Test of the BBC at 450 GeV: preliminary results

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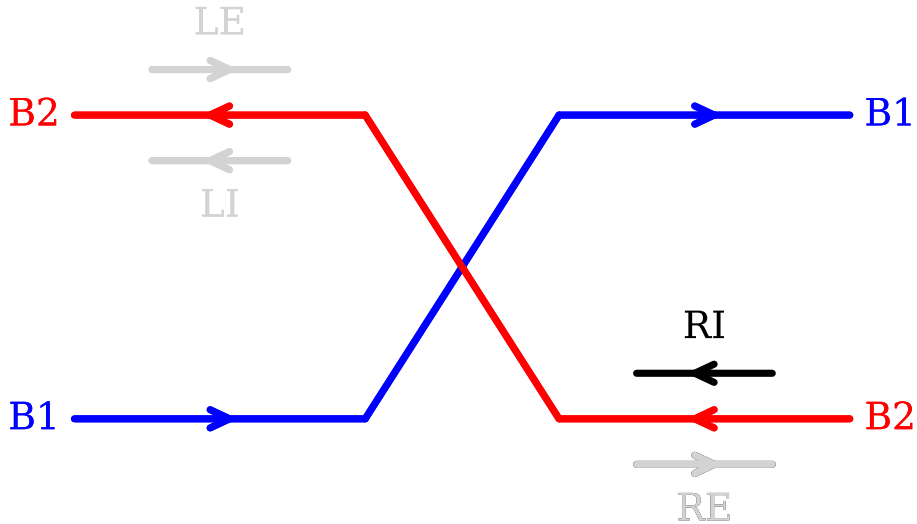
and the BBC team

May 12, 2017

Goal of the test

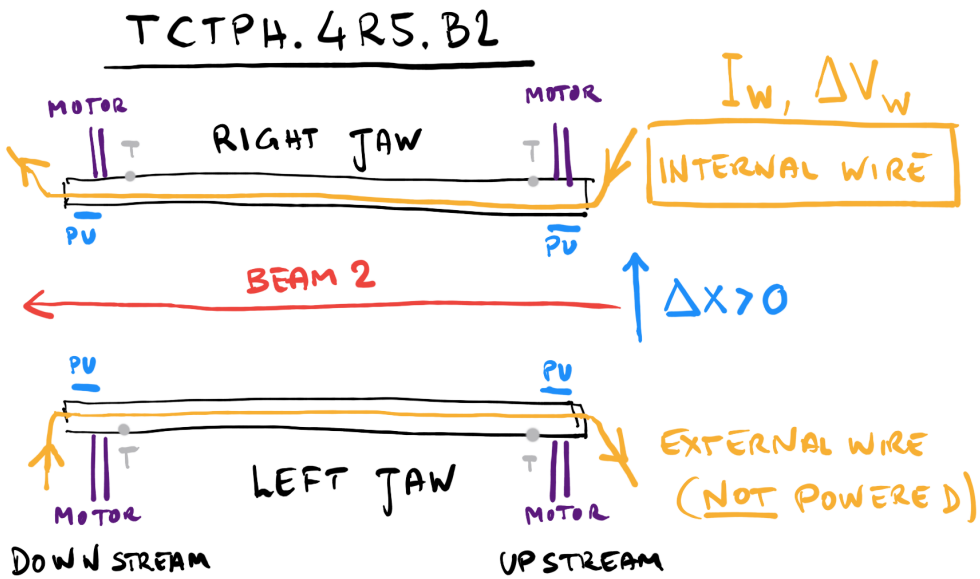


- Align vertically the beam to the wire.
- Check dipolar and quadrupolar response as function of current and beam-wire distance.

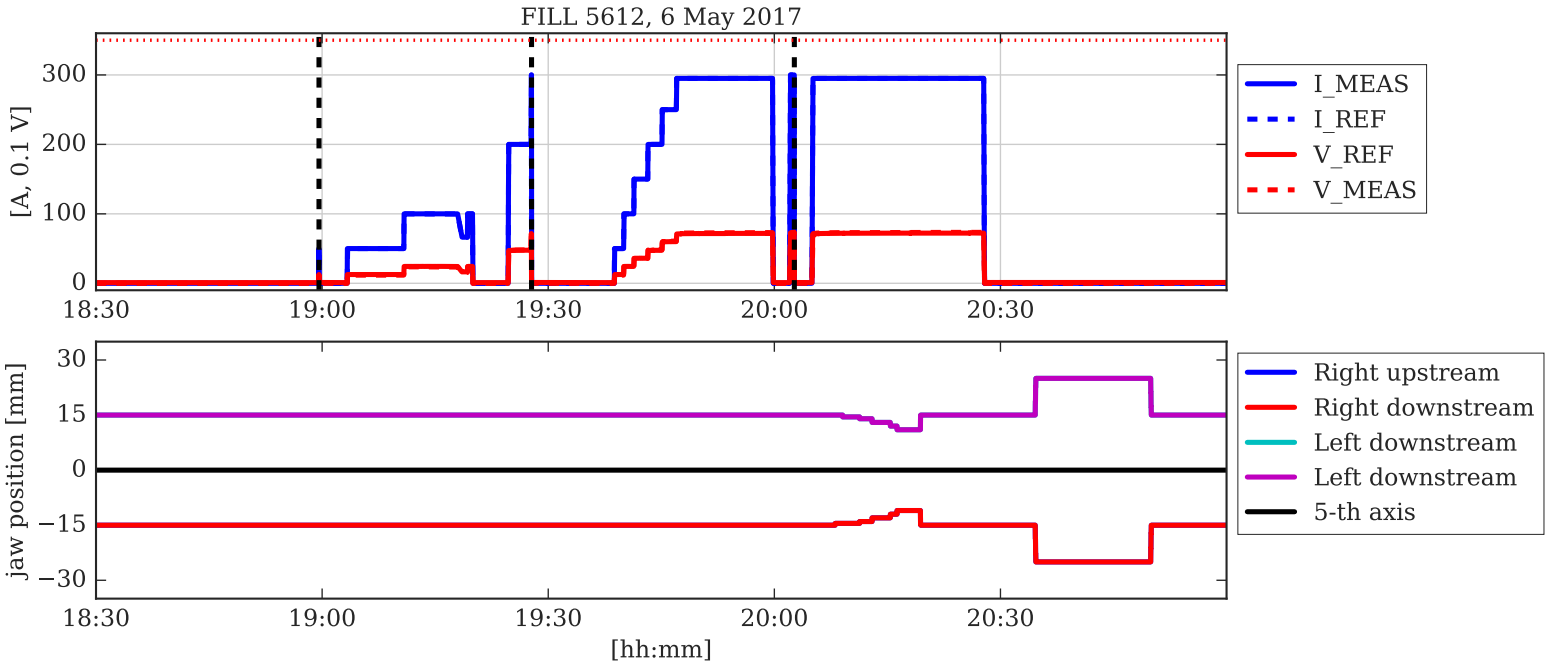
This test was performed for the right wire of IP5 (right jaw of the TCTPH.4R5.B2).

Descriptions of the test conditions

- FILL 5612, 6th May 2017 late afternoon: 2 h with B2. B1 used by another team.
- Injection energy, orbit and Q feedback OFF.
- 3 bunches of $6 - 8\ 10^9$ ppb.
- $\epsilon_{xn} \approx 2$ and $\epsilon_{yn} \approx 1$ mm mrad.
- for $I_w > 0$ (presently $I_w^{MIN} = 0$ A) the B2 has to be attracted by the internal wire.

