

Recent progress of SRF cavities and facilities at IHEP

Feisi He

On behalf of colleagues in IHEP SRF group
Institute of High Energy Physics (IHEP)



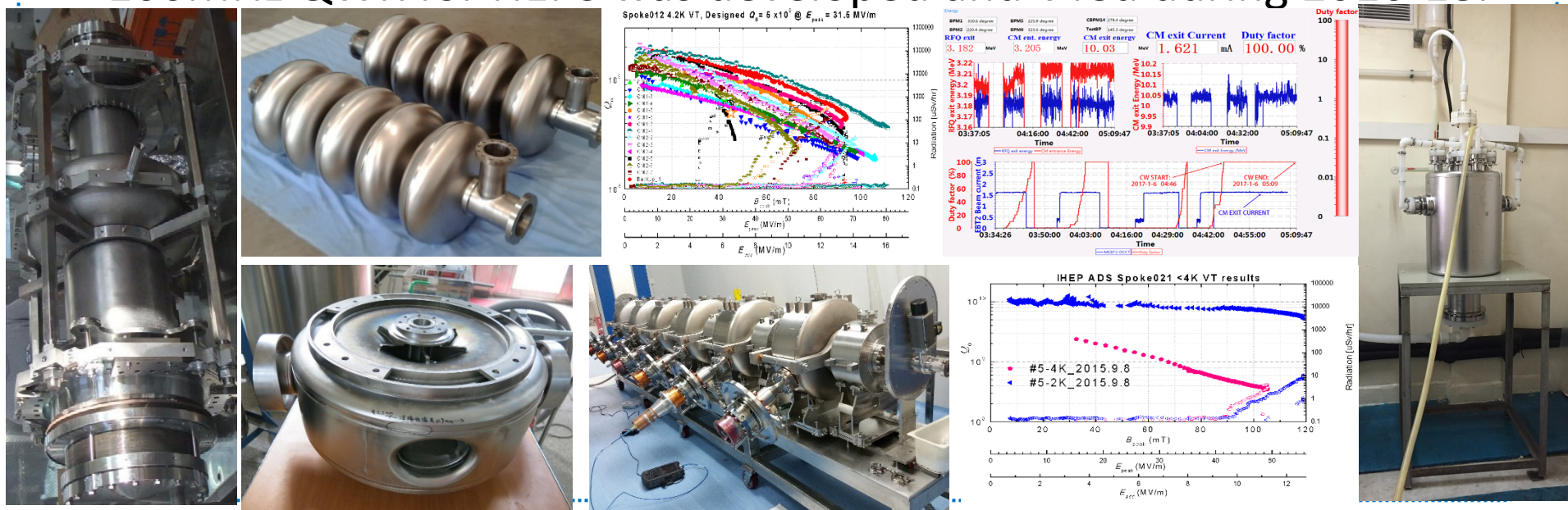
Outline

- Introduction to IHEP SRF activities and active SRF projects
- Cavity development
 - 166MHz QWR horizontal test
 - Double spoke cavity development
 - 1.3GHz cavities development
- Test facilities
 - EP machine
 - New N-doping furnace
 - PAPS SRF facility



