# Studies on BLM Threshold Increase for Long Running Sums in TCTs and TCLs

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# Outline

- Motivation for the study;
- Increase in BLM thresholds;
- Conclusions and outlook;

# Motivation

- During intensity ramp up: BLM signals at TCTs/TCLs (mostly long RSs) got increasingly close to the dump thresholds;
  → to avoid limiting the LHC performance in terms of luminosity: increased BLM dump thresholds at these collimators:
  - these losses pose no threat to collimators;
  - thresholds have been modified only at top energy: rest of the cycle is unchanged;

  → applied changes are documented in LHC-BLM-ECR-0036;

- First clear warnings: in IR8, during fill 3981 (Fri 10$^{th}$ / Sat 11$^{th}$ Jul 2015, 296b);
  → RS12 at 40% of dump threshold (Lumi$_{peak}$ = 40 $\mu b^{-1}$ $s^{-1}$);

# Motivation (II)

- BLMs at TCT and TCL collimators are determined by the physics debris: secondary particles from pp collisions get back to the LHC and scatter on accelerator components, reaching the TCT/TCL location and generating further showers on BLMs;
  → BLM signals linearly proportional to luminosity;
  → Long RSs mostly affected: the signal from debris has time to pile up

  → a similar situation was found in 2009 about BLM thresholds at the inner triplets (simulations);

ATS-Note-2012-014 TECH
January 27, 2012
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**Estimation of Threshold for the Signals of the BLMs around the LHC Final Focus Triplet Magnets**

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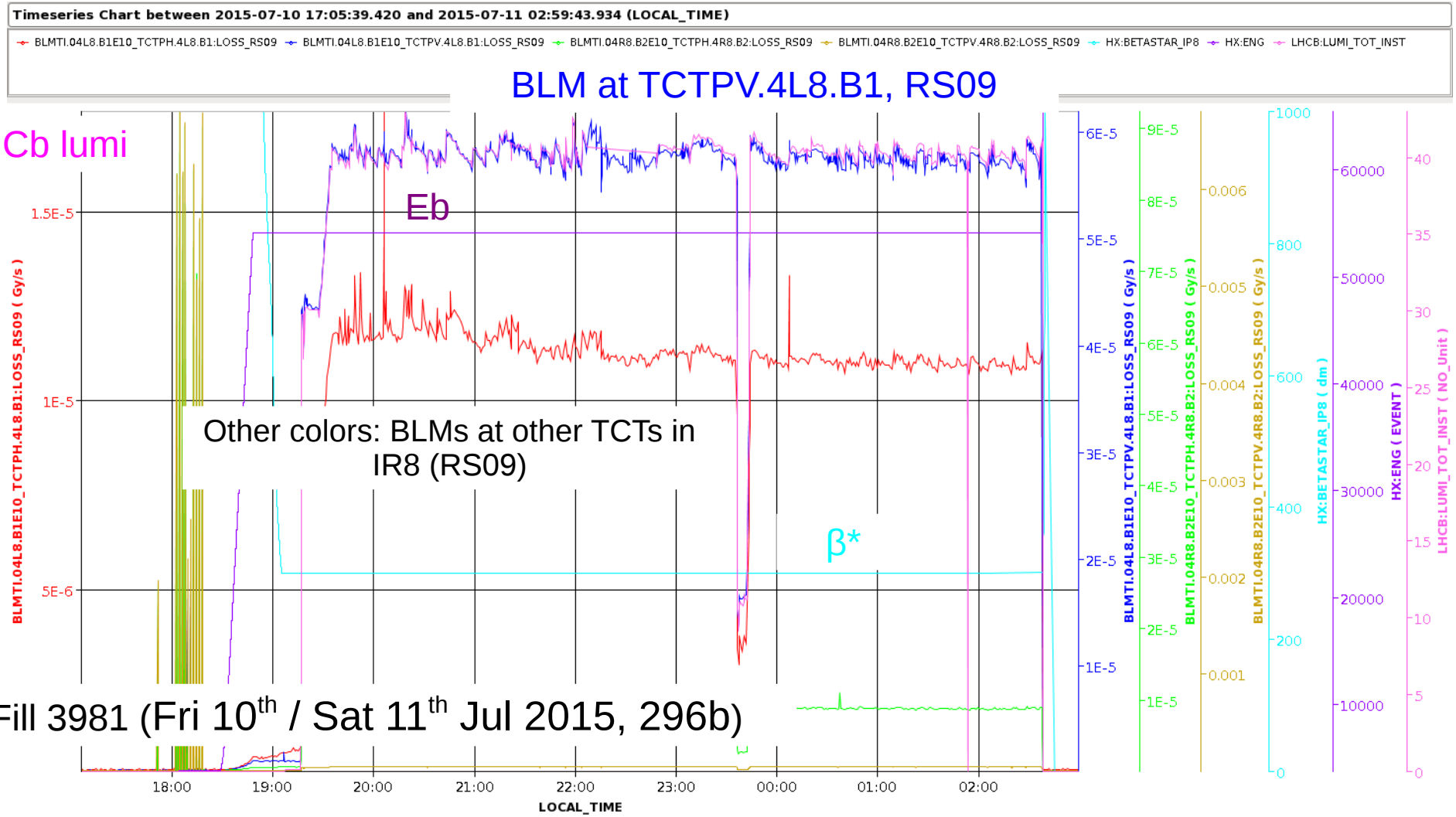
Keywords: insertion region, quench prevention

