1. INET and Its HTGR Activities

2. HTR-PM Dust Research

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Institute of Nuclear and New Energy Technology (INET)

Tsinghua University

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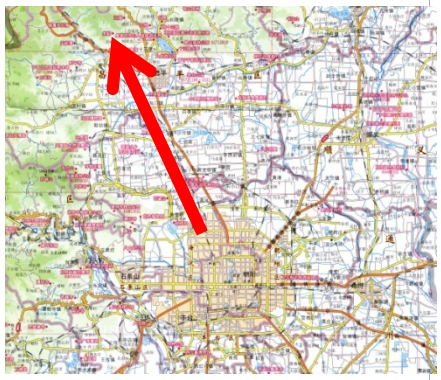
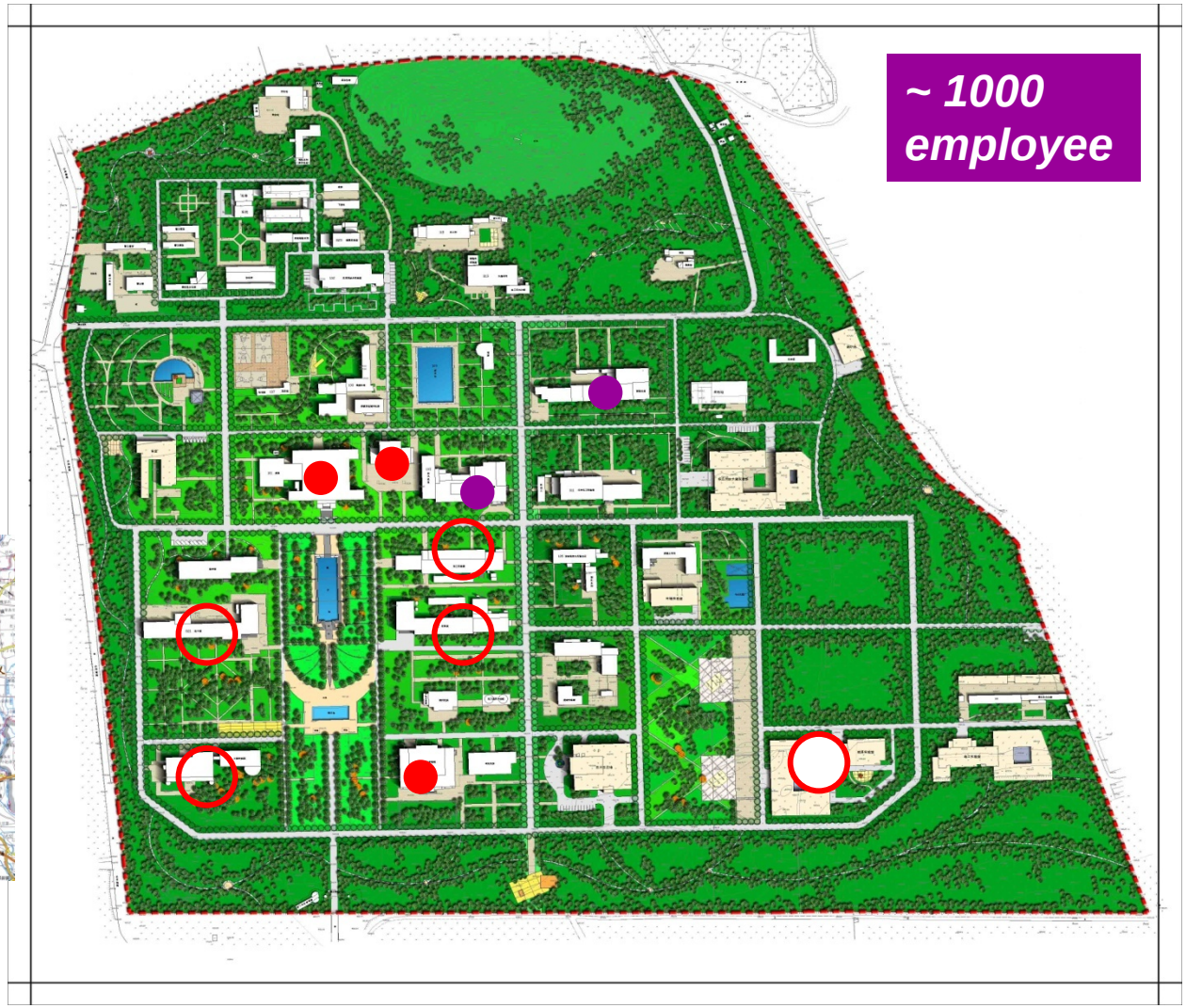
INET : a national R&D Center of nuclear power in China

- *3 Reactors*
- *R&D Lab.*
- *Fuel-cycle Lab*





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INET Briefing

- ***INET has about 500 staffs, 300 contract employees, over 200 graduate students.***
- ***The research fields are :***
  - ***Nuclear energy technology, nuclear chemistry, nuclear technology applications,***
  - ***New energy technology, energy policy (Global warming issue), etc..***
  - ***Material technology, environment protection***
- ***INET has about 100,000 m^2 laboratories and office, 3 test reactors.***

INET

Technical Divisions in INET

Divisions on Nuclear Energy Engineering

Reactor operation, Neutronics and thermal-hydraulics analysis, Structure design, Key technology development, Thermal-hydraulic lab., Nuclear safety, I&C, Fuel development

Divisions on Chemical Engineering

Divisions on Advanced Materials

Divisions on Nuclear Technology Applications

Division on Environment Protection

Division on Energy Policy and Planning

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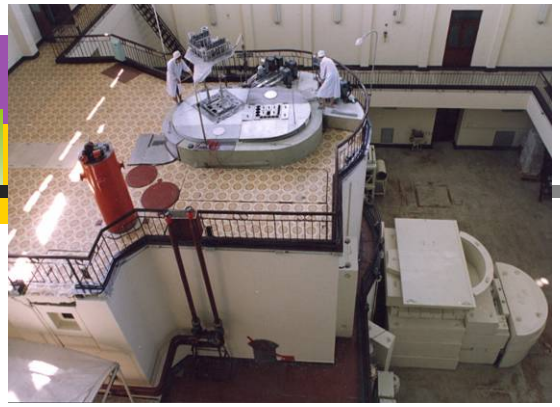
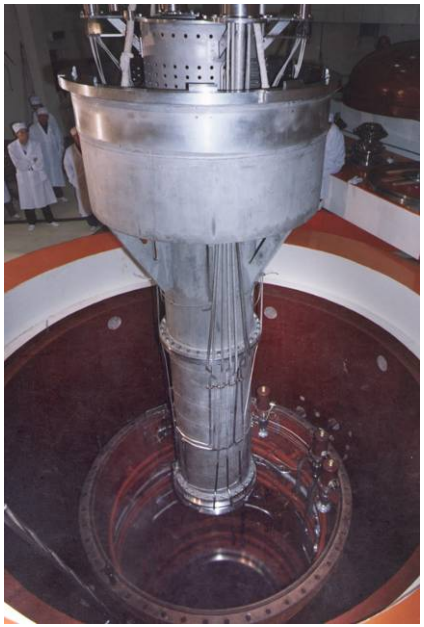


