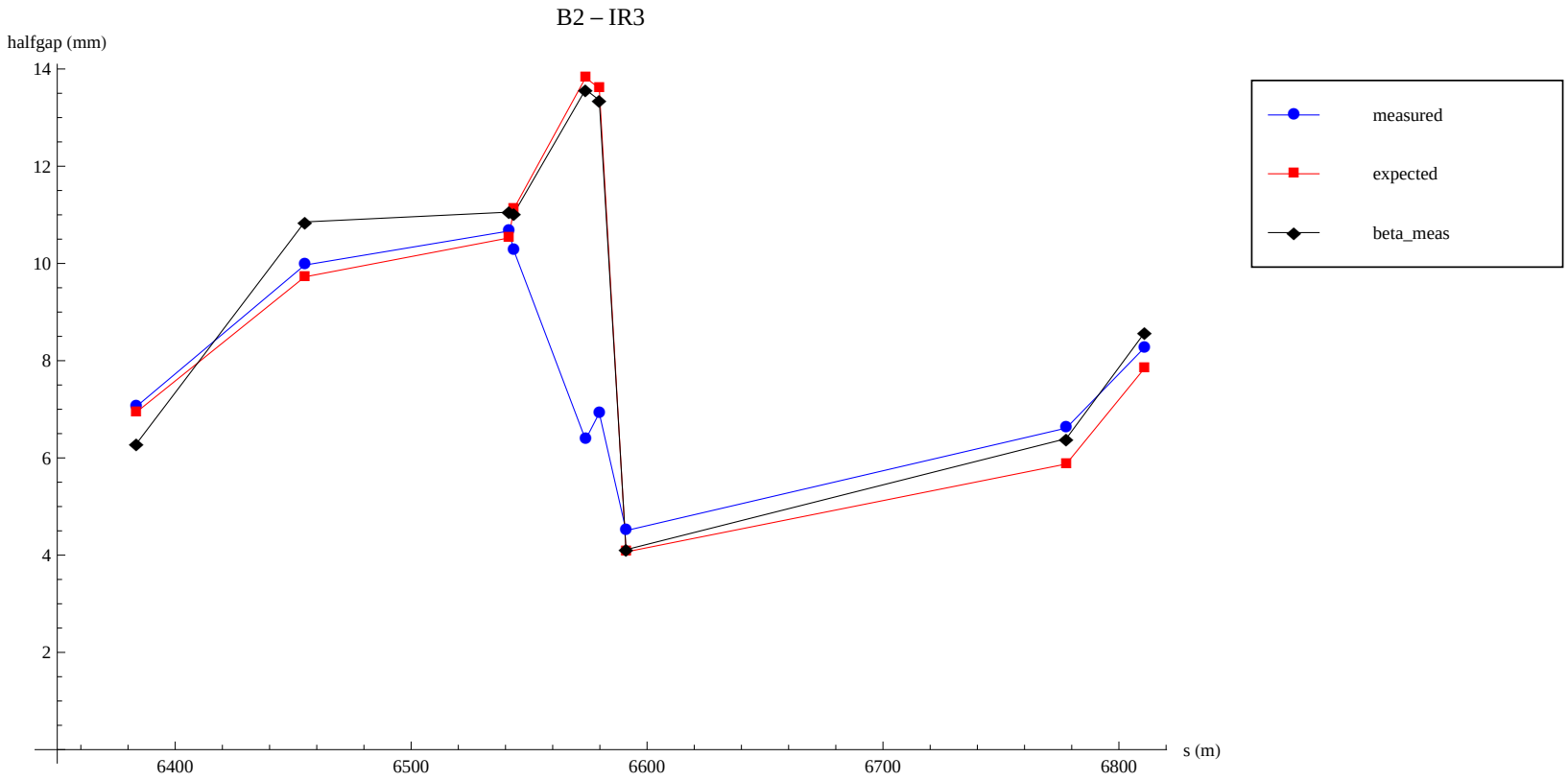
Results - Collimator setup B1

Measurend halfgaps versus expected halfgaps gaps IR7



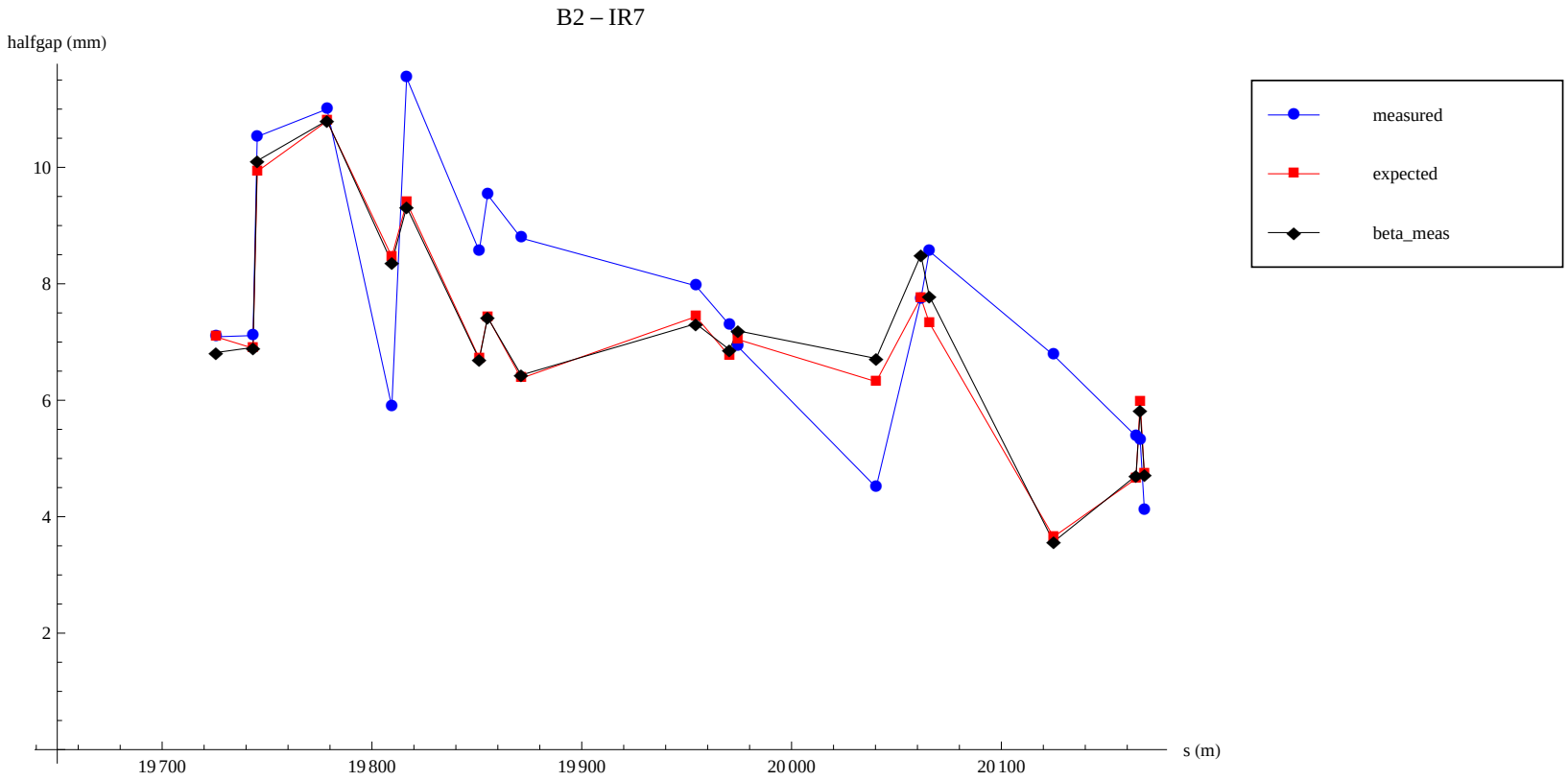
Results - Collimator setup B2

Measurend halfgaps versus expected halfgaps gaps IR3



Results - Collimator setup B2

Measurend halfgaps versus expected halfgaps gaps IR7



Verification of setup with slow losses

Procedure:

