

# Education and Research Activities at SNSE/SJTU

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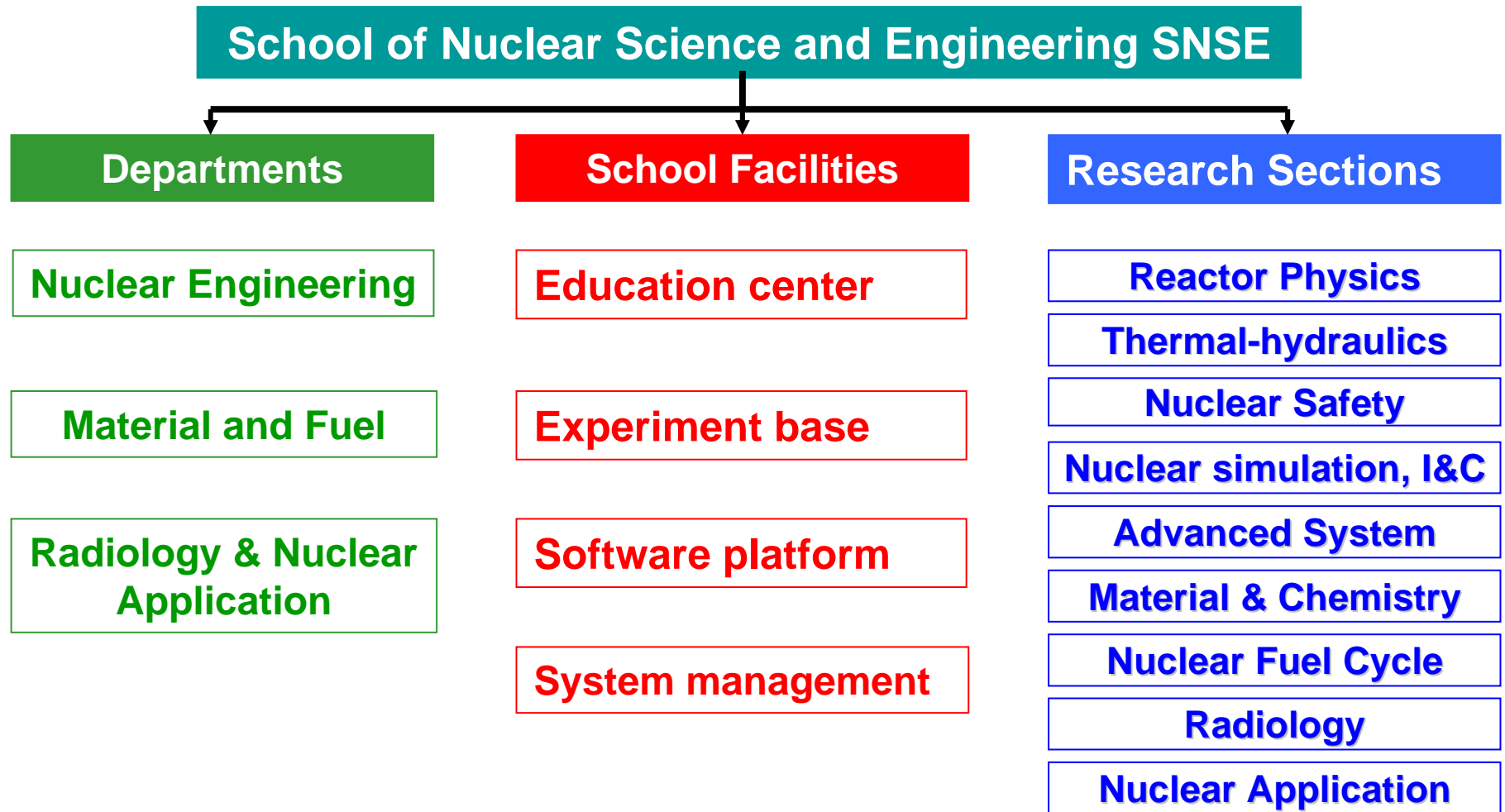
**SJTU 2006 Int. Workshop on Nuclear Power Development  
April 9-10, 2006, Shanghai Jiao Tong University, Shanghai, China**



