

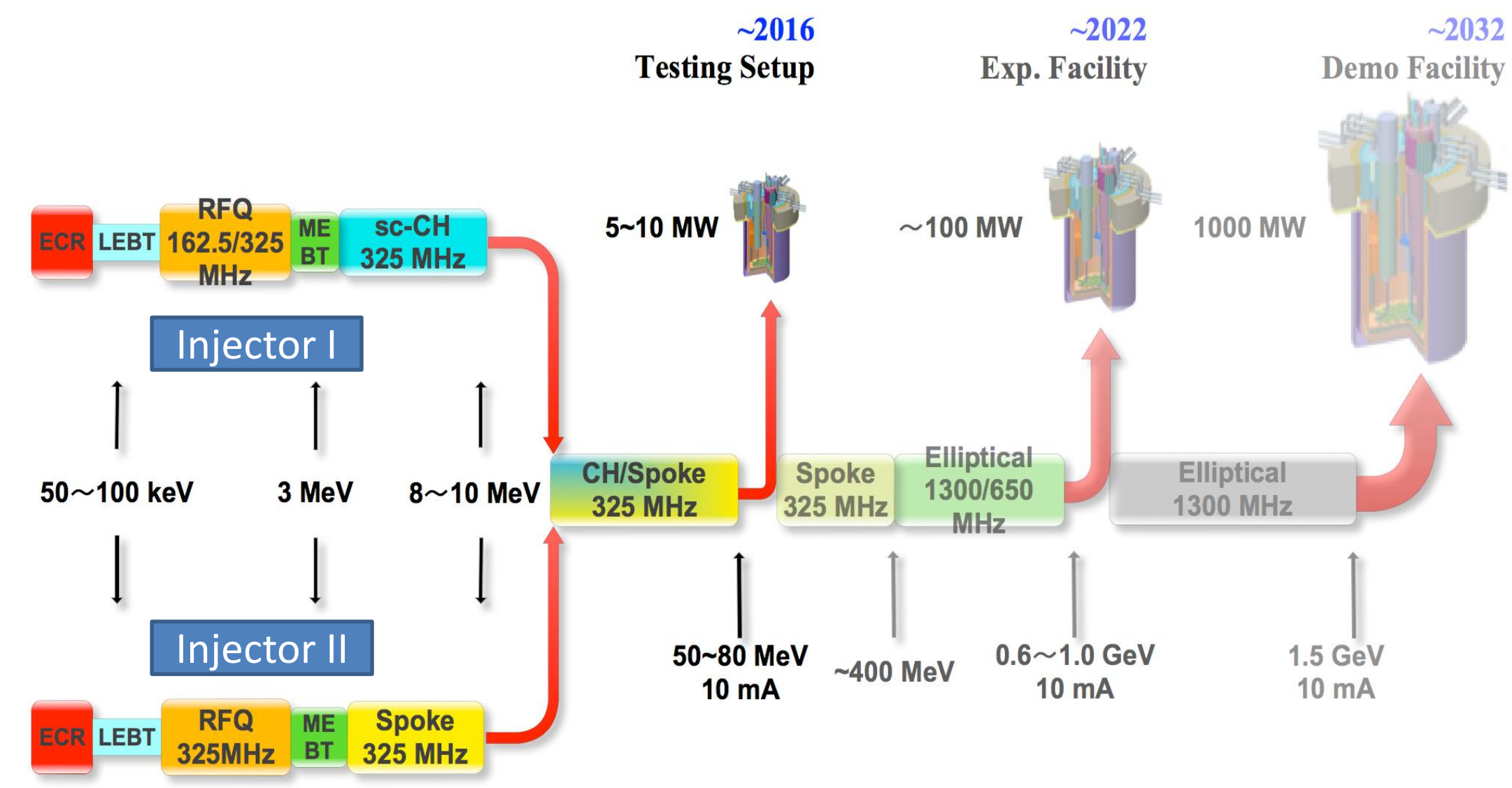
# The construction and commissioning of ADS Injector I cryogenic system

LI Shaopeng, GE Rui, LIU Yaping, ZHANG Zhuo, SANG Minjing, BIAN Lin, HAN Ruixiong, ZHANG Jiehao, SUN Liangrui, XU Miaofu, YE Rui, ZHANG Jianqin  
Institute of High Energy Physics(IHEP), Chinese Academy of Sciences(CAS), Beijing 100049,CHINA

