Longitudinal beam parameters study in SNS Linac

A. Aleksandrov, S. Assadi, J. Galambos, S. Henderson
Oak Ridge National Laboratory, Oak Ridge TN, 37830, USA

A. Feschenko, L. Kravchuk, A. Menshov

Institute of Nuclear Research, Moscow, Russia

UT-BATTELLE

HFIR

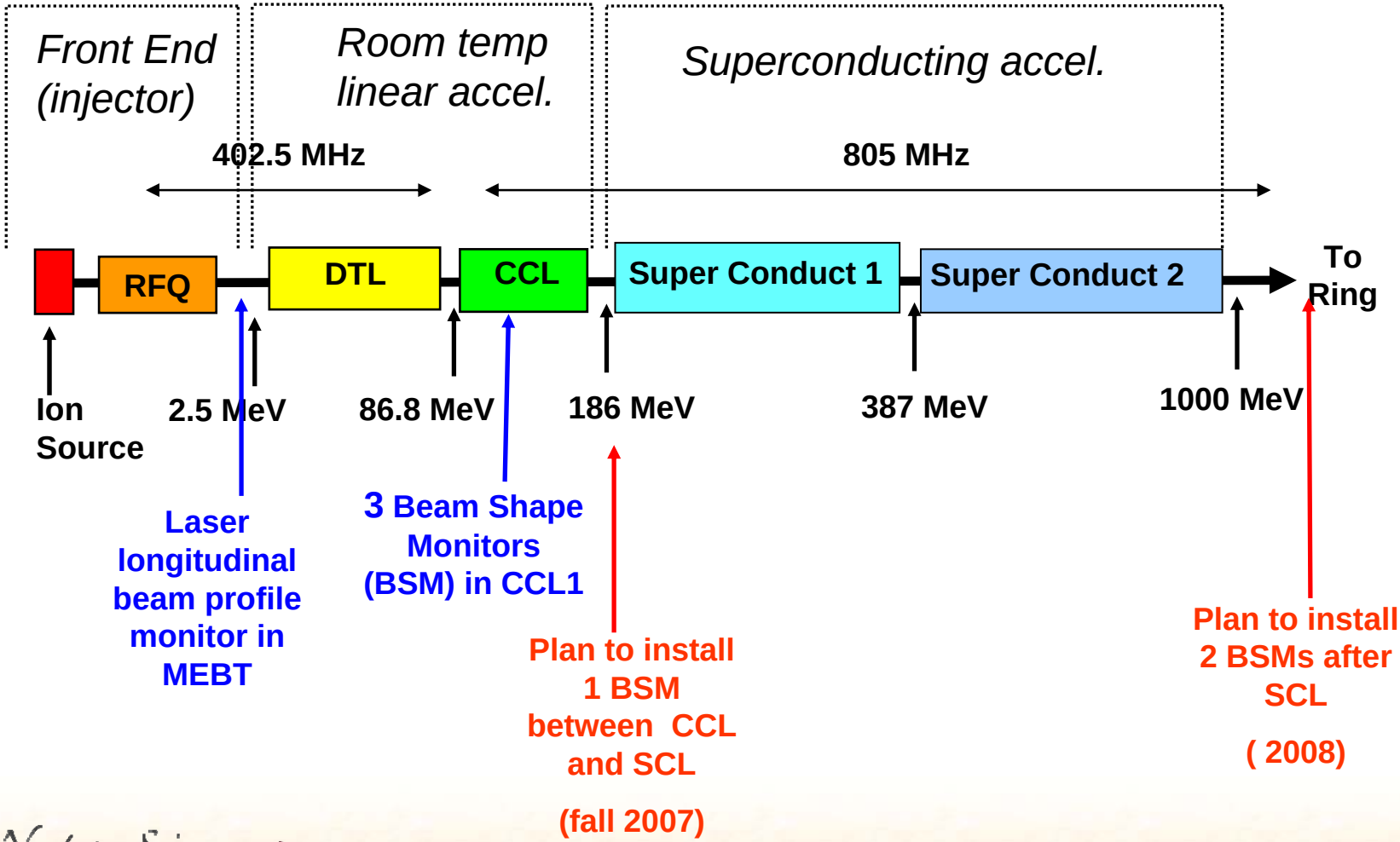
SNS
SPALLATION NEUTRON SOURCE

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

Outline

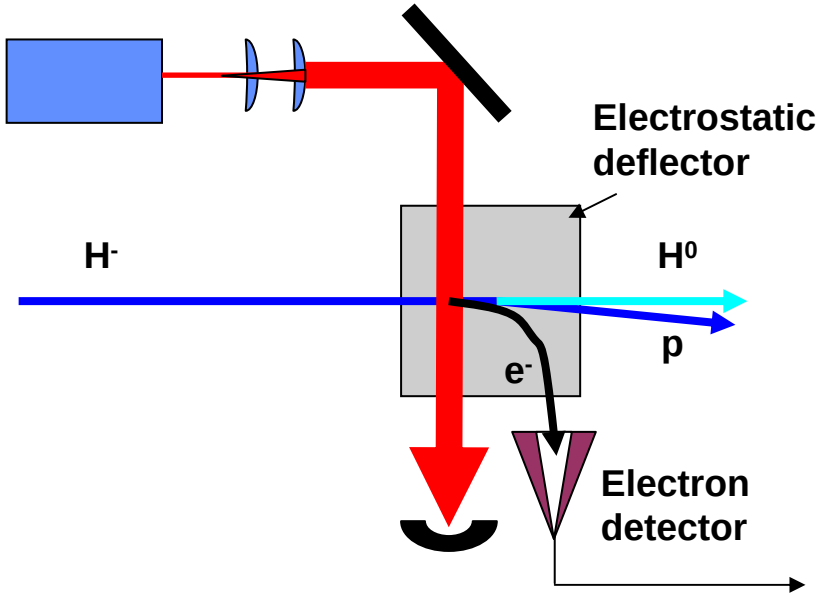
- **Longitudinal beam diagnostics at SNS linac**
- **Use of longitudinal measurements:**
  - **Linac systems troubleshooting**
  - **Model and linac tuning validation**
  - **Beam charachterization**
- **Longitudinal tail measurement capability**

