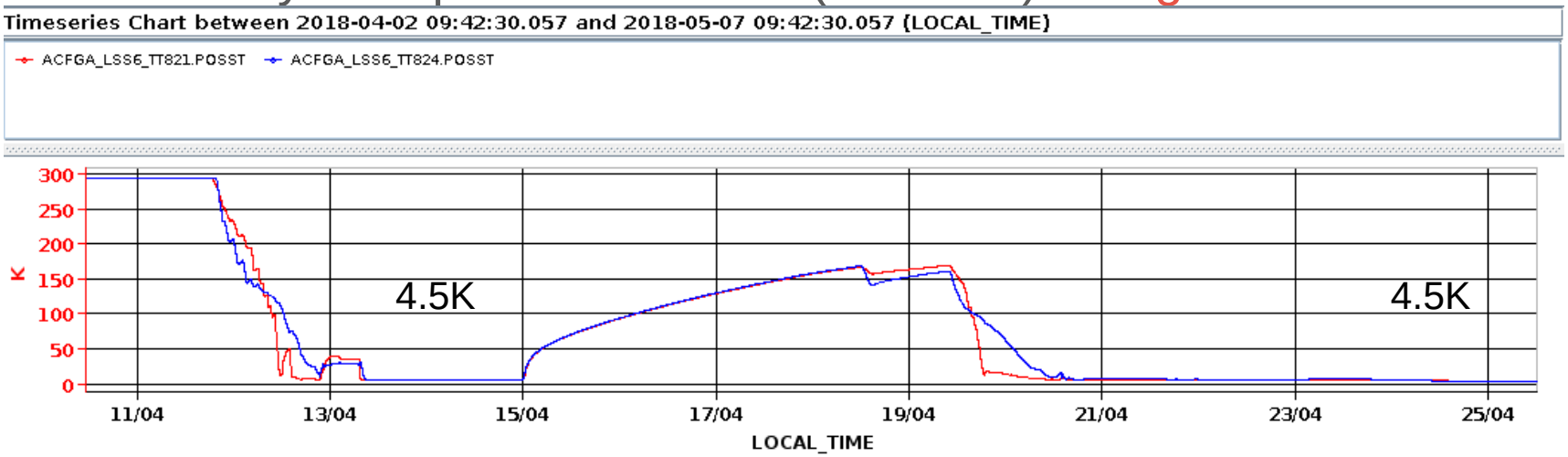
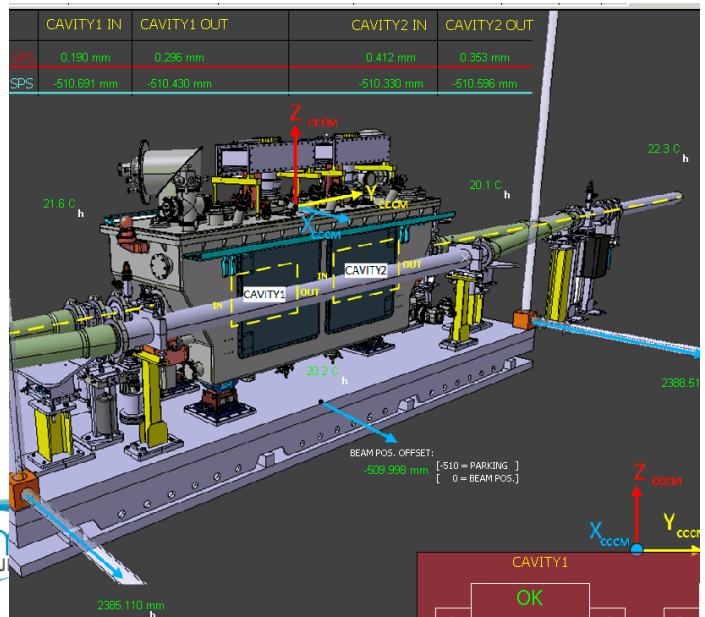
First Cool-down in SPS

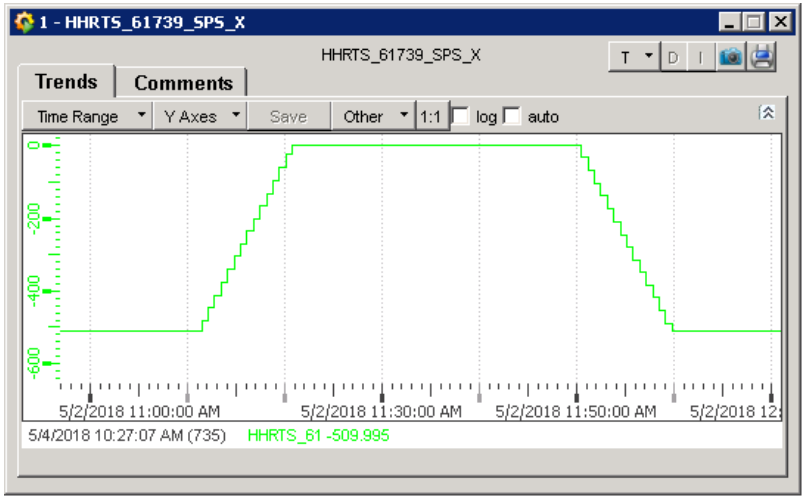
- First frequency measurements (in-situ)
  - @**300 K**: Cav1: 399.959 MHz, Cav2: 399.992 MHz
  - @**4.5 K**: Cav1: 400.638 MHz, Cav2: 400.689 MHz
- Cool-down start: 11/04 → 24/04 stable 4.5K with small interruption of 2 days
- RF conditioning (voltage calibration yet to be done)
  - Cavity 1 – up to 5 kW-CW (~2 MV)
  - Cavity 2 – up to 1 kW – CW (~0.8 MV) – degraded vacuum



