BLM dump thresholds for off-momentum losses in IP3

B.Salvachua, S.Redaelli, D.Wollmann
for the Collimation Team

BLM Thresholds Working Group - 11th July

Introduction

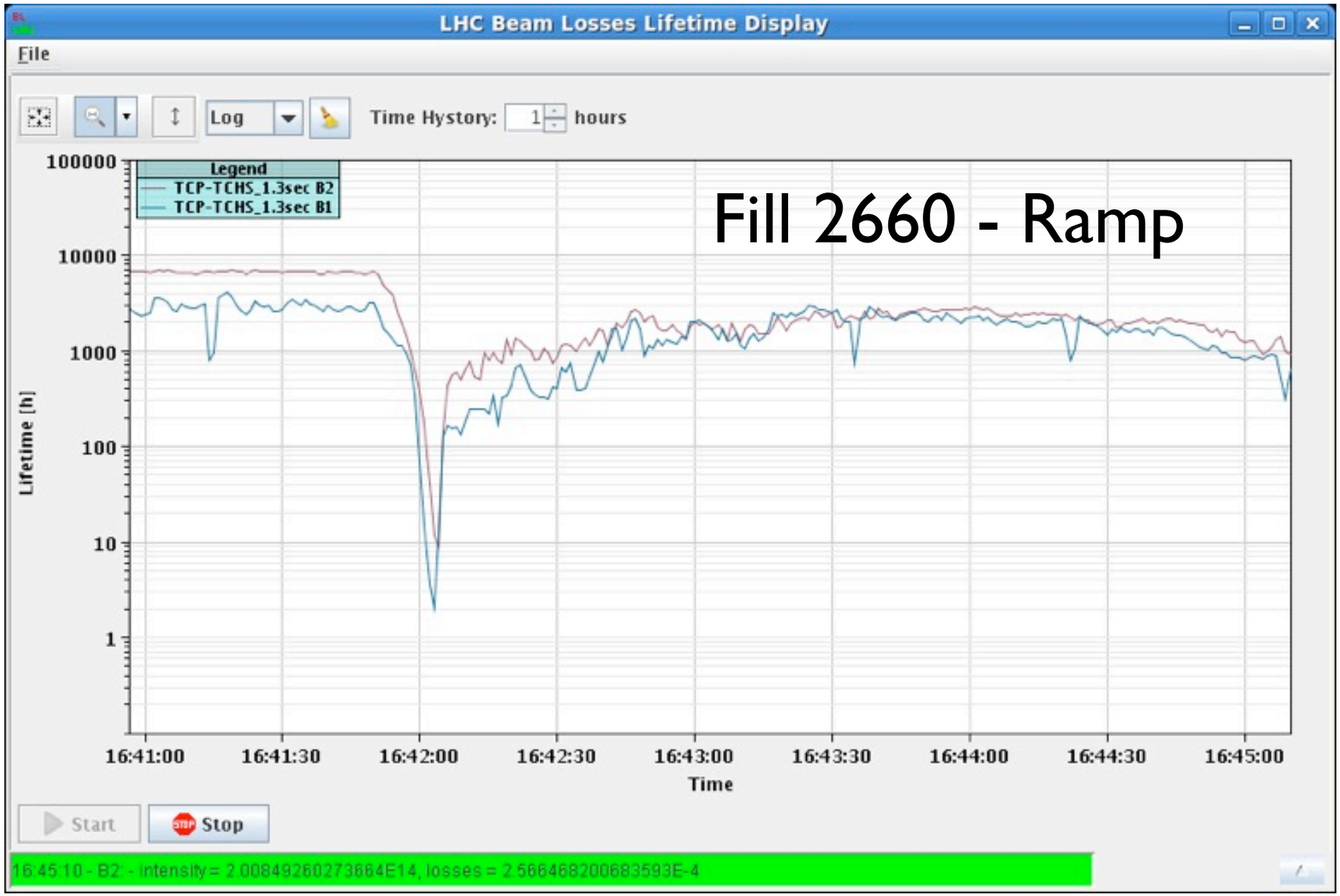
- We showed a recent study on how to update the BLM thresholds for **IP7** (betatron losses) **to achieve the system loss rate in kW**:
  https://espace.cern.ch/lhc-machine-committee/Presentations/1/lmc_133/lmc_133c.pdf
  - The BLM thresholds were increased to accommodate up to:
    - 200kW losses in 1-2 sec (100kW of continuous losses)
    - 500kW (if we set monitor factor 1).
- However, **off-momentum** losses need also **to be reviewed**:
  - Fill 2660:
    →80% of threshold reached at the start of Ramp.
    →60kW

