

# Recent progress of SRF cavities and facilities at IHEP

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



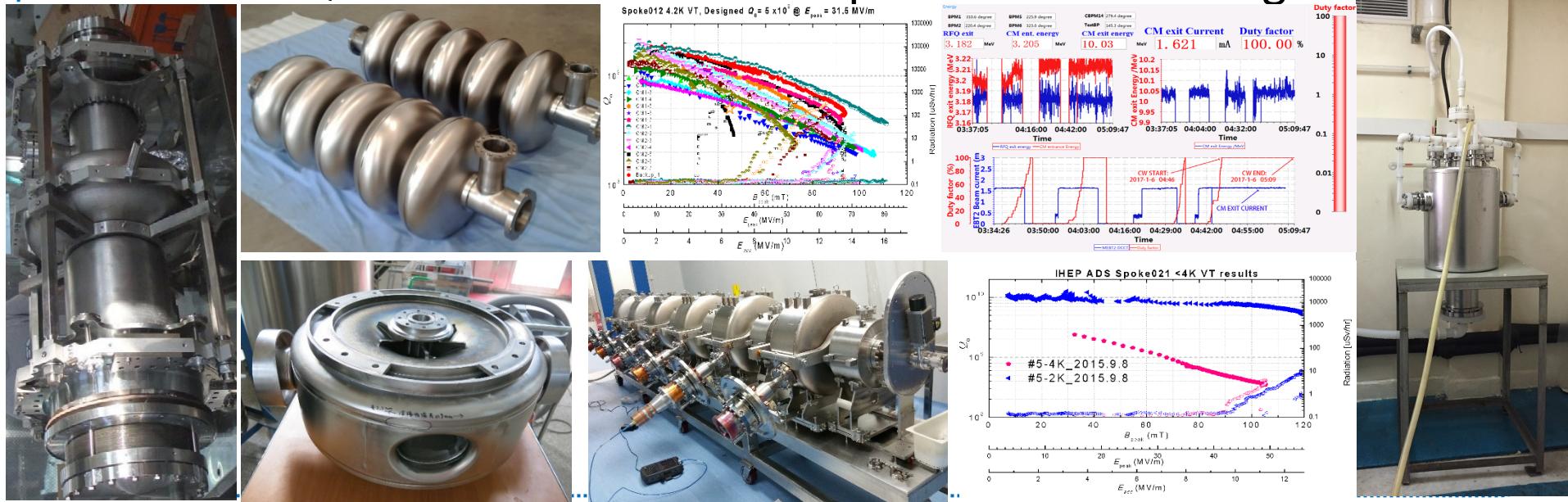
# Outline

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- Introduction to IHEP SRF activites 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 farnance
  - PAPS SRF facility

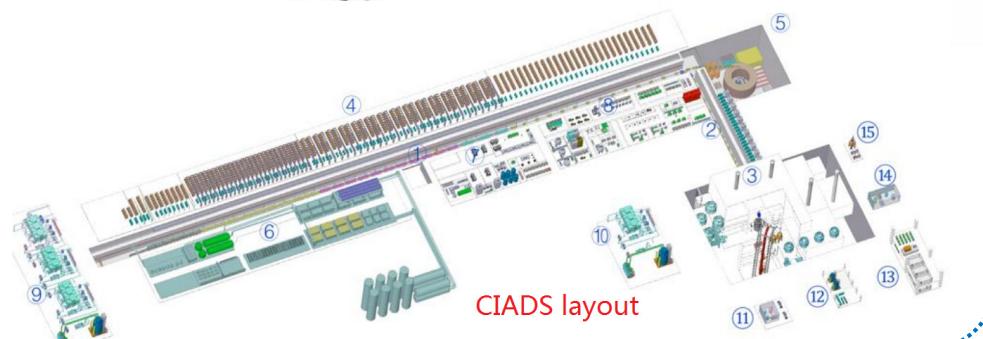
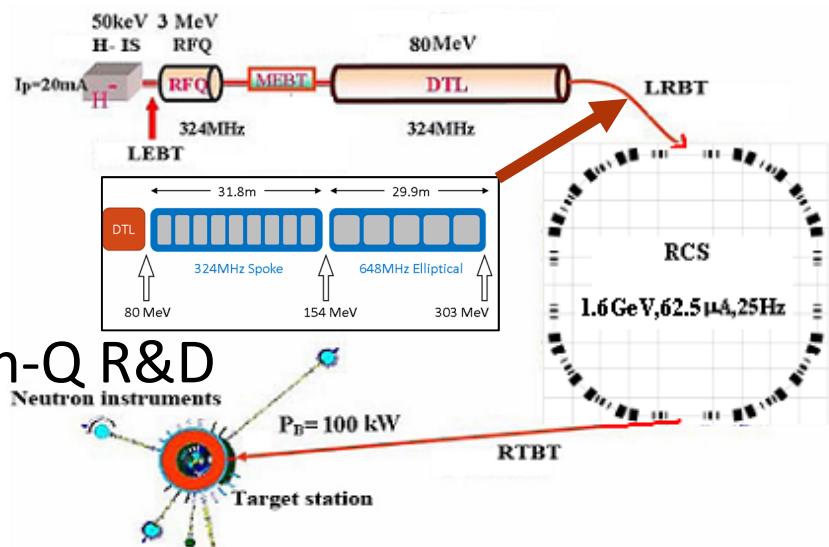
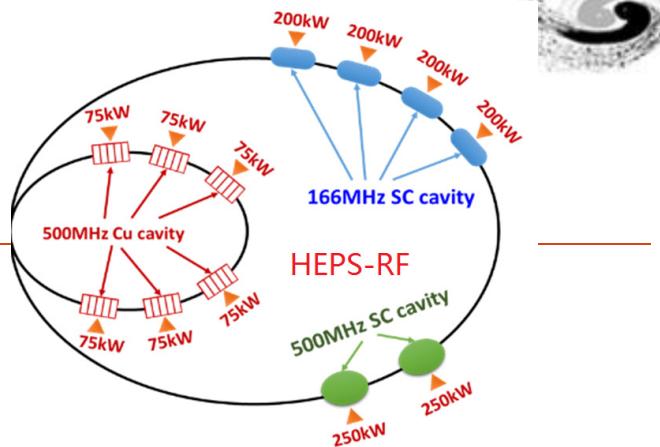
# Introduction to IHEP SRF activities