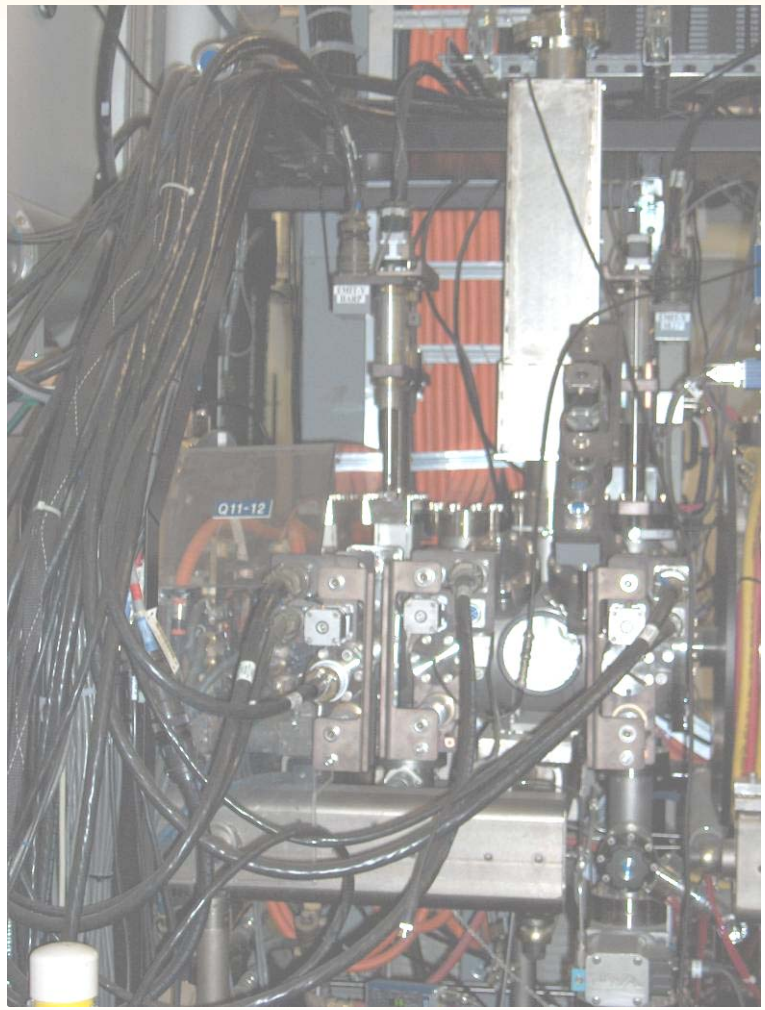
Longitudinal beam profile diagnostics in SNS LINAC



Laser Profile Monitor in SNS MEBT

Mode - locked laser synchronized with 5th sub - harmonic of LINAC RF (~80 MHZ)