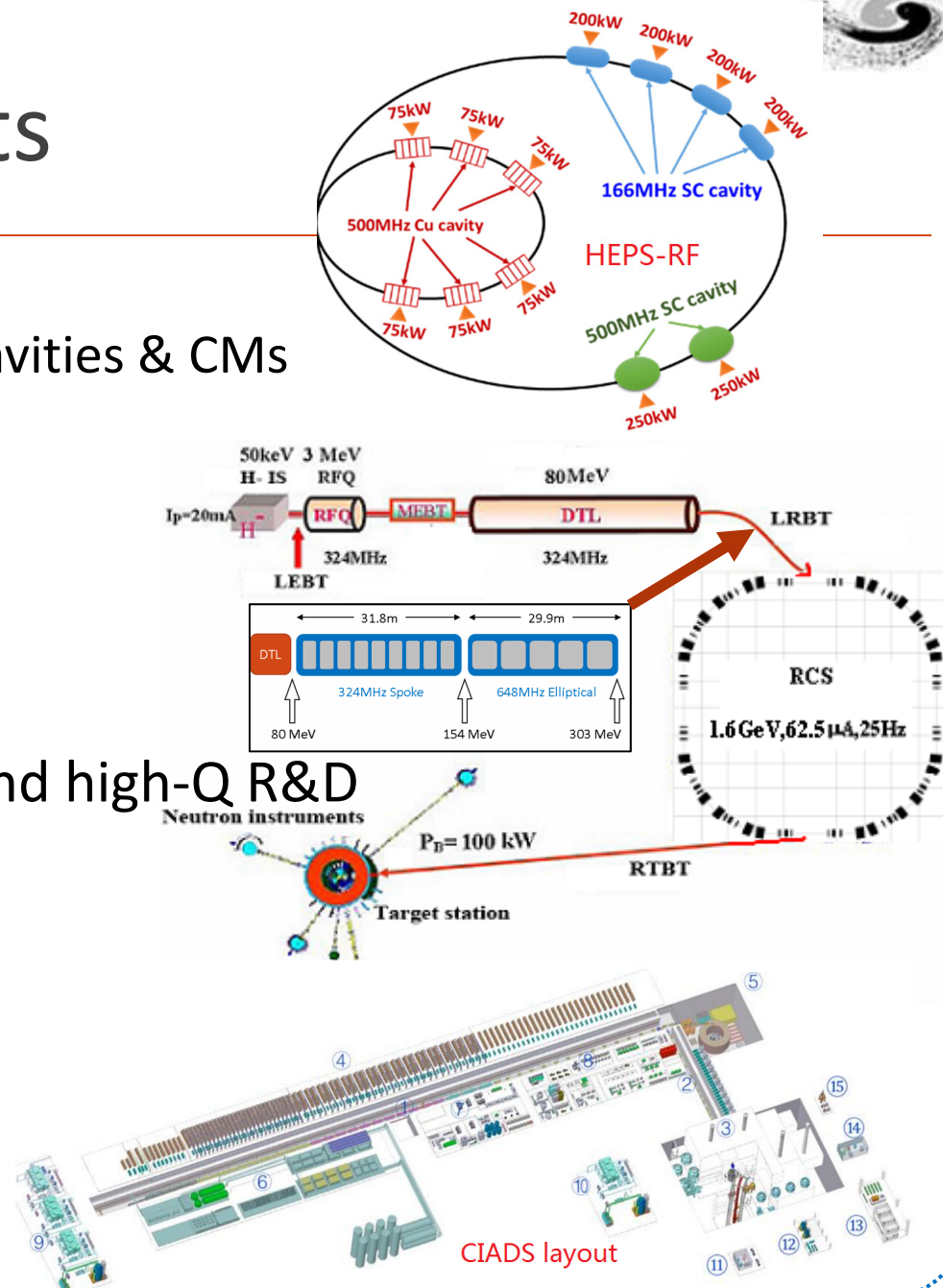
Introduction to IHEP SRF activities

- SRF R&D starts in 1990s, to develop 500MHz cavity for BEPC-II. The full CM was operated with 600mA beam and 100kW RF power.
- **R&D for ILC 1.3GHz cavities started since 2000s**
- During 2011-17, proton linac for ADS project, with 325MHz spoke cavities, were commissioned with 2.1mA CW proton beam.
- 166MHz QWR for HEPS was developed and VTed during 2016-18.



Active SRF projects

- HEPS
 - 166MHz QWR and 500MHz cavities & CMs
- CEPC R&D
 - 650MHz cavities high-Q R&D
 - 16MeV beam test facility
- SHINE collaboration
 - 1.3GHz cavity production and high-Q R&D
- CiADS
 - 325MHz $\beta_0=0.42$ DSR & CMs
- CSNS upgrade
 - 325MHz $\beta_0=0.50$ DSR & CMs
- PAPS-SRF facility construction



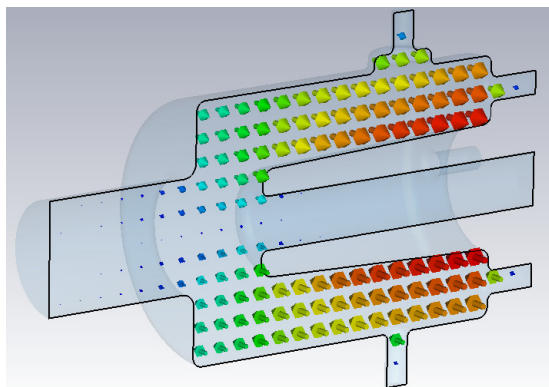


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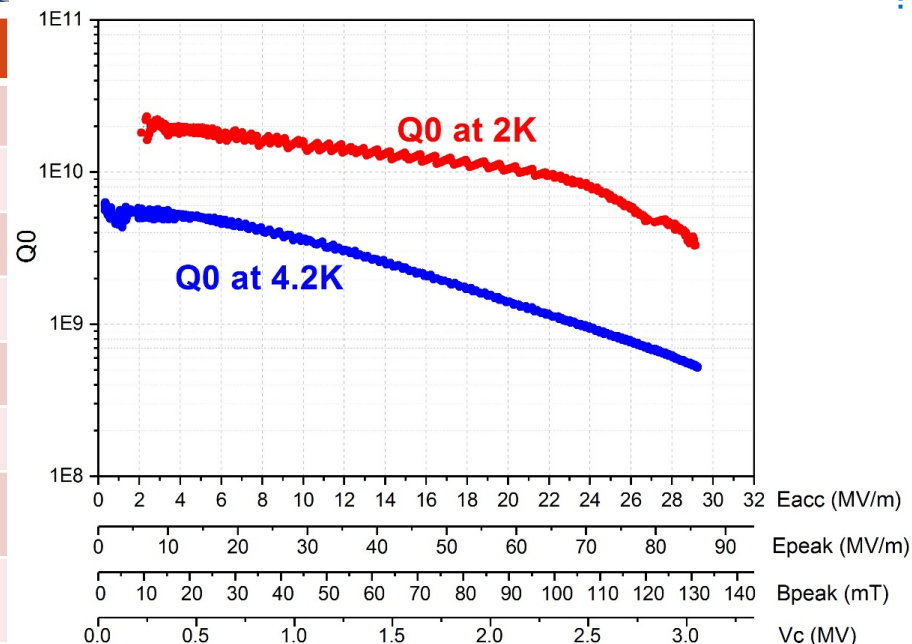


HEPS 166MHz QWR cavity



$\text{Max } E_p = 86 \text{ MV/m}$
 $\text{Max } B_p = 131 \text{ mT}$
 $R_{\text{res}} = 2.3 \text{ n}\Omega$

Parameters	Design	Nominal
RF frequency	166.6 MHz	
Operating temperature	4.2 K	
$R_{\text{sh}}/Q_0 (=V^2/P_c)$	136 Ω	
$G (=R_s \cdot Q_0)$	54.8 Ω	
RF voltage [MV]	1.5	1.2
Eacc [MV/m]	14.5	11.5
Epeak at Vc=1.5MV [MV/m]	42	34
Bpeak at Vc=1.5MV [mT]	64	51



HEPS 166MHz QWR horizontal test

- HEPS 166MHz QWR has just finished horizontal test for the first time the last week
- A second test is planned in late Dec, after modifying cryomodule