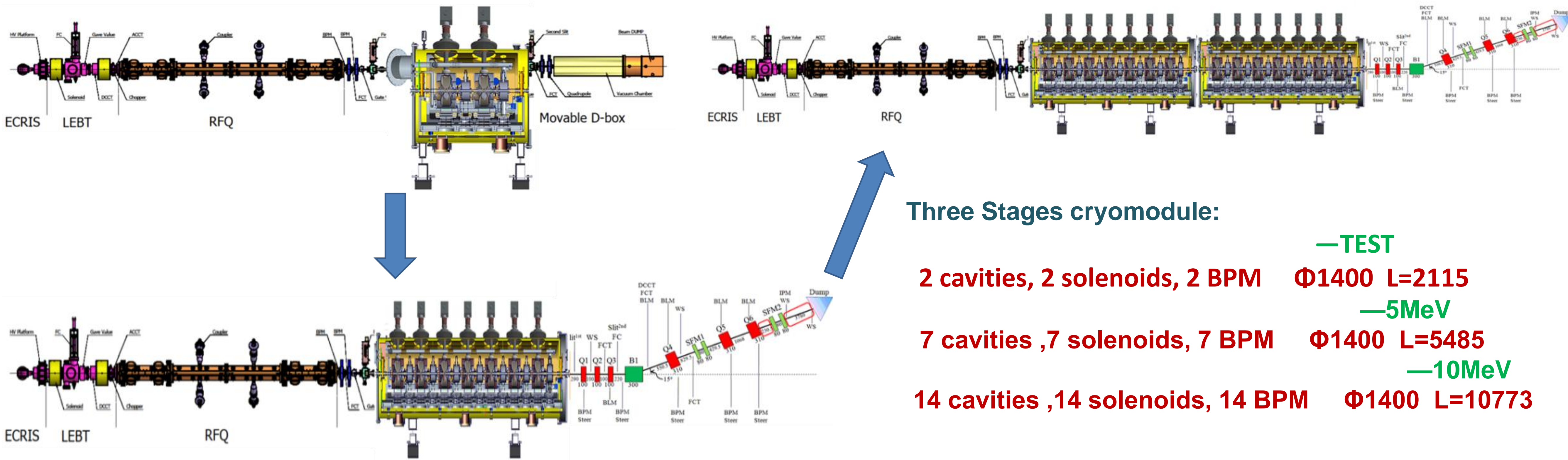


## Background

Accelerator driven sub-critical system (ADS) in China is a kind of transmutation machine to minimize the nuclear wastes. As one of the important parts in ADS, Injector I is built in IHEP,CAS with two superconducting cryomodules. Each cryomodule includes seven spoke cavities and seven superconducting magnets. To achieve the 10MeV Proton beam energy, the cryomodules will be cooled in a liquid-helium bath at a temperature of 2K. A 100W@2K cryogenic system have been designed and built to provide cooling capacity for the 2 cryomodules, vertical test station and horizontal test station. This paper will give a brief introduction about the construction and commissioning of this new 2K cryogenic system.



## Objective



Three Stages cryomodule:

