

Current Issues of Reactor Safety Research in China

X. Cheng

Karlsruhe Institute of Technology (KIT)

EUROSAFE FORUM 2016

November 7-8, 2016, Garching, Germany

Acknowledgement

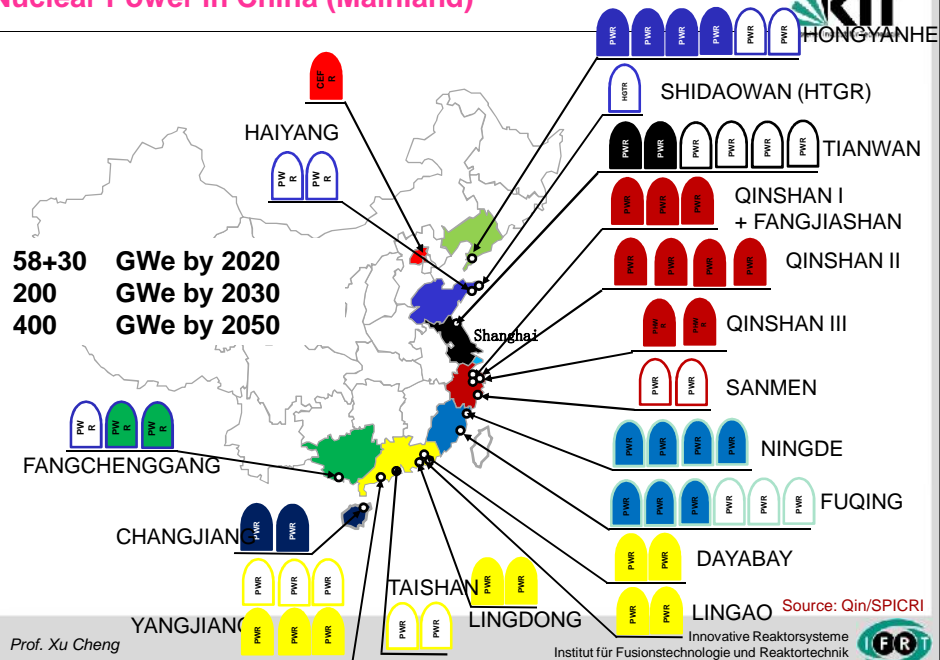
With the support of colleagues from

- CNPRI
- INEST/CAS
- LZB/CAS
- NPIC
- NRSC
- SINAP/CAS
- SPICRI
- NCEPU
- SJTU
- USTC
- XJTU

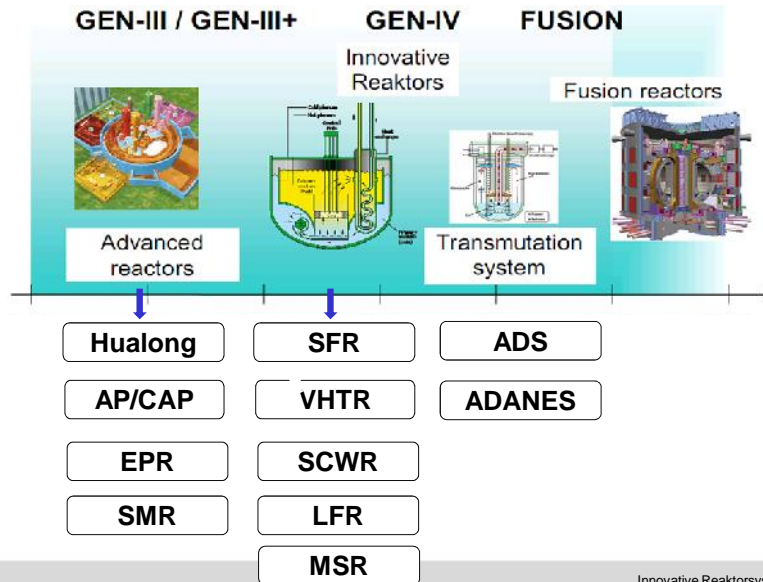
Outline

1. General situation
2. Examples of reactor safety R&D activities

Nuclear Power in China (Mainland)