- 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



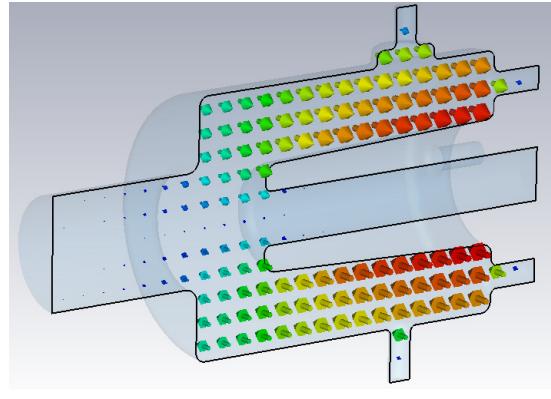


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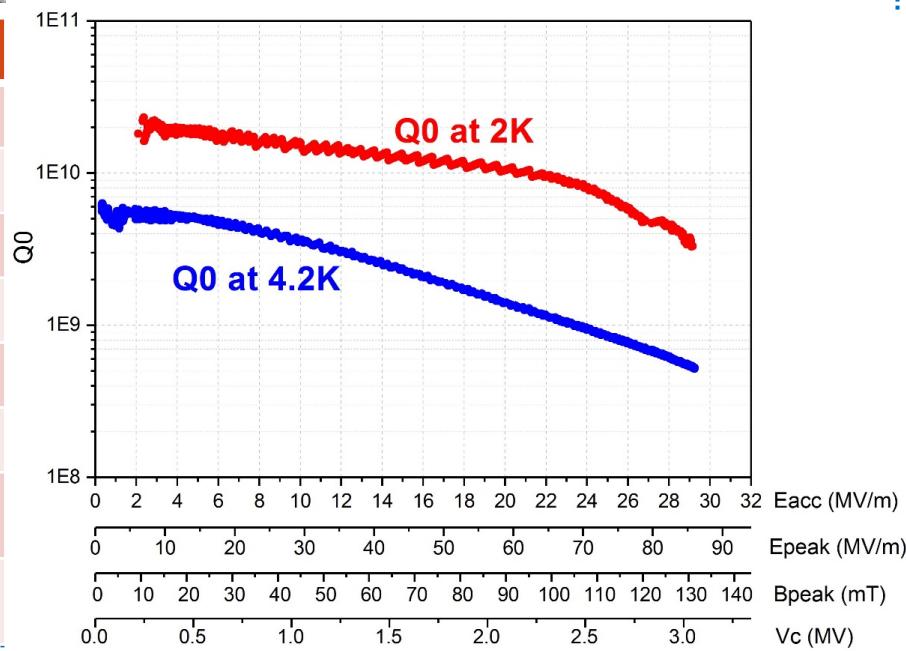
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# HEPS 166MHz QWR cavity



