Progress and Mechanical Engineering of FEL Projects at SINAP

MEDSI 2016 — MECHANICAL ENGINEERING DESIGN OF SYNCHROTRON RADIATION EQUIPMENT AND INSTRUMENTATION

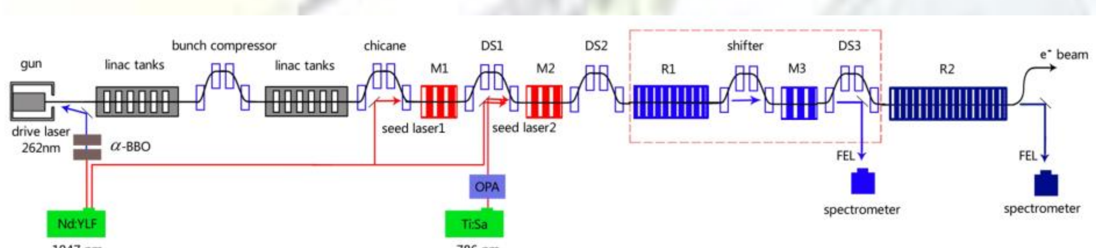
Lixin Yin, Li Wang, Sen Sun, Wei Zhang, Xiao Hu, Luyang Yu, Wencheng Fang

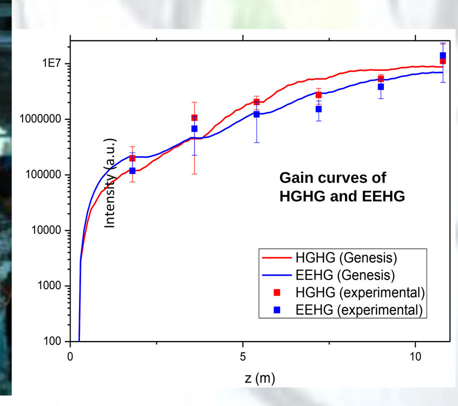
Shanghai Institute of Applied Physics, Shanghai, P. R. China

SDUV-FEL

A test facility for new FEL principles based on a 200MeV Linac, has been operated for 5 years at Jiading campus and got a series of important results. It will be closed when SXFEL starts operation in 2017.

- 2009.12 SASE lasing
- 2010.12 HGHG saturation
- 2011.12 HGHG tunability
- 2012.04 Cascaded HGHG signal
- 2013.08 High harmonic EEHG
- 2013.11 Polarization control





