

LINAC4 Actions Follow up

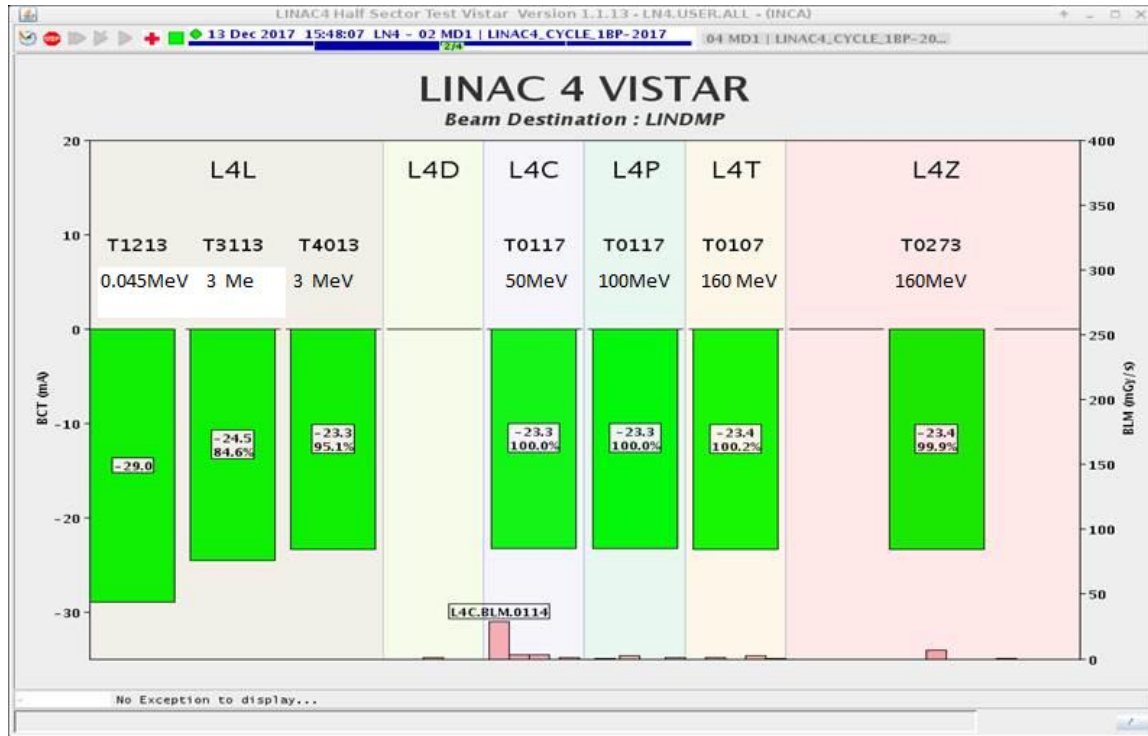
LINAC4 core supervisors : Giulia Bellodi, Jean-Baptiste Lallement, Silvia Schuh, and Alessandra Lombardi