(Short) analysis description:

- Look at highest loss location during ramp, pick-up the time when loss is mainly in IP3.
- Look at qualification off-momentum loss maps at 450GeV
- Compare loss map and physics fills:
  - If they agree, use qualification loss map to calculate the new thresholds
- Determine new thresholds as ratio w.r.t old ones.

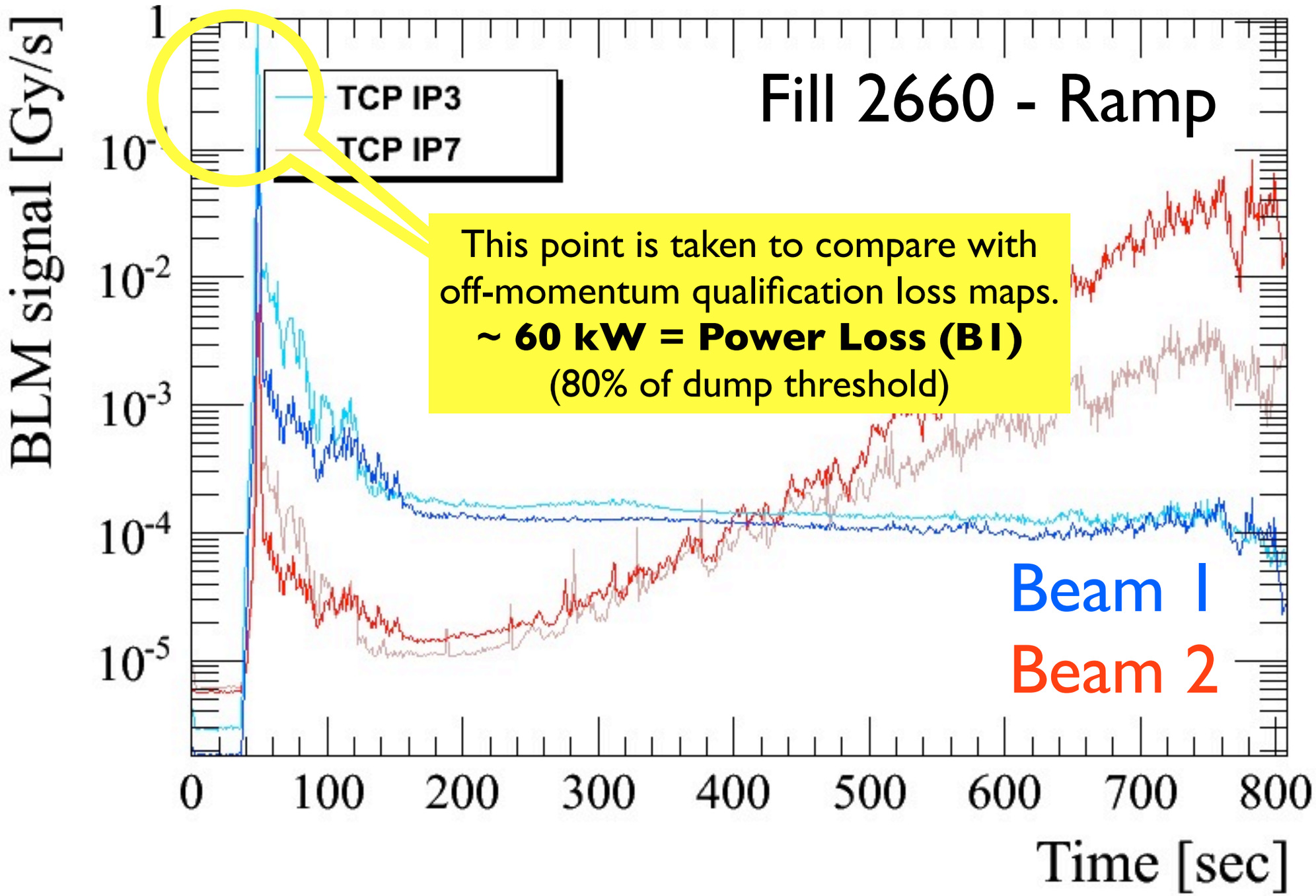
Losses during Ramp

16:42:03 - Warning on: BLMEI.05L3.B1I10_TCSG.5L3.B1, integration time: 1.3 s, losses = 3.089787E-01, threshold = 3.711363E-01, ratio = 83%



