Thermal load on the beam screen in sector 1-2 after thermal cycle (replacement of A31L2)

TETM 22nd June 2017

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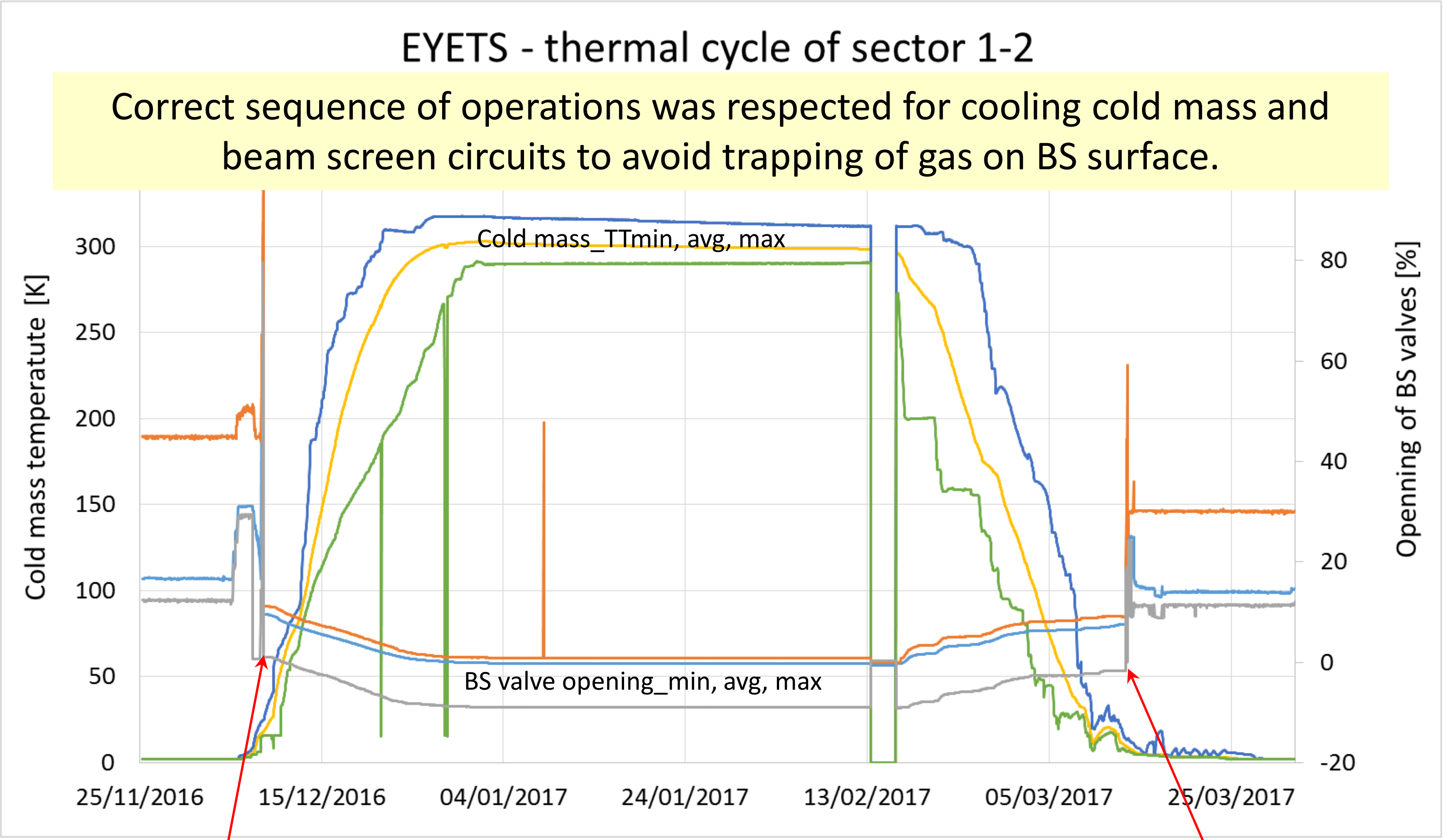
with contribution from Benjamin Bradu

Outlook

- Global thermal cycle
- Heat load all sectors in 2016 - recall
- Heat load all sectors in 2017
    - scrubbing
    - physics
- Sector 1-2
    - focus on s1-2 recently instrumented cell
    - heat load distribution by cells
- Perspectives – capacity limits estimation
- Conclusions