# Motivation (III)

- Thresholds used since beginning of Run 2: those at the end of Run 1;
- With respect to Run 1:
  - Lower luminosity so far, e.g. ~2 $10^{33}$ $cm^{-2}$ $s^{-1}$ vs ~7 $10^{33}$ $cm^{-2}$ $s^{-1}$ in IR1;
  - Different collimator settings:
    - IR1/5 TCTs: 13.7σ vs 9σ;
    - IR2 TCTs: 37σ vs 12σ;
    - IR8 TCTs: 15σ vs 12σ;
    - TCL5: 15σ vs 10σ;
    - TCL4/6: 15σ/25mm vs not installed;
  - Higher beam energy, i.e. 6.5 TeV vs 4 TeV:
    - Physics debris is more populated and energetic;
    - BLM thresholds linearly decrease with energy;

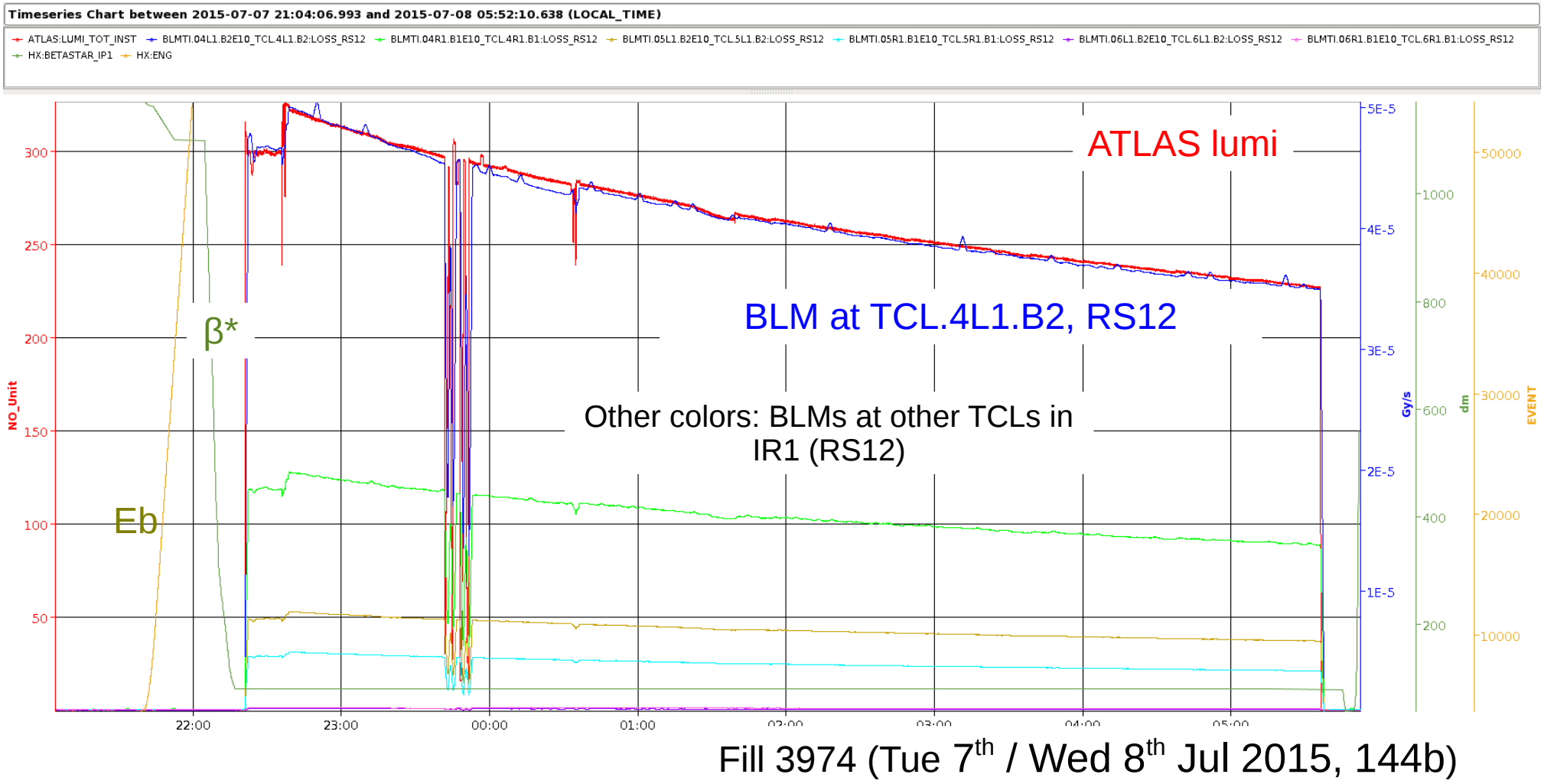
→ net result: less margin to dump thresholds;