ABP linkperson to OP : Silvia Schuh

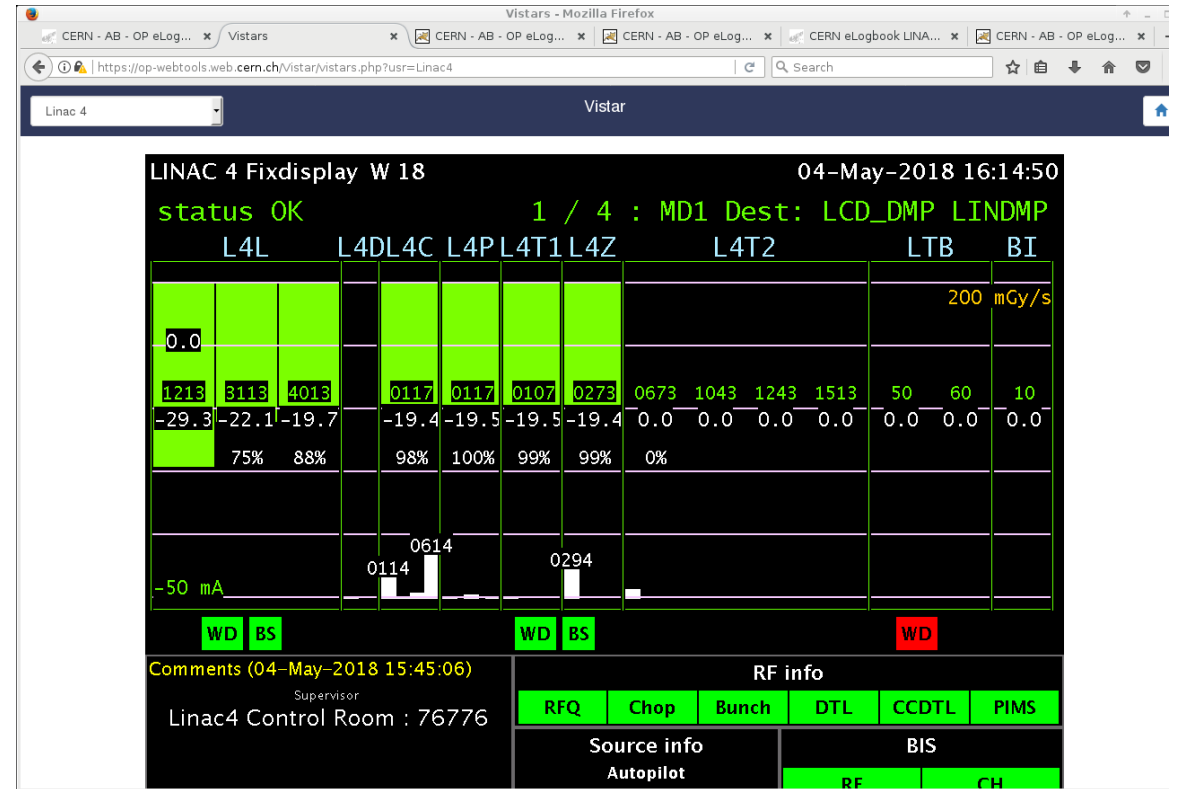
Source in the tunnel during the run2017-18

- Performance achieved (at 160mA) :
 - Current : 20mA
 - Emittance : 0.3 mm mrad rms / smaller with laser system (0.2 mm mrad rms)
 - Useful Pulse length (5%flatness) : 600 μ sec
 - Pulse-to-pulse : 2%

