中国科学院近代物理研究所
Institute of Modern Physics, Chinese Academy of Sciences

10-mA proton beam commissioning of prototype of sc linac for China ADS

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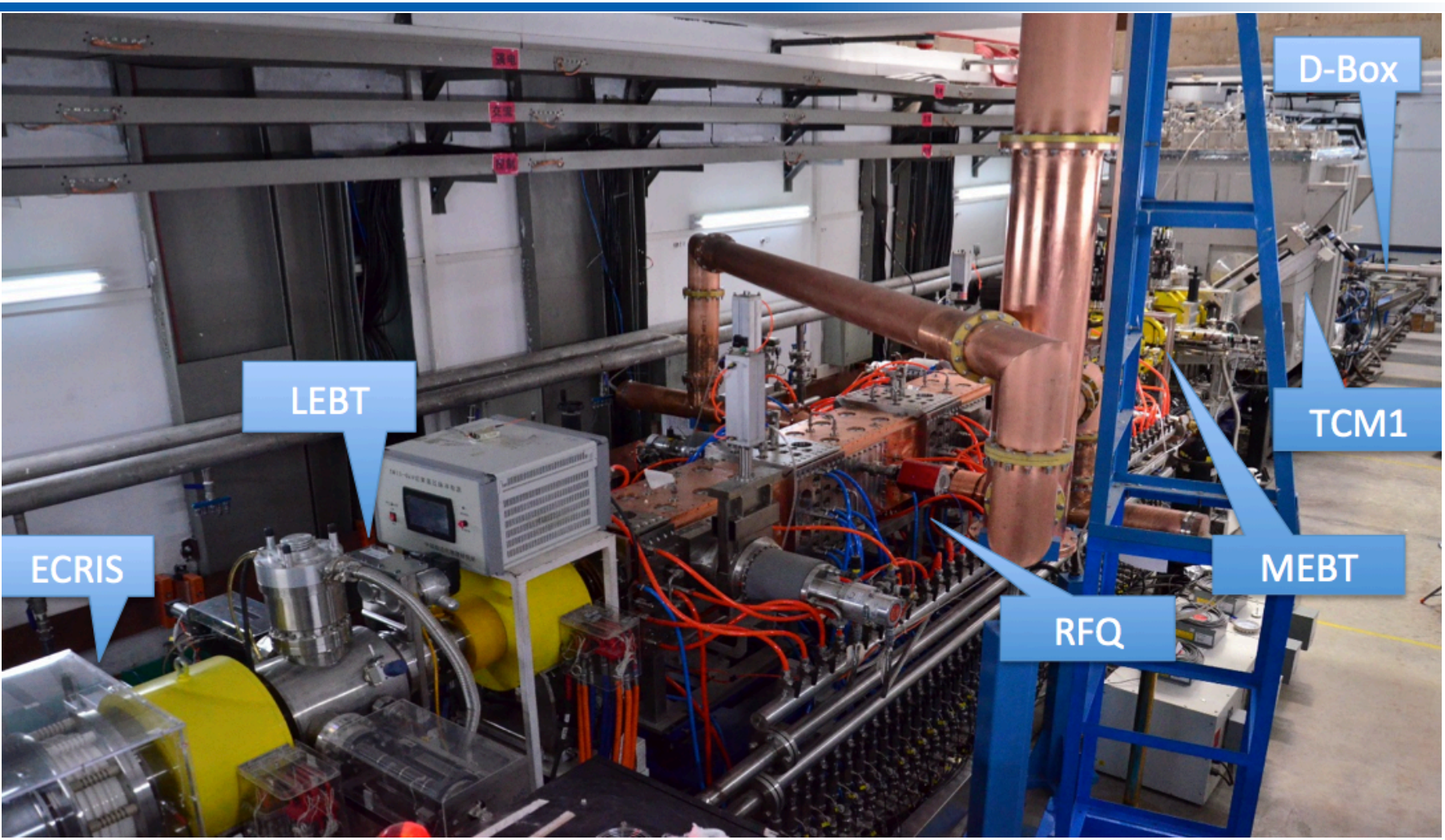
Outline

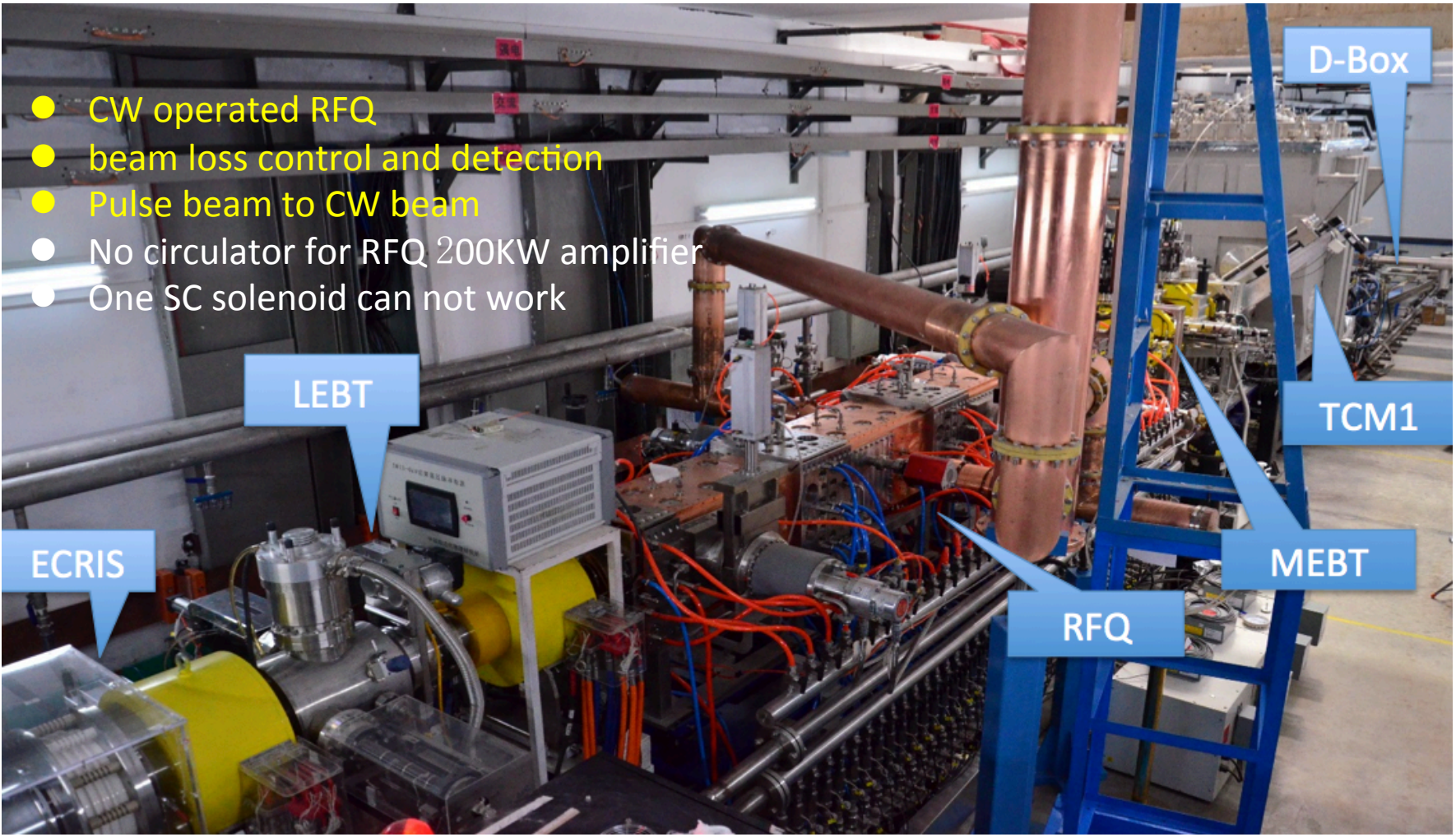
- Challenges of beam commissioning of the demo facility
- The beam commissioning of RFQ
- The beam commissioning of MEBT & TCM1
- Existing problems and further plans
- Acknowledge

Challenges of beam commissioning



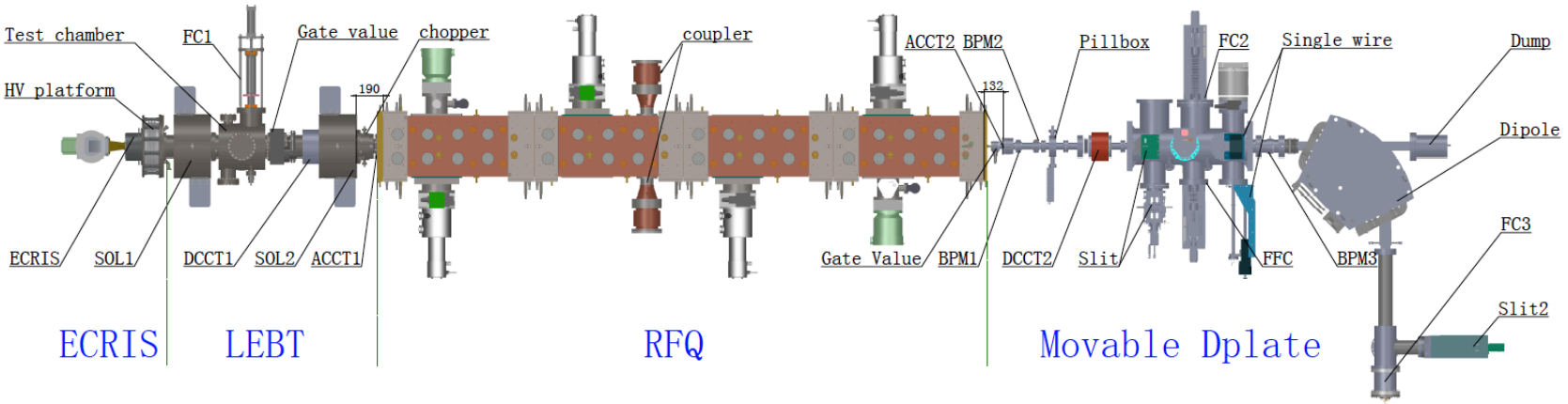
The highest beam current(10mA) and beam power(~28KW) of SC demo facility