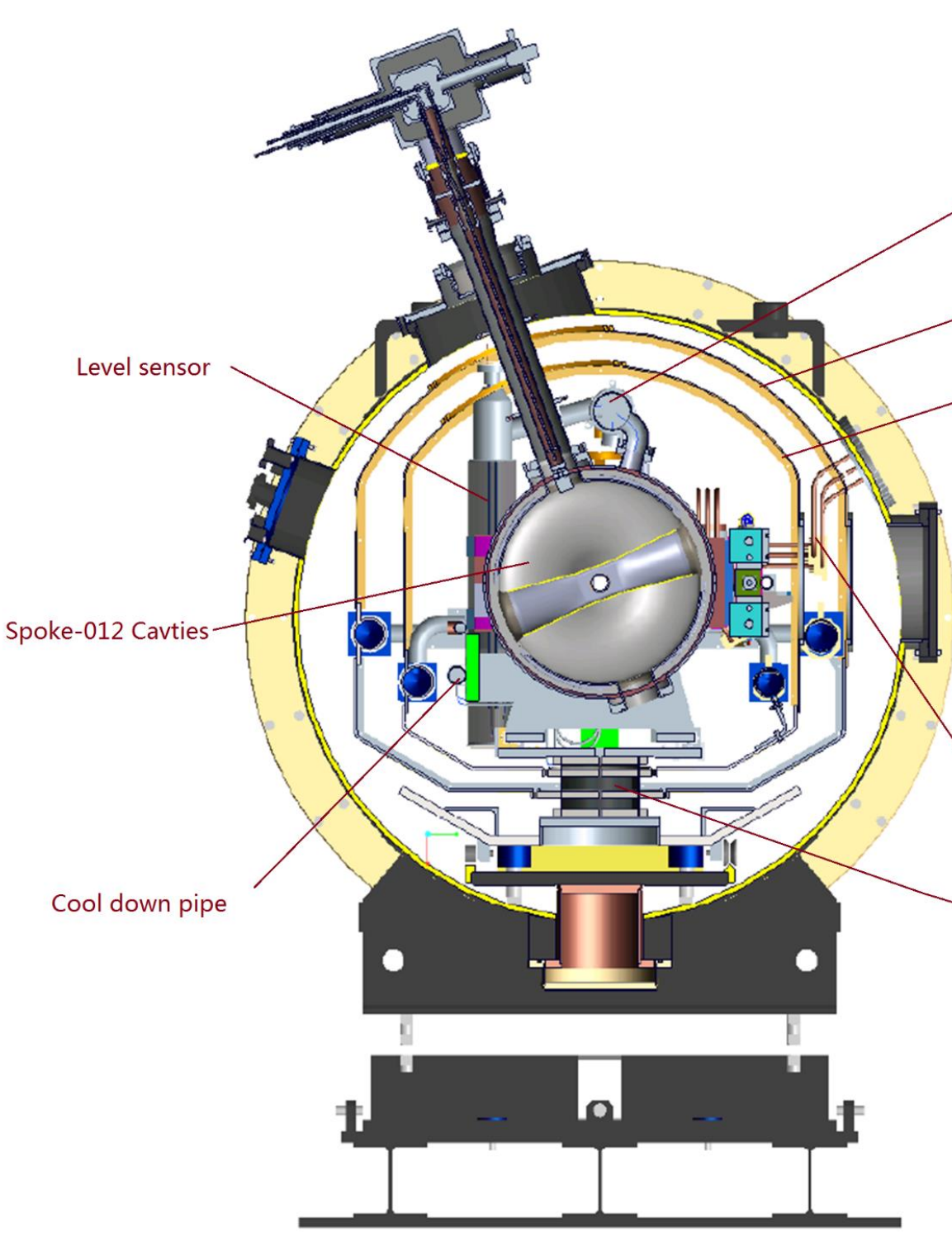
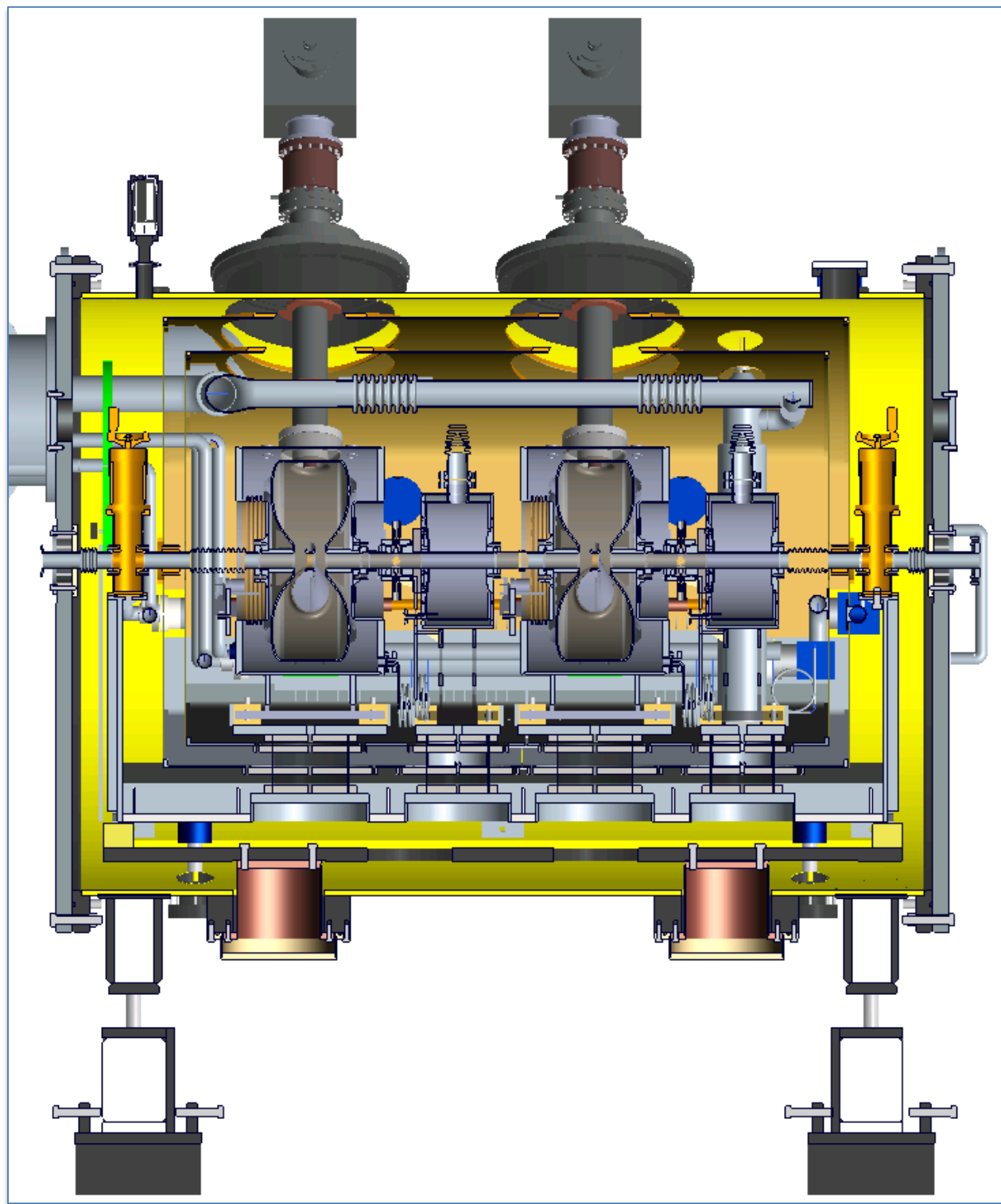
- TEST  
2 cavities, 2 solenoids, 2 BPM  $\Phi 1400$  L=2115
- 5MeV  
7 cavities, 7 solenoids, 7 BPM  $\Phi 1400$  L=5485
- 10MeV  
14 cavities, 14 solenoids, 14 BPM  $\Phi 1400$  L=10773

