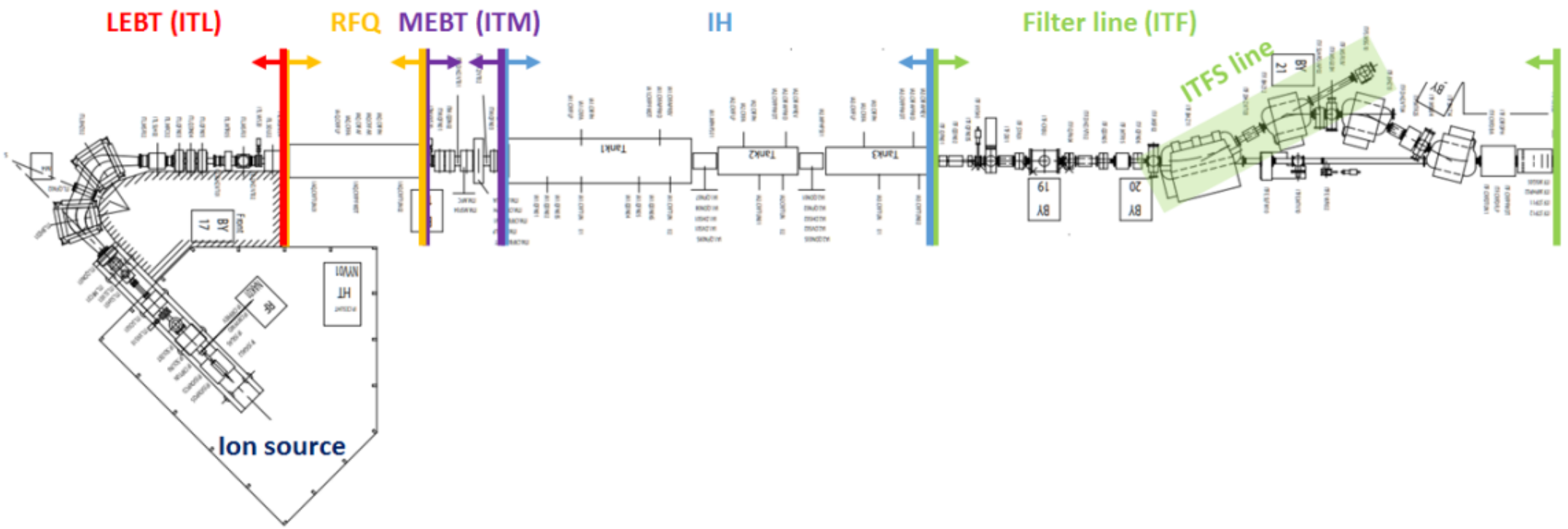
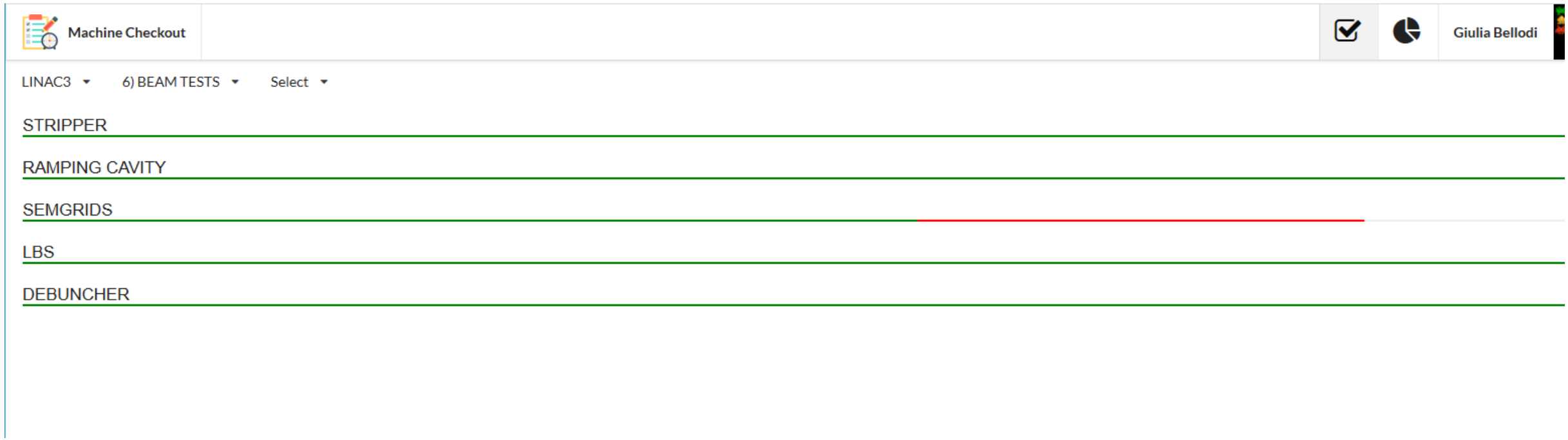
Linac3 reference measurements

G Bellodi, BE-ABP-HSL



A list can be found already on the OpWebTools Machine Checkout page



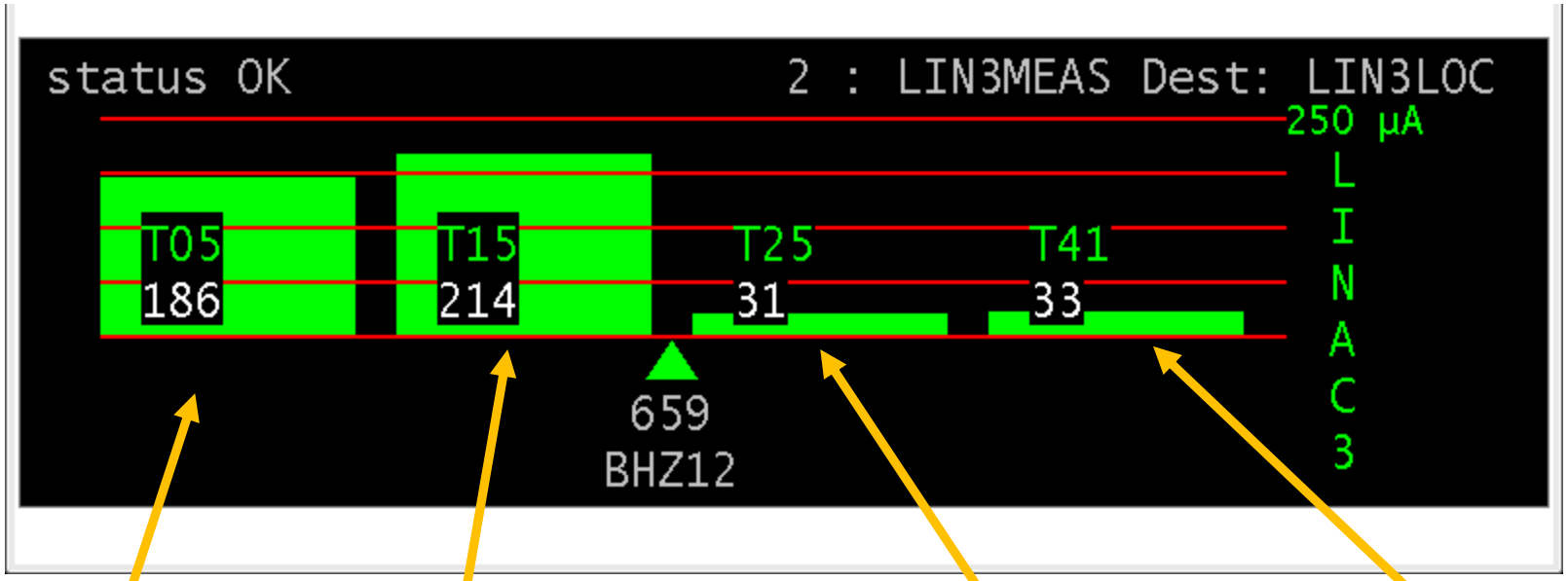
More details of the measurements and procedures to follow in the [Linac3 wiki pages]

Typical start-up schedule

time

What	How	Reference measurements
Ion source	RF still off, ITL and source retuning	measure beam transmission to ITL.FC02 and BCT05 Charge state distribution scans Profile and emittance measurements in ITL
RFQ	RFQ on , IH still off	Manual ITL/source retuning to maximize transmission to ITM.FC03 RFQ transmission curve Profile and emittance measurements in ITM
IH	Beam to ITF	Transmission to ITF.BCT15 (foil out) Profiles and emittance measurements on ITF.BSG02 IH tanks characteristic curves
Stripping foils	Beam to ITF	Foils setup measurements on ITF.BCT15/25 and ITFS line
Phase ramp	Beam to ITF	Setup of the cavities in the ITFS (Ramping Cavity) and LBS (Debuncher cavity) lines and adjustment of phase ramp settings.