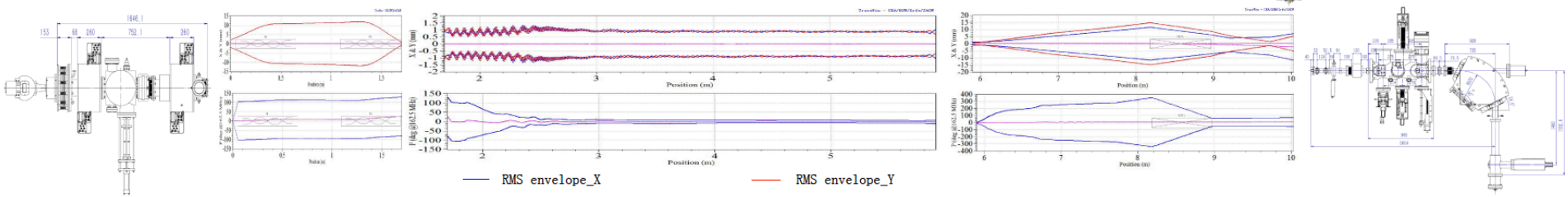
Challenges of beam commissioning

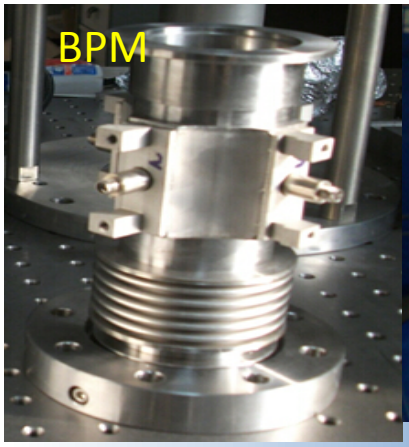


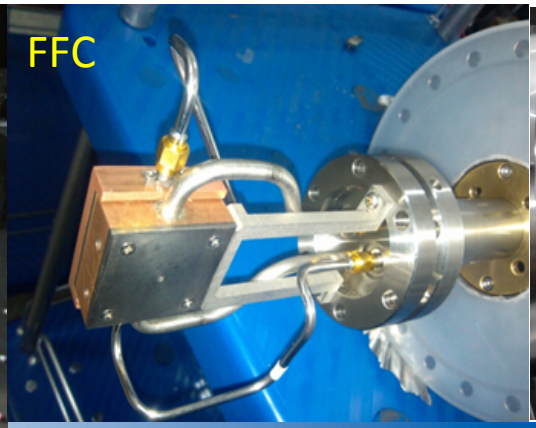
The highest beam current(10mA) and beam power(~28KW) of SC demo facility