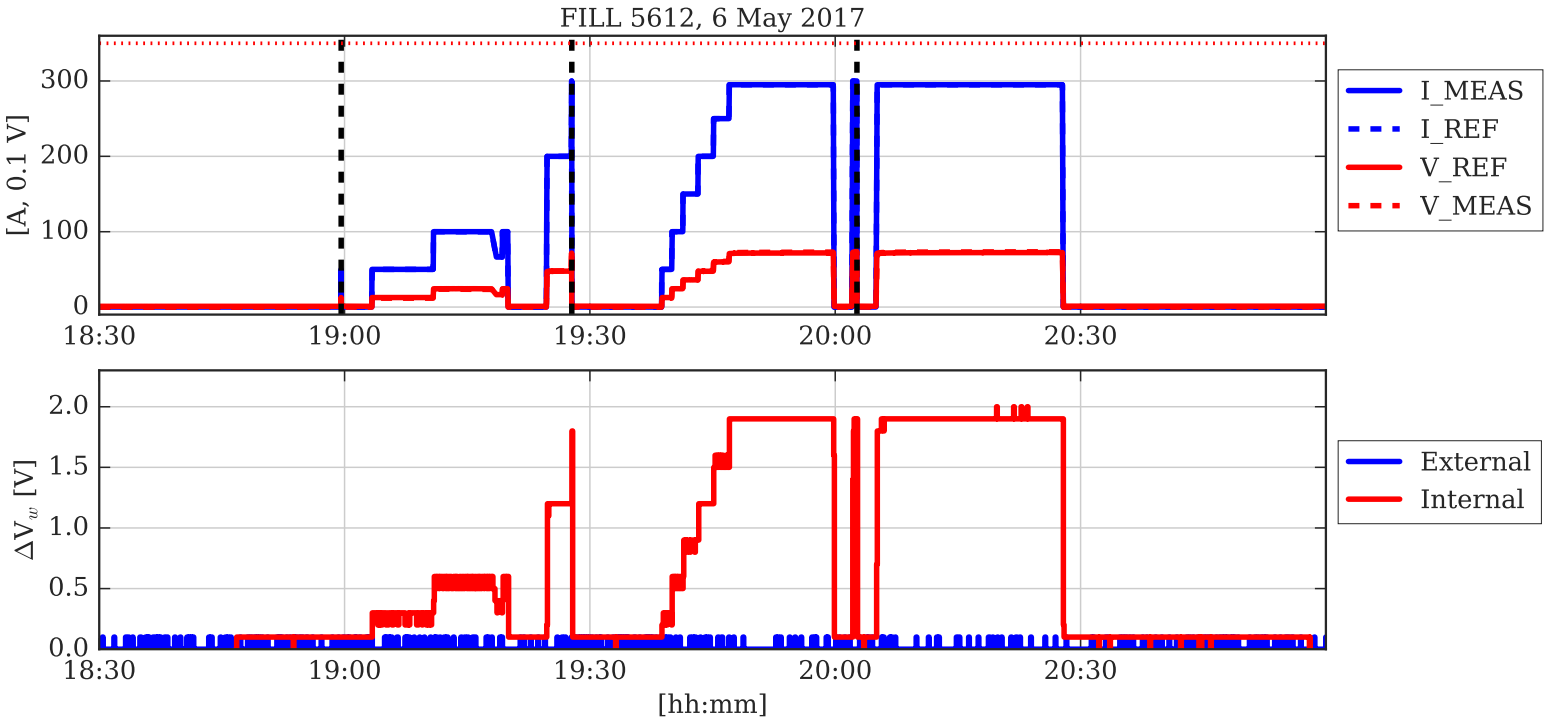


I_w scan and position scan



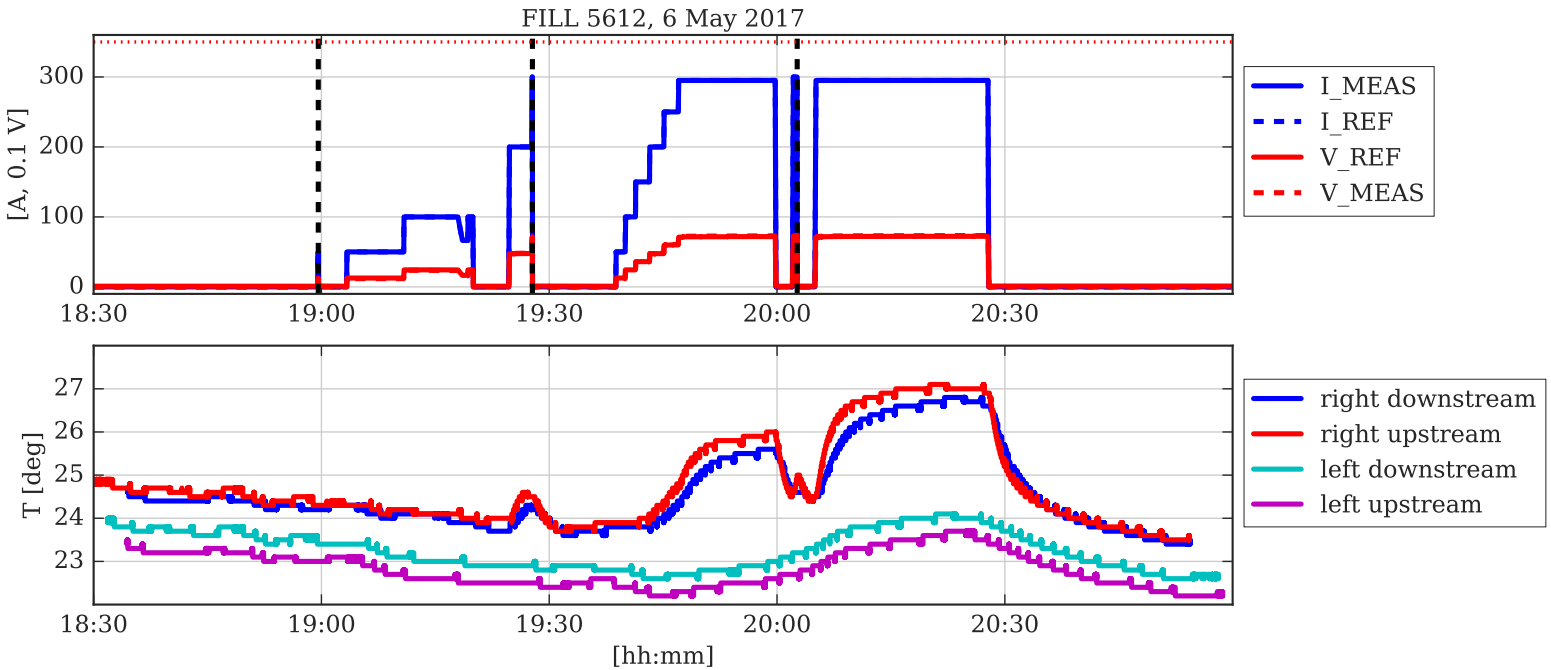
- First part of the test with 30 mm gap and I_w scan up to $I_w = 300$ A.
- Second part of the test with $I_w = 300$ A and reducing the gap down to 22 mm.
- Note different convention of the jaw position wrt PU reading.

Checks on the SW and HW interlocks



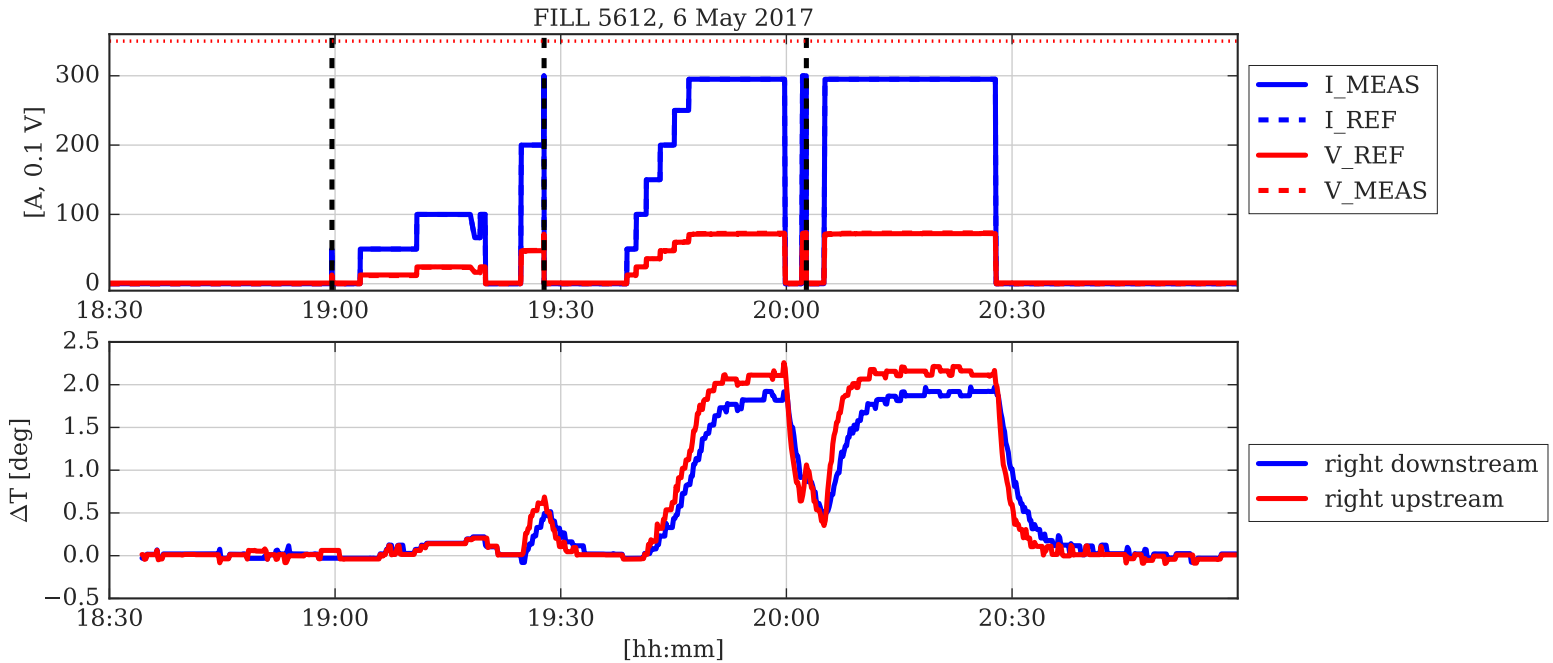
The SW interlock triggered 3 times. All triggers are fully understood. The HW interlock is set $\Delta V_W^{thres} = 2.9$ V. We operated at $\Delta V_W = 2$ V.

ΔT of the jaws



During the test we monitor constantly the temperature of the jaws. The observed $\Delta T_{MAX} = 2$ deg as expected from workshop measurement and simulations. No special vacuum activity was observed during the full test.