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

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

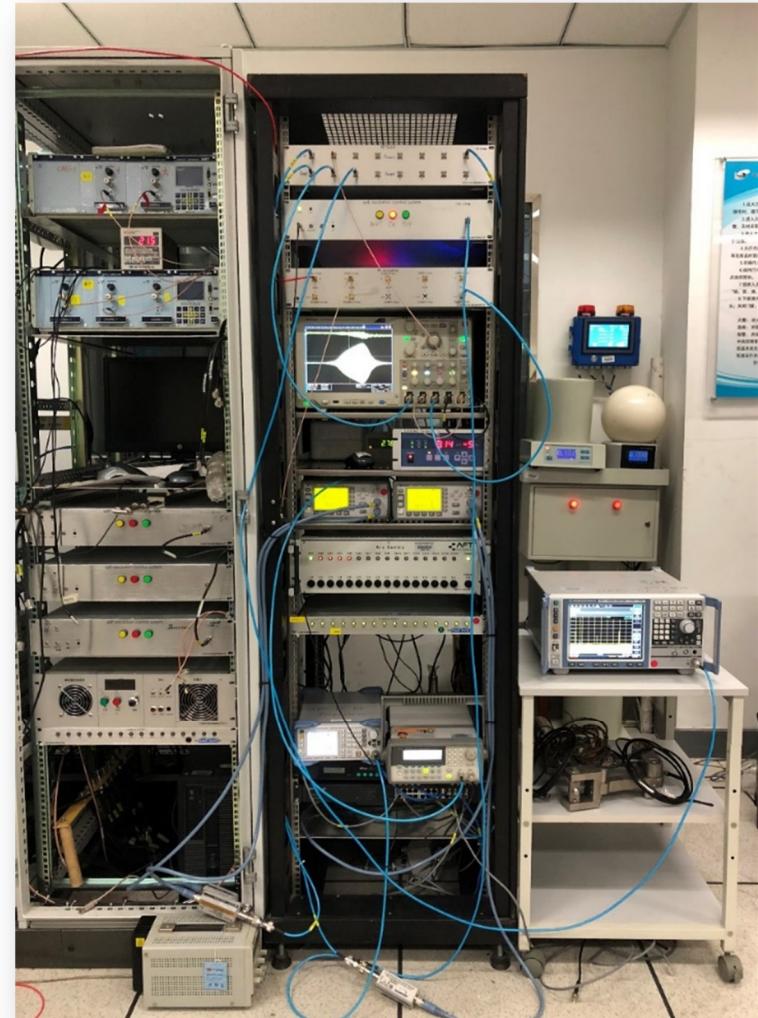
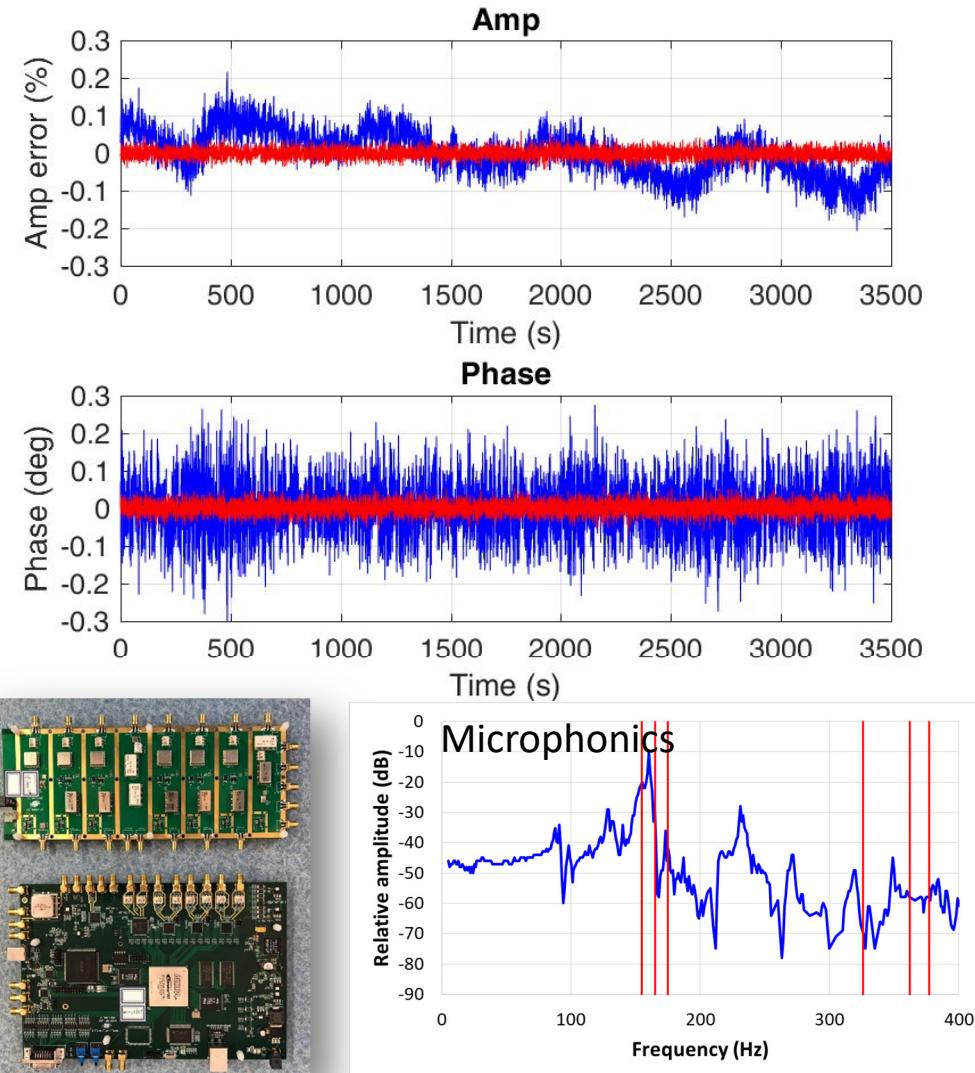


Assembled in the CM



50kW solid-state amplifier

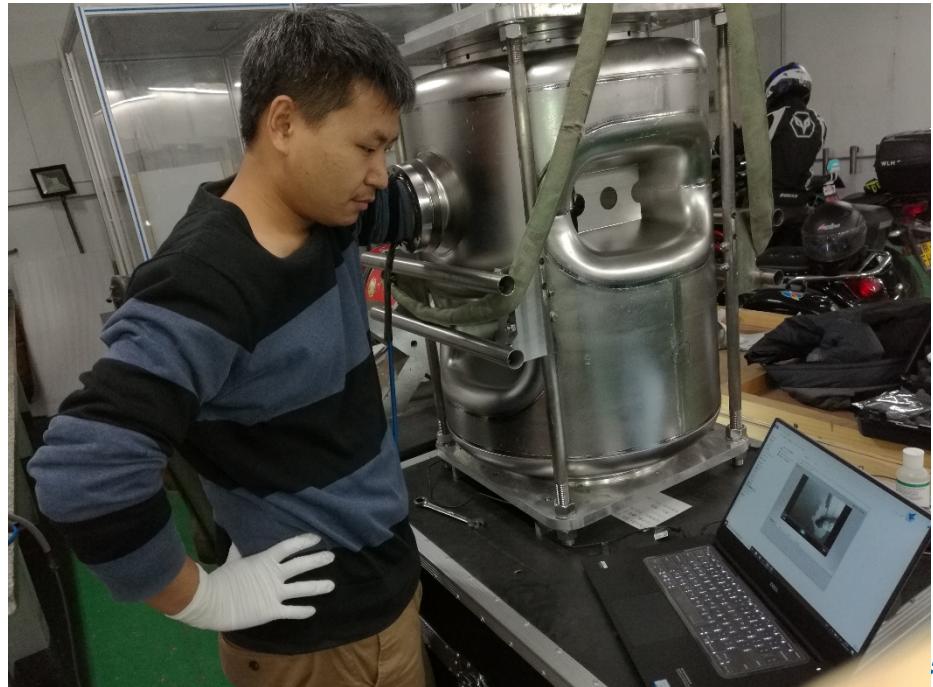
# HEPS 166MHz QWR horizontal test (2)