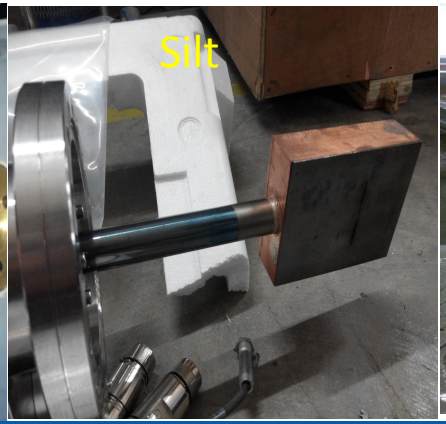
Layout of the RFQ commissioning setup

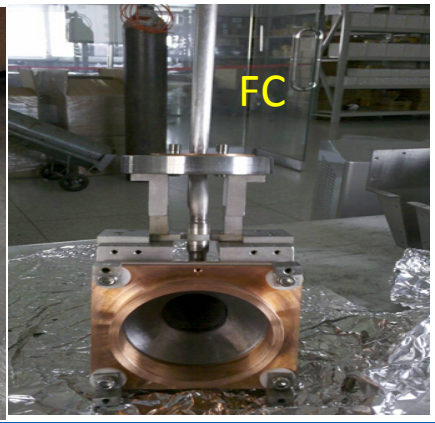




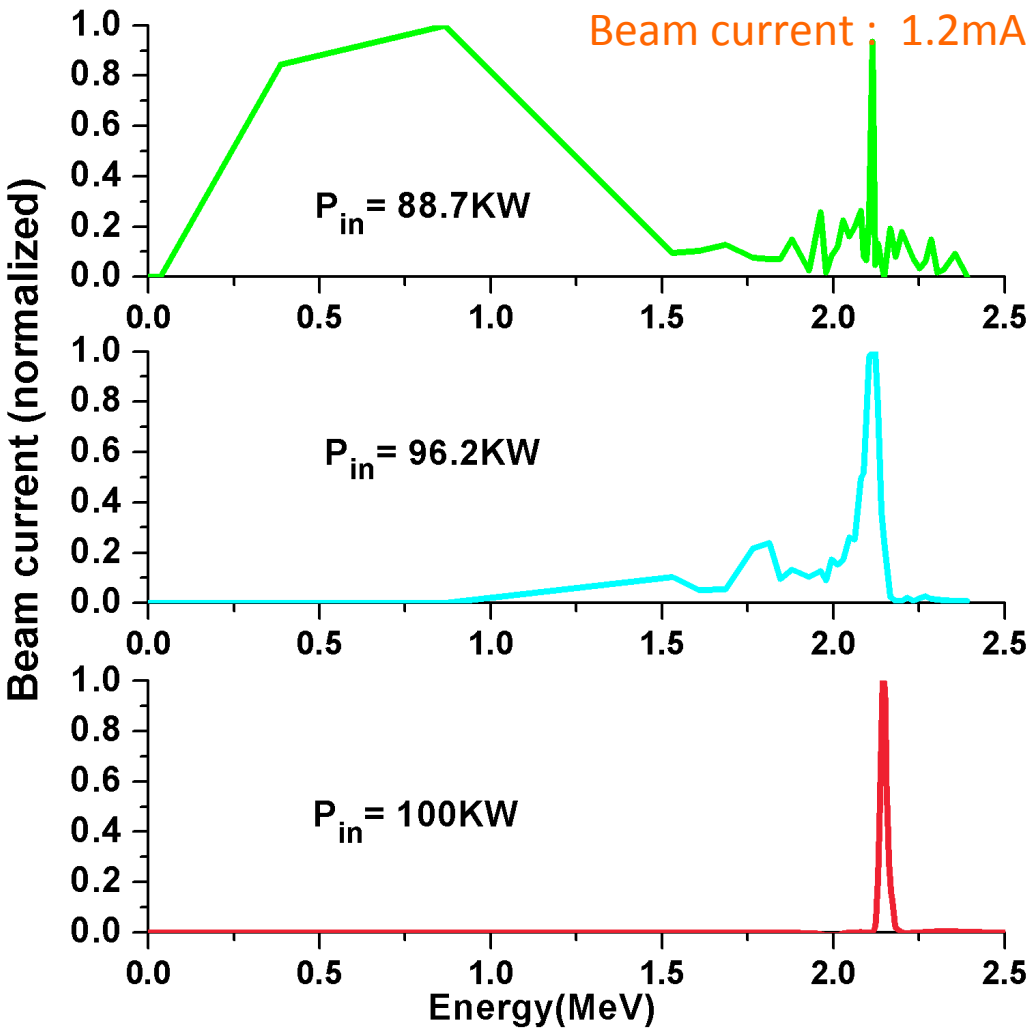






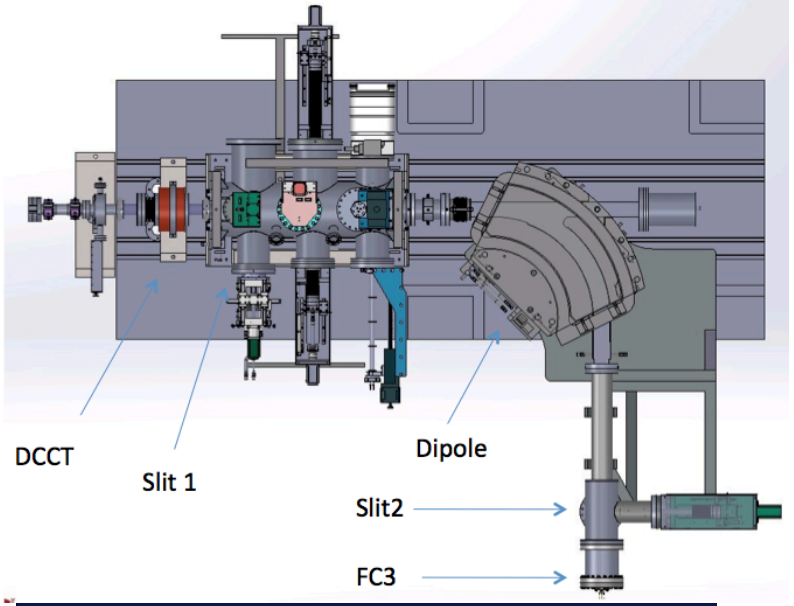


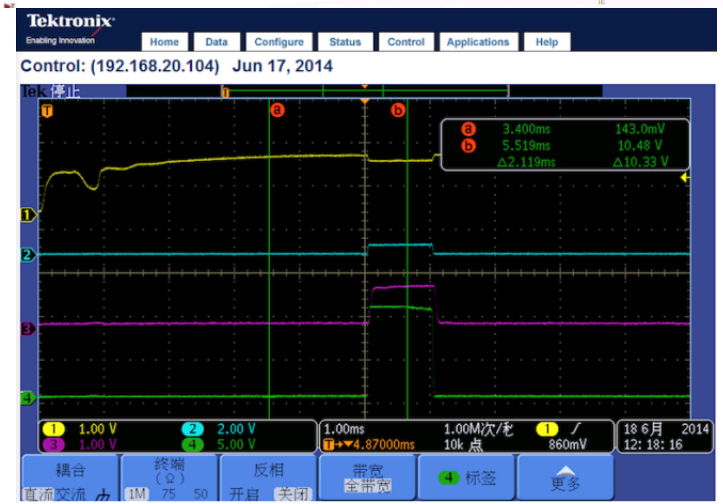
Calibration of inter-electrode voltage of RFQ



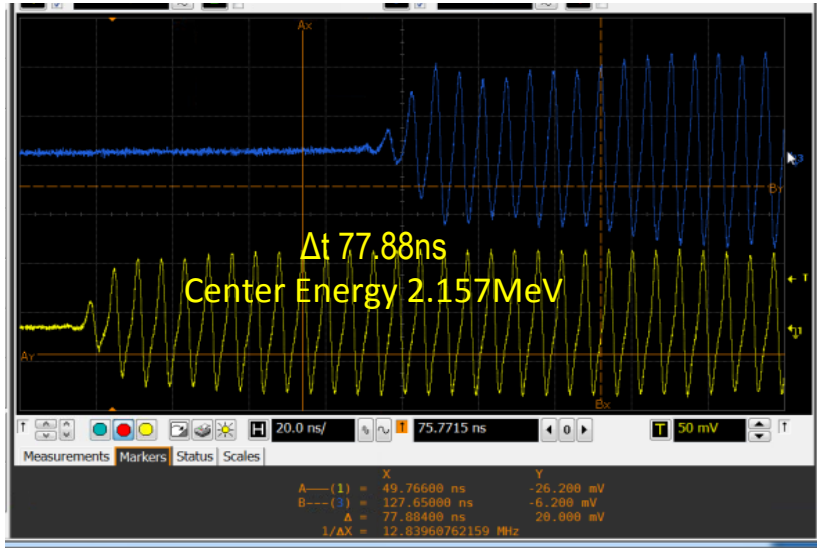
Center energy: 2.145MeV

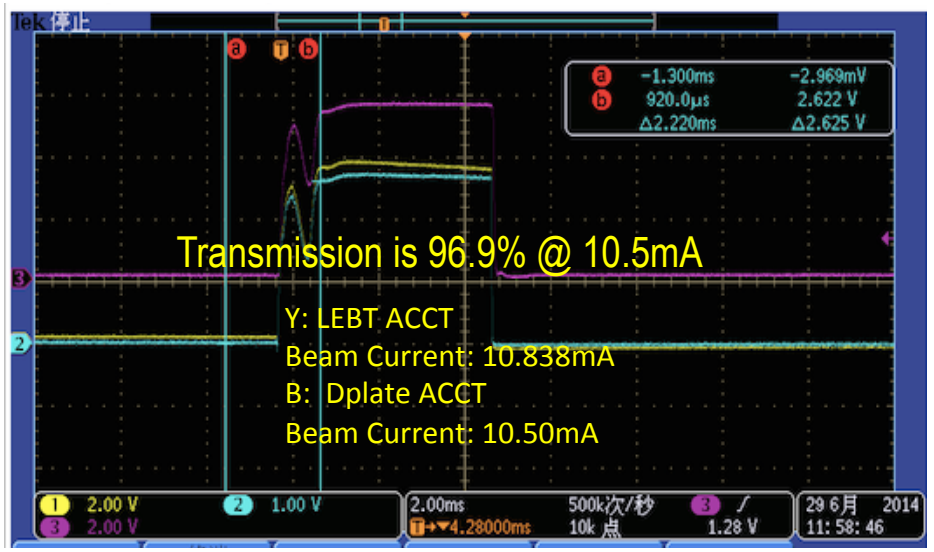
Energy spread： 0.038MeV(FWHM)