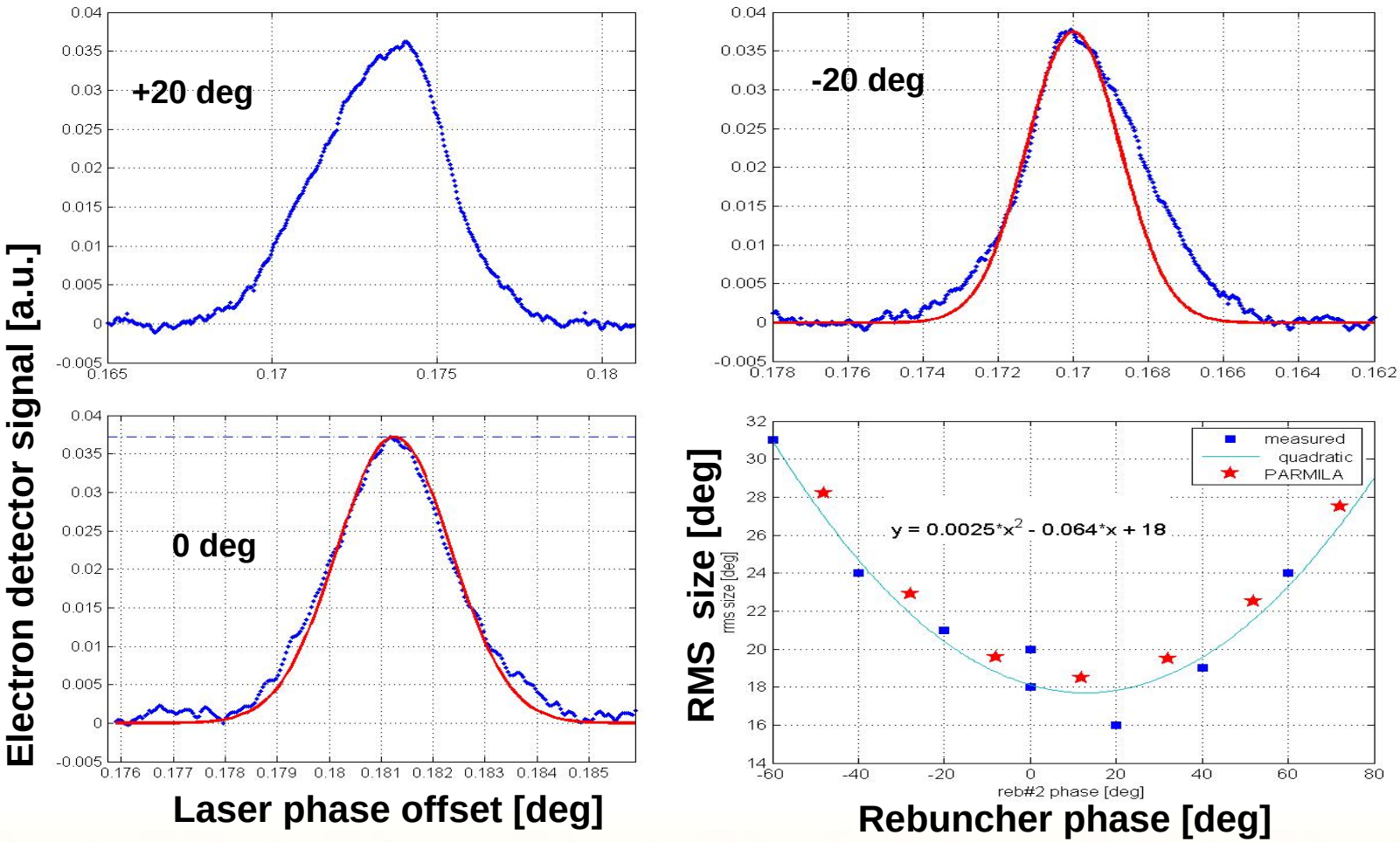




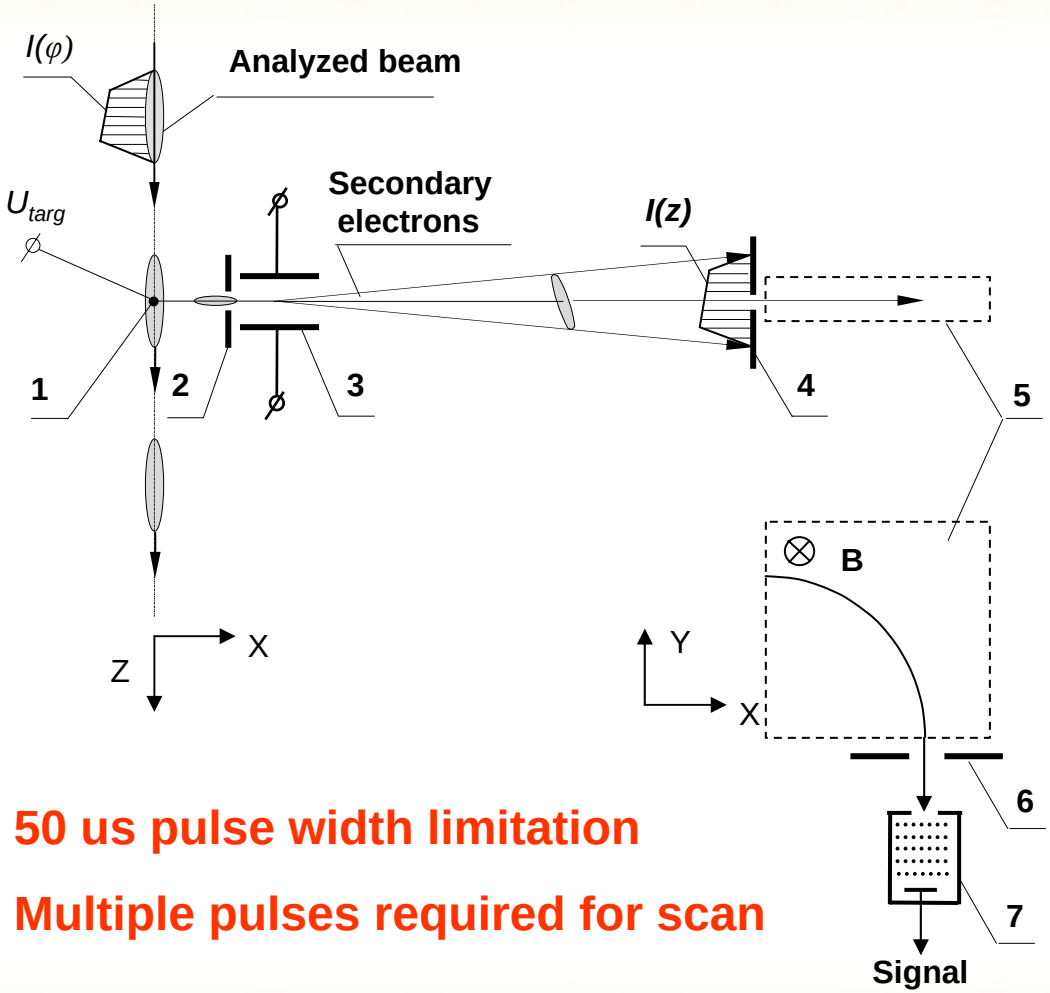
Non-perturbing

Single pulse measurements is possible

Longitudinal beam profile measurements in SNS MEBT



Bunch Shape Monitor (INR development)

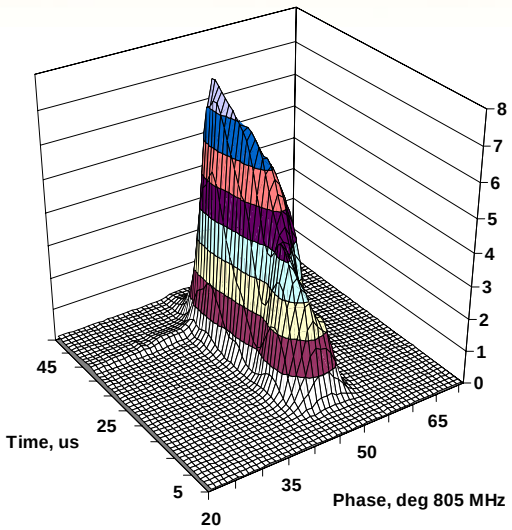


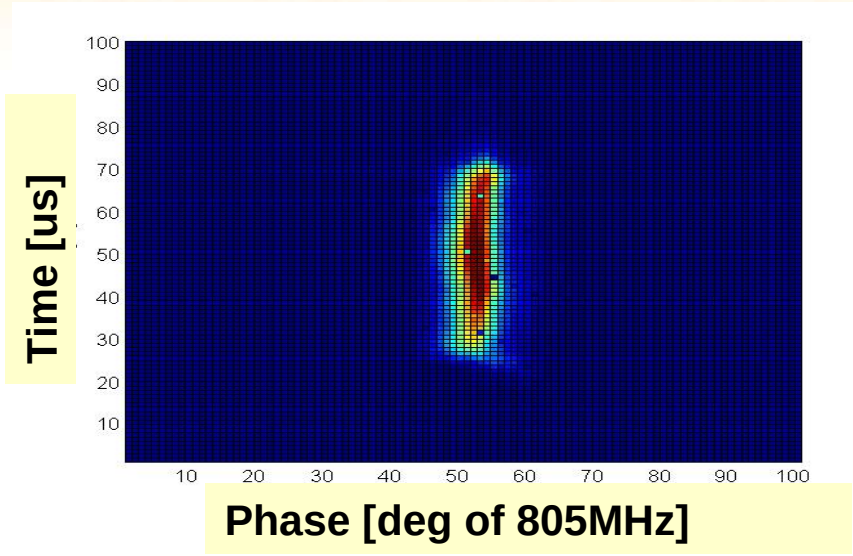
1 - target,
2 - input collimator,
3 - rf deflector combined with electrostatic lens,
4 - output collimator,
5 – bending magnet,
6 – collimator,
7 – Secondary Electron Multiplier