ΔT of the jaws



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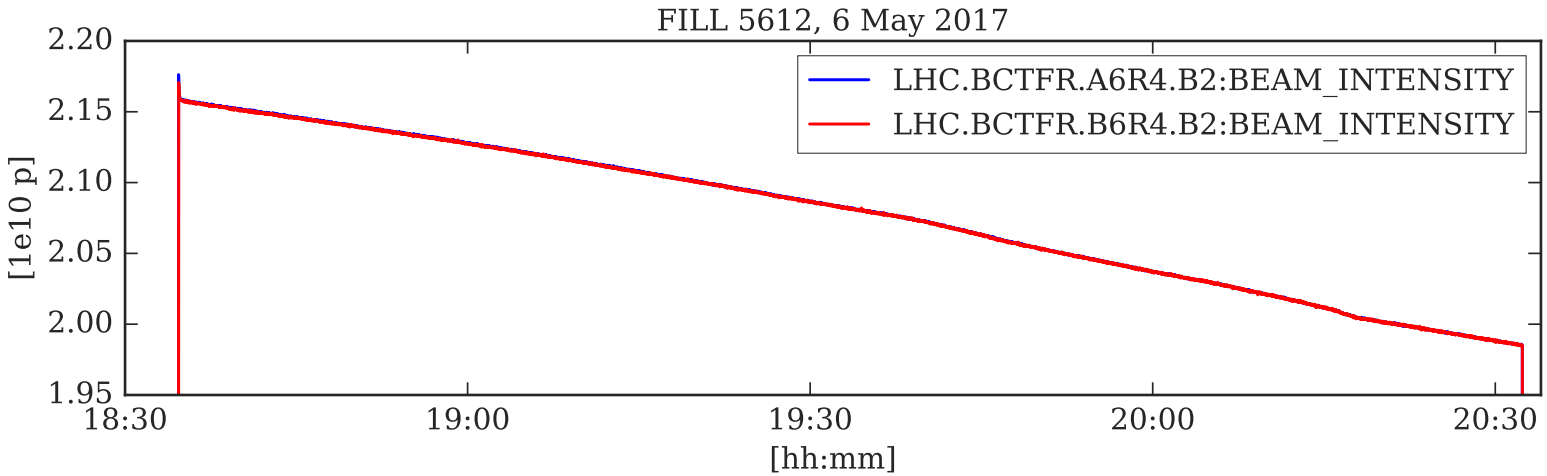
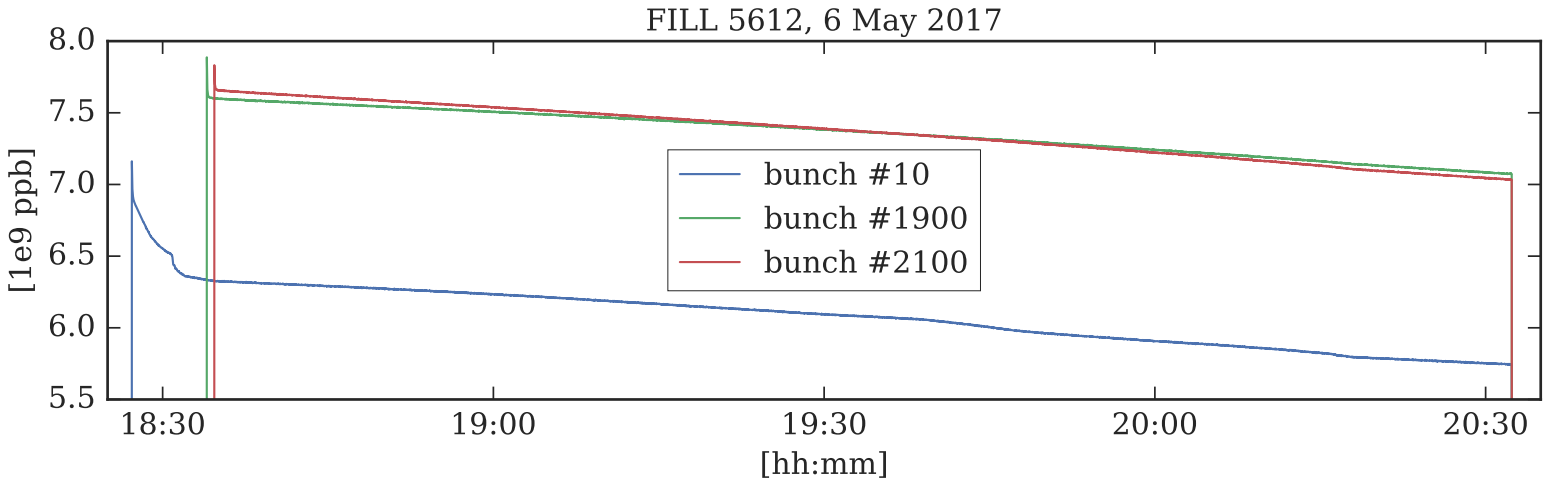
Bunch intensity



There were three pilots in the machine. We maintain the same beam until the end of test. The bunch #10 was suffering more than the others.

Bunch intensity



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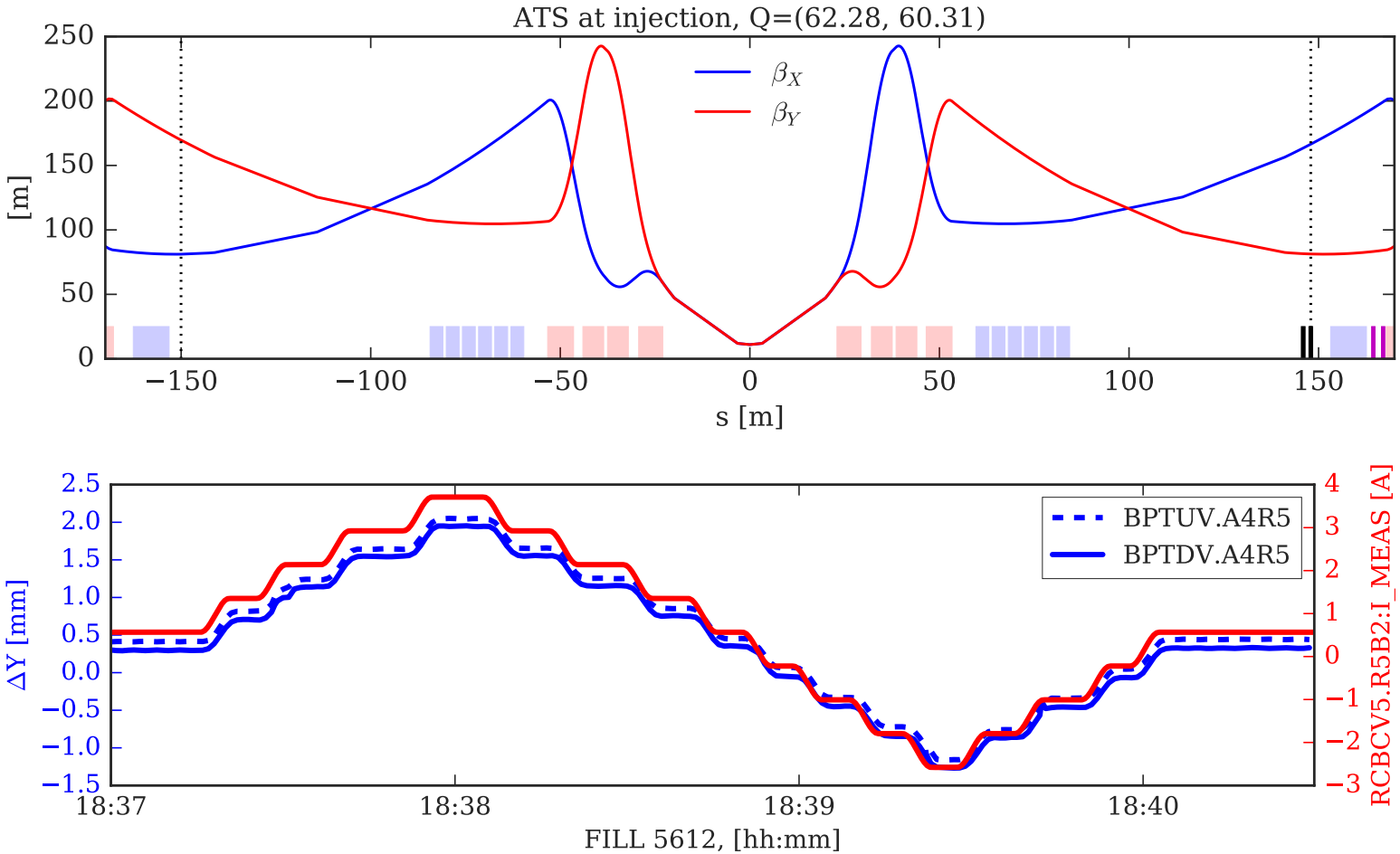
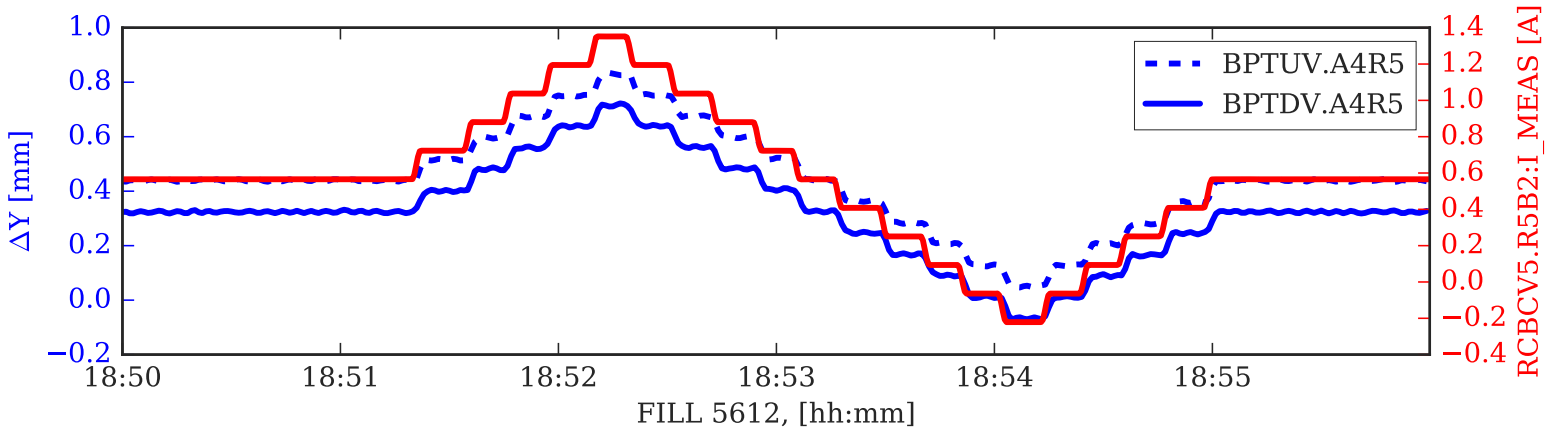
Vertical alignement