# Example – TCTs in IR8, RS09




The time evolution of RS09 faithfully reproduces the one of the luminosity

# Example – TCLs in IR1, RS12




Fill 3974 (Tue 7th / Wed 8th Jul 2015, 144b)

The time evolution of RS12 faithfully reproduces the one of the luminosity

# Increase of BLM Thresholds

- BLM thresholds at TCTs/TCLs raised to allow the luminosity increase during the intensity ramp up;
  → but be sure that no damage is induced in collimators!

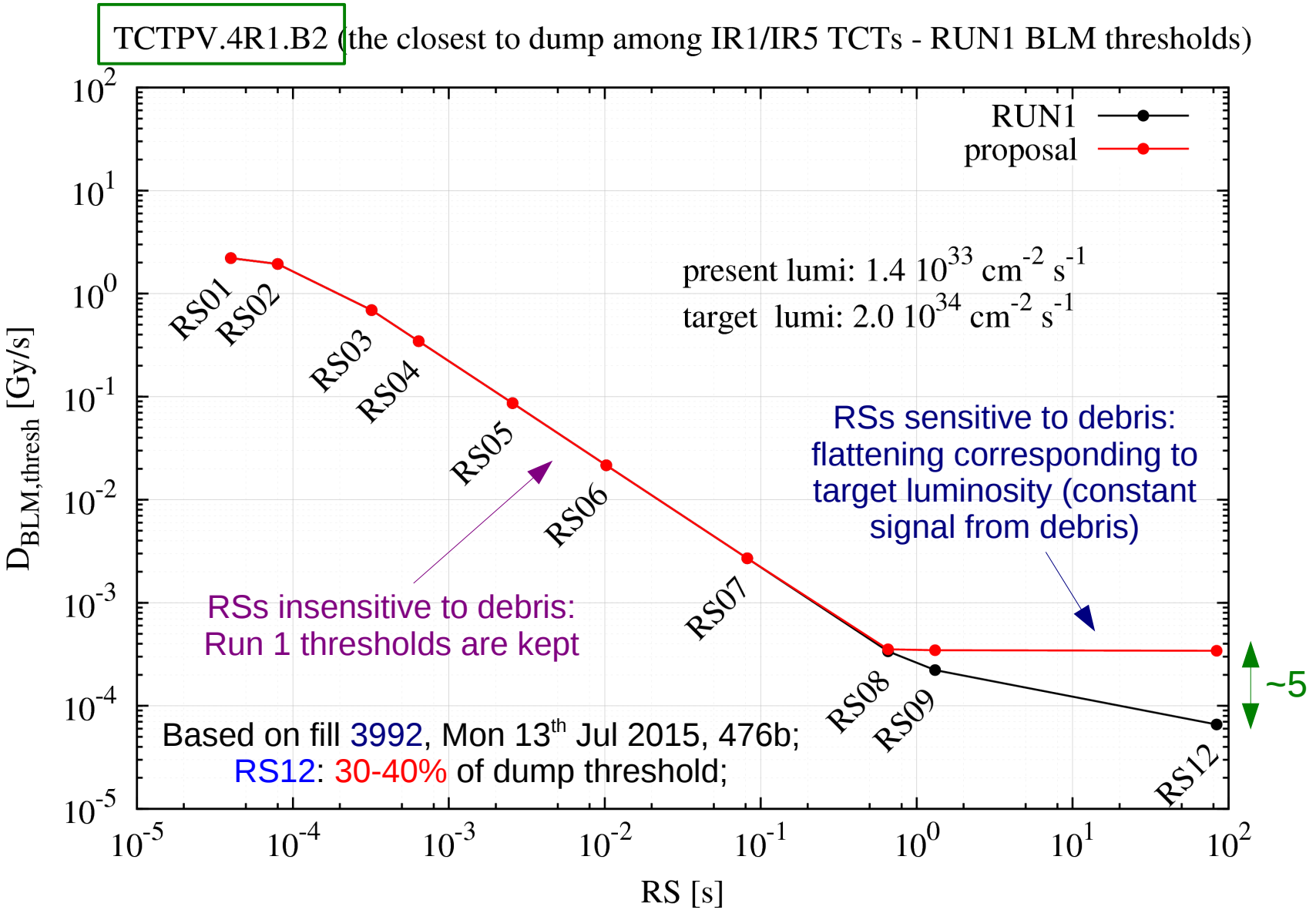
- Analysis based on:
  - measured BLM signals at TCTs/TCLs and luminosity in machine: fill 3992, Mon 13th Jul 2015, 476b;
  - target luminosity in IR1/2/5/8; actually increased by a factor 2:
    - To accommodate further improvements in luminosity;
    - To allow some operational margin;

- In practice:
  - Retrieve data from Timber:
    - BLM readouts: all TCTs / TCLs in IR1/2/5/8, all RSs;
    - Luminosity in machine (IR1/2/5/8);
  - Scale BLM readouts to target lumi, taking into account the one in machine;

| IR | $Lumi_{tgt}$ |
|---|---|
| IR1/5 | $10^{34}$ cm$^{-2}$ s$^{-1}$ (LHC Design Report / M.Lamont, private comm.) |
| IR2 | $9\ 10^{30}$ cm$^{-2}$ s$^{-1}$ (M.Lamont, private comm.) |
| IR8 | $6\ 10^{32}$ cm$^{-2}$ s$^{-1}$ (Gorini, Meschi, Evian 2014) |