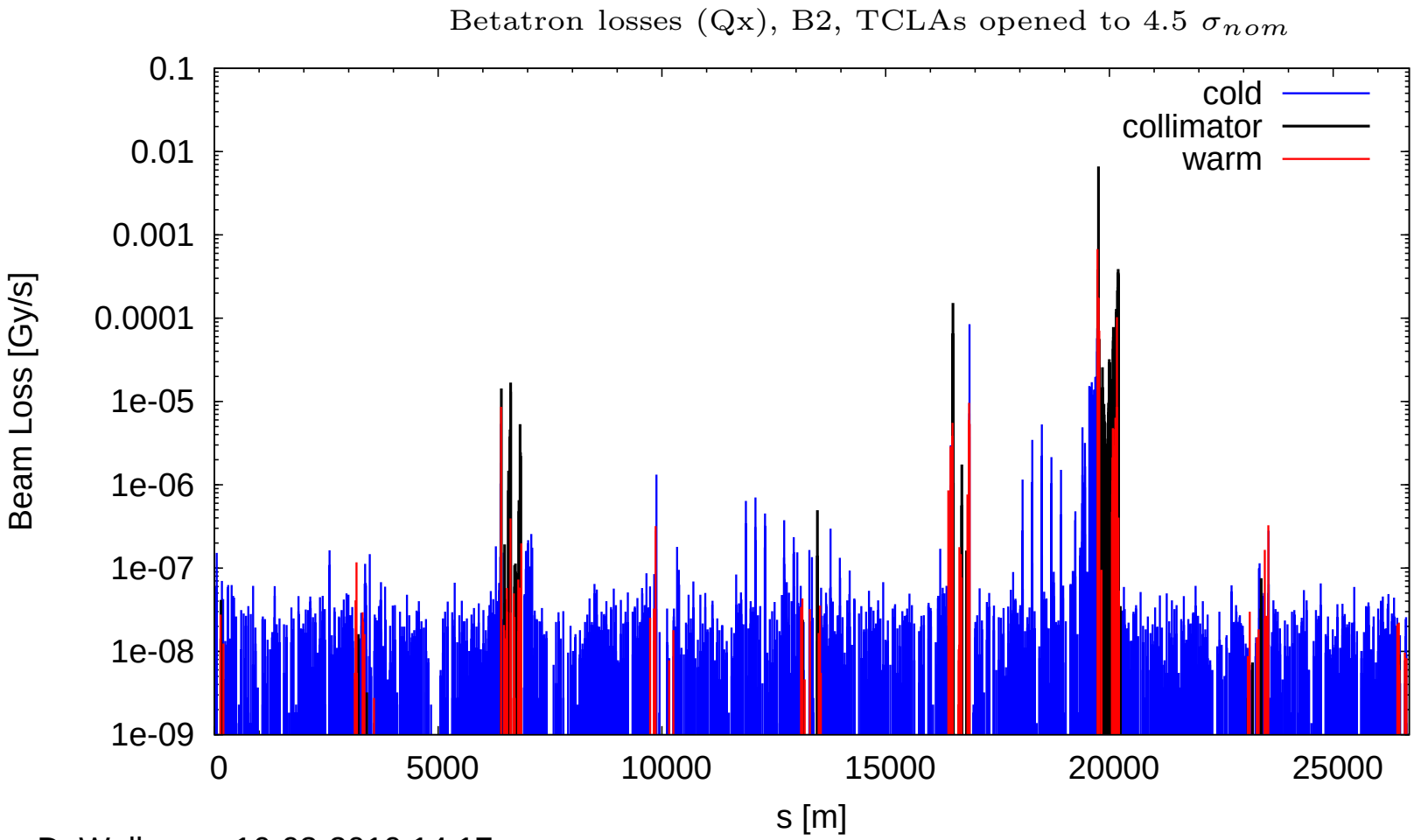
- creating betatron losses by crossing a $\frac{1}{3}$ integer resonance of the tune (Q_h,Q_v)
- creating momentum losses by changing the RF frequency ($\pm 500\,\mathrm{Hz}$)
- performed two different sets:
  - injection and dump protection devices open
  - injection and dump protection devices at nominal settings

Results:

- loss maps showed incorrect hierarchy, due to 3 devices, which unintentionally hadn't been opened up from $4.5\sigma_{nom}$ after alignment (TCSG.A4L7.B1, TCLA.A7L7.B2, TCLA.C6L7.B2)
- after moving them to there nominal positions, normal hierarchy was found

$\rightarrow$ wrong collimator settings can be clearly identified by slow losses

Slow losses - Q_h, B2, with TCLAs at $4.5\,\sigma_{\mathrm{nom}}$



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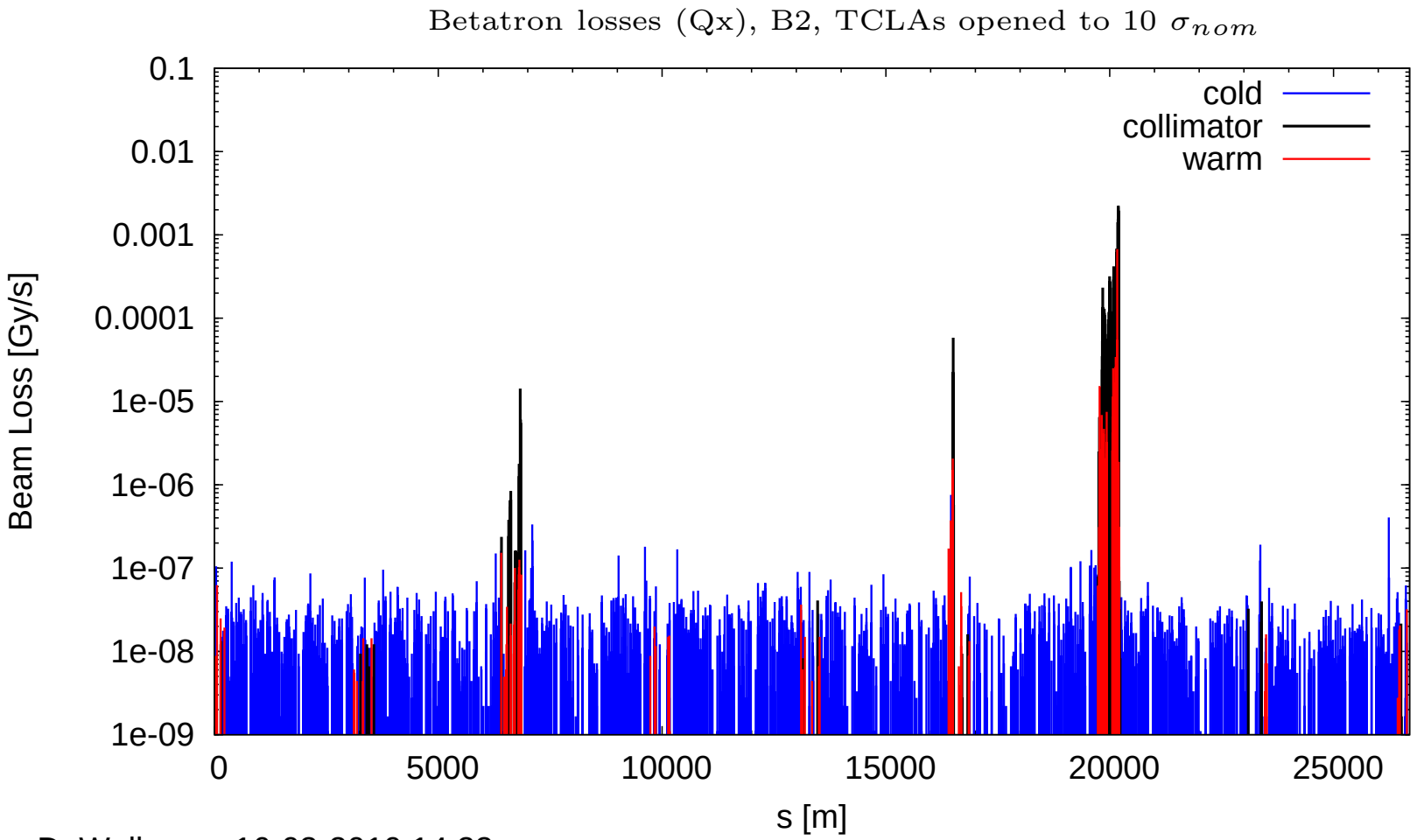
Slow losses - Q_h, B2, with TCLAs opened to $10\,\sigma_{\mathrm{nom}}$