First check is beam transmission



Beam at the end of the LEBT

Beam at the end of the IH:
- 70% RFQ transmission
- 85% IH transmission
- stripping

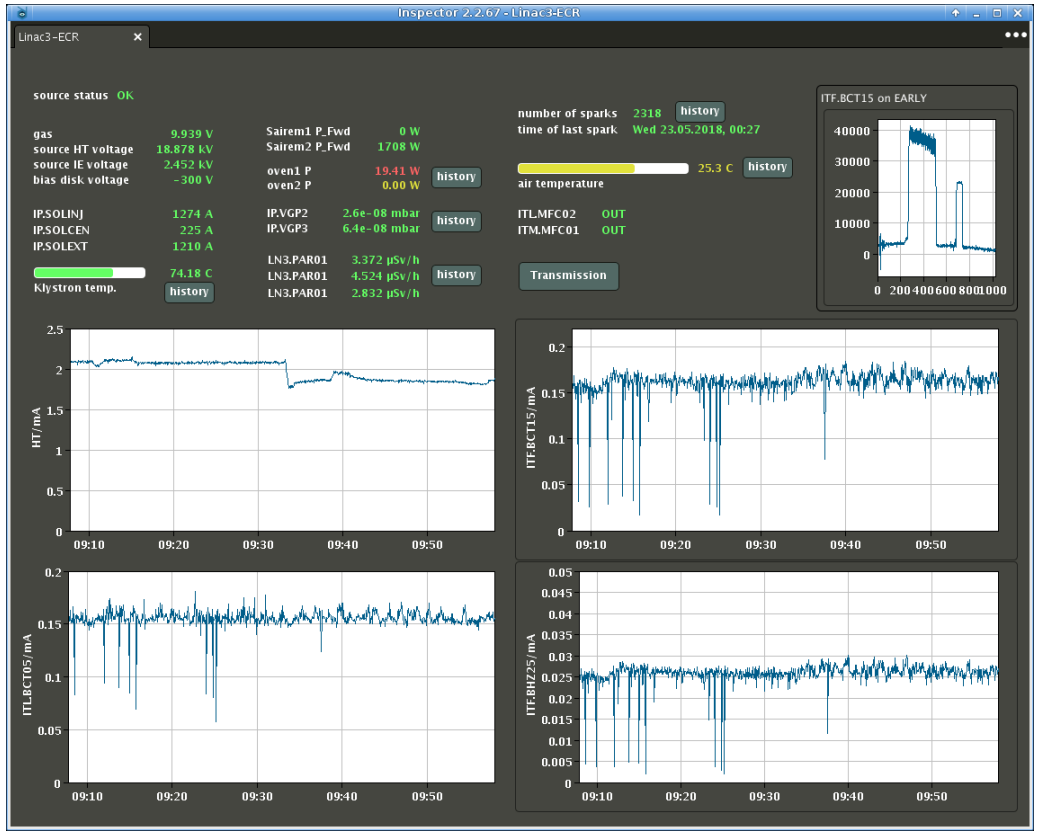
Beam at the end of the ITF:
- ~17% foil efficiency for selected charge

Beam sent to LEIR

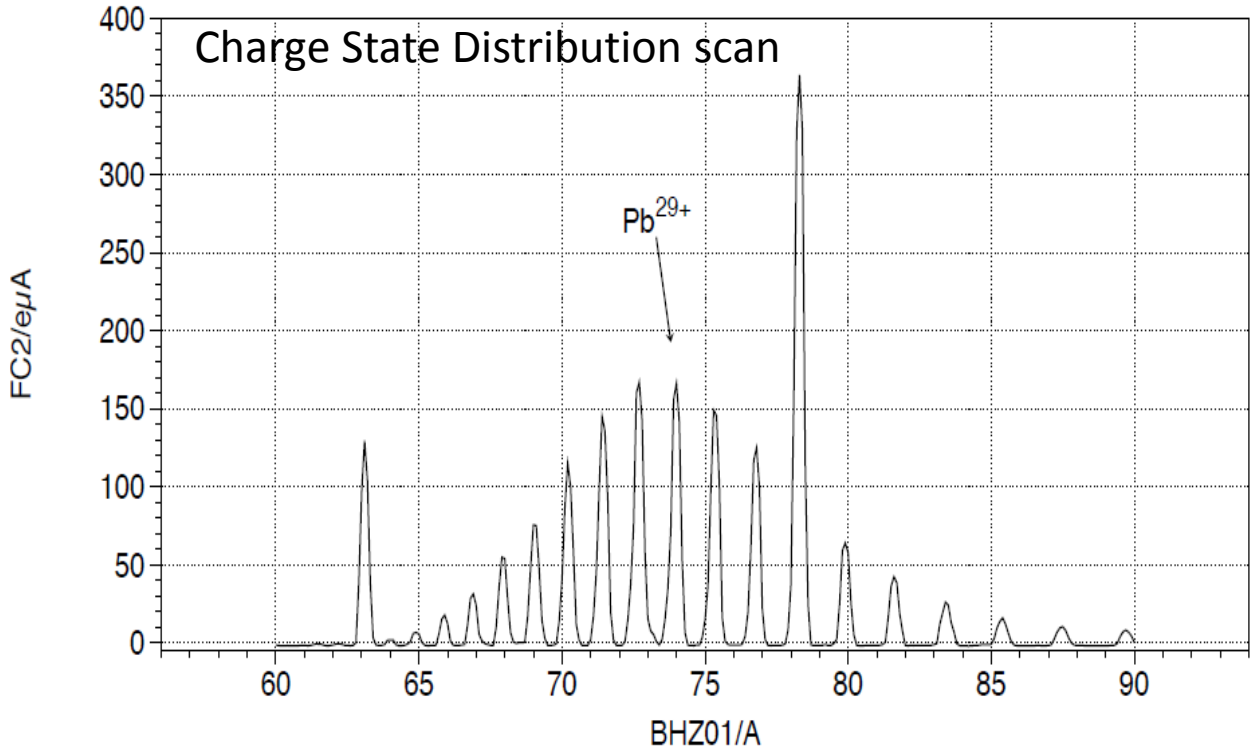
Source

Source and LEBT tuned to optimize transmission in FC2 and FC3 (after RFQ).