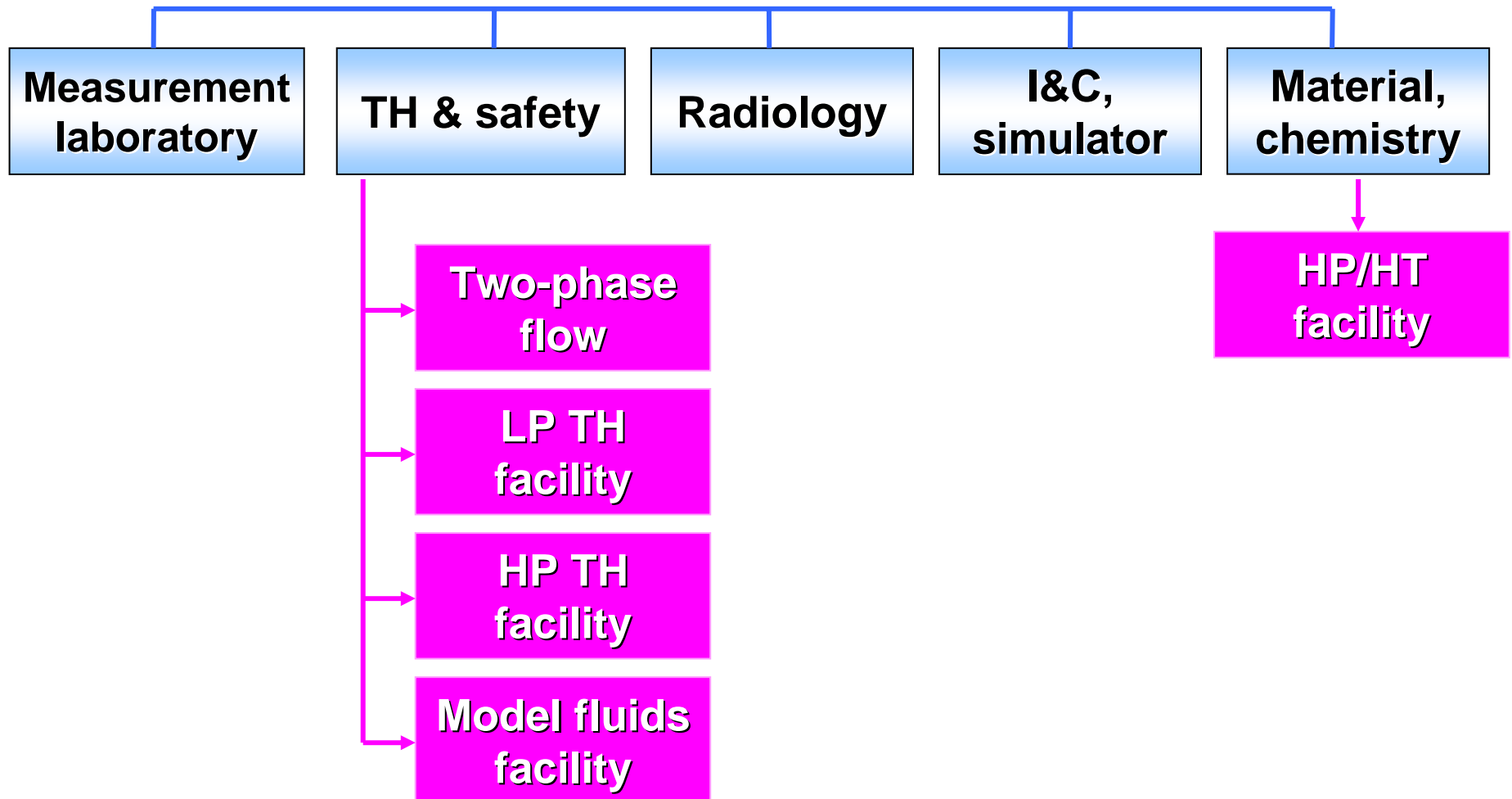
# Content

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- **Summary**

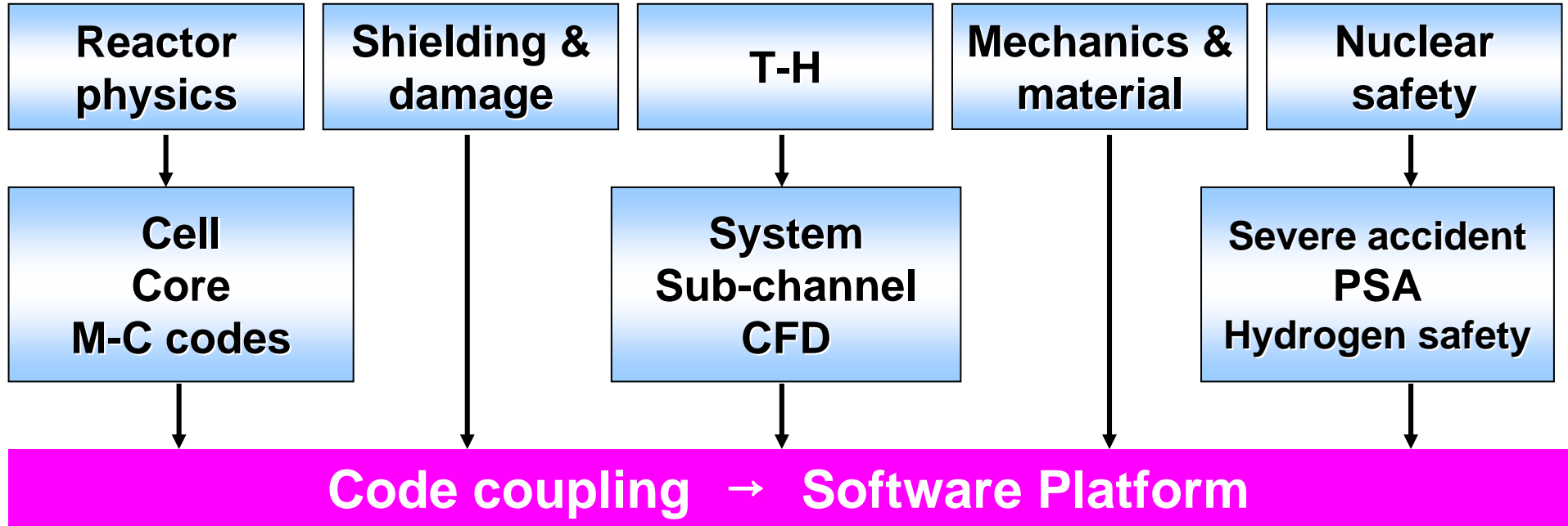
# School structure



# Experimental base



# Software platform



# Human resource plan

	<b>2005</b>	<b>2010</b>
<b>Staffs (工作人员)</b>		
<b>Professor (教授)</b>	<b>4</b>	<b>~ 10</b>
<b>Associate Professor &amp; lecturers</b> (副教授, 讲师)	<b>13</b>	<b>~ 30</b>
<b>Other staffs (工程师、教辅人员)</b>	<b>6</b>	<b>~ 5</b>
<b>Graduate Students (硕士生, 博士生)</b>	<b>50</b>	<b>~ 100</b>

# Collaboration partners

- national nuclear industries
- national research institutions
- national working groups
- int. nuclear industries
- int. research institutions
- int. universities
- int. working groups



# Education

- **Education: key issue in Chinese nuclear power development**
- **High requirement on nuclear engineers and scientists**
- **Limited number of universities with nuclear engineering education**
- **SNSE/SJTU**
  - the only one in southeast China
  - long history and experience in nuclear education
  - important contribution to Chinese nuclear community
  - geological unique feature
  - strong support from Shanghai municipal & University