Nuclear Power Technology in China



Impact of Fukushima accident

- ✓ Nuclear program slowed down, but kept;
- ✓ Safety as 1st priority: highest level safety standard;
- ✓ Technology from GEN-II to GEN-III, passive safety system emphasized;
- ✓ Enhancing capability of safety licensing & supervision authority
- ✓ Central coordination (government) for:
 - nuclear strategy, nuclear standards, technology, R&D, HR
- ✓ Importance of safety culture
- ✓ Public work & network
 - e.g. nuclear society, university networks
- ✓ Enhance international exchange & collaboration

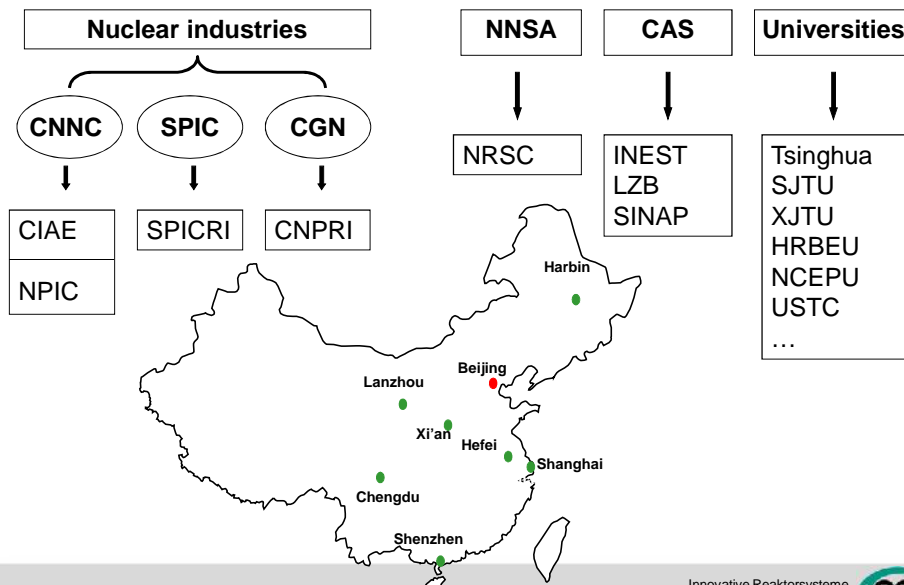
Outline



1. General situation
2. Examples of reactor safety R&D activities



Nuclear safety R&D community



Safety R&D issues and challenges



- ✓ GEN-III PWR as highest priority
- ✓ Passive safety systems for large NPPs
- ✓ Reliable SA mitigation measures
- ✓ Numeric simulation tools

R&D approach

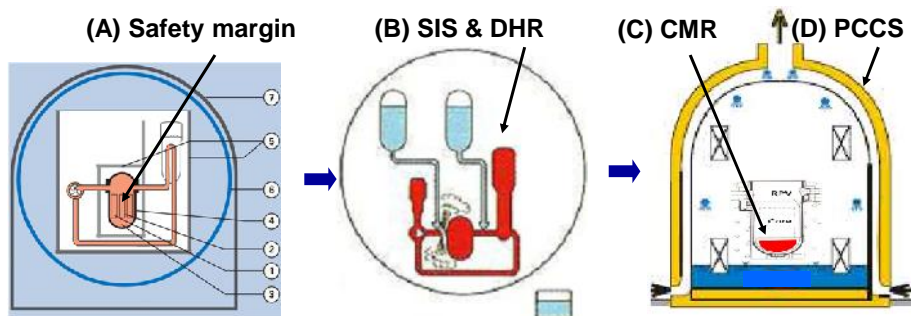
- ✓ Nationwide coordination (national projects)
- ✓ Strong interaction inside community
- ✓ International collaboration

Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



Safety R&D issues



Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



(B) SIS & DHR

Integral facility at SPICRI

✓ Main organizations

- SPICRI
- NRSC
- CNPRI

ACME test facility at SPICRI



Source: SPIC

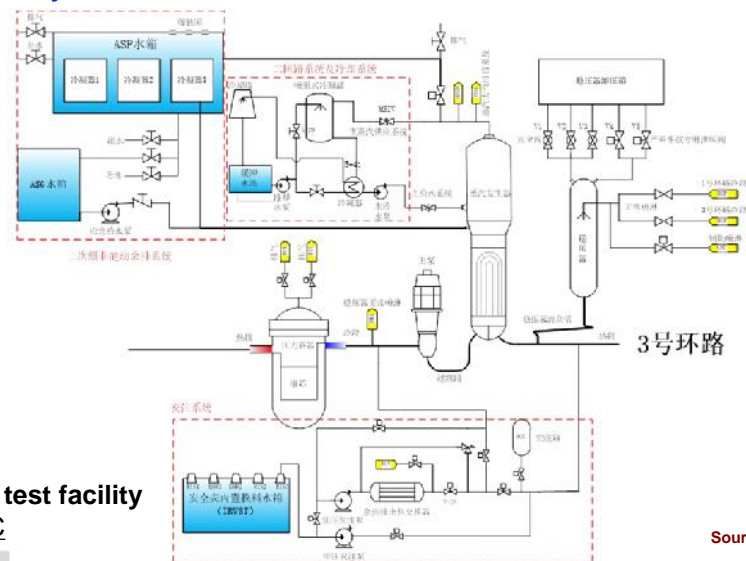
Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



(B) SIS & DHR

Integral facility at NRSC



Integral test facility at NRSC

Source: NRSC

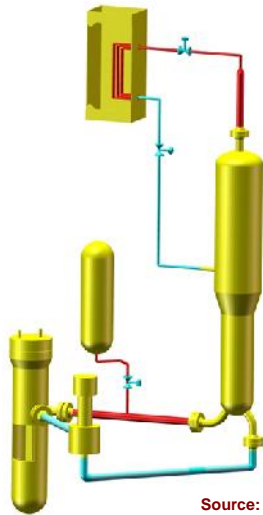
Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



(B) SIS & DHR

Integral facility for SCP at CNPRI



Source: CNPRI

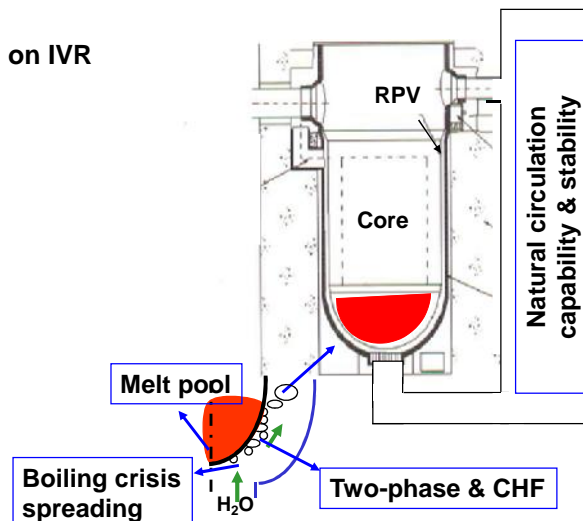
Prof. Xu Cheng



Institut für Fusionstechnologie und Reaktortechnik

(C) Core melt retention & cooling

- ✓ Mainly concentrated on IVR
- ✓ Main organizations
 - SJTU
 - CNPRI
 - SPICRI
 - XJTU



Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik

(C) Core melt retention & cooling



Test facility CORPA at XJTU



Geometry	2D 1/4 circular pool radius 2200cm width 20cm
Scale	1:1 for ACP1000
Simulant	1) Water 2) 20% NaNO ₃ -80% KNO ₃
Heating	Electrical heating rod
Boundary	Top wall: Insulated or cooling Side wall: Insulated Bottom wall: cooling condition
Ra'	10 ¹⁶