Inspector panel for reference source parameters and performance check

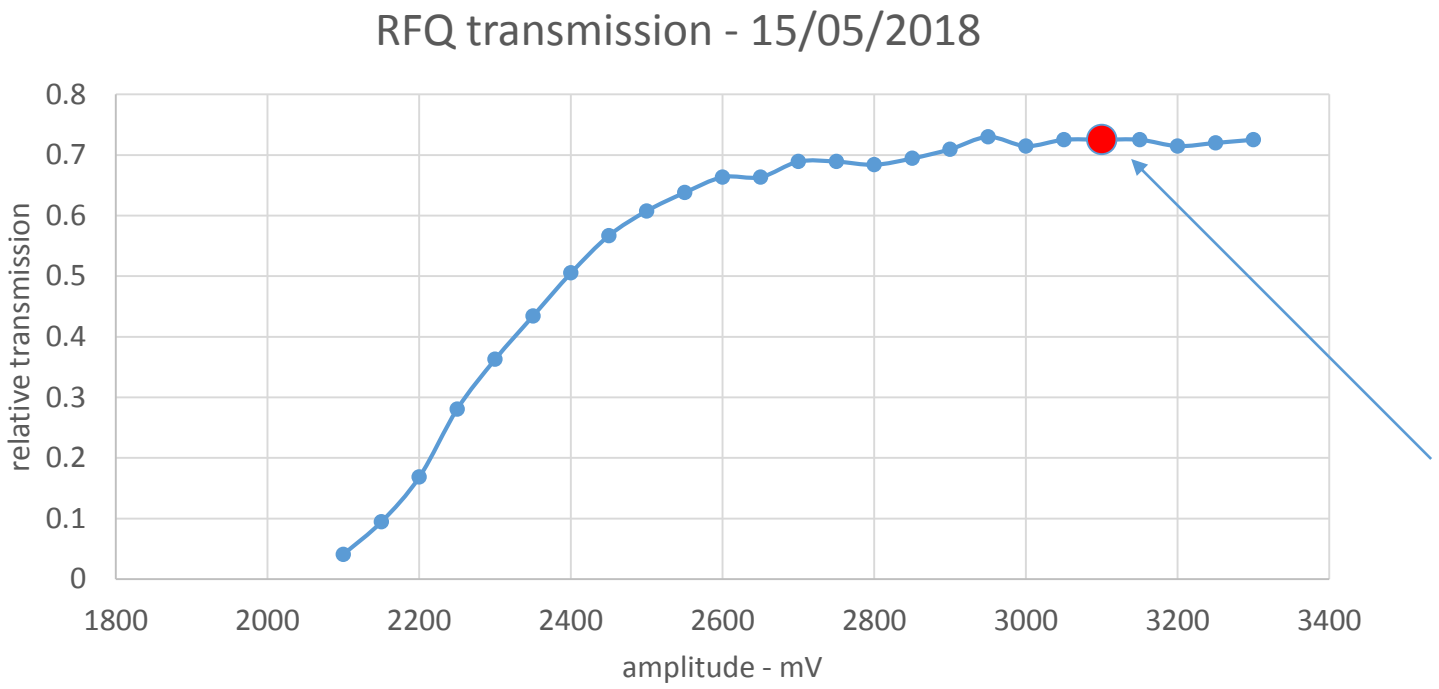


Scan BHZ01/02 current and measure transmission in FC2 to obtain the charge states spectrum .



RFQ

RFQ characteristic transmission curve:
Measure relative transmission between ITM.FC03 and ITL.BCT05 while scanning RFQ amplitude



Operational point

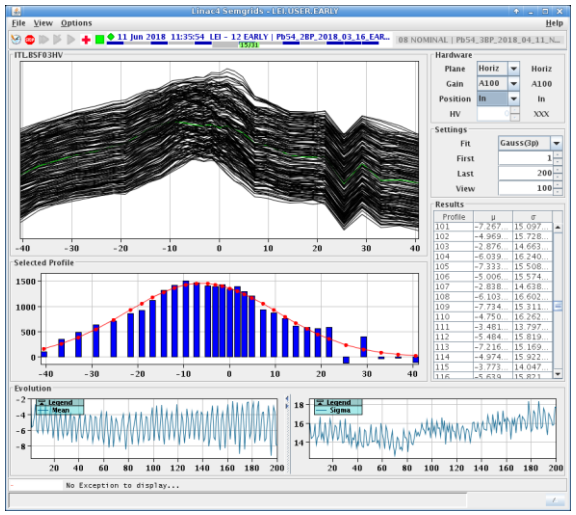
Reference beam profiles in ITL, ITM, ITF