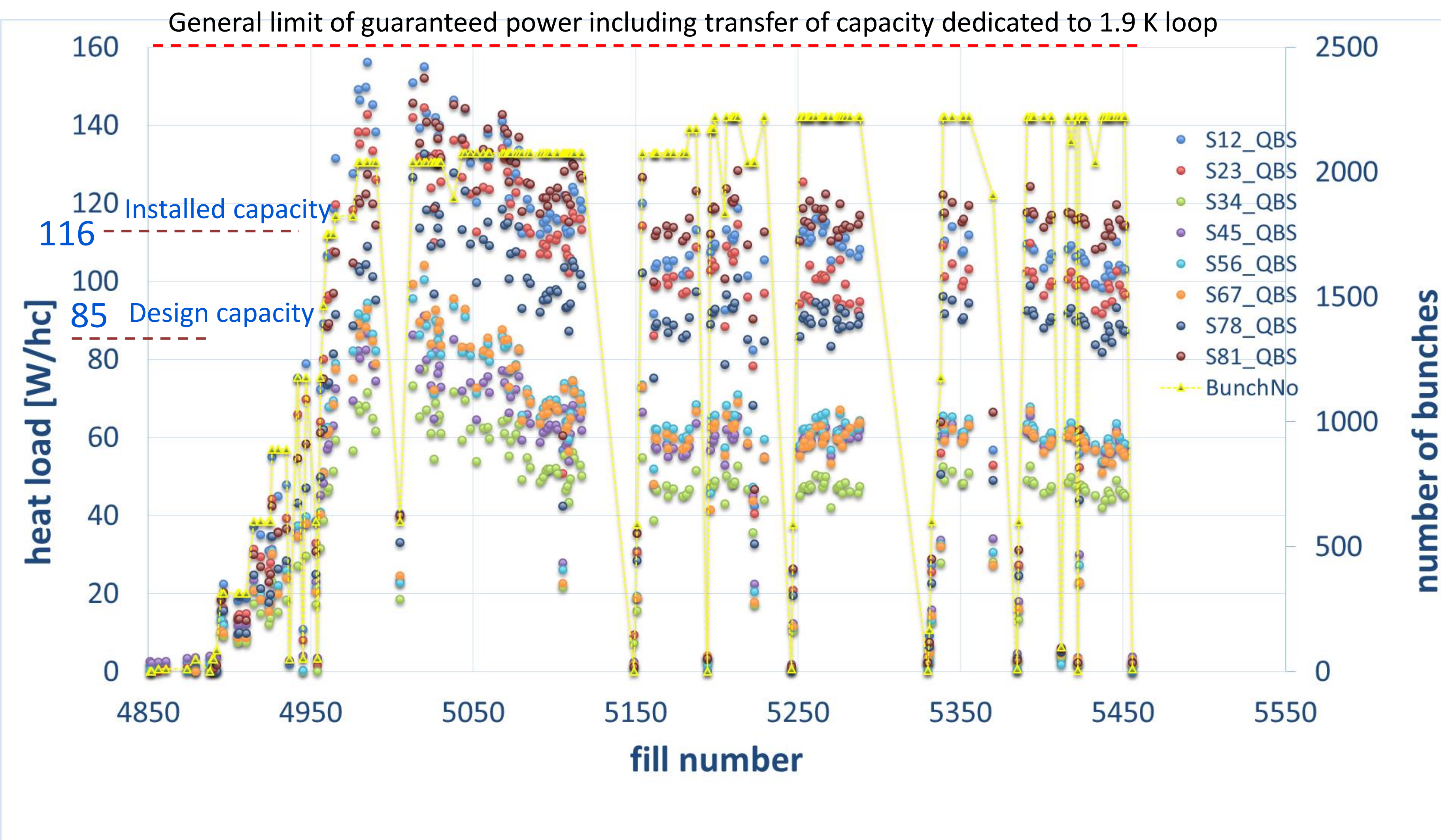
Sector 1-2 thermal cycle global view



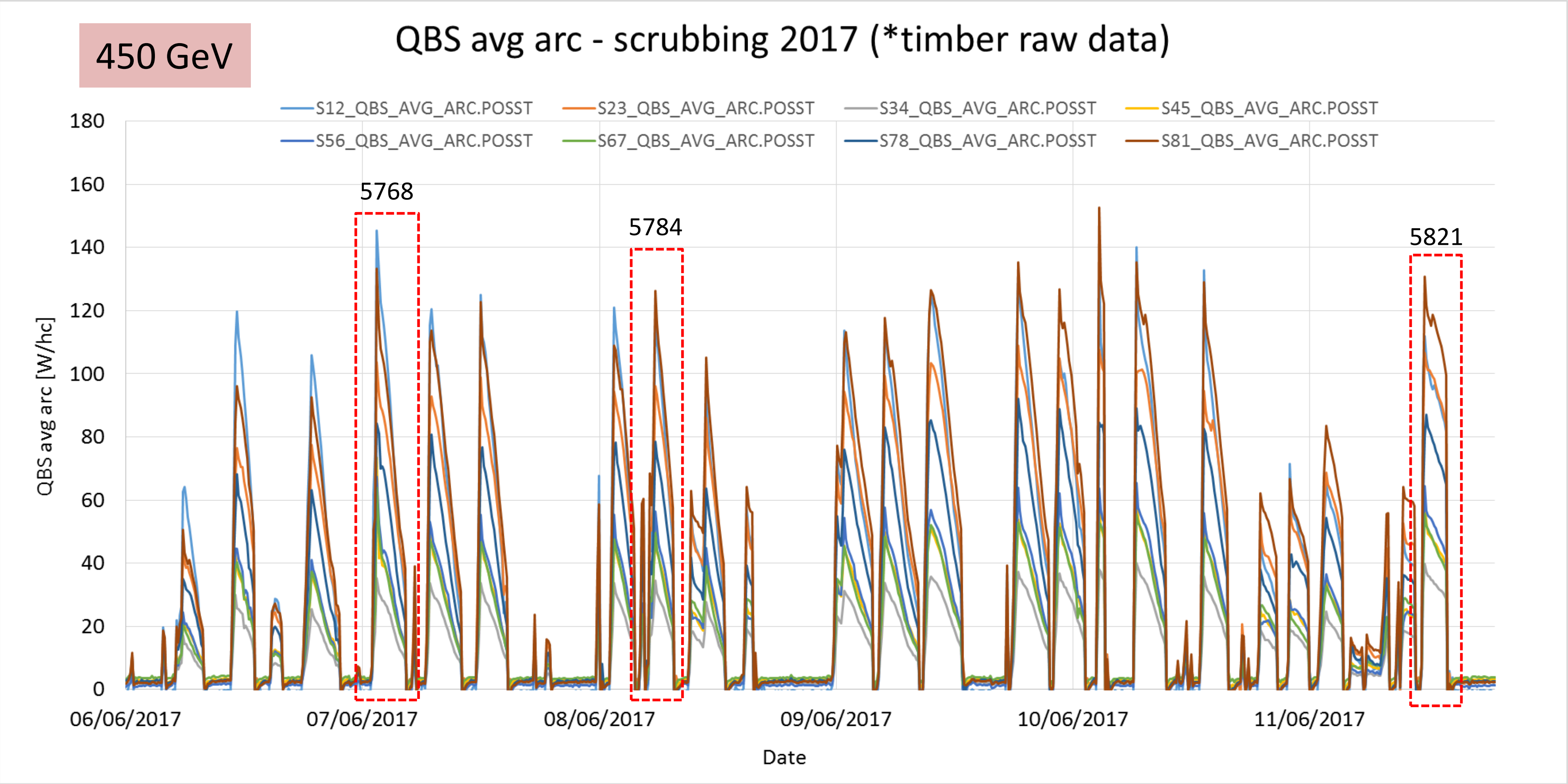
Stop of BS cooling at CM_TTavg T=18 K

Start of BS cooling at CM_TTavg T<10 K

Beam screen heating – 2016



Focus on scrubbing

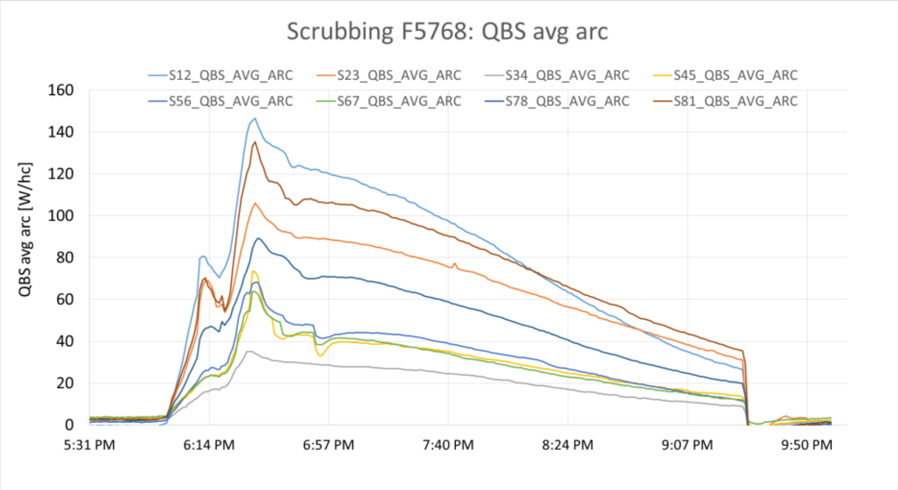


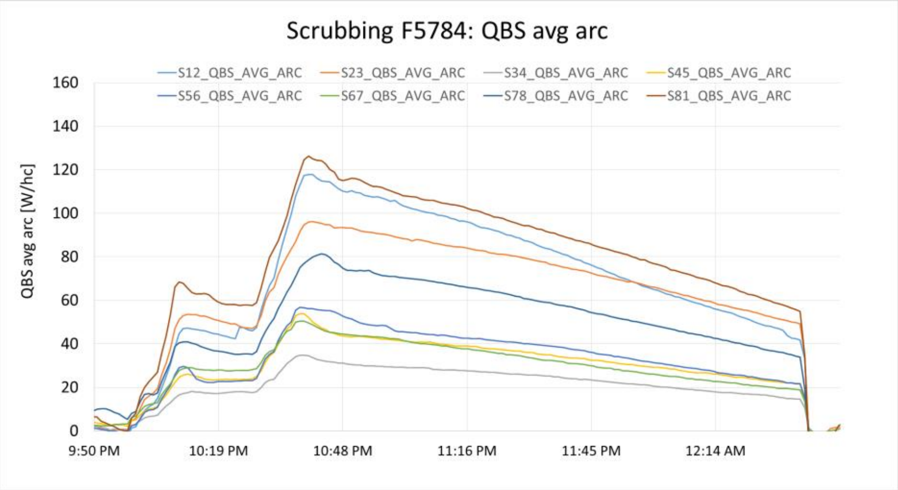
Fills 5768 and 5784: B1 144 bpi -> 2460 b, B2 288 bpi -> 2604 b