current



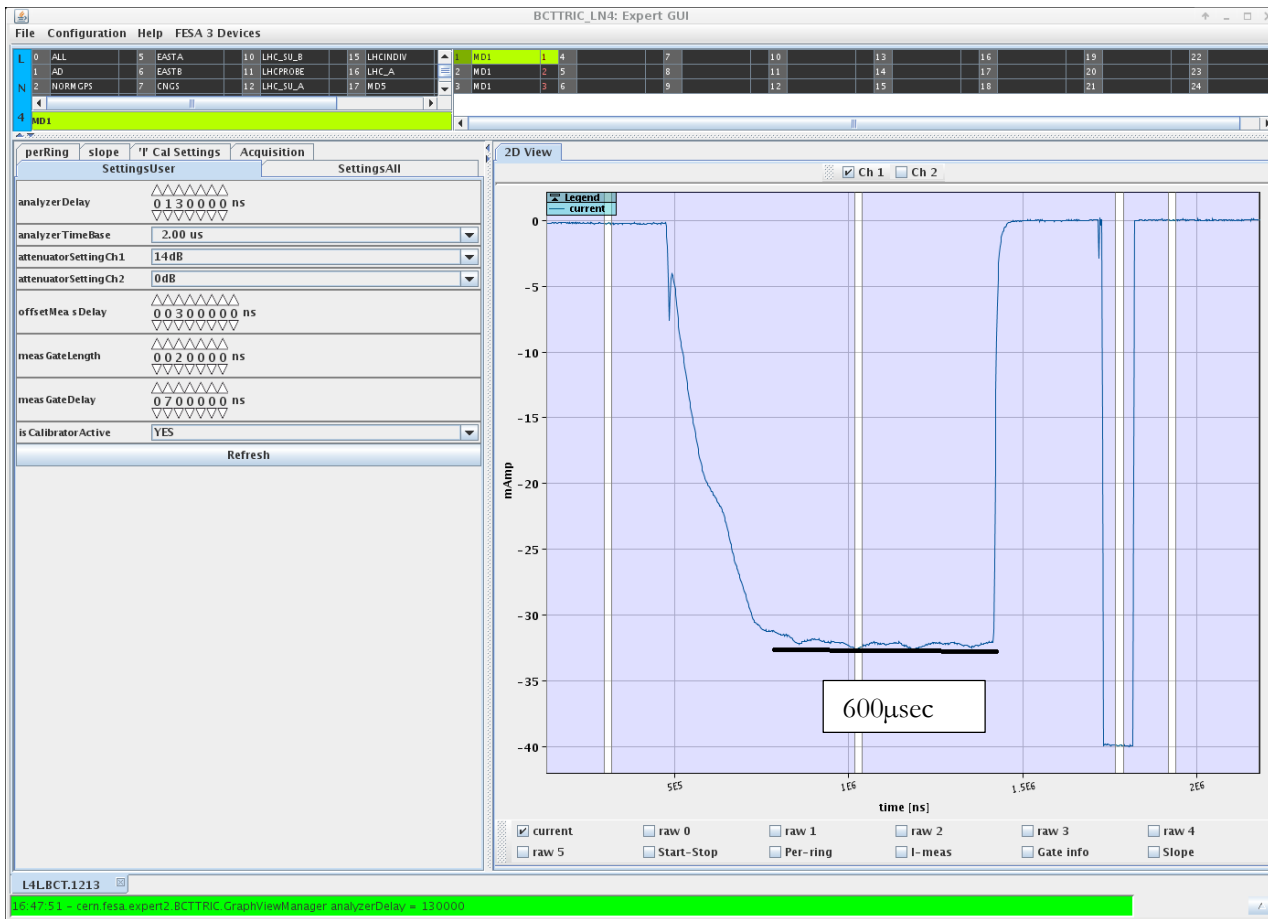
Run 2017 – December



Run 2018 – May – after cesiation

The source has had issues during the 2018 run. These issues are due to a problem in the gas valve. This should be sorted out by the next run. We count on 20mA at the end of the linac

600 μ sec good pulse length



Measured 18 may 2018 –variation over 600 μ sec is 6% but when going through the RFQ the difference are flattened to few %.

From the linac4 side we can inject 150turns per ring.

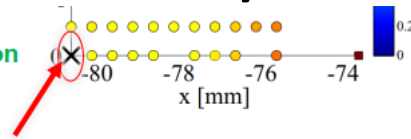
We need to get rid of the head of the pulse :

- 1) Part with the pre-chopper (tests in septembre)
- 2) Part with the chopper (1 ms operation is demonstrated with additional cooling, Anthony Jones and Mauro Paoluzzi)

With this source we can do all the beams that are produced today

Vincenzo Forte HB2018

- Negligible impact of reduced L4 current (20 mA before chopping) on final LIU LHC Standard beam emittance



5000 turns

L4 current = 40 mA; $\epsilon_{x,y,n} = 0.4 \mu\text{m}$; Matched optics

L4 current = 20 mA; $\epsilon_{x,y,n} = 0.3 \mu\text{m}$; Matched optics

L4 current = 20 mA; L4 $\epsilon_{x,y,n} = 0.3 \mu\text{m}$; Mismatch. optics

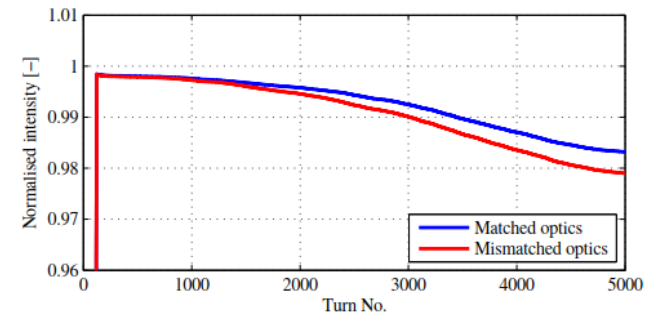
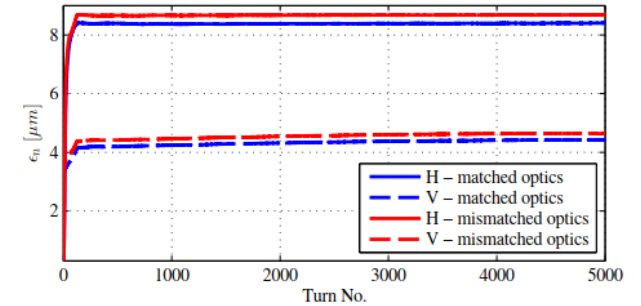
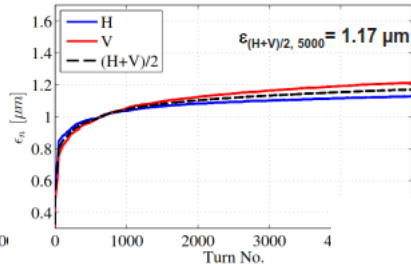
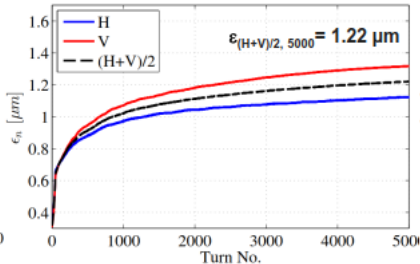
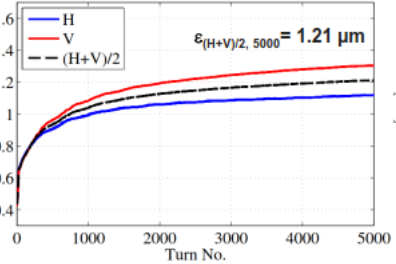