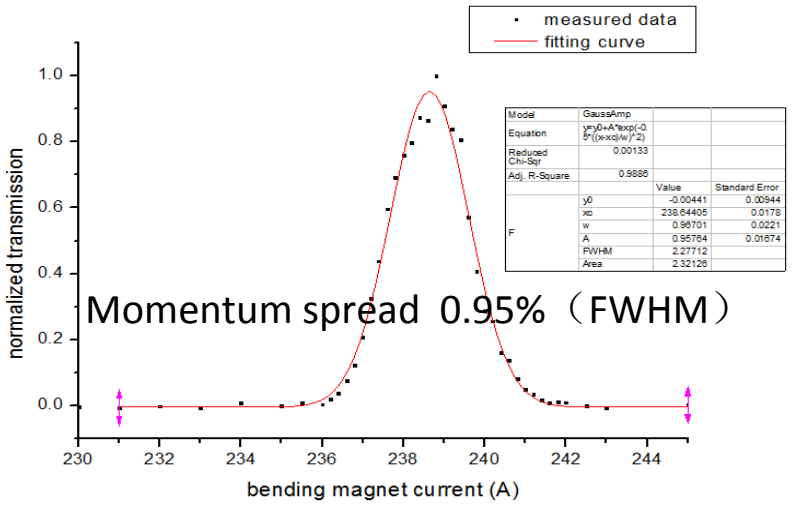


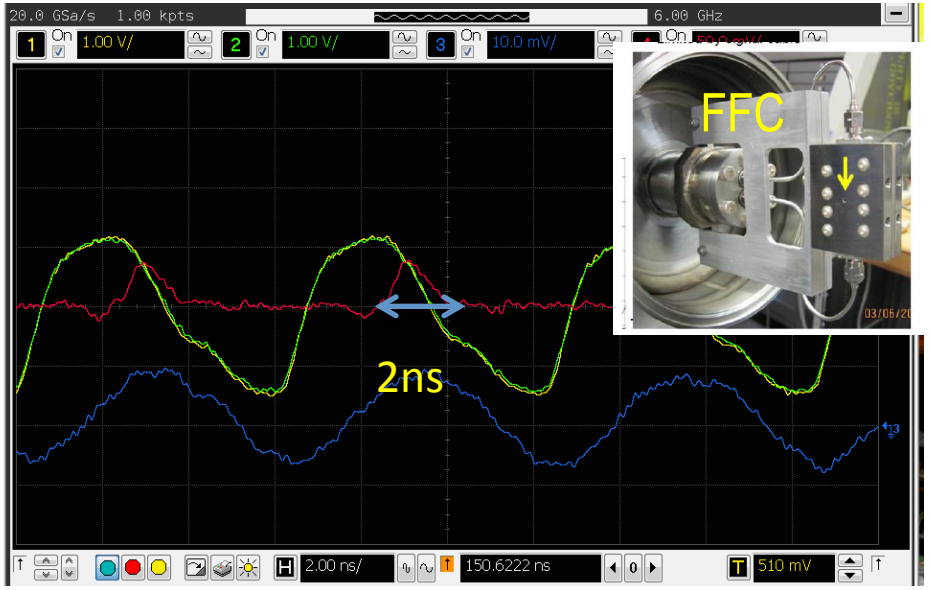


Beam quality from RFQ

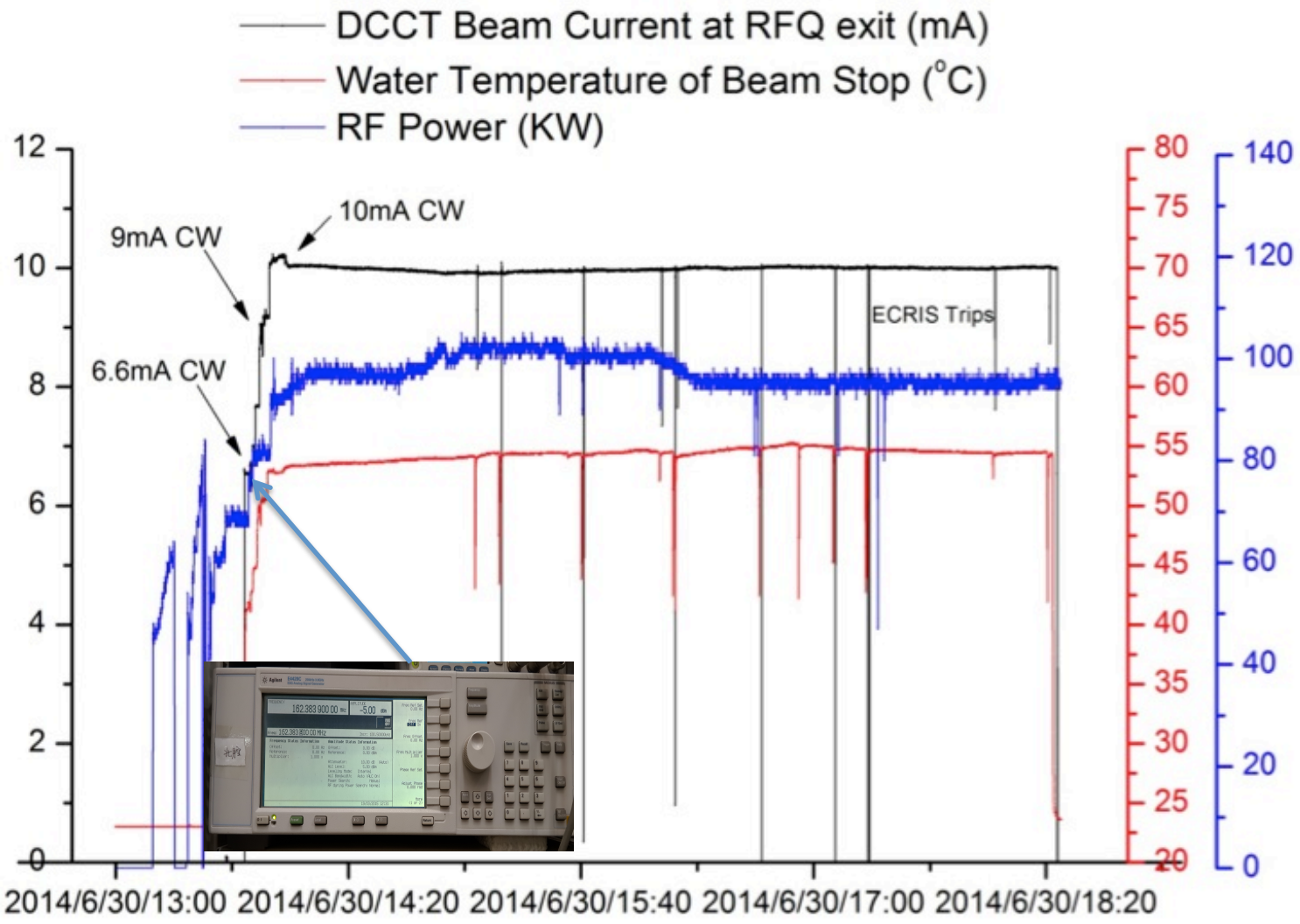




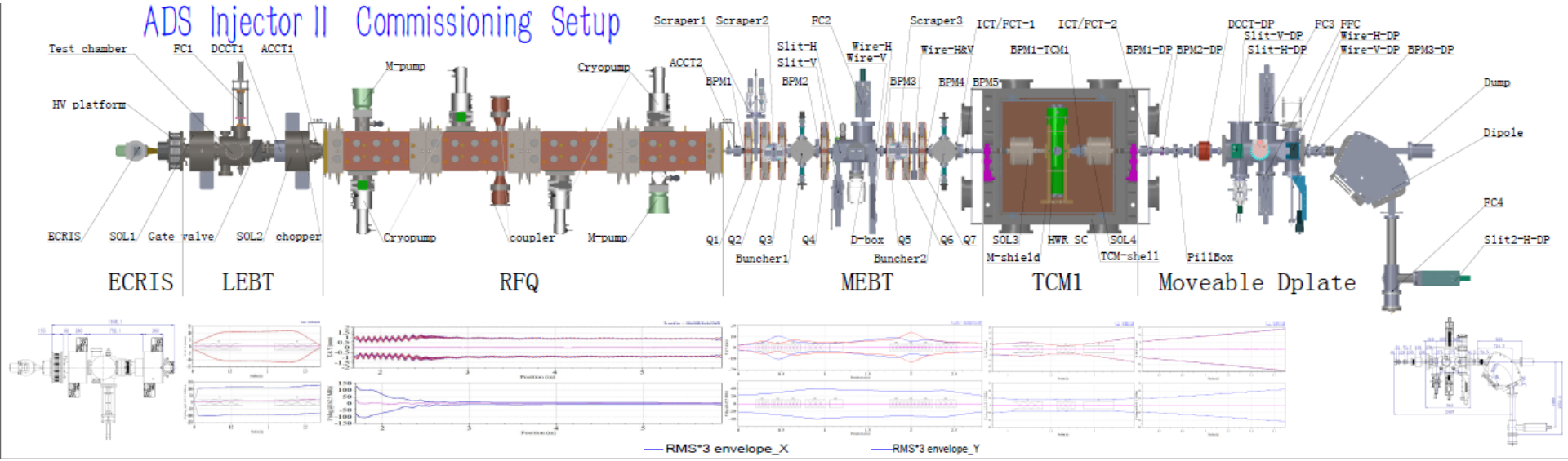




10 mA CW beam tuning of RFQ

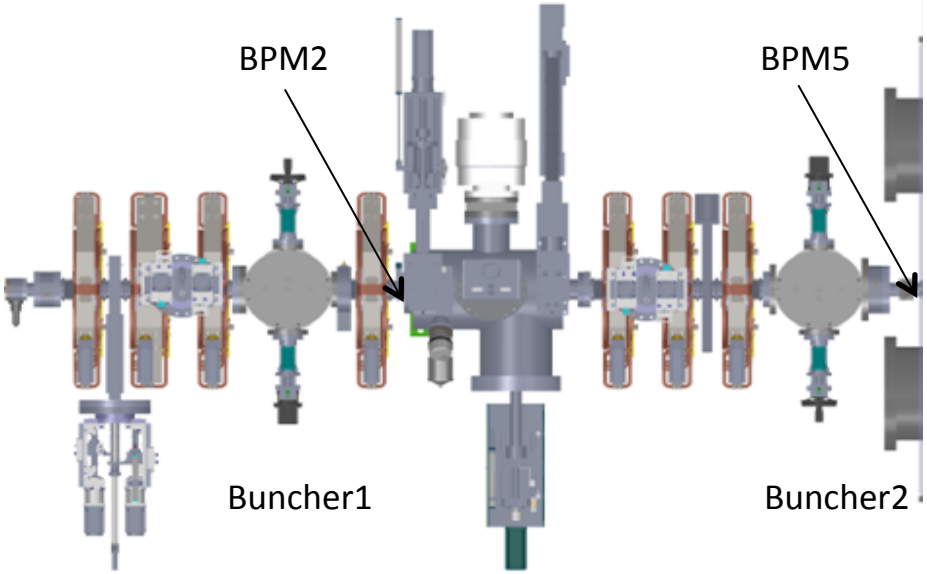


Beam commissioning setup of the demo facility

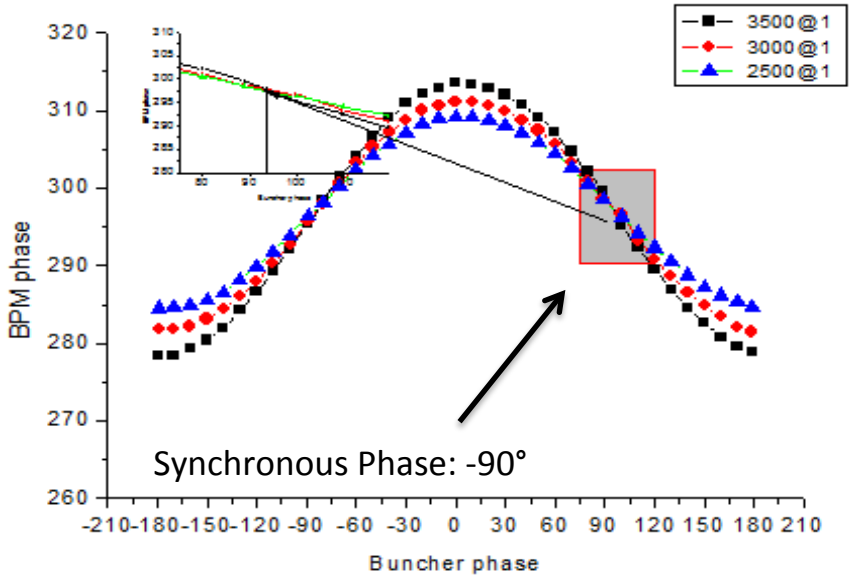


- Calibration of single hardware
- Measurement of beam parameters and lattice setting
- Beam tuning