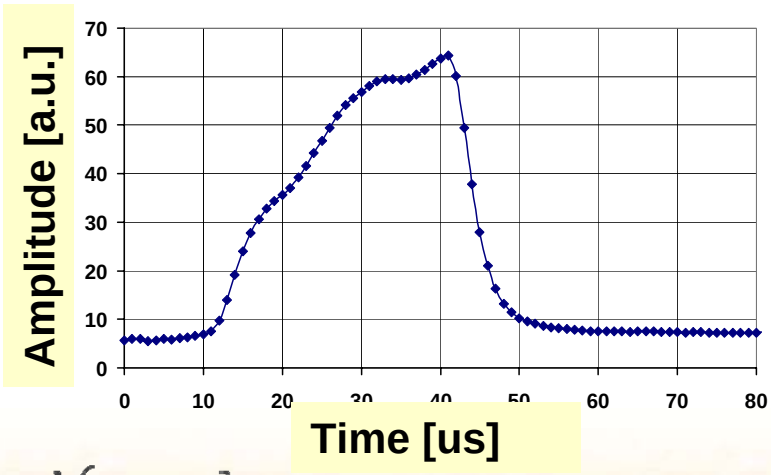
50 us pulse width limitation

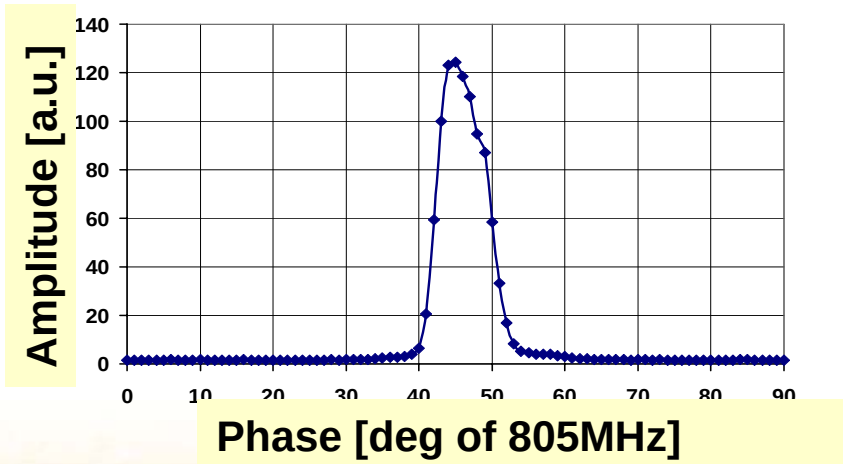
Multiple pulses required for scan

Longitudinal beam profile in SNS CCL1





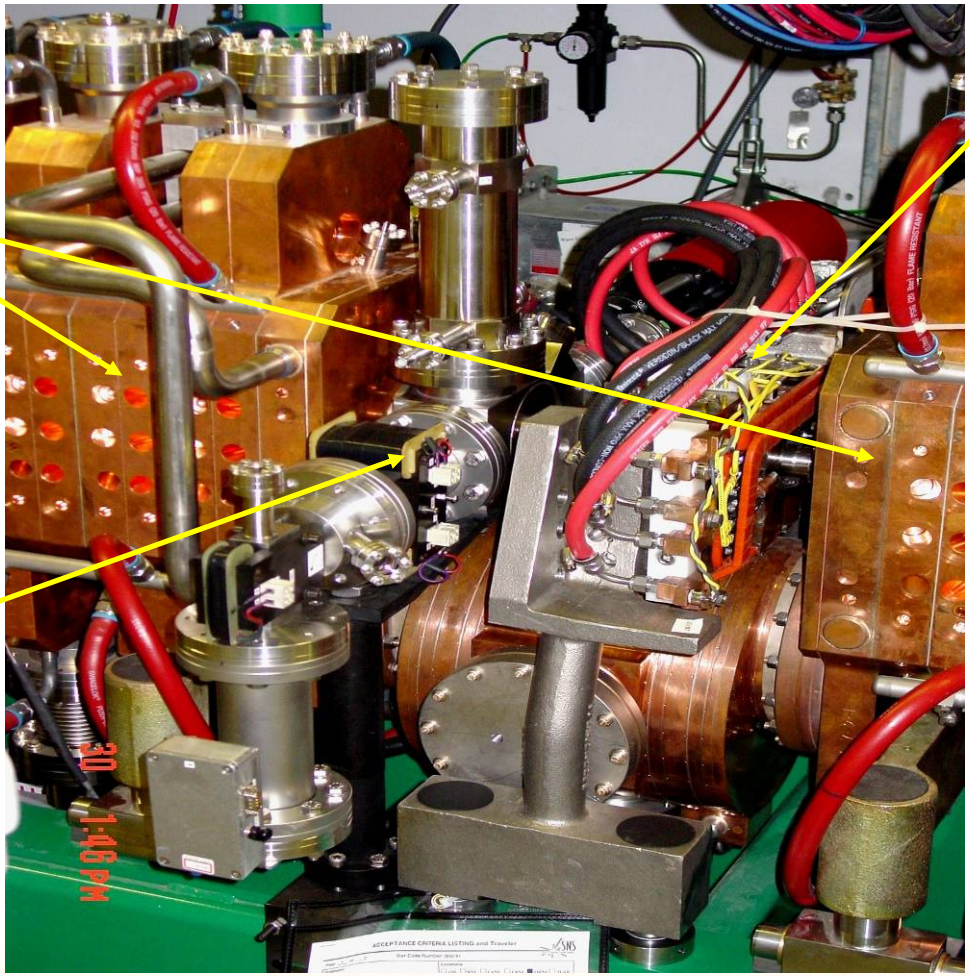




BSM installed in SNS CCL1