Pool-type test reactor, 1964

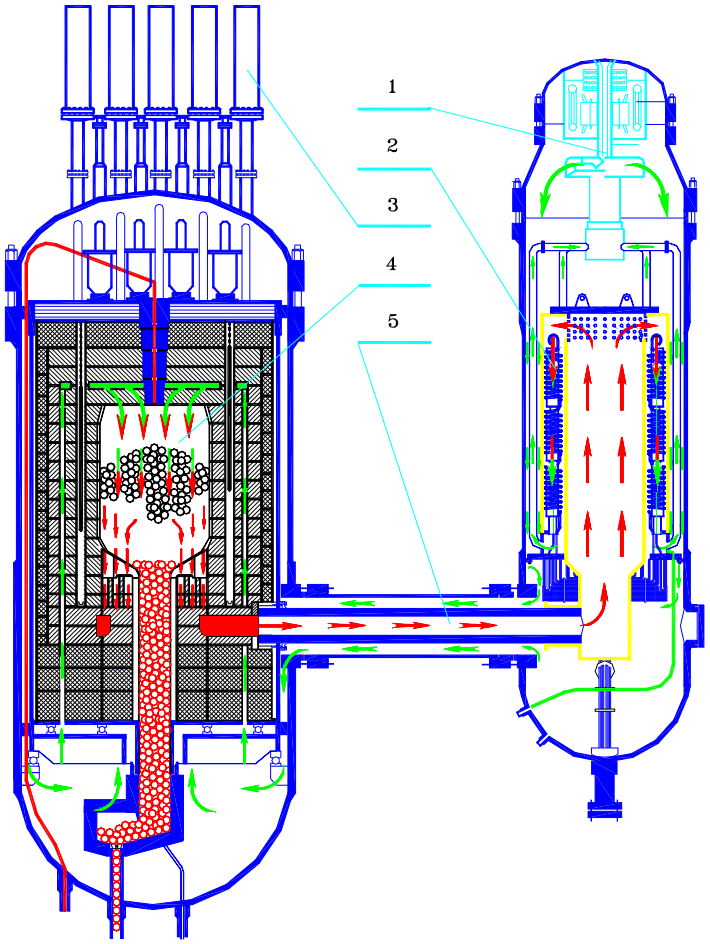
5 MW nuclear heating test reactor, 1989



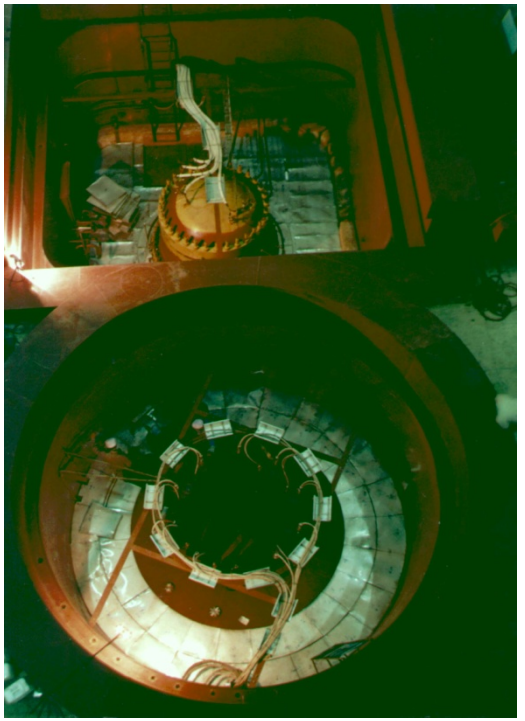
10 MW high temperature gas cooled reactor, 2000

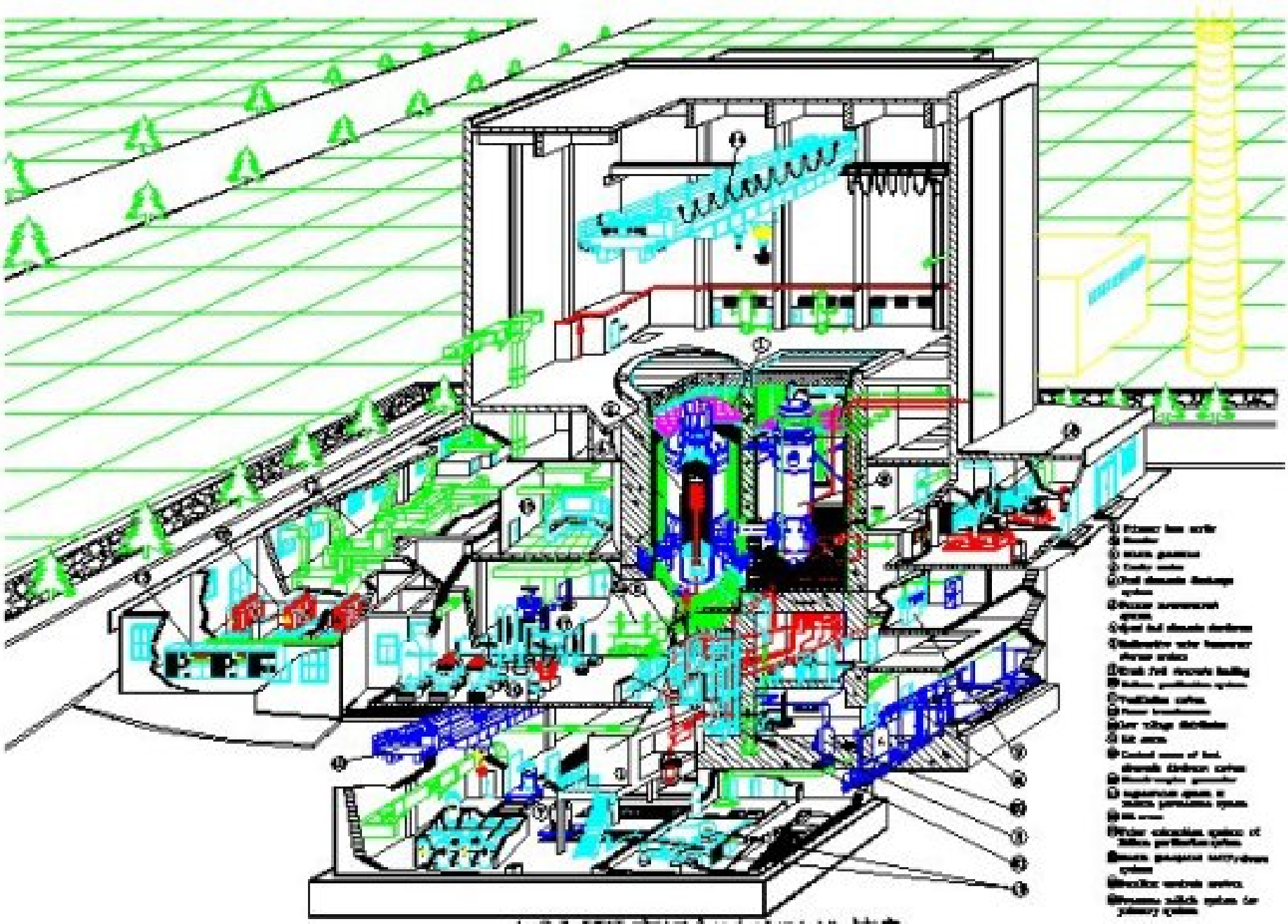
10MW high temperature gas-cooled test reactor (HTR-10)