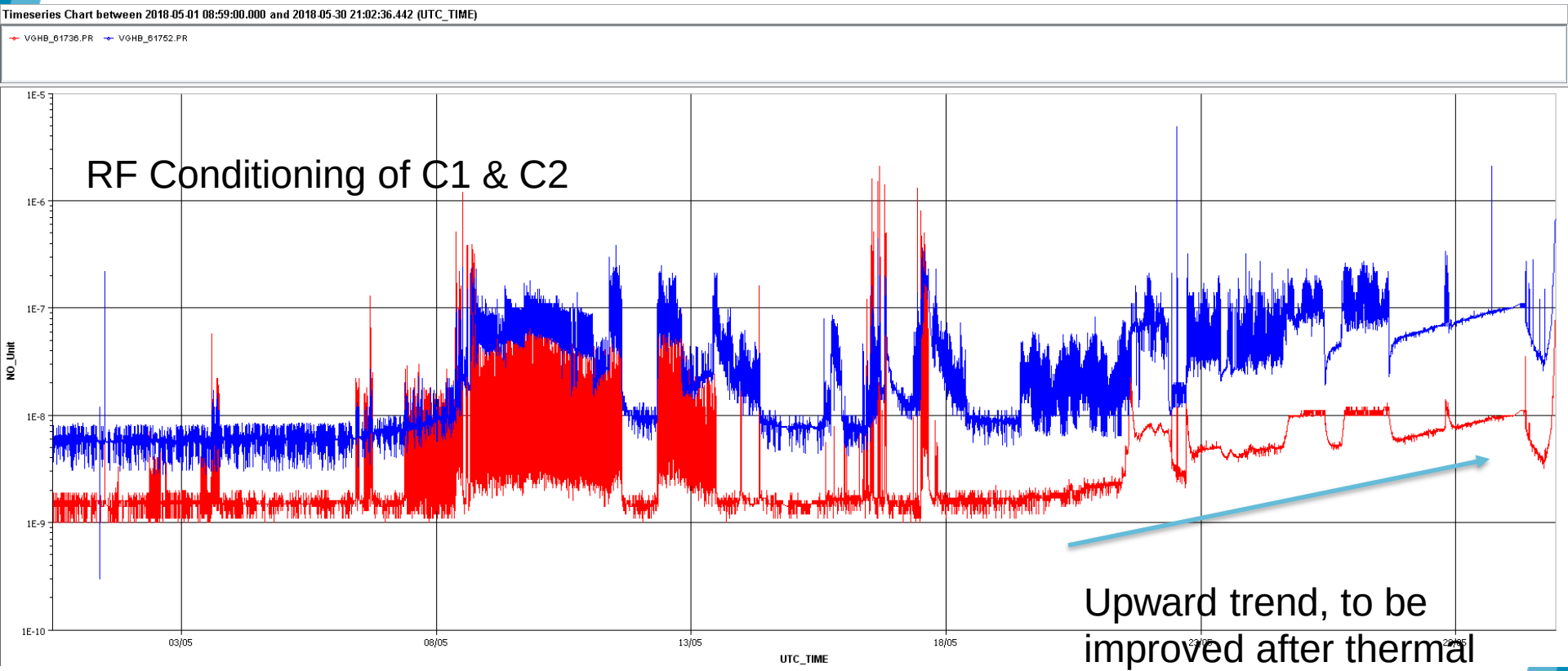
May 2, MD#0 for Equipment Check

- Cavities moved with 60% LHe
- Test of interlocks: vacuum valves, access, liquid level
- Safe position table for beam confirmed by position switches (Parking, experiment)
- Absolute positions measured on line by EN Survey with FSI system, well within requirements (repeatable to within few μm)





RF Conditioning, Vacuum Evolution, May 2018



No static offset, timber plotting artifact

Upward trend, to be improved after thermal cycling & pumping

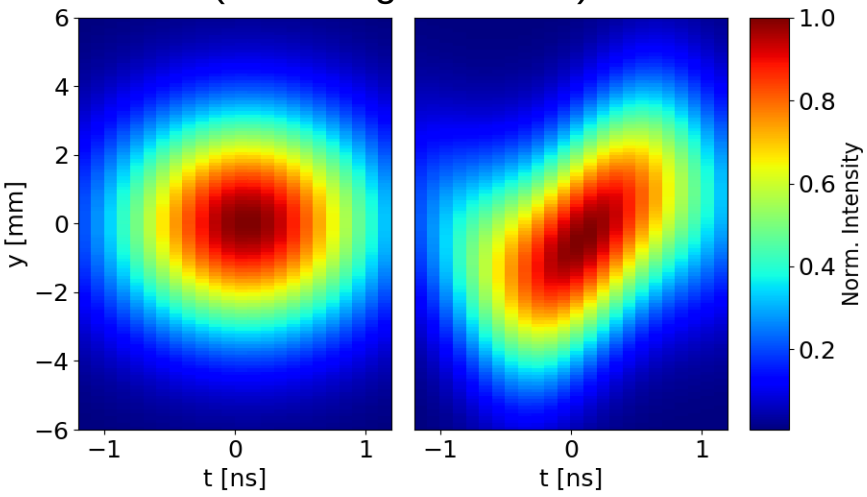
MD #1 – Protons meet Crabs

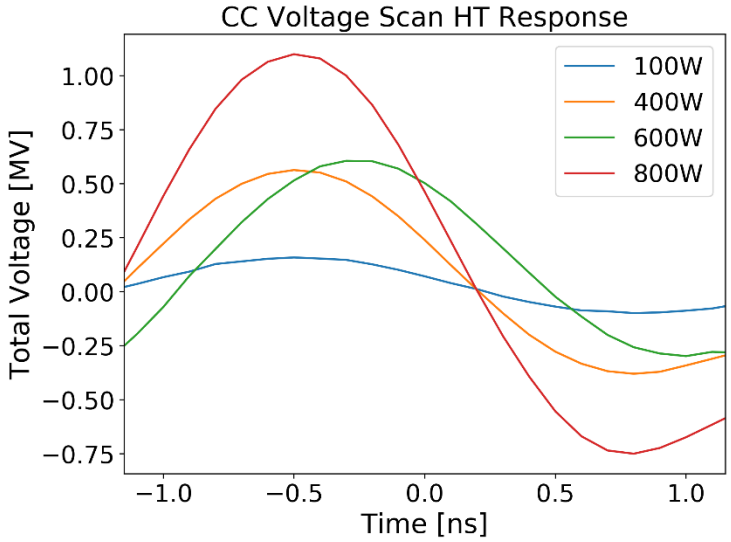
First injection – 12:55, May 23

Worked w/o RF feedback

$0.2 - 0.8 \times 10^{11}$p/b

Crabbing reconstruction
(assuming Gaussian)