CCL segments

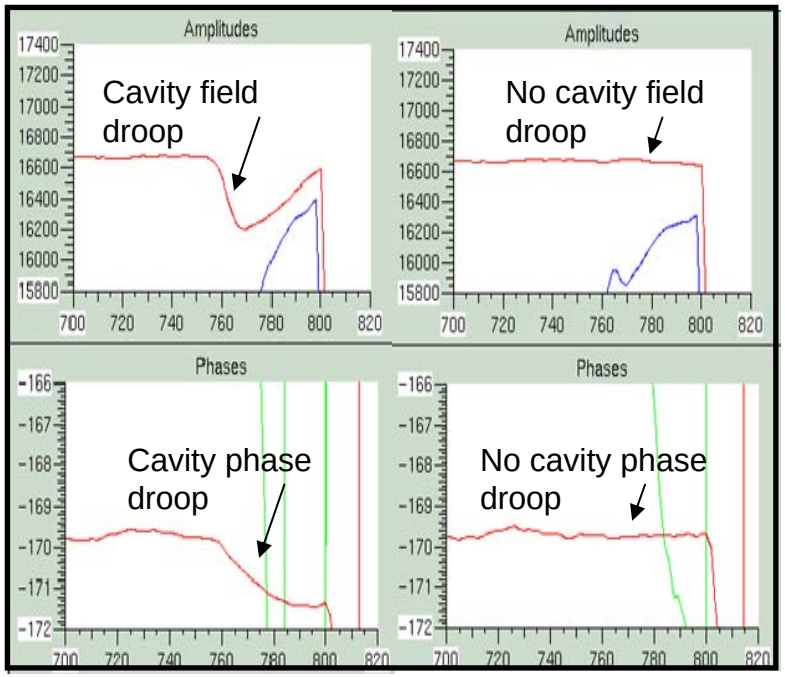
Quadrupole magnet

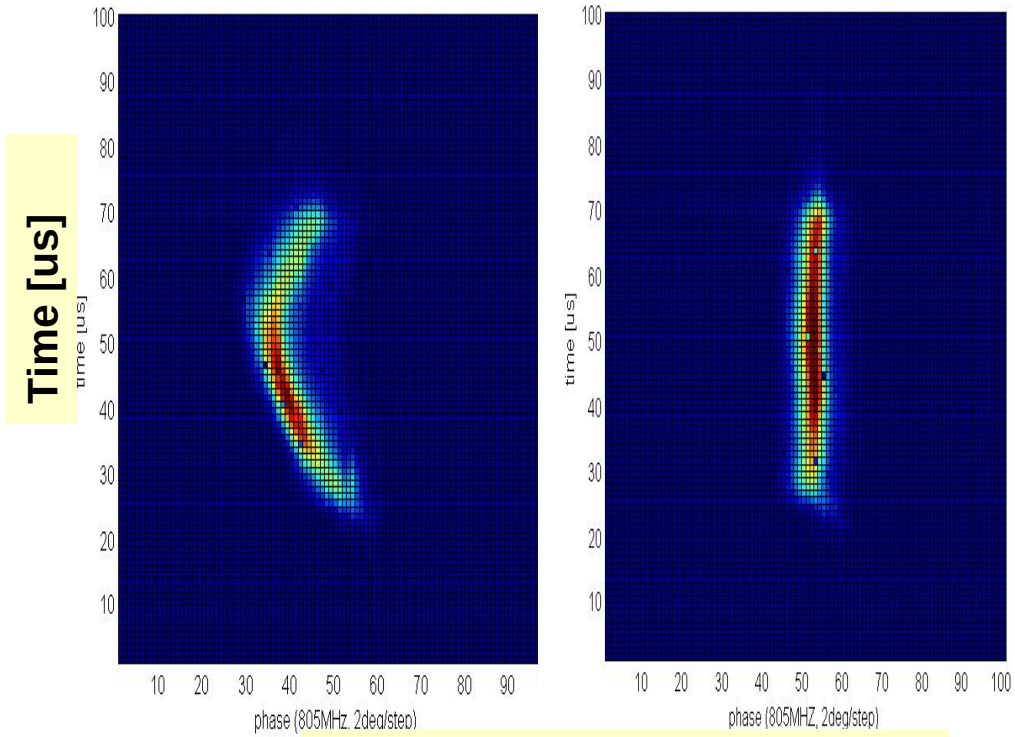


BSM

Beam tuning troubleshooting examples (I)

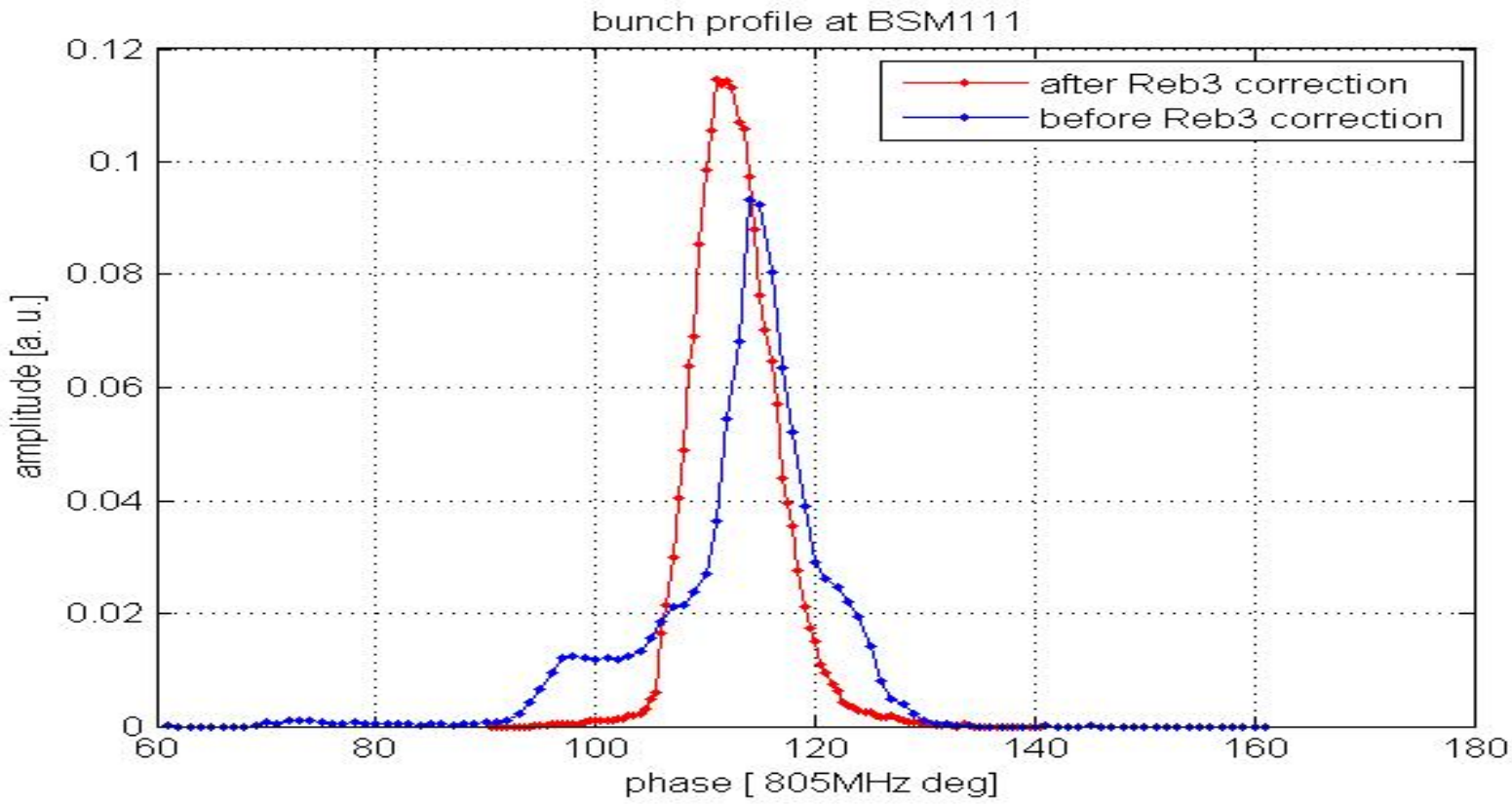
Phase variation along the pulse due to poor RF feedback operation