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Overview - Collimator setup and verification for 3.5TeV

- setup of reduced set of ring collimators for both beams (~ 52) - no TCLAs
- 5 attempts due to beam dumps caused by lost cryo-modules, Atlas, ...
- beam scraping with TCP.6R2.B2
- verification of setup with slow losses (one fill for Q_h and Q_v, one fill for combined B1, B2 $\frac{\Delta p}{p}$ losses)

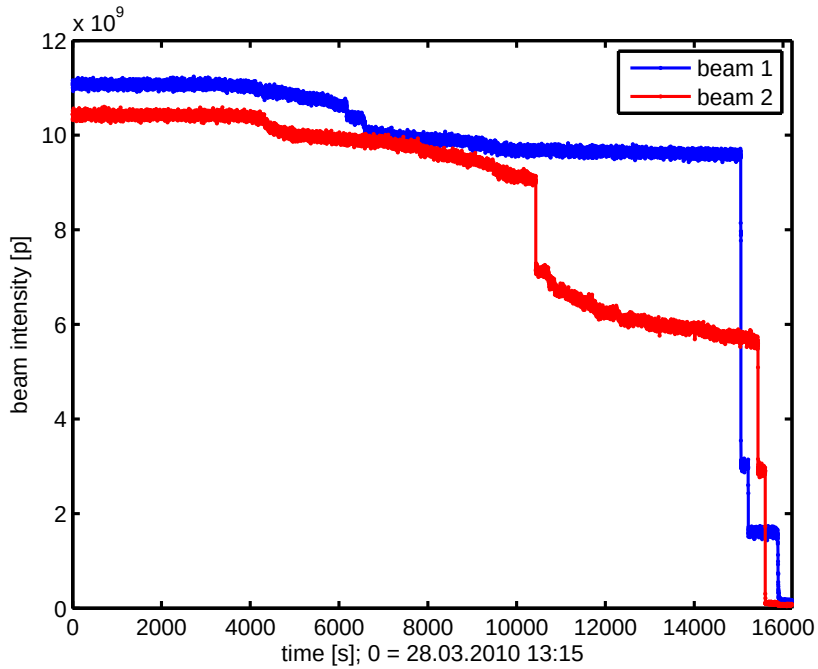
Procedure - Collimator setup for 3.5TeV

- creating a reference beam edge at $6\sigma_{nom}$ with TCPs in IR7
- centering the other collimators with respect to the reference collimators from back to front (as seen from the beam) and opening them to intermediate settings
- B1: starting in IR6; B2: starting in IR8
- Problems:
  - small beam sizes and very slow repopulation of the halo
  - → scraping deeper and deeper into the halo during setup
  - → reference edge not defined anymore by TCPs but by last collimator moved into beam
- Solution:
  - current setup: used only measured beam centers; set collimators to intermediate settings with nominal beam size at 3.5TeV
  - refined setup method: move reference TCPs to the beam edge after each centering of a collimator (used for TCT setup)
  - beam excitation: excite beam during setup to speed up the repopulation of the halo (can cause low life times)