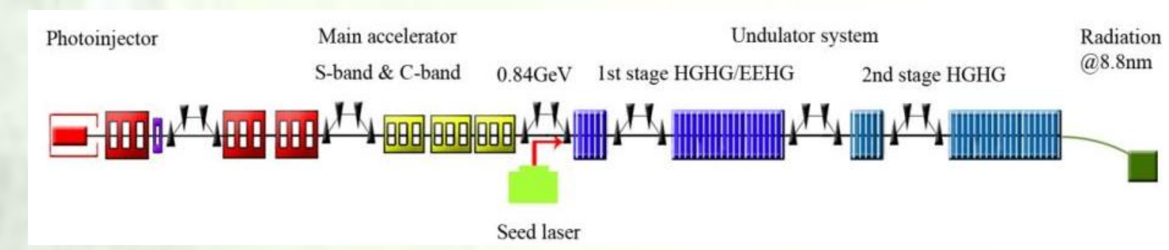
DCLS

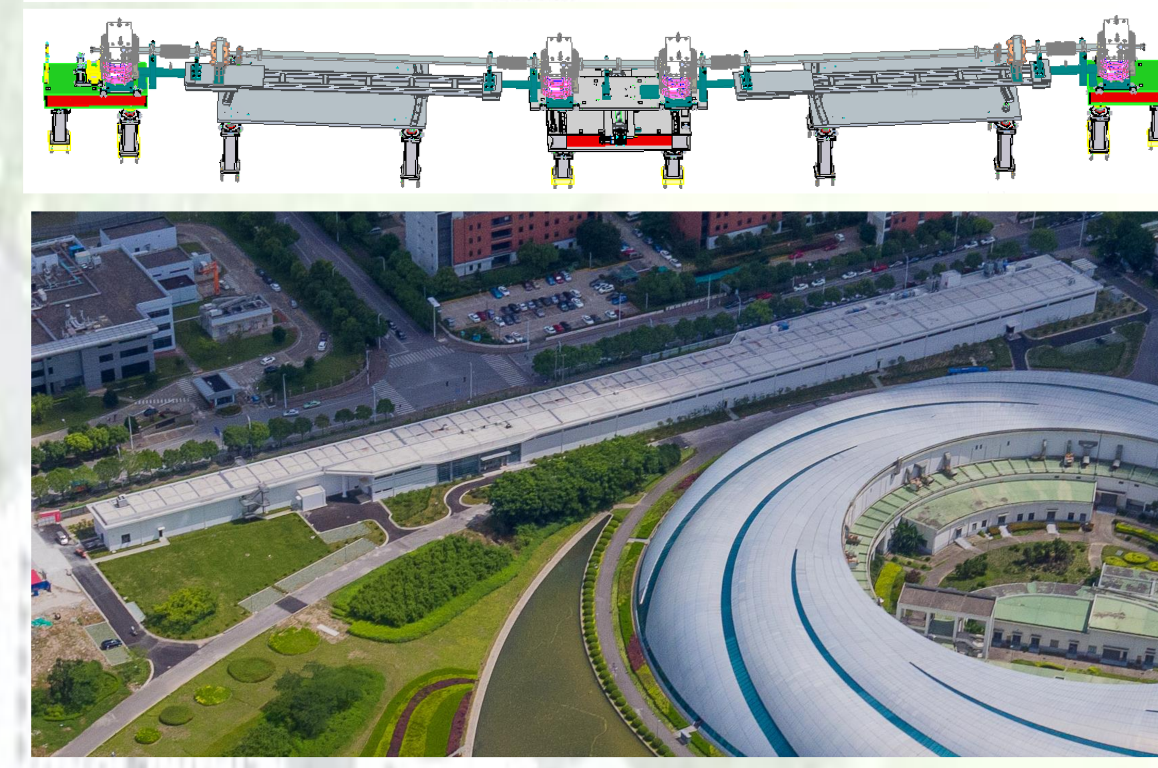
An user facility, based on the HGHG technique, developed jointly by DICP and SINAP at Dalian, will be operating exclusively in the EUV wavelength regime with full tunability. It is under commissioning and the first FEL radiation is expected in September.

Beam energy	300 MeV
Normalized emittance	1-2 mm.mrad
Bunch charge	500 pC
FEL wavelength	50-150 nm
FEL pulse energy	>100 μJ
Rep-rate	50 Hz

SXFEL

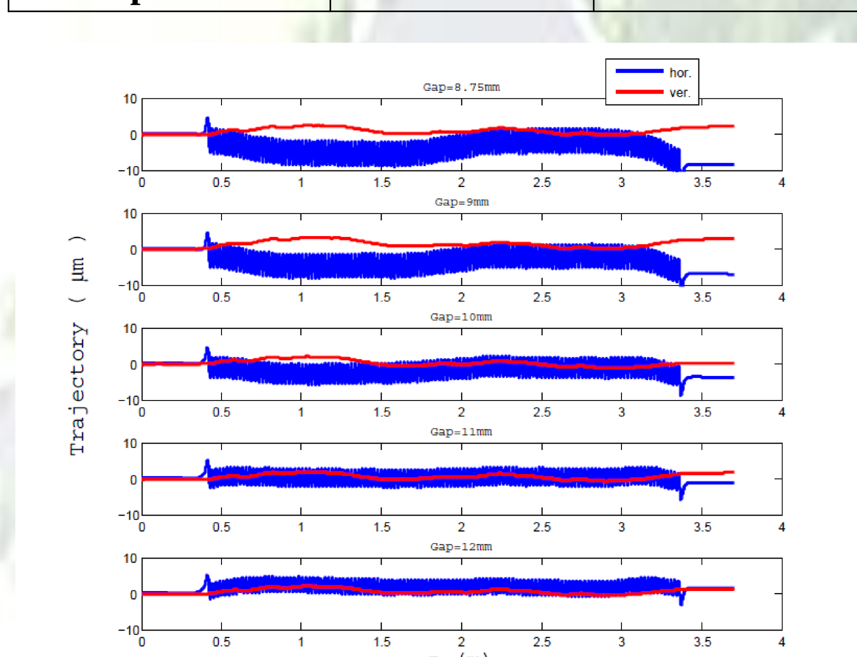
Based on an 840MeV linac, aims at generating 8.8 nm FEL radiation with two-stage cascaded HGHG-HGHG and EEHG-HGHG schemes. It is an R&D prototype for future hard X-ray FEL, to explore the key FEL schemes and techniques. It has the potential to be upgrade to user facility. The commissioning is scheduled at the end of 2016.