Source: XJTU

Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik

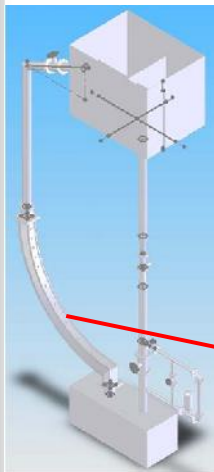


(C) Core melt retention & cooling



Test facility REPEC-1 at SJTU

Test facility REPEC-2 at SJTU



Source: SJTU

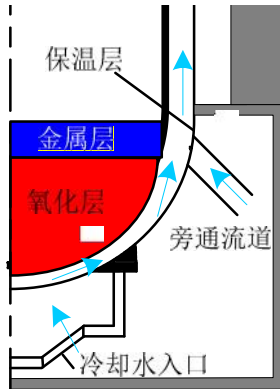
Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



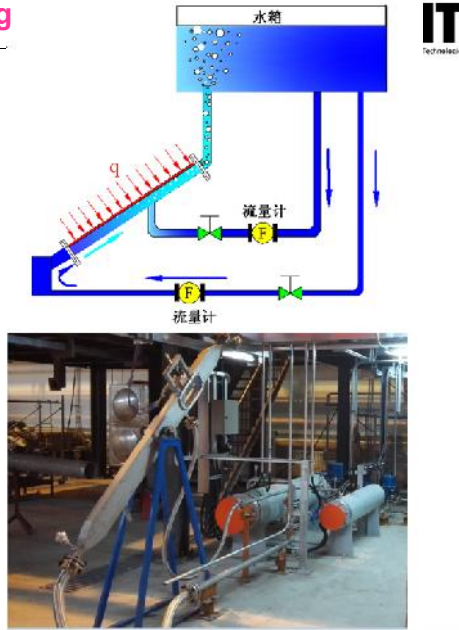
(C) Core melt retention & cooling

Test facility at SPICRI



Source: SPICRI

Prof. Xu Cheng

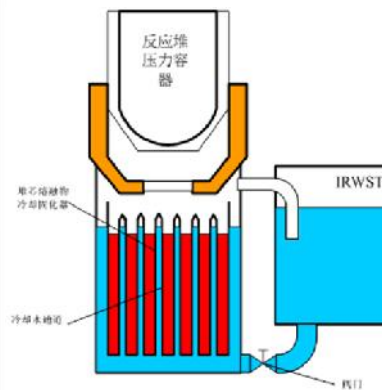


Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



(C) Core melt retention & cooling

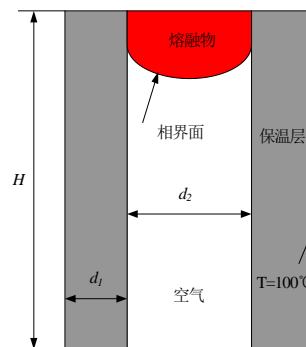
New core catcher concept of CNPRI



(a) sketch



(b) SE-test



(c) simulation

Source: CNPRI

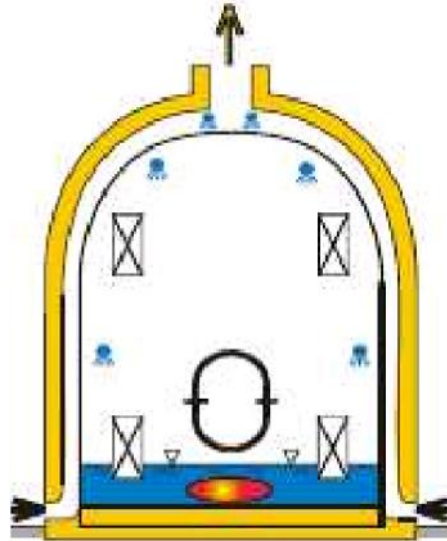
Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



(D) PCCS

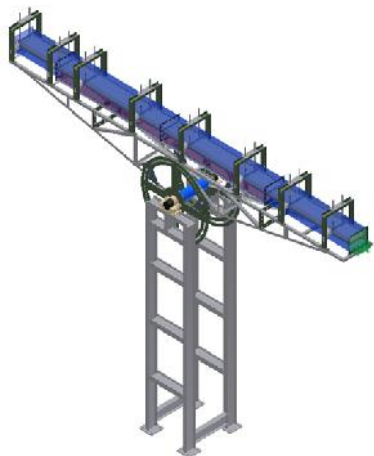
- ✓ **Main organizations**
 - SPICRI
 - CNPRI
 - SJTU