HTR-10: Construction during 1995-2000



Thermal Power, MW	*10*
Pressure, MPa	*3*
Helium Temp. , ℃	*250/700*
Fuel Number	*27000*





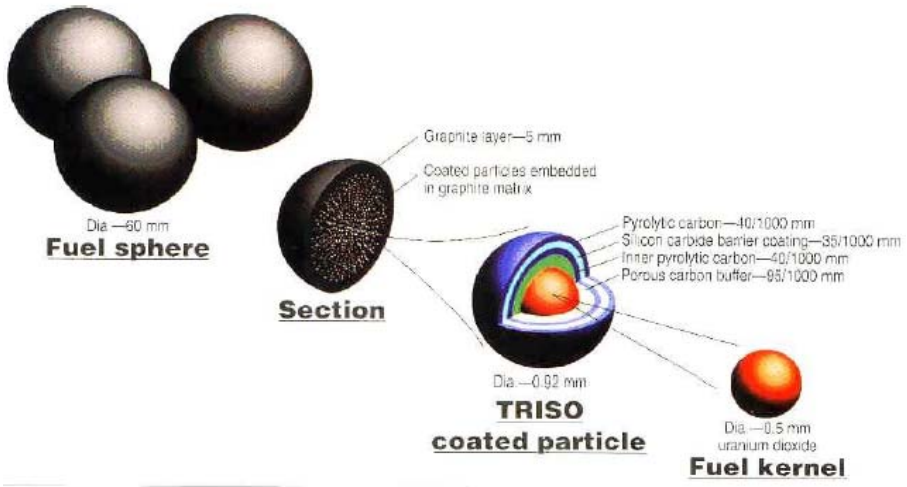
10MW 高温气冷实验堆核岛

HTR-10 construction

- *1975: basic scientific research*
- *1986: research work on computer codes, key technology under the support of national high technology program*
- *1992: government approved to construct a 10 MW high temperature gas cooled reactor*
- *1995: started to construct the reactor*
- *2000: reached first criticality*
- *January, 2003: started full power operation*

