PAPS introduction

--what infrastructure is needed to support SRF accelerator

Feisi He

Institute of High Energy Physics (IHEP)

Outline

- PAPS project overview
- The SRF facility – what is needed?
- Future project that may need PAPS

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  - RF system
  - Cryogenic system
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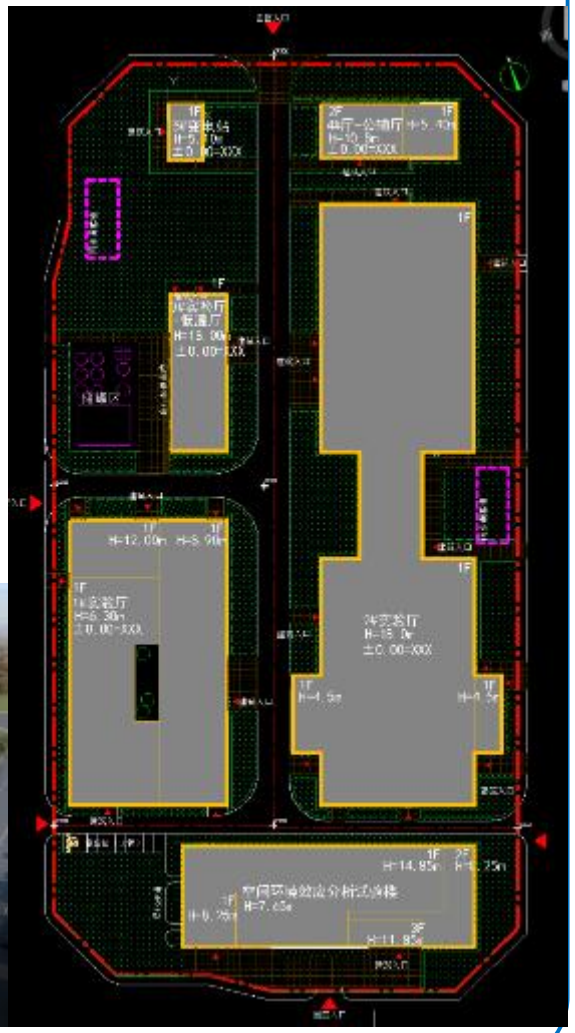
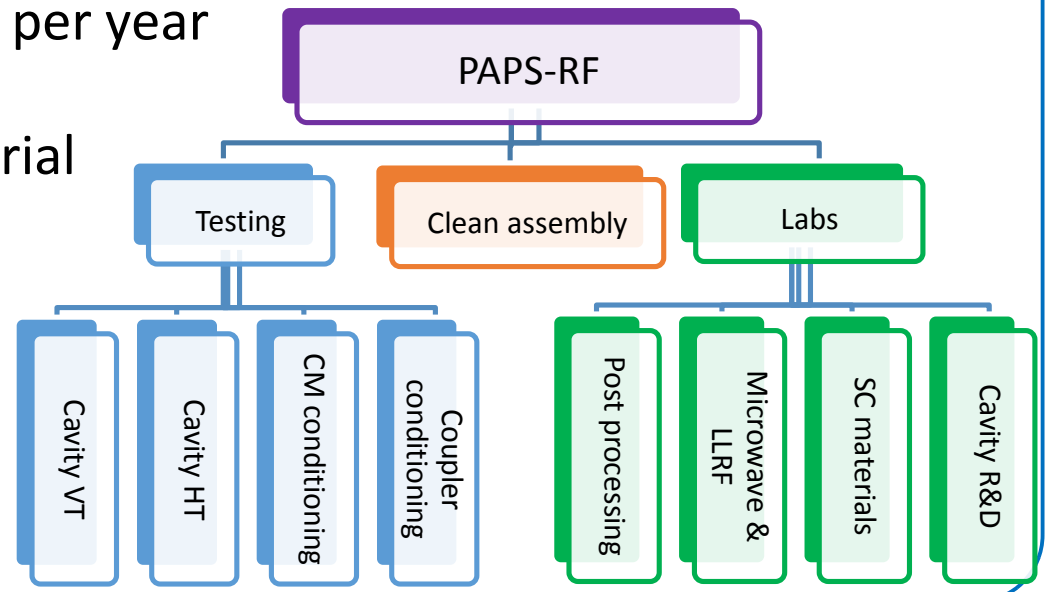
PAPS project overview

- “Platform of Advanced Photon Source Technology R&D”, to provide infrastructure for construction of future project.
- Budget: 500M CNY funded by Beijing Gov.
- Construction: 2017.5-2020.6
- Consist of 7 systems:
  - RF system
  - Cryogenic system
  - Magnet technology
  - Beam test
  - X-ray optics
  - X-ray detection
  - X-ray application



