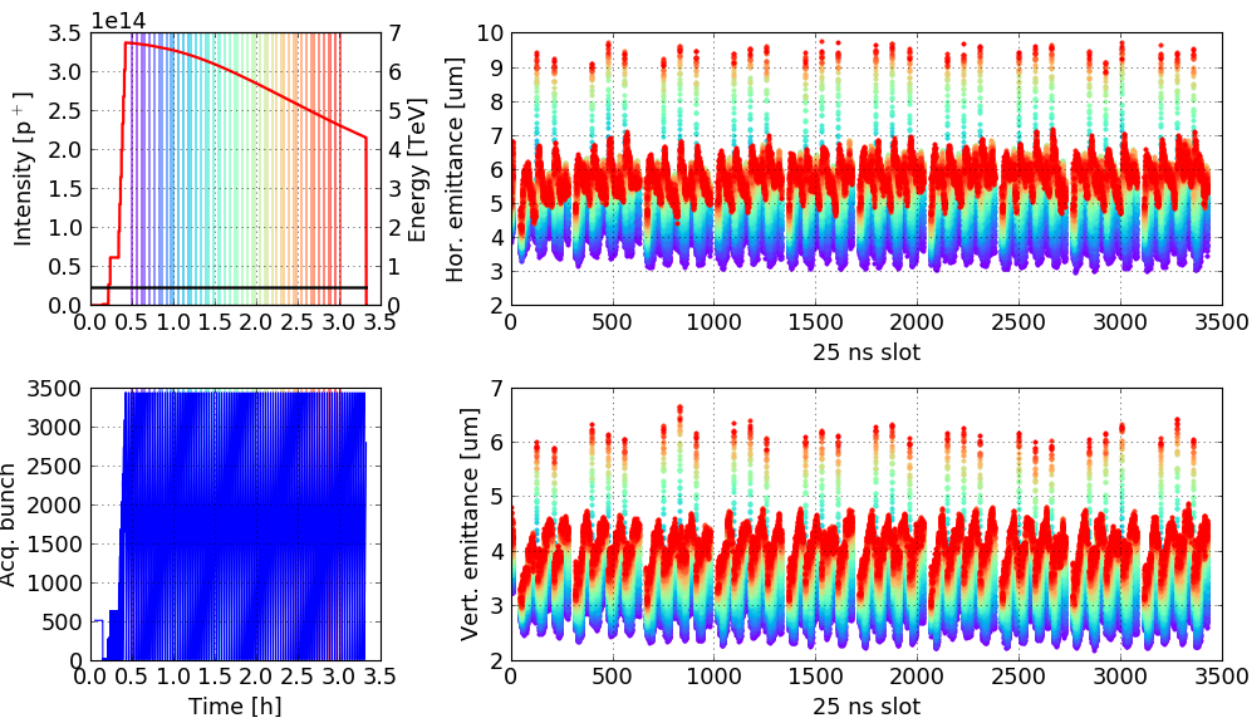


Observations on beams growing hair

2017 scrubbing



Fill 5800: B2, started on Sun, 11 Jun 2017 01:00:17

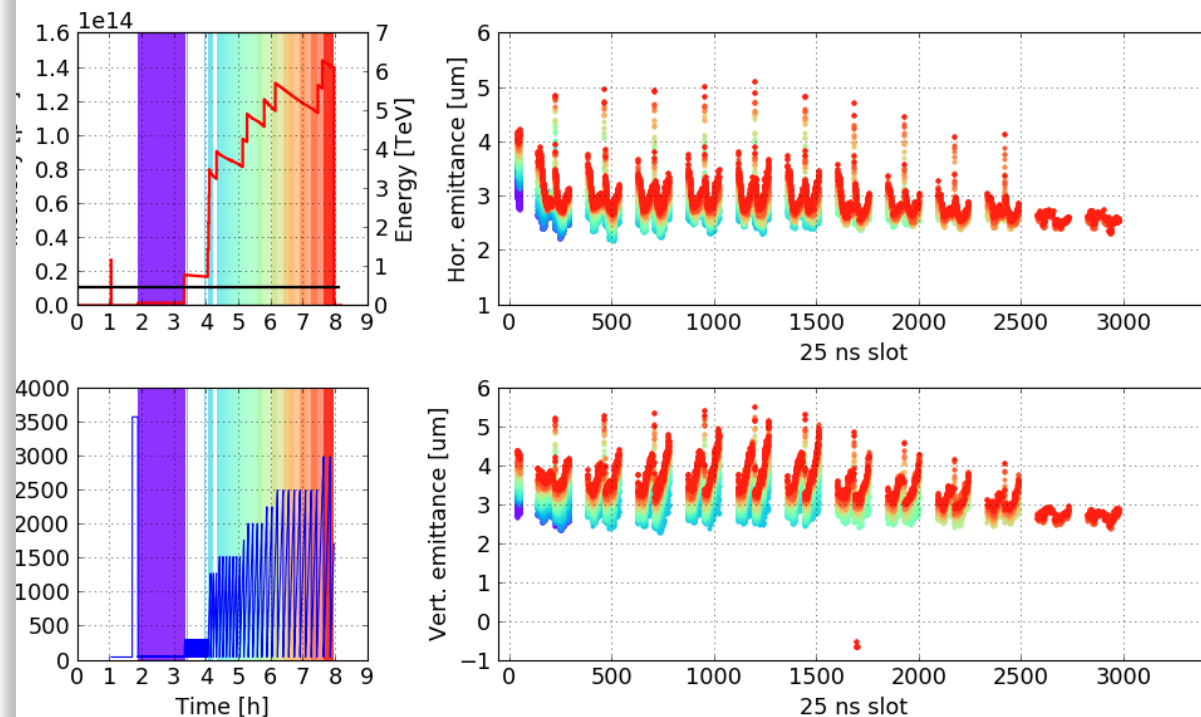


x=0.383543 y=2025.4

2015 scrubbing



Fill 4108: B2, started on Fri, 31 Jul 2015 13:18:57

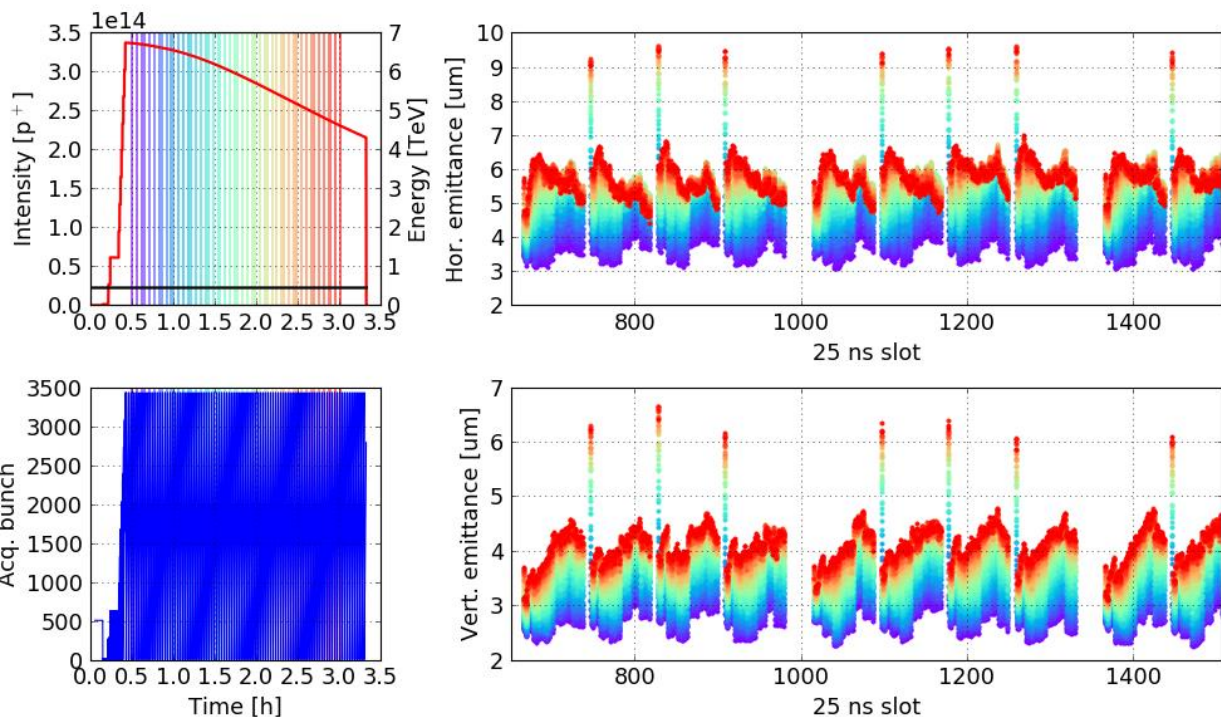


m rect, x=1.41472 y=2.59443

2017 scrubbing