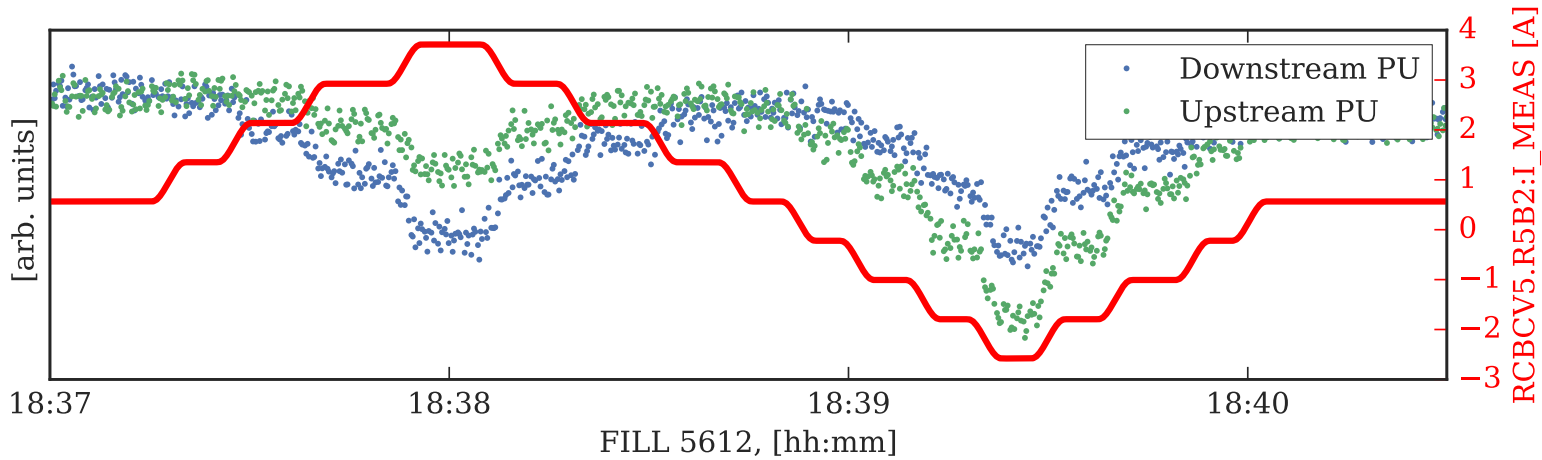
Since we could not use the 5th axis we move vertically the beam.
We programmed a V bump from 2 mm at the wire.

Vertical alignement



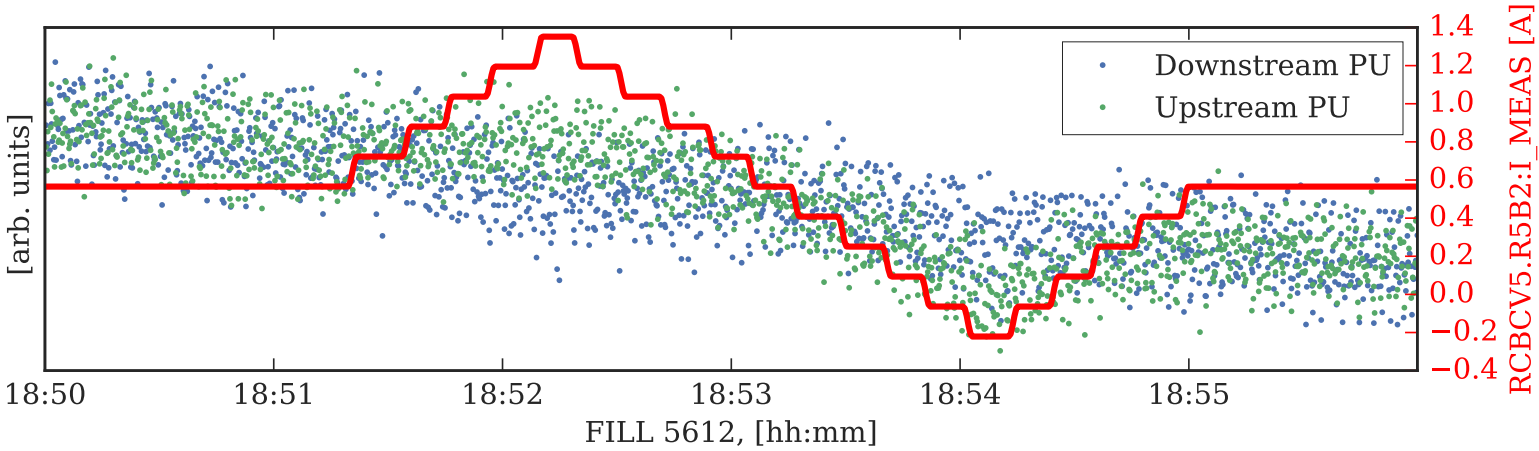
And we programmed a V bump from 0.5 mm at the wire to check the resolution of the approach.

Vertical alignement



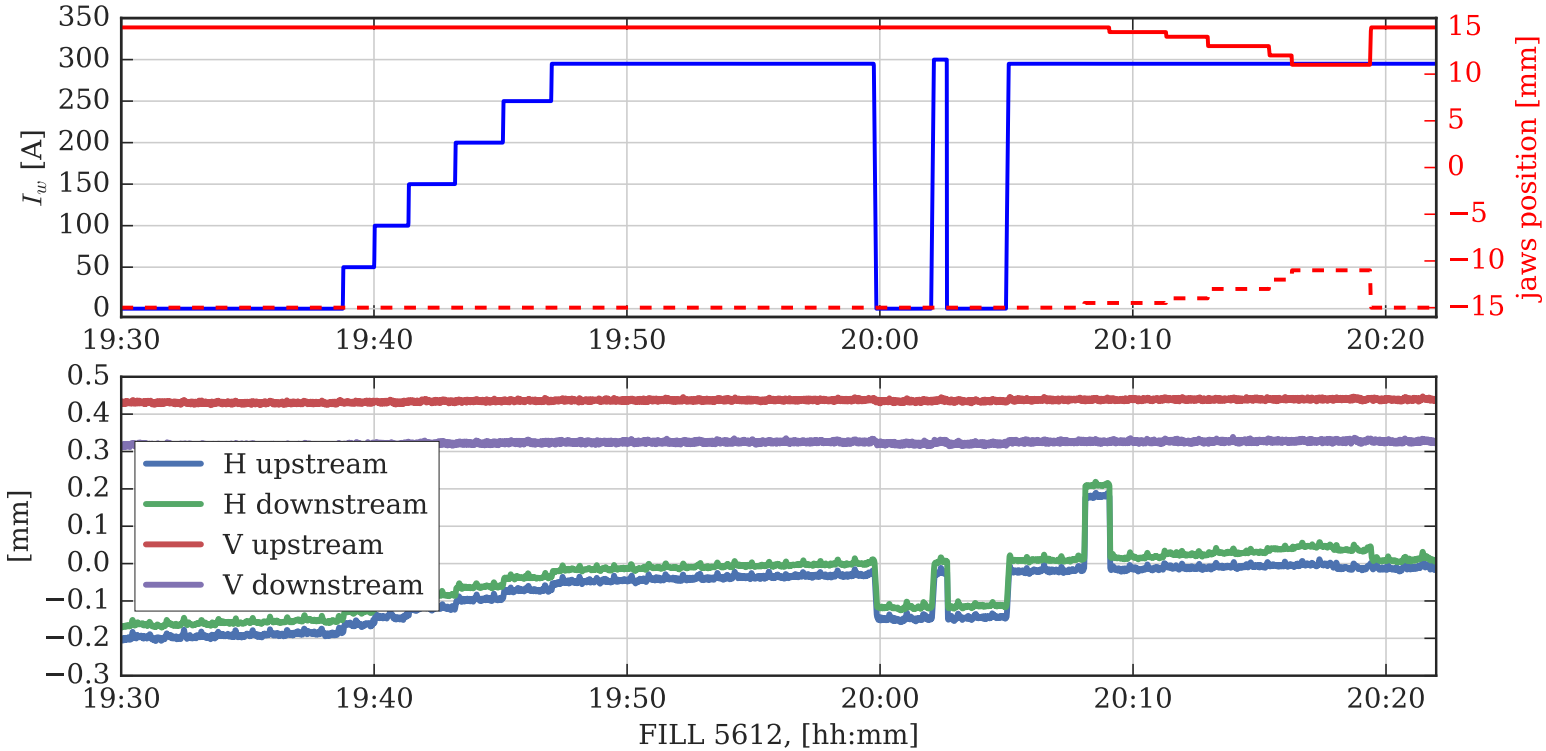
The beam is centred if the sum signal on the H PUs of the BBC is maximized. We noticed that the beam was almost centred vertically. To note the difference in the maxima position of the downstream and upstream PU.