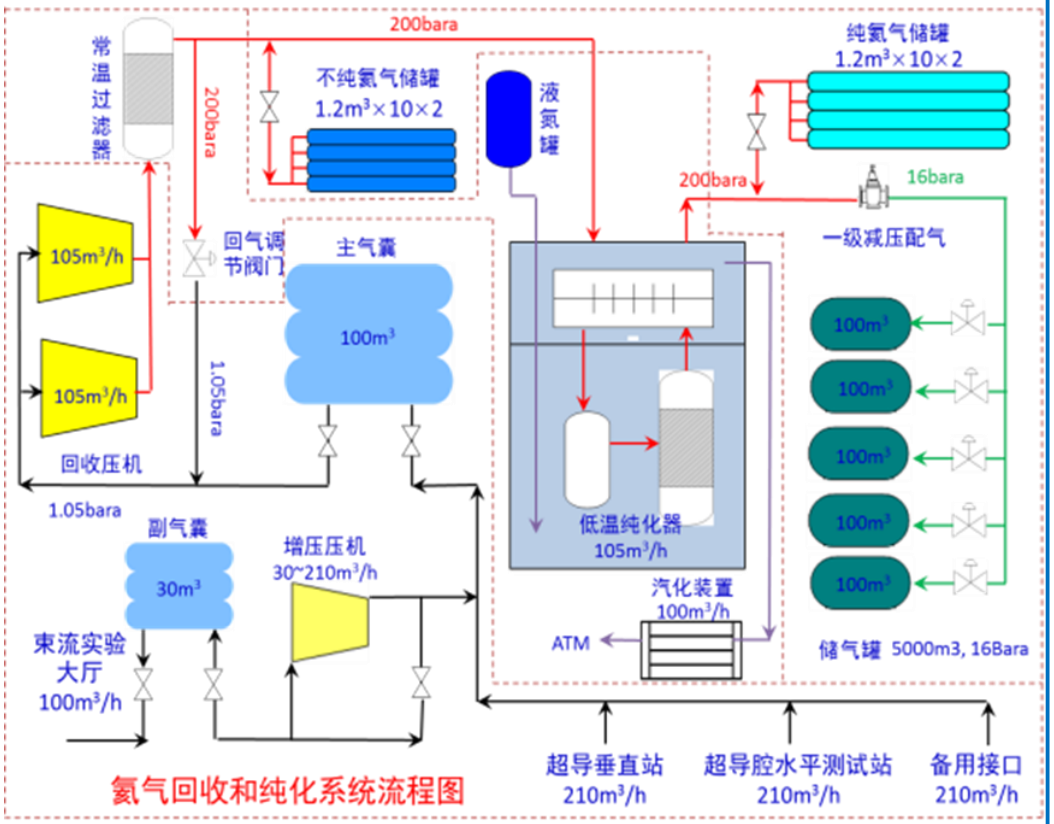
PAPS-RF system

- The PAPS-RF system has two targets :
  - Build a SRF facility
  - Conduct R&D on cavities and ancillaries
- The SRF facility is biased on mass production for SRF projects
  - Post-processing, clean assembly, VT/HT/conditioning of cavities, couplers, and cryomodules.
  - Compatible of 166MHz, 325MHz, 500MHz, 650MHz, and 1.3GHz
  - 200-400 cavities (couplers) per year
  - ~20 cryomodules per year
  - Support R&D on new material and new technology
  - Total area of 4500 m^2
- Cryogenic system: 300W @ 2K



Cryogenic system

- The cryogenic system
  - 2.5KW@4.5K and 300W@2K LHe system
  - 210m^3/h gas recycle and 100m^3/h gas purify capability
- Supply 2K LHe to:
  - 3 vertical test (VT) dewars
  - 2 cryomodule test stations
  - 1 beam test facility



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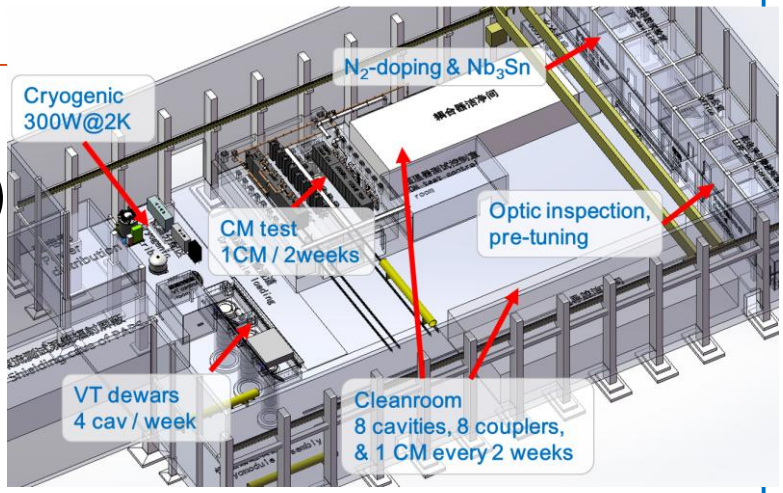
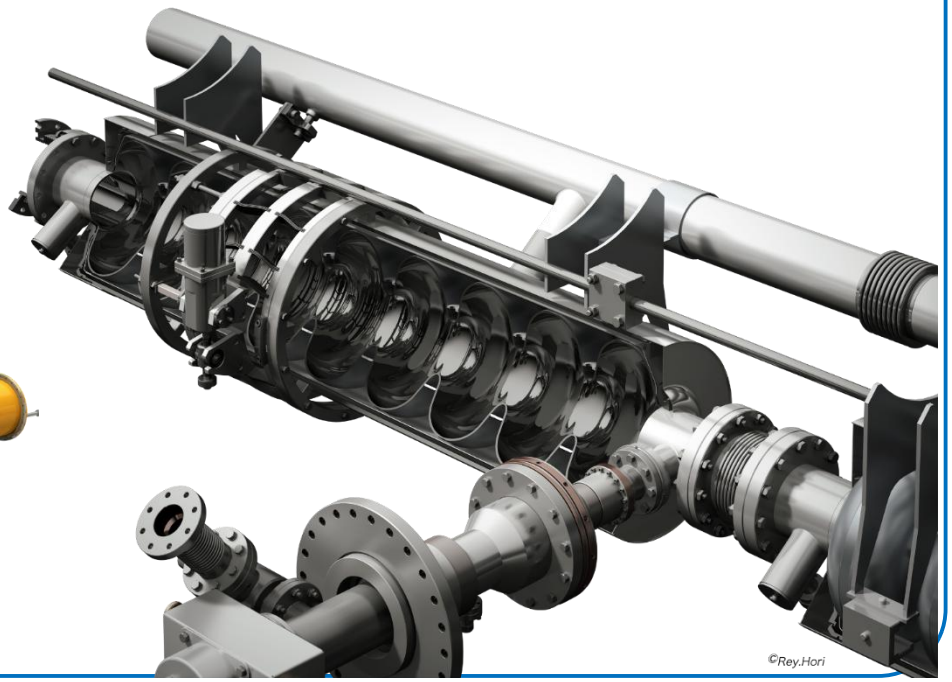
SRF related components in SRF accelerator

- Basic unit: cryomodule
  - SRF cavity (helium vessel, magnetic shielding)
  - Main coupler (or so called FPC)
  - Tuner (sometimes with piezo)
  - HOM coupler (or damper)
- Every element has to be tested before assembly
- The whole cryomodule has to be tested before operation





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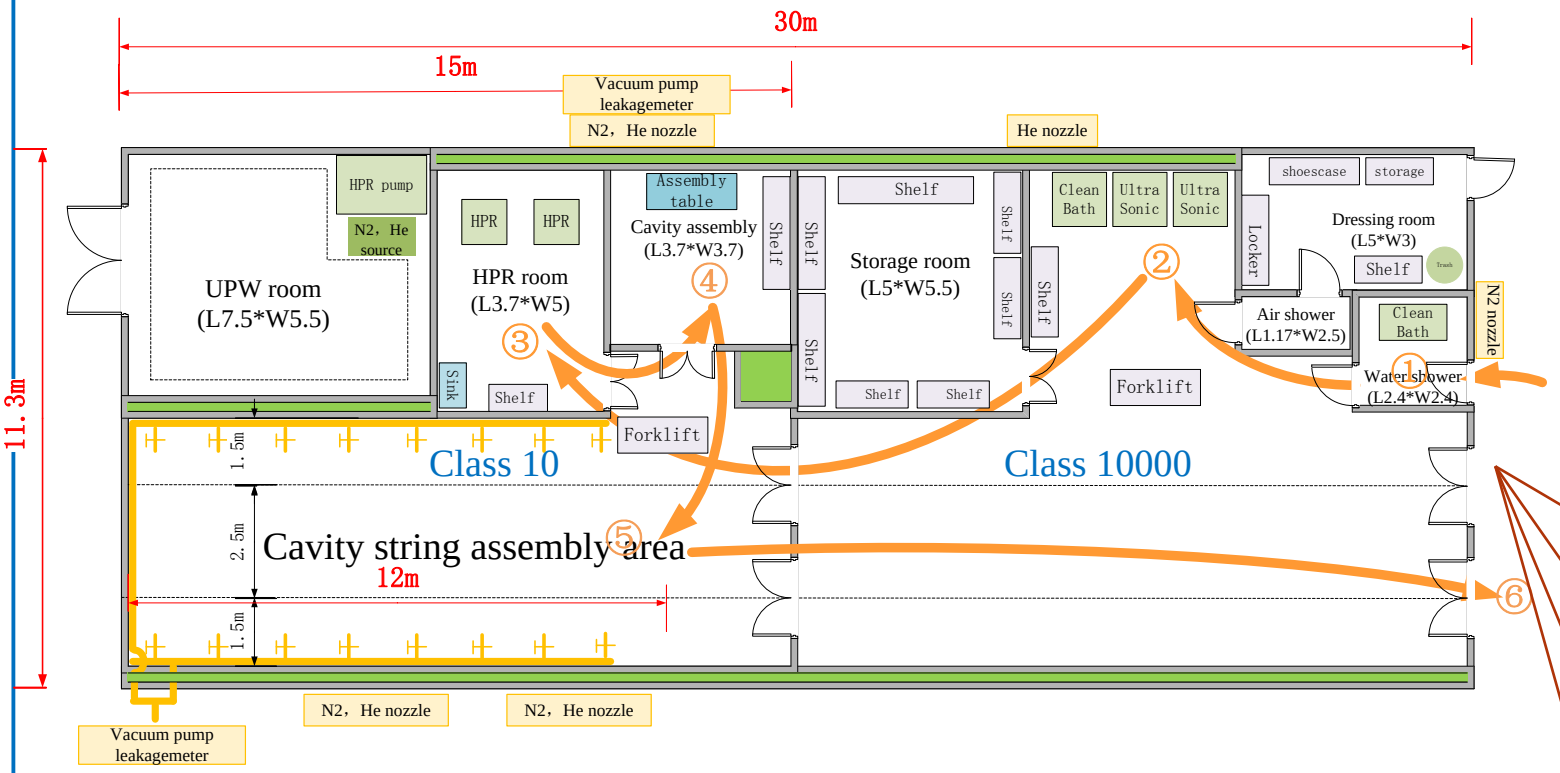
Cavity post processing