Figure 13: Results of tracking studies for an ISOLDE beam at $N_{\text{target}} = 1 \times 10^{13}$ ppb.

CONCLUSIONS

The recent performance of the Linac4 corresponds to $I_{\text{peak}} = 20$ mA before chopping and a transverse normalised emittance $\epsilon_{x,y,n} = 0.3 \mu\text{m}$. New simulations for the PSB injection process of the LIU LHC Standard beams were performed with these latest parameters. Space charge, optics mismatch, scattering foil and beta-beating compensation due to the lattice perturbation introduced by the injection bump were included in the tracking studies. The results showed a negligible impact with respect to the target performance with Linac4 $I_{\text{peak}} = 40$ mA and emittance $\epsilon_{x,y,n} = 0.4 \mu\text{m}$, if other requested Linac4 parameters are inside the defined range [8].

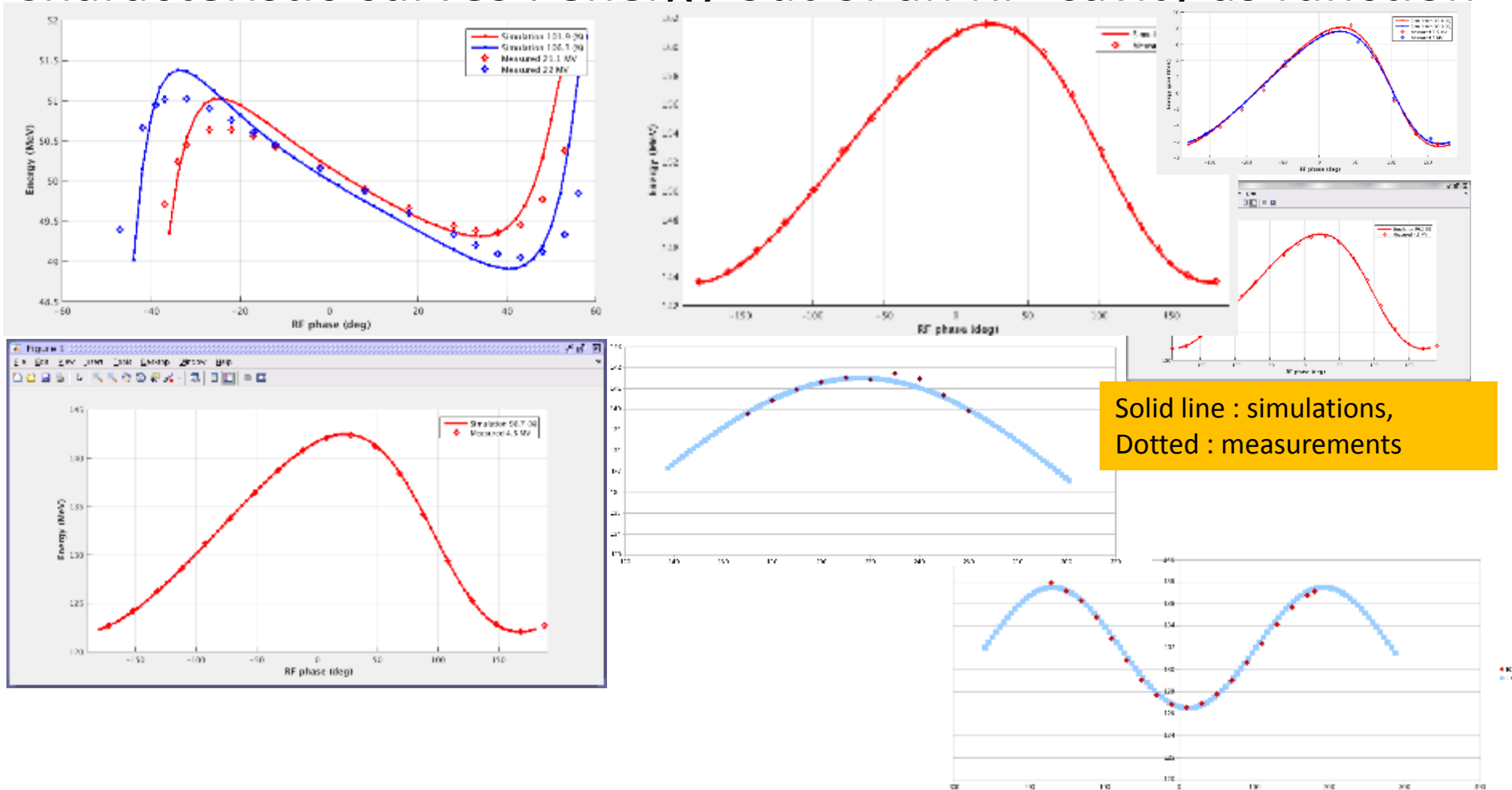
Simulations for high intensity beams (ISOLDE) showed that, with the present current, the PSB should be able to produce bunches of 1×10^{13} ppb in 124 turns, which might vary depending on the choice of longitudinal painting parameters. If one considers a maximum of 150 turns injection per ring,