Fill 5821: B1 288 bpi -> 2820 b, B2 288 bpi -> 2820 b

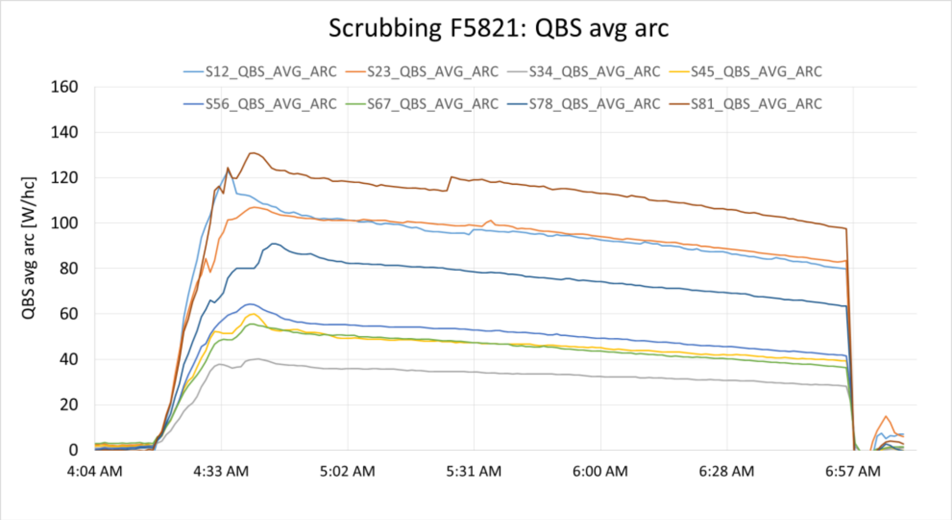
Focus on scrubbing

Fills 5768 and 5784: B1 144 bpi -> 2460 b, B2 288 bpi -> 2604 b

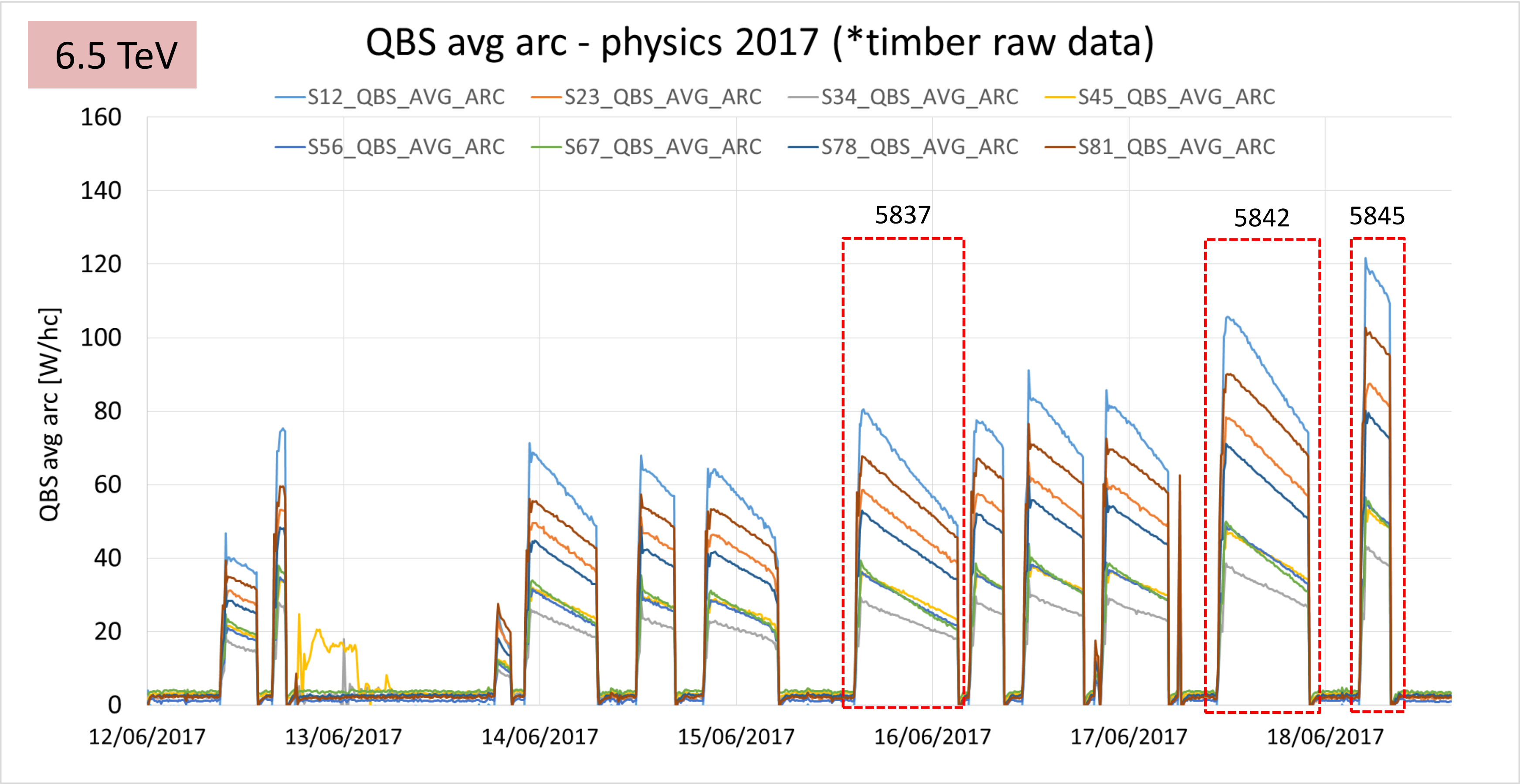




Fill 5821: B1 288 bpi -> 2820 b, B2 288 bpi -> 2820 b



Focus on physics

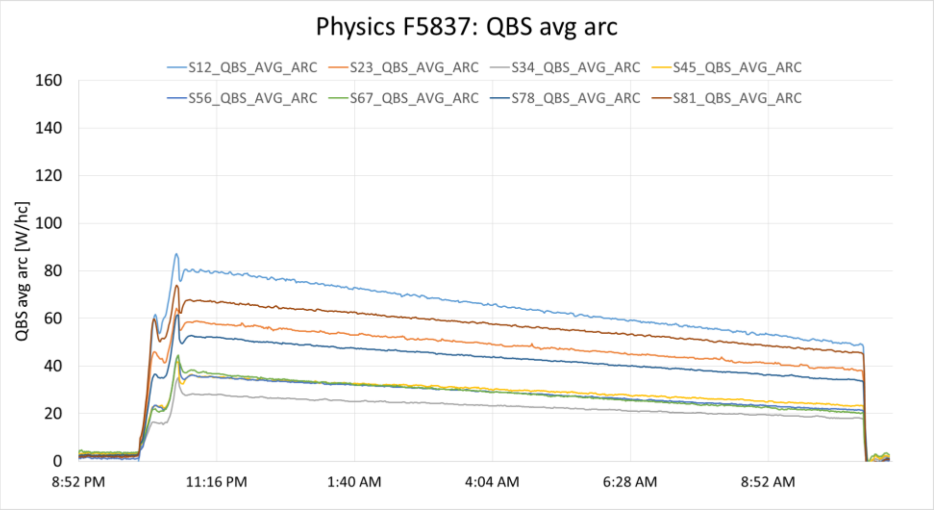


*sharp peaks on the beginning of the fills does not reflect real heating effect and should be neglected