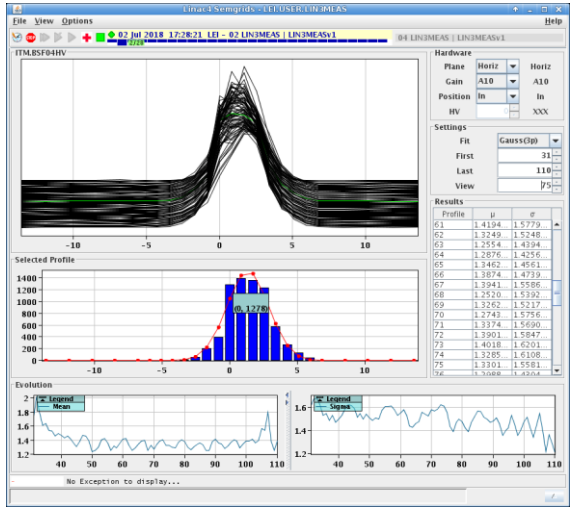
ITL horiz, ver

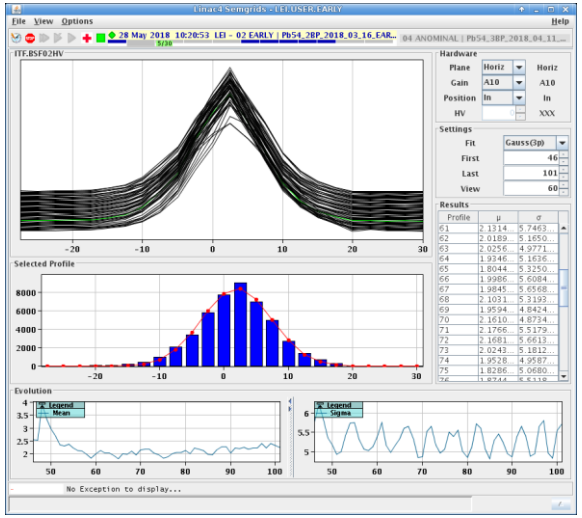
ITM horiz, ver

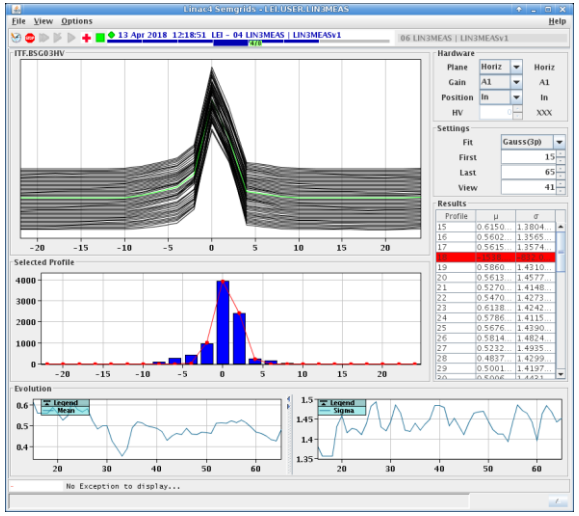
ITF.BSG02 horiz, ver

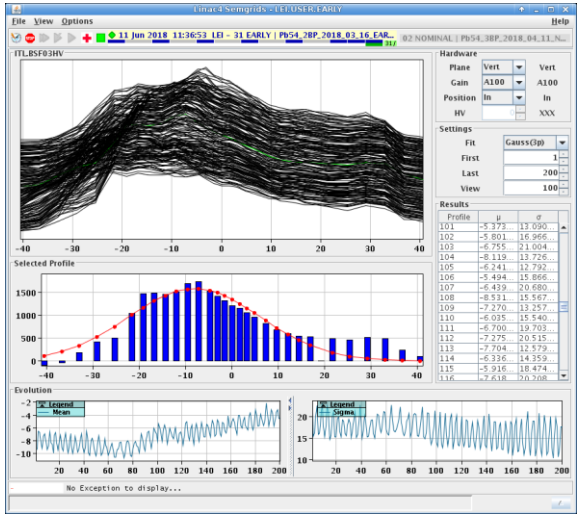
ITF.BSG03, slit open and closed

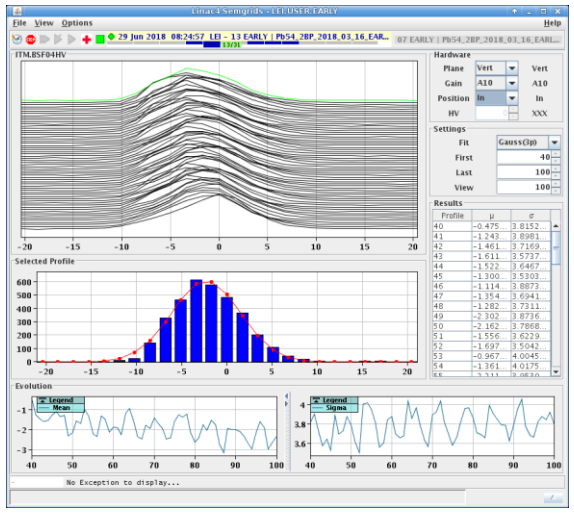


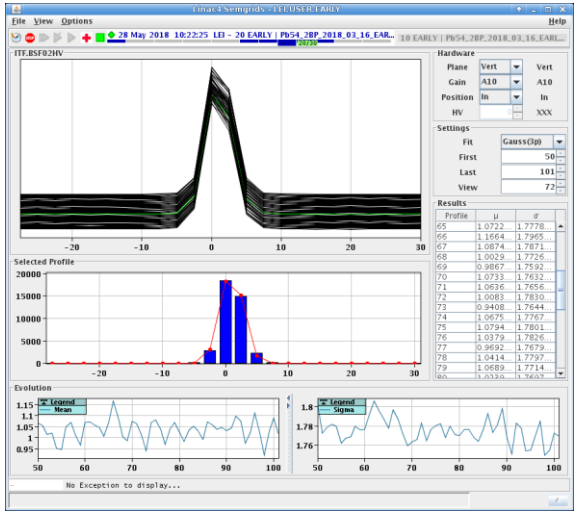


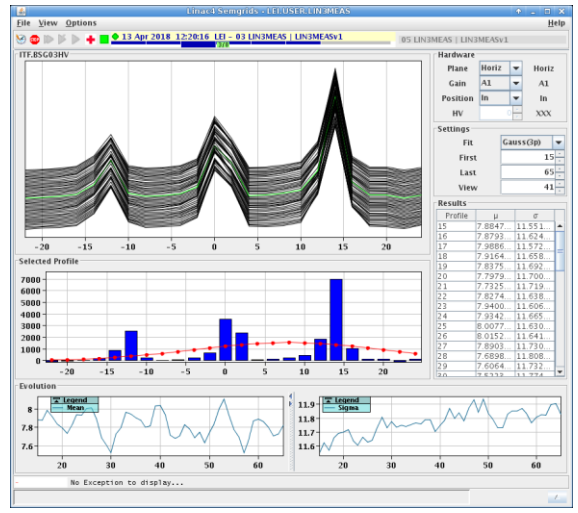




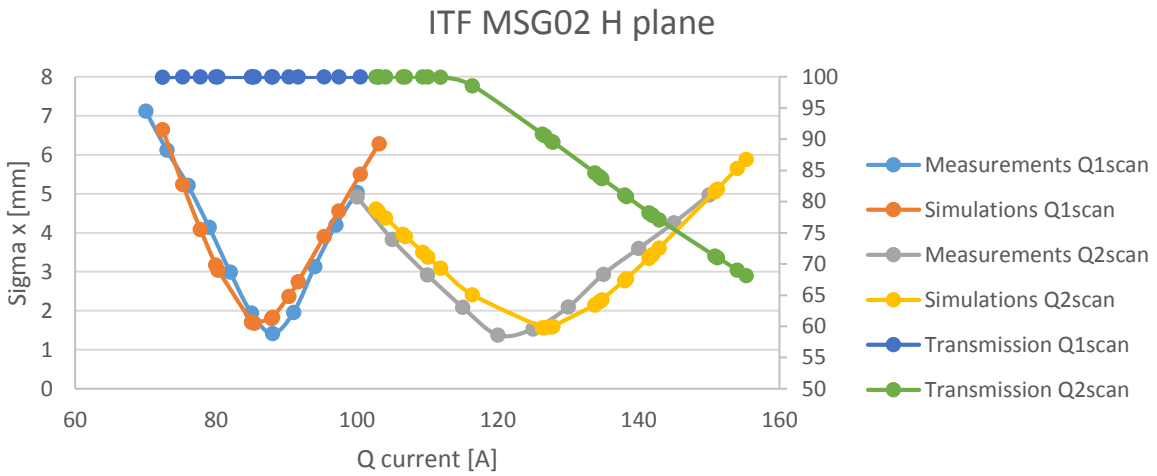


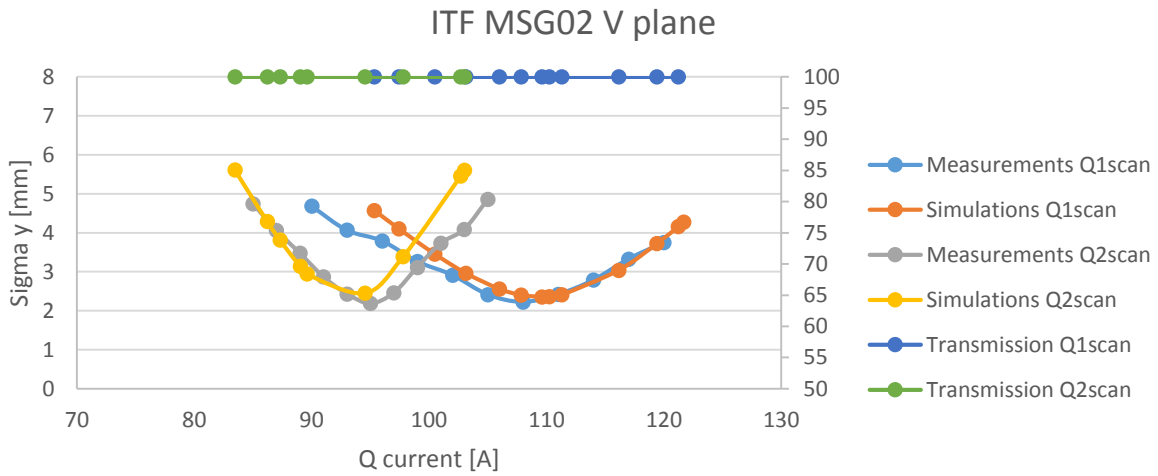




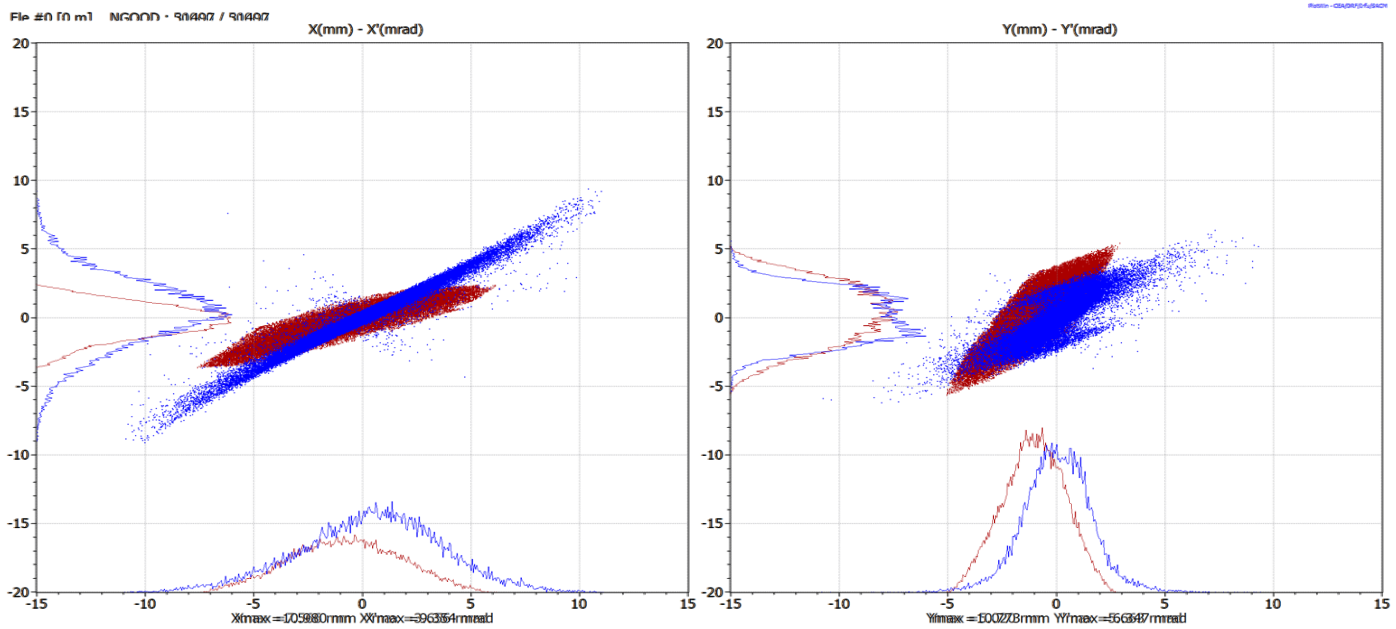


Emittance measurements via quadrupole scans and analytic/tomographic reconstruction





Example at IH exit

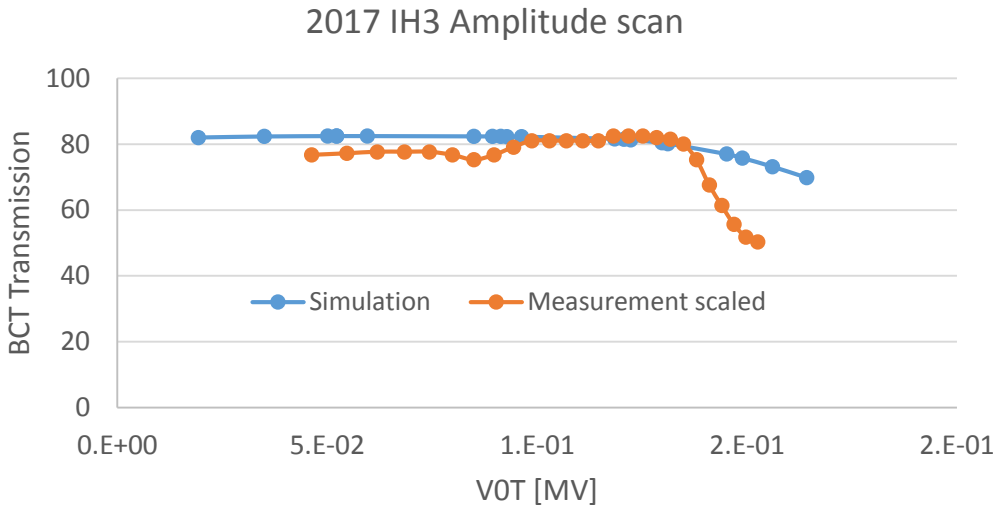


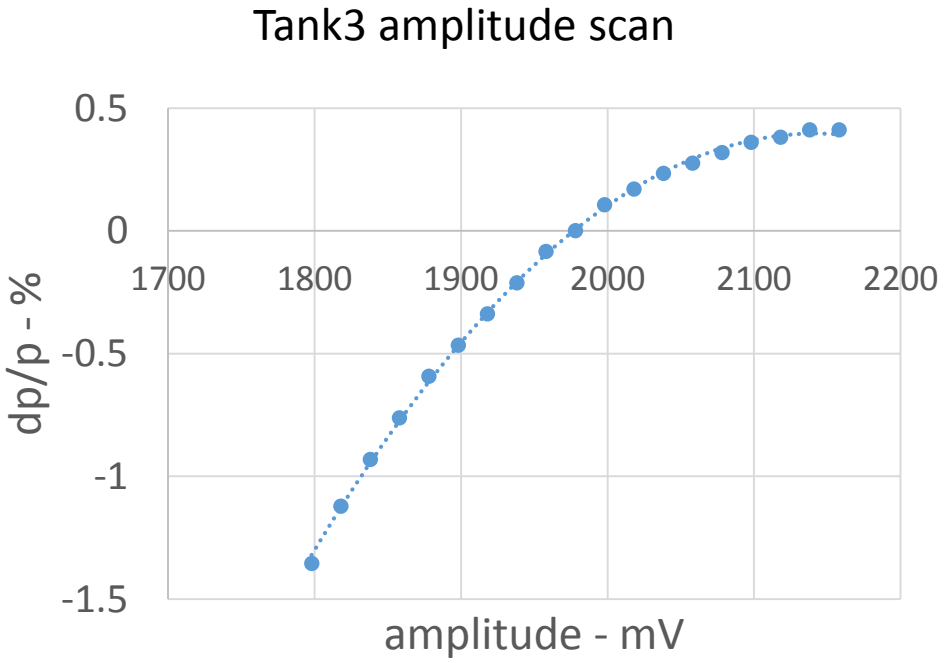
RMS normalized emittances, 2017 measurements with xenon beams