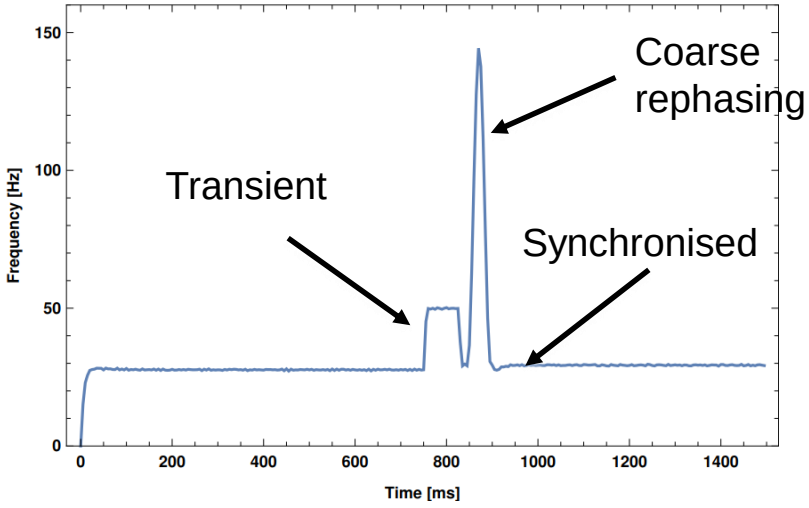




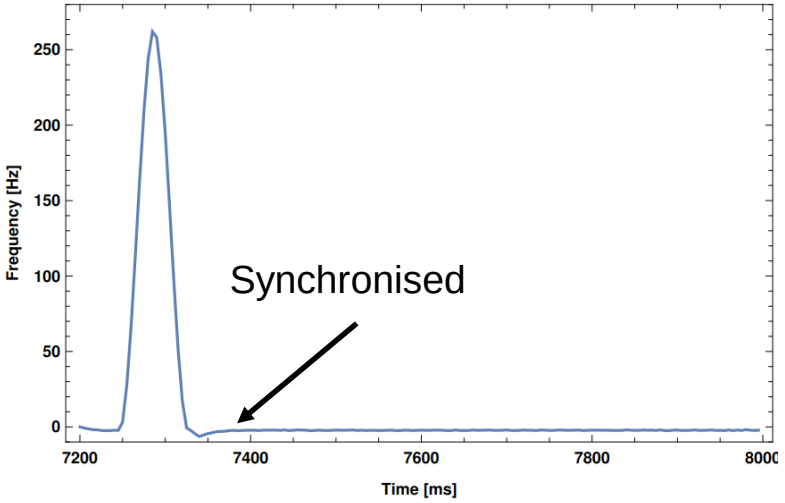
Crab-RF Sychronization

- Crab cavity rf set point from BA6 to BA3
- CC ~400 MHz, SPS RF ~200 MHz
- Rephasing of SPS RF to become synchronous with crab signal.

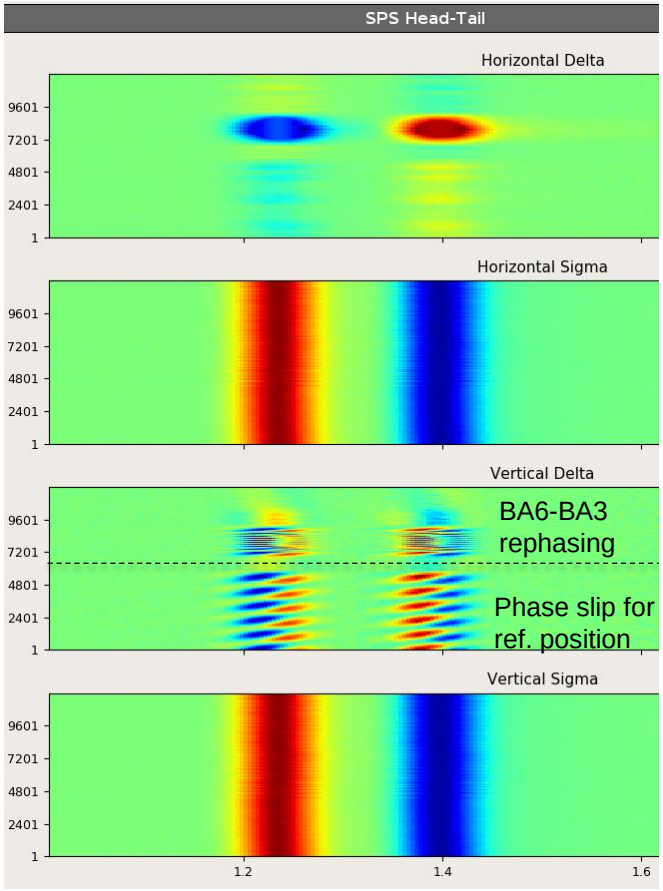
26GeV rephasing
Synchronised from ~1s
after injection

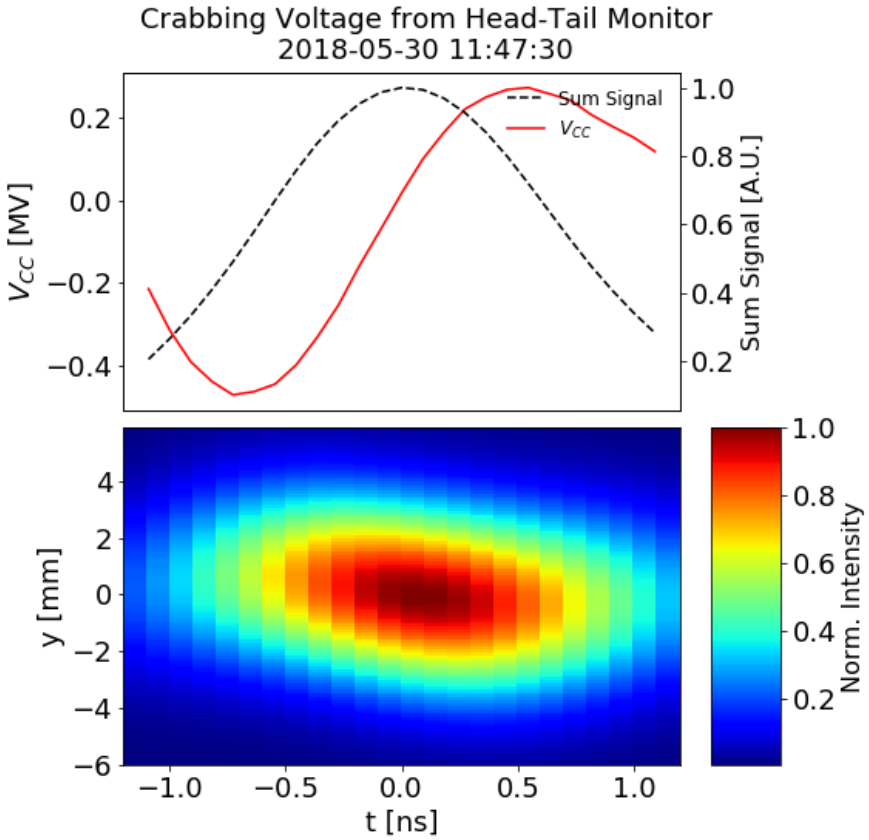


270GeV rephasing
Synchronised from ~7.4s
i.e. 0.2s after reaching flat top



Reconstruction of Crabbing using HT

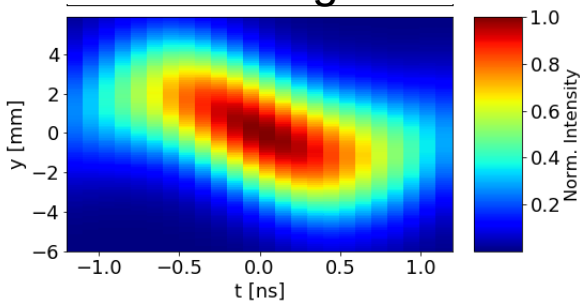




# of turns for ref position along the bunch ~ 2k turns
RF re-synchronization ~ 1s after injection

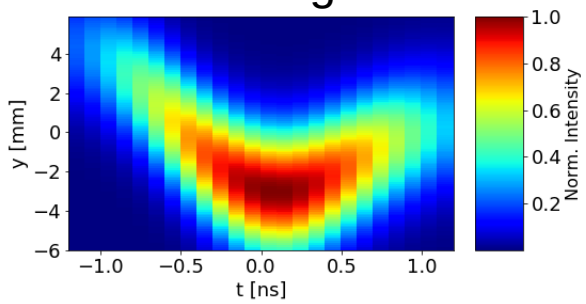
MD #2: Nominal Bunches 26 & 270 GeV

0 Deg



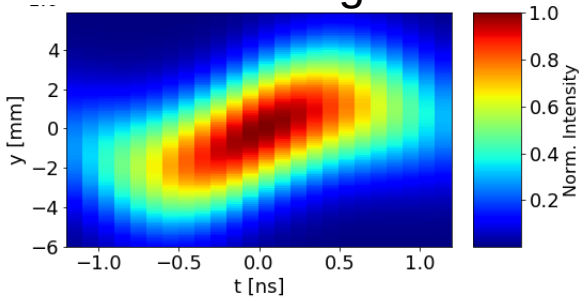
RF phase scan w.r.t the beam phase with cavity 1