Vertical alignement



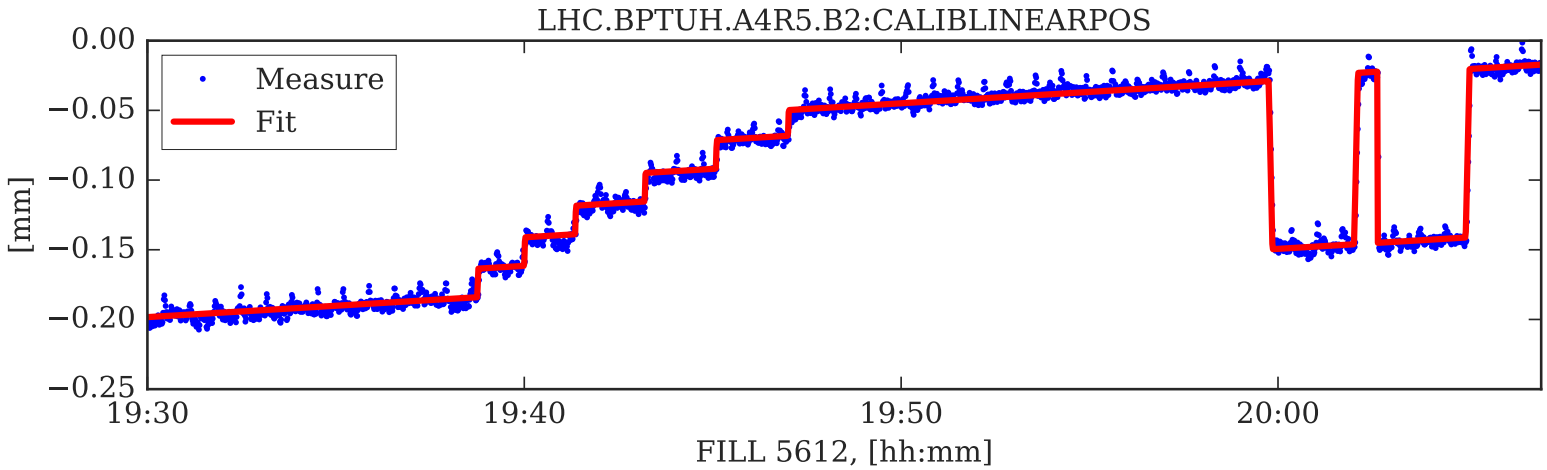
With the 0.5 mm bump the signal is too noisy.

Orbit vs I_W



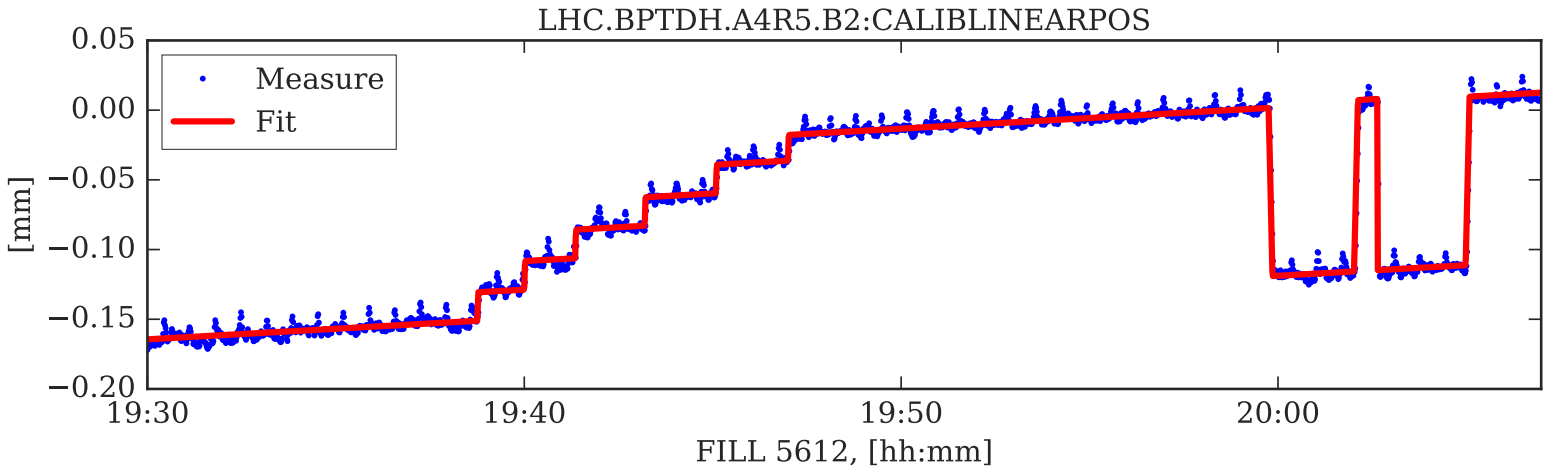
Visible effect of the beam position. Let's quantify it.

Orbit vs I_W



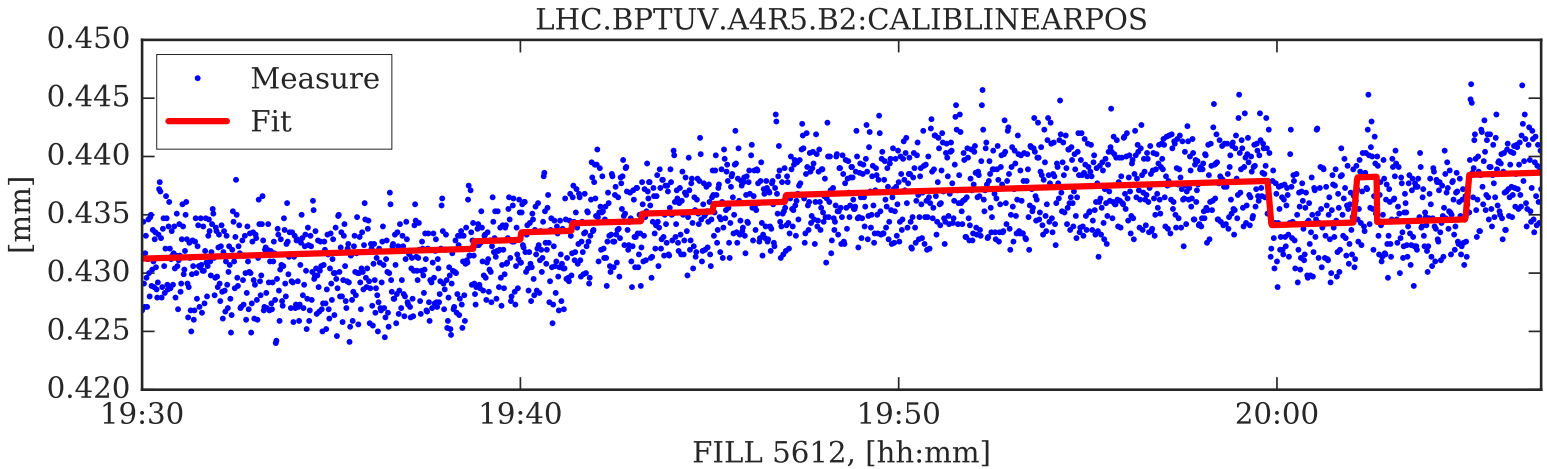
We fit the measurement point with a simple 2 parameters linear model (linear in time due to the drift and wrt the wire current). From the fit: ΔX_{up} at $I_W = 300$ A and $x_w = 18.3 \mu m$ is 122.8 μm (expected 164 μm).

Orbit vs I_W



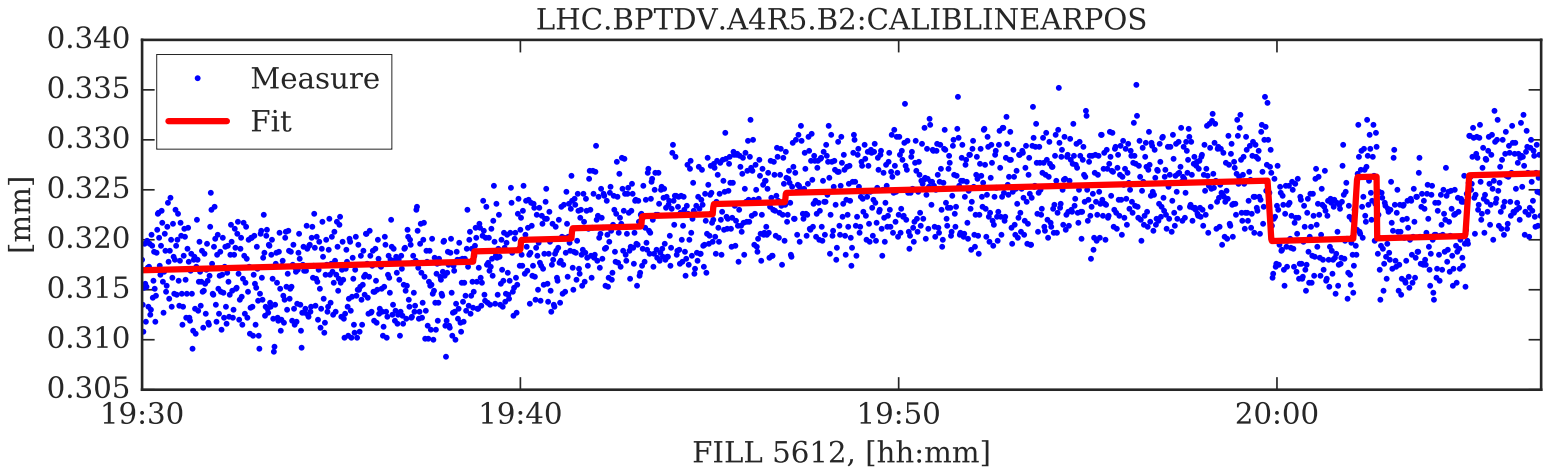
From the fit: ΔX_{down} at $I_W = 300$ A and $x_w = 18.3$ μm is 122.8 μm (expected 164 μm). Observable drift.