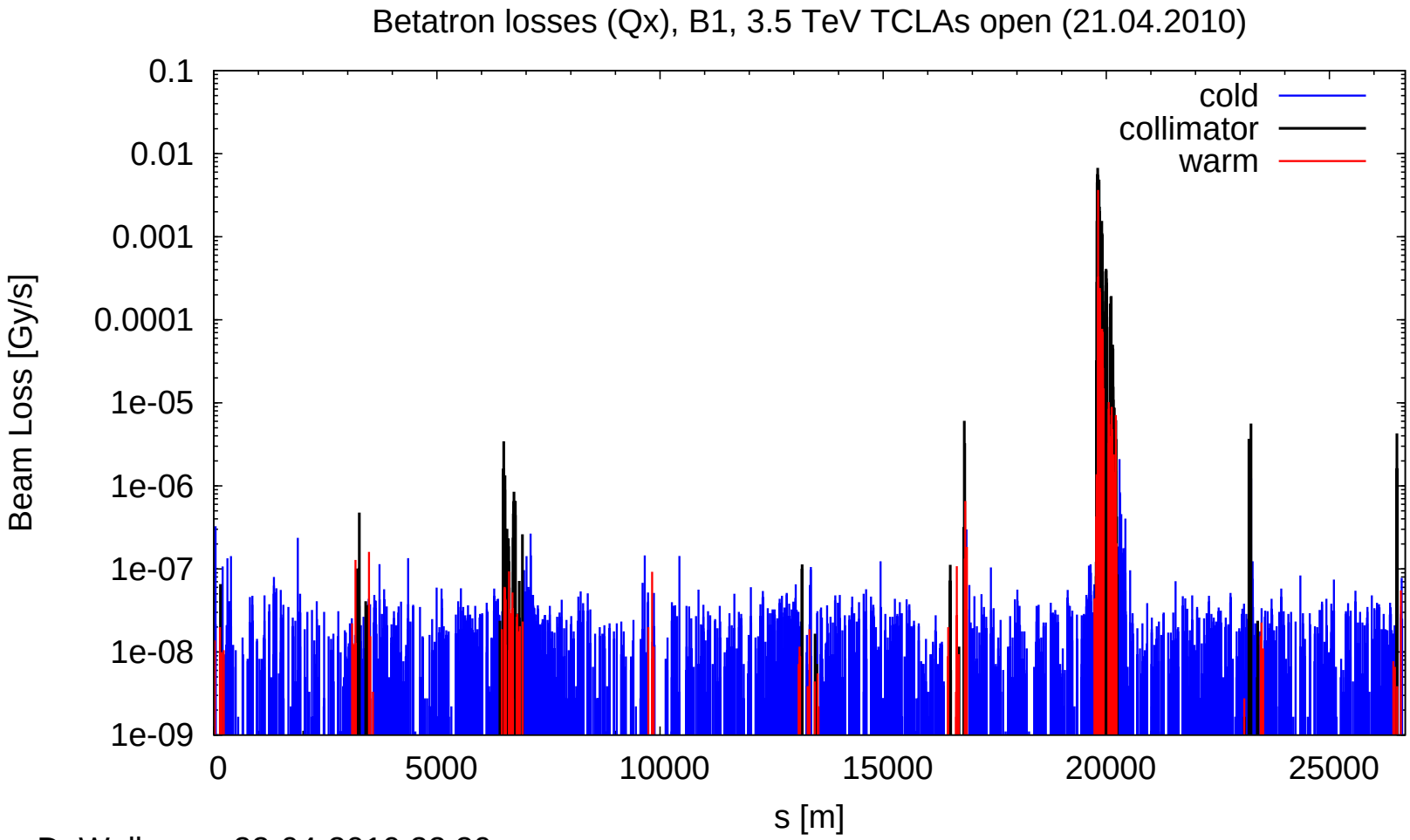
Procedure - Collimator setup for 3.5TeV

Collimator type	σ_{nom}
TCP IR3	15
TCSG IR3	18
TCLA IR3	injection
TCP IR7	6
TCSG IR7	8.8
TCLA IR7	injection

Collimator type	σ_{nom}
(TCDQ IR6	11.5)
TCSG IR6	10.5
TCLI IR2/IR8	injection
TCT	12.8



Slow losses - Q_h, B1, 3.5TeV



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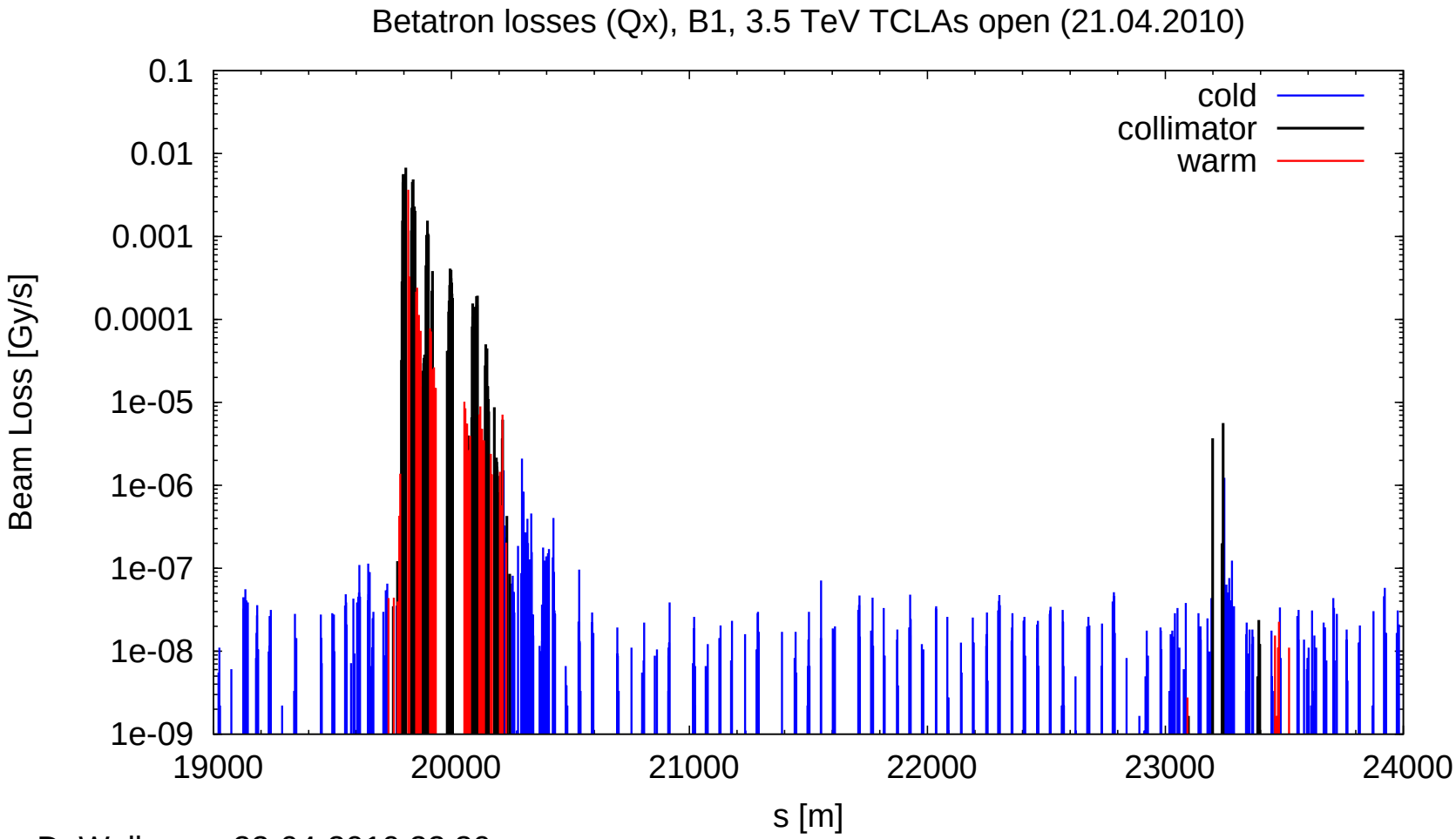
Slow losses - Q_h, B1, 3.5TeV