90 Deg

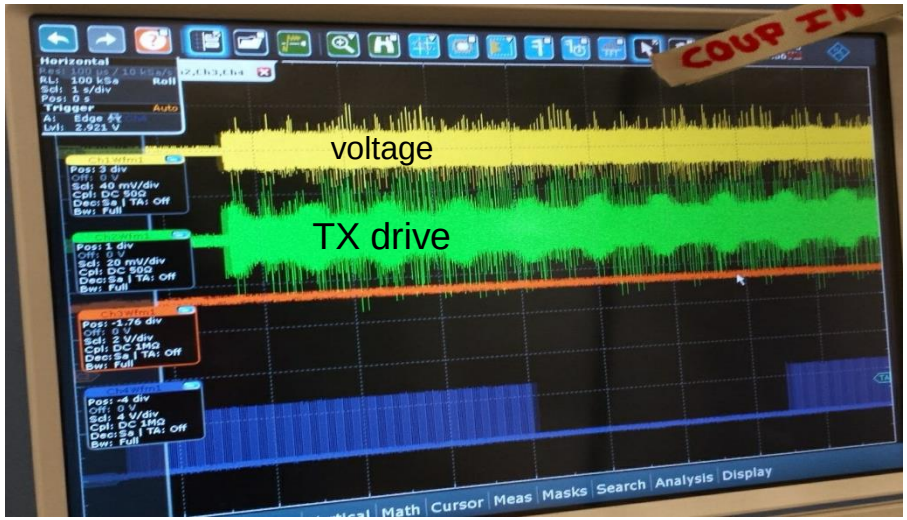


1 MV in cavity 1 (up to 2MV in some cases)
~50 kV in cavity 2, limited by cavity vacuum

180 Deg



RF Feedback & Beam Induced Signal



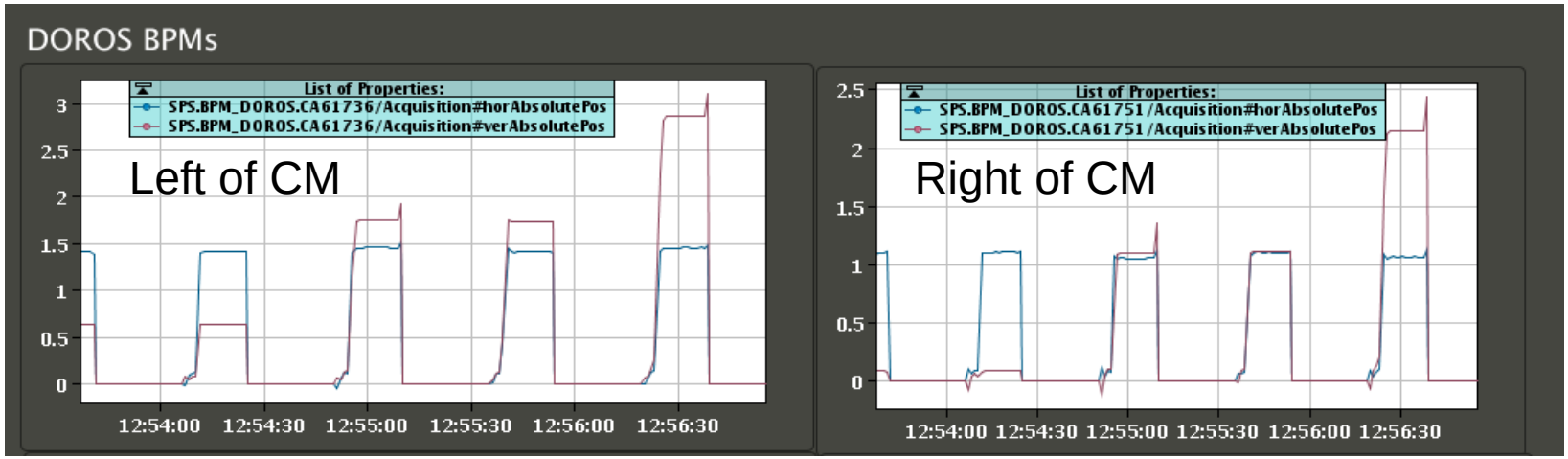
Input drive and voltage spikes at F_{rev}, due to direct beam coupling

Need to filter antenna signals better to suppress the direct beam induced signals

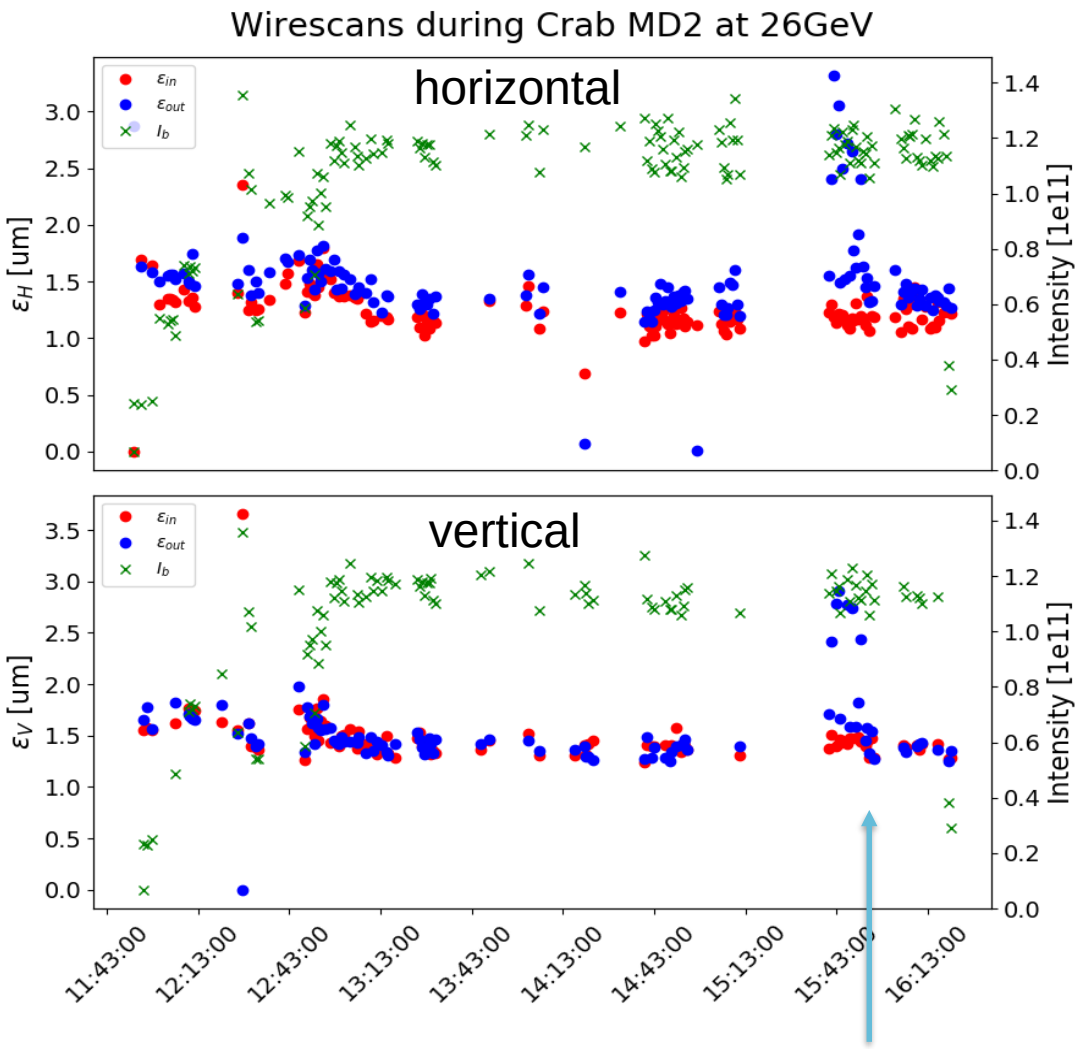
In parallel looking at alteration to cavity antenna to minimize effect