- Typical infrastructure for post-processing:
  - 18 MΩ ultra-pure water (UPW) system
  - BCP and/or EP system
  - Furnace
  - Ultrasonic basin
  - Clean-room ISO4-7
  - Vacuum system

Ultrasonic
↓
Bulk BCP/EP
↓
>600C baking
↓
(Pre-tuning)
↓
Flash BCP/EP
↓
HPR
↓
Clean assembly
↓
Slow pumping
↓
Leak check
↓
<150C baking

PAPS cavity clean-room



- ① Water cleaning
- ② Ultrasonic cleaning
- ③ High pressure rinsing
- ④ Clean room assembly
- ⑤ Cavity string assembly
- ⑥ To cryomodule area

Ultrasonic
↓
Bulk BCP/EP
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>600C baking
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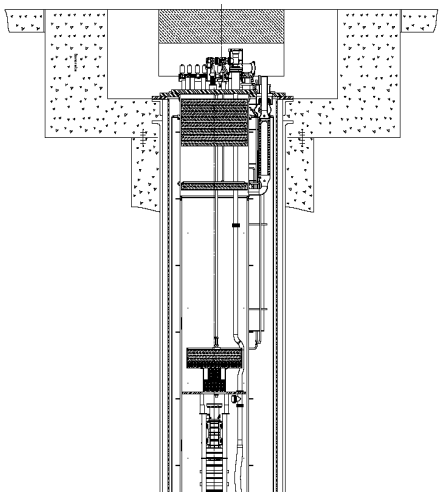
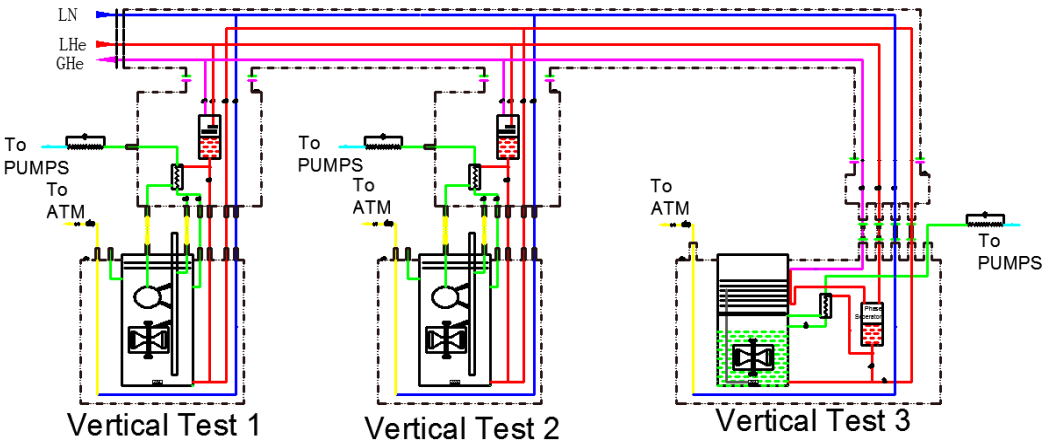
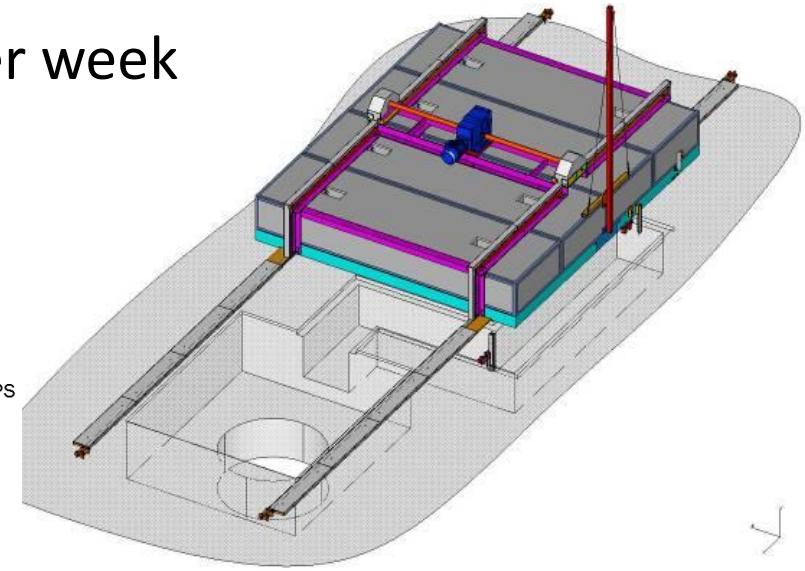
PAPS vertical test dewars

- The cavity is immersed into LHe during a vertical test, to measure gradient and Q value
- 2 large dewars of ID=1.25m, 4 of 1.3GHz cavities at a single test
- 1 small dewar of ID=0.8m for R&D, T-mapping, second sound equipped.
- 8~10 of 1.3GHz 9-cell cavity tests per week