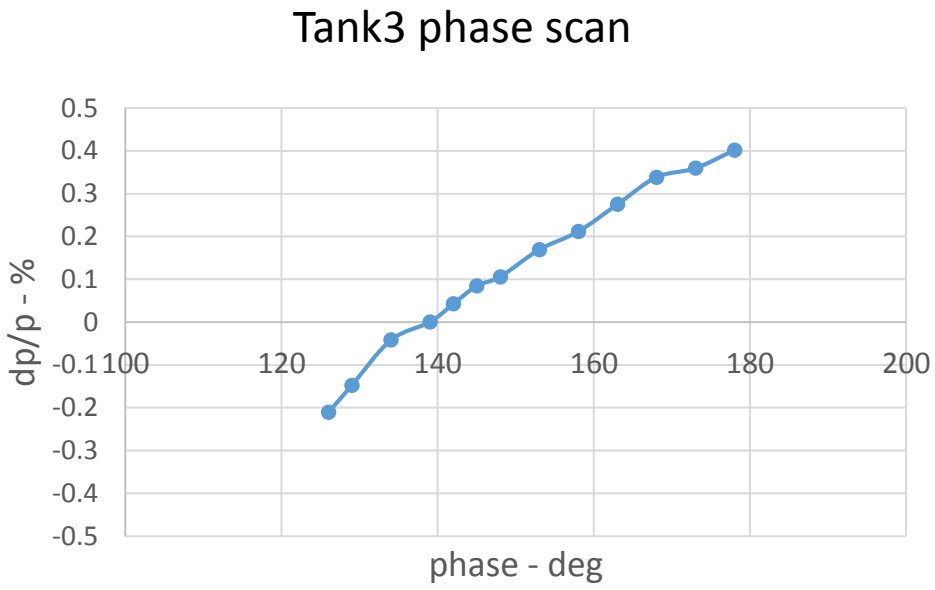
		ε_x π mm mrad	ε_y π mm mrad	α_x	α_y	β_x m/rad	β_y m/rad
ITL	*Analytical reconstruction*	0.13 0.14 0.13 0.11	0.15 0.18 0.18 0.18	-3.90 -3.49 -3.37 -3.39	-1.59 -2.50 -2.77 -2.67	1.32 1.15 1.08 0.96	0.57 0.72 0.83 1.11
	Tomographic reconstruction	0.11 0.11 0.12 0.09	0.14 0.15 0.16 0.17	-4.68 -3.98 -4.02 -3.55	-1.73 -2.57 -2.54 -2.47	1.65 1.37 1.41 1.07	0.97 0.88 0.89 1.22
ITM	*Analytical reconstruction*	0.08 0.07	0.21 0.20	0.05 0.18	3.63 4.87	0.06 0.10	0.79 1.07
	Tomographic reconstruction	0.08 0.08	0.29 0.36	0.07 0.25	2.38 3.04	0.06 0.09	0.63 0.80
ITF	*Analytical reconstruction*	0.13 0.12	0.16 0.13	-2.76 -1.82	-1.75 -1.25	6.17 4.87	1.56 1.07
	Tomographic reconstruction	0.14 0.12	0.17 0.15	-2.38 -2.09	-1.81 -1.60	5.17 5.04	1.58 1.30