(D) PCCS

Mixed air convection test (MICARE) at SJTU

Water film behavior test (WABREC) at SJTU



Source: SJTU

(D) PCCS



Containment safety verification integral test (CERT) at SPIC

Height ratio	1:8
Free Volume Ratio	1:146.5
Steam Flow Rate (kg/s)	0-30
Steam Pressure (MPa)	0-4.4
Steam Temperature (C)	150-315



Source: SPIC

Prof. Xu Cheng

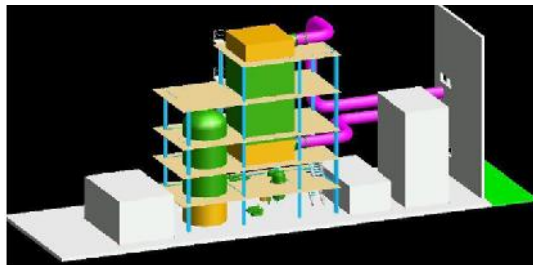
Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



(D) PCCS



Test facility TUPAC (Time-Unlimited PASSive Containment Cooling)
at SPICRI



TUPAC-CPTF (in process of construction)



TUPAC-SPTF Source: SPICRI

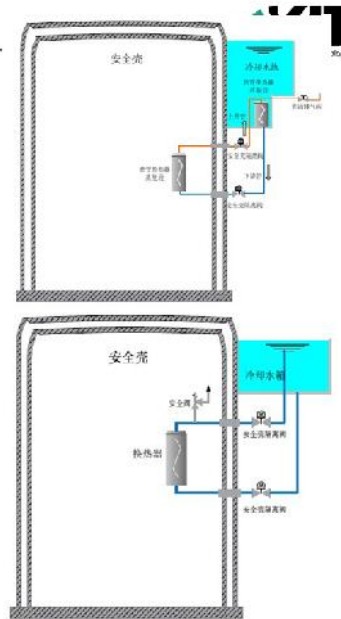
Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



(D) PCCS

PCCS for Hualong and test facility at CNPRI



Source: CNPRI

Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik

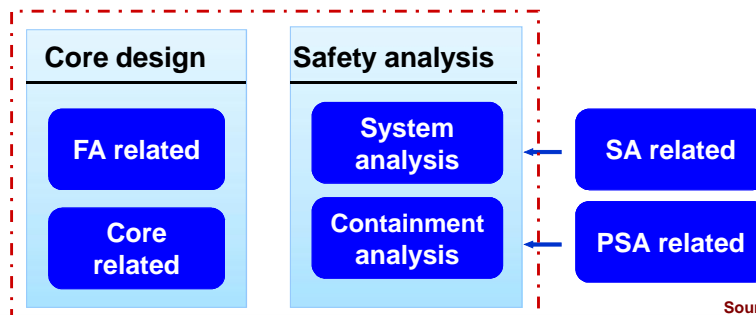


(E) Software development



- ✓ National key lab with government financial support
- ✓ Main organizations
 - SPICRI
 - Universities, SNERDI, CNPRI, ...

COre and **S**ystem **IN**tegrated **E**ngine for design and analysis
(*COSINE*)



Source: SPICRI

Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



(F) International collaboration



- ✓ **Government actions**
 - promote int. collaboration
 - actively involved in activities coordinated by int. organizations such as IAEA, OECD/NEA
 - sharing of nuclear safety experience, capability and nuclear accident information
- ✓ **Regional and bilateral collaboration**
 - growing bilateral collaboration in R&D
 - education & training
 - *scientific and technical exchange*

Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



(F) International collaboration



Int. scientific exchange

Int. Topic Meeting: NUSSA



Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



(F) International collaboration



Int. scientific exchange

Sino-German Workshop: SG-FANS



Prof. Xu Cheng

Innovative Reaktorsysteme
Institut für Fusionstechnologie und Reaktortechnik



NUTHOS-12

12th International Topical Meeting on
Nuclear Thermal-Hydraulics
Operation and Safety



Oct. 2018, Qingdao,
China



Thank you for your attention!