Fill 5800: B2, started on Sun, 11 Jun 2017 01:00:17

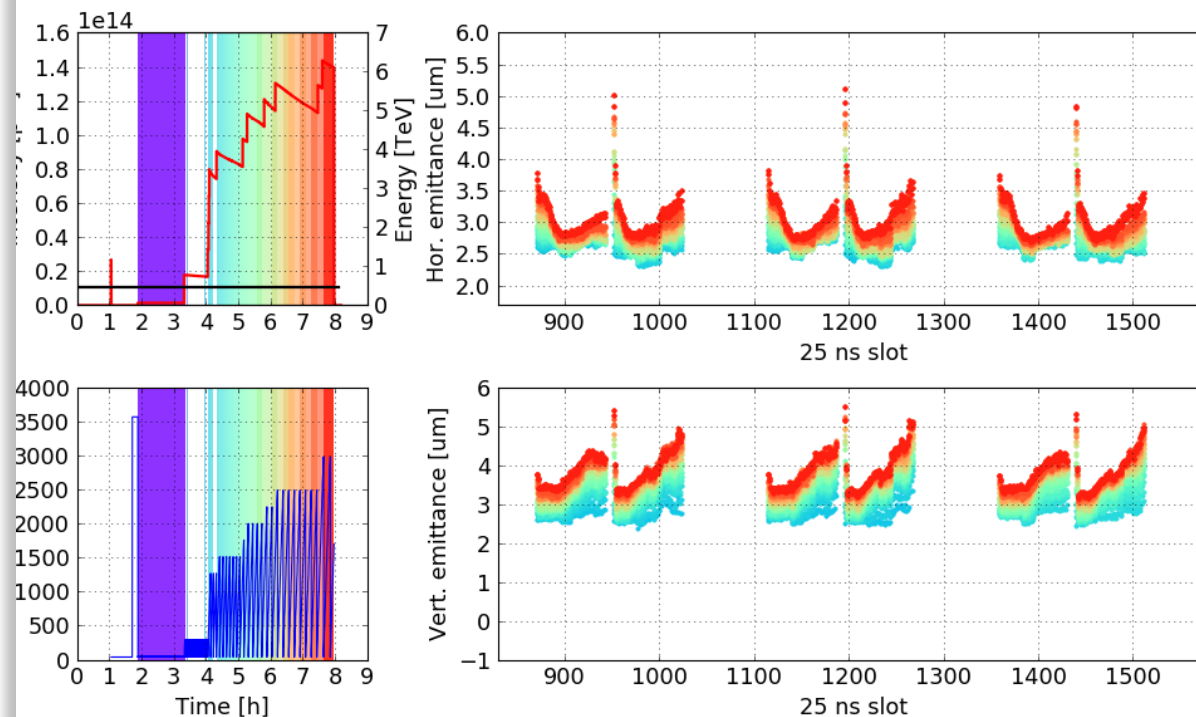


x=1.14093 y=2.82019

2015 scrubbing



Fill 4108: B2, started on Fri, 31 Jul 2015 13:18:57



m rect, x=1.84319 y=2.78794

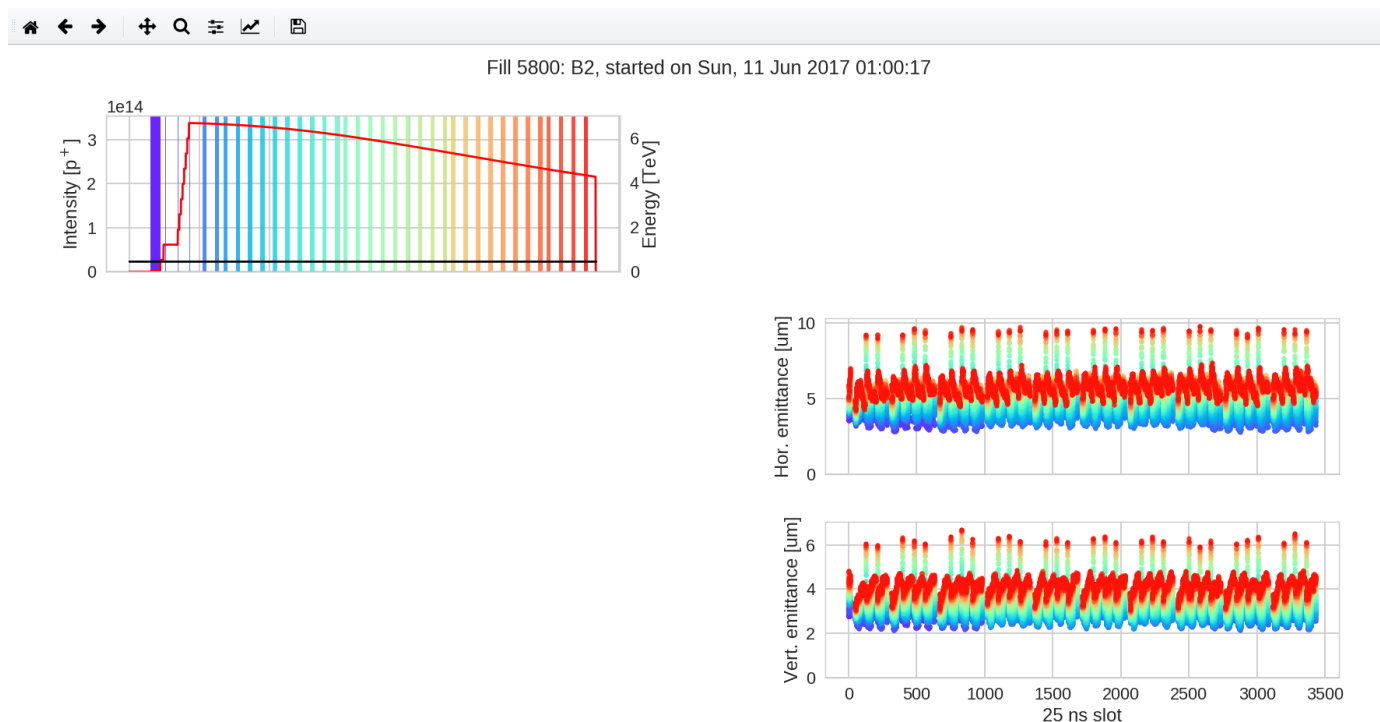
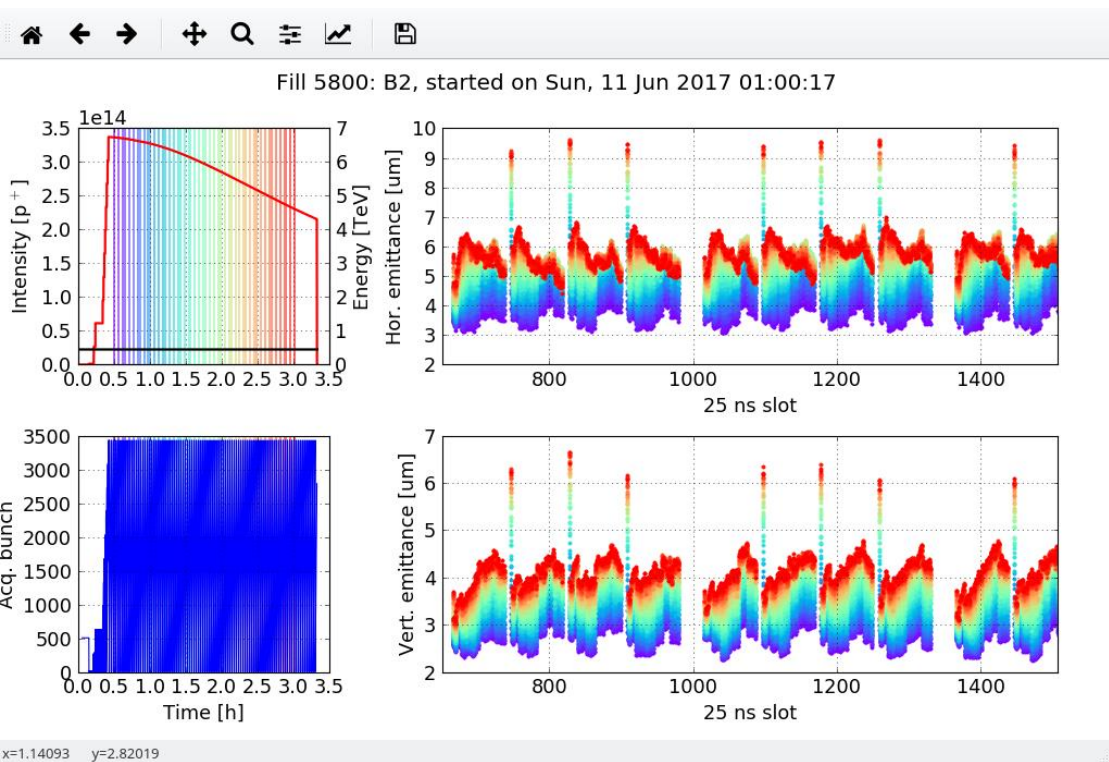
- Clearly first bunches of 72 bunch train (except for the first of the 288 bunch batch)