The RF phases setting –completely solved

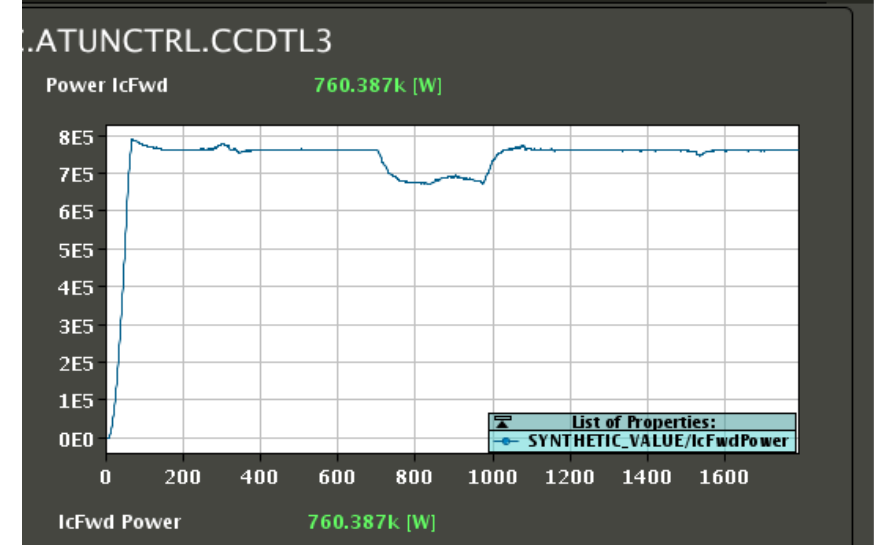
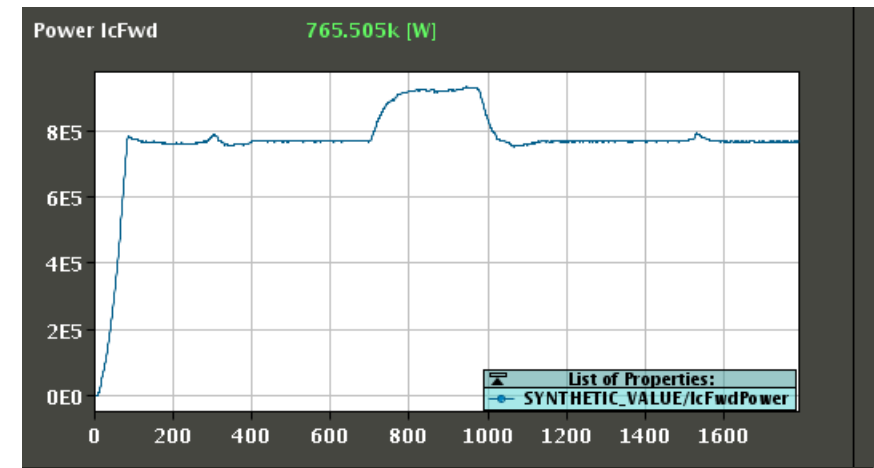
- To set the phases use the beam characteristics
- Scan the phase of each cavity, measure the beam average energy and find the match with pre-calculated curves
- To find the beam energy : either beam loading or ToF (more precise at the higher energy)
- Script based on beam loading written by ABP, setting of the whole linac in 1 hour. - available since xx
- Procedure being written by ABP to set the phases of each cavity (total is 25 phases to be set)