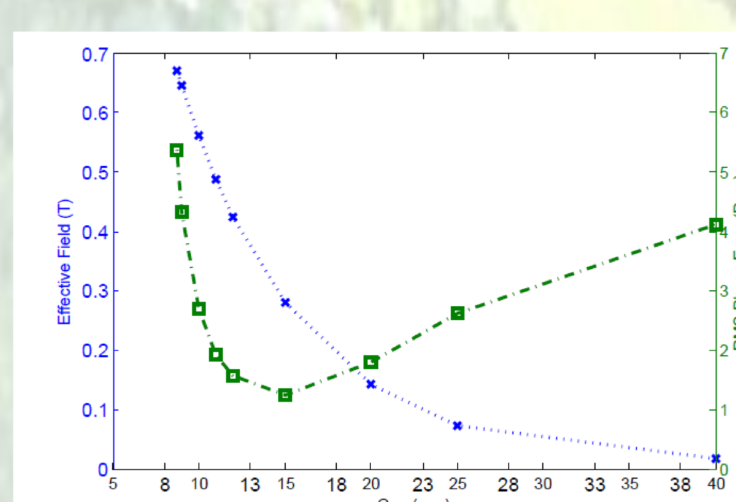




Undulator

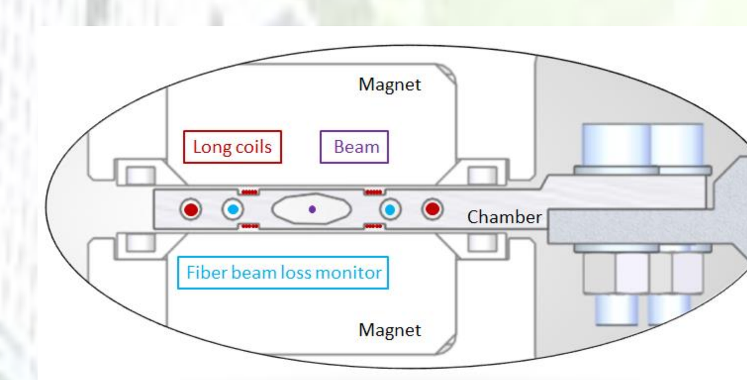
Parameter	Specification	Measured
Minimum gap	8.75 mm	8.75 mm
Resolution of gap	< 5 μm	< 3 μm
Peak field	0.65 T	0.69T
R.M.S trajectory deviation	< 5 μm	< 3 μm
R.M.S phase error	< 5 °	< 5.3 °