# Education

	2005	2010
<b>Education (人才培养), 1/year</b>		
<b>Undergraduate students (本科生)</b>	~30	~ 100
<b>Graduate students (研究生)</b>	~15	~ 30
<b>Engineering master (工程硕士)</b>	~40	~ 150
<b>Professional training (职业培训)</b>	~350	~ 500
<b>Subject oriented training (专题培训)</b>		

# Professional training

NPP managers; NPP operators;  
Nuclear engineers; Engineering master

CPI



CGNPC



CNNC

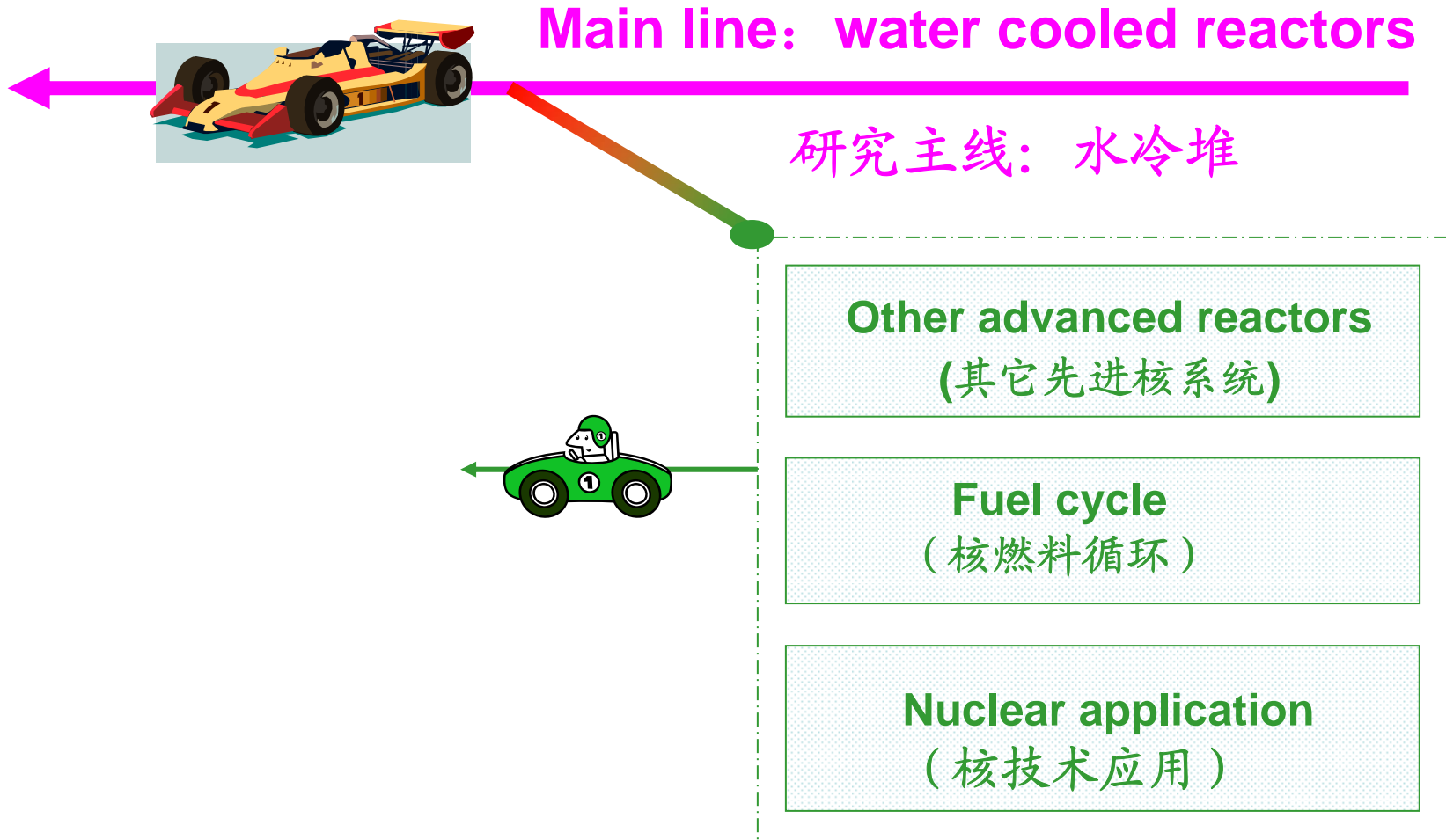


Who?