Characteristics curve

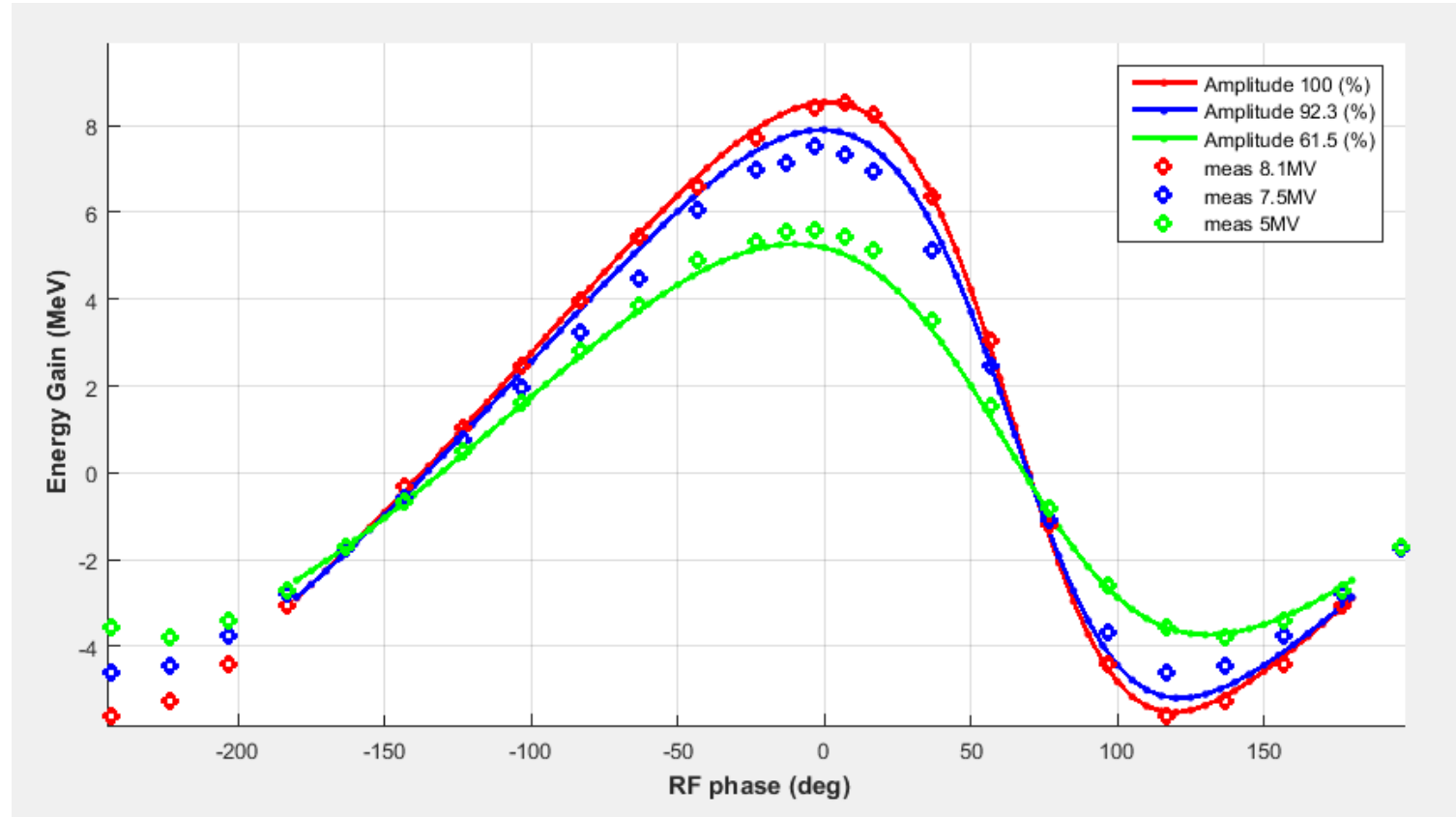
Characteristic curves : energy out of an RF cavity as function