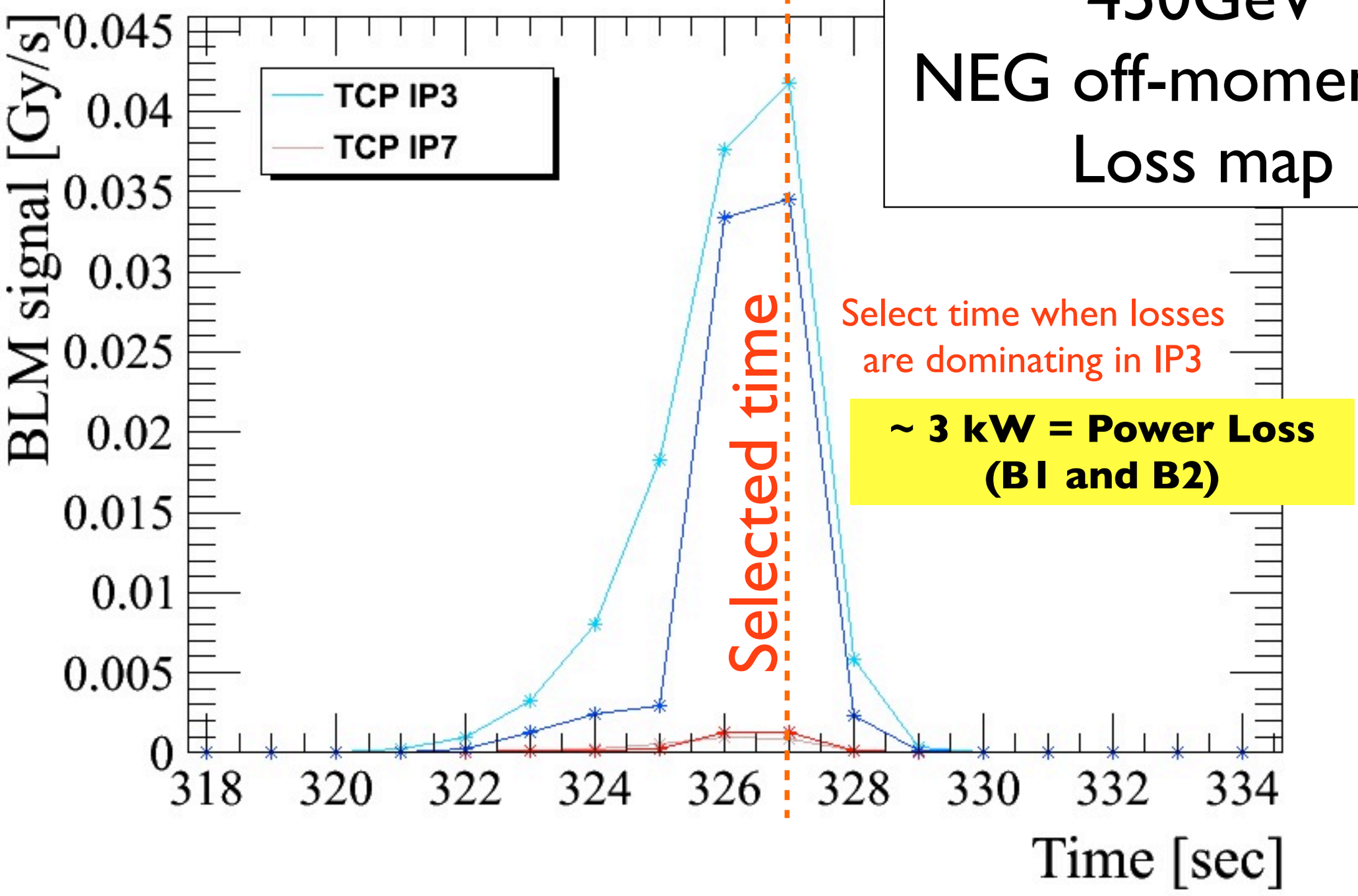
Losses during Ramp

During ramp there is a **dramatic change on the loss location.** Fast off-momentum losses are dominating at the start of ramp in IR3. Peak occurs in frist few seconds (loss of uncaptured beam). Betatron losses increase slowly towards the middle of the ramp until they become dominating in IR7 (when collimators move to tight settings).