- Growth occurs only after a while



Arising questions

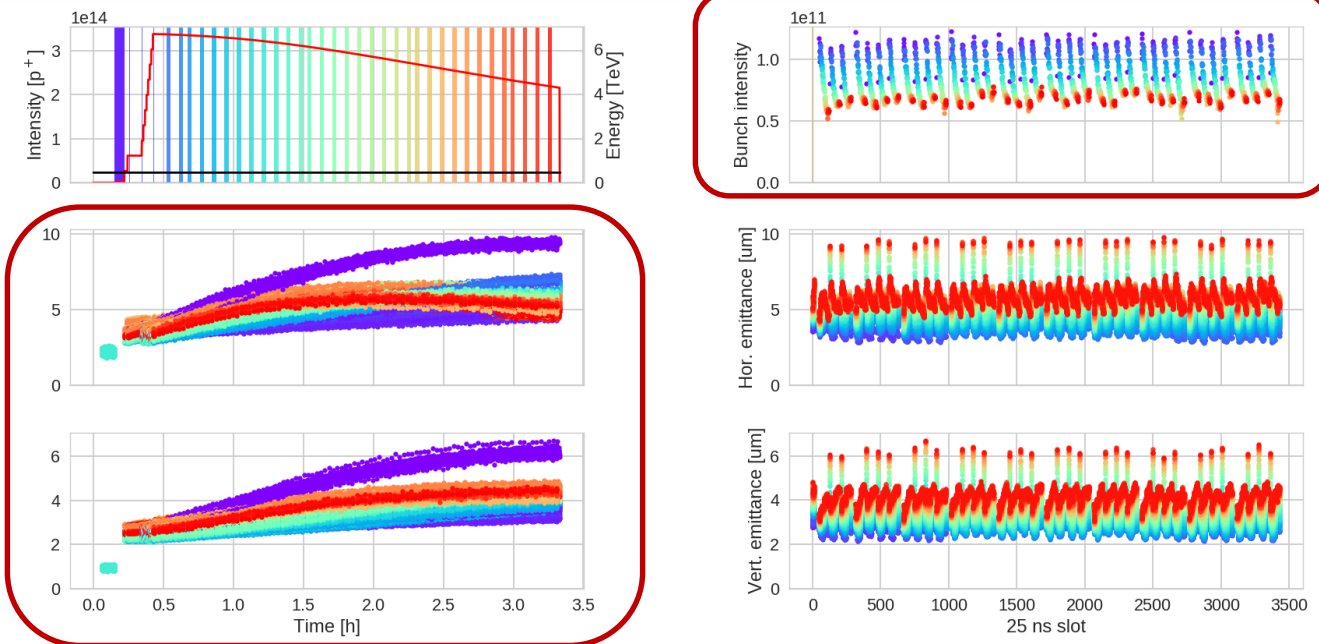
- Why this characteristic pattern?
- Was it there in 2016?
- What are the rise times?
- What is the impact of damper settings such as gain or bandwidth?
- What is the impact of the filling scheme?

→ Will not answer them here – but just give some first impressions.