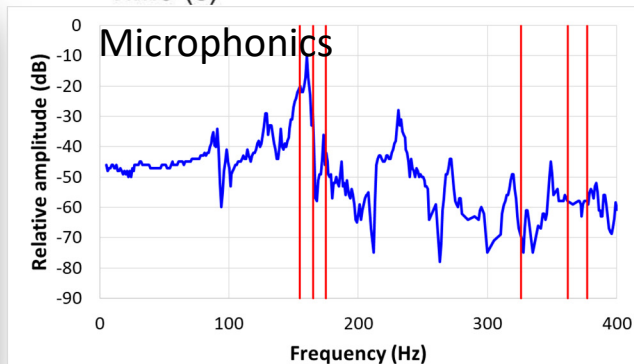
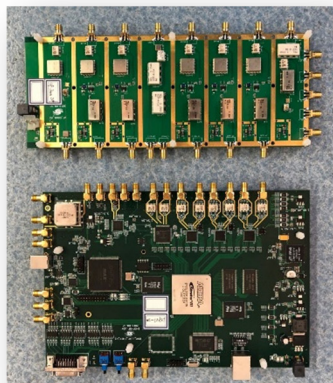
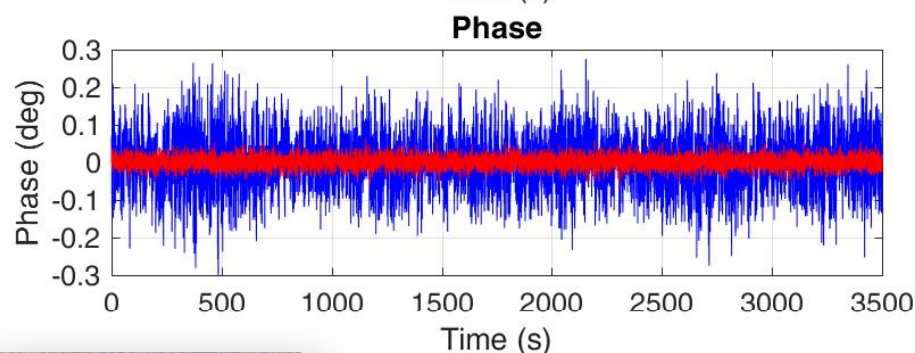
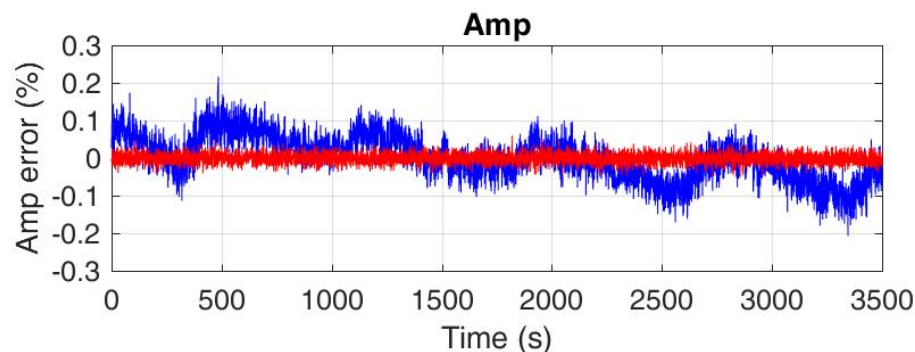
Assembled in the CM



50kW solid-state amplifier



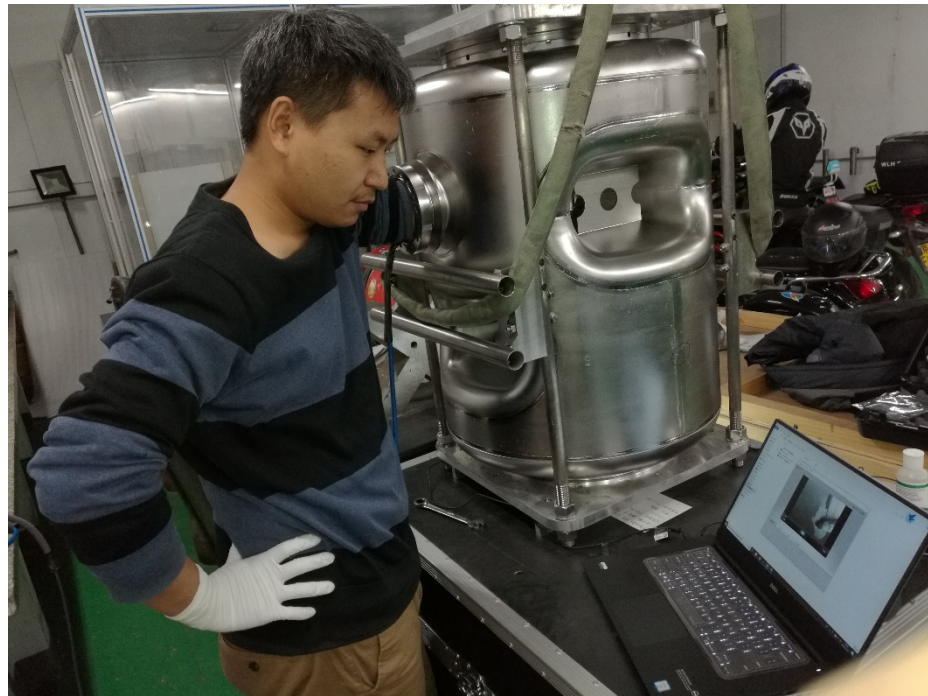
HEPS 166MHz QWR horizontal test (2)





Double spoke cavity development

- For CiADS and CSNS-upgrade project
- Fabrication were finished last month
- Frequency was controlled by trimming length of out-conductor
- Some welding seals were grinded after final EBW