Pebble-bed Fuel

TRISO



The fuel production by INET

60mm diameter

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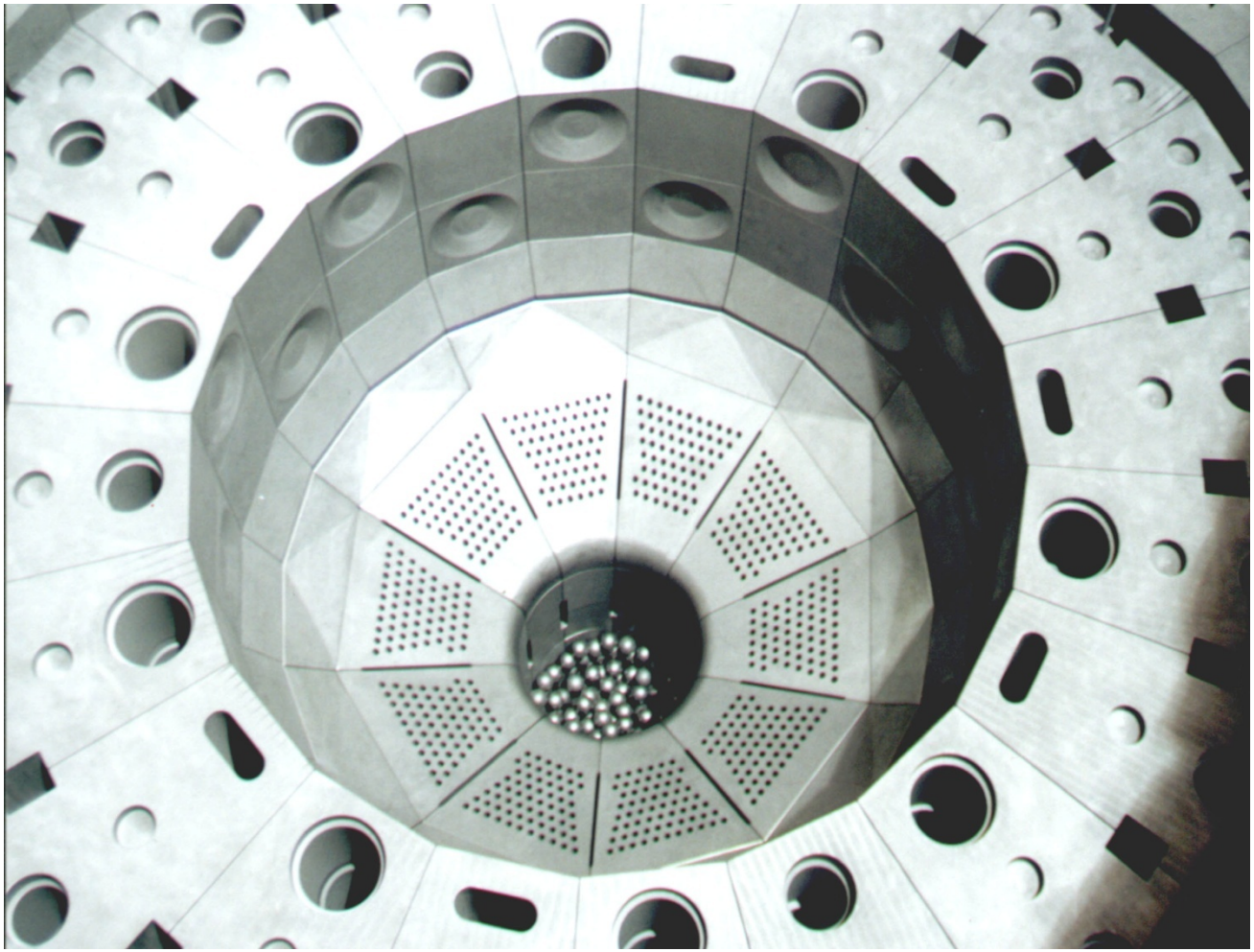
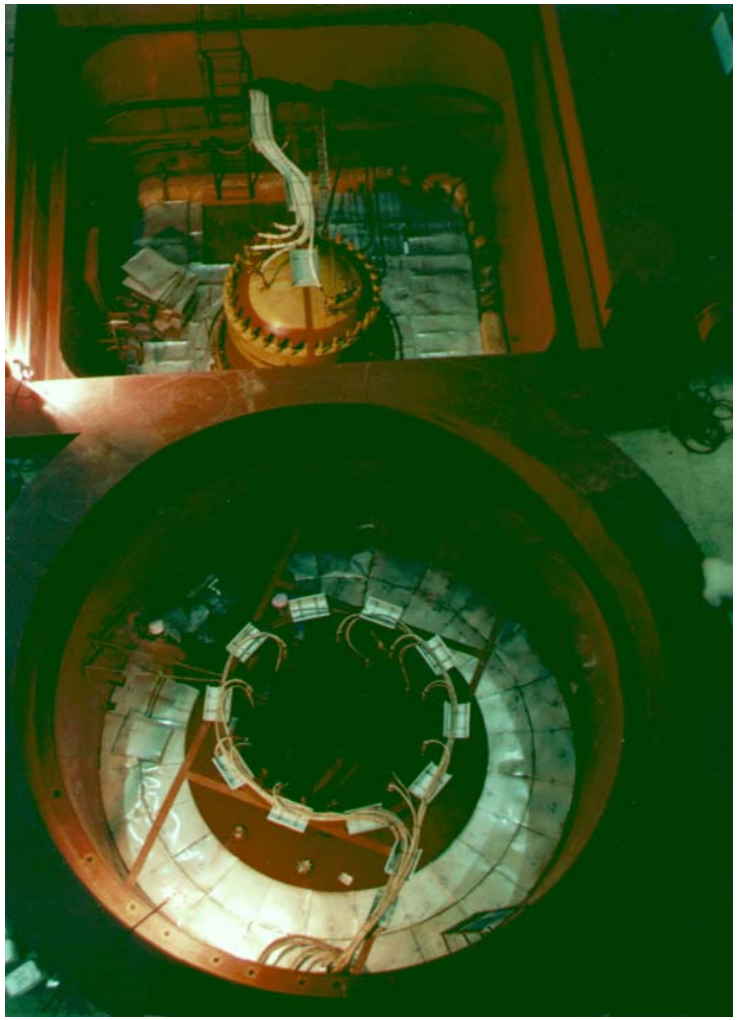
Graphite Reactor Structure