RF characteristic curves of IH tanks

Scan amplitude and phase of each tank and measure transmission, beam energy and energy spread

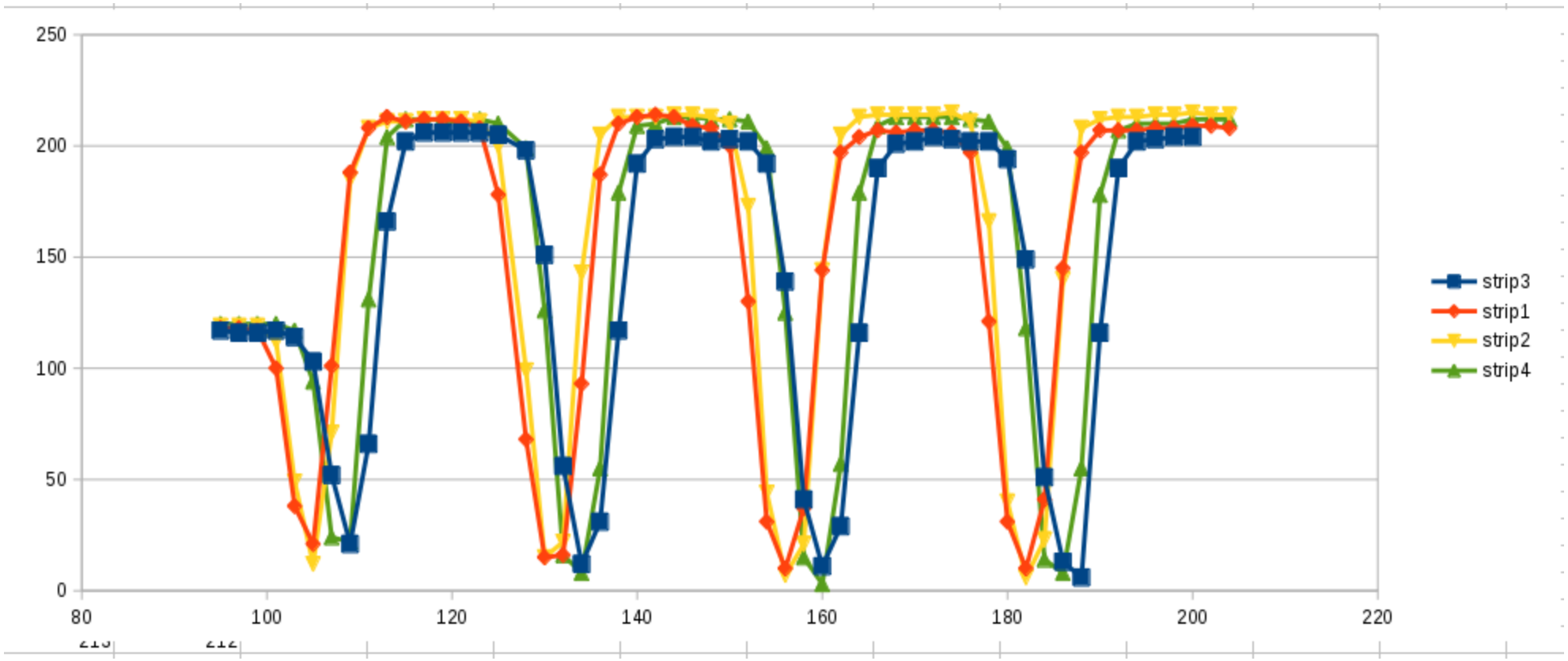






Stripper foils setup: positions measurements

Scan the stripper foil arms position (90→210mm in steps of 2mm) and record the beam current measured on ITF.BCT15 to find the center of the foils (center of the plateau with max transmission)