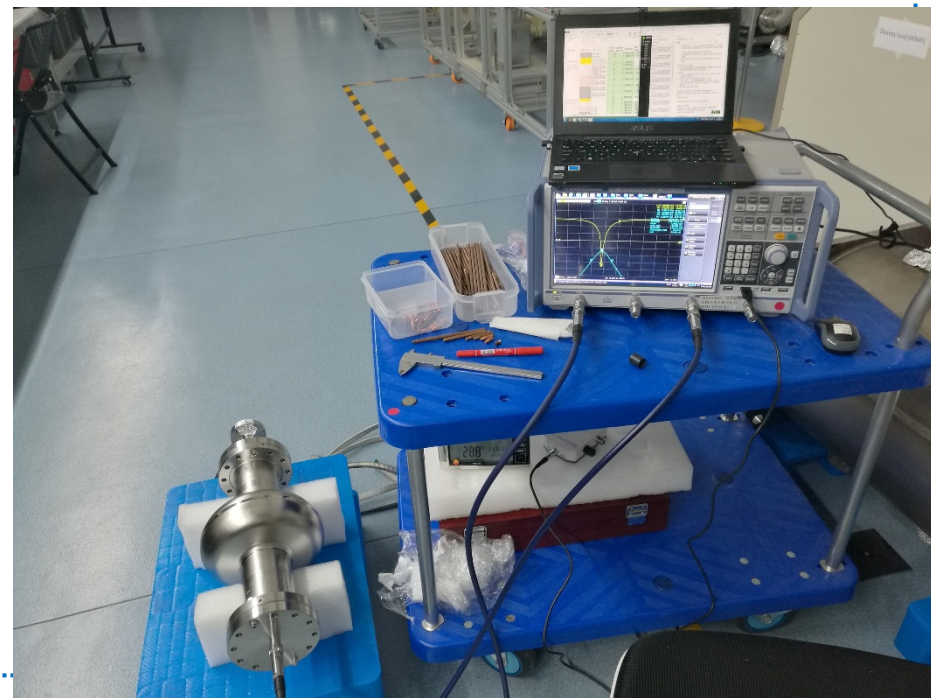
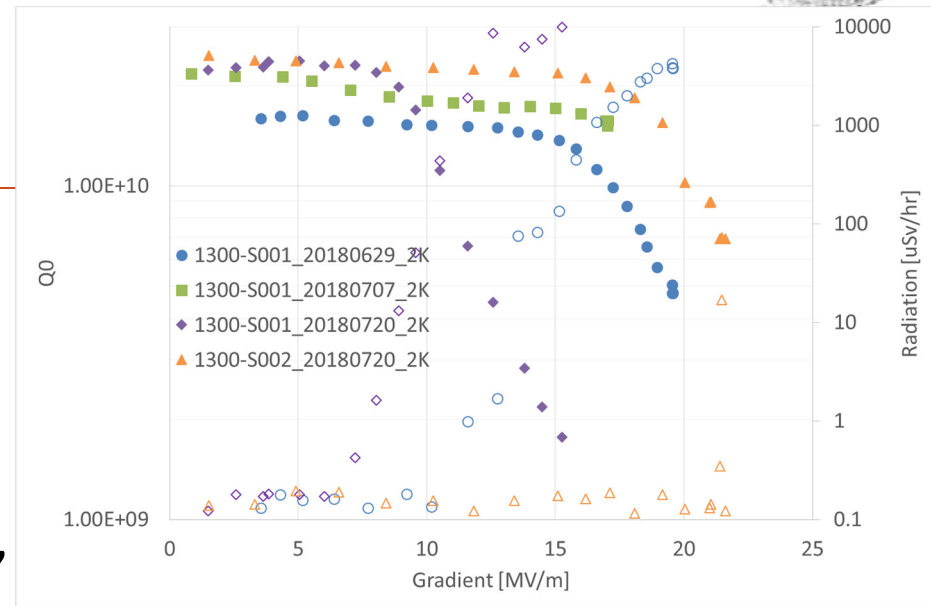
Double spoke cavity development (2)

- BCP has been finished the last week
- HPR is in progress today
- Vertical test is planned late Nov or early Dec



1.3GHz cavity R&D

- Six 1.3GHz single-cell cavities has been fabricated
- Baseline BCP and VT have been applied to 1300-S1/S2
- 30 μm EP was applied to 1300-S2, and it will be VT this weekend; then N-infusion will be applied
- 1300-S3/S4 is in KEK for doping and VT
- 1300-S5/S6 has just be EBWed this Tuesday, and will go through EP and VT
- These cavities will serve for conditioning of the EP machine



1.3GHz cavity R&D (2)