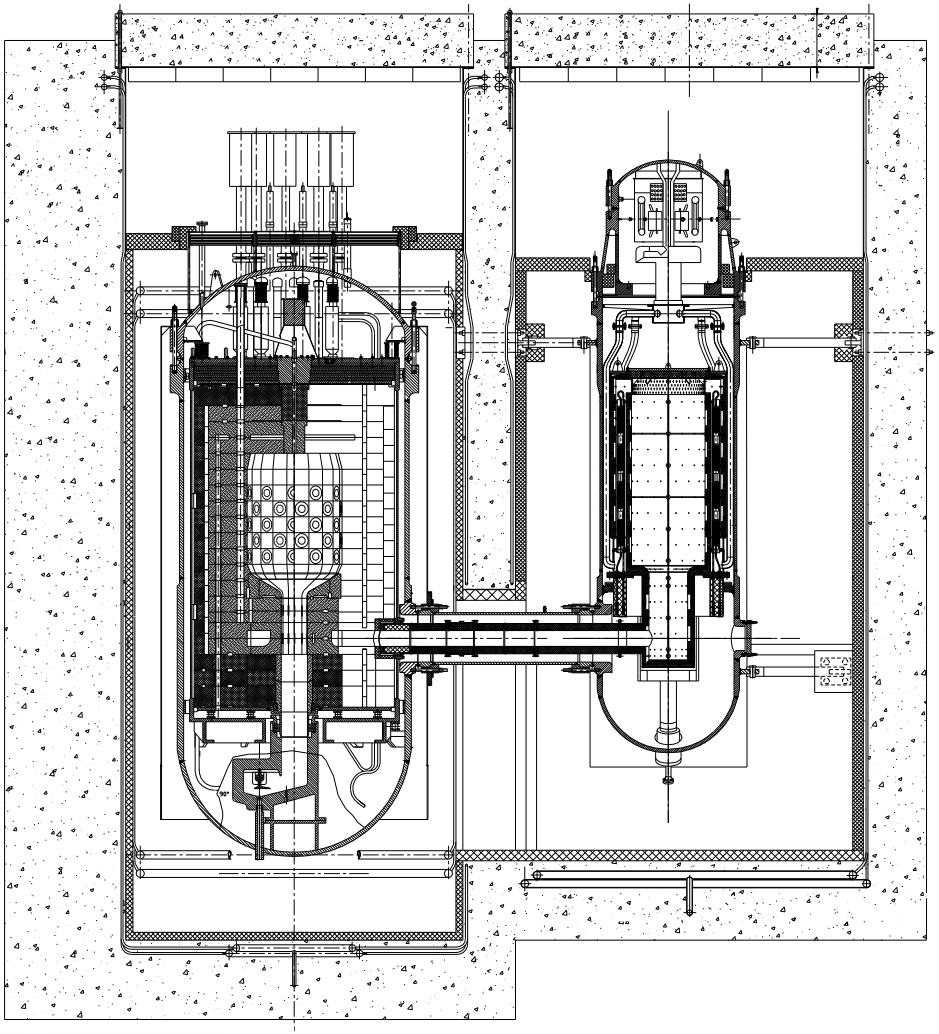
The Reactor and Steam Generator

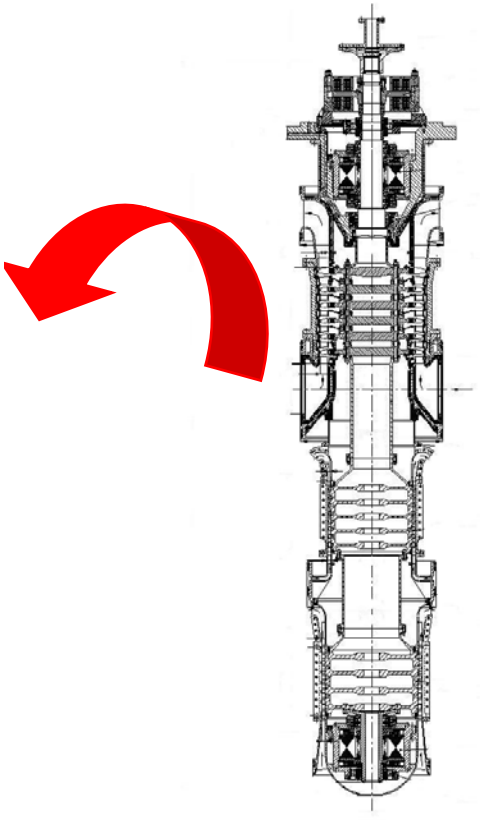


10 MW High Temperature Gas Cooled Reactor

10MW high temperature gas-cooled test reactor- gas turbine cycle (HTR-10GT)