Orbit Scan for Electrical Center

- ± 5 mm orbit bumps around the crab location
- Electrical center measurements were tried for fundamental mode and HOM
- Geometrical center from DOROS $+1.25$ mm, cavity measurements not conclusive (need higher current)



Emittance Measurements



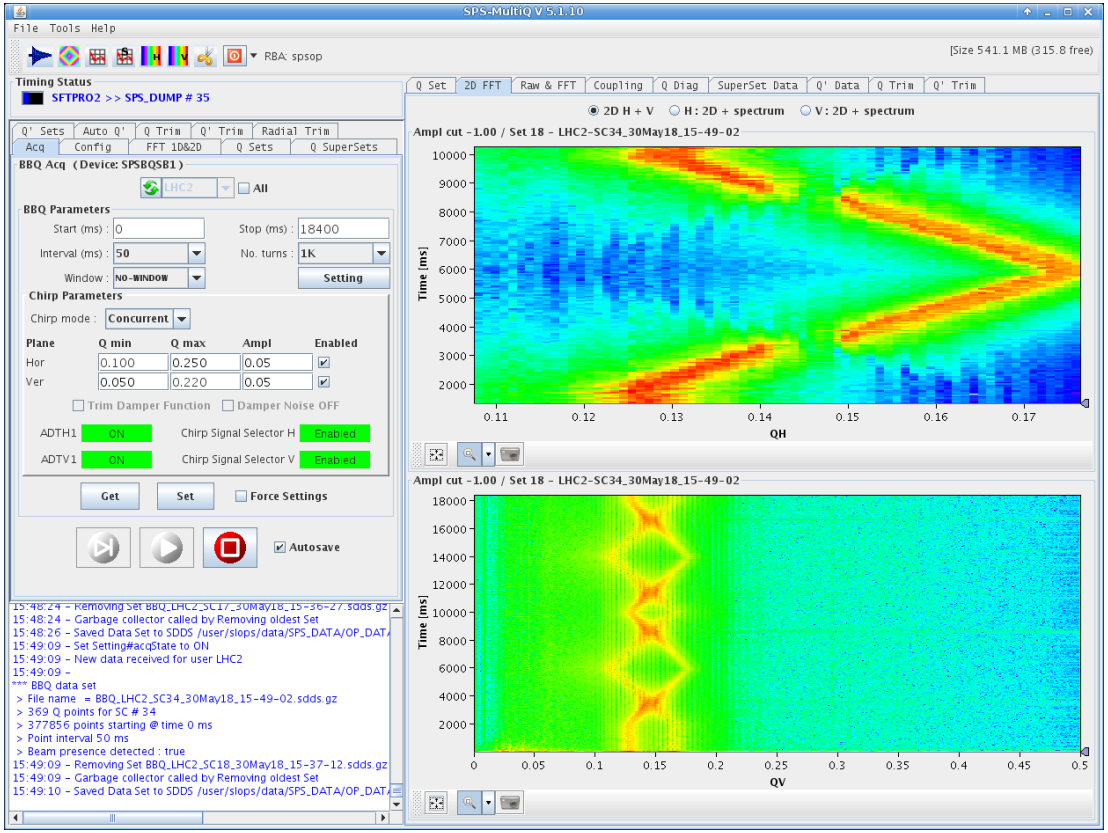
Start Cycle, ϵ_{in} (red)
End Cycle, ϵ_{out} (blue)
Vertical crabbing