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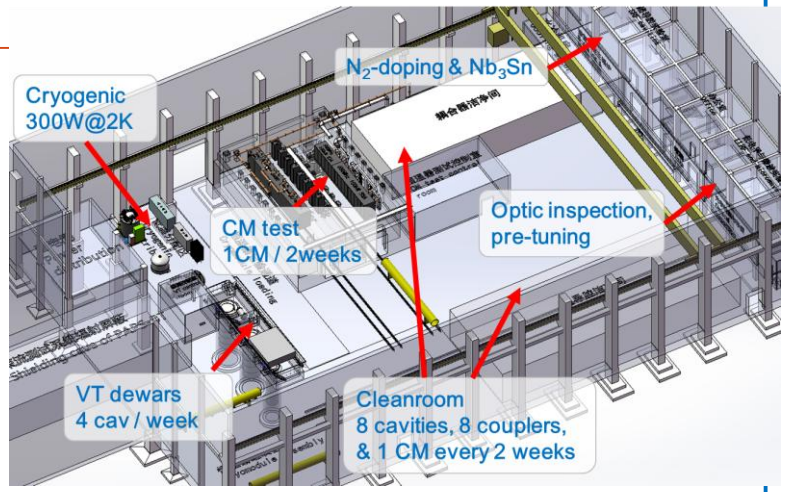
Cavity string and cryomodule assembly

- Requirement:
  - Well arranged large space
  - Dedicated toolings
- Key issue: remain the cavity inner surface extremely clean



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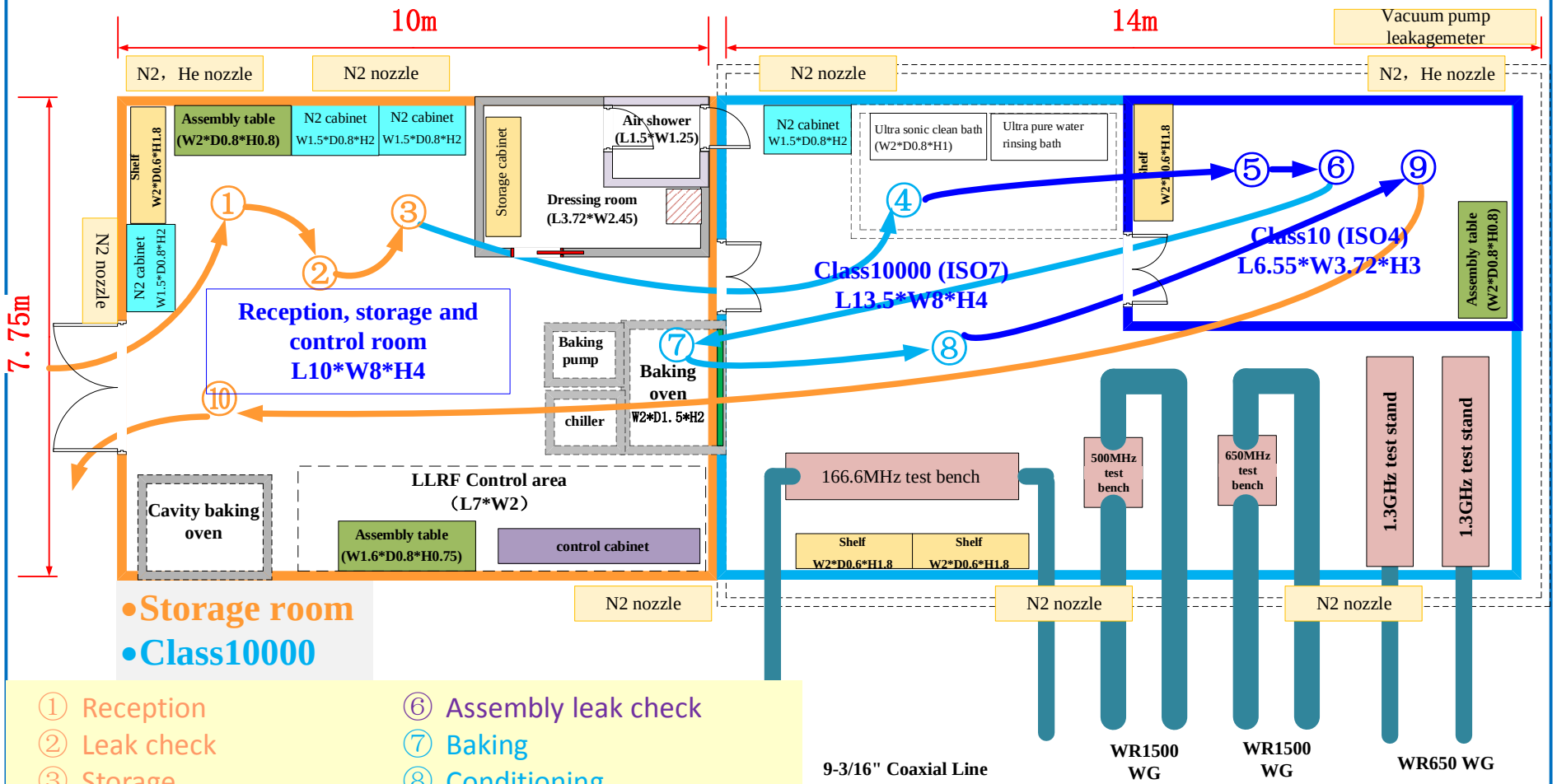
PAPS FPC cleanroom



- Storage room
- Class10000

① Reception
② Leak check
③ Storage
④ Cleaning processing
⑤ Clean assembly
⑥ Assembly leak check
⑦ Baking
⑧ Conditioning
⑨ Dismounting and packing
⑩ Delivery