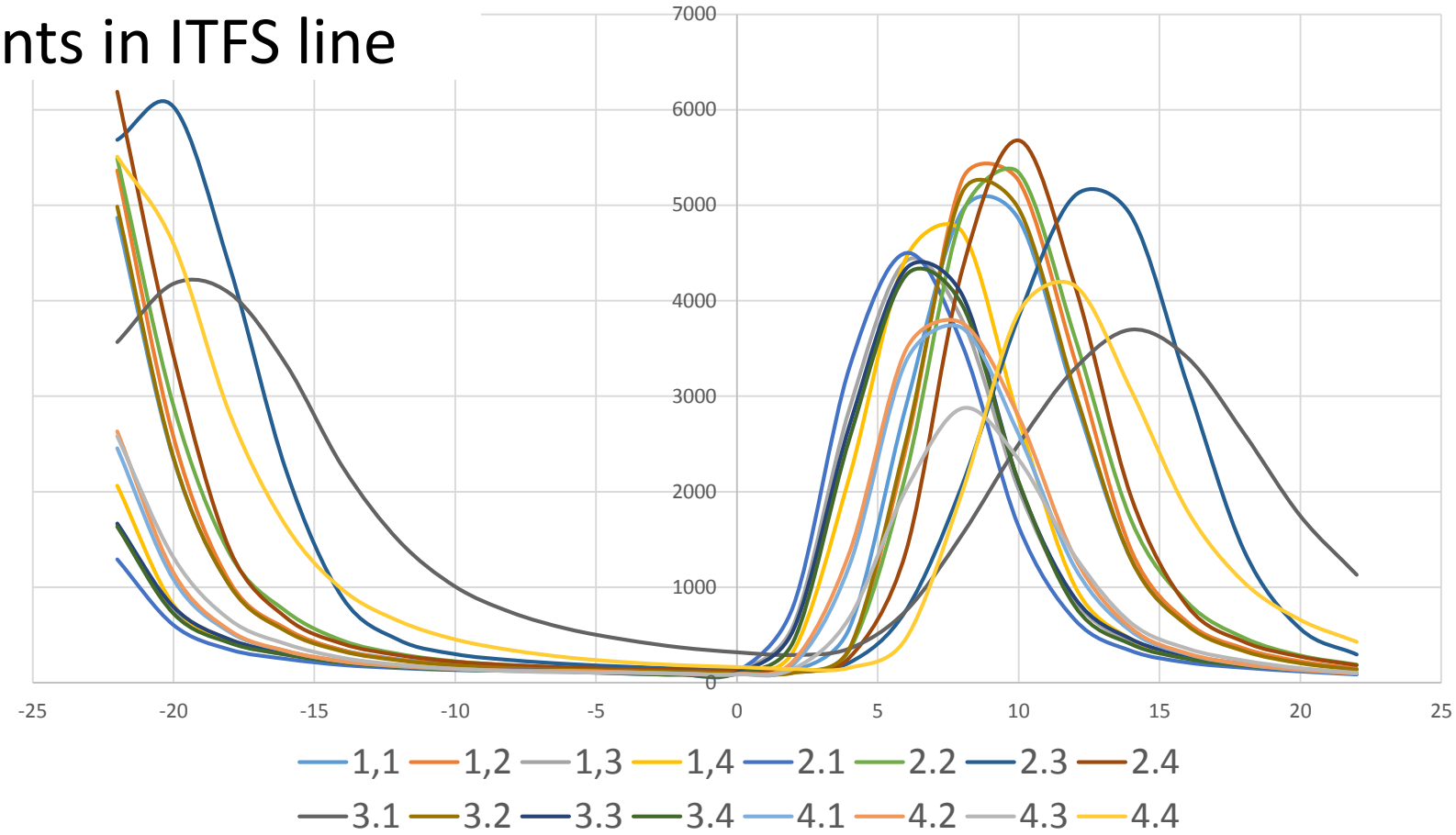


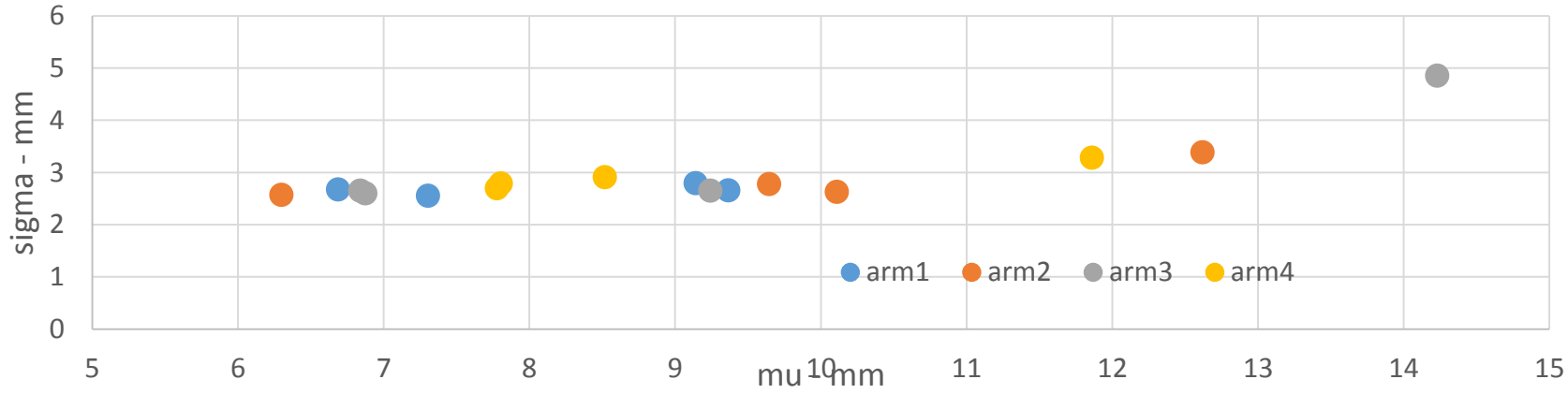
Stripper foils measurements in ITFS line

Take beam in ITFS line (ITF.BHZ12 off) with special optics for pencil-like beam and RC cavity on flat phase (zero crossing point, see later).

Measure the profiles and fit with Gaussian curve to obtain beam center and width (corresponding to energy and energy spread).