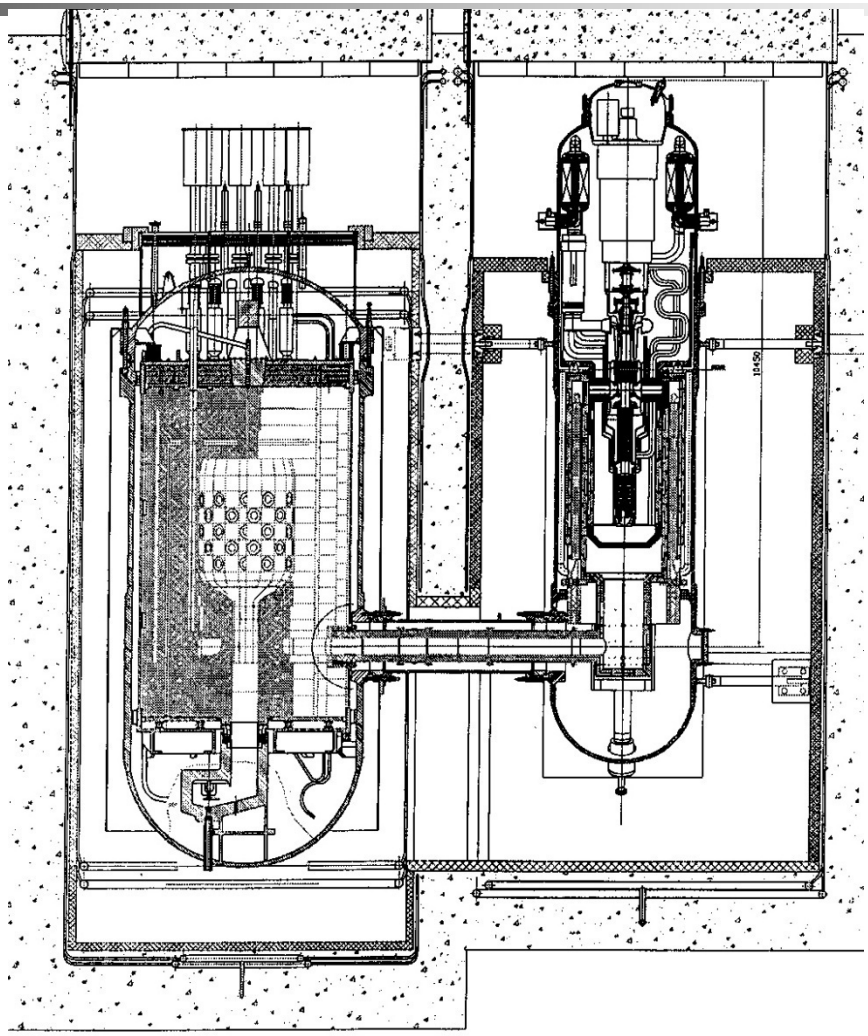
HTR-10GT: Gas Turbine for HTR-10





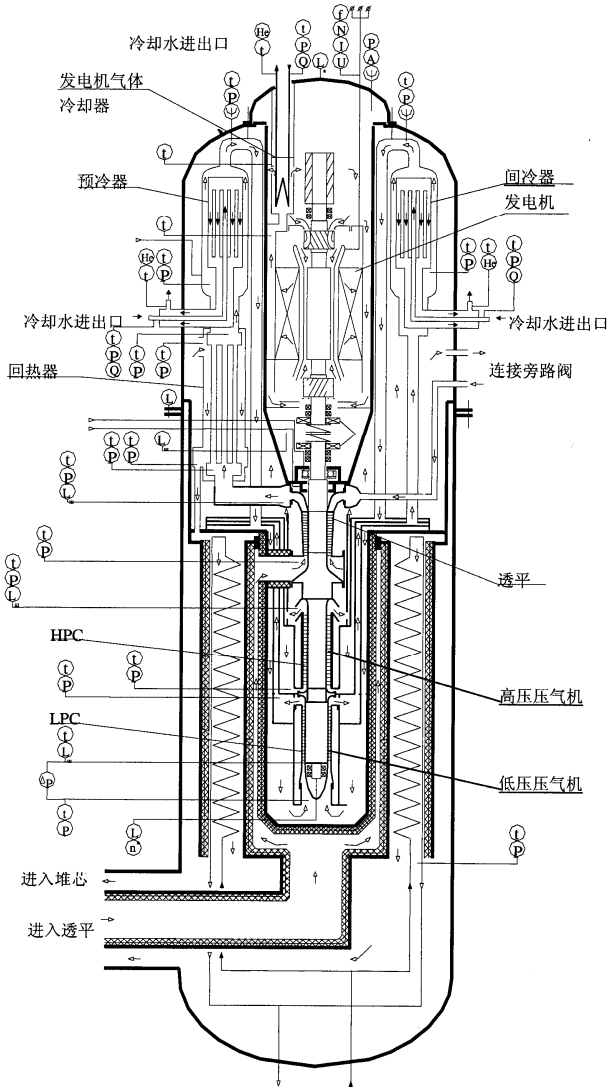
Helium Turbine-Compressor

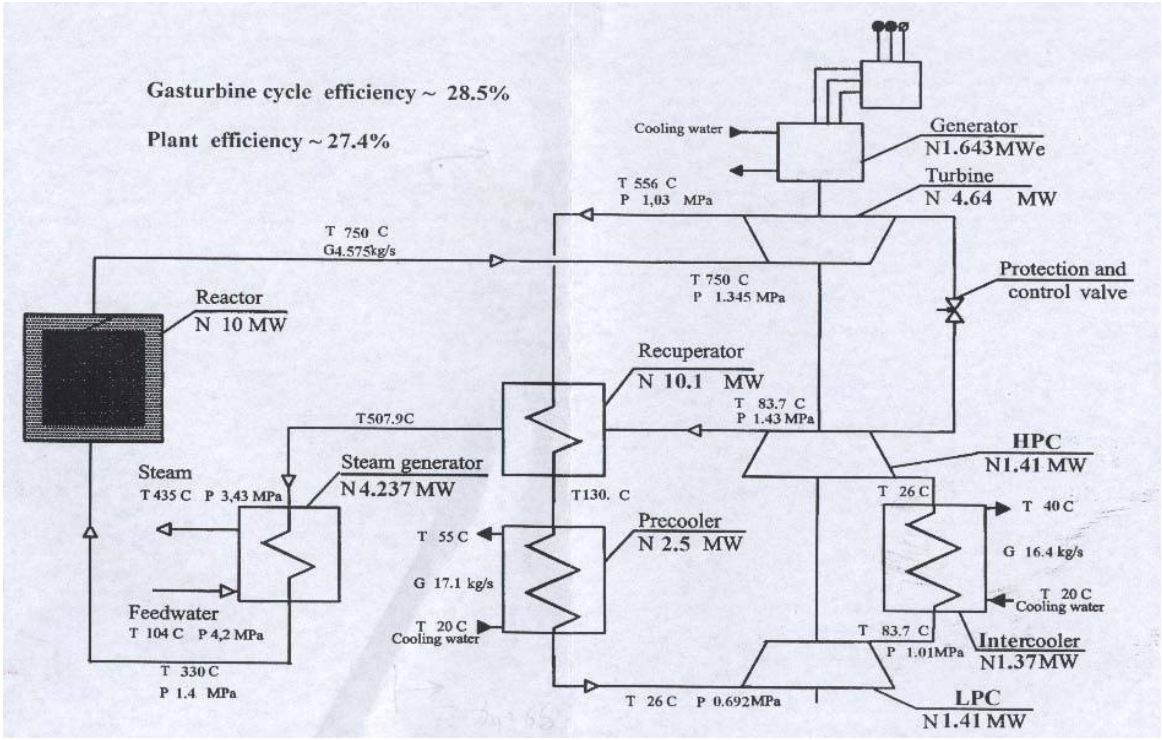
HTR-10GT: Gas Turbine for HTR-10



HTR-10 layout with PCU in Steam Generator vessel

Helium Cycle for HTR-10GT

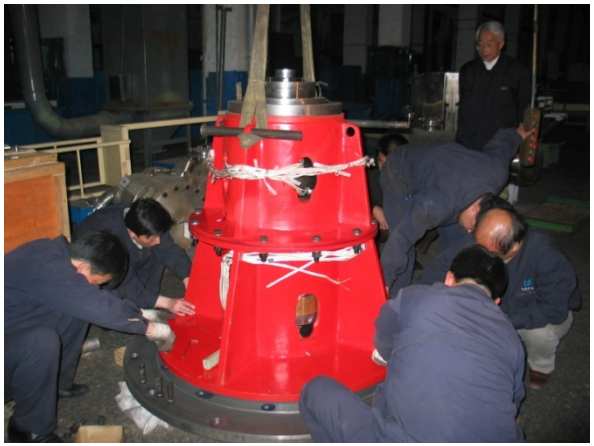




Helium compressor test

Electrical Magnetic Bearings(EMB)

Generator Rotor weighting 3.5 ton,



Catch Bearing Test

Pass 1st, 2nd Bending Critical Frequencies

High temperature gas-cooled reactor demonstration project (HTR-PM)