# 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





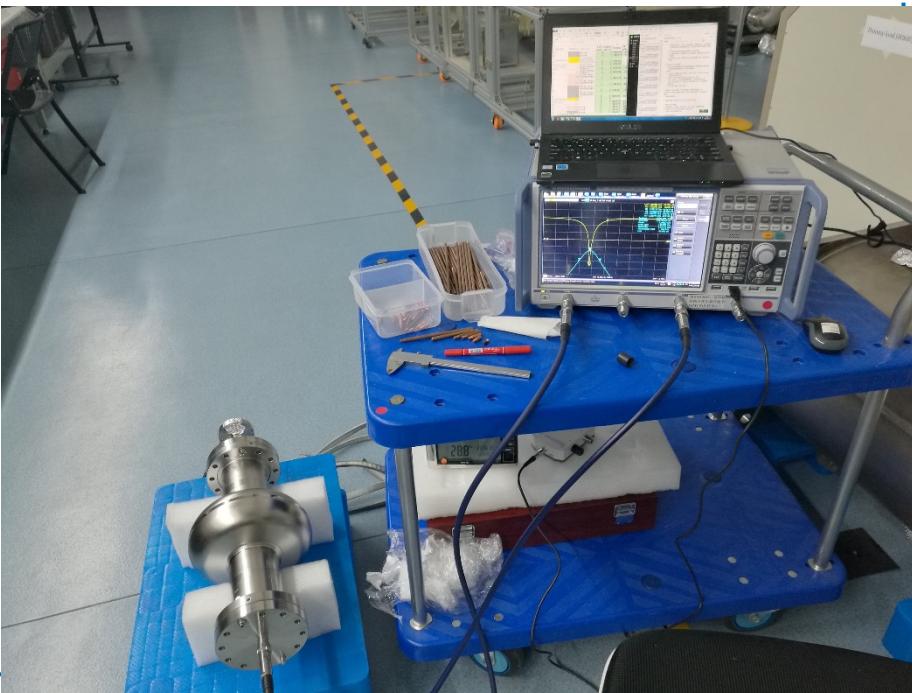
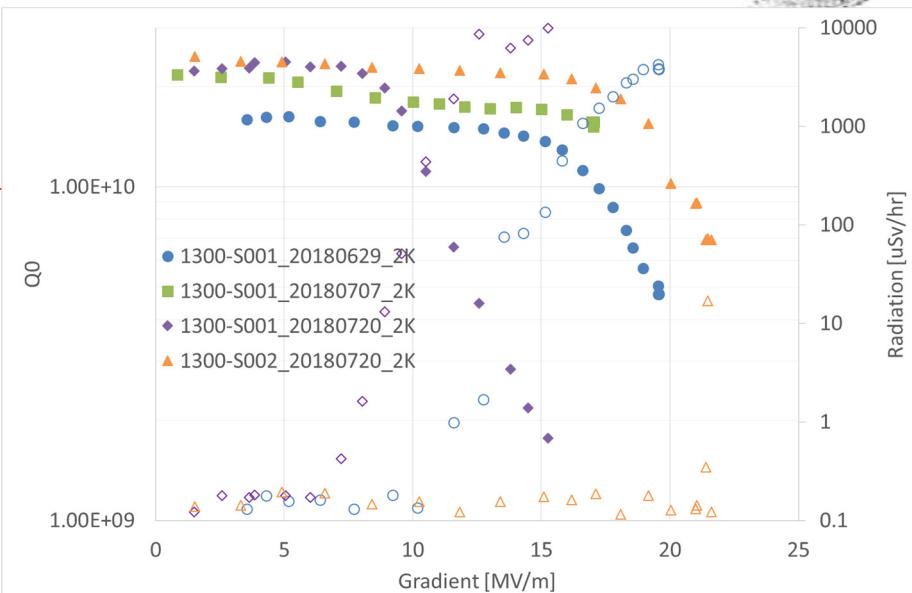
# Double spoke cavity development (2)

- 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 um 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)