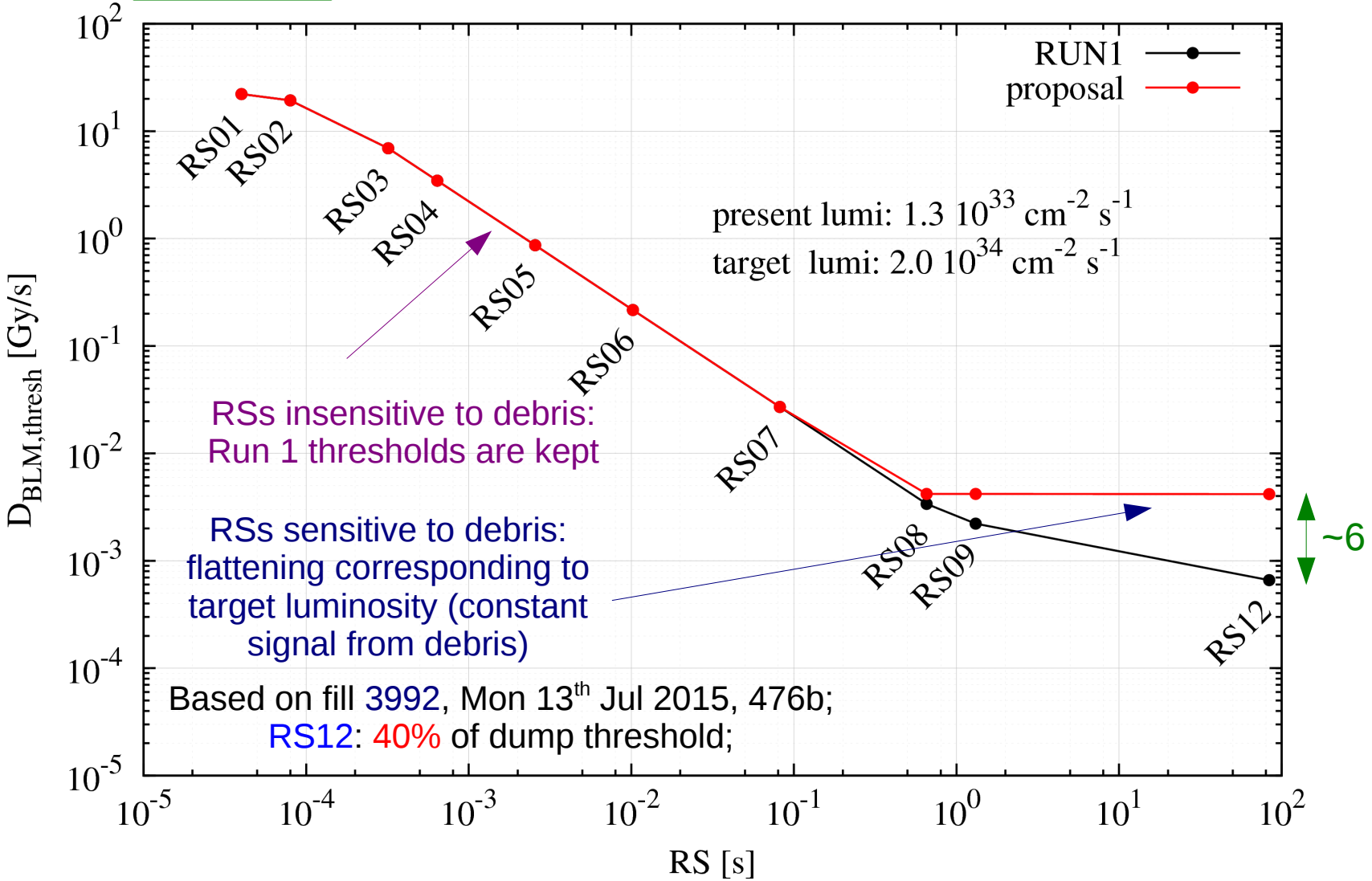
$$D_{BLM,th} = max(D_{BLM}) \frac{Lumi_{tgt}}{peak(Lumi)}$$