## Refrigerator / Cryomodule



Test results of refrigerator performance

| Performance                           | Guaranteed Values | Test Results       |
|---------------------------------------|-------------------|--------------------|
| Refrigeration With LN2                | > 1000W@4.5K      | > 1020W@4.5K       |
| Liquefaction With LN2                 | >284L/h           | > 322L/h           |
| Refrigeration & Liquefaction With LN2 | >350W@4.5K&200L/h | >353W@4.5K &223L/h |



## Pumping system / recovery & purify system



Leybold pumping station



20MPa compressors

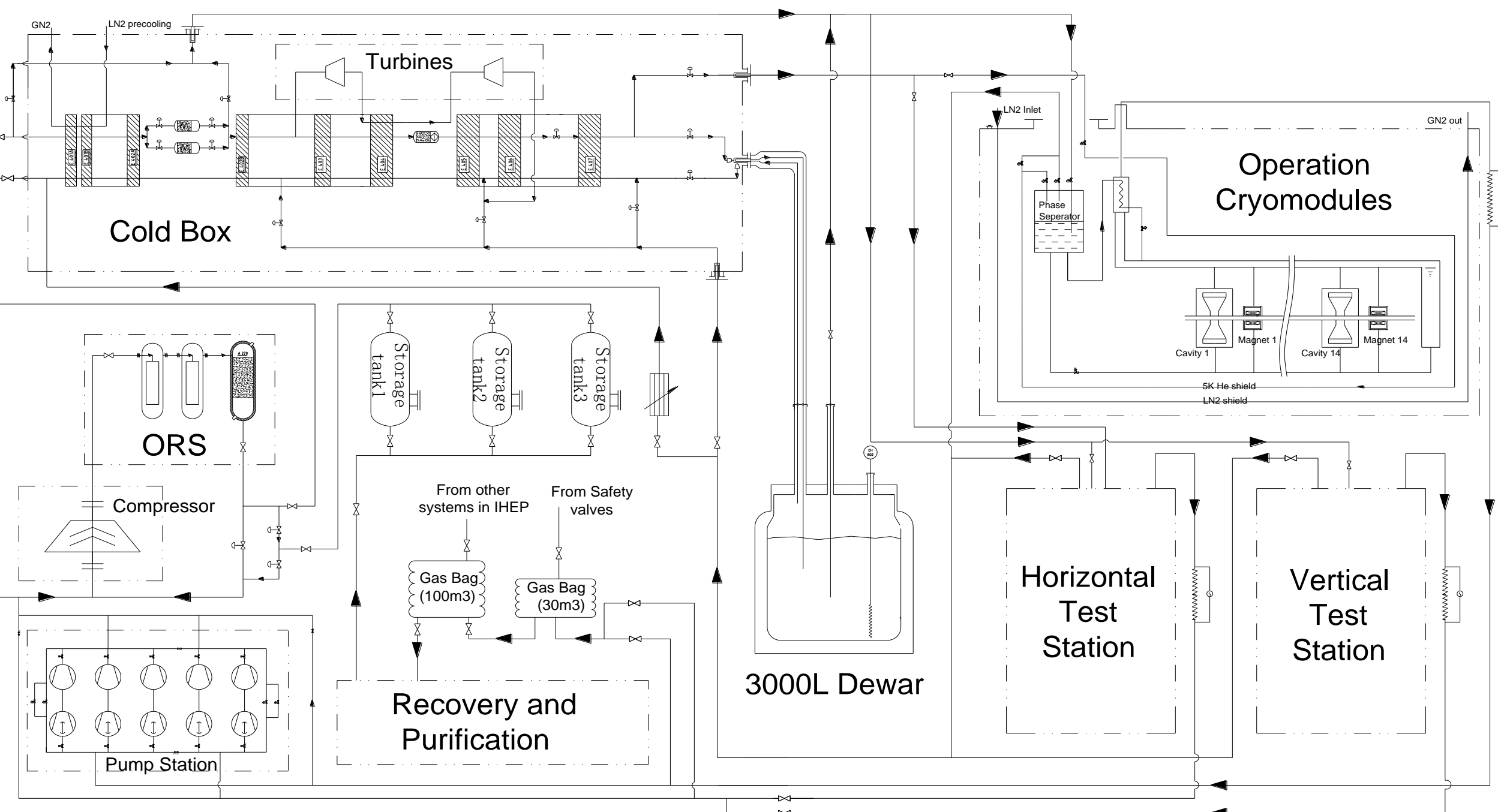


Helium storage

Pumping system:  
Working pressure:  $3130 \pm 30$ Pa  
Design flow:  $(4g/s+6g/s)/10g/s$   
Pumping speed:  $1600m^3/h/set *5$

Recovery and purify system:  
Helium recovery capacity:  $210Nm^3/h$ ,  
Purify capacity:  $105Nm^3/h$ ,  
Outlet purity:  $\leq 5ppm$ .  
Storge capacity:  $10000Nm^3$  impure helium  
+  $10000Nm^3$  pure helium