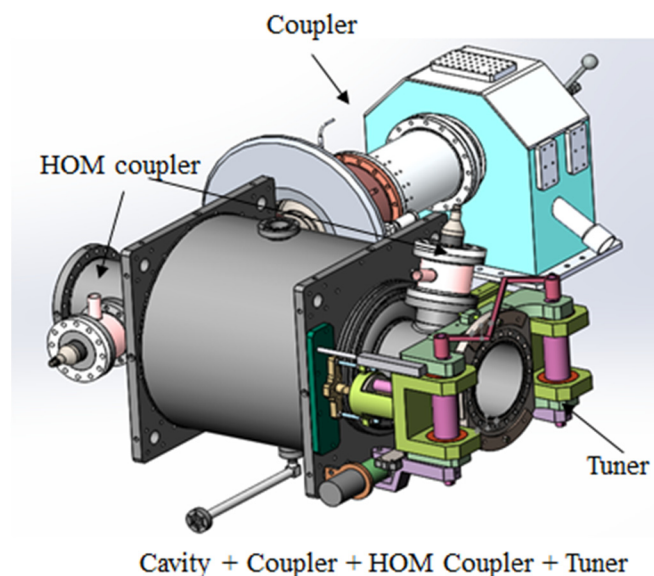
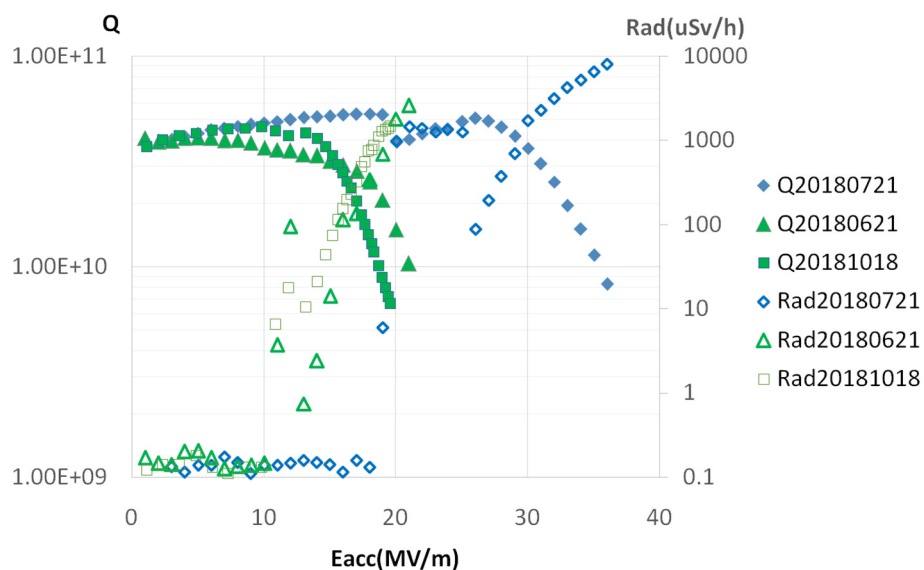
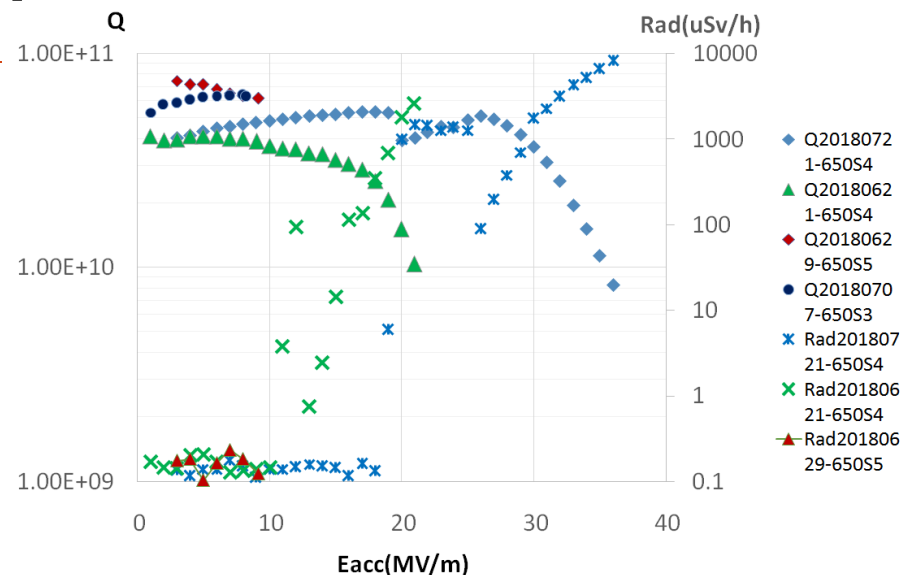
- Two 1.3-9cell fine grain cavities were under fabrication, and the first one will be final EBWed early next week
- Toolings for mass-production were developed and tested
- Procedures for size and frequency control were still in the learning curve





CEPC 650MHz cavity R&D

- Six 650 single cell cavities were fabricated and gone through VT
- More chemistry and N-doping will be applied to these cavities
- Two-cell cavity has just finished mechanical design





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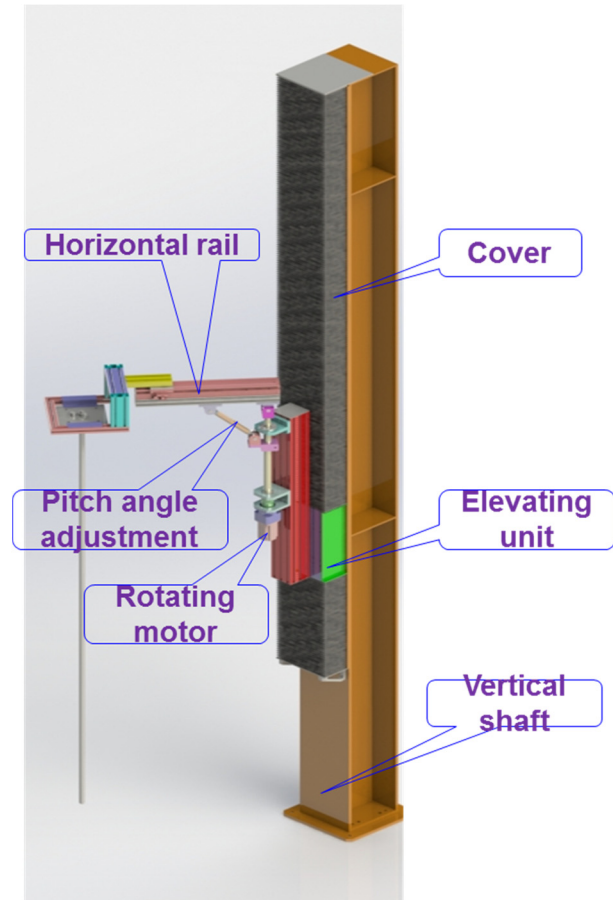
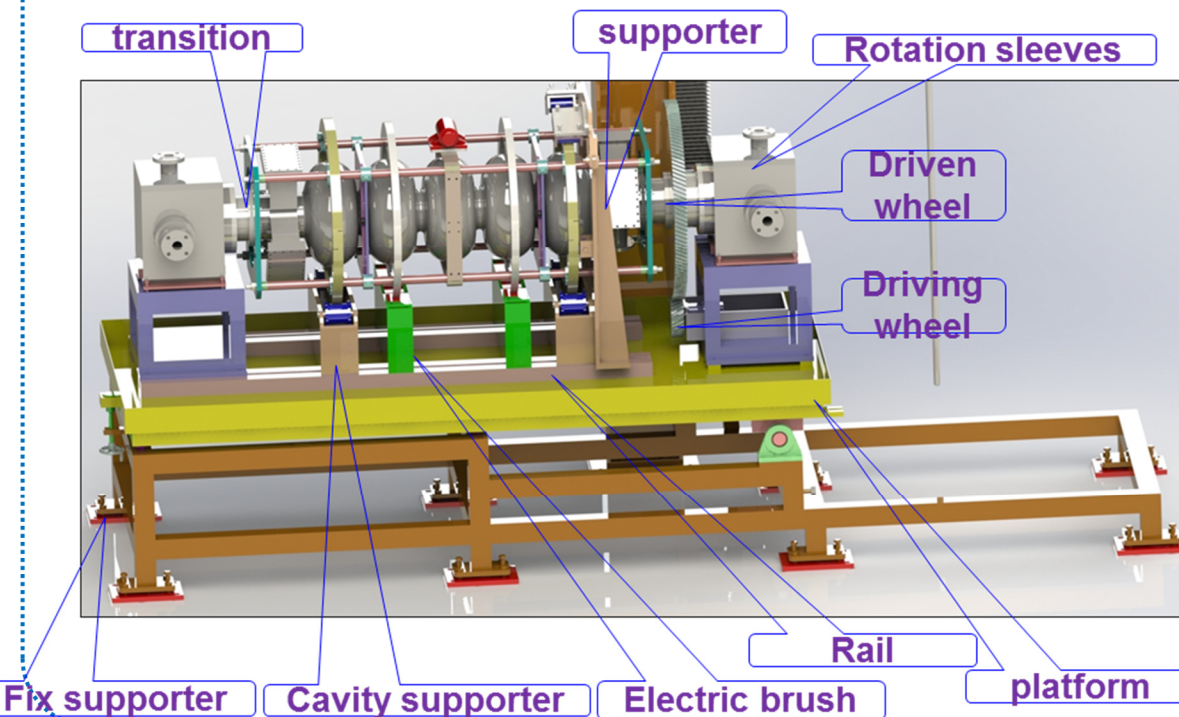
EP system