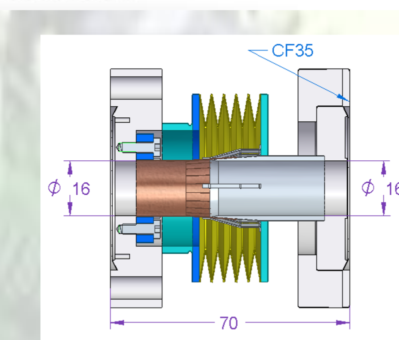


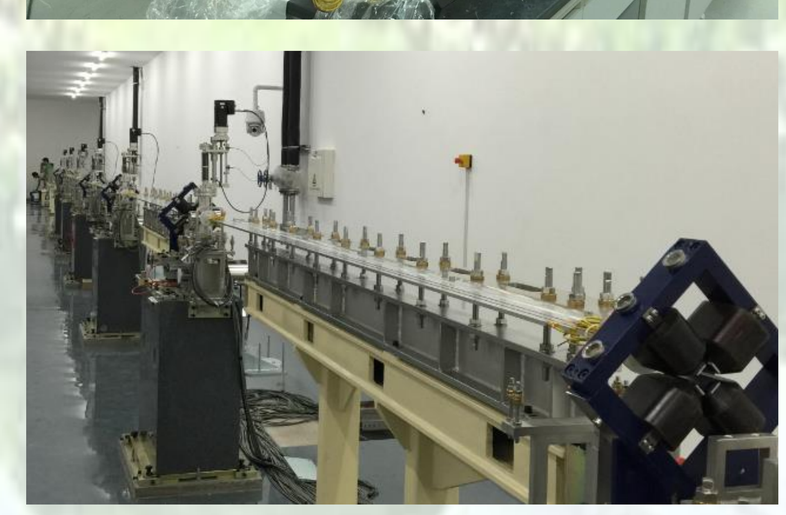


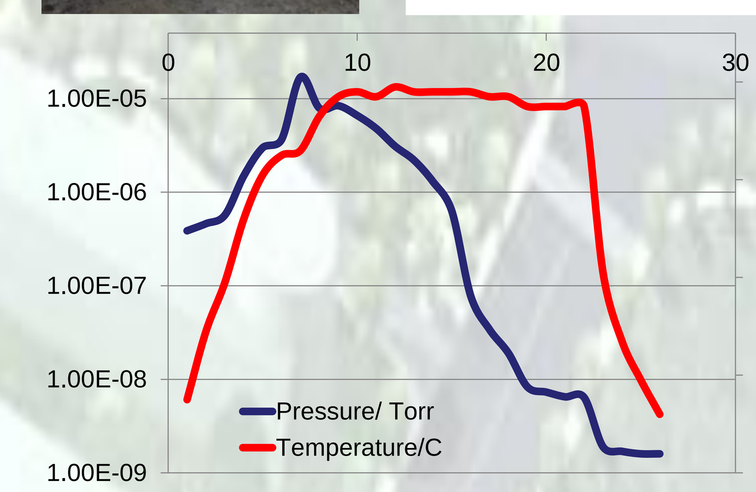
Vacuum chamber

- A6063 extrusion chamber
  15mm×6mm, δ0.75mm, L3.3m
- Surface roughness R_A ~ 200 nm
- P < 1×10^{-6} Pa (after 90 ℃ bakeout)
- Flatness ~ 0.2 mm