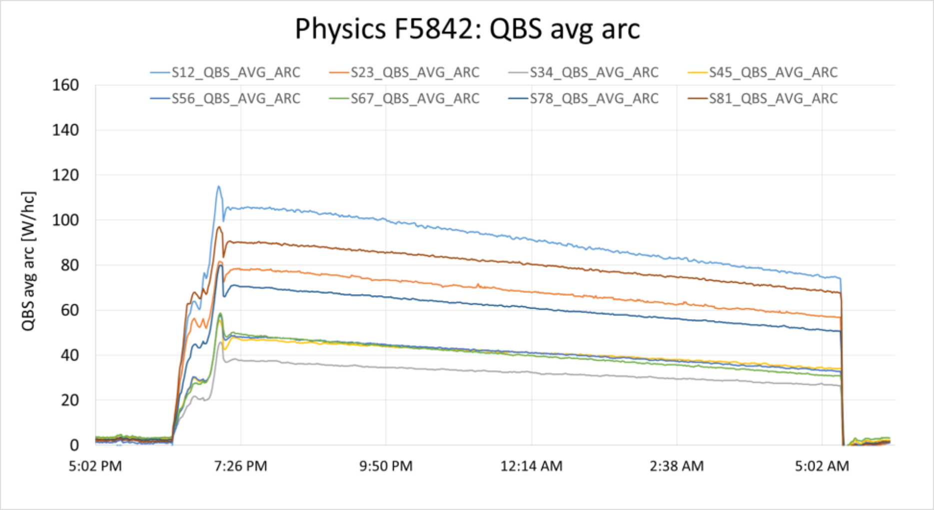
Differently to scrubbing where s1-2 was aligned at level of s2-3, at 6.5 TeV sector 1-2 generates the highest heat load among all sectors,

Focus on physics

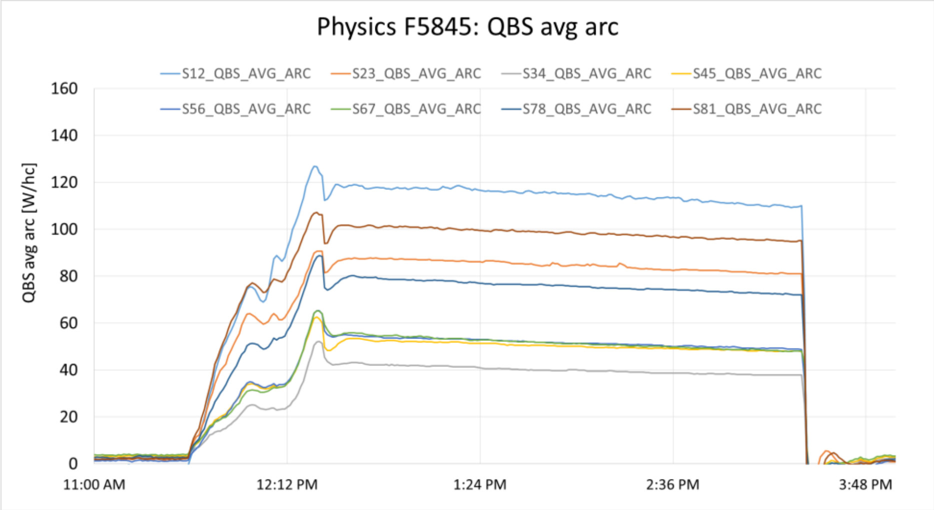
Fill 5837: B1 144 bpi -> 1225 b, B2 144 bpi -> 1225 b



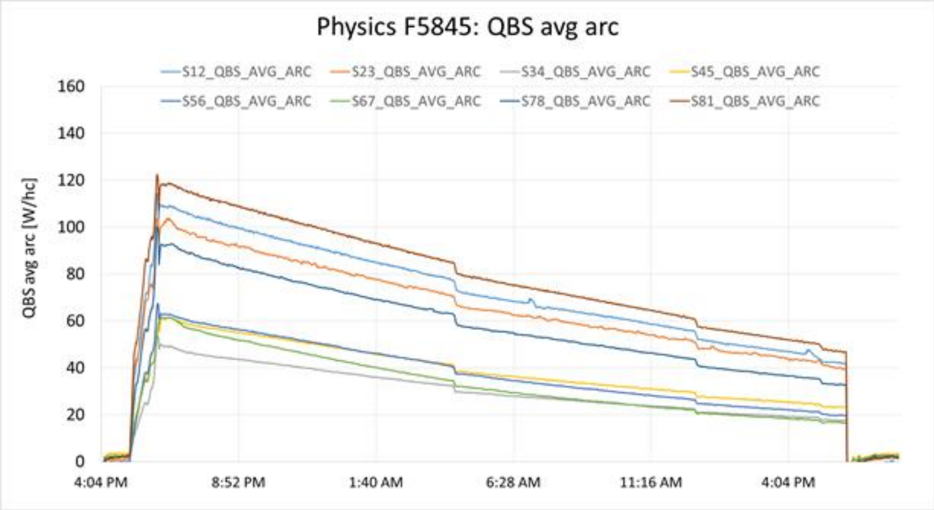
Fill 5842: B1 144 bpi -> 1561 b, B2 144 bpi -> 1561 b