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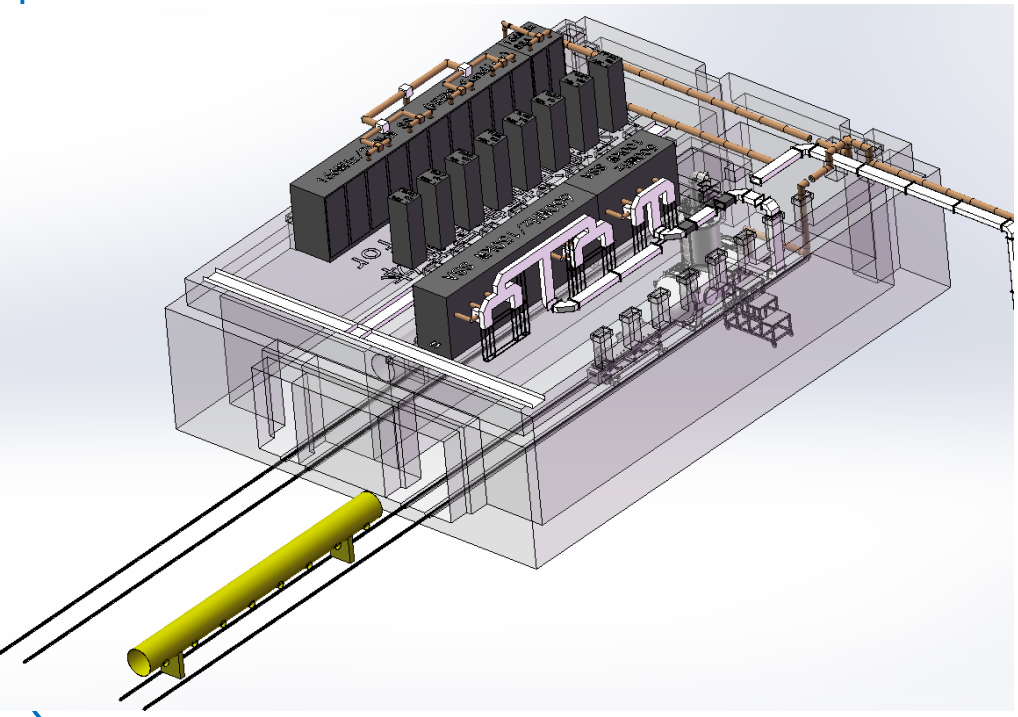
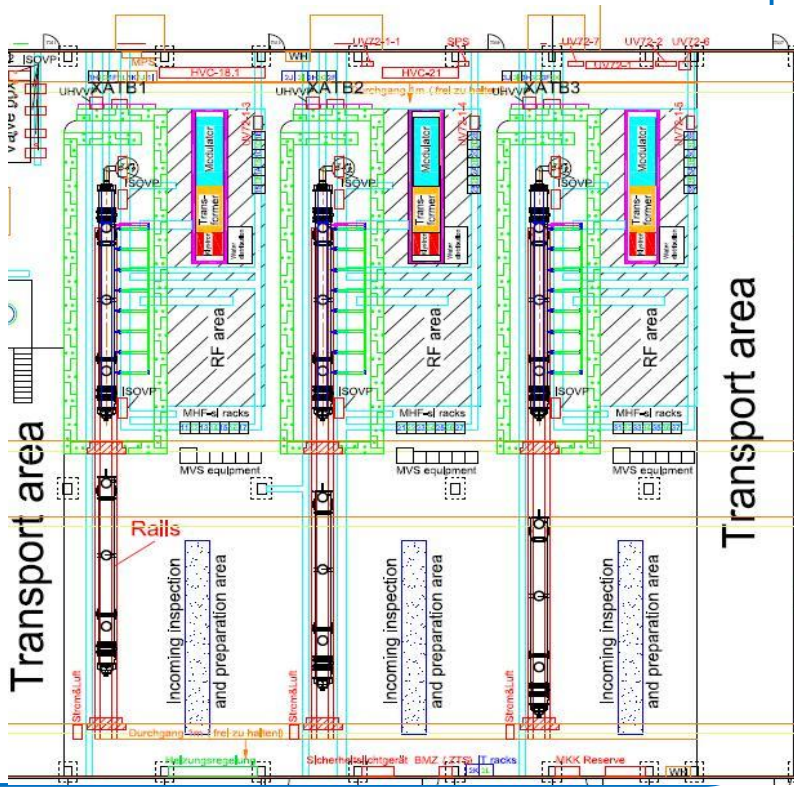
Cryomodule test

- Radiation during test, so test in test-stand is essential before tunnel installation
- Time consuming (4-5 weeks per CM), thus 2-3 test stands are needed





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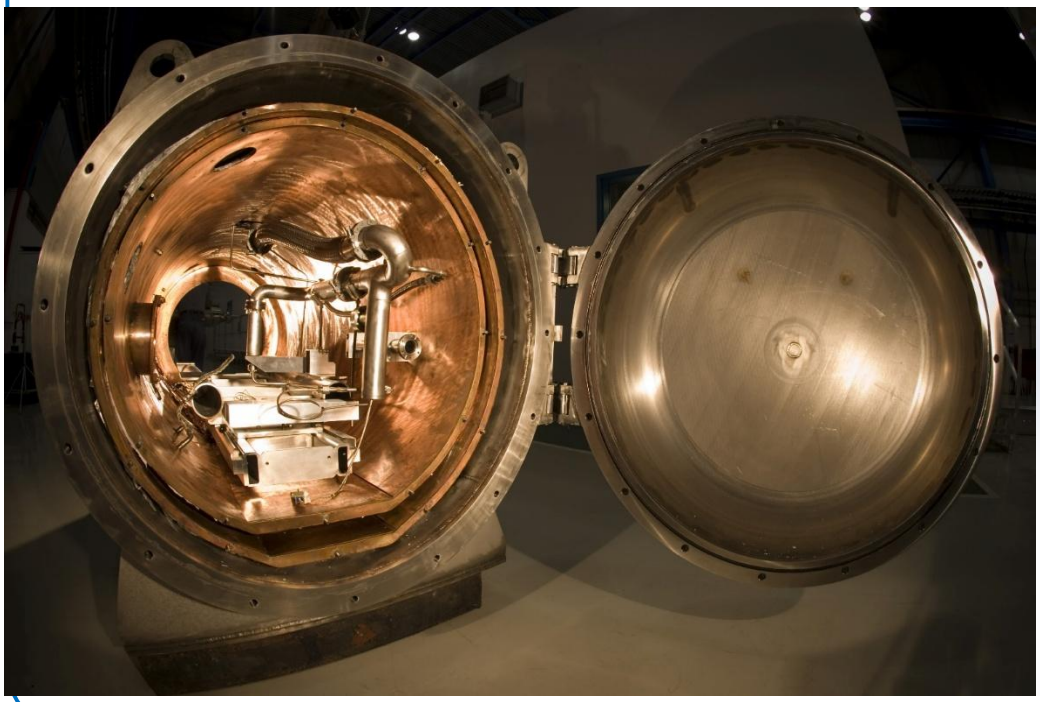
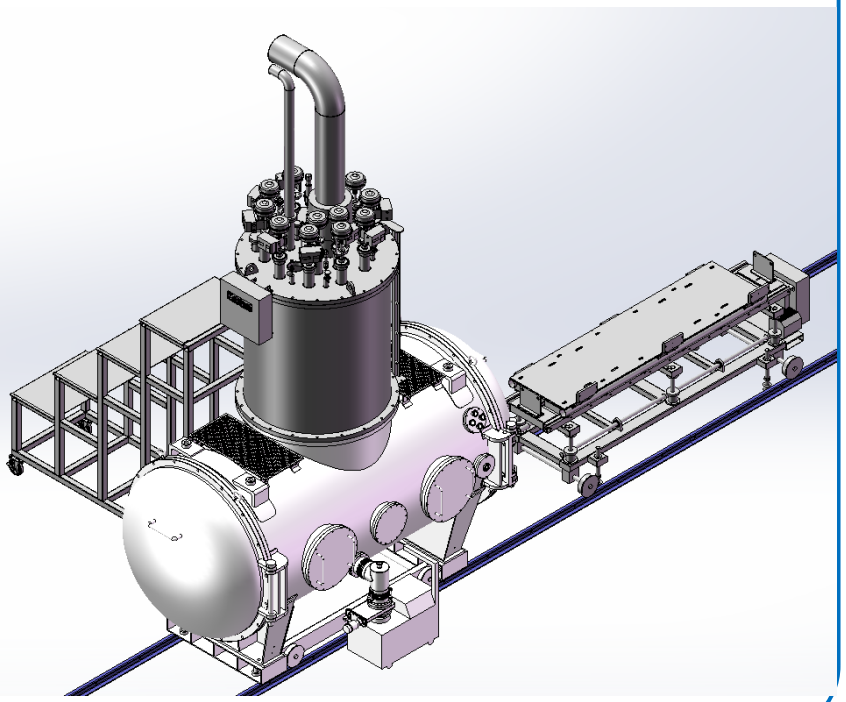
HT cryomodule for new cavity R&D