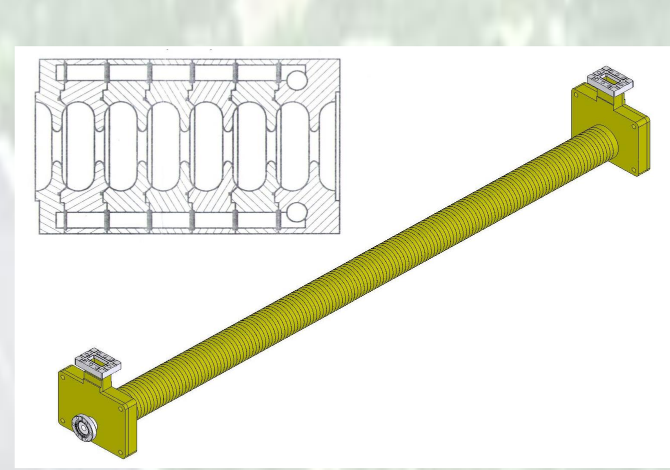




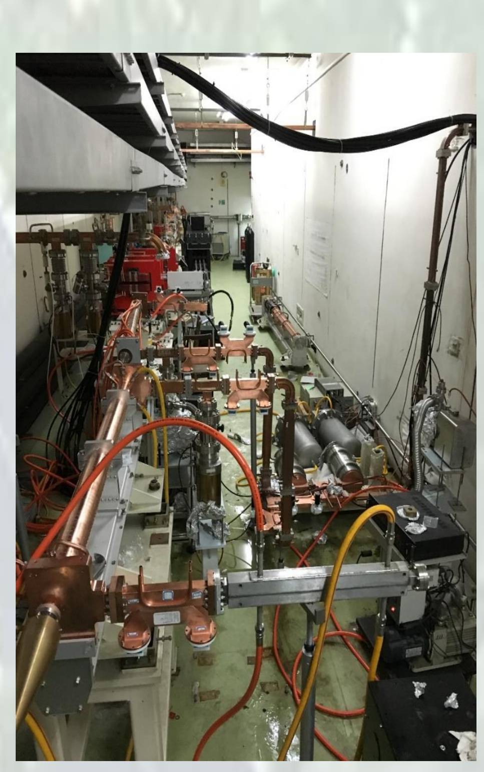


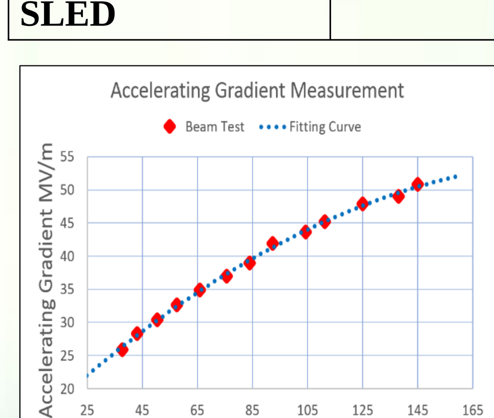
C-band unit

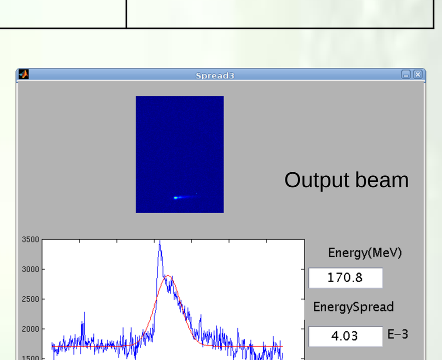
- Rounded cell, inner water cooling, compact coupler.
- High precise machining, Ag-Cu brazing.
- Final gradient reached 50.8 MV/m



Parameter	Design target	Test results
Operating mode	4π/5	4π/5
SWR	< 1.05@5712MHz	1.017@5712MHz
Accelerating gradient	40 MV/m	50.8 MV/m
Gain factor of peak power from SLED	5.5	5.3