Nothing systematic during 20 sec

Tune crossing for $a3$

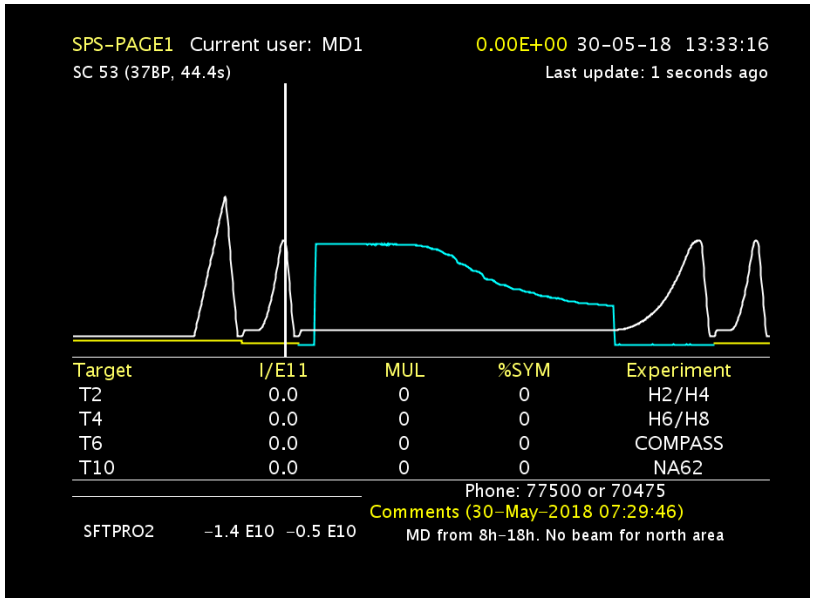
Tune Crossing for a3 Measurements

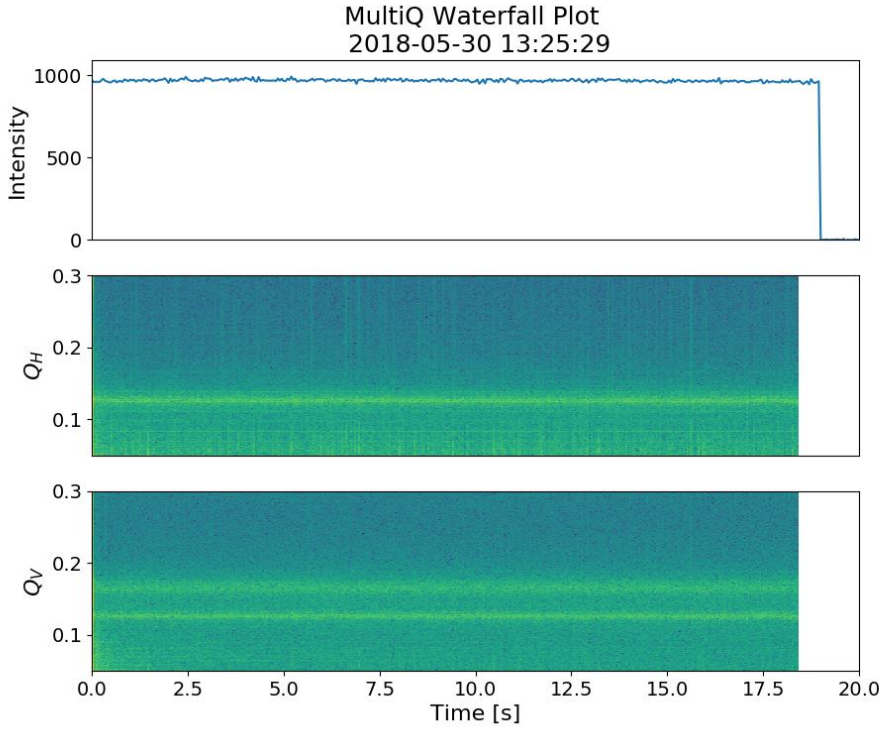
- First attempt using closest tune approach to determine the $a3$ multipolar of the crab
- Better setup required for future MDs



Slow Losses at 26 GeV

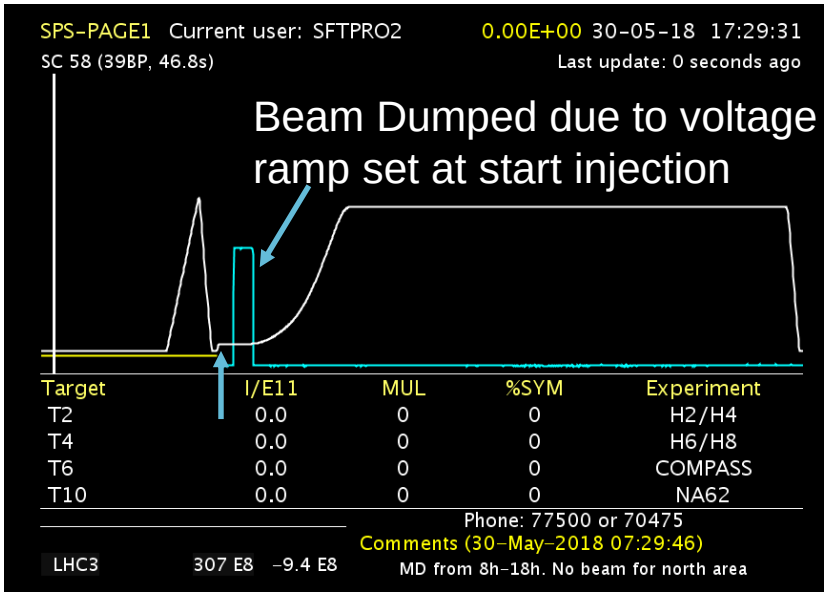
- Cav 1 tuner loop setup and crossed the vertical tune

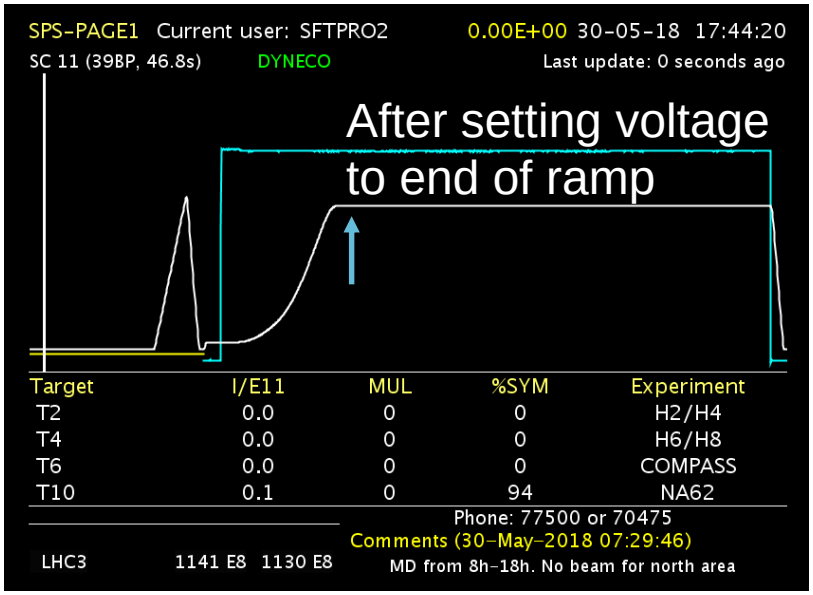




270 GeV Ramp

Cav1 ~1MV (400.787 MHZ), Cav2 off (400.528 MHz)





- Checked with and w/o transverse feedback beyond nominal bunch
- Longitudinally unstable w/o 800 MHz

Ramp to 270 GeV

Vertical tune: $Q_y = 0.18$

RF Freq:

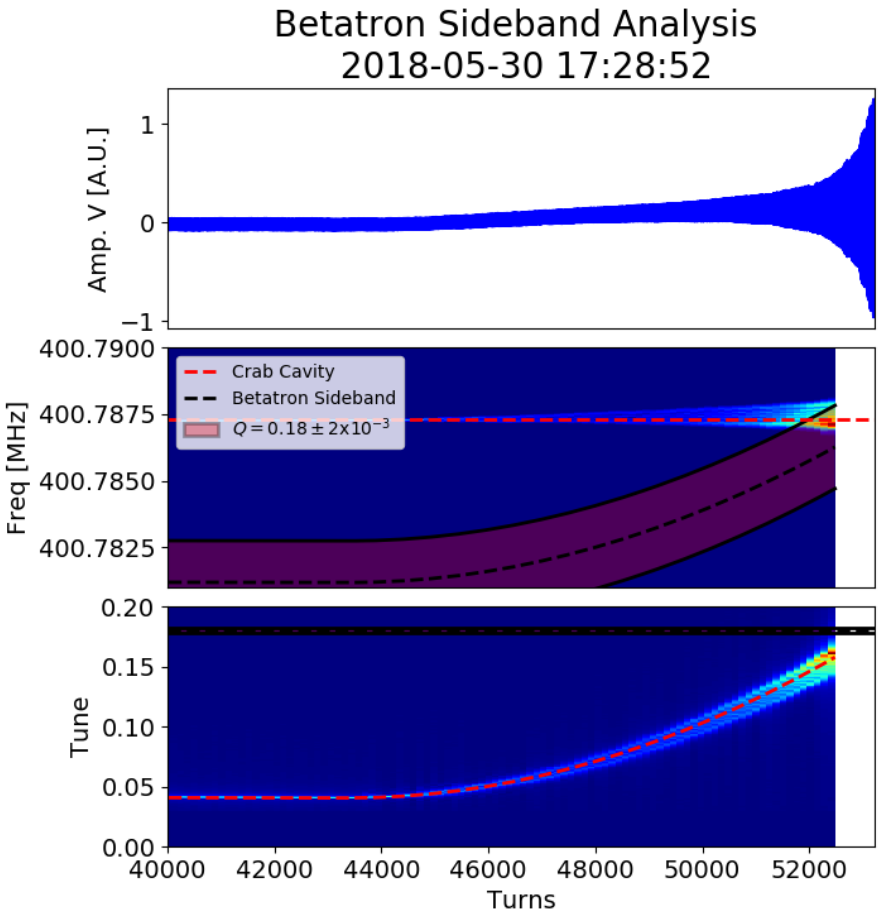
Cavity 1: 400.787 MHz (~1 MV)

Cavity 2: 400.528 MHz (almost zero)

Resonant excitation observed as we cross the vertical tune (black dotted lines).