Setting of buncher amplitude and phase



2.4mA, 100us,1Hz



Formula method:

$$E_0TL = \frac{d\Psi_{BPM}(\phi)}{d\phi}\left(\frac{m}{2T_0}\right)^{-1/2}\left(\frac{\omega_{BPM} * S}{c}\right)^{-1}\frac{2T_0}{\sin(\phi+\Delta\phi)}$$

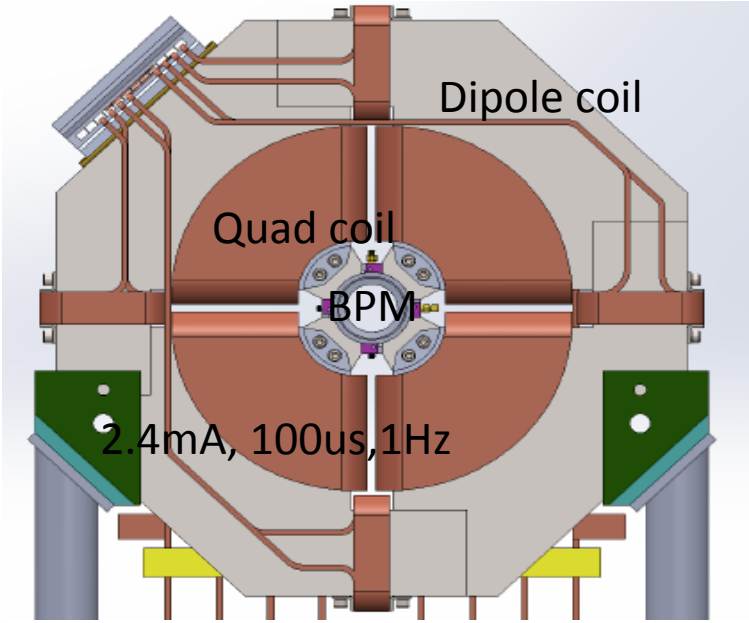
$$\frac{E_0TLCOS(\phi+\Delta\phi)}{2T_0} \ll 1$$

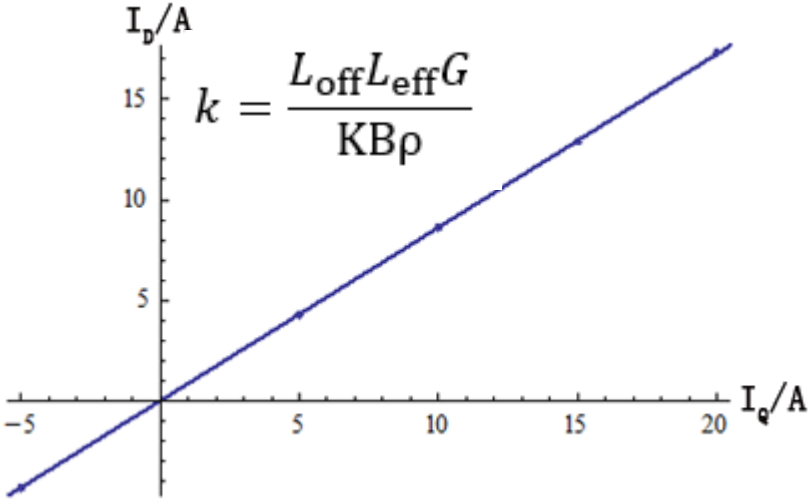
Fitting method:

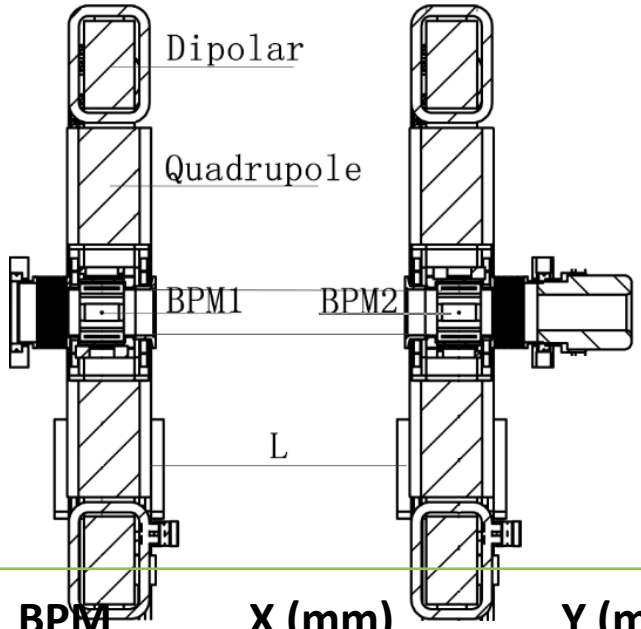
$$\Psi[\phi\_] := -(\omega * s/(c * \beta[\phi]) + \Psi 0)/(2\pi) * 360$$

	Buncher1	Buncher2
Amp number	4500	5500
Formula(KV)	76.6	102
Fitting(KV)	82.36	105.81
Vacc(KV)	76.57	101