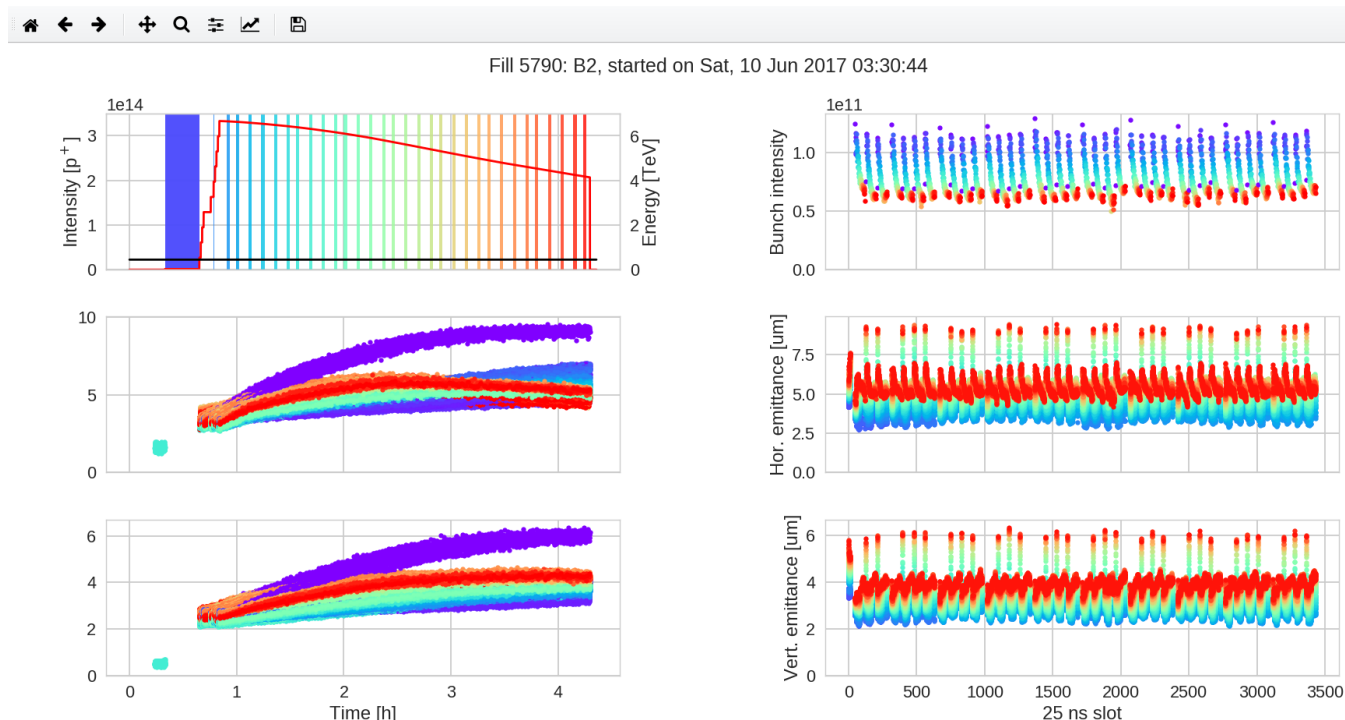
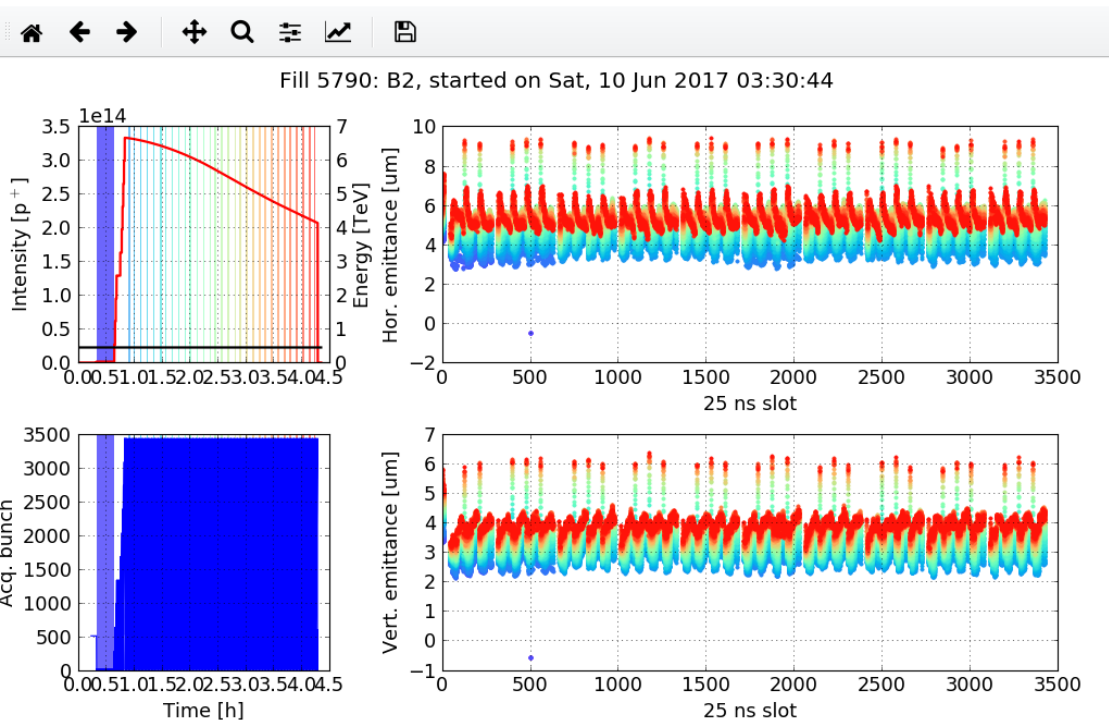
- Clearly first bunches take off with the effect becoming visible after **roughly 1 h** at injection.

-



- Clearly first bunches take off with the effect becoming visible after **roughly 1 h** at injection.
- The rate is roughly 1-2 um per hour.
- This was a fill with **reduced damper setting, i.e. gain at 0.1**. What happened to the fills with **higher gain**?

Impact of damper gain

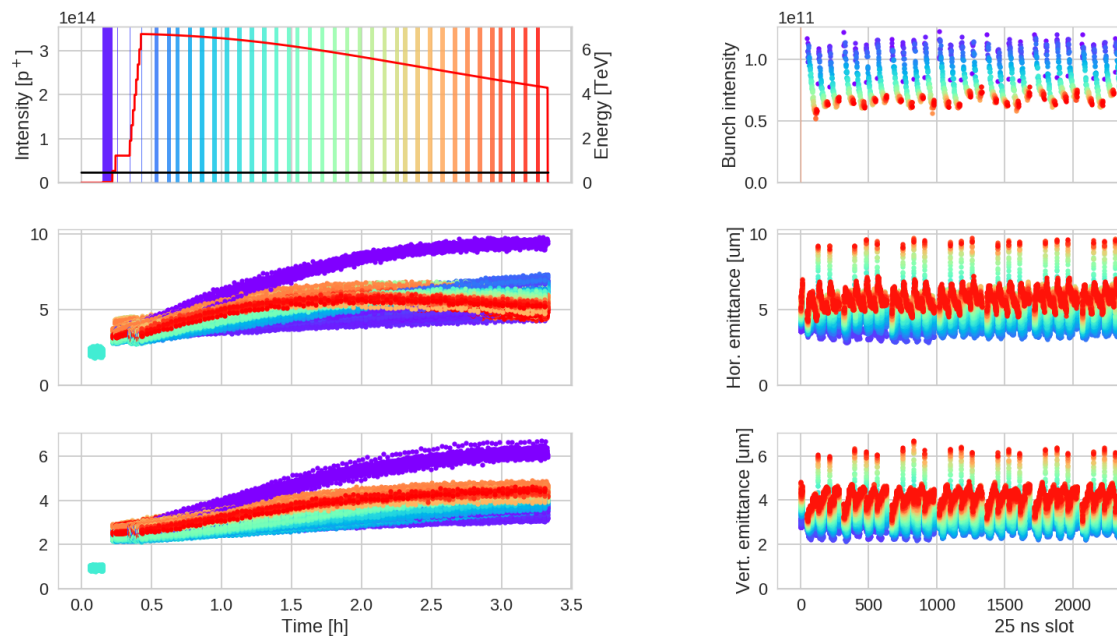


- Clearly first bunches take off with the effect becoming visible after **roughly 1 h** at injection.
- The rate is roughly 1-2 μm per hour.
- This was a fill with **reduced damper setting, i.e. gain at 0.1**. What happened to the fills with **higher gain**?