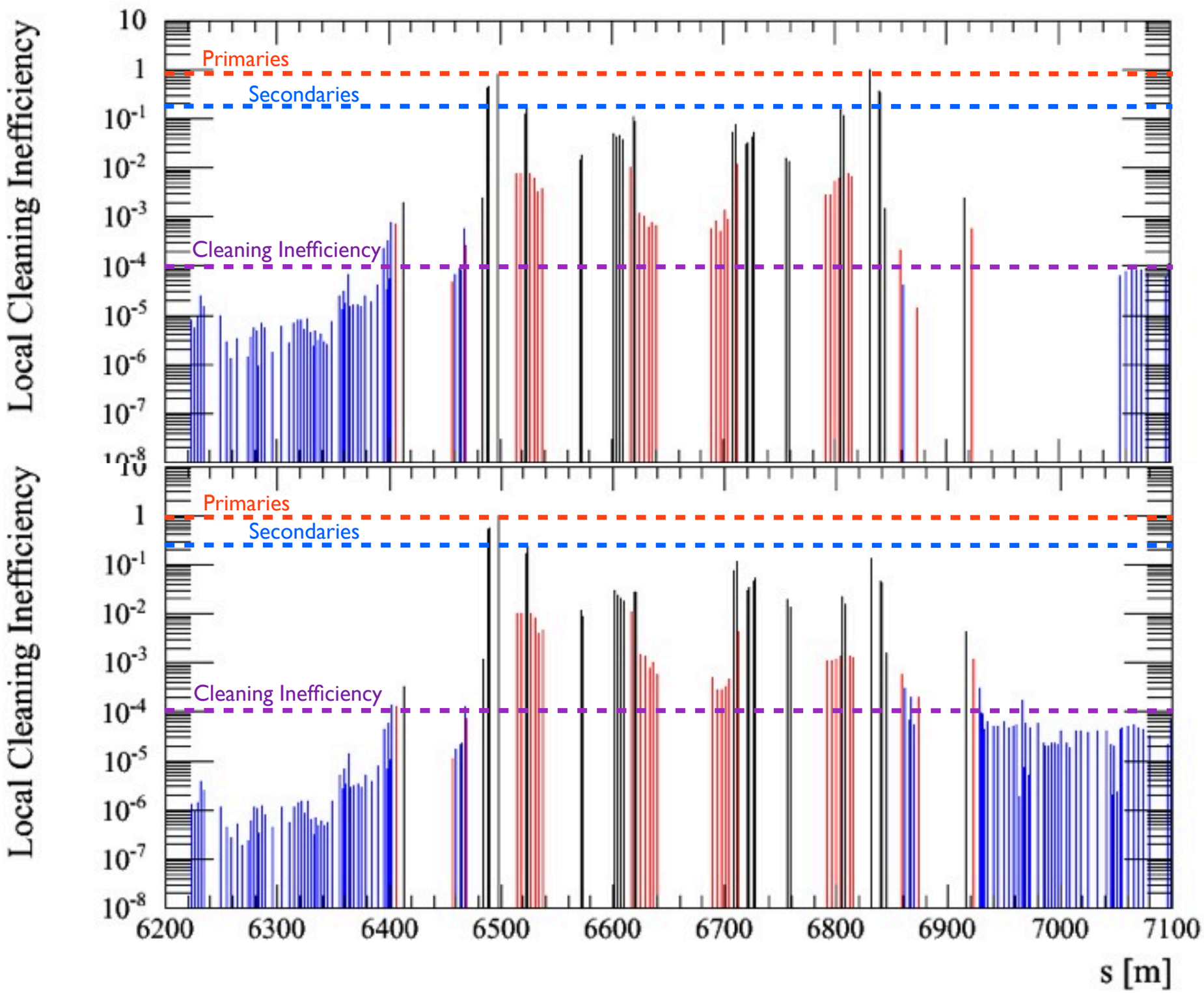
Compare off-momentum losses with qualification loss maps

Use of qualification **loss maps at 450GeV** since the dominant IP3 loss during a standard fill occurs at the start of ramp.