HTR-PM Site


北京
华北平原
太行山脉
黄海
渤海
长江中下游平原
武夷山脉
南岭
台湾山脉
澎湖列岛

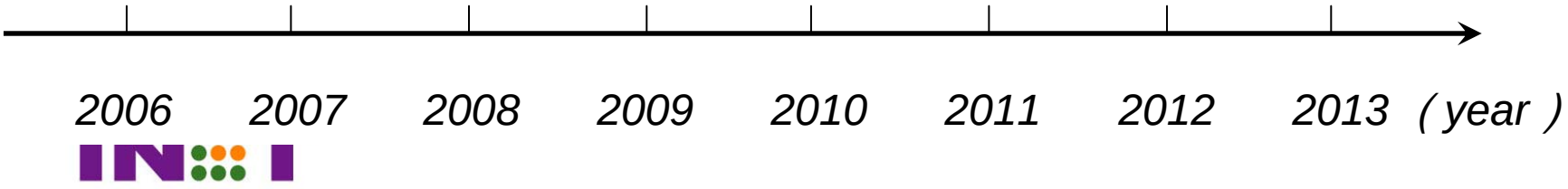

高温气冷堆核电示范工程
（山东荣成宁津厂址）

Site Preparation

HTR-PM Project

HTR-PM: High Temperature gas-cooled Reactor- Pebble bed Module

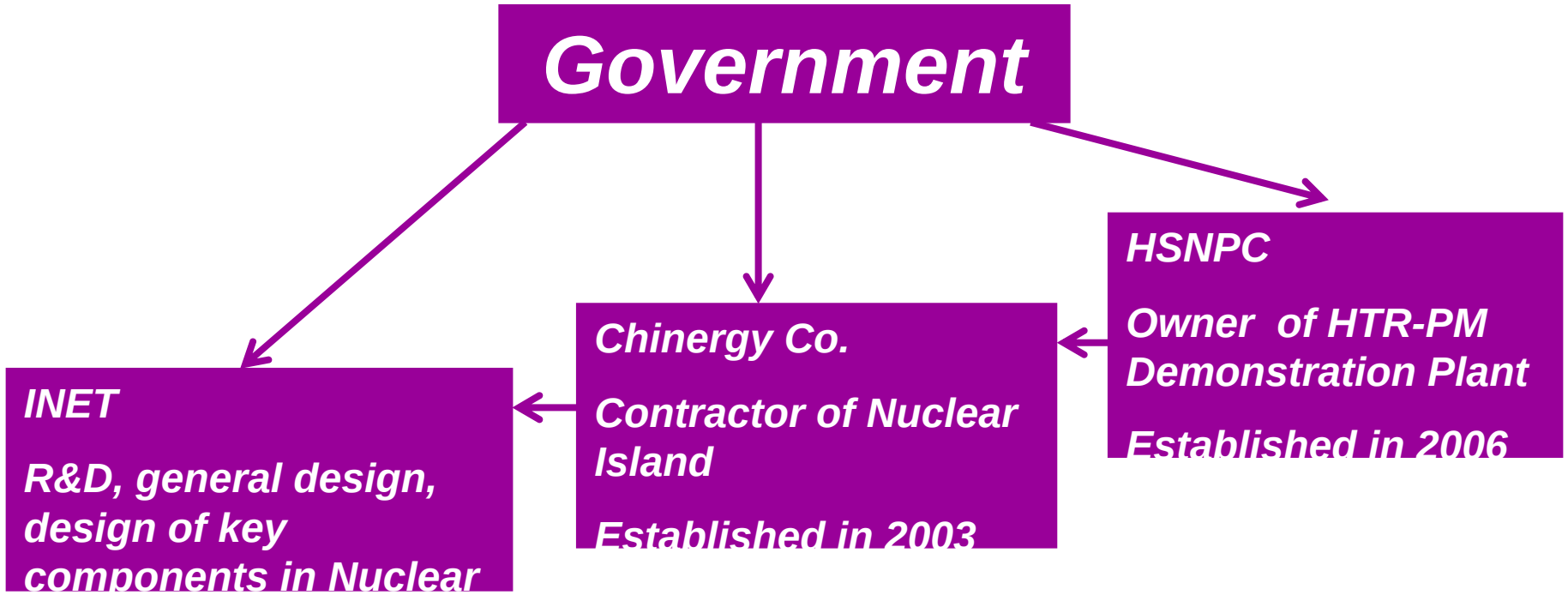
- Listed in major national projects
- Project approved(2008.02);
- Key contracts issued; Site work started
- CP from NNSA; pouring the first concrete
- Construction Finish



Technology objectives

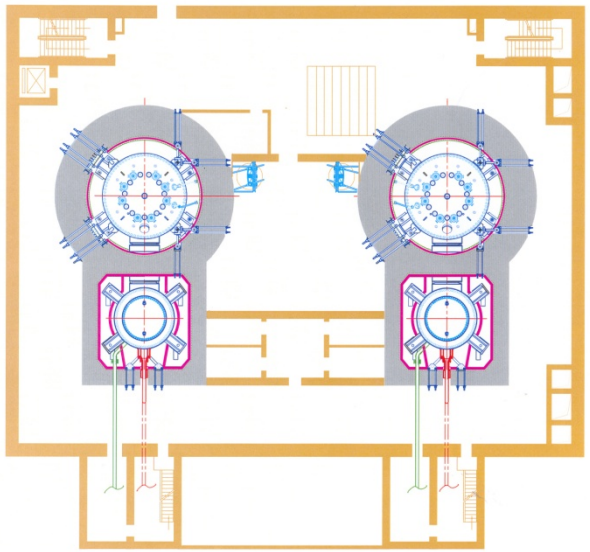
- ***Inherent safety***
- ***Potential competitiveness***
- ***Proven technologies***
- ***Standardization and modularization***

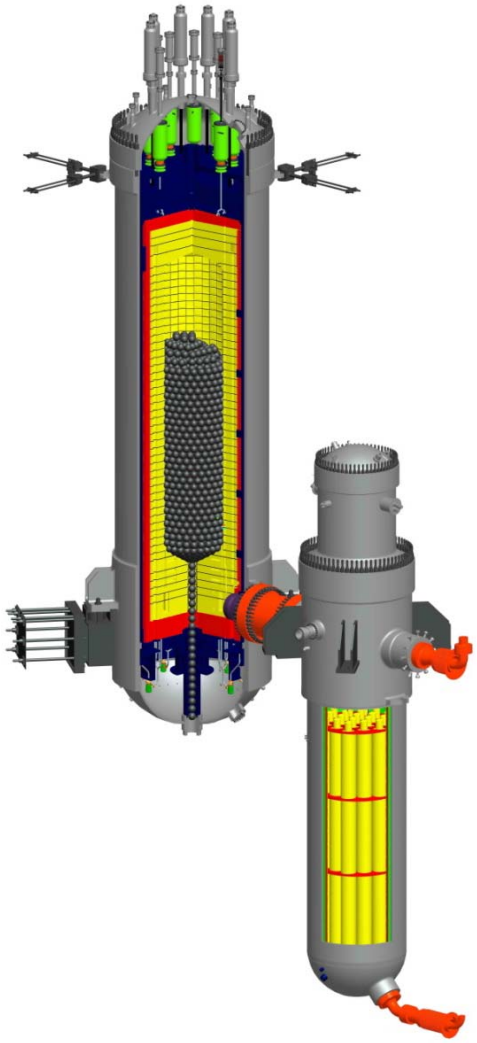
Project organization



HTR-PM ：Final technical design by 2006

Thermal power, MW	500
Electrical power, MWe	212
Pressure, MPa	7
Helium temp., ℃	250/750
Steam temp. , ℃	566





Fuel fabrication

- ***Test of key technology from 5g/fuel to 7 g/fuel;***
- ***Re-construction of INET fuel fabrication pilot facility (FFPF), 100000/year;***
- ***Finalization of the know-how in FFPF, Manufacture of fuel for irradiation;***
- ***Construction of 3 INET FFPF in one of fuel fabrication company, 300000/year;***
- ***Manufacture of fuel for HTR-PM.***