Fill 5845: B1 144 bpi -> 1741 b, B2 144 bpi -> 1741 b

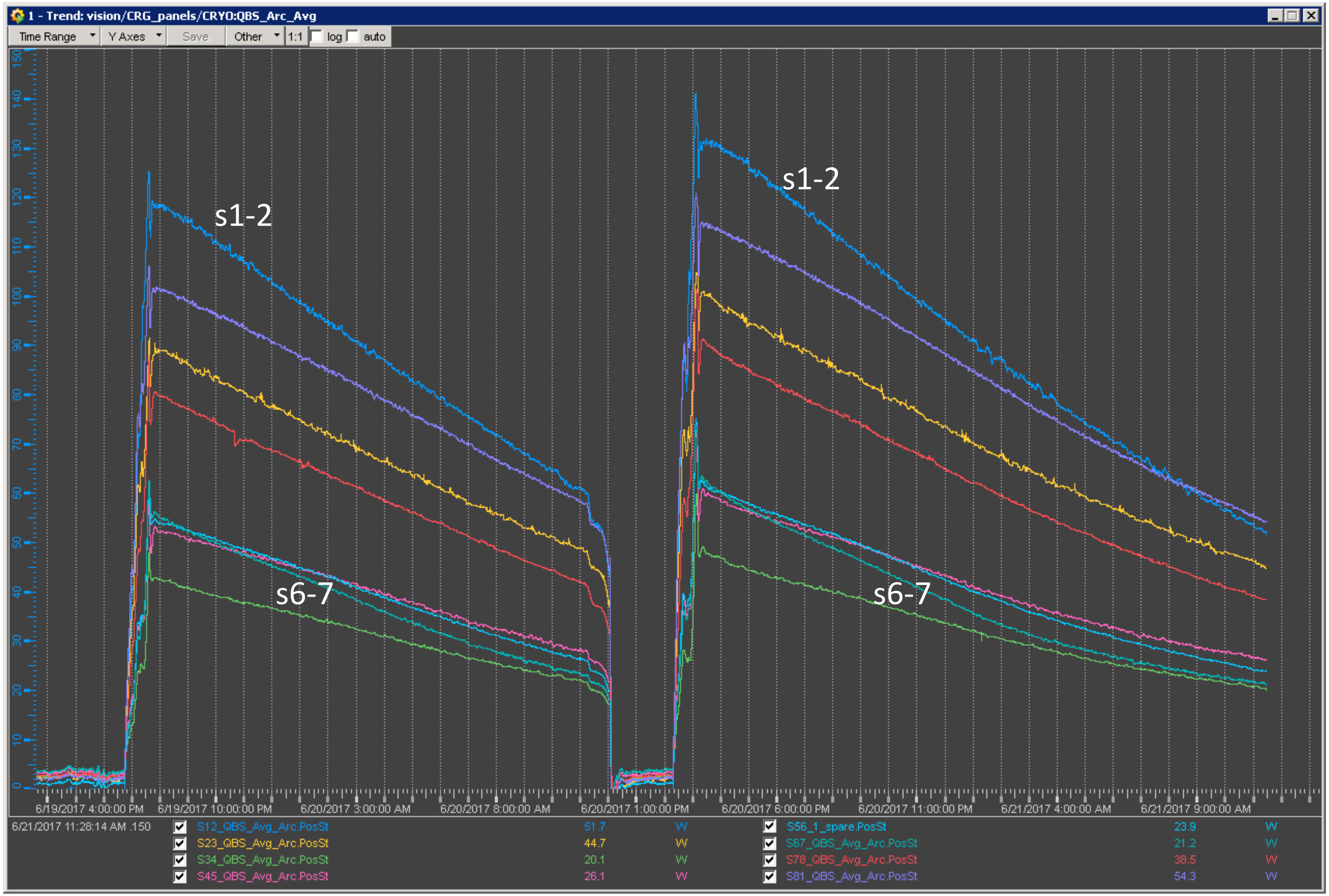


(2016) Fill 5416: B1 96 bpi -> 2220 b, B2 96 bpi -> 2220 b



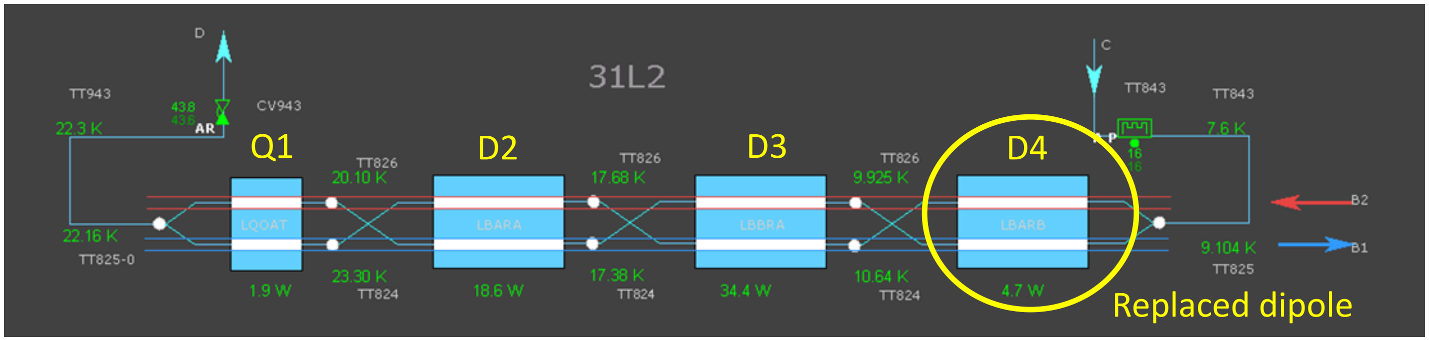
Very last fills observation

Heat load generated in s12 and s67 decreases visibly faster in function of intensity than in other sectors