- Easy to assemble and remove cavities to the CM
- To test all SRF, cryogenic, and mechanic parameters of the whole set of cavity, coupler, tuner, and LLRF





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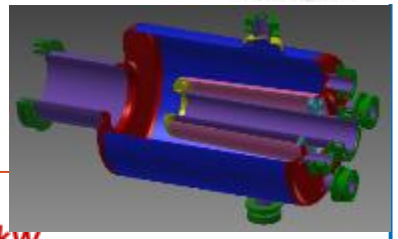
Future project: HEPS

- High Energy Photon Source will be built in Beijing by IHEP from 2018 to 2024
- Budget: 4.8B CNY

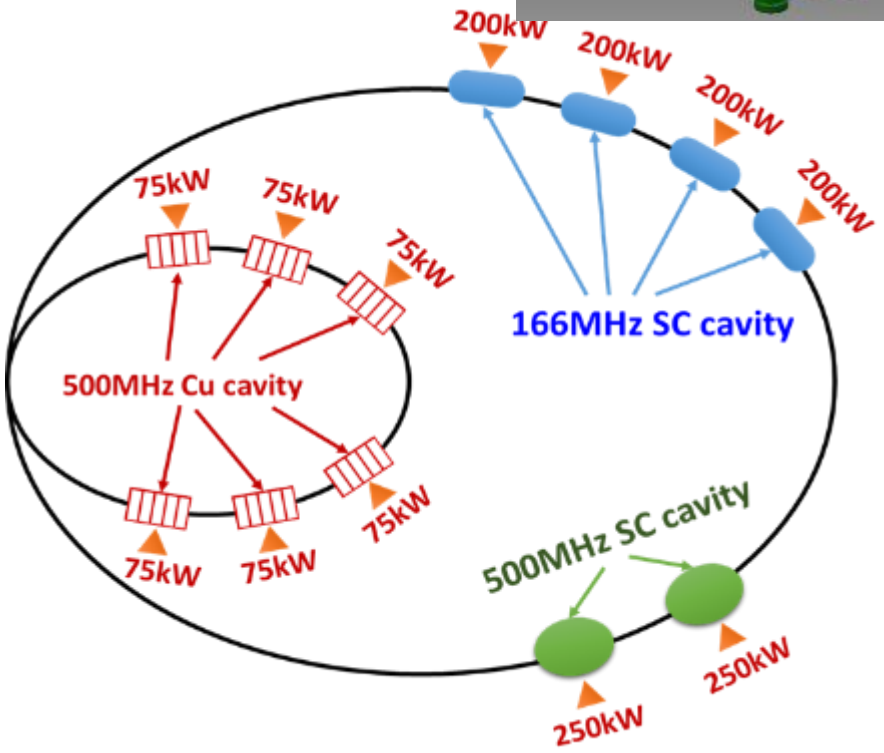
Booster	
Circumference	432 m
Beam energy (inj./ext.)	0.3 / 6 GeV
Beam current	10 mA
Energy loss per turn	4.6 MeV
Beam power	~50 kW
Storage ring	
Circumference	1295.6 m
Beam energy/current	6 GeV / 200 mA
Energy loss per turn	2.5 MeV
Beam power	500 kW
Bunch length (inj./op.)	2.8/32 mm

Future project: HEPS (2)



Fundamental SC cavity	
Frequency	166.6 MHz
RF voltage	3.5 MV
No. of cavities	4
RF voltage per cavity	1.2 MV
Peak power per cavity	145 kW
Amp./ϕ stability (p-p)	±0.3% / ±0.3°

3rd harmonic SC cavity	
Frequency	499.8 MHz
RF voltage	3.2 MV
No. of cavities	2
RF voltage per cavity	1.7 MV
Peak power per cavity	200 kW