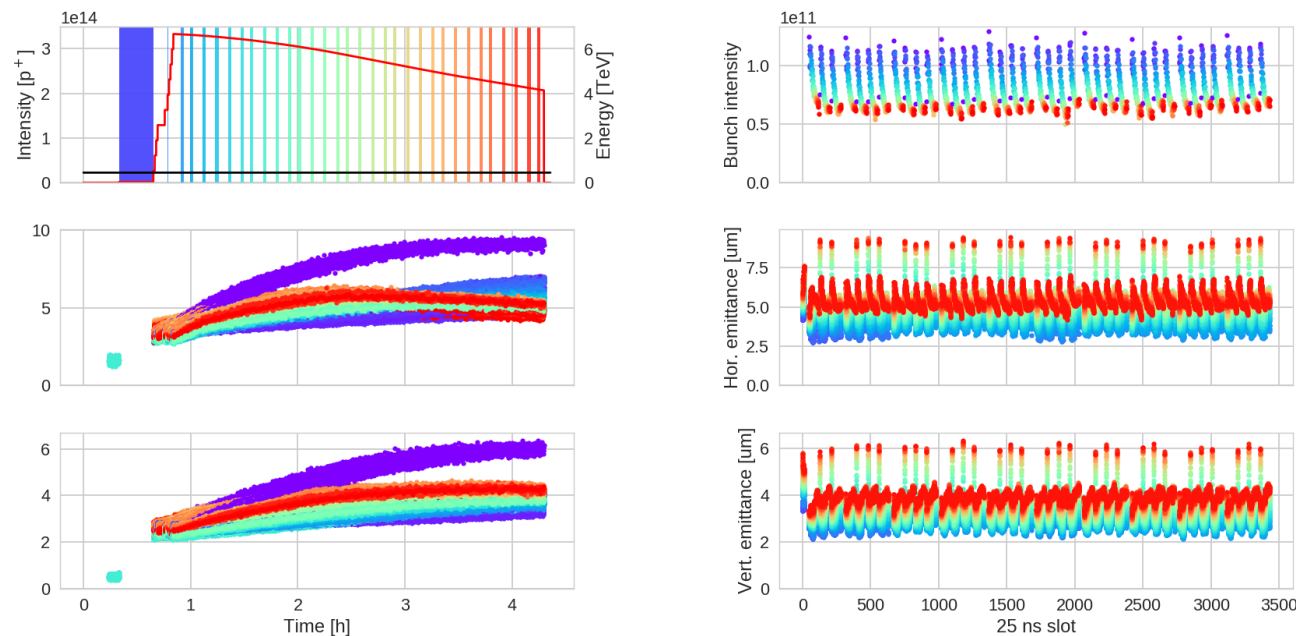
Impact of damper gain for better comparison



Fill 5800: B2, started on Sun, 11 Jun 2017 01:00:17



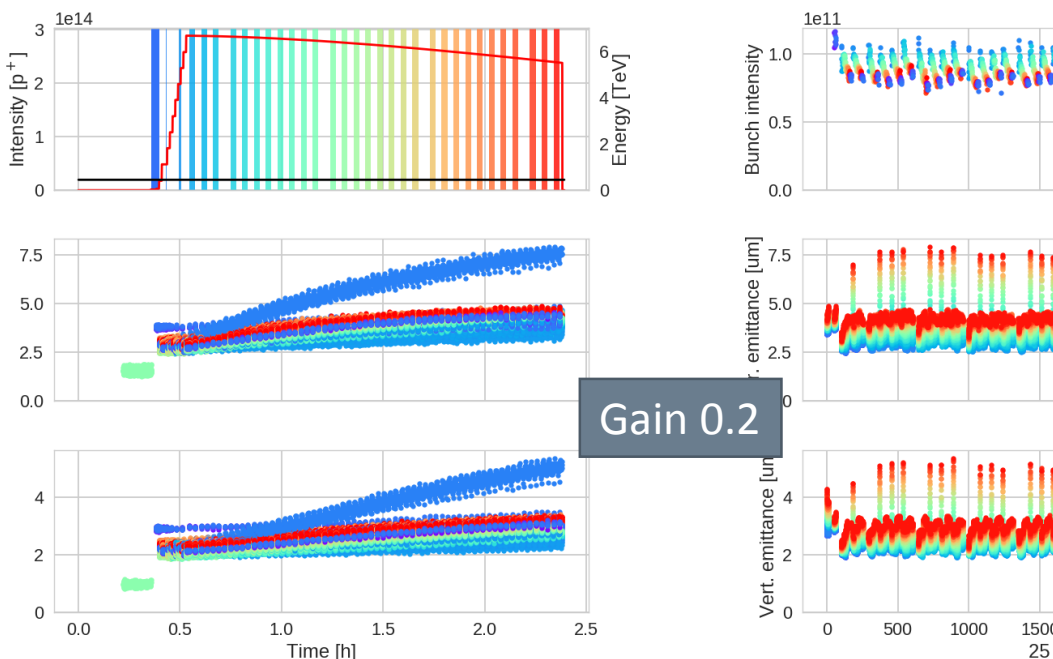
Fill 5790: B2, started on Sat, 10 Jun 2017 03:30:44



- Clearly first bunches take off with the effect becoming visible after **roughly 1 h** at injection.
- The rate is roughly 1-2 μm per hour.
- This was a fill with **reduced damper setting, i.e. gain at 0.1**. What happened to the fills with **higher gain**?
→ **not much of an impact** it seems
- Note though that these are just 2 fills for comparison. The damper gain was set back to 0.2 after this fill.