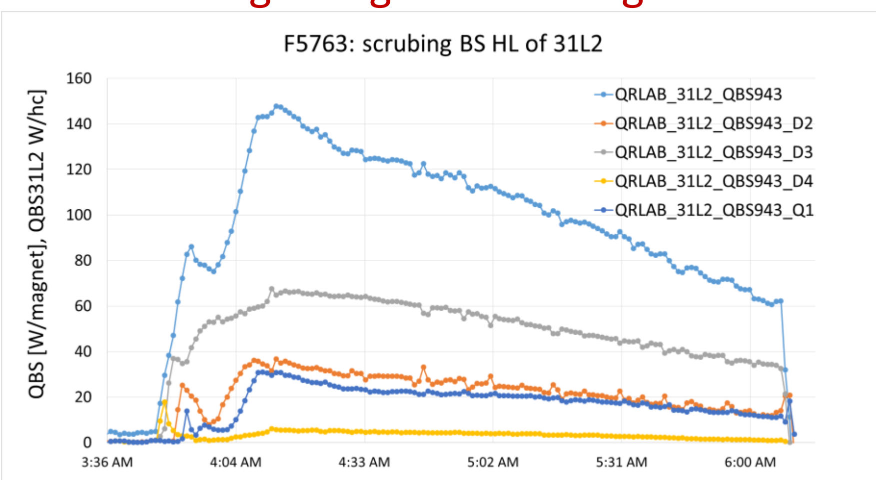


31L2 investigation – scrubbing

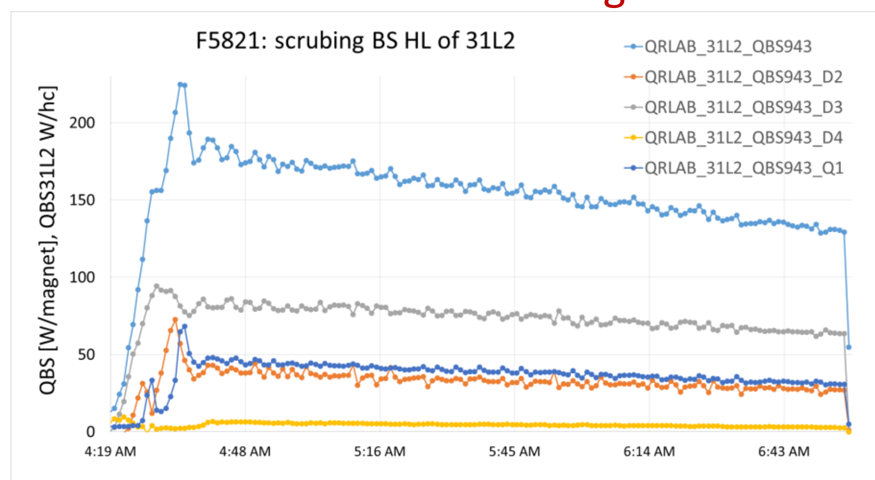
Cell 31L2 was instrumented by TE-CRG during EYETS for detailed investigation of the BS heat load.



Beginning of scrubbing



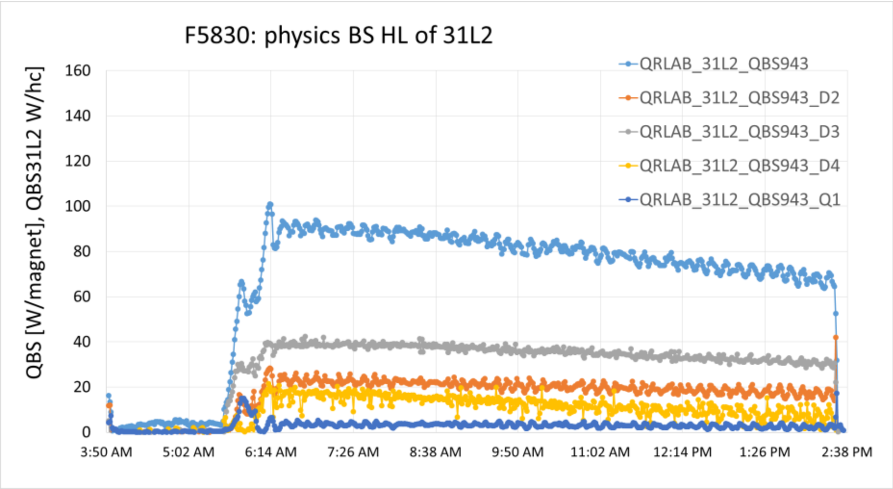
End of scrubbing



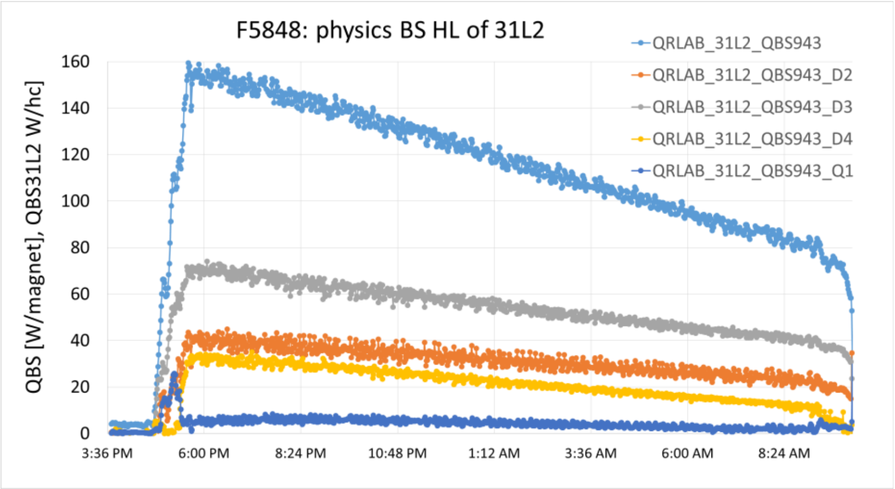
The replaced magnet generated the lowest HL in 31L2.