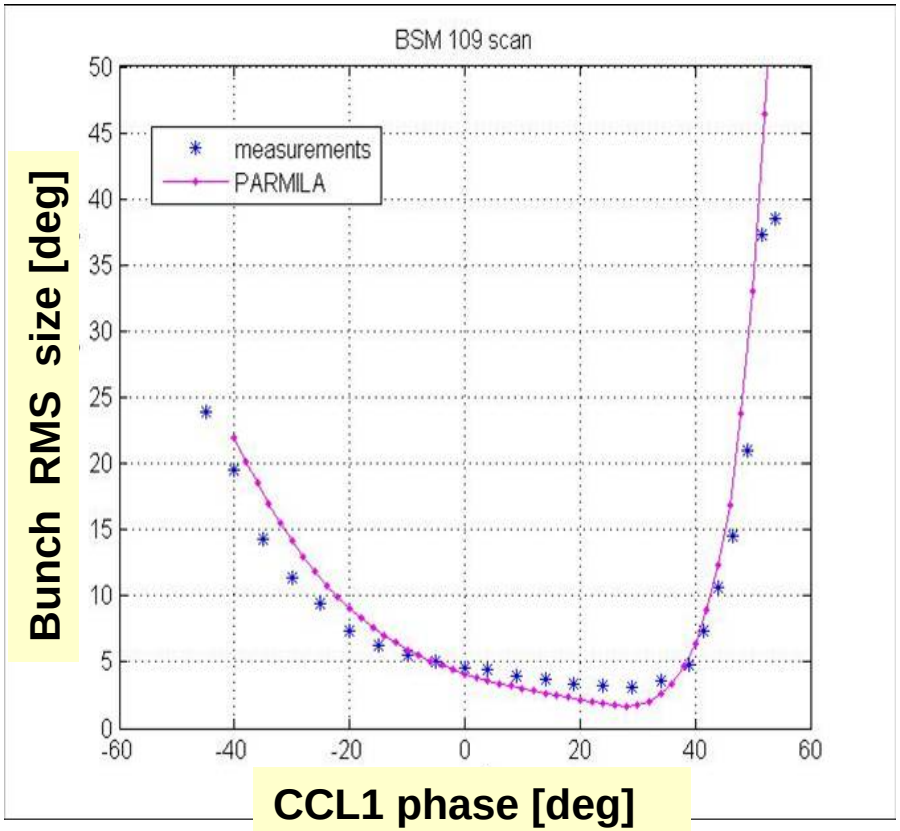


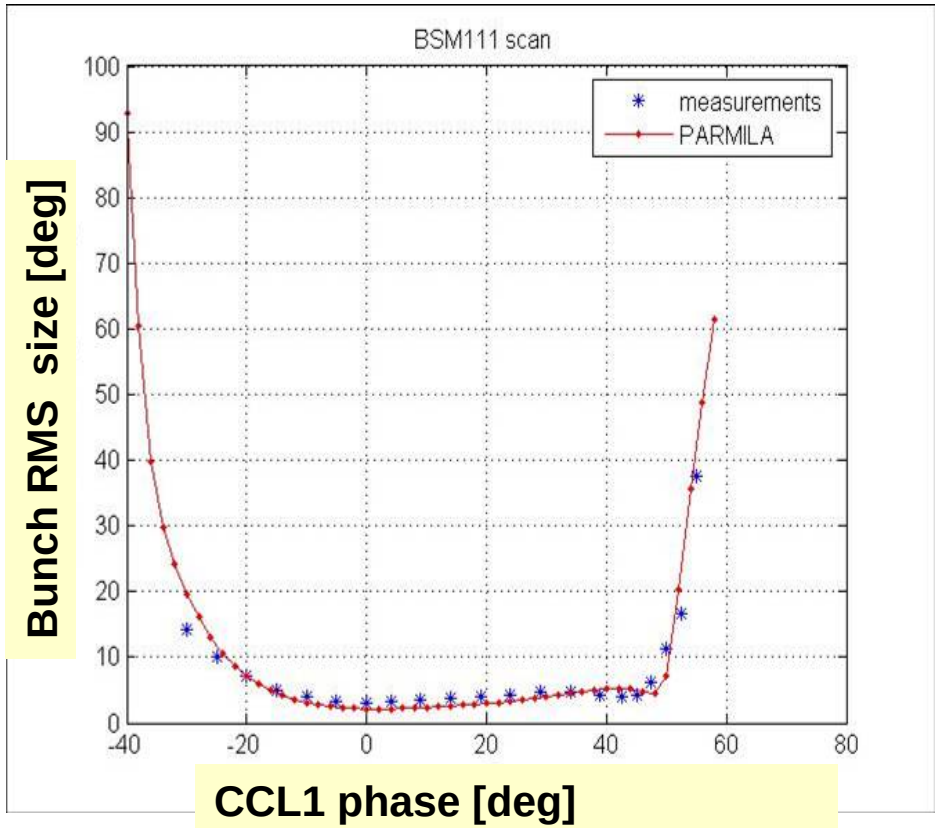
Beam tuning troubleshooting examples (II)

Improper setting of the MEBT rebuncher phase caused longitudinal tail resulting in puzzling losses in the HEBT.