Calibration of BPM based on beam

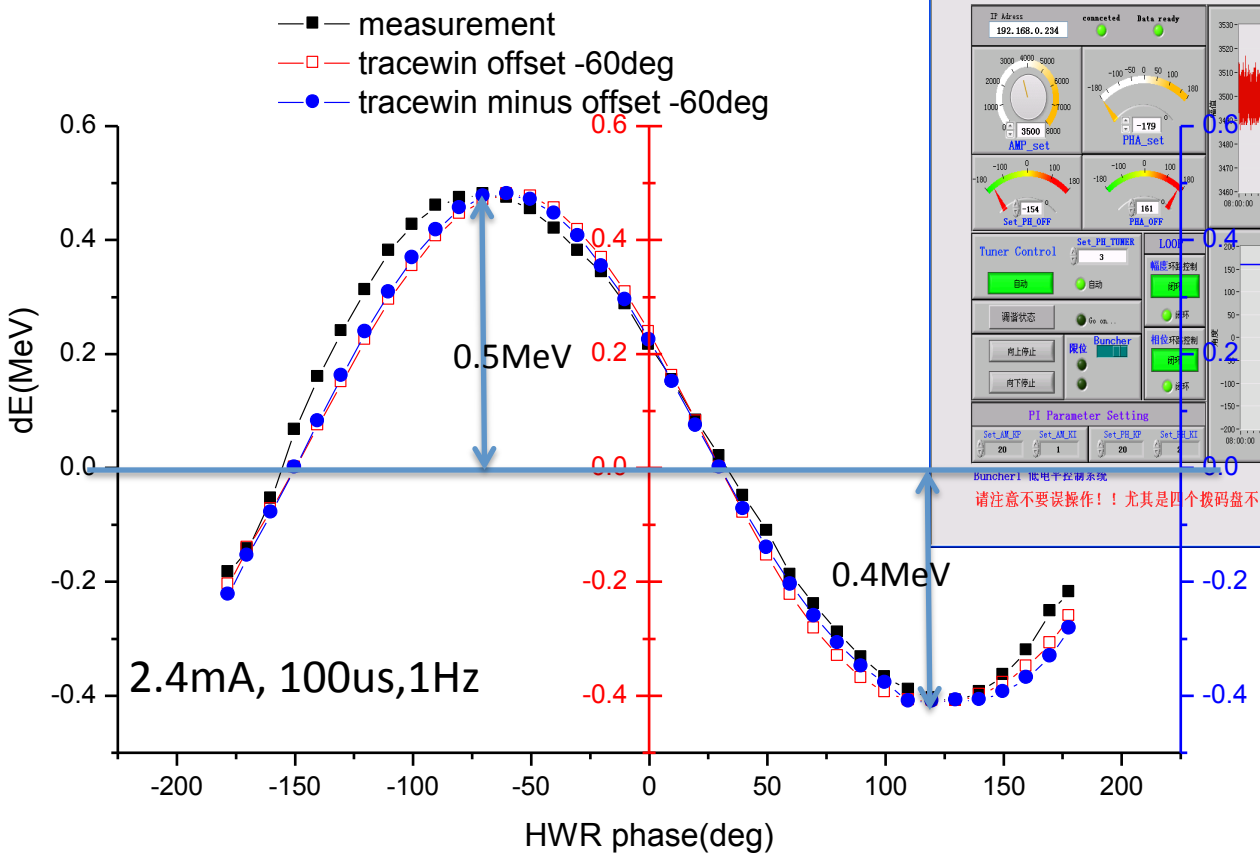


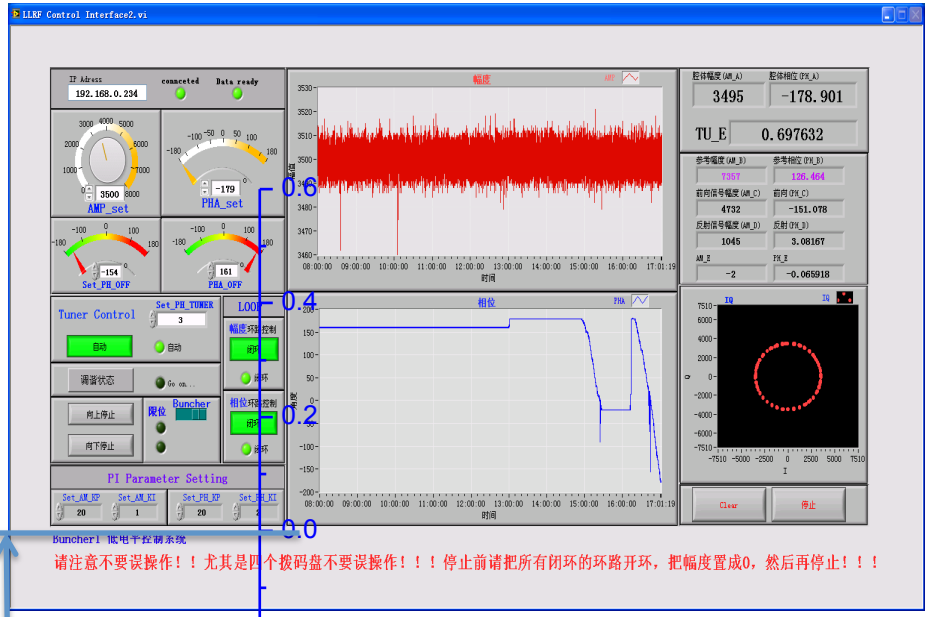




BPM	X (mm)	Y (mm)
BPM1	0.449	0.559
BPM2	-0.026	0.432
BPM3	0.063	-0.325
BPM4	0.434	0.158

Calibration of HWR cavity amplitude



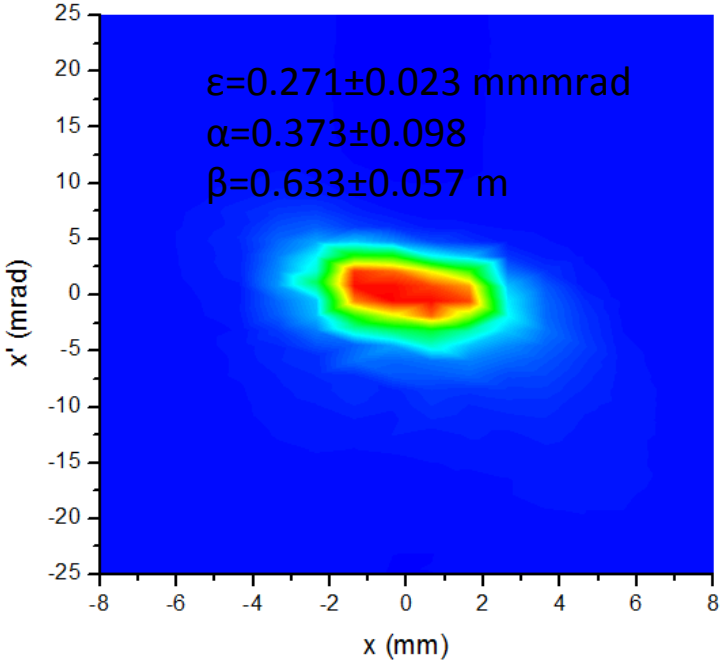


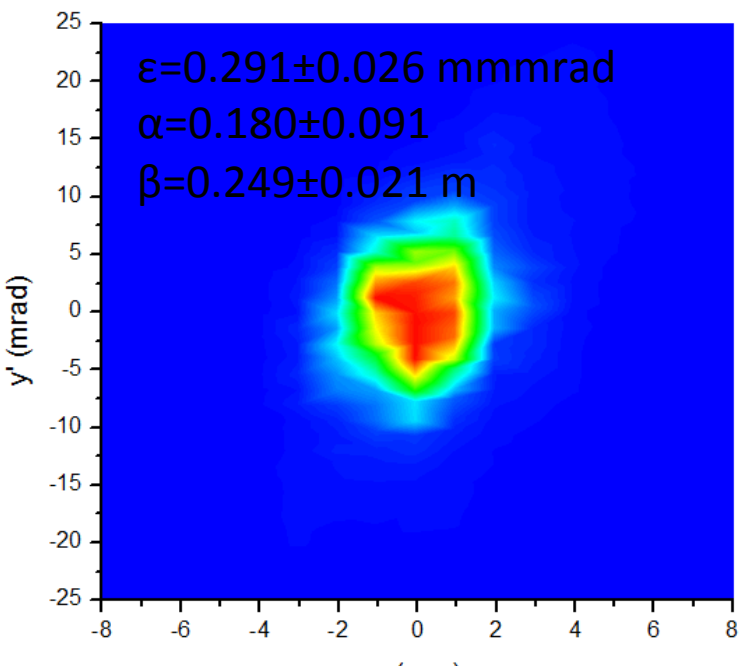
LLRF interface

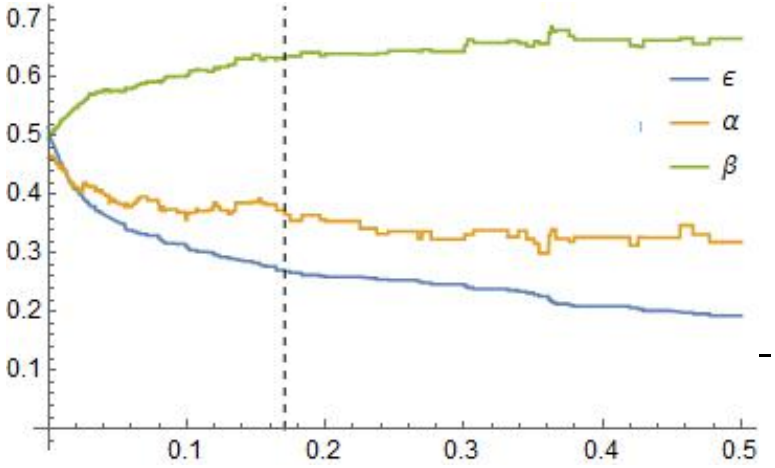
Ep=18.44 MV/m @ Beam calibration