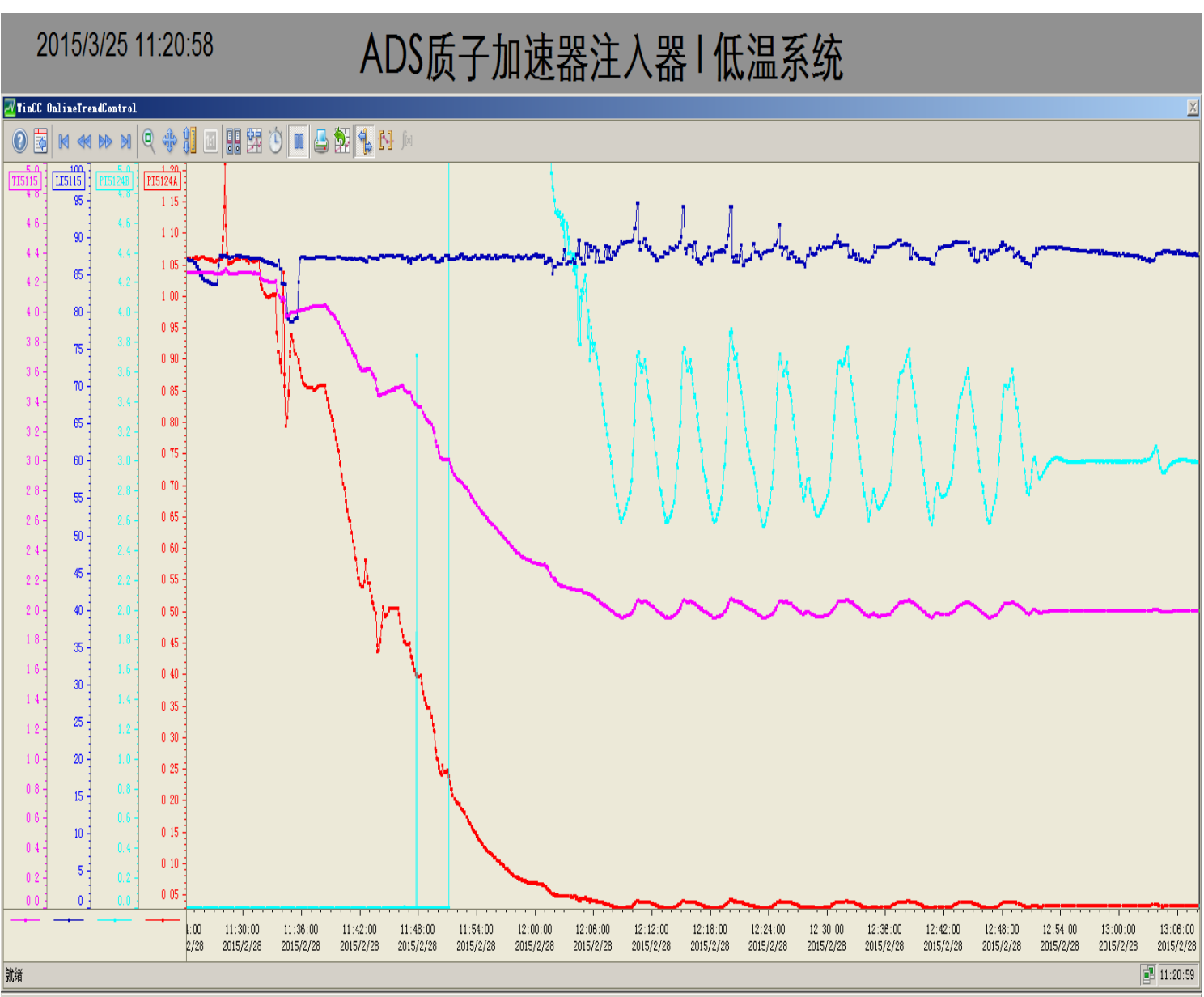
## Flow diagram



## Heat load

|   | Quantity | Heat loads @80K(W) | Heat loads @5K(W) | Heat loads @2K(W) |
|---|----------|--------------------|-------------------|-------------------|
| 3000L Dewar                                   | 1        | --                 | 8.00              | --                |
| Single-channel Liquid Helium transfer lines   | 54m      | --                 | 27.10             | --                |
| Single-channel Liquid Nitrogen transfer lines | 62m      | 28.02              | --                | --                |
| Multi-channel Cryogenic transfer lines        | 72m      | 72.00              | 36.00             | --                |
| 4K Main Distribution Valve Box                | 1        | 15.10              | 25.03             | --                |
| Cryomodules                                   | 2        | 571.10             | 165.65            | 50.50             |
| 4K-2K Valve Box                               | 1        | 15.33              | 9.64              | 0.90              |
| Total for system operation                    |          | 701.55             | 271.42            | 51.40             |

## Commissioning



TCM Cooling down to 2K



Onsite TCM

## Milestone and conclusion

### MILESTONE

2014-7-30, refrigerator acceptance test  
2015.1-19, helium recovery & purify system acceptance test  
2015-1-26, first cooling down to 4.5K  
2015-2-4, first cooling down to 2.0K

### CONCLUSION

ADS Injector I cryogenic system is the first self-design and construct 2K system in China. The system has been tested on the Test Cryomodule (TCM) which contains 2 superconducting spoke cavities and two superconducting magnets. In the next month, the first 7-cavities and 7-magnets cryomodule(CM01) will be installed in the tunnel and tested and the second cryomodule(CM02) is following. The whole ADS injector I will commissioning at the beginning of next year.