Orbit vs I_W



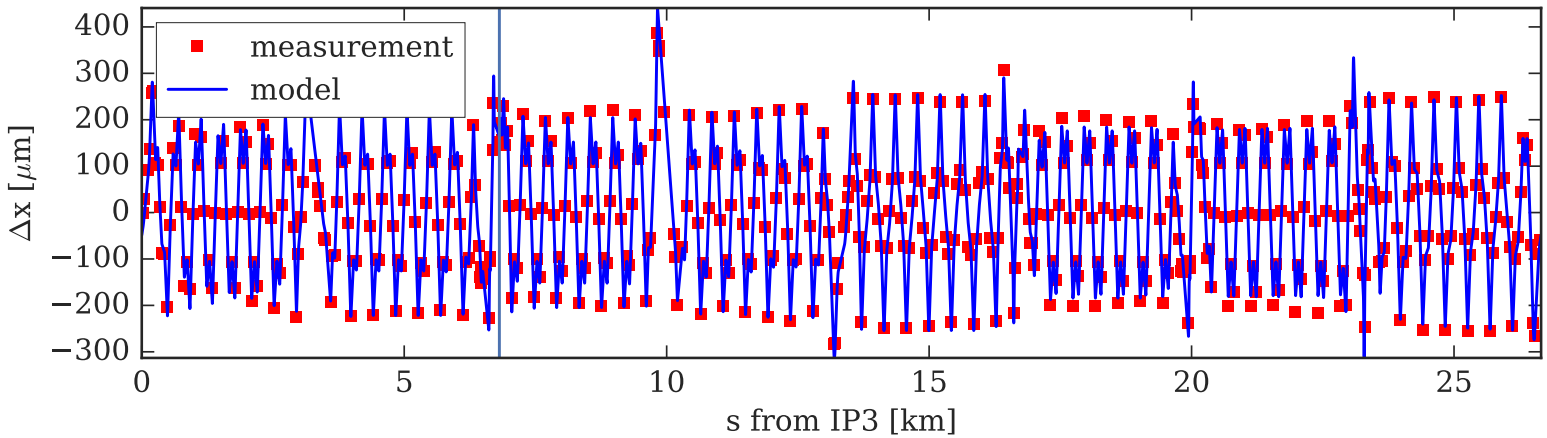
From the fit: ΔY_{up} at $I_W = 300$ A and $x_w = 18.3\mu$m is 3.9 μm (expected 0 μm). Very limited drift.

Orbit vs I_W

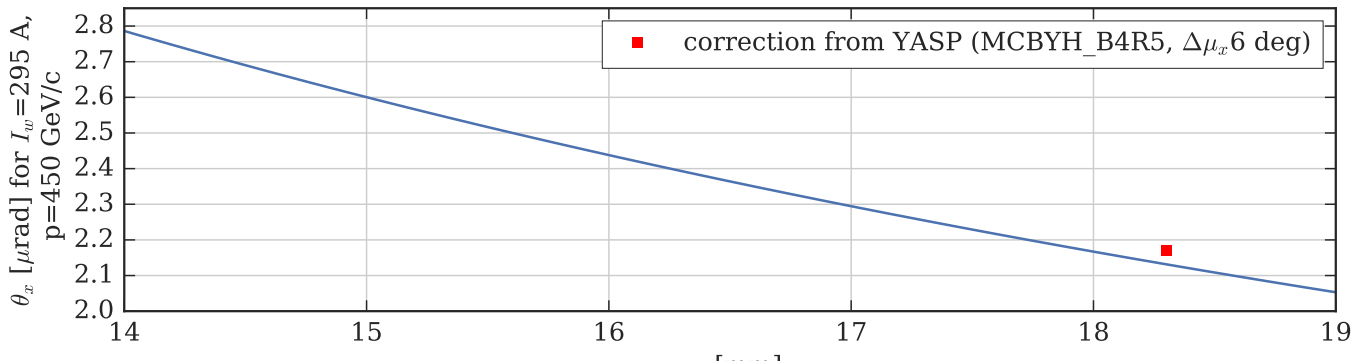


From the fit: ΔY_{down} at $I_W = 300$ A and $x_w = 18.3\mu$m is 6.1 μm (expected 0 μm). Very limited drift.

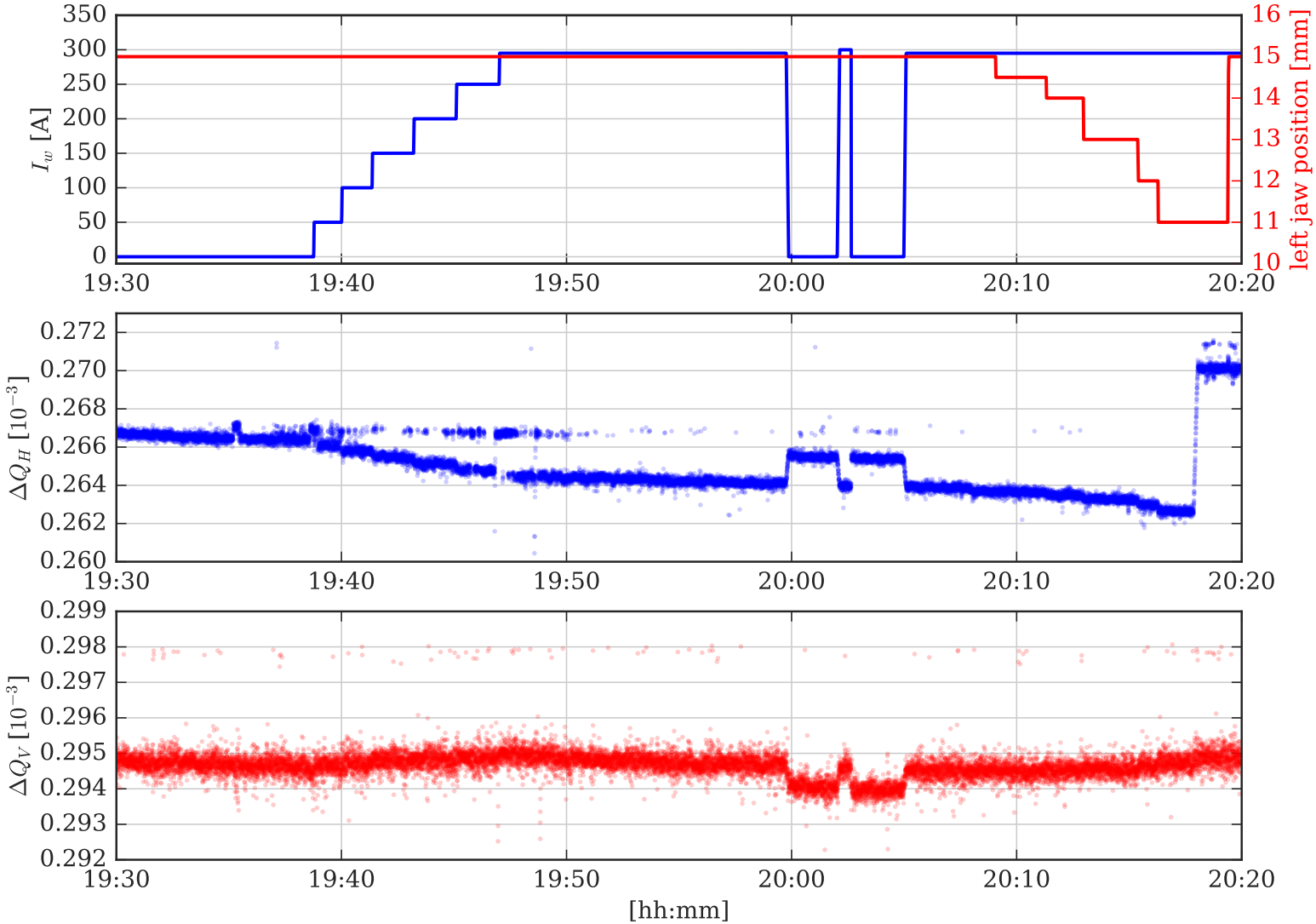
Orbit vs I_W


measurement
model
400
300
200
100
0
−100
−200
−300
Δx [μm]
0
5
10
15
20
25
s from IP3 [km]