Validation of beam simulation



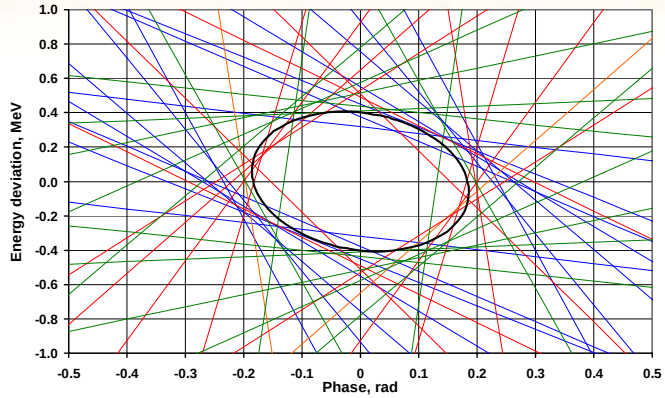


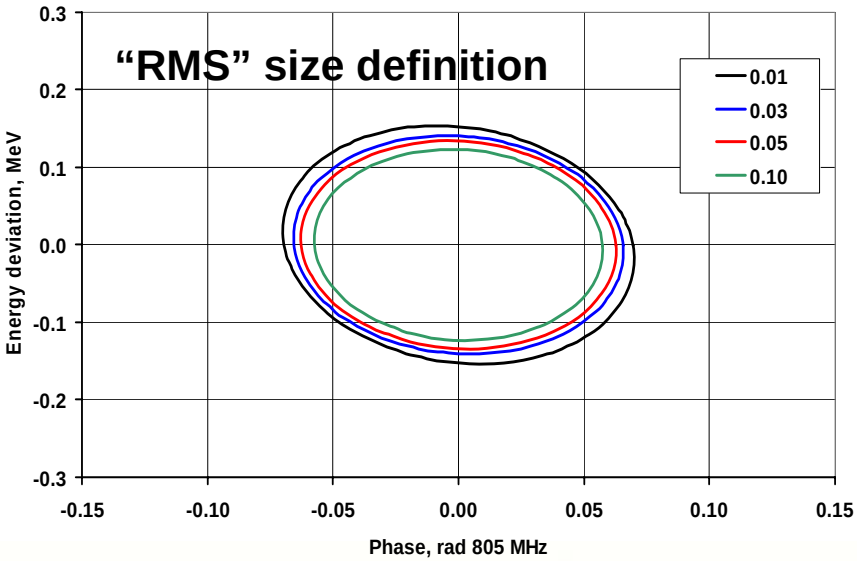
Measurement of longitudinal Twiss parameters

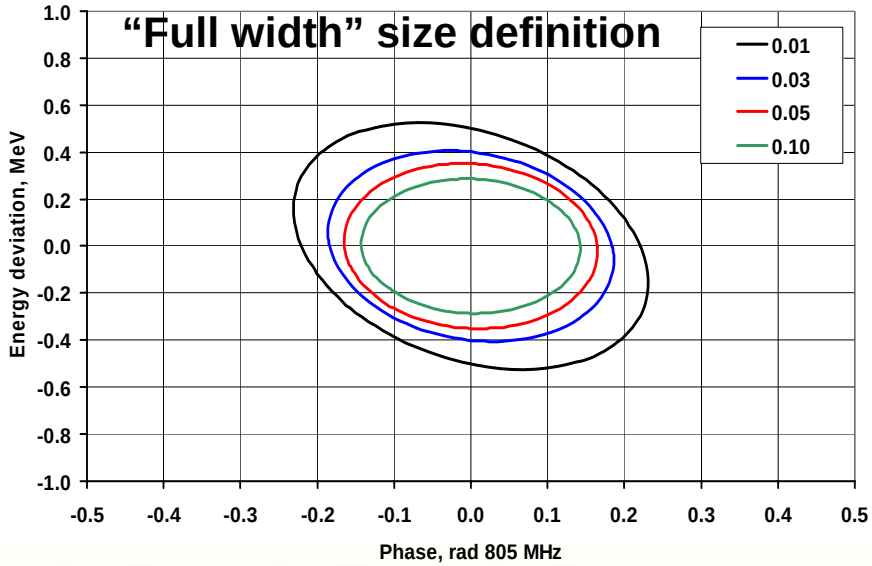
Bunch profile is measured at 3 points for several cavity field amplitudes

Transport matrixes calculated in several iterations with space charge effect included

Typically obtain longitudinal emittance of 1.2 – 2.0 times larger than design value