Normalized losses in IR3

Good agreement! Consistent losses during 450GeV off-momentum lossmap and fill 2660



Lossmap

450GeV
Similar losses in B1+B2
~3kW

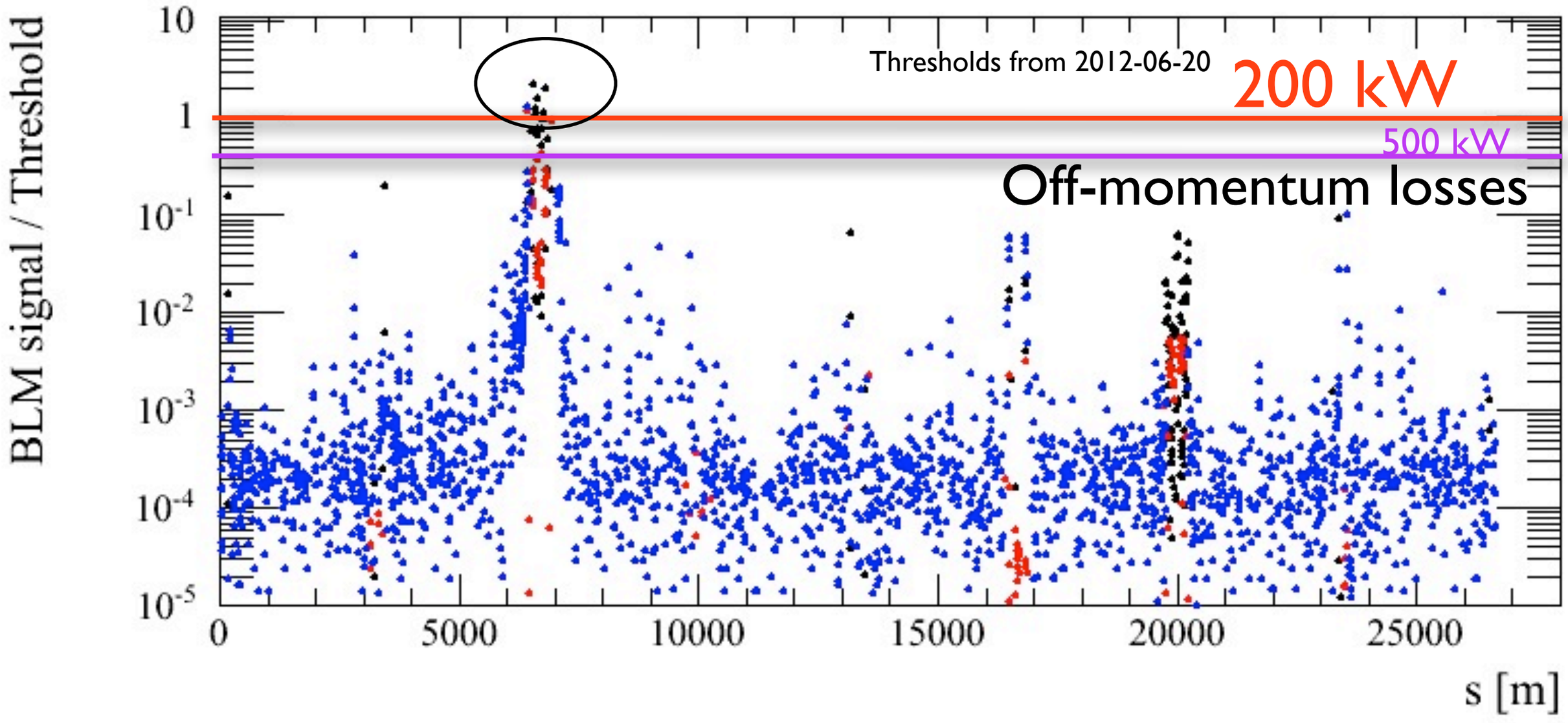
Fill2660

Start Ramp
Losses in B1
~60kW

Ratio Loss to Threshold

Comparison of expected losses for 200kW at **IP3** with Current BLM thresholds using RS09 (1.3s).
Only thresholds in IR3 need to be increased