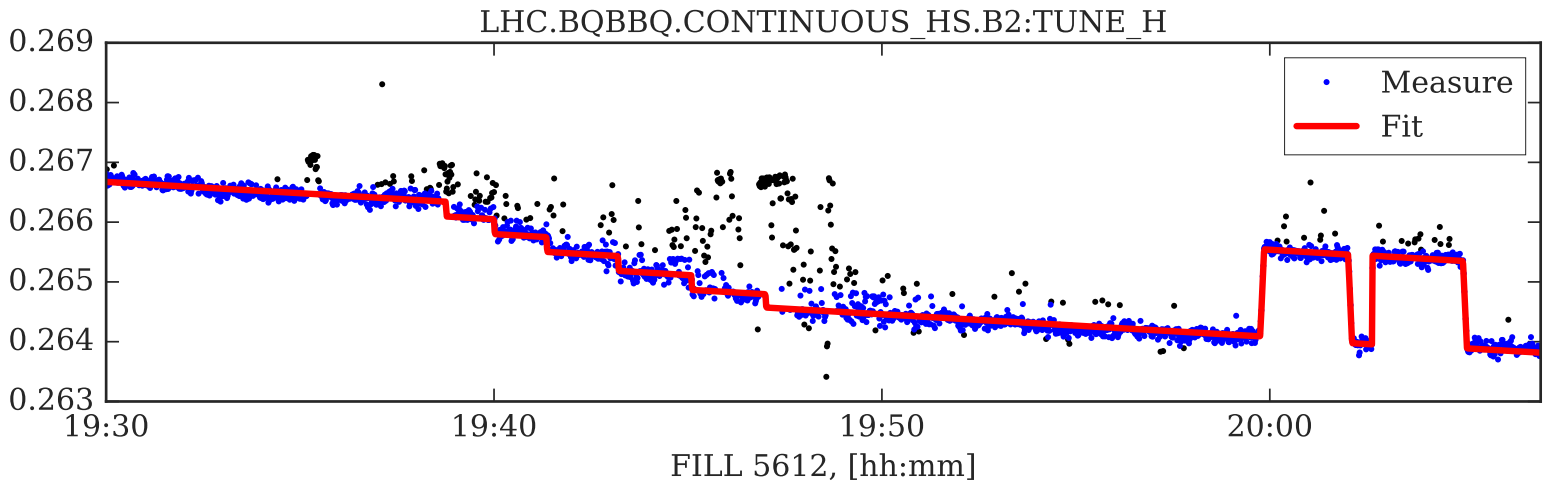
Orbit vs I_W


correction from YASP (MCBYH_B4R5, $\Delta\mu_x$6 deg)
θ_x [μrad] for I_w=295 A, p=450 GeV/c
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
14
15
16
17
18
19

Tune vs I_W

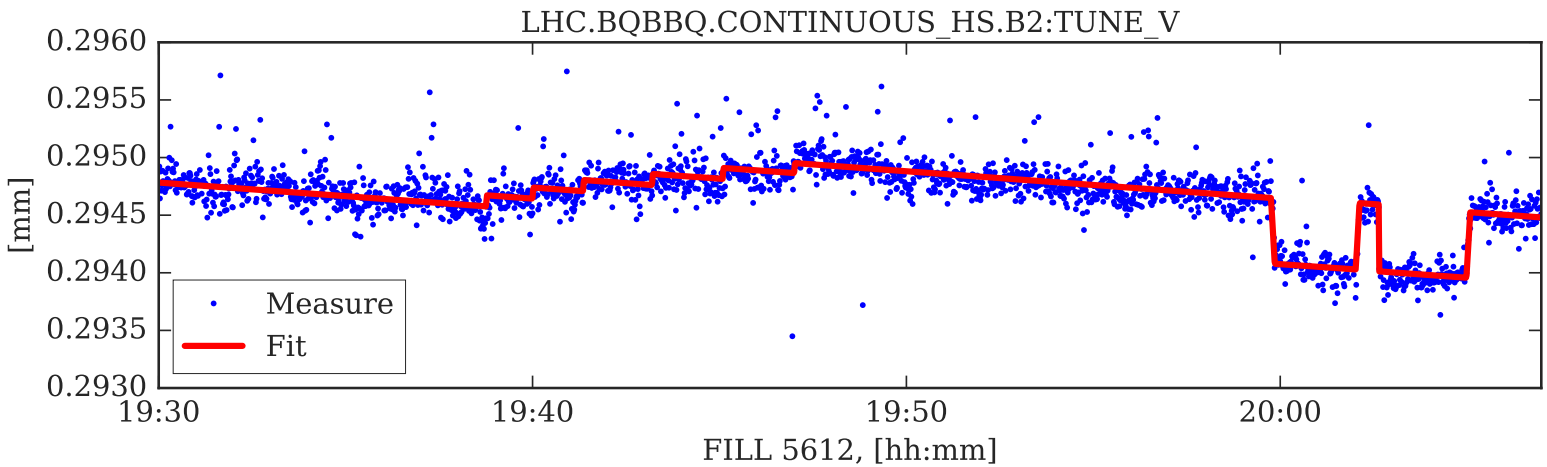

350
300
250
200
150
100
50
0
I_w [A]
16
15
14
13
12
11
10
left jaw position [mm]
19:30
19:40
19:50
20:00
20:10
20:20
0.272
0.270
0.268
0.266
0.264
0.262
0.260
ΔQ_H [10^{-3}]
0.299
0.298
0.297
0.296
0.295
0.294
0.293
0.292
ΔQ_V [10^{-3}]
[hh:mm]

$\Delta Q_H / I_w$



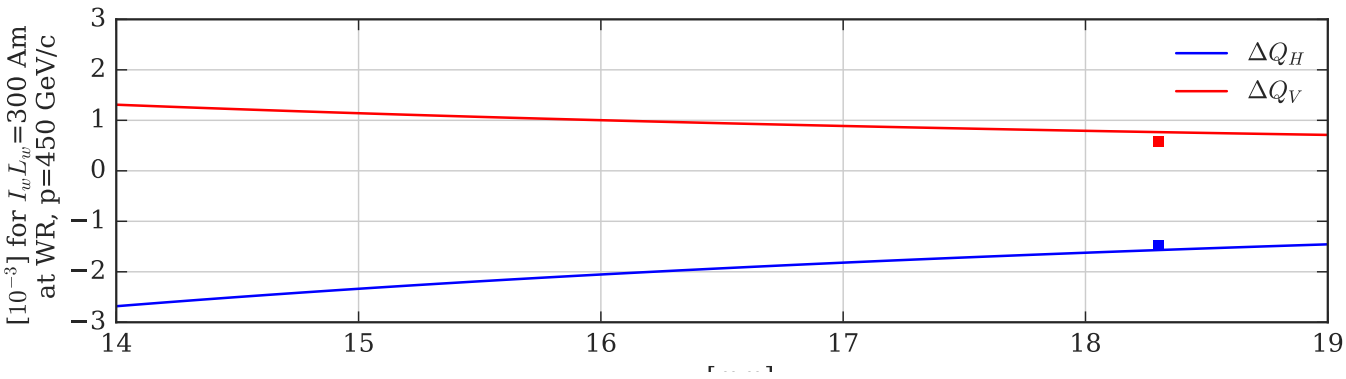
ΔQ_H and $I_W = 300A$ at -1.48e-3.

$\Delta Q_V / I_w$



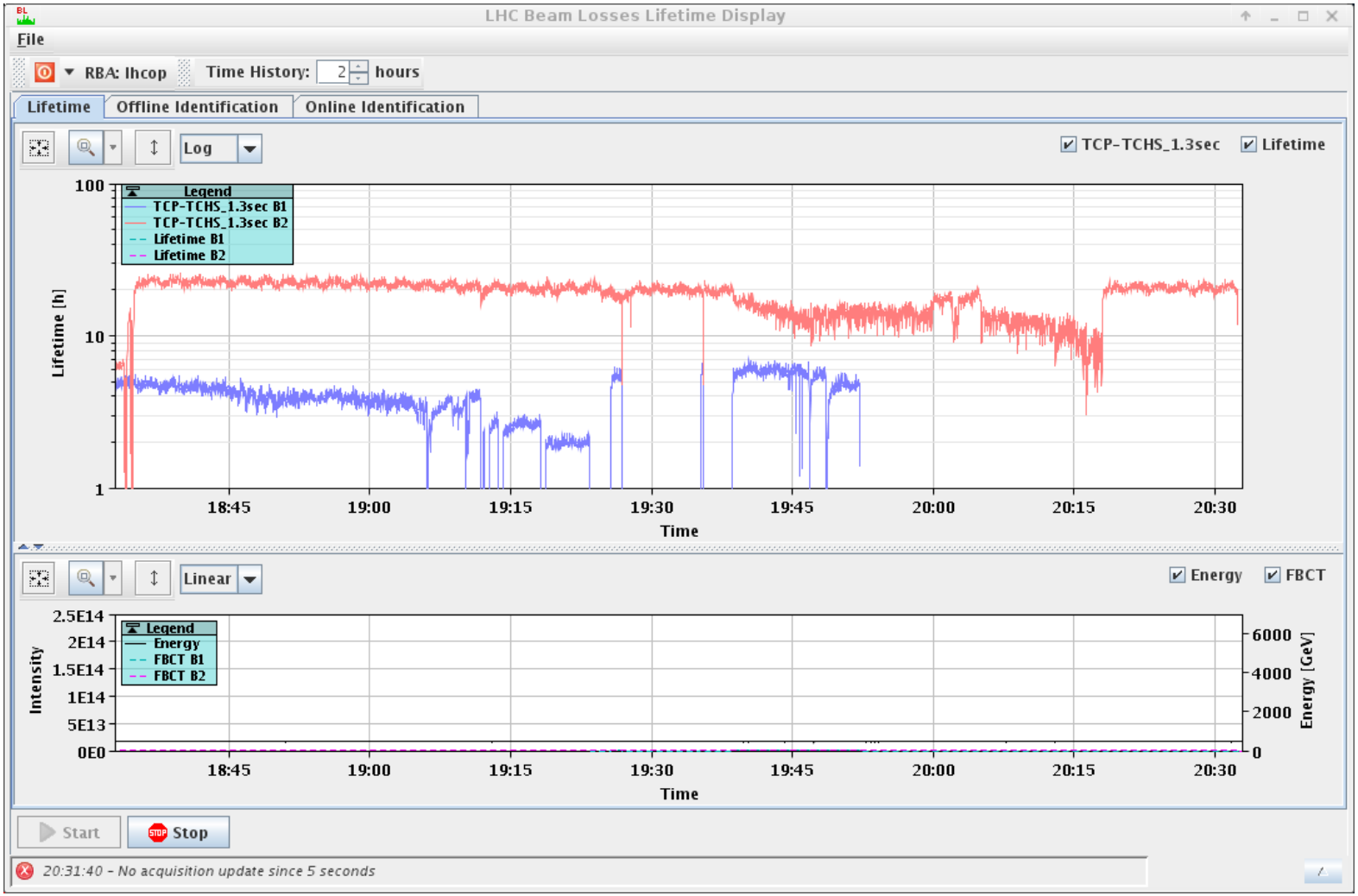
ΔQ_V and $I_W = 300A$ at $+0.58$e-3.