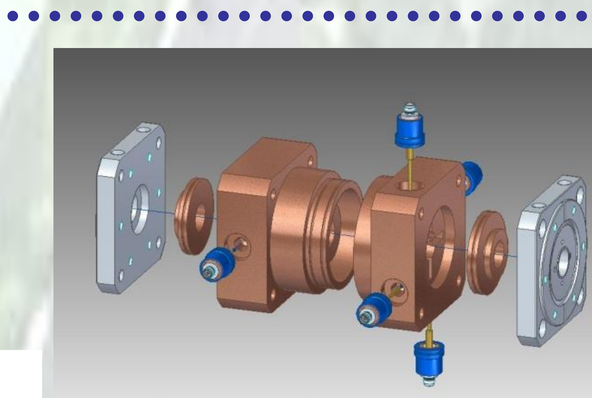


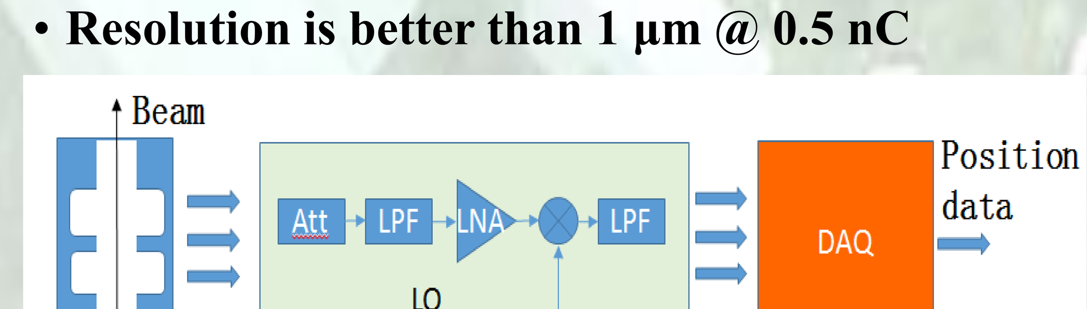


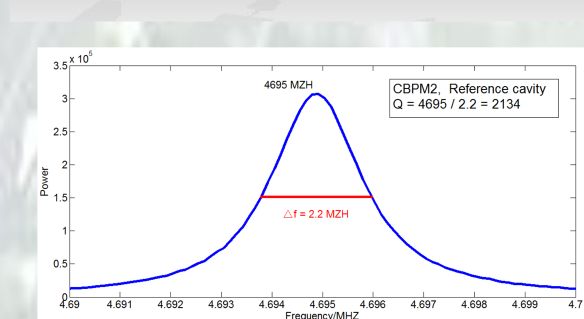


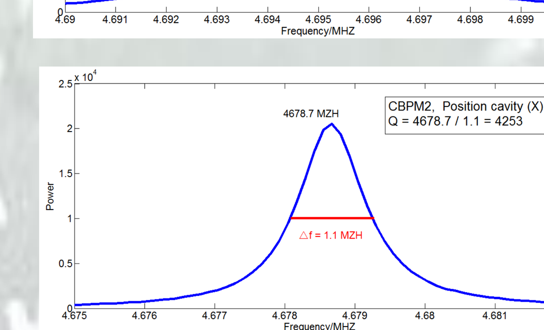
CBPM

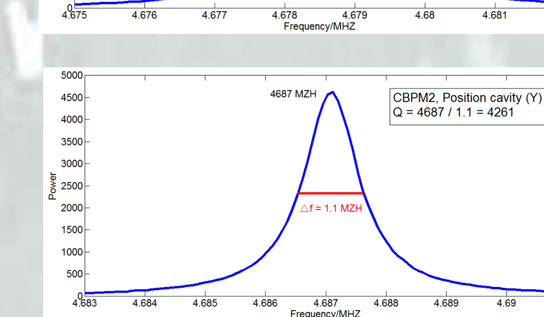
- Reference cavity + position cavity.
- High precise machining, Ag-Cu brazing.
- Resolution is better than 1 μm @ 0.5 nC



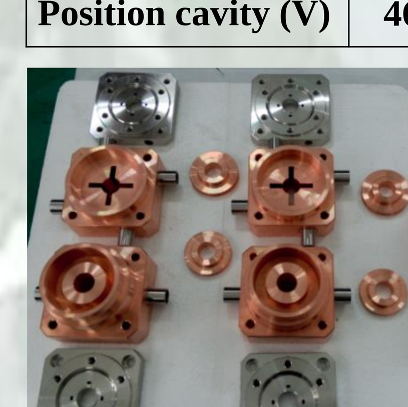


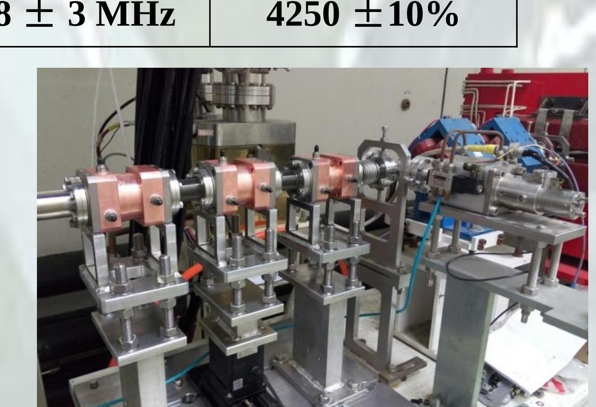






Parameter	Frequency	Q value
Reference cavity	4693 ± 3 MHz	2230 ±10%
Position cavity (H)	4680 ± 3 MHz	4250 ±10%
Position cavity (V)	4688 ± 3 MHz	4250 ±10%





SINAP 中国科学院上海应用物理研究所

Shanghai Institute of Applied Physics, Chinese Academy of Sciences