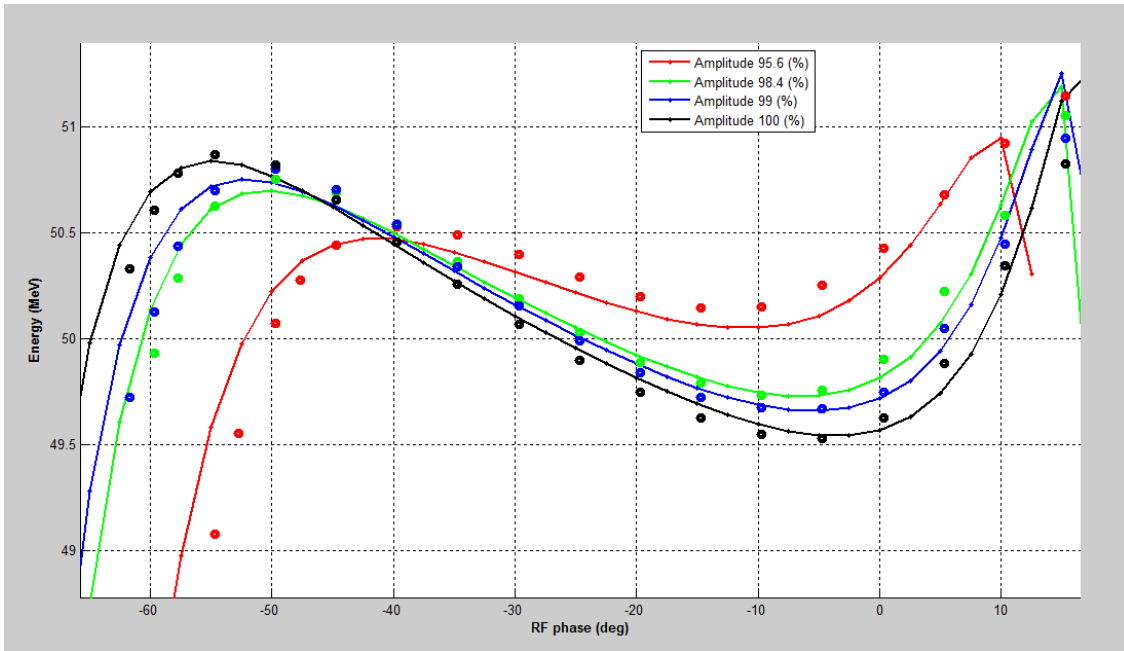
Measure the energy : ToF vs beam loading