— Cold
— Warm
— Collimator



Collimators

Thresholds from 2012-06-20

BlmName	s[m]	200.0kW-THRESH[Gy/s]	Ratio	OldThreshold [Gy/s]
BLMEI.05L3.B1I10_TCSG.5L3.B1	6521.99	0.803853079	2.166136025	0.3711
BLMEI.05R3.B2E10_TCSG.5R3.B2	6807.45	0.751592697	2.02531042	0.3711
BLMEI.04L3.B2E10_TCSG.4L3.B2	6620.87	0.571853363	1.540968371	0.3711
BLMEI.05L3.B2E10_TCLA.A5L3.B2	6573.22	0.115335951	1.242978241	0.09279
BLMEI.05R3.B1I10_TCLA.A5R3.B1	6756.22	0.103787849	1.118524076	0.09279
BLMEI.05L3.B2E10_TCLA.B5L3.B2	6571.22	0.097147071	1.046956256	0.09279

Cold Elements

Thresholds from 2012-06-20

Cold Elements

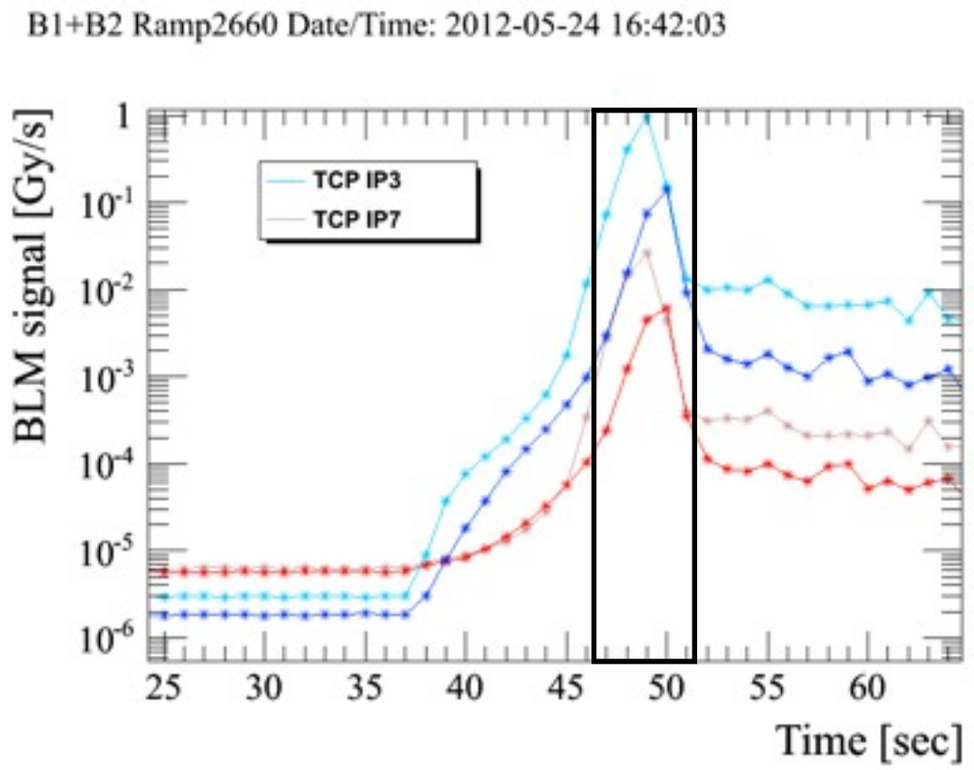
BlmName	s[m]	200.0kW-THRESH[Gy/s]	Ratio	OldThreshold [Gy/s]
BLMQI.07L3.B2E10_MQ	6402.31	0.005218581	1.316161575	0.003965
BLMQI.07L3.B1I30_MQ	6405.86	0.00467529	1.179140056	0.003965