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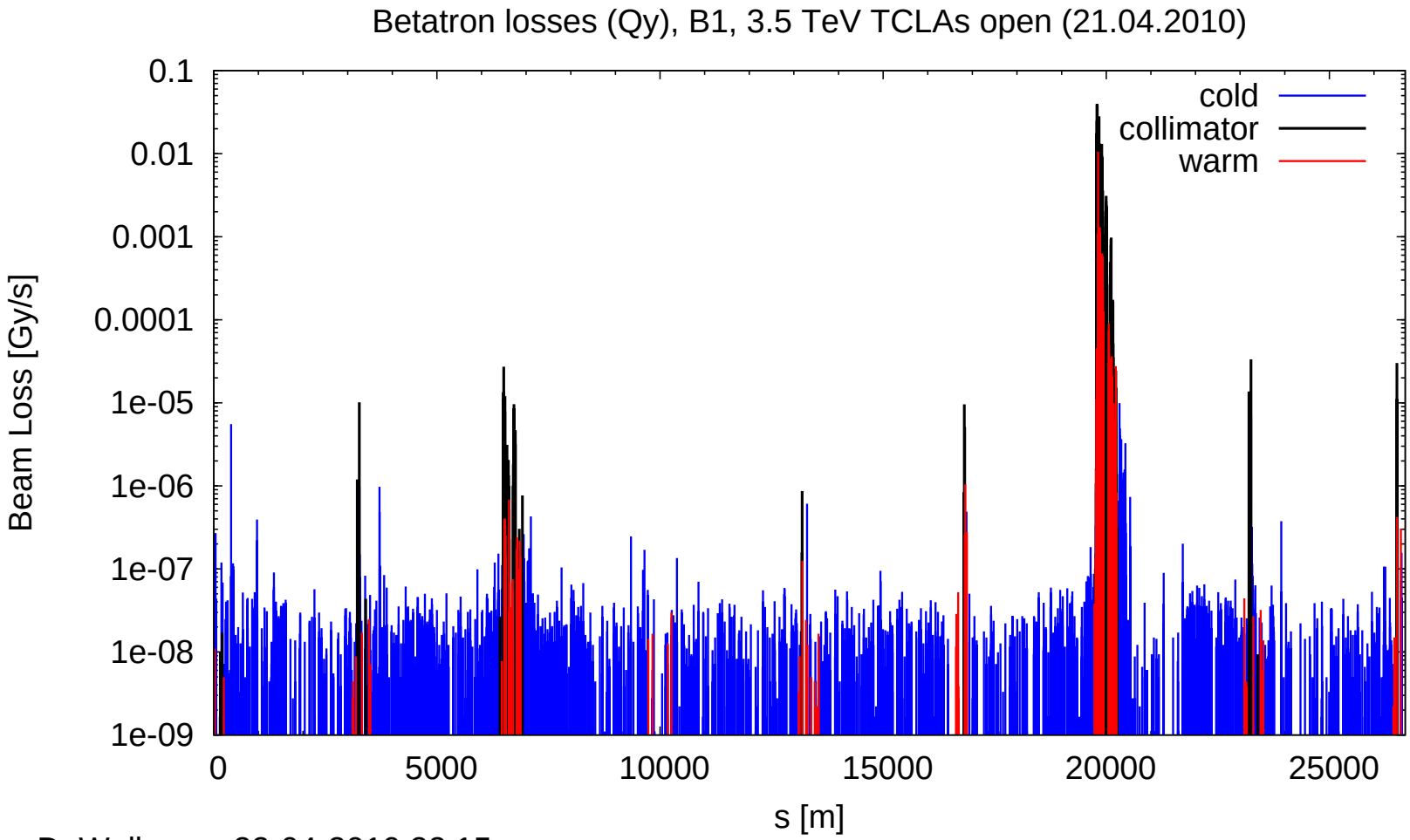
Slow losses - Q_v, B1, 3.5TeV



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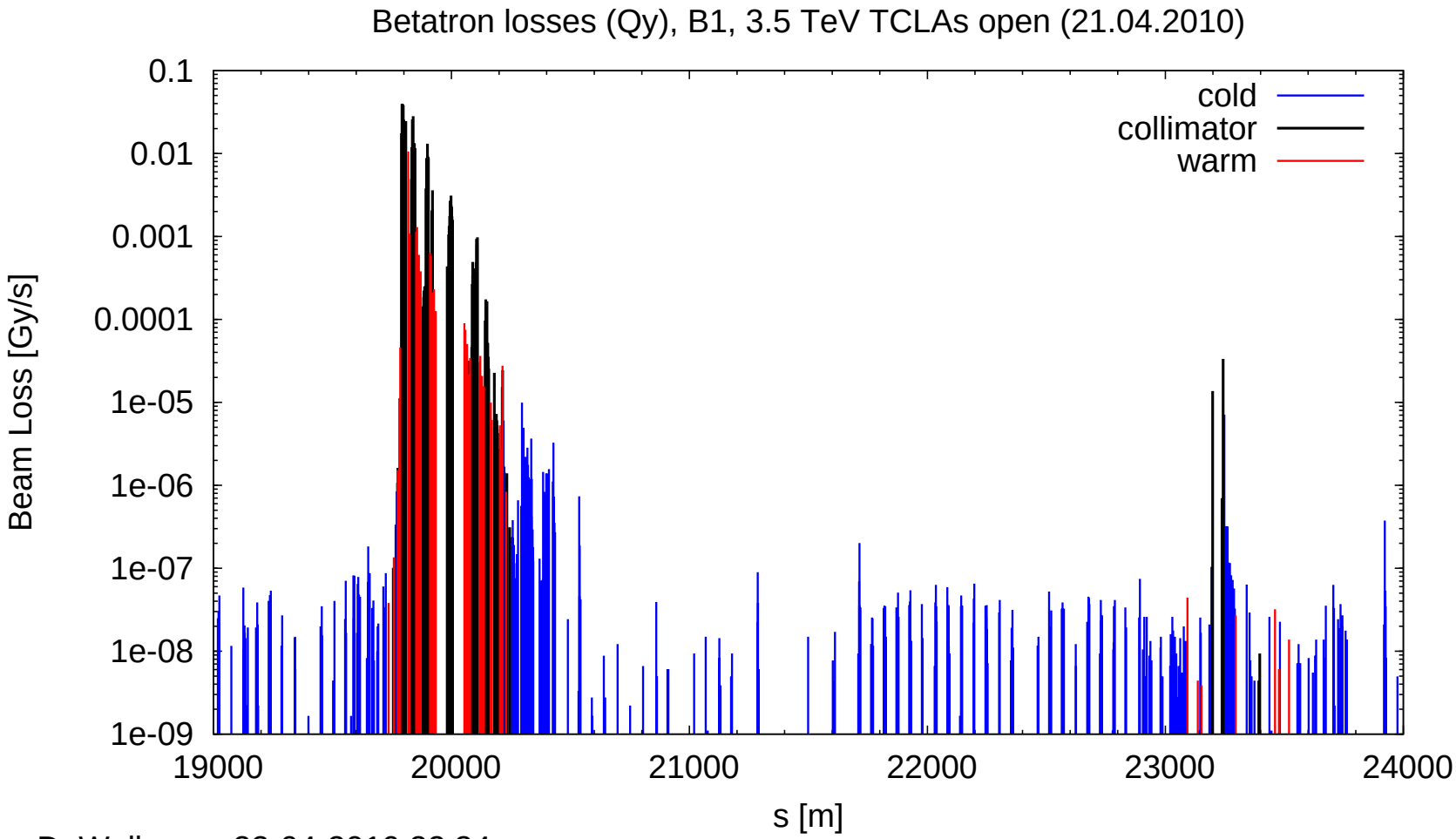
Slow losses - Q_v, B1, 3.5TeV