Kicking the beam at 270 GeV equivalent frequency , while sweeping the beam frequency from 26-270 GeV

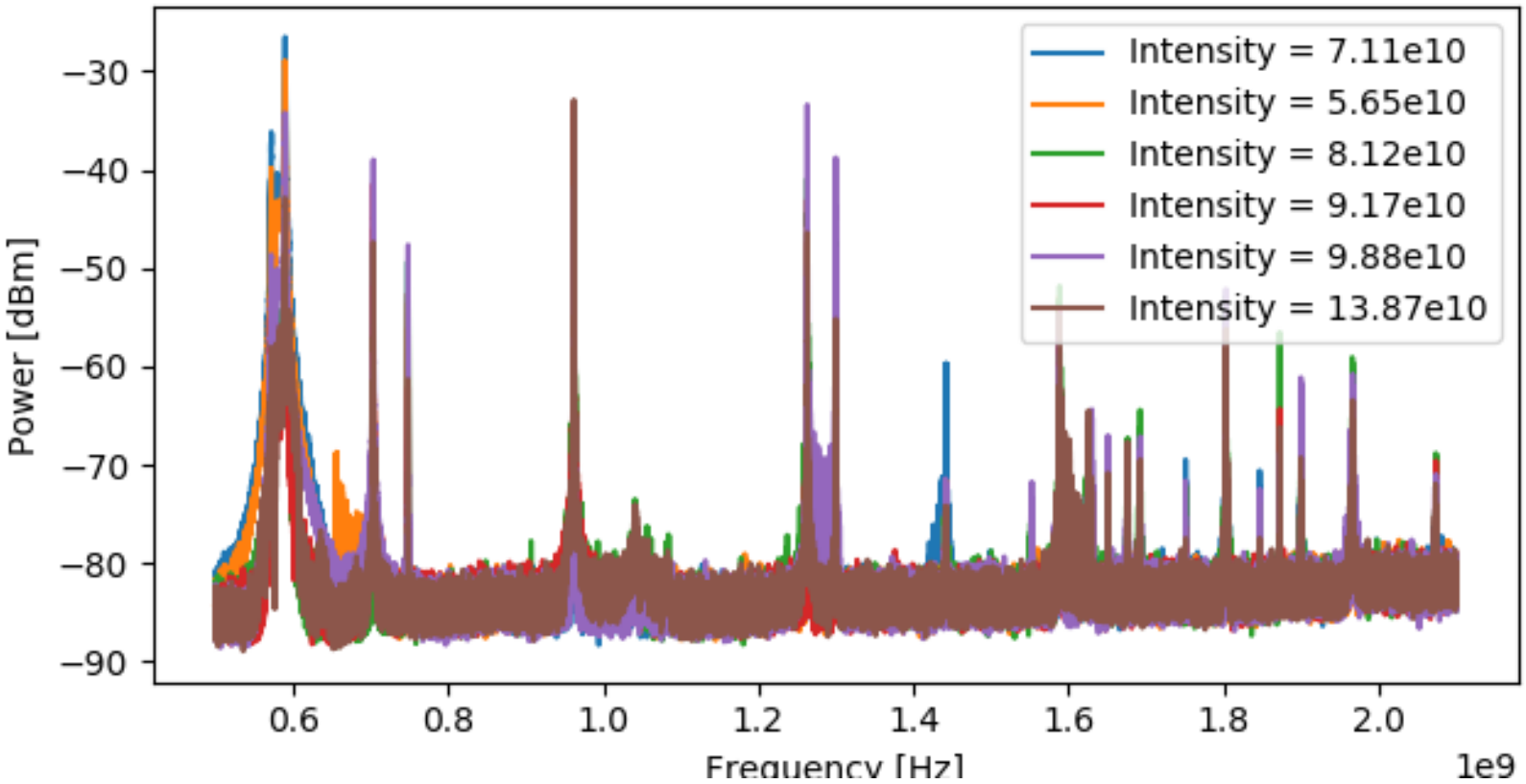
After setting the correct cycle start voltage to 270 GeV equivalent, beam circulated w/o any issue



HOMs

Peak HOM power estimated $< 100\ \mathrm{mW}$ (analysis **ongoing** to account frequency dependent cable losses)