What should be the maximum allowed loss rate

- What is the max. power loss allowed in IR3?
- Specified nominal loss rate:

Mode	T [s]	τ [h]	R_{loss} [p/s]	P_{loss} [kW]
Injection	cont	1.0	0.8×10^{11}	6
	10	0.1	8.6×10^{11}	63
Ramp	≈ 1	0.006	1.6×10^{13}	1200
Top energy	cont	1.0	0.8×10^{11}	97
	10	0.2	4.3×10^{11}	487

- Specified loss rate with current settings:
  - loss max. of 5% of the beam at injection
  - this corresponds 800kJ with current intensities (2.2e14 protons/beam)
  - If the loss develops in:
    - ~ 1 sec → 800kW
    - ~ 2 sec → 400kW



500kW (with MF=0.4 to set 200kW) is a **Good Assumption**.
Same as IR7

Summary: IR3 BLM thresholds

- Calculation of new BLM thresholds for **200kW** and **500kW** losses in **IR3** using off-momentum loss maps.
  Comparison of 450GeV loss maps with Fill 2660 during ramp: **Good agreement**
- For 200kW: 6 collimator thresholds need to be updated by a factor of 2
  - 2 cold elements need to be updated also:
    BLMQI.07L3.B2E10_MQ and BLMQI.07L3.B1I30_MQ
- For 500kW the maximum increase of 14 collimator factor between 5-1.2
  - 4 cold elements
- Some discussing:
  - Is 200kW a good assumption for IR3 also?

IR7: Calculation of new BLM thresholds for 500kW at primary collimator for integration times >= 1.3sec and 200kW continuous losses for RS12 (83sec).
The allow loss rate are reduced from 500kW(200kW) to 200kW (80kW) using the MF = 0.4

Table with collimators and cold elements for 500kW

Collimators

Thresholds from 2012-06-20

BlmName	s[m]	500.0kW-THRESH[Gy/s]	Ratio	OldThreshold [Gy/s]
BLMEI.05L3.B1I10_TCSG.5L3.B1	6521.99	2.0096	5.4153	0.3711
BLMEI.05R3.B2E10_TCSG.5R3.B2	6807.45	1.8790	5.0633	0.3711
BLMEI.04L3.B2E10_TCSG.4L3.B2	6620.87	1.4296	3.8524	0.3711
BLMEI.05L3.B2E10_TCLA.A5L3.B2	6573.22	0.2883	3.1074	0.09279
BLMEI.05R3.B1I10_TCLA.A5R3.B1	6756.22	0.2595	2.7963	0.09279
BLMEI.05L3.B2E10_TCLA.B5L3.B2	6571.22	0.2429	2.6174	0.09279
BLMEI.05R3.B1I10_TCLA.B5R3.B1	6758.22	0.2246	2.4209	0.09279
BLMEI.04R3.B1I10_TCSG.4R3.B1	6708.58	0.8961	2.4147	0.3711
BLMEI.05R3.B1I10_TCSG.B5R3.B1	6725.74	0.7266	1.9579	0.3711
BLMEI.05L3.B2E10_TCSG.B5L3.B2	6603.7	0.7051	1.9001	0.3711
BLMEI.06L3.B1I10_TCP.6L3.B1	6488.67	6.7354	1.8150	3.711
BLMEI.05L3.B2E10_TCSG.A5L3.B2	6609.52	0.6053	1.6310	0.3711
BLMEI.06R3.B2E10_TCP.6R3.B2	6840.77	5.5725	1.5016	3.711
BLMEI.05R3.B1I10_TCSG.A5R3.B1	6719.92	0.4795	1.2920	0.3711

Cold-Warm Elements

Thresholds from 2012-06-20

BlmName	s[m]	500.0kW-THRESH[Gy/s]	Ratio	OldThreshold [Gy/s]
BLMQI.07L3.B2E10_MQ	6402.31	0.0130	3.2904	0.003965
BLMQI.07L3.B1I30_MQ	6405.86	0.0117	2.9479	0.003965
BLMQI.07R3.B2E30_MQ	6923.08	0.0093	2.3348	0.003965
BLMQI.04R3.B2E10_MQWA.E4R3	6712.65	0.1874	1.0707	0.175