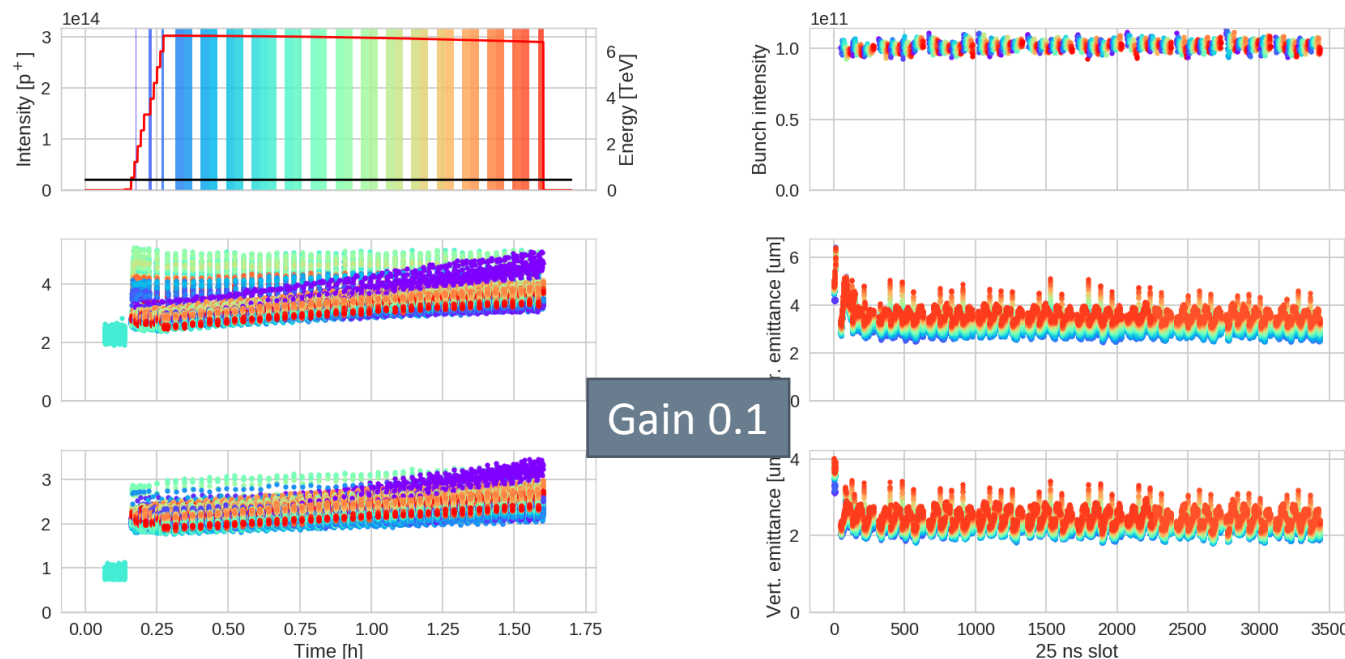
Impact of damper gain – another example

Fill 5812: B2, started on Sun, 11 Jun 2017 13:22:11



Gain 0.2

Fill 5819: B2, started on Mon, 12 Jun 2017 04:04:27

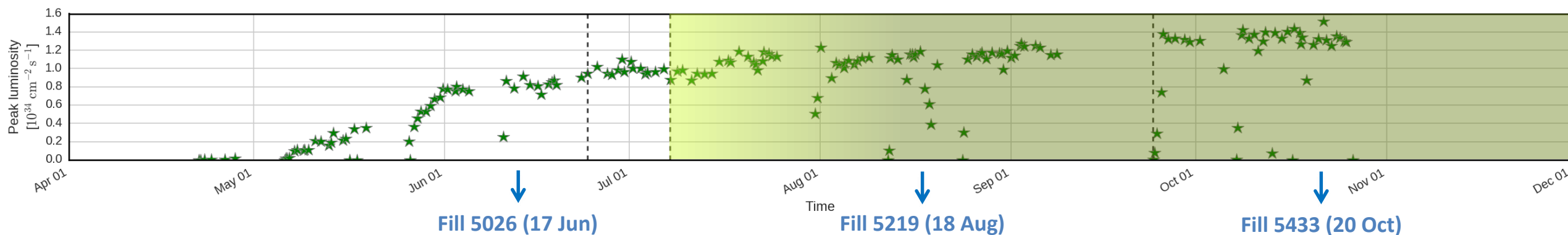


Gain 0.1

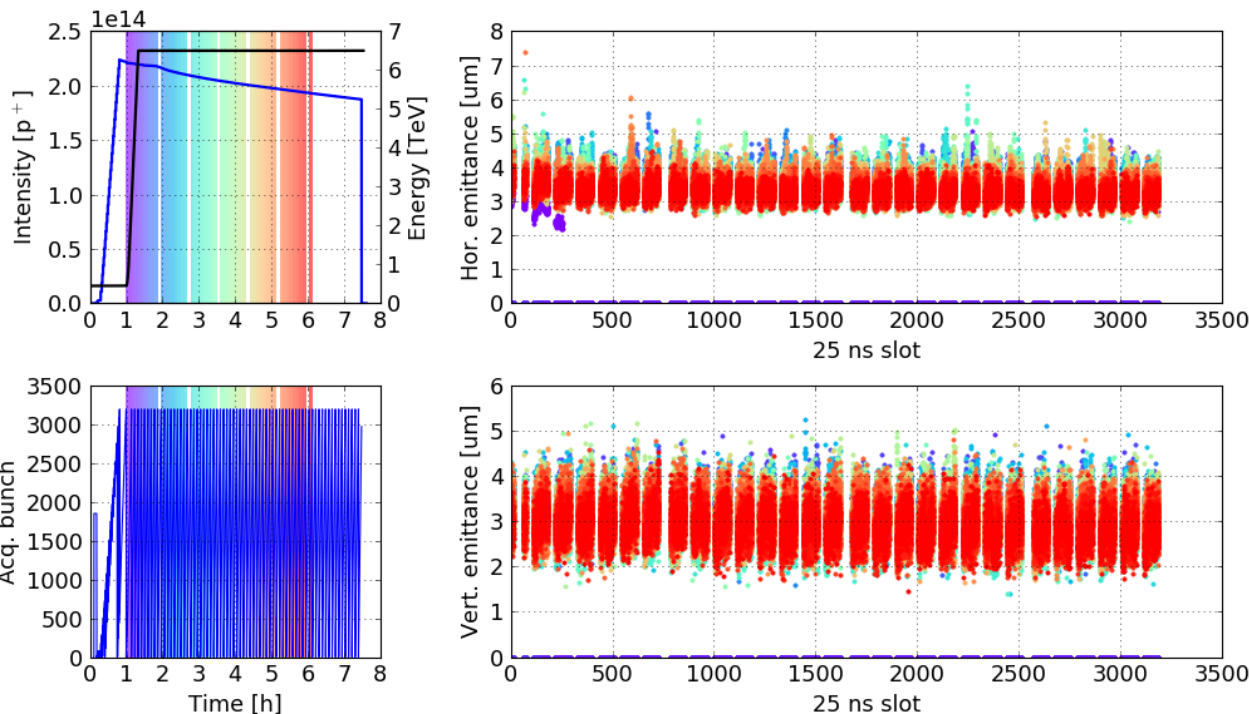
- Clearly first bunches take off with the effect becoming visible after **roughly 1 h** at injection.
- The rate is roughly 1-2 μm per hour.
- This was a fill with **reduced damper setting, i.e. gain at 0.1**. What happened to the fills with **higher gain**?
→ **not much of an impact** it seems
- Note though that these are just 2 fills for comparison. The damper gain was set back to 0.2 after this fill.

What about 2016?