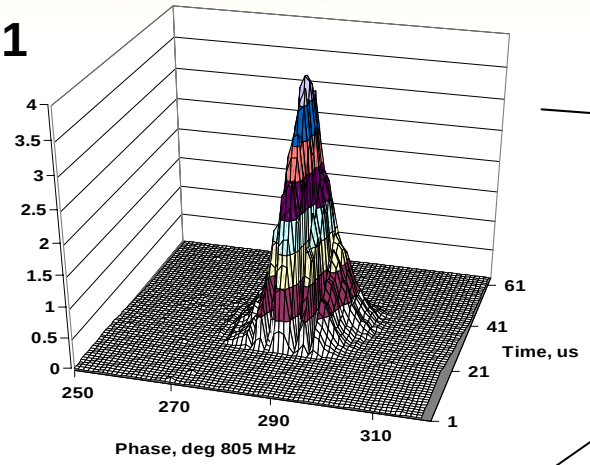




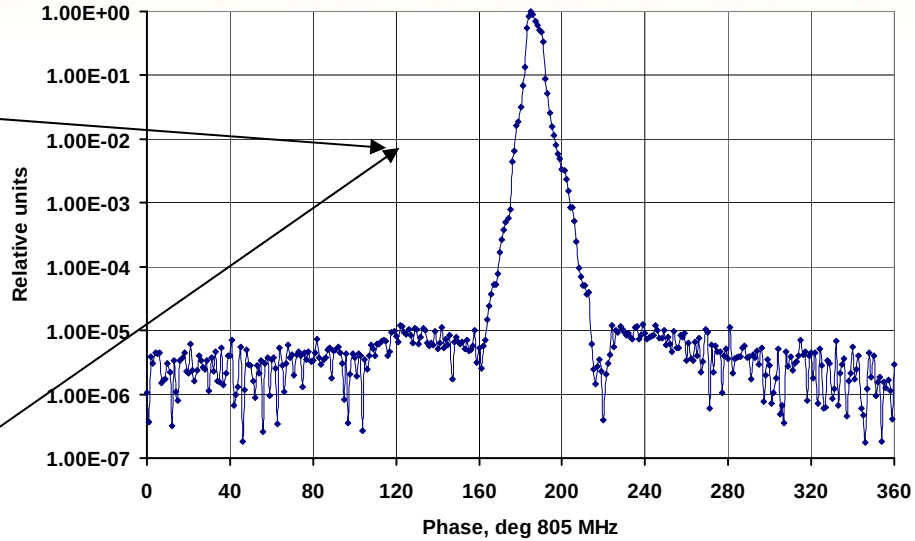


Longitudinal tail measurement

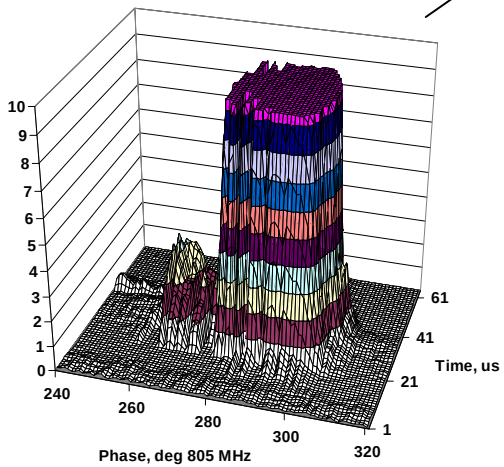
Gain = 1



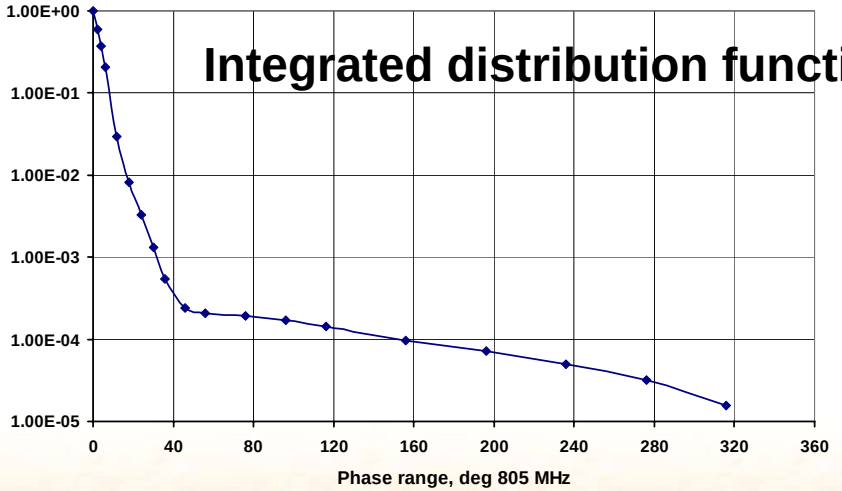
Combined profile



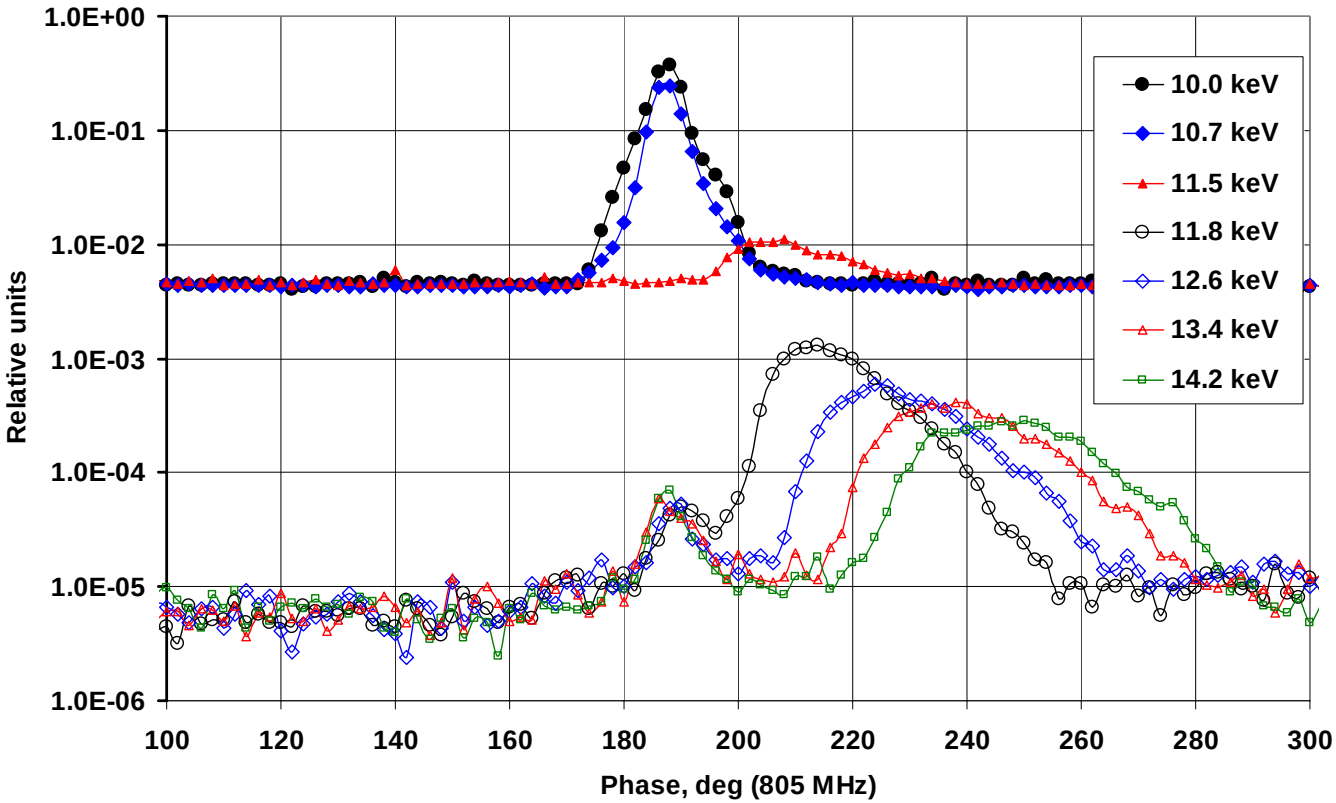
Gain = 160



Integrated distribution function



Suppression of stripped electrons contribution using energy selection in the magnetic field



Conclusions

- **Have a good set of longitudinal profile diagnostics**
- **Would like to add more at higher energy**
- **Beam Shape Monitors are very useful for**
  - **General linac troubleshooting**
  - **Model and tuning validation**
  - **Twiss parameters measurements**
- **Addition of energy selecting magnet allows measuring low level longitudinal tails in negative hydrogen ions beam**

Observe beam losses in HEBT, which we believe are caused by longitudinal tails – good reason for further study