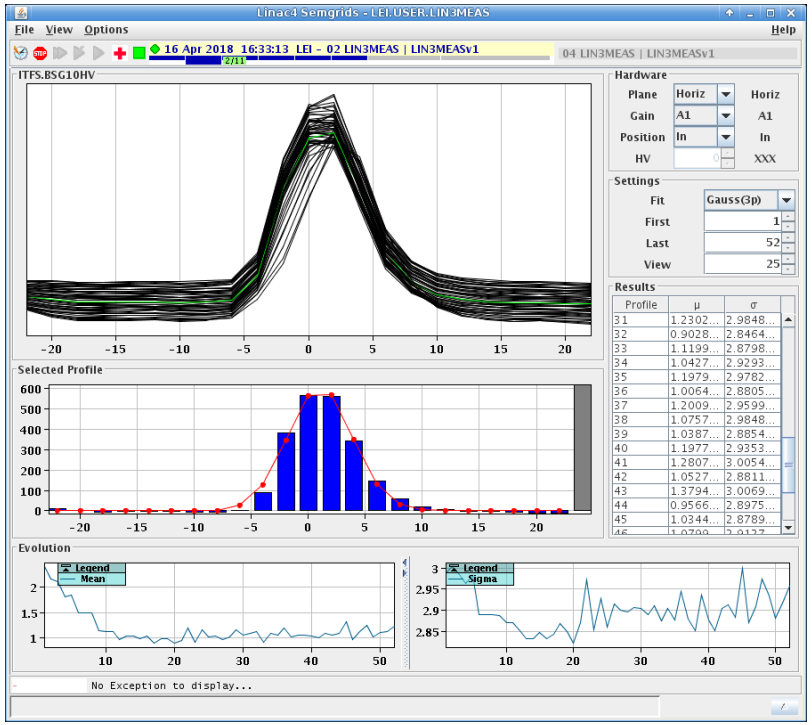
Conversion factor ~ 4.5-5keV/u per mm

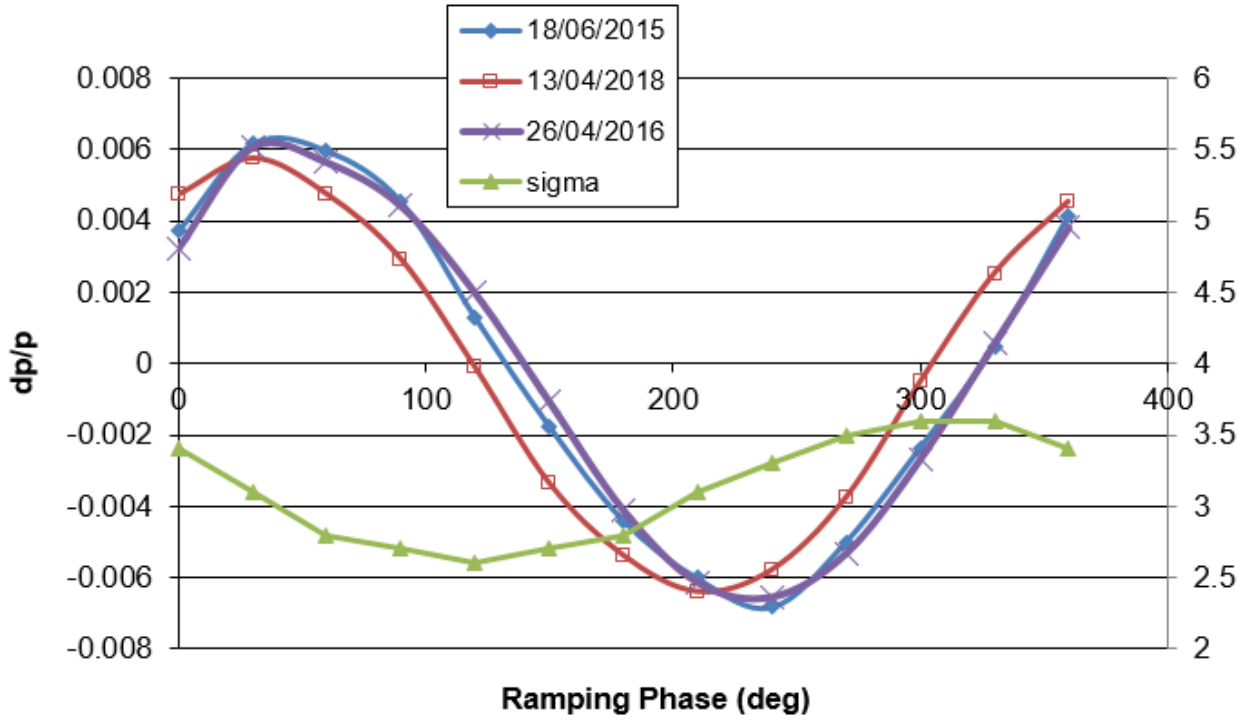




Ramping cavity setup

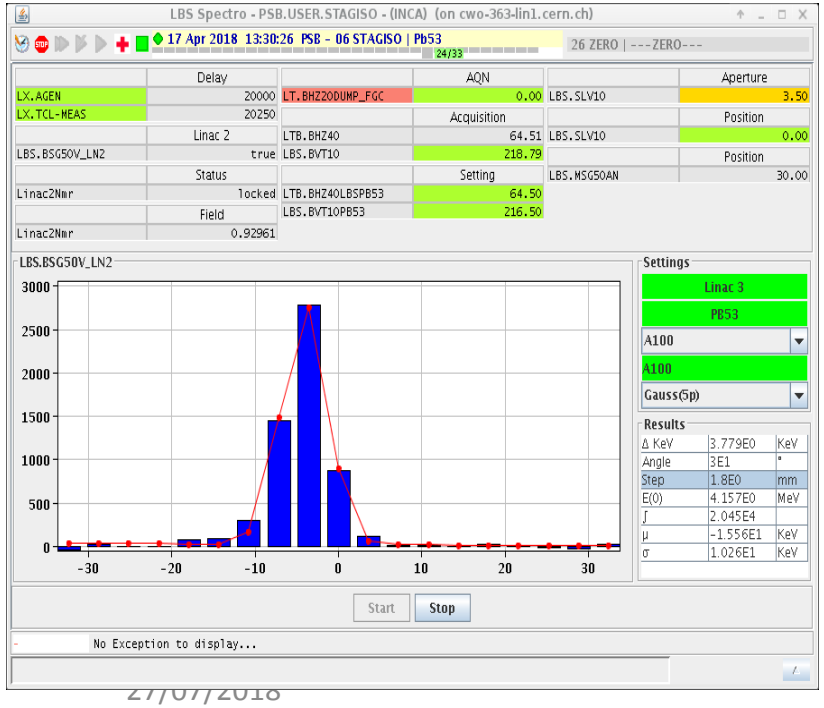
- Take the beam in ITFS line (BHZ12 off, RC on a flat phase, no ramp)
- Scan RC phase and measure the ITF.BHZ11 field that recenters the beam on ITFS.BSG10.
- Plot dp/p vs cavity phase and identify zero crossing points
- Double-check zero crossing points by switching off the cavity (modulator)

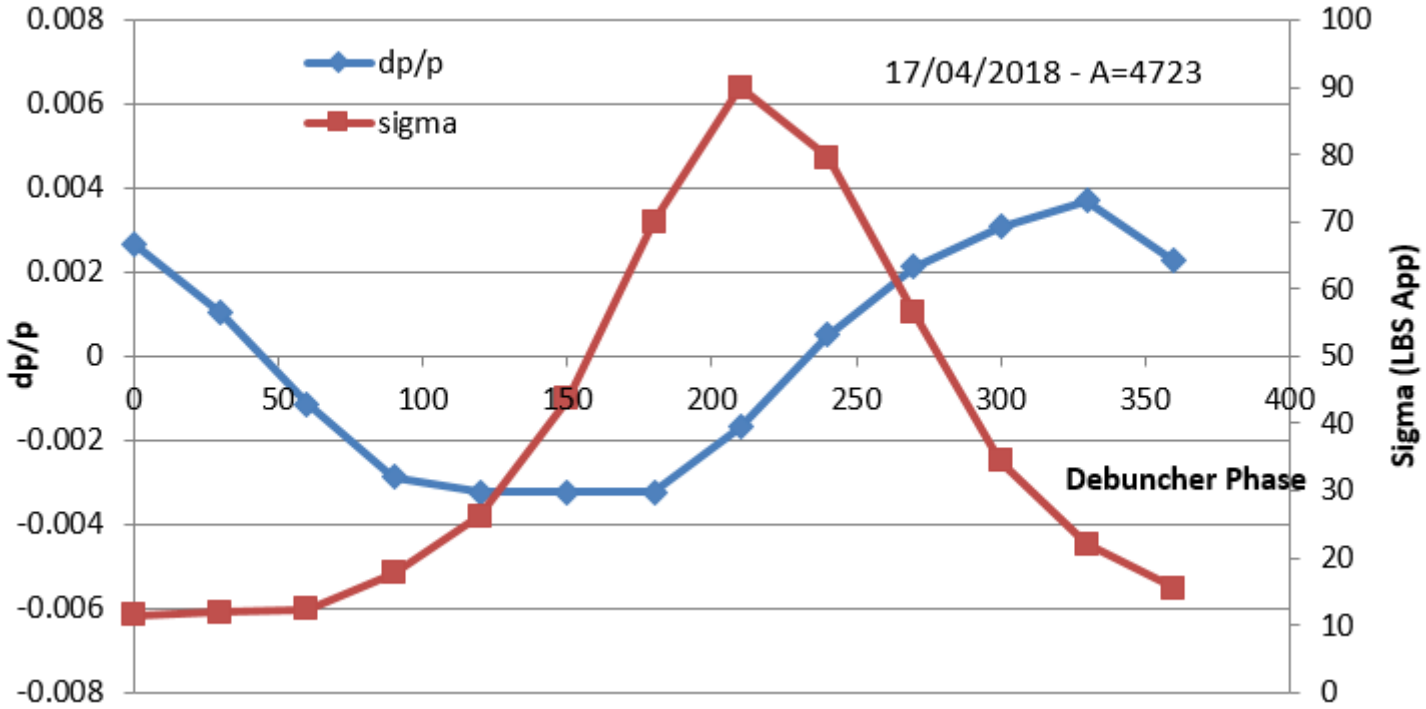




Debuncher cavity setup

- Take beam in LBS line with PSB cycle mapped to ions – use special ITH optics settings
- Scan DB phase over 360 deg (30 deg steps @ flat phase, no ramp) and re-center the beam changing LBS.BVT10 magnetic field
- Plot dp/p vs cavity phase and identify zero crossing points
- Double-check zero crossing points by switching off the cavity (modulator)





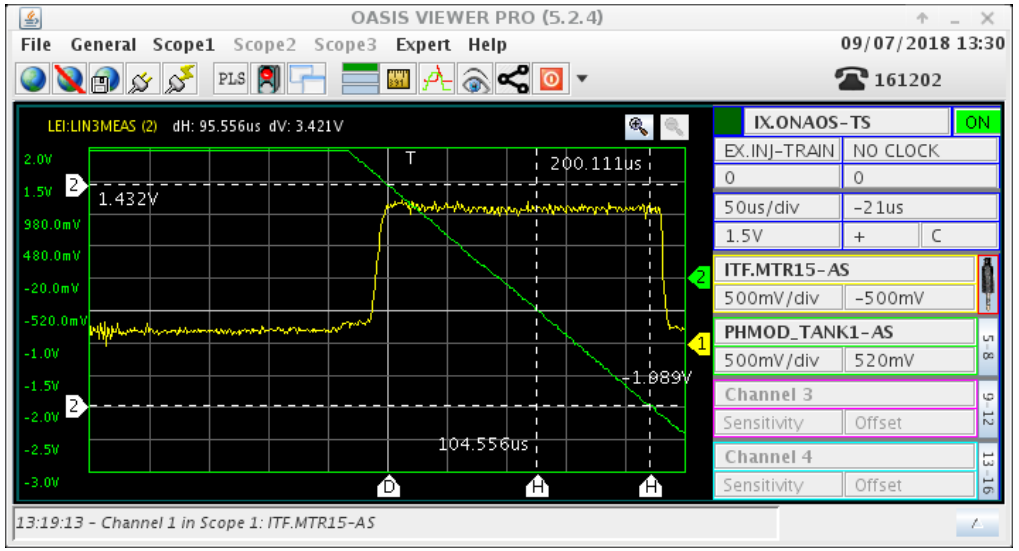
Phase ramp

Adjust phase ramp to have RC and DB zero crossing points in correspondence of the beam centre (~100 us).
The ramp settings in the RF working sets are defined over a 1ms span (-400us → 600us).
The phase ramp seen by the 200us long beam is roughly 68/73 degrees for the RC/DB cavity, roughly centered on the respective zero crossing points.

At the beam centre time (104us)
Ramping = 110 degrees.
Debuncher = 65 degrees.

The ramp rates are:

Ramping = 149->81 degrees/200us.
Debuncher = 107->34 degrees/200us.



Measurements planning and data storage

Today:

- Reference measurements are taken during the machine setting-up period at the beginning of the run (normally first ~6 weeks) and during MD time (current agreement of one day per week, on Mondays, outside of physics run).

- Data logged locally in /acc/java/data/ln3/ and transferred to dfs space: G:\Workspaces\h\HadronLinacs\Linac3

- Some summaries of data analysis and reference plots are published on the Linac3 wiki pages

In the future:

-scope to make the procedure more methodical (e.g. add documentation to the Wiki pages with description of procedures, reference plots etc.)