- An EP machine for 500MHz (HEPS), 650MHz (CEPC), and 1.3GHz (CEPC & SHINE) cavities

		IHEP	KEK	DESY	JLab	ANL
1	1.3GHz 9cell	√	√	√	√	√
2	650MHz 5cell	√	×	×	×	√
3	500MHz 1cell	√	√	×	×	√
4	Electrolyte Preparation	√	×	×	×	×
5	Cavity outside water cooling	√	×	×	√	√
6	Vertical cathode assembly	√	√	?	×	√
7	New and old acid separation	√	×	√	√	√
8	Pre-EP unit	√	√	×	×	×

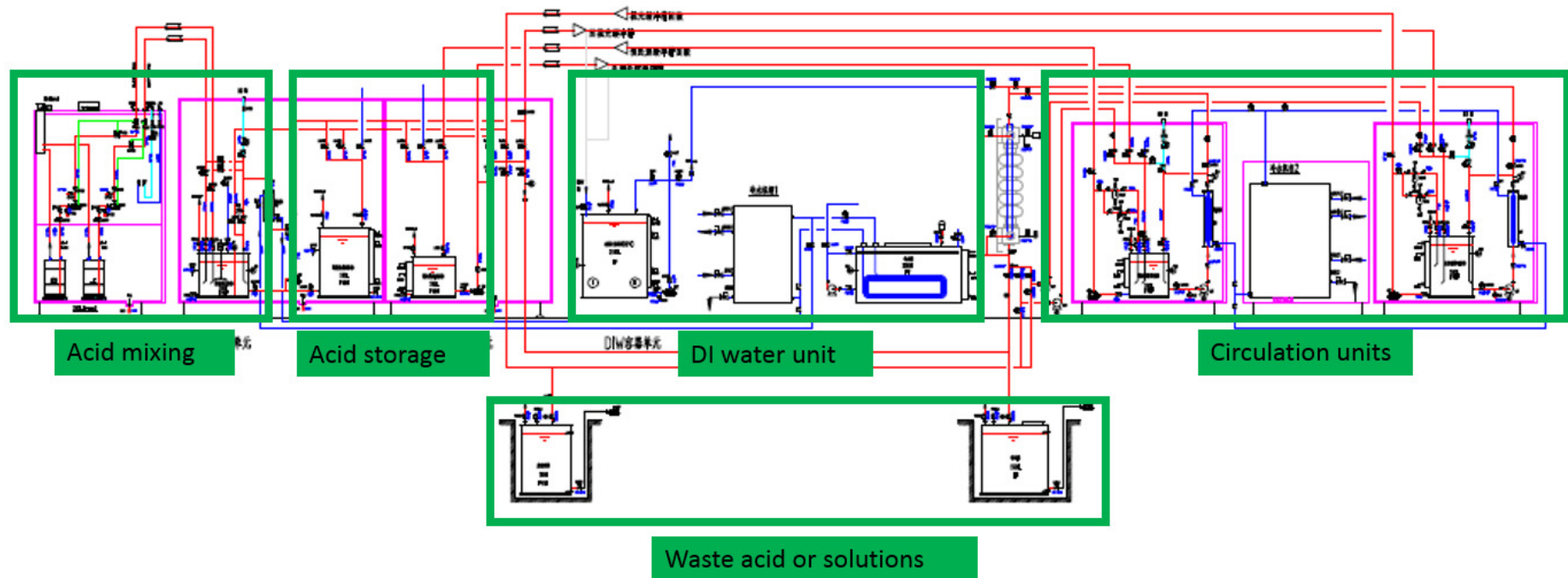
EP system (2)