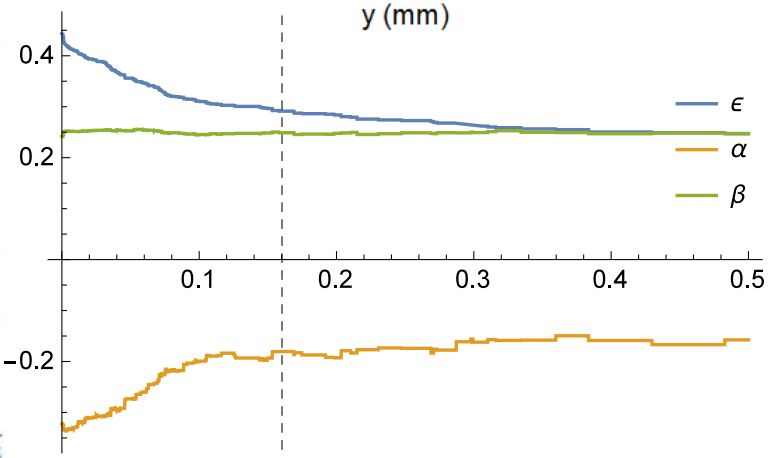
Ep=18.5MV/m @ Cavity measurement

Transverse emittance measurement





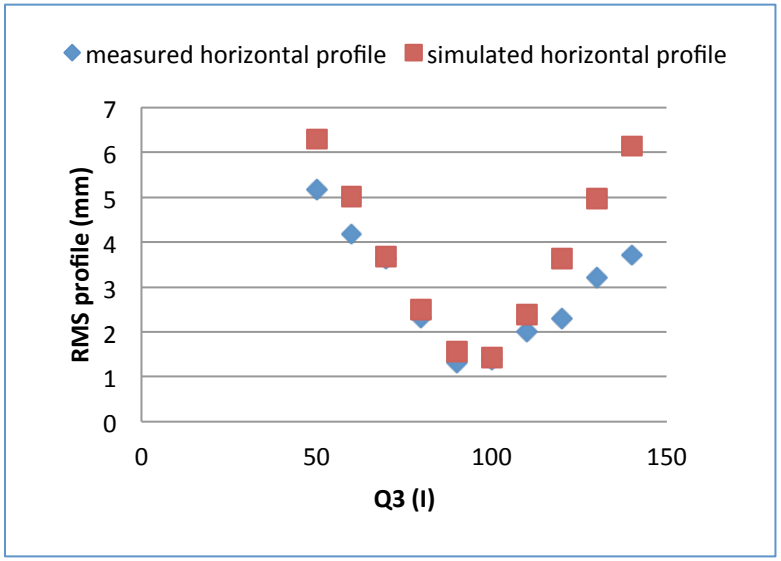


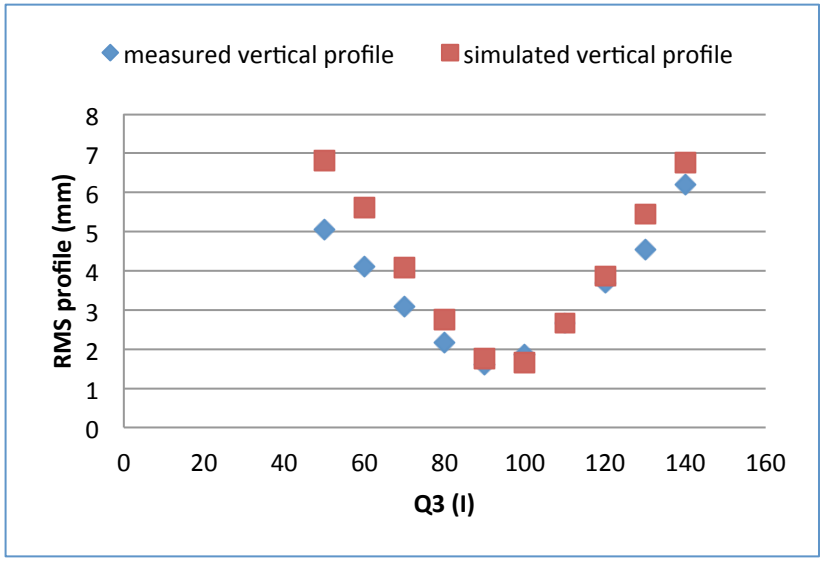


Verification of emittance measurements

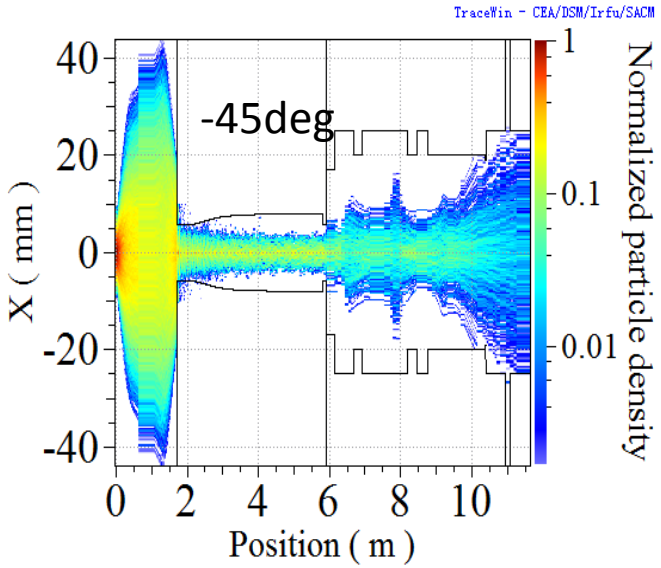
Initial Twiss parameters at the beginning of MEBT

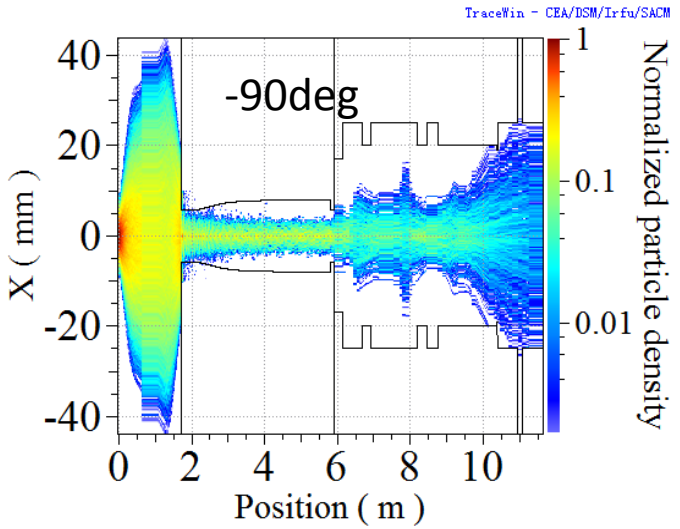
	Emittance(mm.mrad)	Alpha	Beta(mm)
Horizontal	0.286	0.302	0.201
Vertical	0.297	-0.102	0.124