31L2 investigation – physics

Beginning of physics 2017



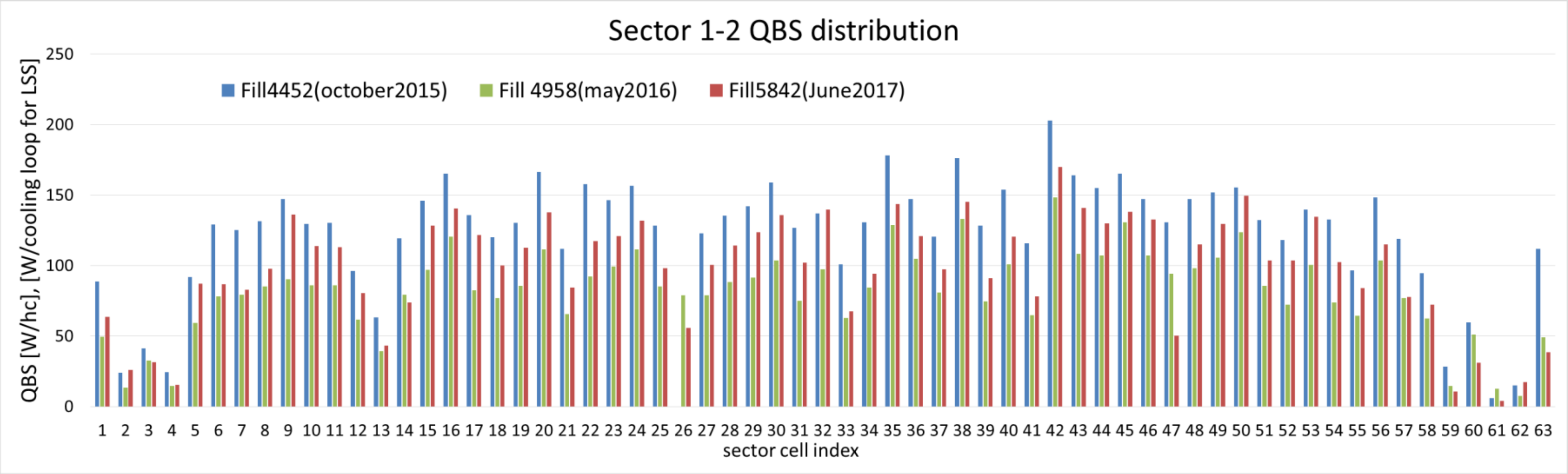
Physics fill on 19th June 2017

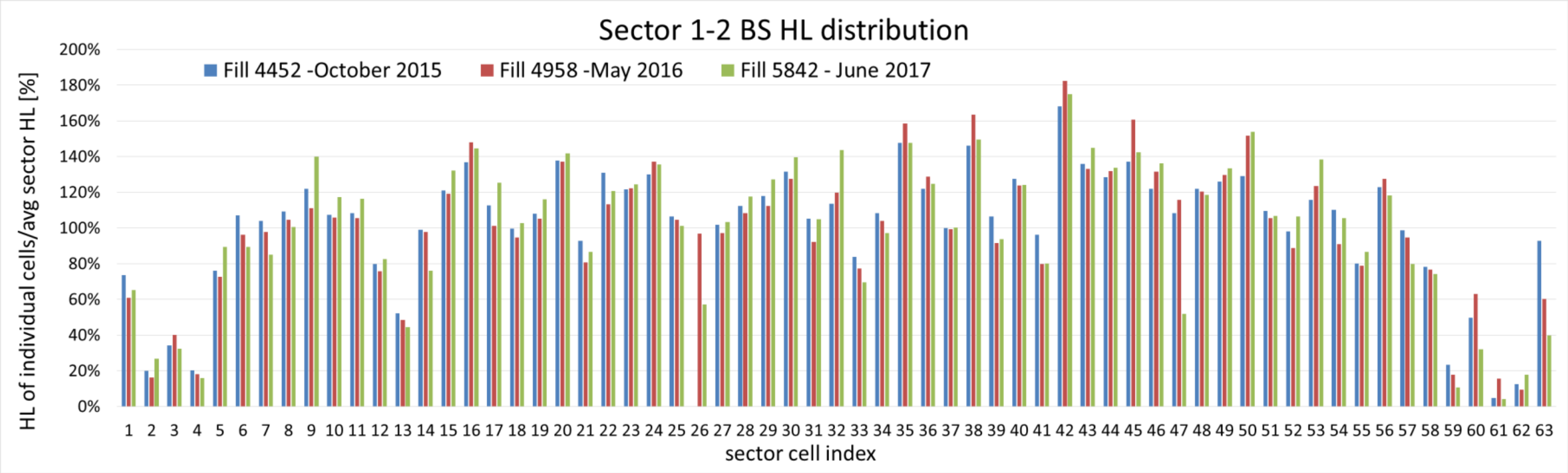


The replaced magnet generated the lowest HL in among all 3 dipoles in 31L2, only Q1 has lower HL (attention – graphs with units W/magnet).

Why D4 which could be expected not conditioned at all behaves better than other magnets?

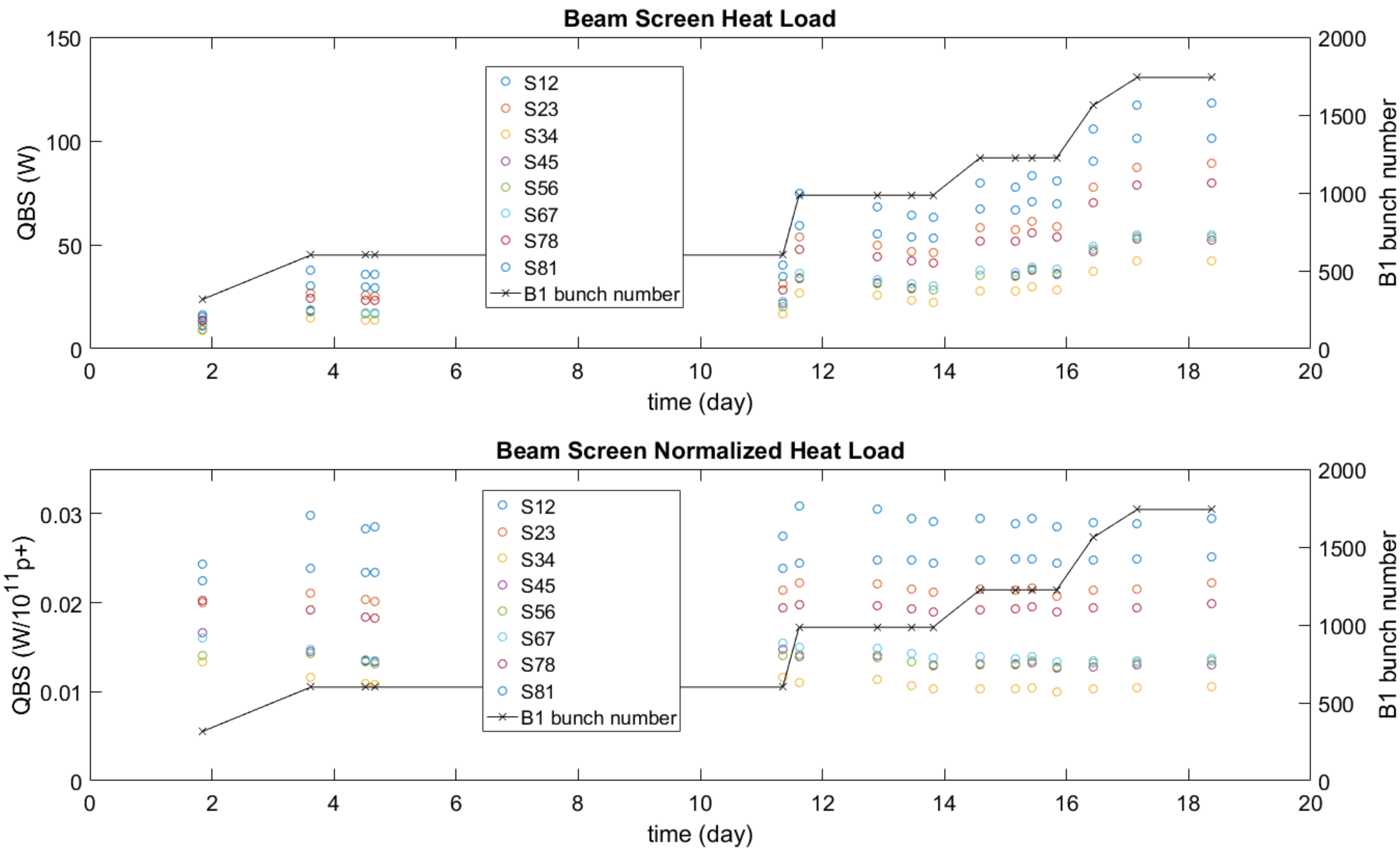
Sector 1-2 heat load distribution





The HL distribution in sector 1-2 during Run2 stays the same, also after thermal cycle during EYETS.