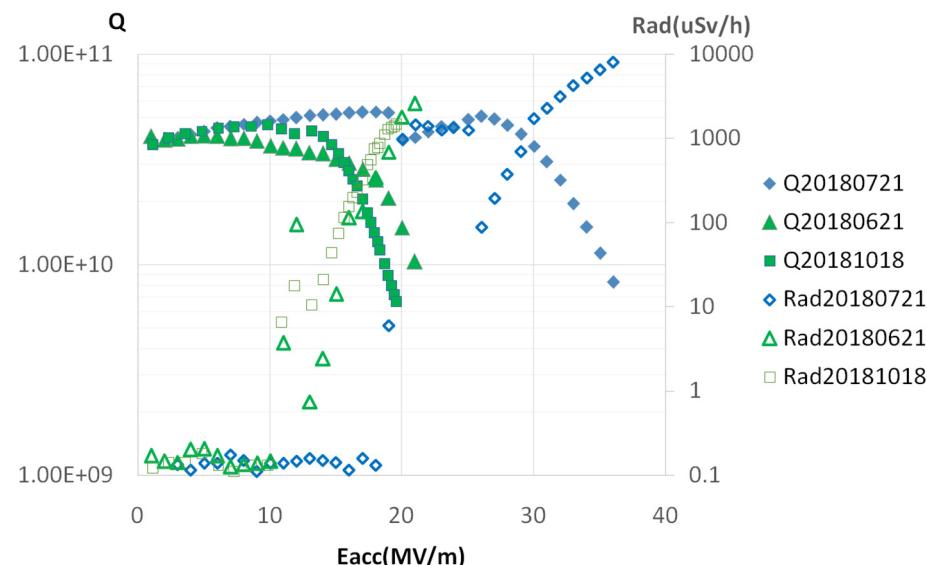
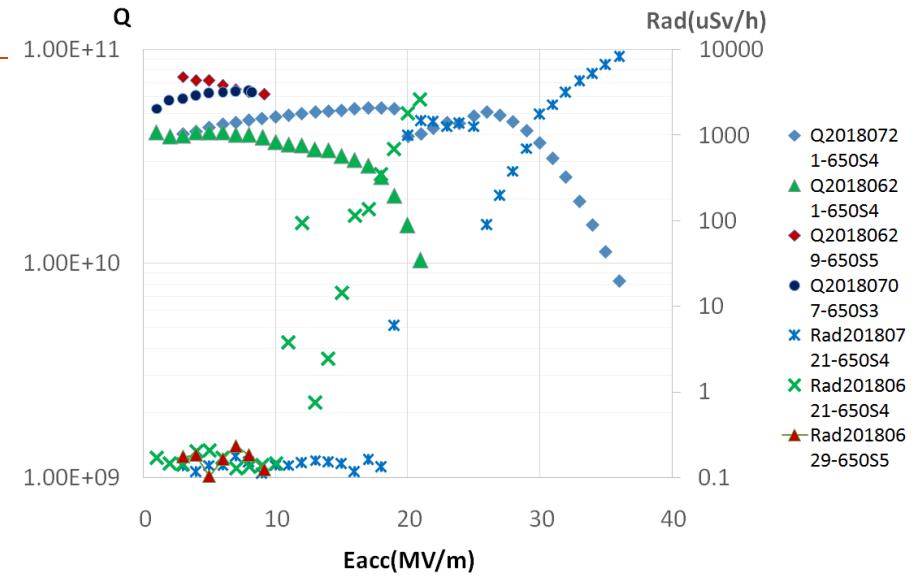
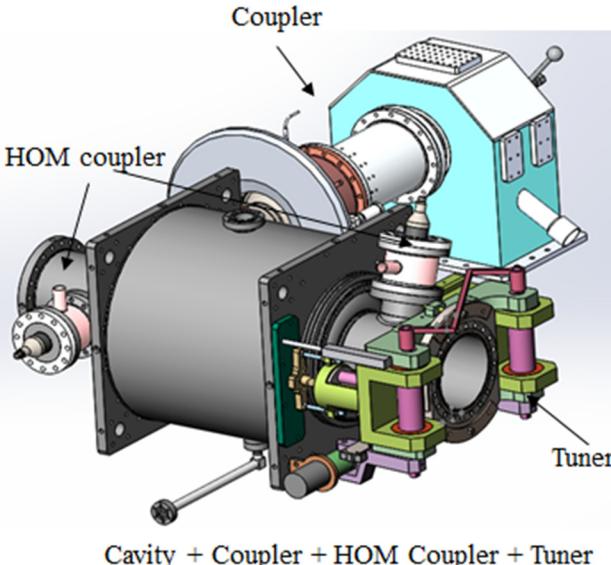
- Two 1.3-9cell fine grain cavities were under fabrication, and the first one will be final EBWed early next week
- Toolings for mass-production were developed and tested
- Procedures for size and frequency control were still in the learning curve