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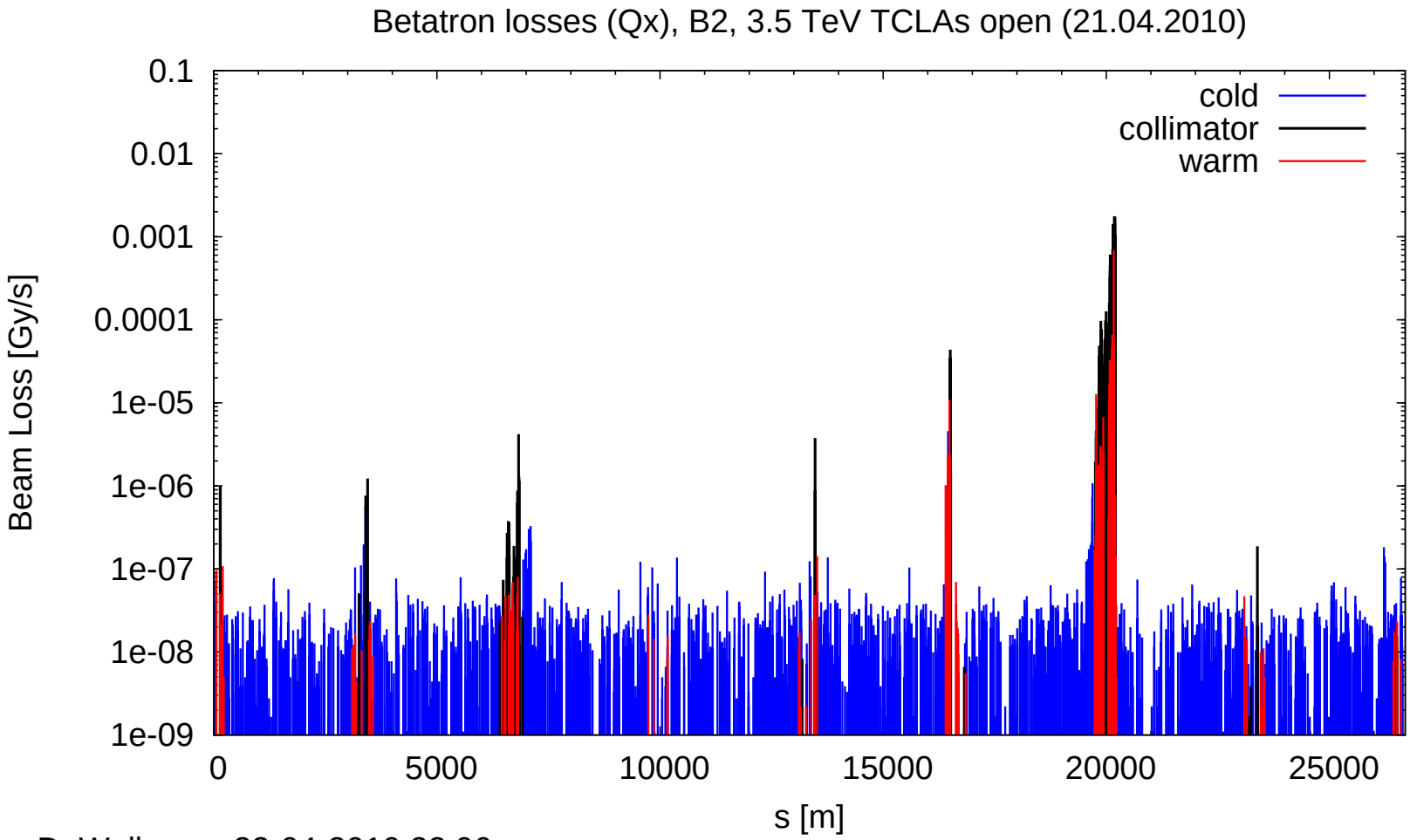
Slow losses - Q_h, B2, 3.5TeV



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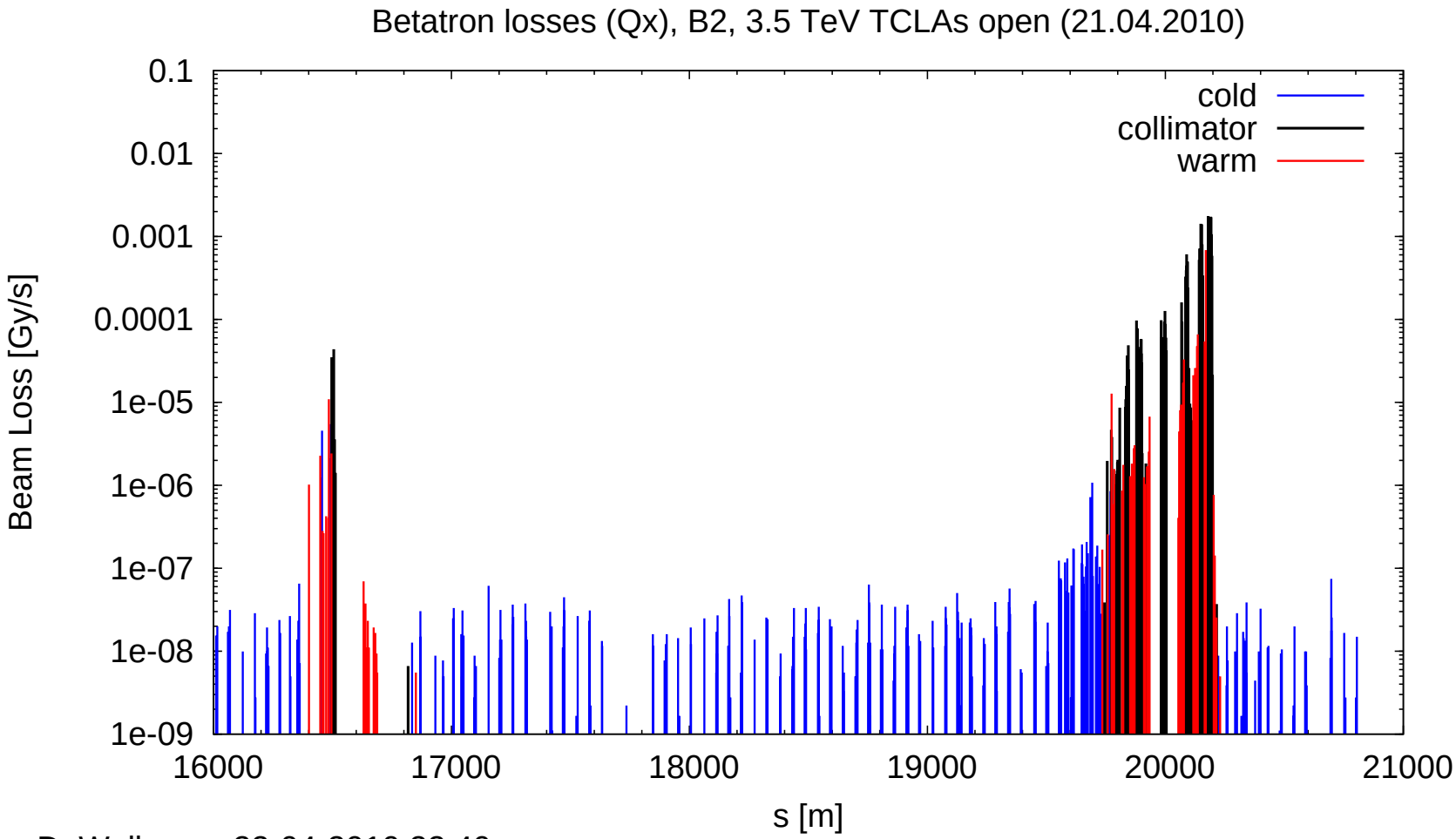
Slow losses - Q_h, B2, 3.5TeV