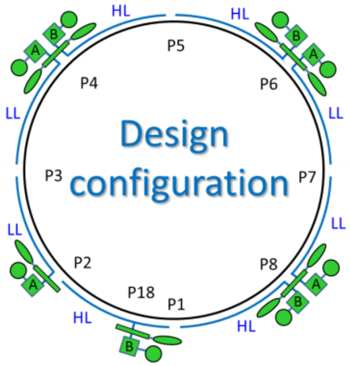
Beam screen heating – 2017

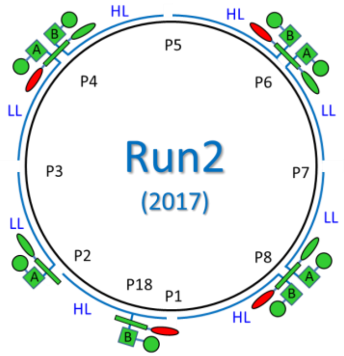


Cooling capacity

K. Brodzinski – LMC 21.06.2017

Default estimated value of guaranteed refrigeration capacity is 160 W. Specific four sectors were tested in their design configuration. The values for their capacity limit for BS cooling is presented in table below.





measured in:	?	2016	2017				2016	2017
	S1-2	S2-3	S3-4	S4-5	S5-6	S6-7	S7-8	S8-1
Capacity (design conf.) [W/hc]	160	195	125*	160	160	160	175	230

*cryo-plant at P4 loaded for RF modules

Reconfiguration of the system for using of 1 cold pumping unit/cryo-islant allows to spare about ~3 kW (~20 W/hc – estimated values) of capacity for BS but has an influence on equilibrium of capacity between cryoplant A and B of about 10-15%.

The chosen configuration of the cryoplants can be adapted according to needs of the machine.

Such mapping will be continued progressively during TS/YETS to investigate on real limits of the cryogenic plants. It is worth to mention that these tests were done in between other activities, no related time slot was allocated in the planning to perform the tests.

BS – run 2017

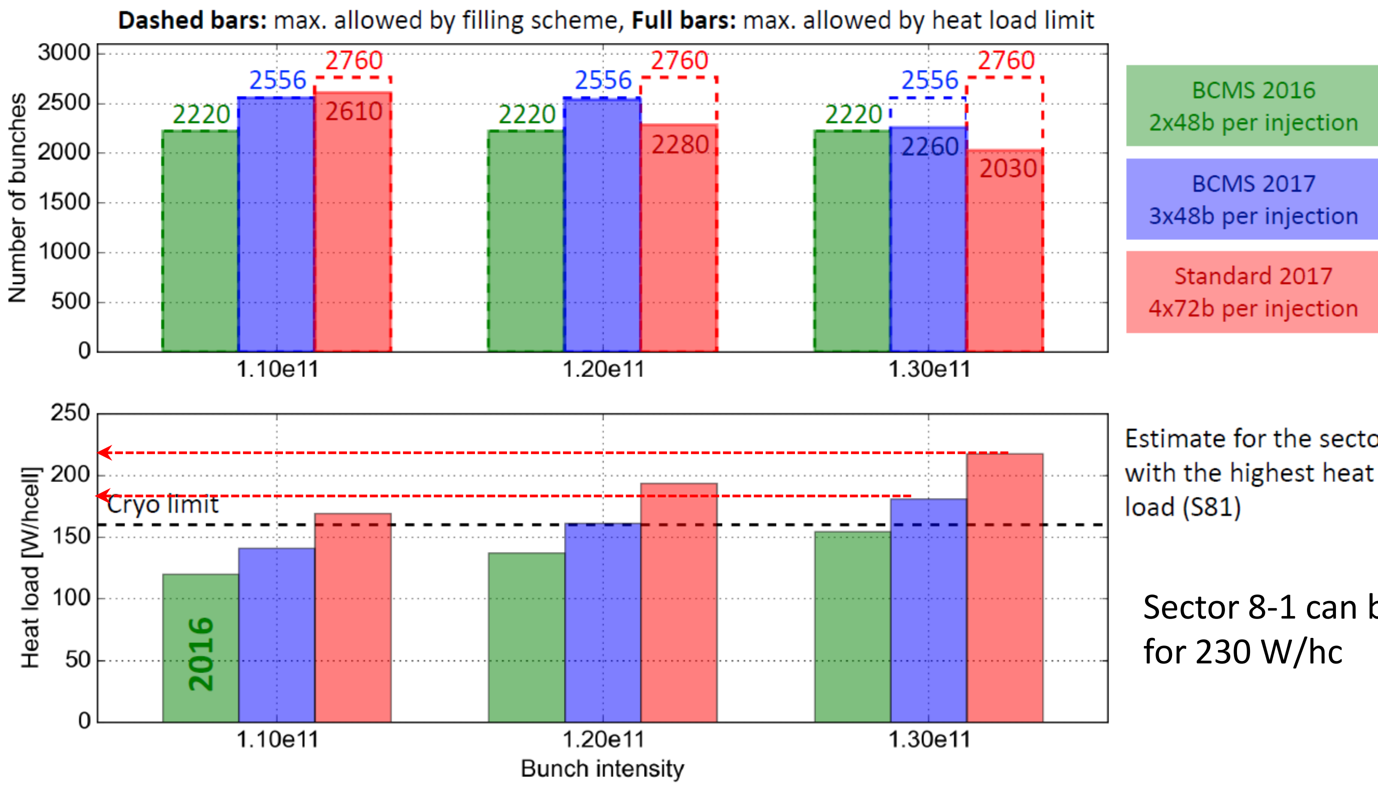
G. Iadarola – Chamonix 2017

Heat load estimates: BCMS vs standard

Case 3: "Standard 2017", 2760b., 4x72b per injection

→ Cryo capacity **limit is already reached** for a bunch intensity of **$1.1x10^{11}$ p/bunch**

→ For larger bunch intensity the standard scheme is limited to a **number of bunches** that is even **lower than BCMS**



physics

scrubbing

Estimate for the sector with the highest heat load (S81)

Sector 8-1 can be compensated for 230 W/hc

Progressive increase of intensity from 1.1e11 to 1.3e11 is planned to be applied during 2017 physics.

Conclusions

- The thermal cycle of cold mass was done with no circulation of He in BS circuits – prevention from trapping of the impurities on the BS instead on the cold bore, thermal regeneration of BS after cool down was applied on all sectors according to the procedure and in coordination with TE-VSC,
- Relatively fast recovery (conditioning) of s1-2 was observed during scrubbing (450 GeV), s1-2 recovered at level of s2-3 staying below s8-1,
- During physics (6.5 TeV) until 20.06.2017 s1-2 stays as top heat loaded sector
- The replaced magnet in 31L2 shows the lowest HL among all magnets in the cell during scrubbing and the lowest HL among all dipoles in the cell during physics,
- HL distribution between the cells in s1-2 during 2015, 2016 and 2017 is very similar,
- Two additional tests were performed during EYETS on s3-4 and s8-1. BS limit for s3-4 is 125 W/hc, while for s8-1 is 230 W/hc (design configuration). The results for s8-1 are very satisfactory showing capability to compensate for BS heat load during planned scrubbing and physics operation in 2017.
- Behavior of sector 1-2 must still be observed and analyzed.
- It is still difficult to identify what will be the limiting sector in 2017.

Thank you for your attention!

Back up 1: 31L2 during scrubbing

Back up 1: 31L2 during physics