- Mechanical platform and cathode assembly



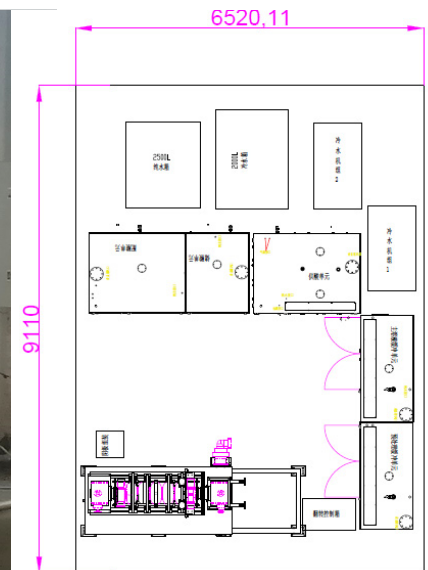
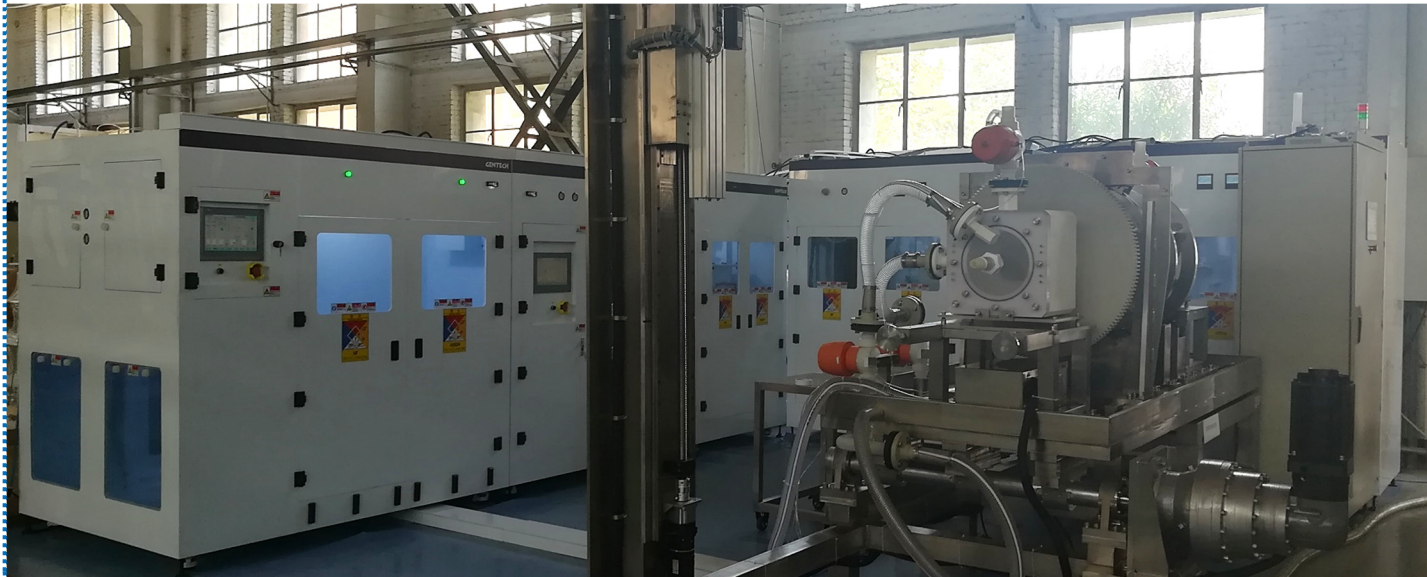
EP system (3)

- Solution unite include:
 - Acid mixing, Acid storage, DI water cleaning, Acid circulation, Acid lever control, Acid cooling , Cavity cooling, Acid draining, DI Water rinsing, Hydrogen gas exhaust



EP system (4)

- The EP machine just passed the functional test at IHEP
- We will see it in the lab tour

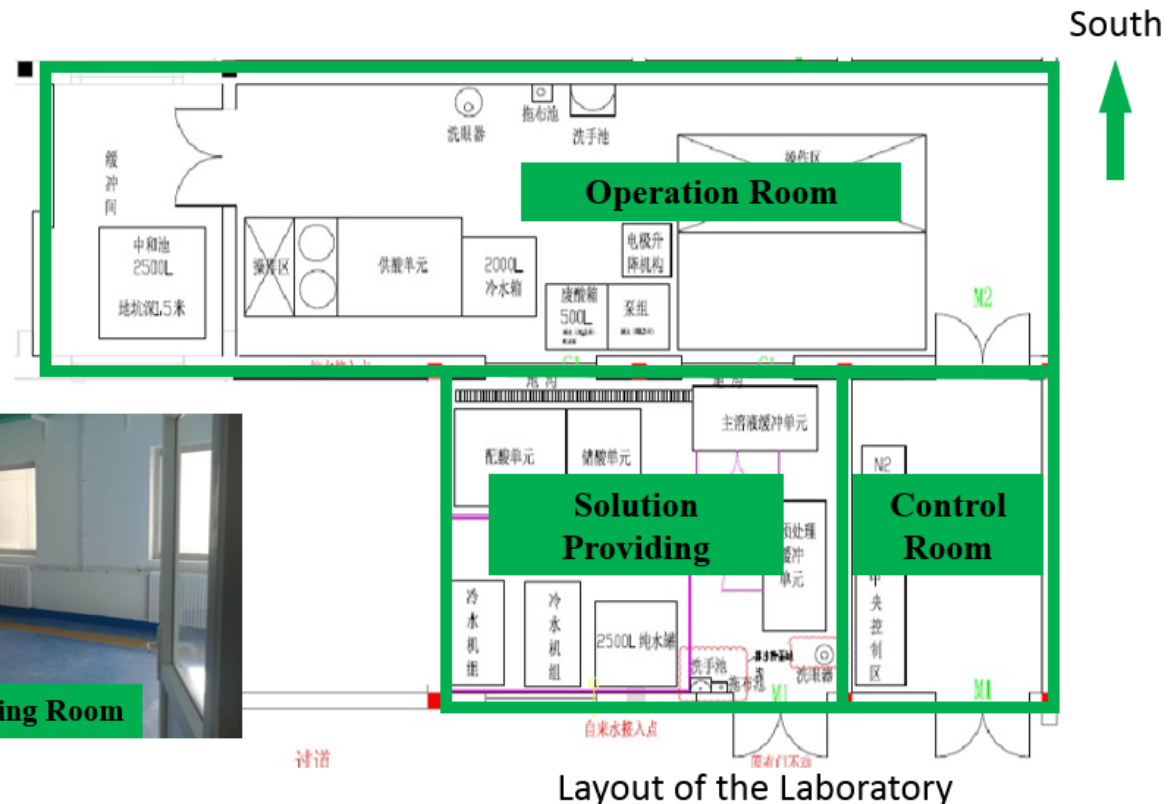


EP system (4)