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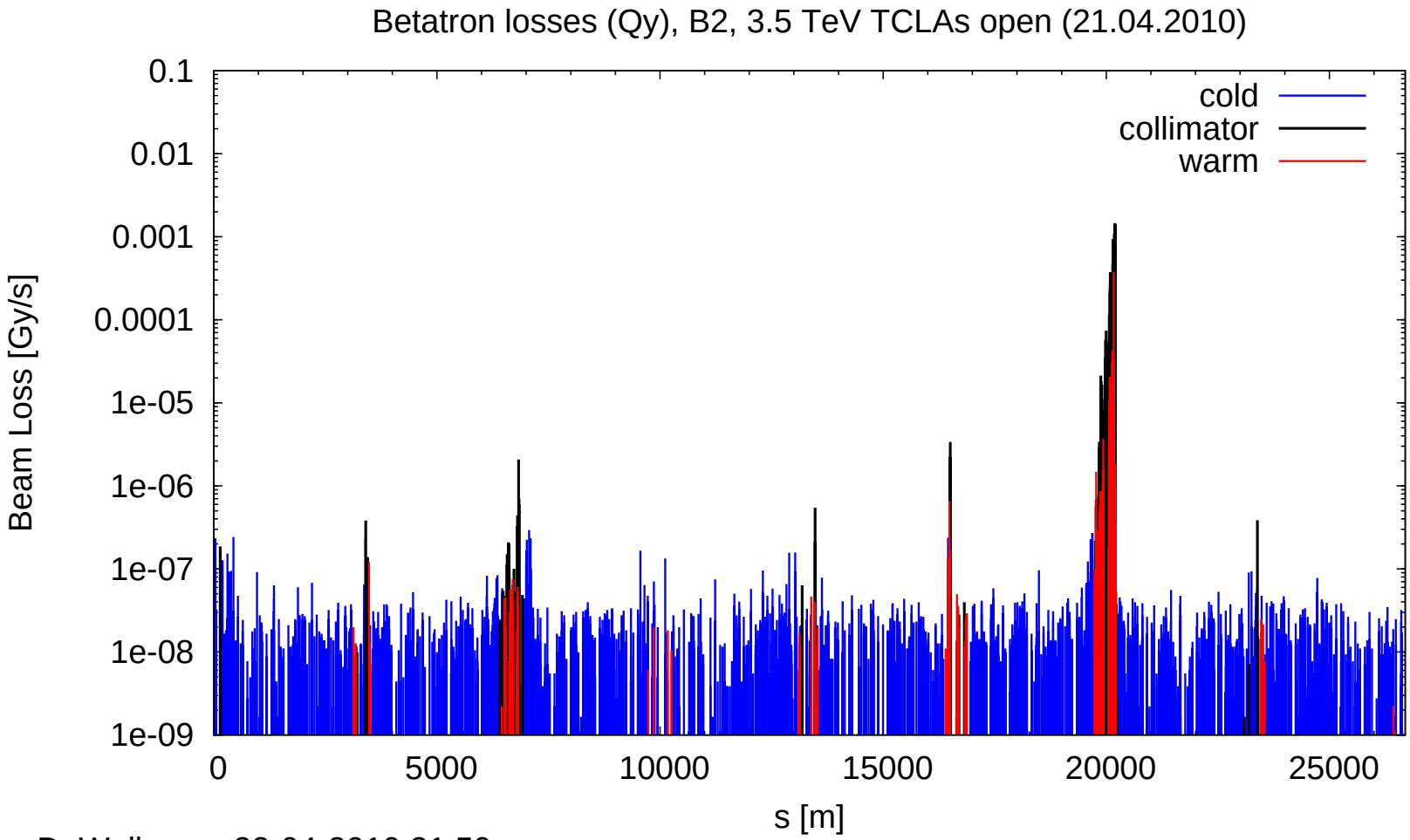
Slow losses - Q_v, B2, 3.5TeV



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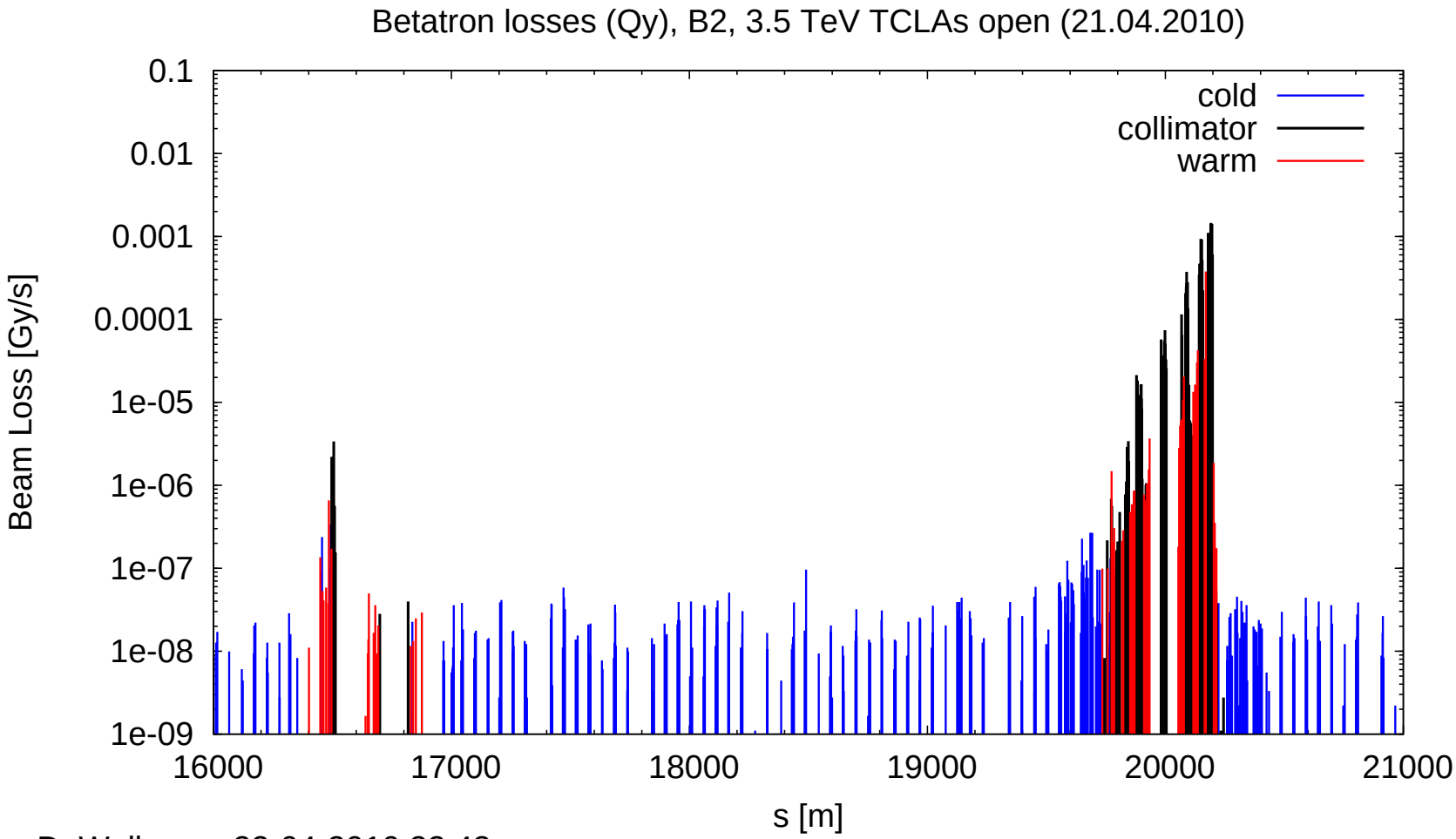
Slow losses - Q_v, B2, 3.5TeV