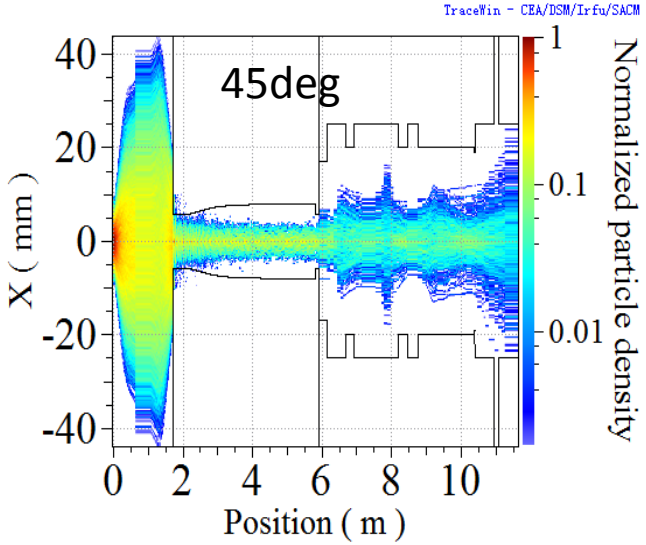


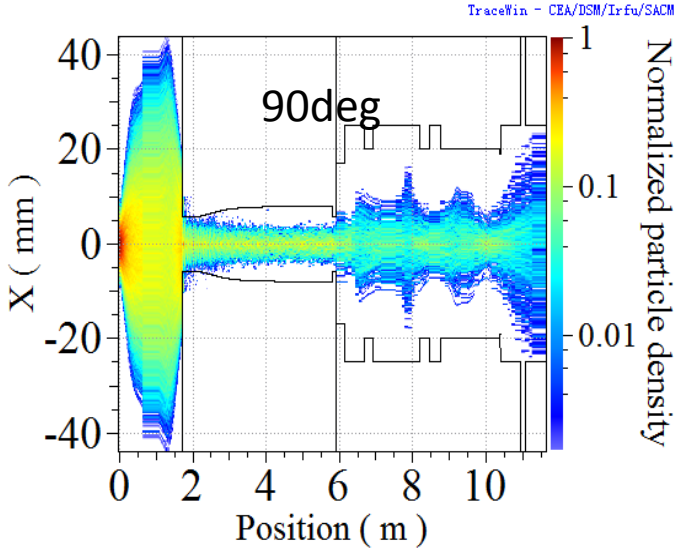


Optimization of lattice setting

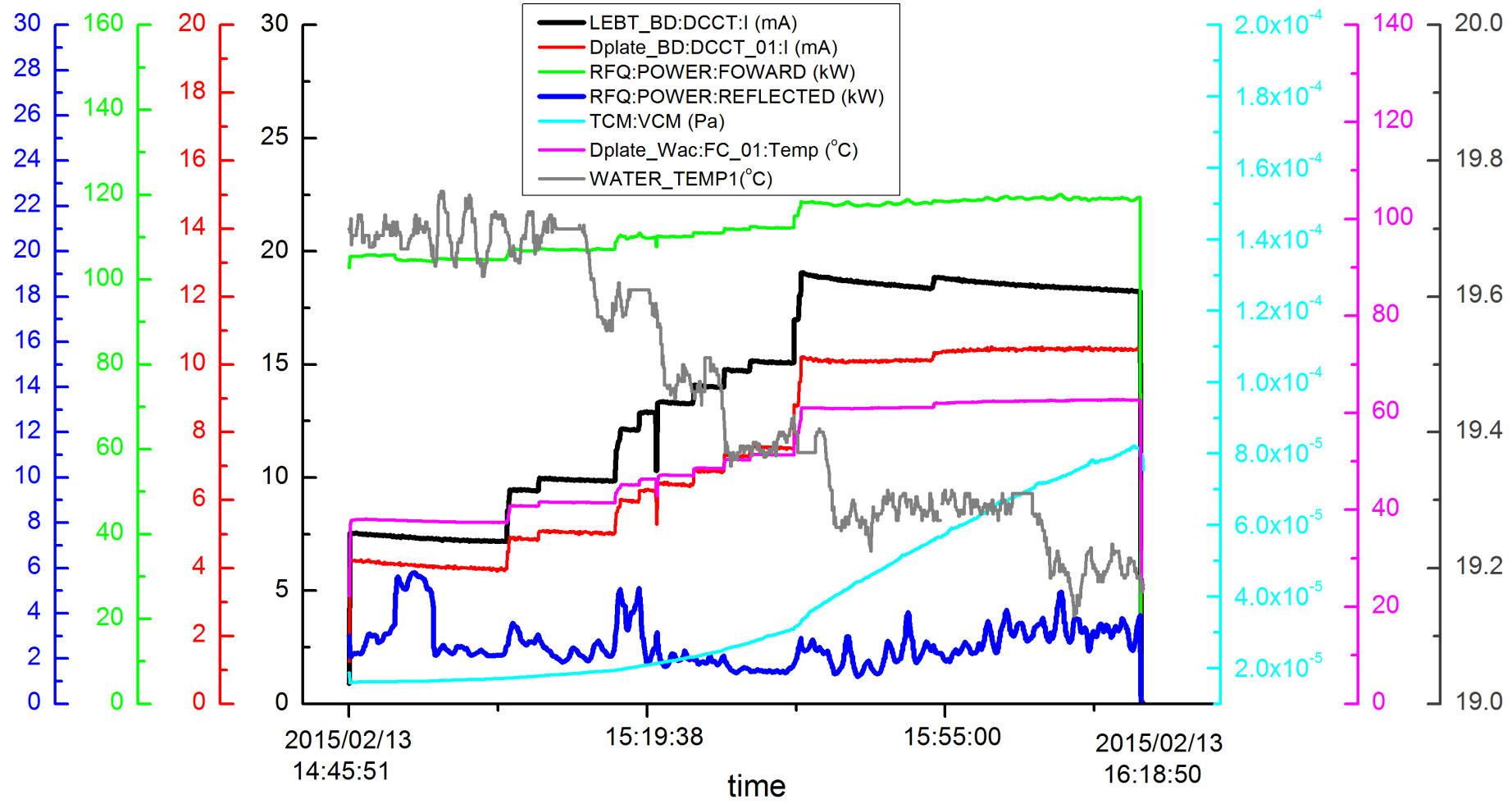




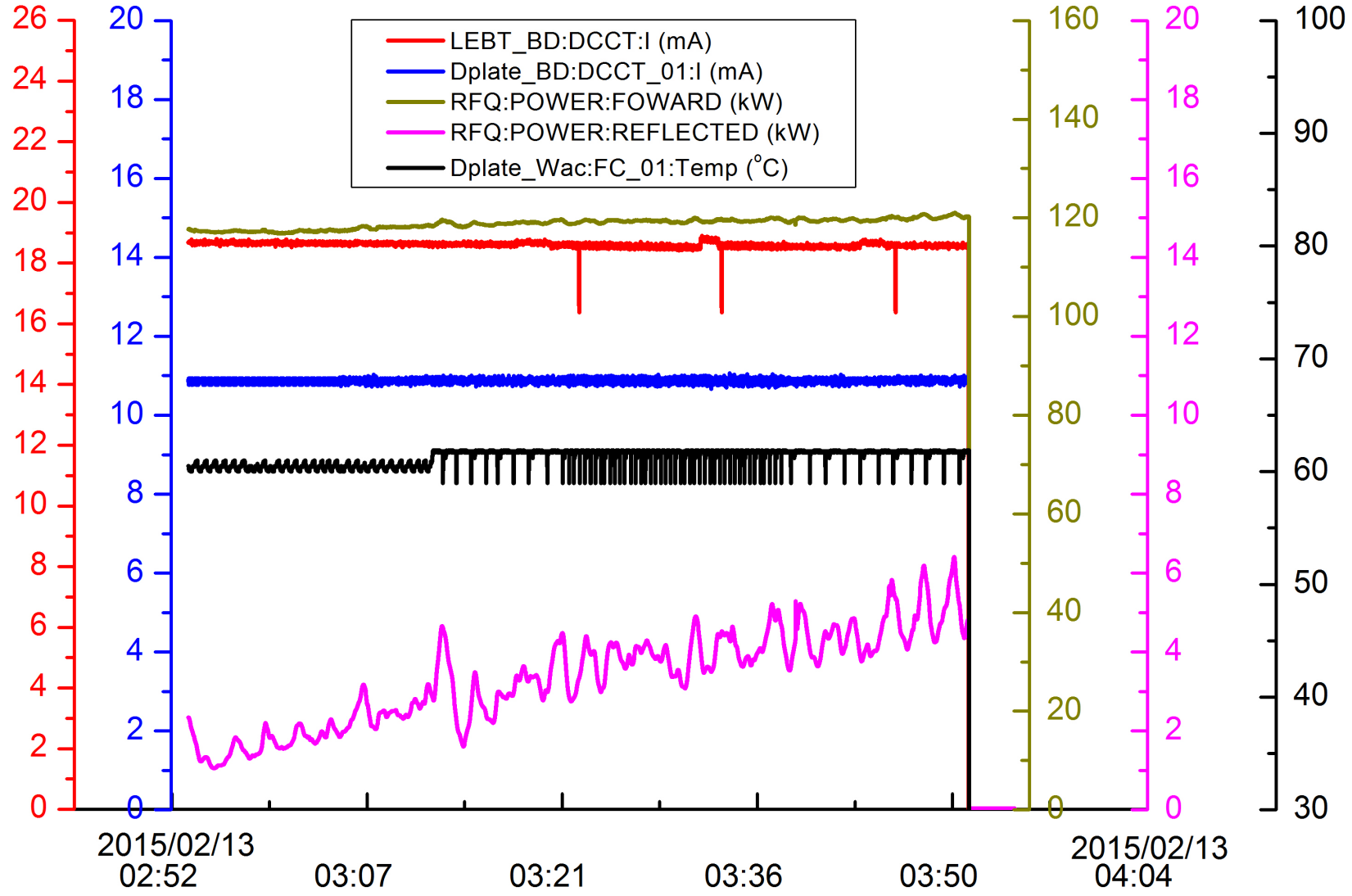




10 mA CW beam tuning of MEBT&TCM



~11 mA CW beam commissioning （Feb 13th ）

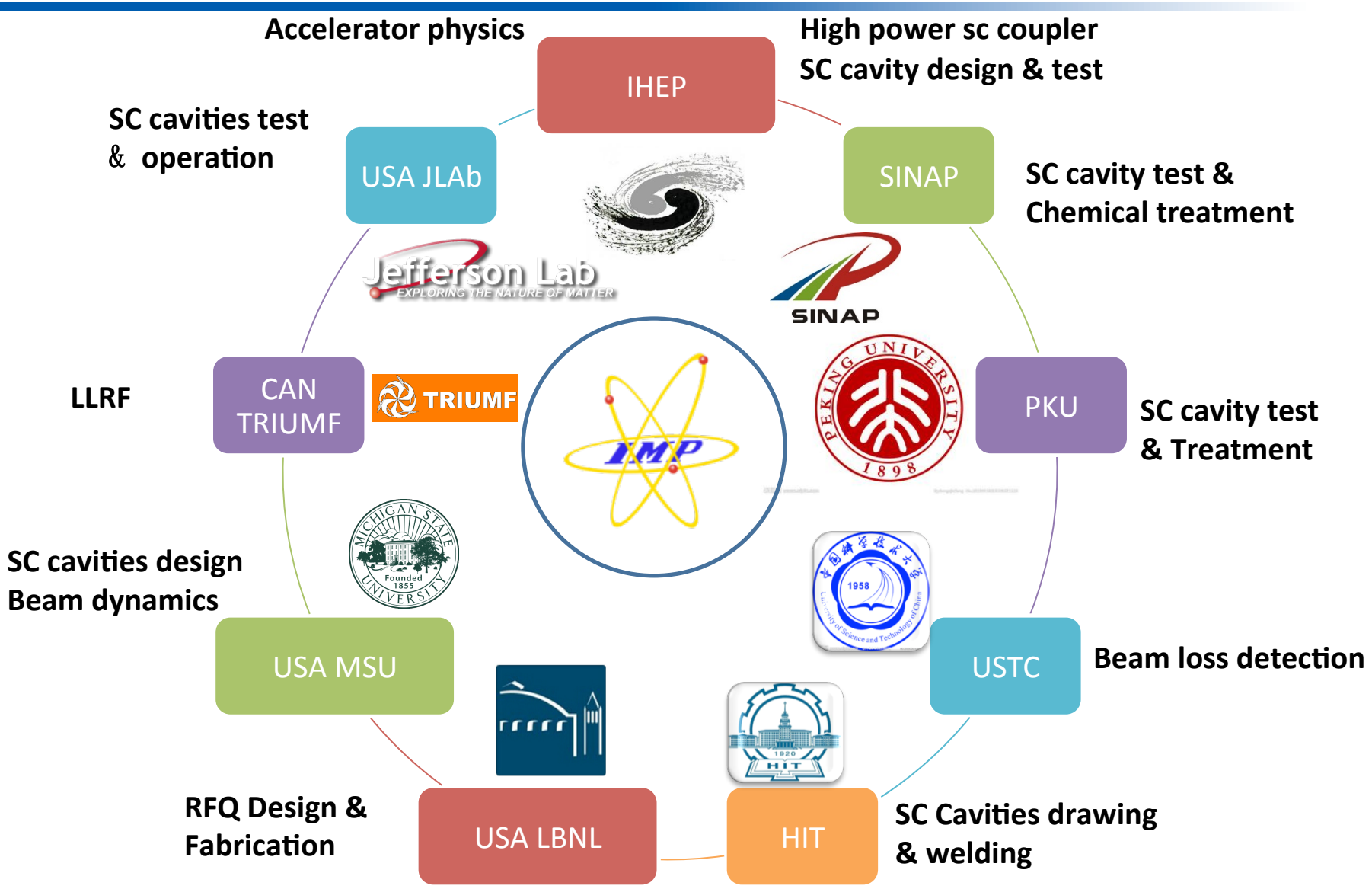


Existing problem and further plan

- Beam loss detection for the SC linac
  1. Temperature sensors
  2. Differential SC BCT
  3. Beam loss monitor, ion chamber, diamond detector
- MPS for the high beam power machine
  1. Most important for high power machine
  2. Preliminary MPS was setup, more factors need to be considered
- Beam commissioning software
  1. OpenXAL was chosen, phase scanning app
  2. Model needed to be modified for Low beta SC linac
- Calibration of BPM offset for Solenoid
- ……

We plan to solve the above problems at 5MeV test stand at June 2015!!

Acknowledge



Thanks for your attention!
&
Look forwards for corporations from all of you!