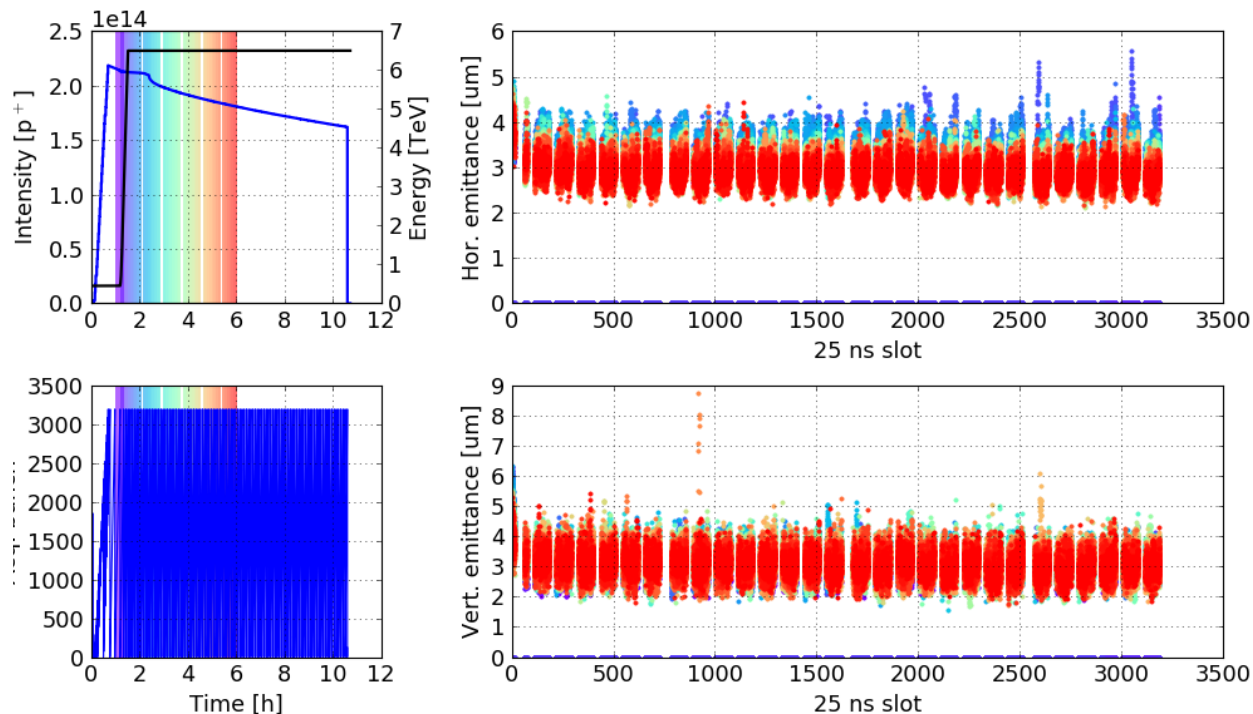
- We know we need to be at injection for some time (~ 1 hour) to see the effect – **scrubbing in 2016 was rather short...!**
- Reference fills have only 72 bunches...



Fill 5219: B1, started on Thu, 18 Aug 2016 22:31:39



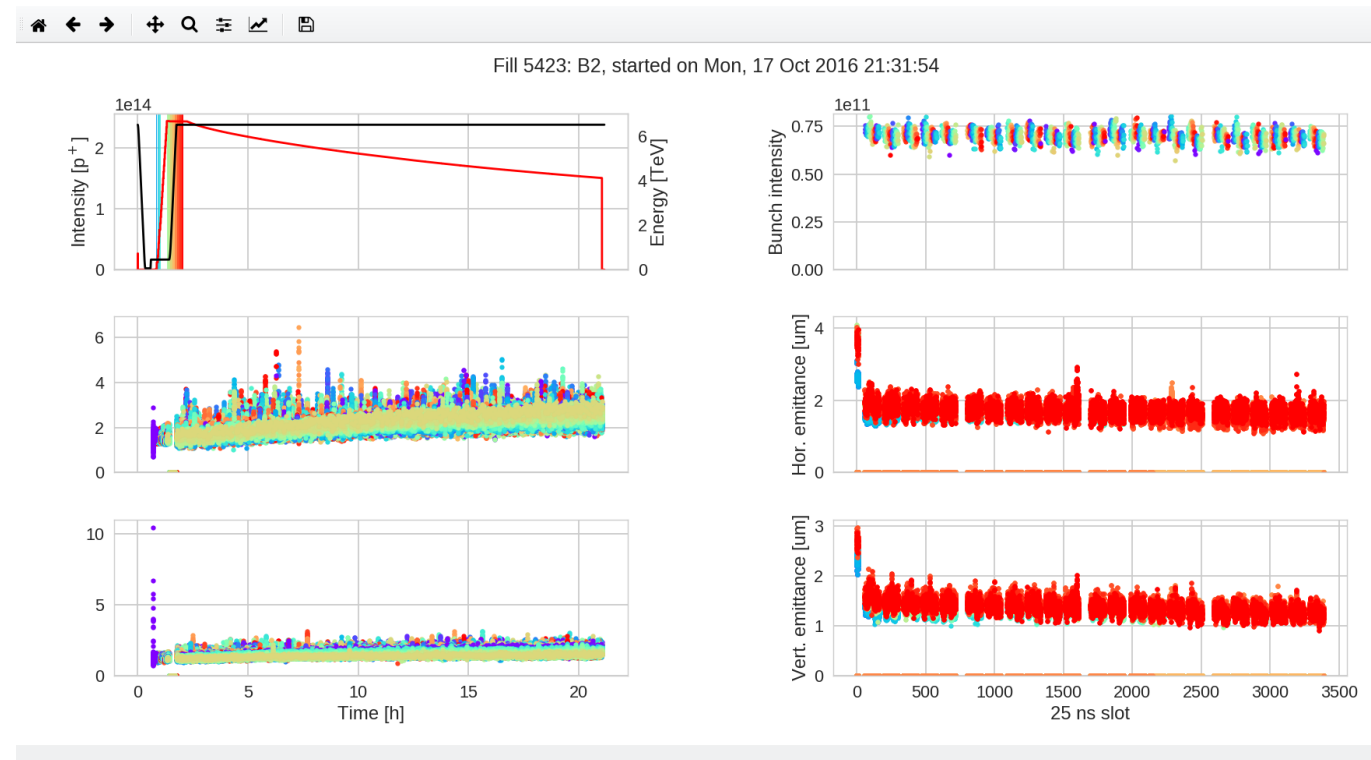
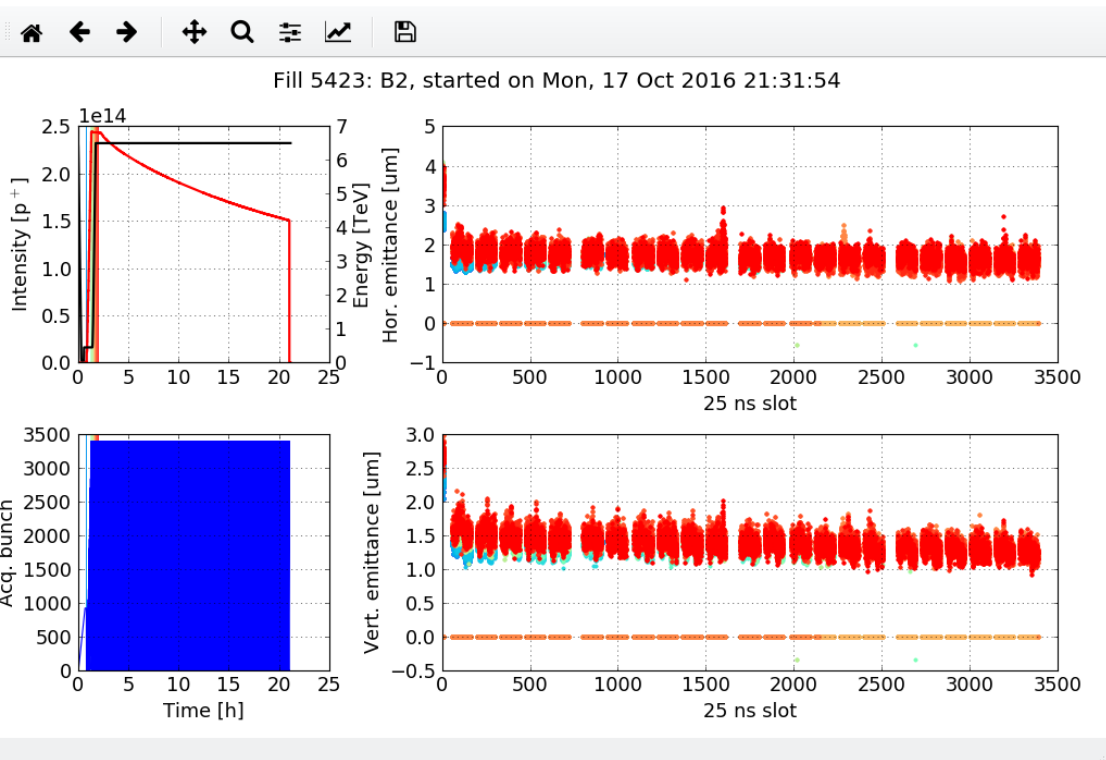
Fill 5433: B1, started on Wed, 19 Oct 2016 22:26:07