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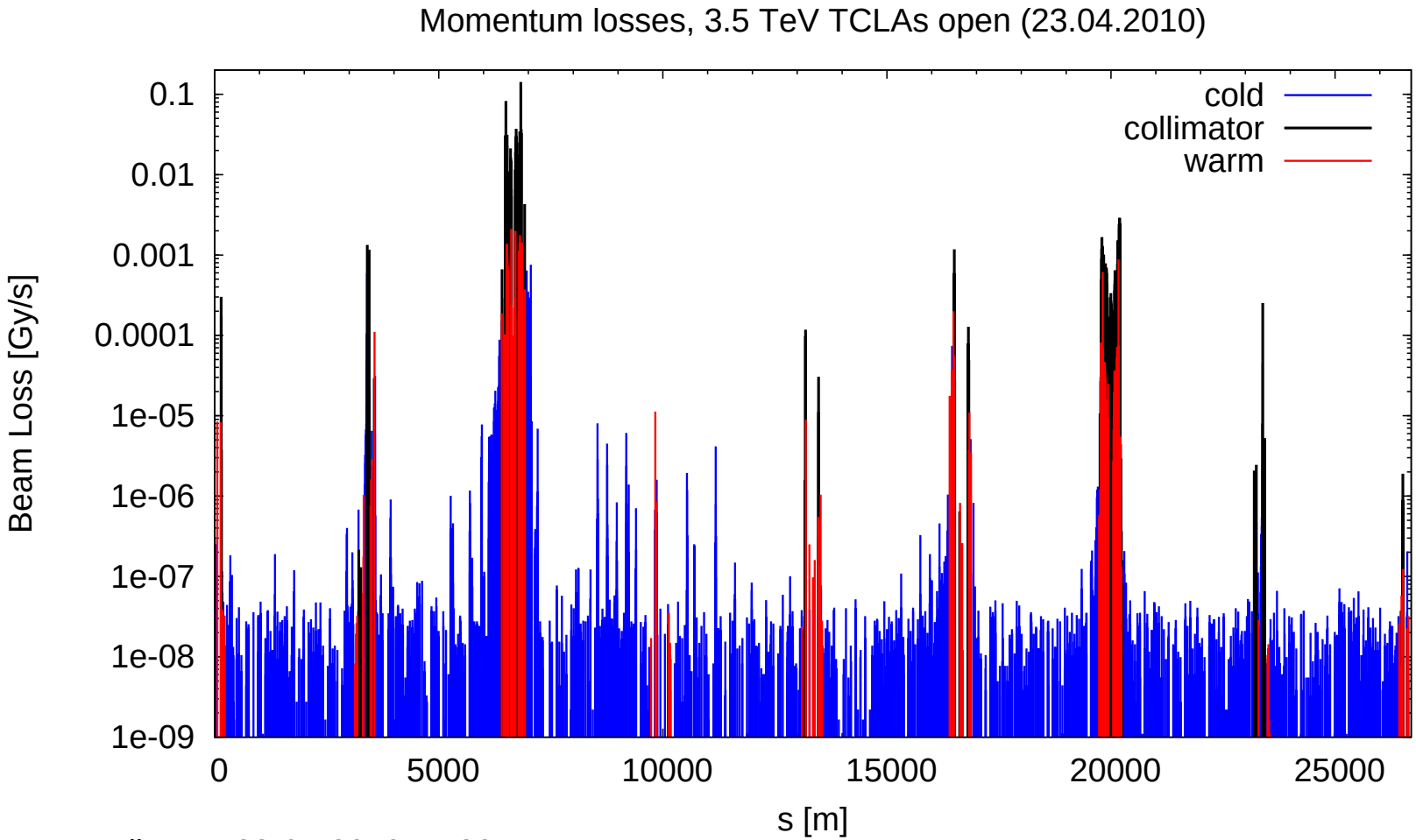
Slow losses - $\Delta p/p$, B1+B2, 3.5TeV



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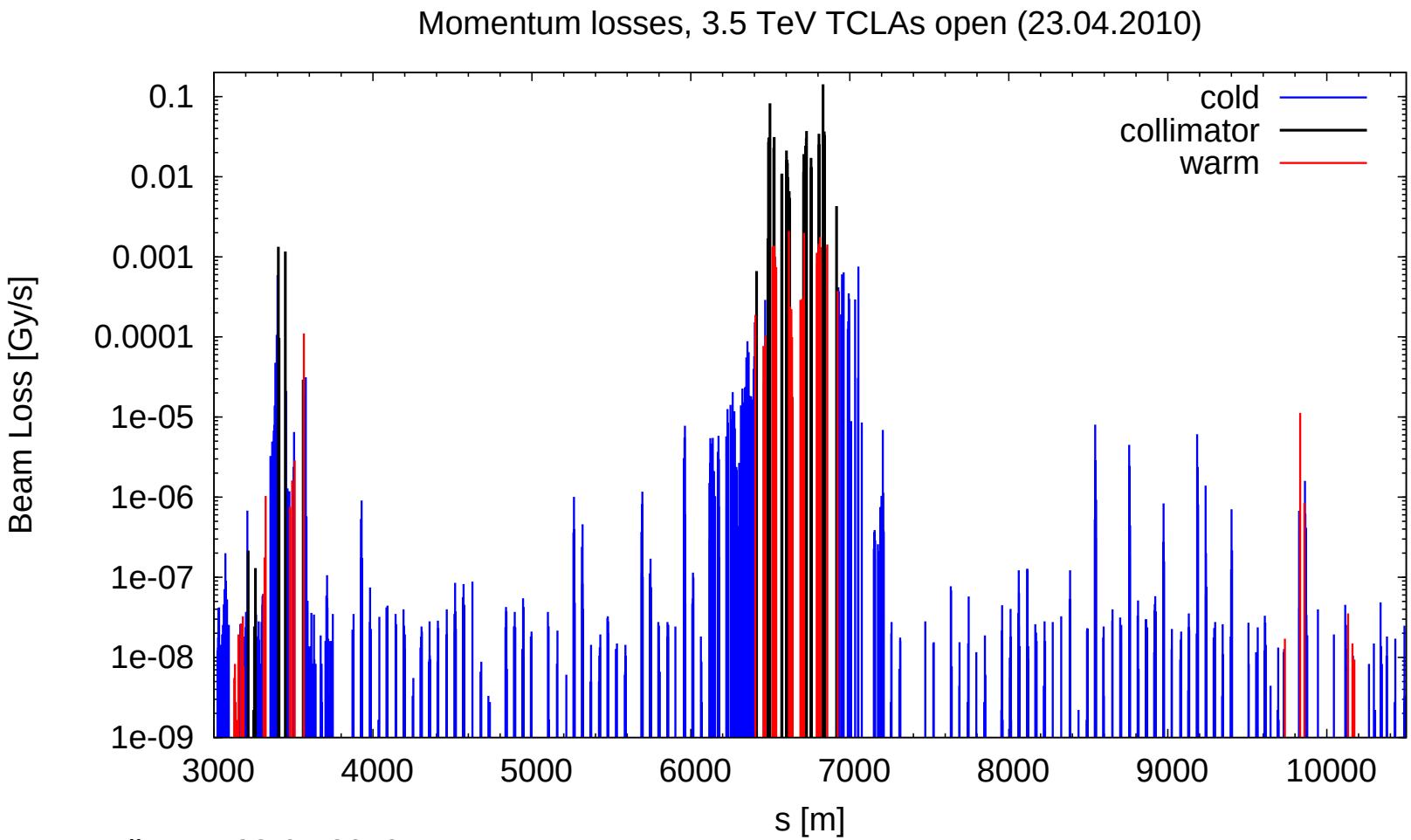
Slow losses - $\Delta p/p$, B1+B2, 3.5TeV



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Summary

- Setting up the full system within 10h and with 2x2 people is possible → better 2x 8h
- B1 at 450GeV: measured halfgaps (i.e. beam size) bigger than expected, as already seen in the 2009 run
- Each collimation setup needs to be validated by creating slow losses
- Small beam sizes and slow repopulation of halo at 3.5TeV request changes in the setup procedure
- Current 3.5TeV collimator setup shows leakage into sc arcs and experimental regions during momentum losses