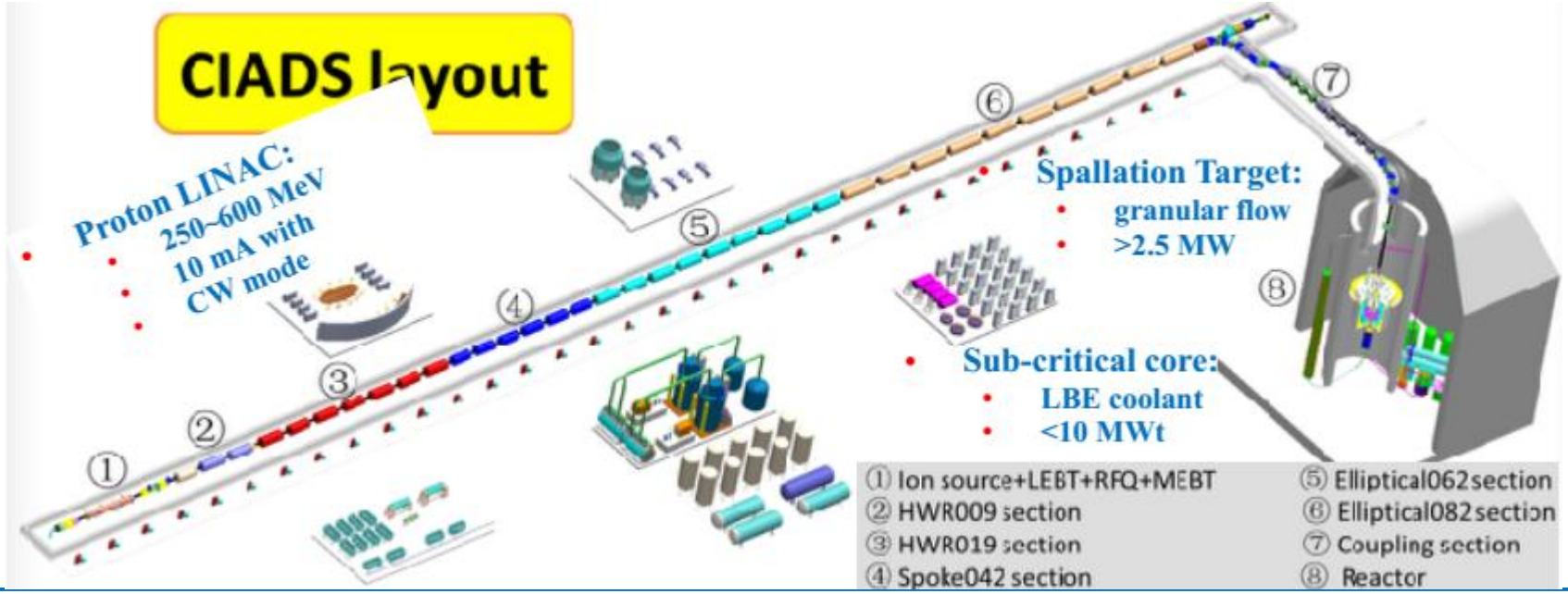
Solid-state amplifier: 166MHz, 200kW

500MHz, 75kW

Klystron: 500MHz, 250kW

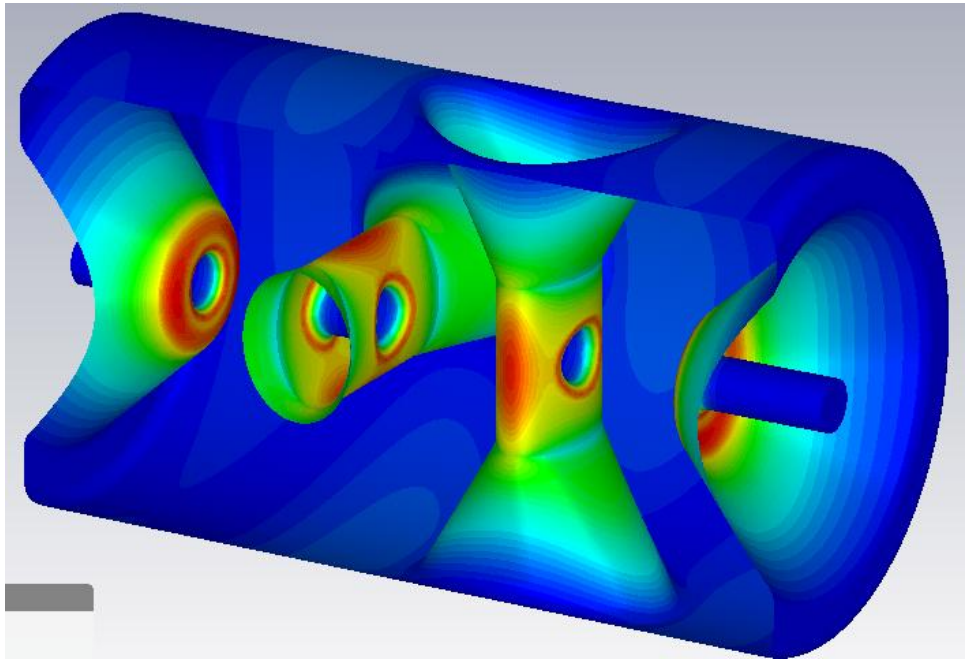
Future project: CIADS

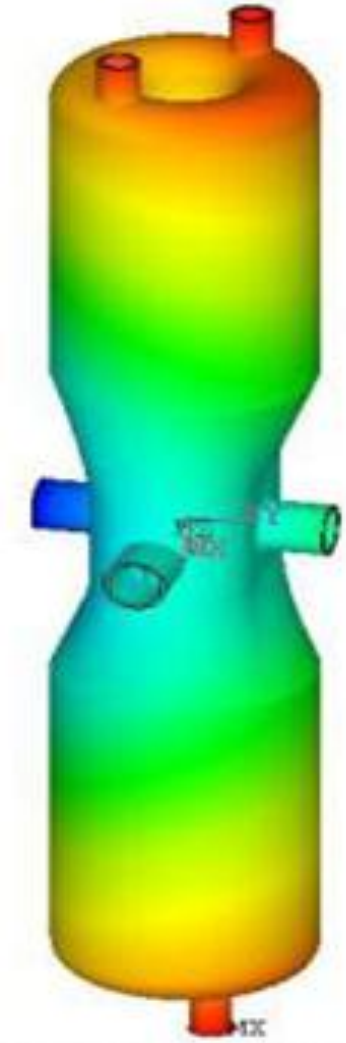
- Approved by Chinese government in Dec. 2015
- Budget: >1.8B CNY
- Proton CW linac > 250MeV
- In collaboration of IMP, IHEP, and many other institutes



Future project: CIADS (2)

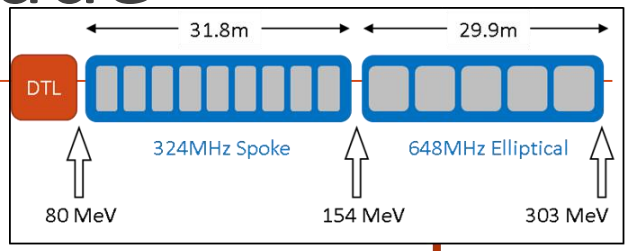
- Current optics design:
  - HWR009
  - HWR019
  - 56 of Double spoke β_0=0.42

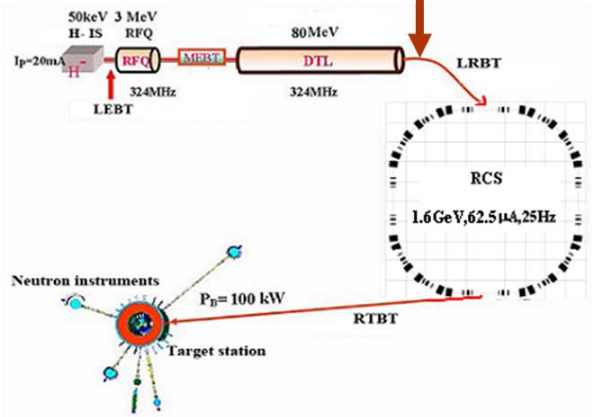


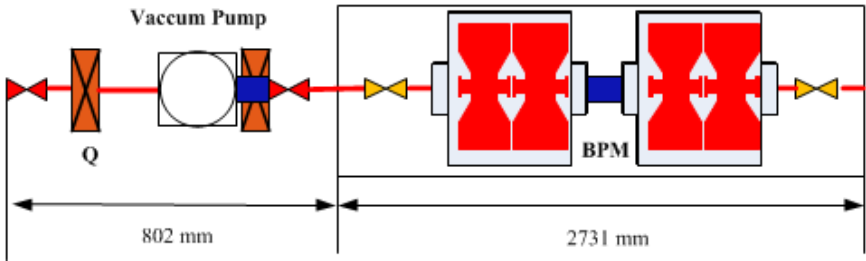


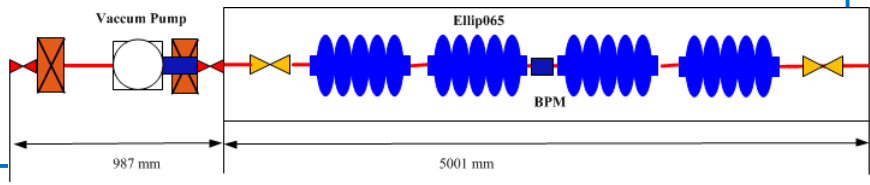
Future project: CSNS upgrade

- Target of the CSNS upgrade:
  - Beam power 500kW (1.6GeV)
  - Linac length <85m
  - Peak current 40mA
  - Pulse width 1.25ms
  - Repetition rate 25Hz
- Double-spoke(β_0=0.50) + 5-cell elliptical (β_0=0.65) + RT quadrupole
- 38 SRF cavities, linac 61.7m + matching 2m， 303MeV at exit
- Safety margin on cavity EP: 15% - 25%, 315MeV with 10% Pf margin