HTR-PM Progress

- create a feasible design, √
- establish a partnership with industry and form a team, √
- establish a project, including detailed schedule and R&D program, √
- get support from government and have budget approved, √
- test key components and finish R&D program, √
- Licensing
- Fabricate key components,
- Fabricate qualified fuels,
- …… around 2013

There is still a lot of challenges and we are looking for the international co-operation

Graphite Research

- **Mechanical Strength** 雒晓卫 高明山 亢方亮
- **Thermal Property** 周湘文
- **Oxidation** 雒晓卫 喻新利 王鹏 CEA
- **Dust** 雒晓卫 华宏亮 Yannick Benichou 陈志鹏 刘州洋
- **Irradiation** 韩风山 Petten, Delft U.
- **Stress Analysis and Assessment**

李海燕 汪超阳 方向

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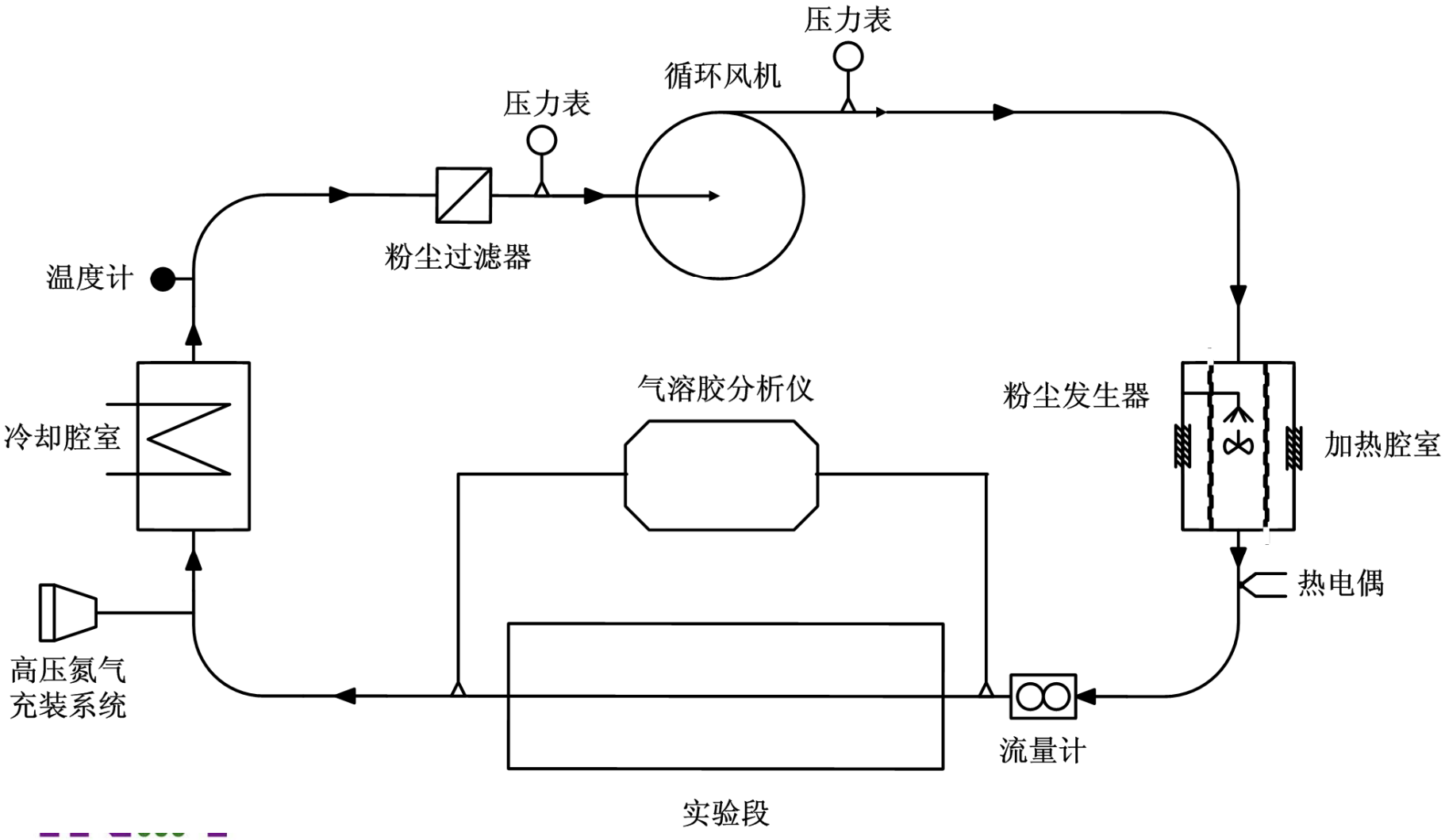
Dust Test for HTR-PM

2009-11-07

Test rig diagram



Test consideration

- *High Temperature and High Pressure to simulate HTR-PM primary Loop*
  - *Nitrogen with heating*
- *Test rig*
  - *Flow simularities*
  - *Restrains*
    - *room、blower power、budget*
- *Dust in the loop*
  - *Addition*
  - *Measurement*
  - *Filter*

Test rig parameters

- *Motor driven*
- *Maximum Loop Pressure 1.0MPa*
- *Temperature 25℃~250(750 ?)℃*
- *Pressure drop ： ~2kPa*
- *Motor Effective Power: ~1.5kW*
- *Pipe lines D=800mm,*
- *Gas density: 3.2682kg/m3*

Test Section

- Room temperature：
  - D=300mm, T=25℃ , P=0.289MPa
  - v=10m/s（Re=5e5自模）
  - Volume rate =2500m^3/h（10%~100%）
  - High temperature：
  - T1=250℃ , P1=0.5085MPa, Cp1=1.062KJ/(kg·℃)
  - T2=750℃ , P2=1MPa,Cp2=1.173KJ/(kg·℃)
  - Heating power W=Cp*Qm*ΔT
    - v=10m/s,Qm=ρQ=2.27kg/s,W1=550kW,W2=1800kW
    - v= 1m/s,Qm=ρQ=0.227kg/s,W=55kW,W2=180kW

Dust Research to be done

- *Dust generation and development*
- *Dust deposition and resuspension*
- *Dust size distribution and features*
- *Dust release at primary loop break*
- *Fission product behavior affected by dust*
- *I-131 fate*
- *…*

Thanks