Energy: 26 GeV
Bunch intensity $0.2 - 1.3 \times 10^{11}$



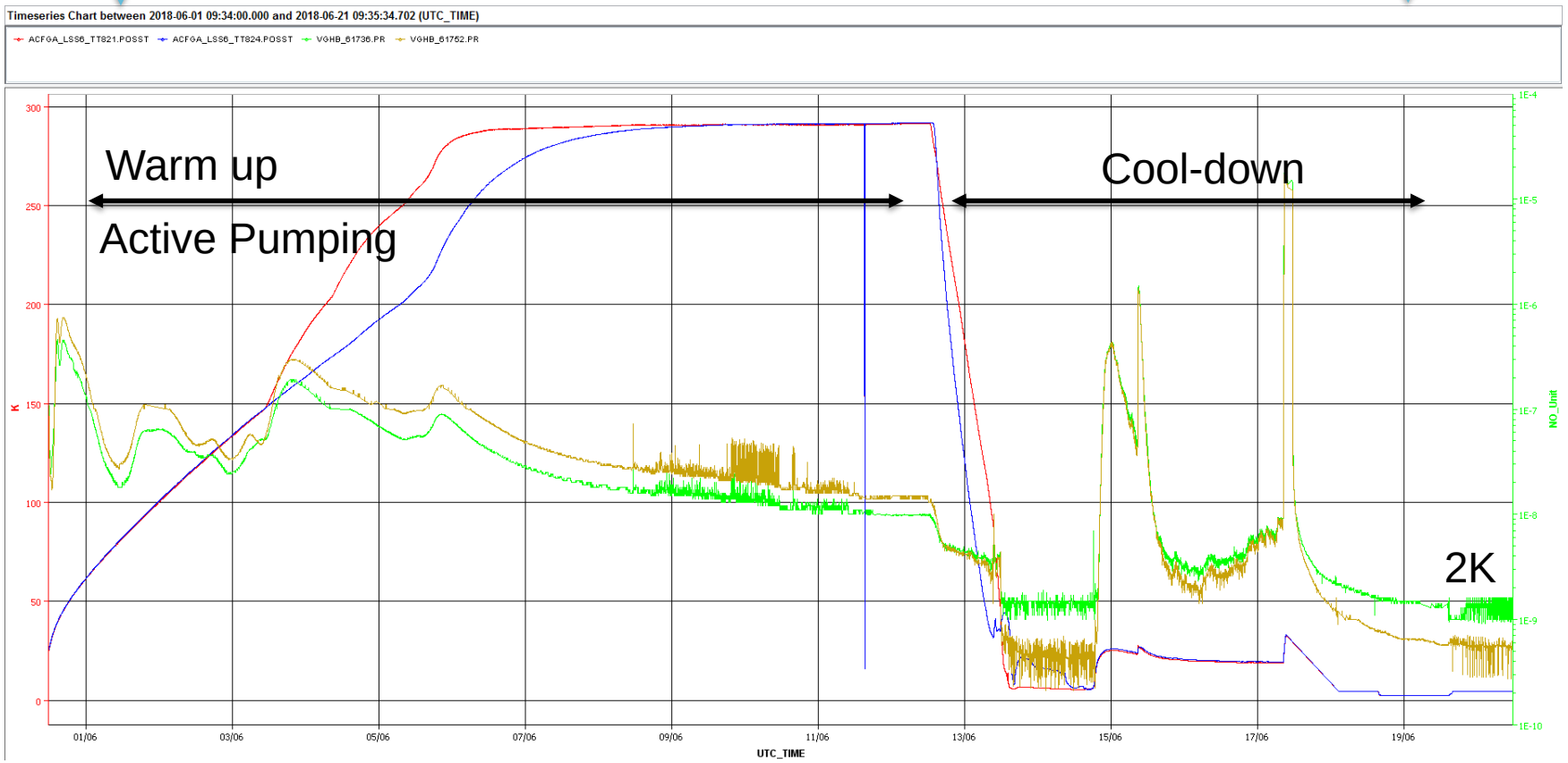
Nest Steps

- May: 2 MDs with beam
  - 23 May: Operated in RF open loop at 26 GeV low intensities (cav1 $\sim 200 - 300\ \mathrm{kV}$, cav2 $\sim 50\ \mathrm{kV}$), tried up to nominal
  - 30 May: RF feedback on. 26 GeV & 270 GeV nominal bunches (cav1 $\sim 1\ \mathrm{MV}$, cav2 $\sim 50\ \mathrm{kV}$)
- June: No MDs planned
  - Warm up done immediately after MD#2
  - TS1: Commissioning of the warm pumping units + some other interventions on instrumentation.
  - Validated 2K in manual mode (up to 25 mbar) producing superfluid helium
  - Continue operation of the module at 4.5 K for next days to adapt control logic to have automatic 2 K operation within next 2 weeks
- July: LLRF fully deployed → >2 MV/cavity
  - RF Feedback + tuner loop for both cavities for transparency tests
  - Higher intensities (up to train of 60 nominal @ 26 GeV & 2 nominal bunches at 270 GeV)

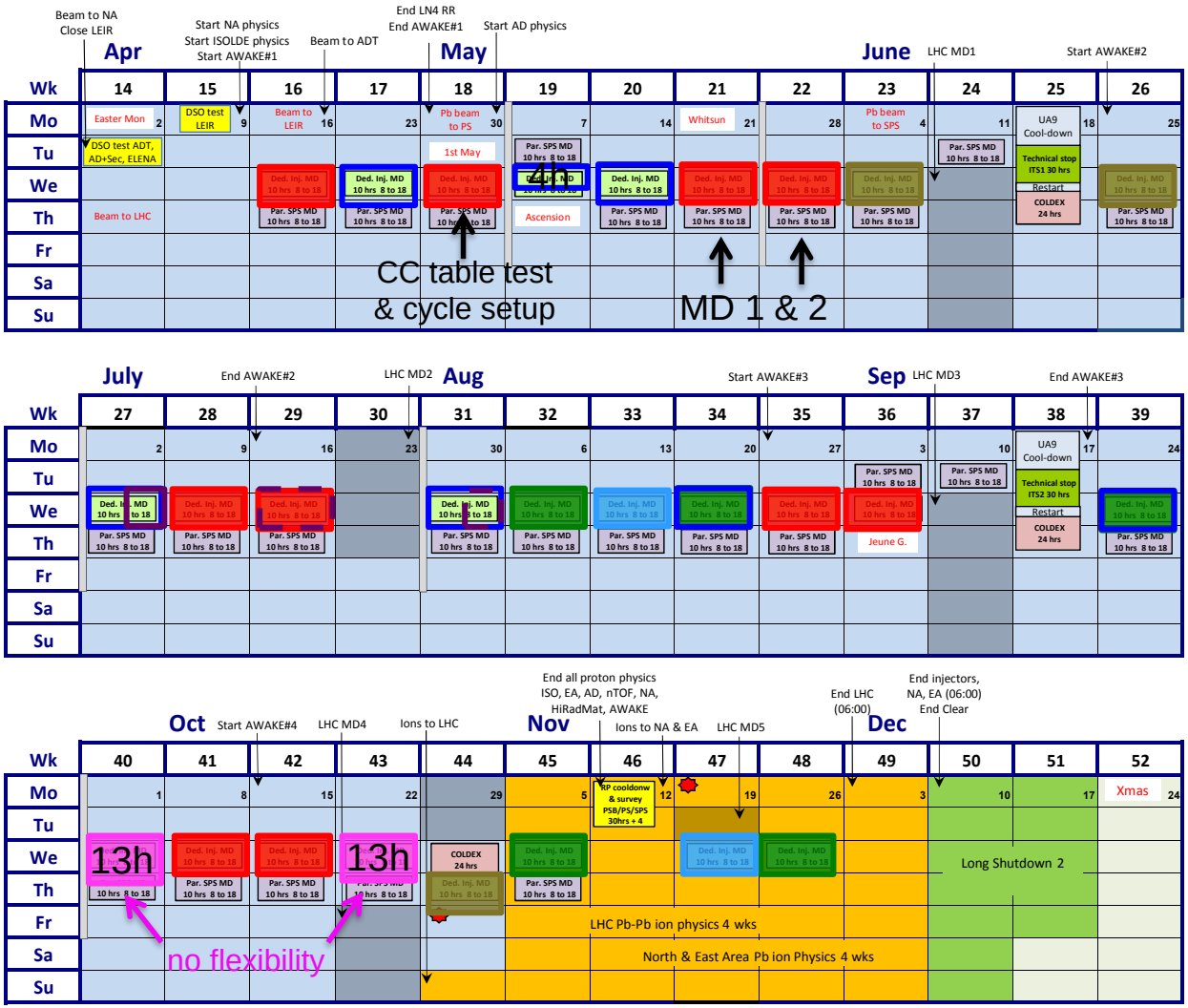
Since MD#2

June 1

June 19



MD slot allocation for 2018



- Crab Cavities
- Slow extraction
- Target test for BDF
- SPS BPMs
- Ion MDs
- Partially stripped Pb
- UA9 (collimation + shadowing)
- LIU SPS Thursdays (RF / transv. alternating)