Comparison of the measurement with the model



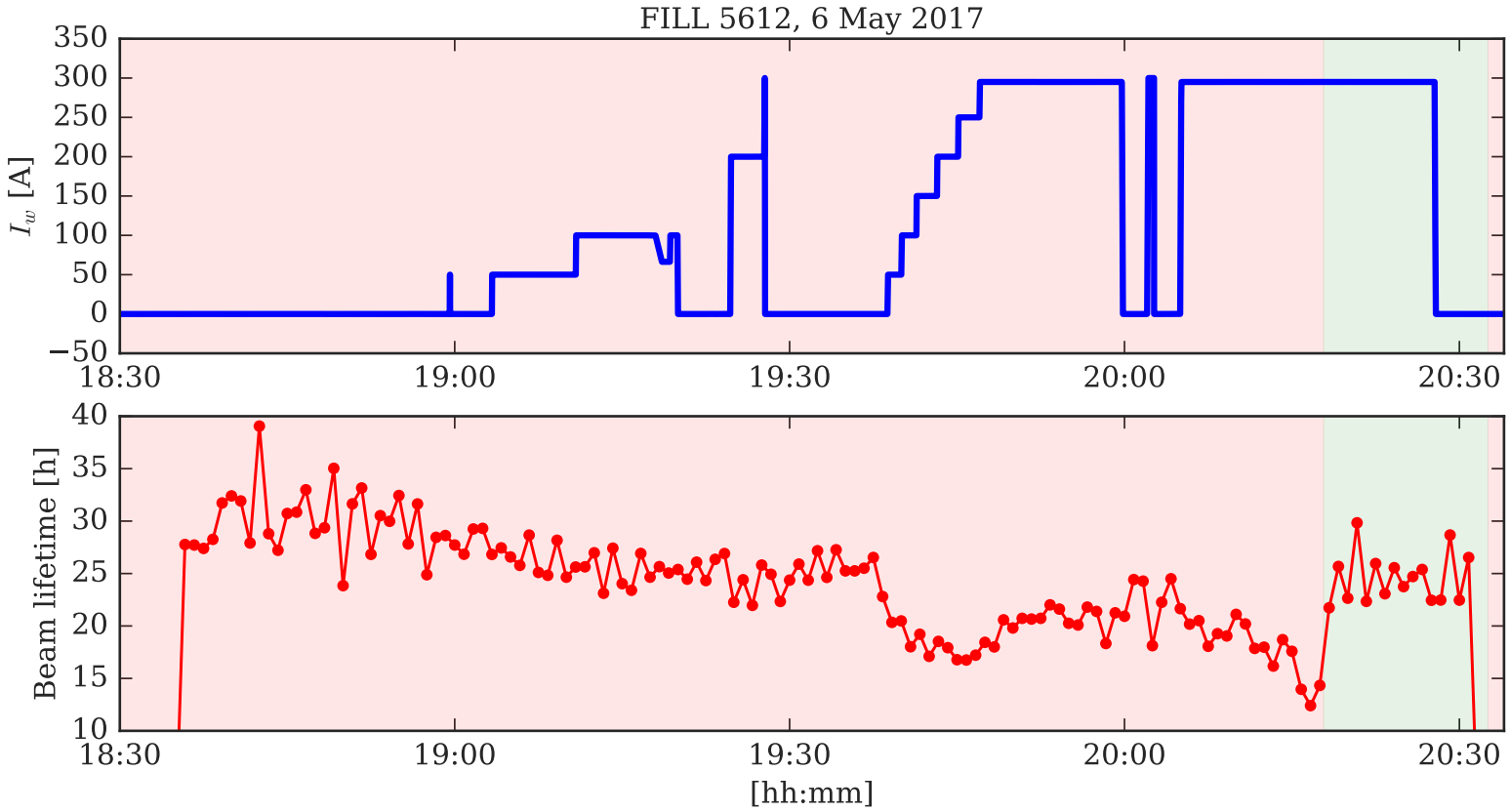
GOOD AGREEMENT.

Beam lifetime



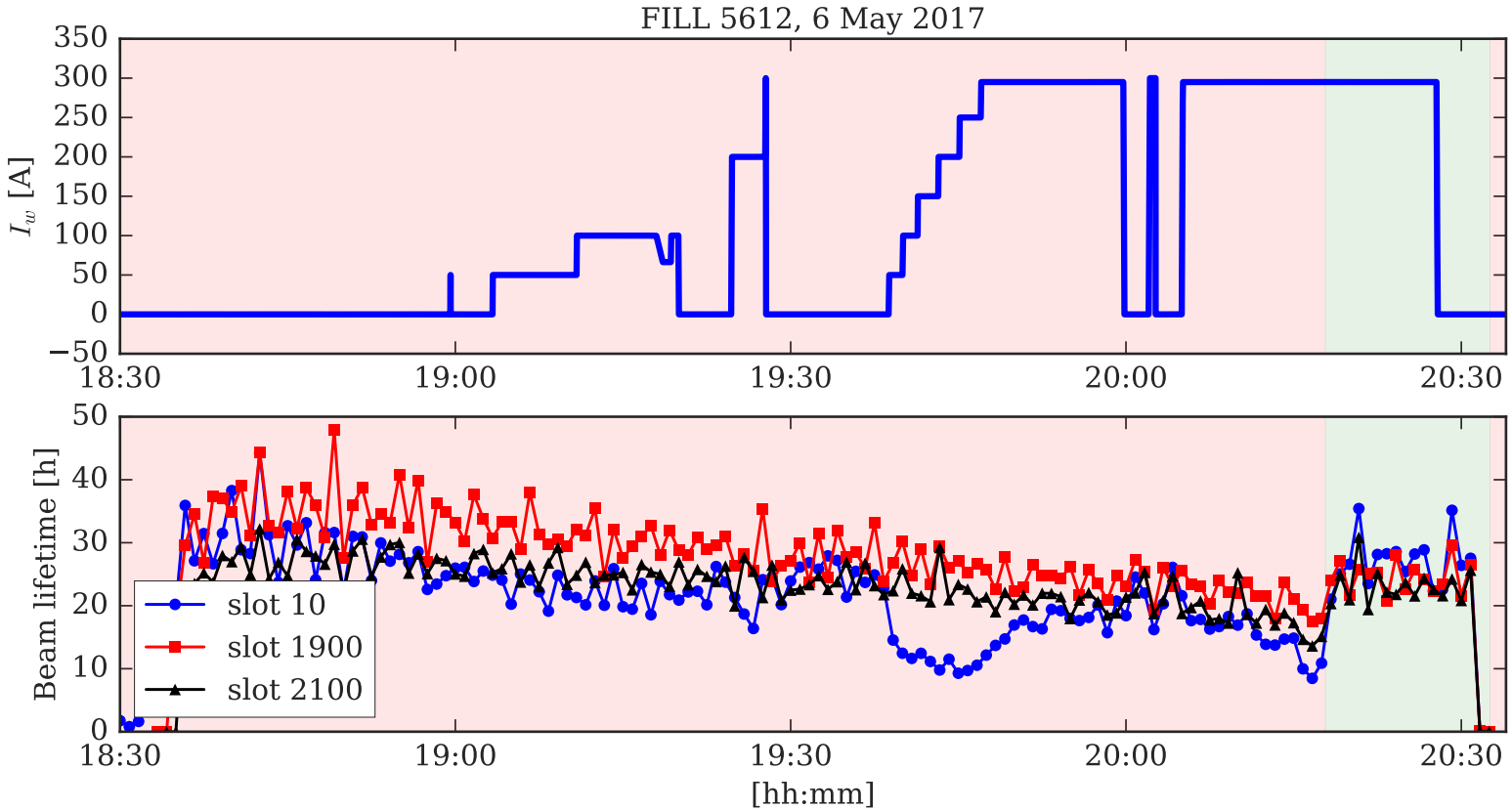
The tune feedforward is crucial.

Beam lifetime



The tune feedforward is crucial.

Beam lifetime



The tune feedforward is crucial.

Conclusion and next steps

- A lot of data with just 2 h!
- From the preliminary analysis with beam the wire is performing as expected.
- Orbit response easy to quantify (still to calibrate some PUs).
- Tune response noisy: we will use NAFF with the BBQ, we will ask/use multi-turn data.
- can we use the 5th- axis?
- can we have a BLM-computed lifetime on CALS?
- COMMENT: (1) to reduce the error bar we have to approach the wire. (2) Repeat the test for the left wire. (3) Implement the feedforwards. (4) What is the minimal distance at top energy.

Details of the fill

FILL	mode	startTime	endTime	duration
5612	SETUP	2017-05-06 17:58:36.894	2017-05-06 18:24:58.137	00:26:21.243000
5612	INJPROT	2017-05-06 18:24:58.138	2017-05-06 21:26:58.781	03:02:00.643000
5612	INJDUMP	2017-05-06 21:26:58.782	2017-05-06 21:27:50.681	00:00:51.899000

Vacuum level

No visible effect on the vacuum level.

	VGPB.935.4R5.R.PR
2017-05-02 18:05:02.587	1.200000e-11
2017-05-02 18:05:10.590	1.100000e-11
2017-05-02 18:05:19.593	1.000000e-11
2017-05-02 18:05:34.585	1.100000e-11
2017-05-02 18:06:38.822	1.100000e-11