- It will be transferred to Ningxia post processing center this week-end



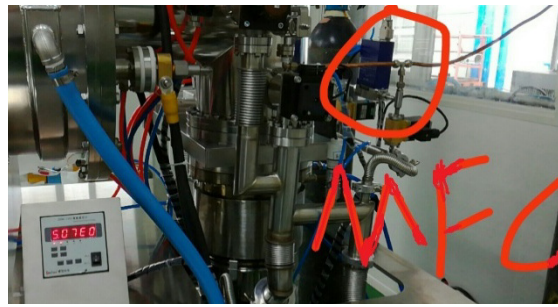
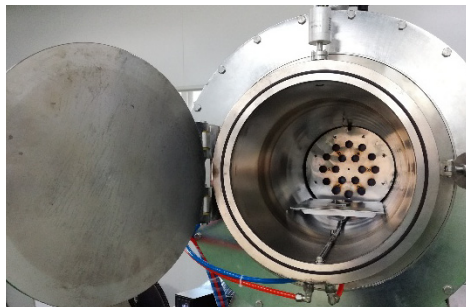
Pictures of the EP laboratory



New N-doping furnace

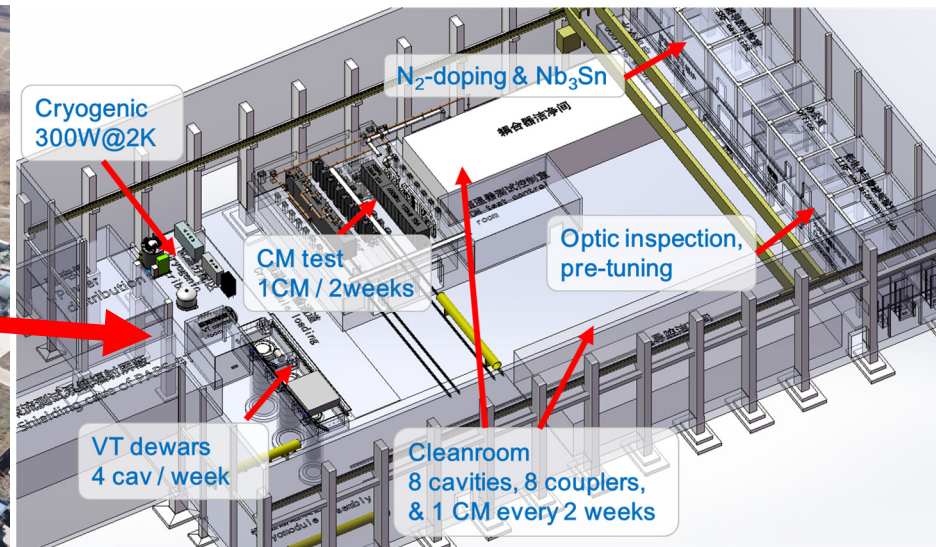


- $\phi 300\text{mm} \times 500\text{mm}$
- Outside heating
- Cryopump
 - 2500 L/s for H₂
- MFC vent controlling
- Ultimate vacuum
 - 25°C 6E-7Pa
 - 850°C 2.4E-5Pa



PAPS-SRF facility

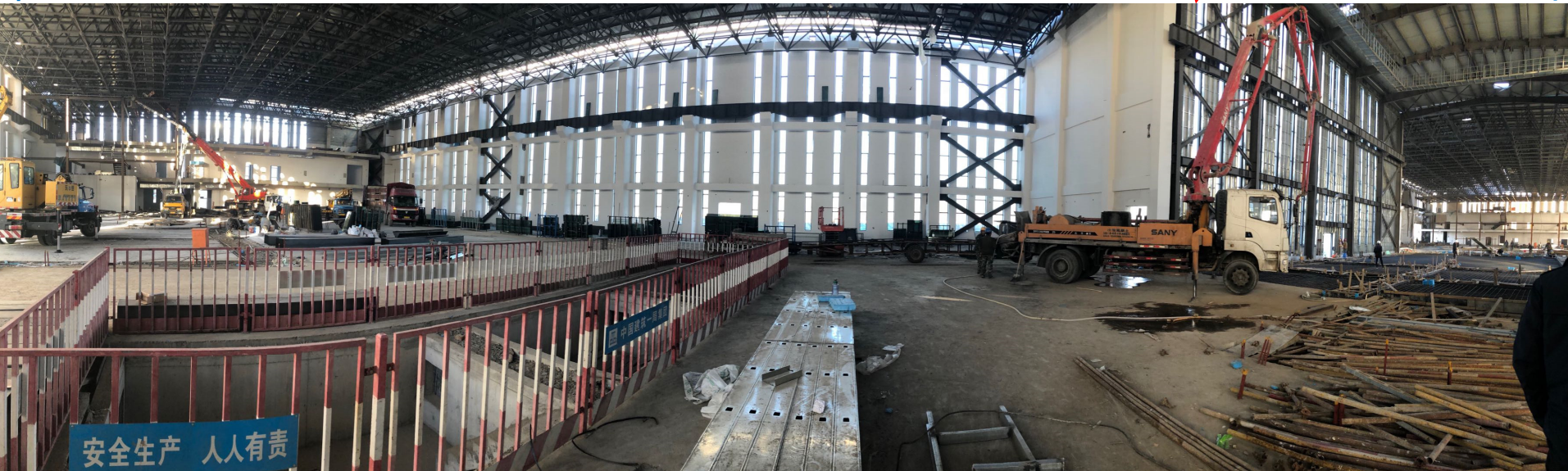
- The new facility is biased on mass production for SRF projects
 - Post-processing, clean assembly, VT/HT/conditioning of cavities
 - 200-400 cavities (couplers) per year; ~20 cryomodules per year
- Civil construction will be finished May 2019



Civil construction as last weekend

PAPS-SRF facility

- The roof of all buildings will be finished tomorrow
- Equipment will be assembled and conditioned since May 2019.



Civil construction as yesterday



Thanks for your attention!