# 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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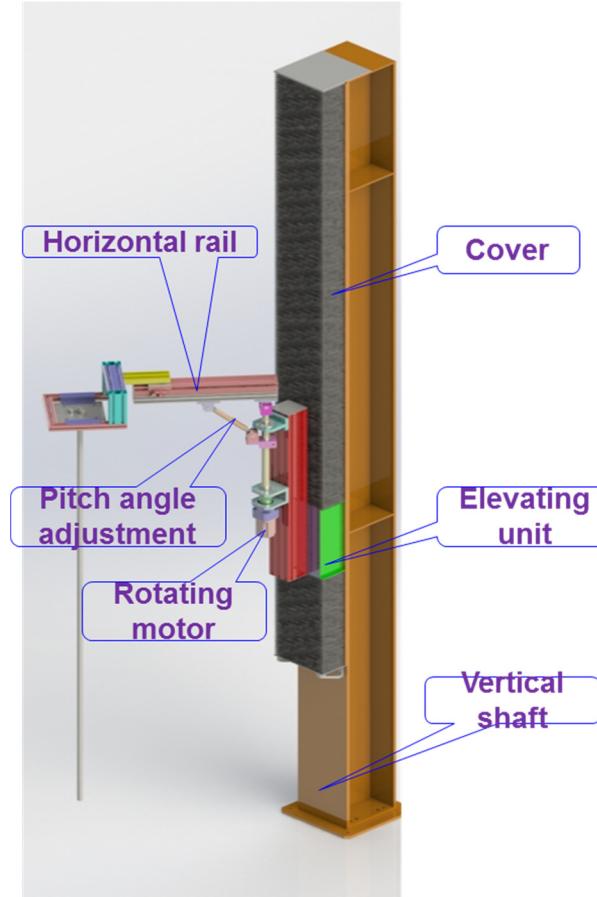
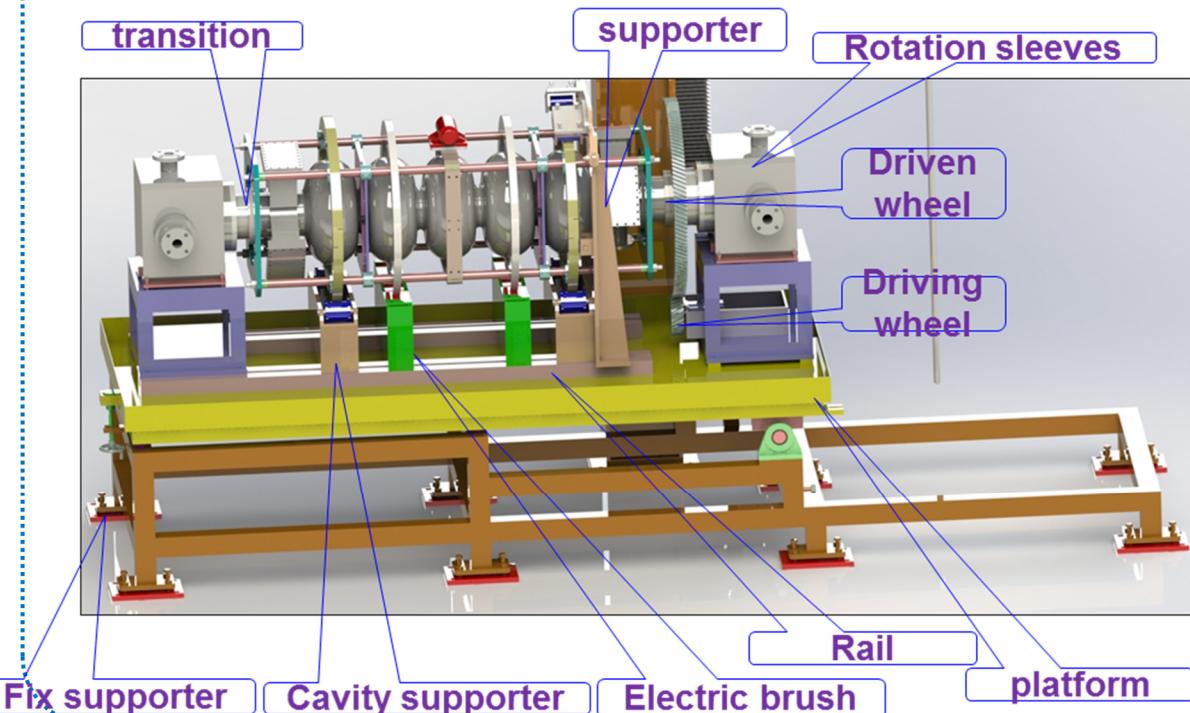
# EP system

- 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	✓	✓	✗	✗	✗

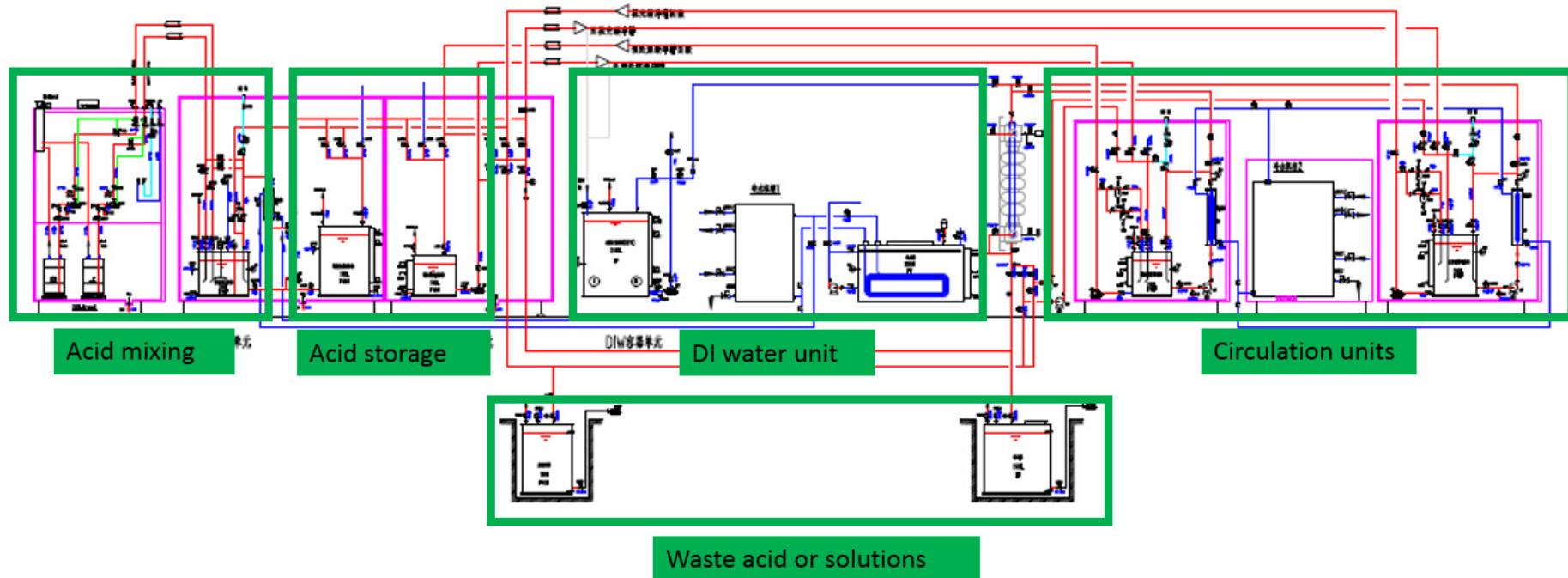
# EP system (2)