# TCTs in IR1 & IR5

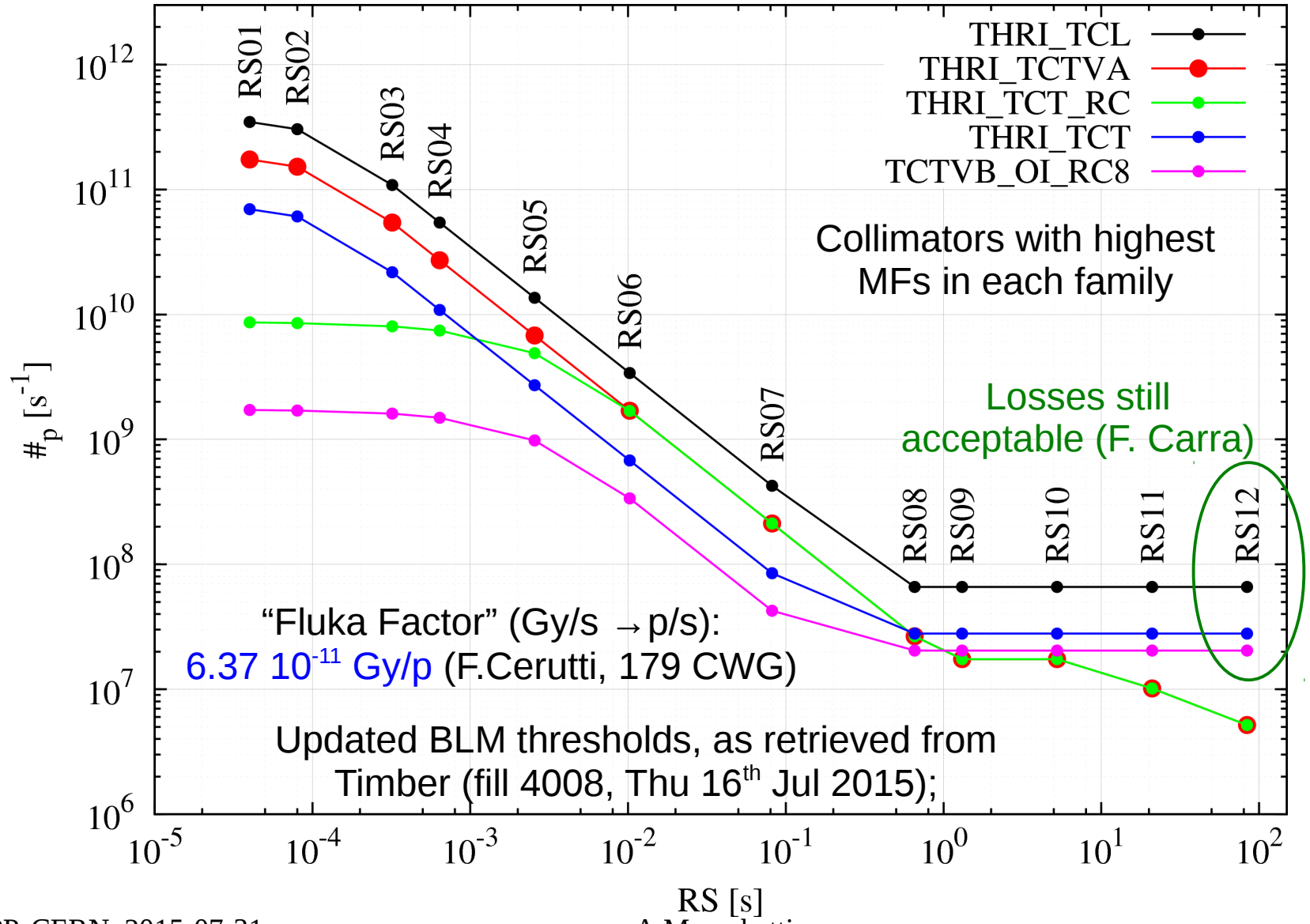


# TCLs in IR1 & IR5

TCL.4R5.B1 (the closest to dump among IR1/IR5 TCLs - RUN1 BLM thresholds)



# Equivalent Losses



# Conclusions and Outlook

- during intensity ramp up, BLMs at TCTs/TCLs are affected by the physics debris;
  - in particular long RSs: signal from debris has time to pile up;
  - signals linearly proportional to luminosity: increasing the luminosity would have led to reach dump thresholds (sooner or later) before the end of the ramp up;