x=3476.51 y=5.49014

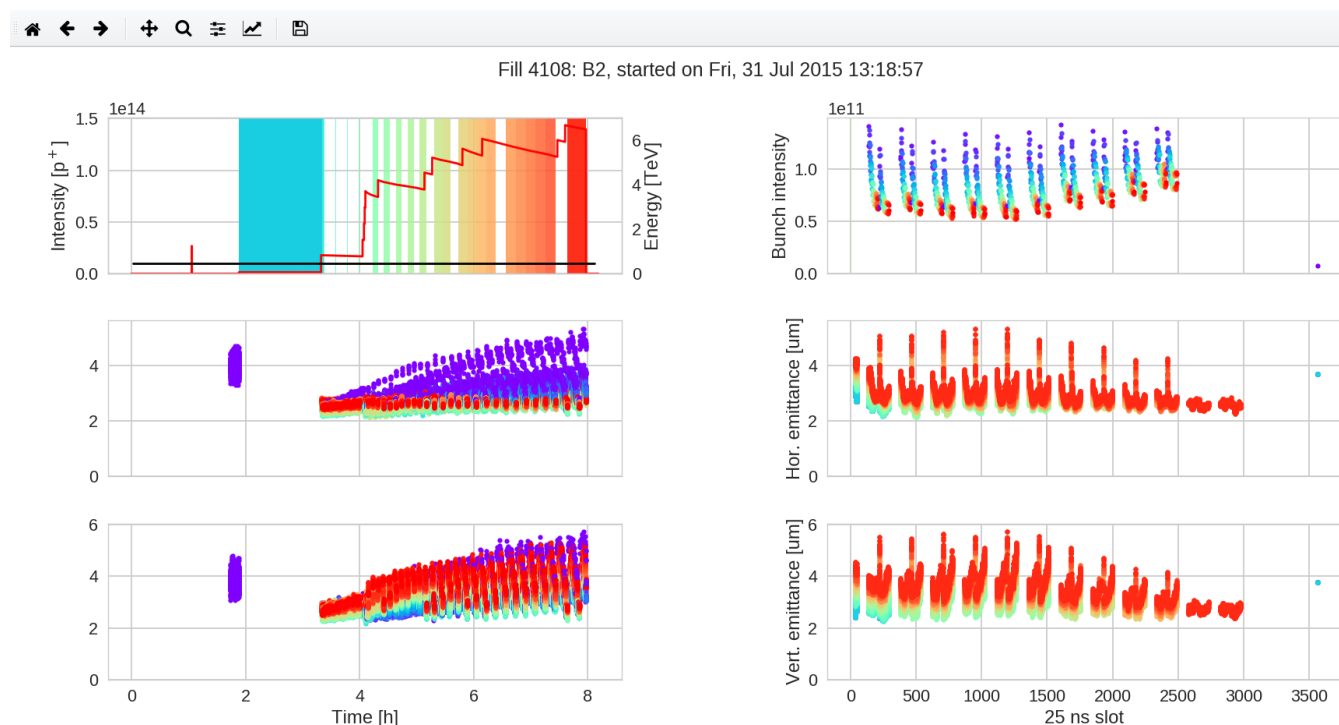
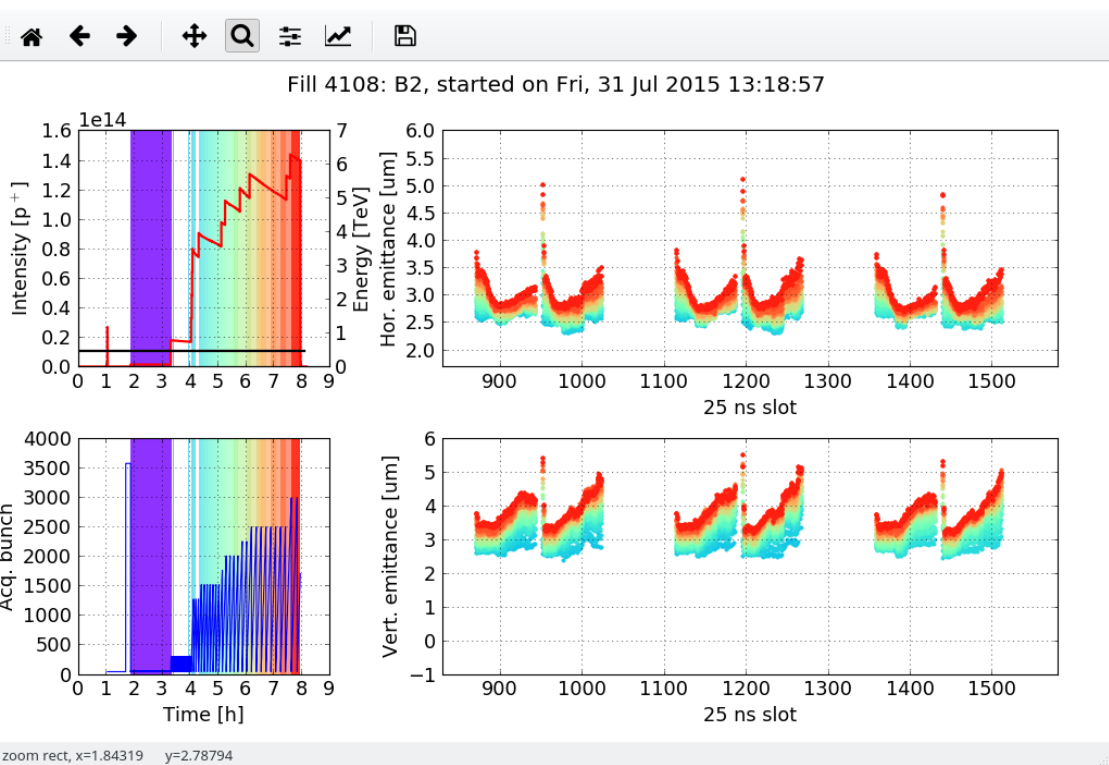


- As expected, with 72 bunch batches, the effect is **not visible** in the reference fills from 2016.



- Moreover, the effect is **not visible** in the physics fills (some representative ones – not all) from 2016. Of course the **time at injection was usually limited** and below the required 1 hour.

And the 2015 occurrences?



- Behaviour in 2015, instead, **very similar** – though not as clean.
- Often perturbed by bunch still blowing up towards end of batches due to e-cloud.

- The effect is clearly visible in 2015 and in 2017.
- Effect is visible after roughly **an hour** at injection.
- Emittance rise times are in the range of **1-2 um per hour**.
- The damper gain **does not seem** to have a significant impact on the behaviour.
- Open questions:
 - What is the impact of damper bandwidth?
 - What is the impact of filling schemes?
 - Would be good to get some more statistics as well...