- Mechanical platform and cathode assembly



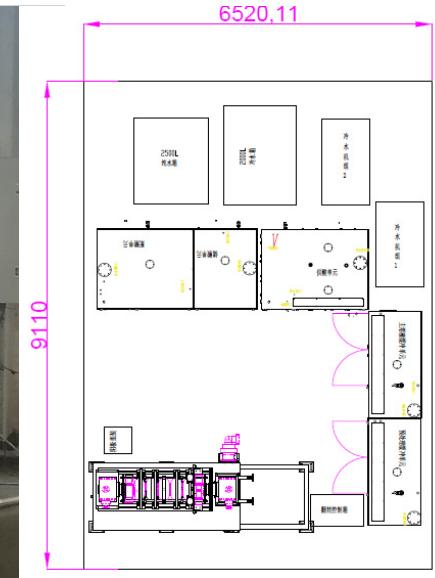
# EP system (3)

- 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



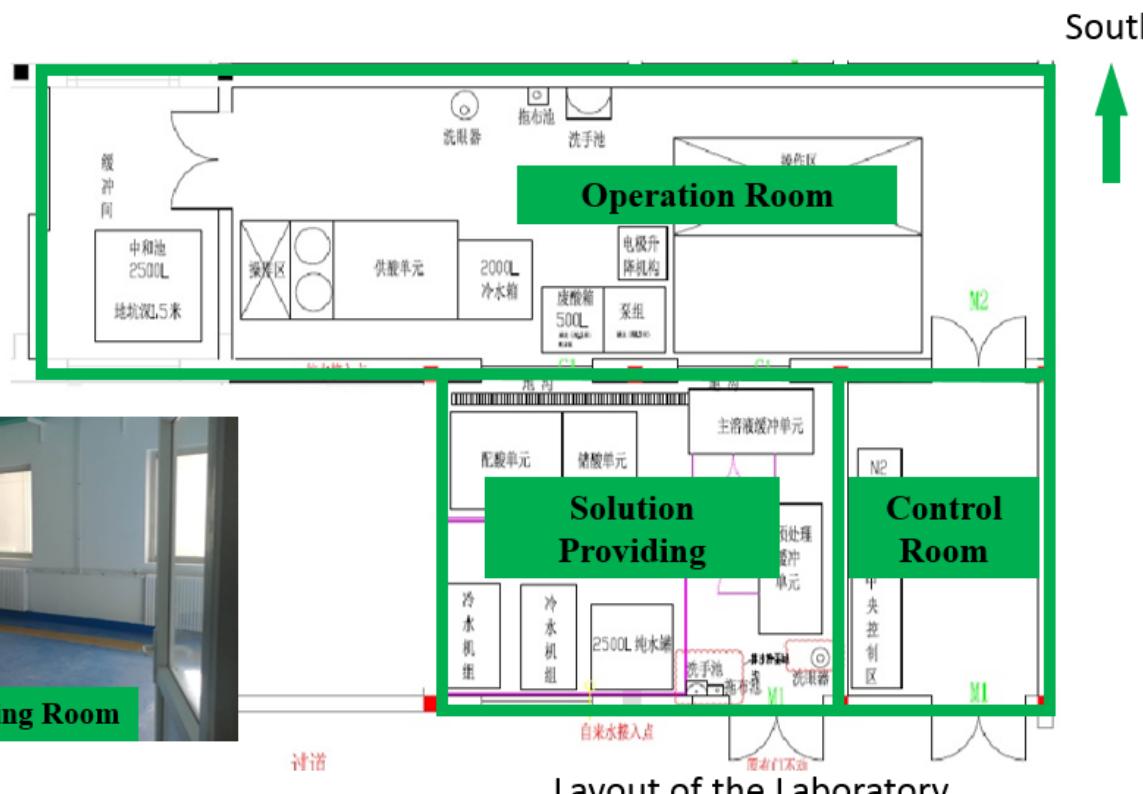
# EP system (4)

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



# EP system (4)

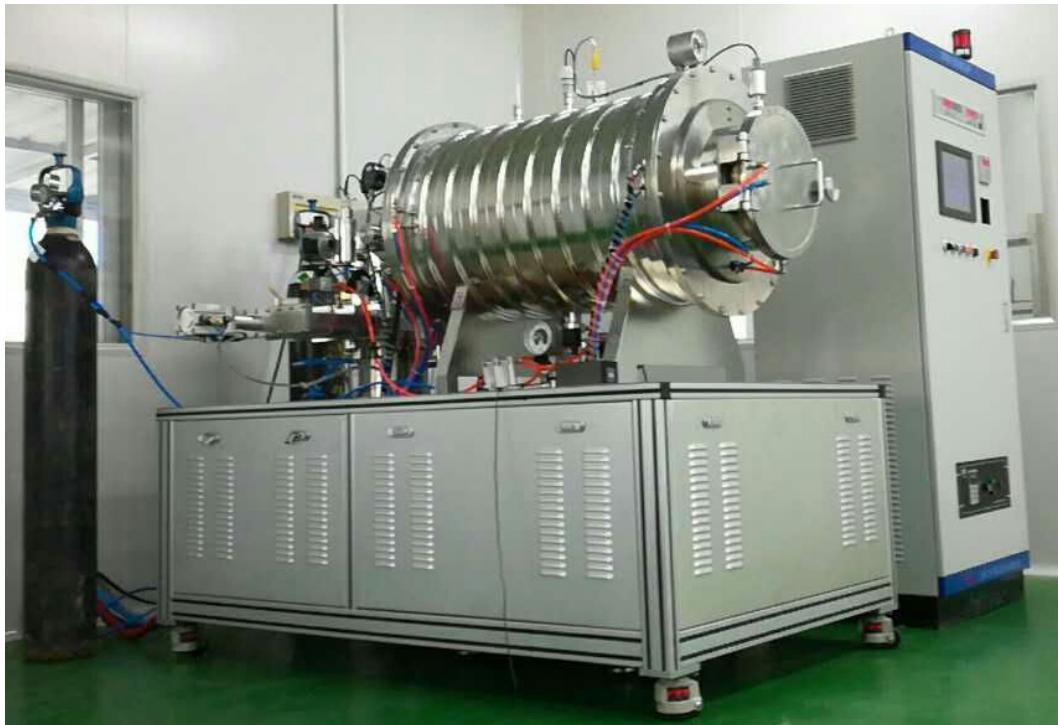
- It will be transferred to Ningxia post processing center this week-end