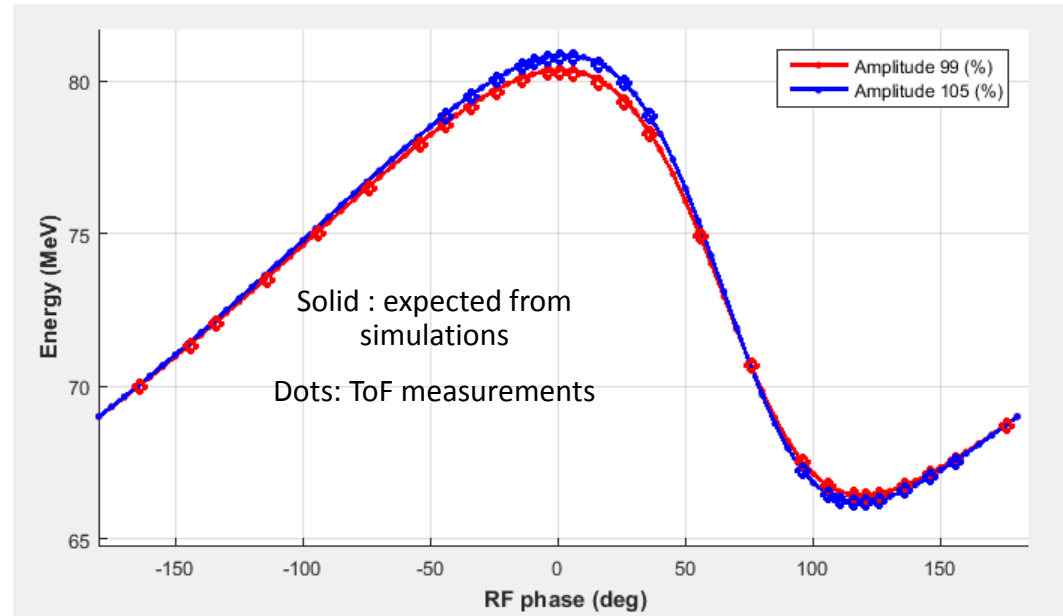
Energy gain from beam loading vs phase



Time-of-flight



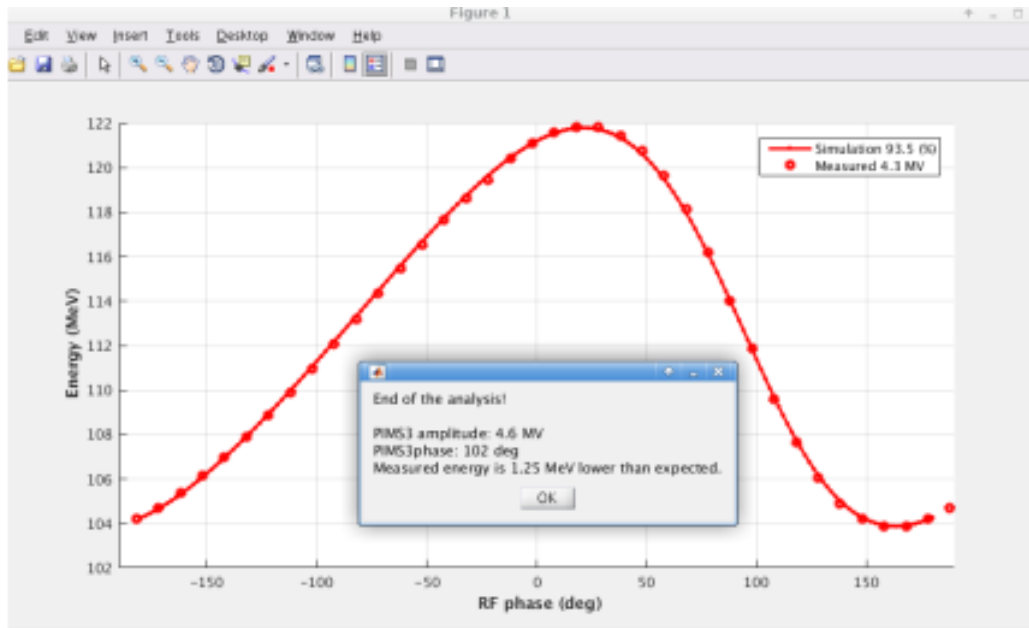
50 MeV : Energy measurement vs DTL tank3 Phase for different amplitudes



80MeV : Energy measurement vs CCDTLmodule4 Phase for different amplitudes

Automated procedure based on beam loading

- Script (python) to scan the phase and calculate the energy from beam loading written by ABP
- Off line analysis to fit data and find phase



Proposal : OP picks this up and makes into a suitable application

- Another question was the LINAC4 during 2019. Malika commented that it is not given that it will be possible to run in 2019. She would like to know what it would take to do all the tests foreseen for 2019 in 2018. **Action to Giulia:** Analysis to be made to identify what can be anticipated in the case this is needed.

Min. peak current (before chopping)	40 mA	comments
Intensity flatness along the pulse for pulse lengths up to 160 μ s Intensity flatness along the pulse for pulse lengths >160 μ s Beam energy Current stability shot-by-shot Nominal chopper operation/extinguish factor	$\pm 2\%$ $\pm 5\%$ 160 MeV $\pm 2\%$	Measured during the 2017-18 run . No special need to remeasure. Certainly no need to arrive to the PSB lines
Horizontal/vertical position variations along the pulse	± 1 mm	Measured during the 2017-18 , can be projected at the PSB entrance, would be better to measure at the LBE.
Horizontal/vertical injection angle error	$\pm < 0.4$ mrad	
Normalized transverse emittances	≤ 0.4 mm mrad	Measured during the 2017-18 at the end of the linac , to be measured in 2019 at the PSB. Not that important for the emittance value but crucial for alphas and betas.
Ppm energy spread	$\sim 80-450$ (600) keV	Can be measured only in 2019 because we need debuncher
Energy painting		Can be measured only in 2019

Planning up to 2020

- So far the 2019 run during LS2 is on, Julie has a meeting on July 2nd to finalise details, no show stoppers identified. Coordination needed especially during the critical period of LS2.
 - 2018
 - 2019 running to the LBE
- Get planning or delete

<https://indico.cern.ch/category/10274/>

June 2018

 26 Jun [Linac4 towards operation - review](#)

May 2018

 09 May [Towards Operations meeting #5](#)


 02 May [Towards Operations meeting #4](#)

April 2018

 25 Apr [Towards Operations meeting #3](#)

 18 Apr [Towards Operations meeting #2](#)

 11 Apr [Towards Operations meeting #1](#)

 Managers

 Mike Lamont