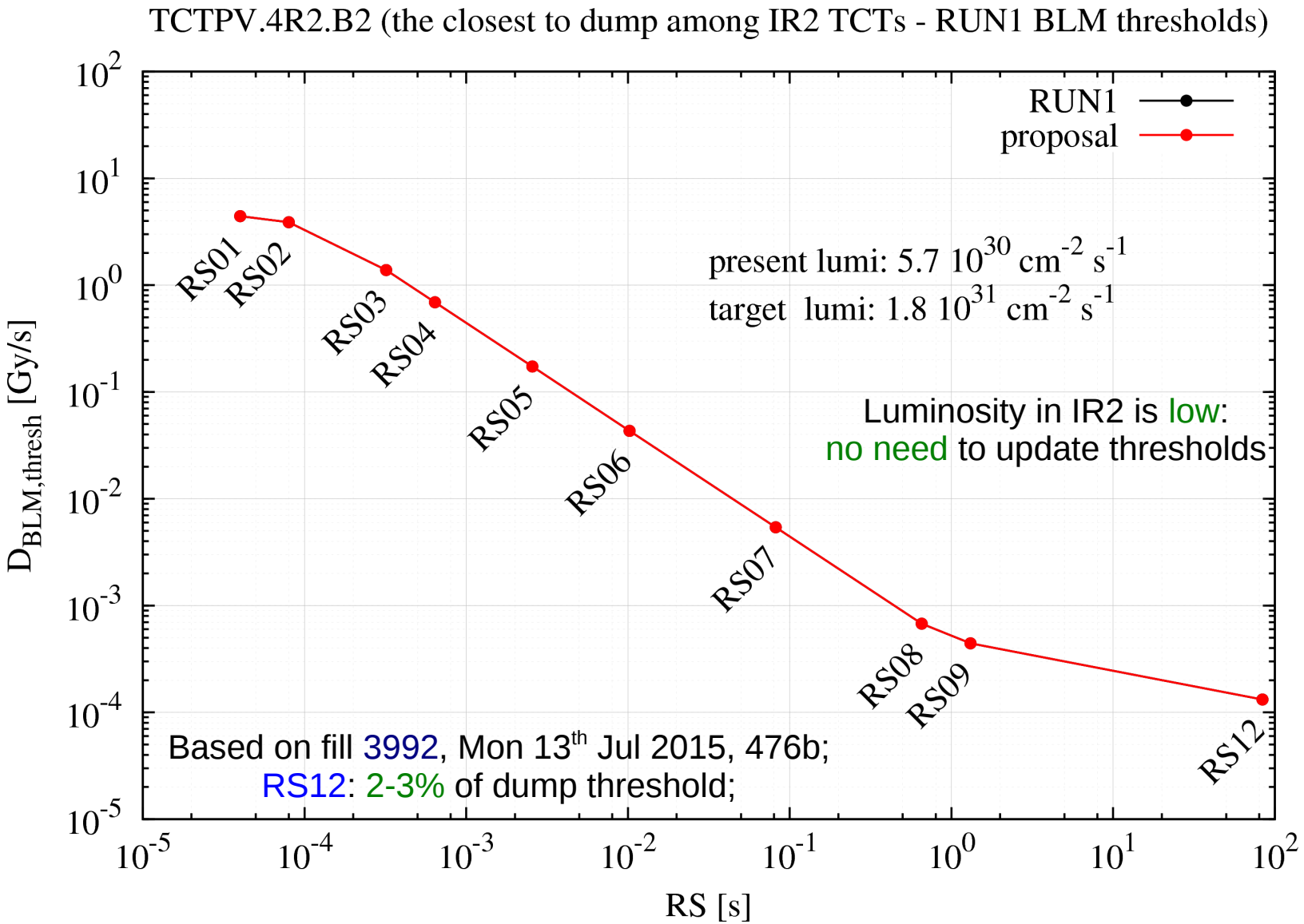
- in order not to dump, BLM thresholds at TCTs/TCLs have been increased (by a factor ~13 at most, in IR8) taking into account:
  - luminosity and BLM signals presently in machine (fill 3992);
  - target luminosity at IRs for the intensity ramp up;

  → green light on new thresholds by hardware team;
  → changes documented in LHC-BLM-ECR-0036;