Pictures of the EP laboratory



# New N-doping furnace

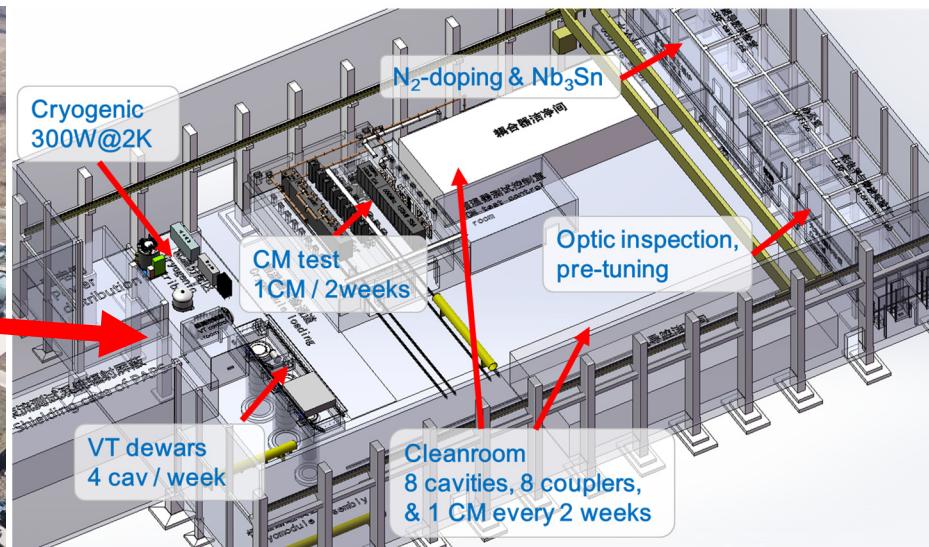


- $\phi 300\text{mm} \times 500\text{mm}$
- Outside heating
- Cryopump
  - 2500 L/s for H<sub>2</sub>
- MFC vent controlling
- Ultimate vacuum
  - 25°C      6E-7Pa
  - 850°C      2.4E-5Pa



# PAPS-SRF facility

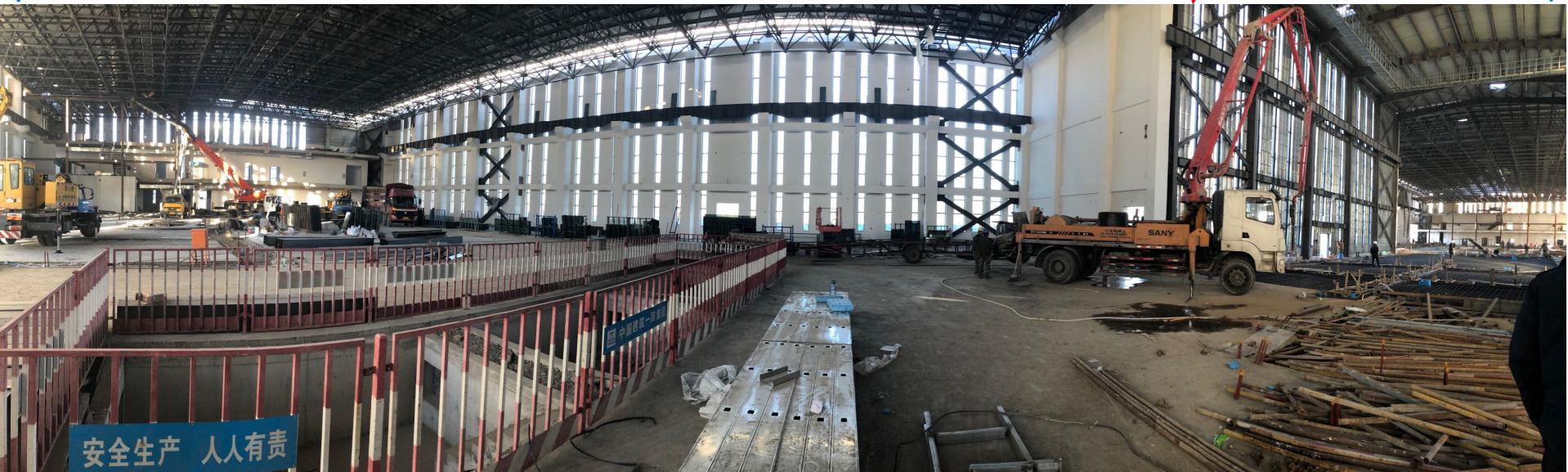
- The new facility is biased on mass production for SRF projects
  - Post-processing, clean assembly, VT/HT/conditioning of cavities
  - 200-400 cavities (couplers) per year; ~20 cryomodules per year
- Civil construction will be finished May 2019



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



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Thanks for your attention!