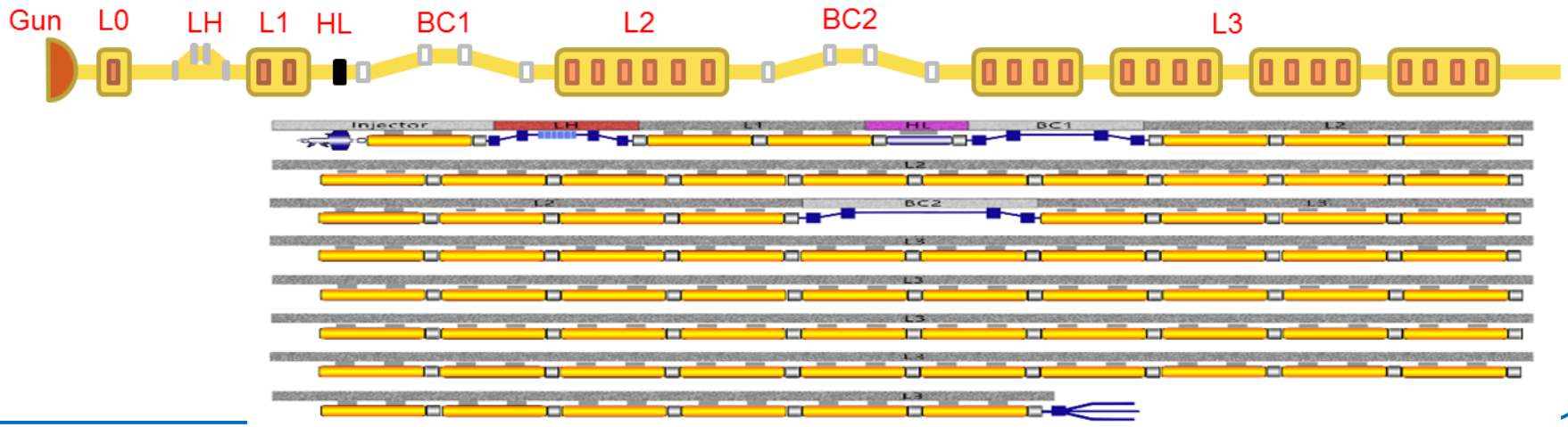






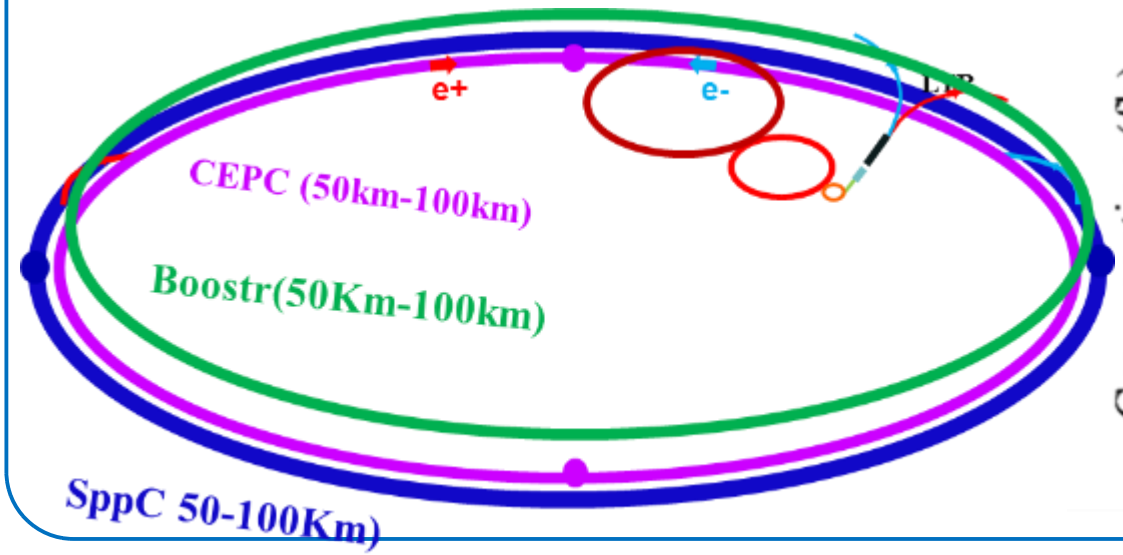
Future project: Shanghai-XFEL

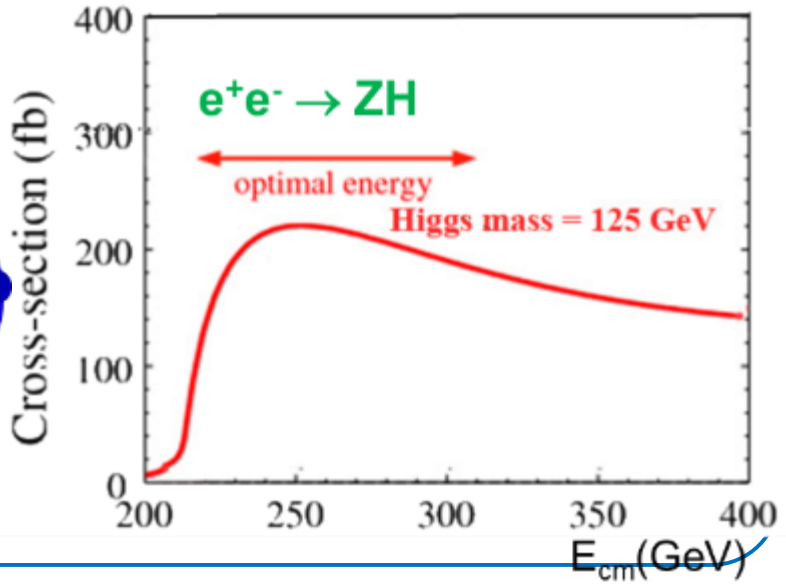
- Approved with 8B CNY, to be built in 7 years
- Dominated by Shanghai-Tech University and Sinap at Shanghai
- 8GeV CW Linac, with 600 of 1.3GHz TESLA cavities in 75 cryomodules
- 8 cavities in one cryomodule



Future project: CEPC

- Proposed by IHEP, pre-research in progress
- Circular electron-positron collider at 2 x 120GeV
- e+e- Higgs (Z) factory for precision measurement of the Higgs boson (and the Z boson)
  - Ecm~240GeV, luminosity ~2×10^{34} $cm^{-2}s^{-1}$, two detectors, 1M ZH events in 10yrs





Future project: CEPC (2)

- ~160 of 1.3GHz TESLA cavities and 336 of 650 MHz 2-cell cavities are needed. 2 or 6 cavities in one cryomodule.
- 5-cell cavities at 650MHz are possible according to optics design
- Operation specification: Q_0>2e10@E_{acc}=16MV/m
- VT specification: Q_0>4e10@E_{acc}=22MV/m