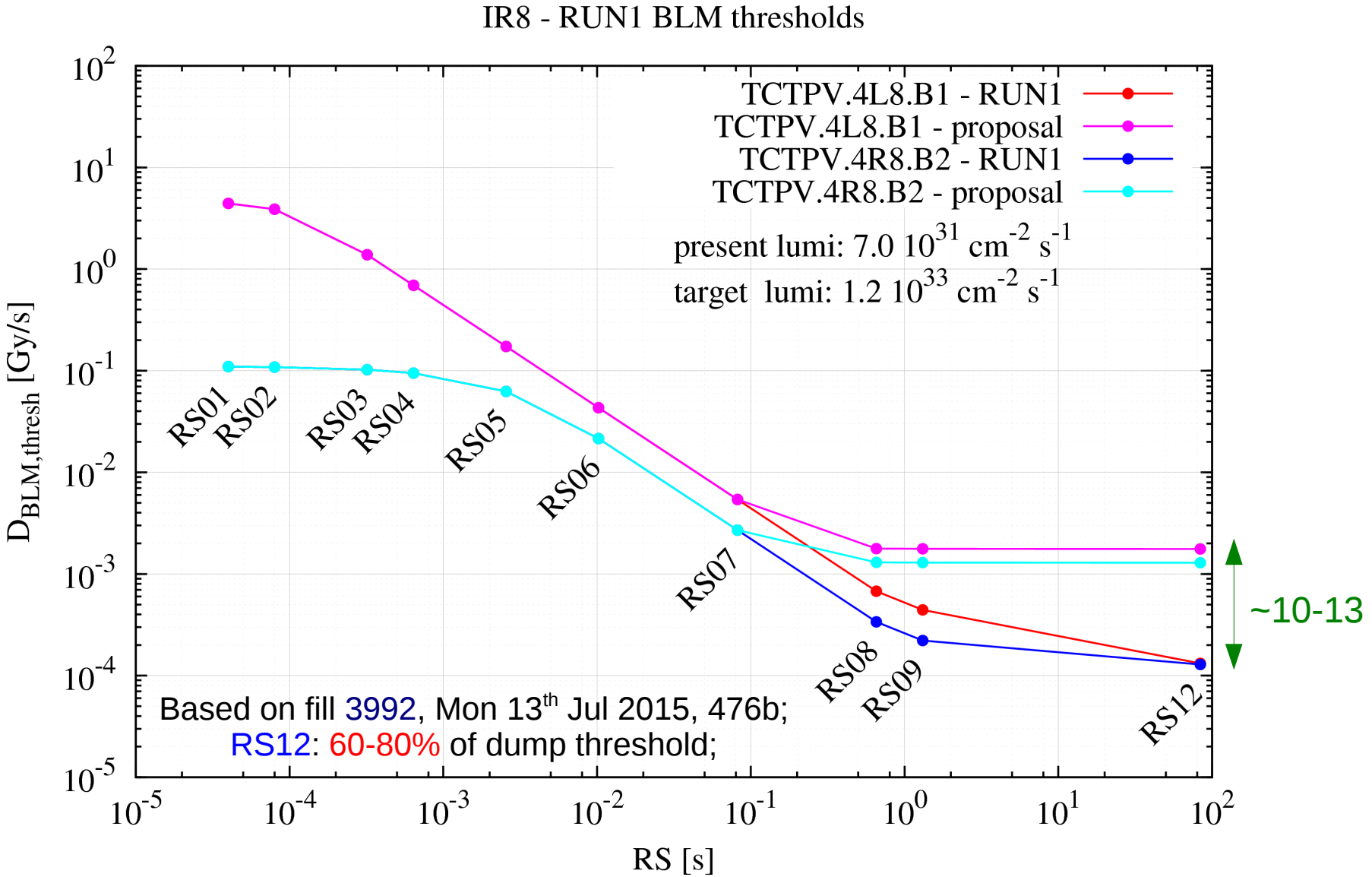
- Outlook:
  - revising BLM thresholds at all collimators based on measured loss maps;
  - refine BLM thresholds at metallic collimators via simulations;
  - apply these changes on top;

# Back Up Slides

# TCTs in IR2


TCTPV.4R2.B2 (the closest to dump among IR2 TCTs - RUN1 BLM thresholds)
RUN1
proposal
present lumi: 5.7 10^30 cm^-2 s^-1
target lumi: 1.8 10^31 cm^-2 s^-1
Luminosity in IR2 is low:
no need to update thresholds
Based on fill 3992, Mon 13th Jul 2015, 476b;
RS12: 2-3% of dump threshold;
RS01
RS02
RS03
RS04
RS05
RS06
RS07
RS08
RS09
RS12
D_BLM,thresh [Gy/s]
RS [s]

# TCTs in IR8 (I)


IR8 - RUN1 BLM thresholds
TCTPV.4L8.B1 - RUN1
TCTPV.4L8.B1 - proposal
TCTPV.4R8.B2 - RUN1
TCTPV.4R8.B2 - proposal
present lumi: 7.0 10^31 cm^-2 s^-1
target lumi: 1.2 10^33 cm^-2 s^-1
RS01
RS02
RS03
RS04
RS05
RS06
RS07
RS08
RS09
RS12
~10-13
Based on fill 3992, Mon 13th Jul 2015, 476b;
RS12: 60-80% of dump threshold;
D_BLM,thresh [Gy/s]
RS [s]

# TCTs in IR8 (II)