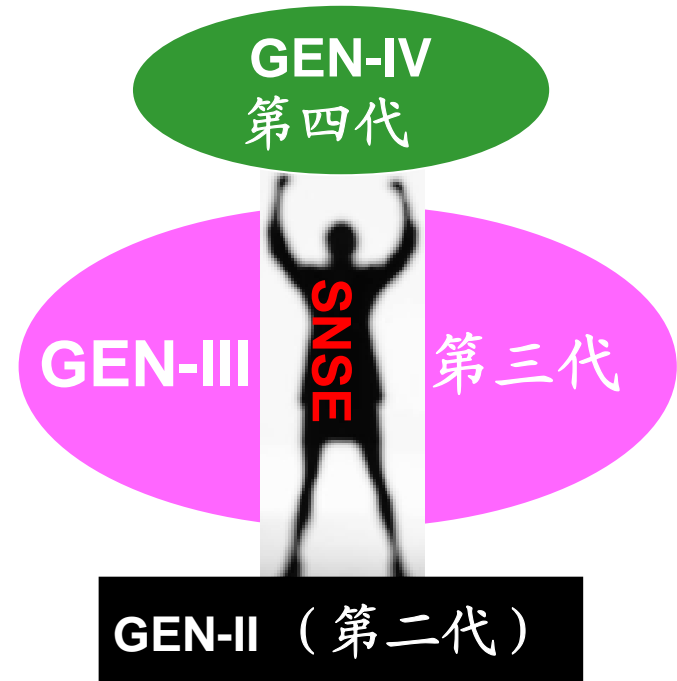
Subject oriented training

# Research subjects (研究方向)



# Main line: water cooled reactors

- **GEN II (II<sup>+</sup>) as base**  
以第二代为基础
- **GEN-III as main body**  
以第三代为主体
- **GEN-IV as future target**  
以第四代为发展目标



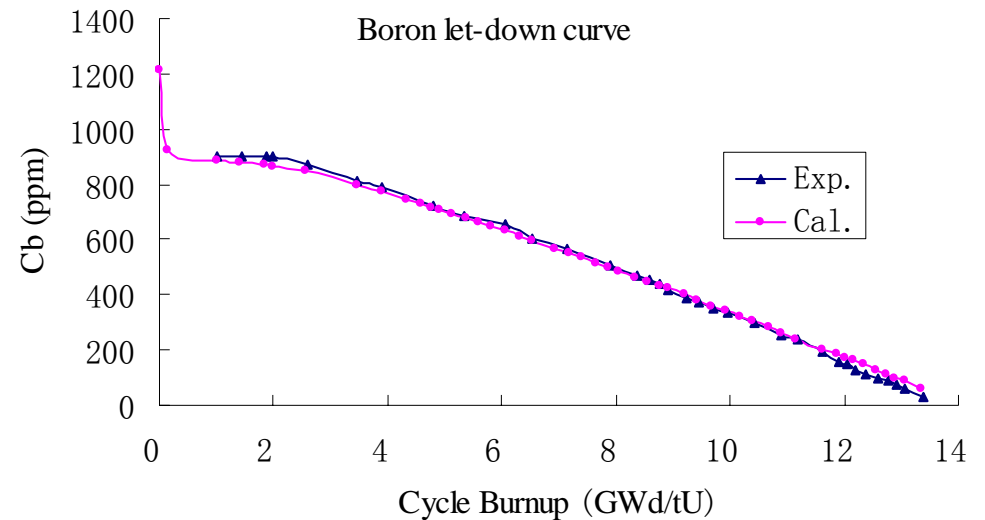
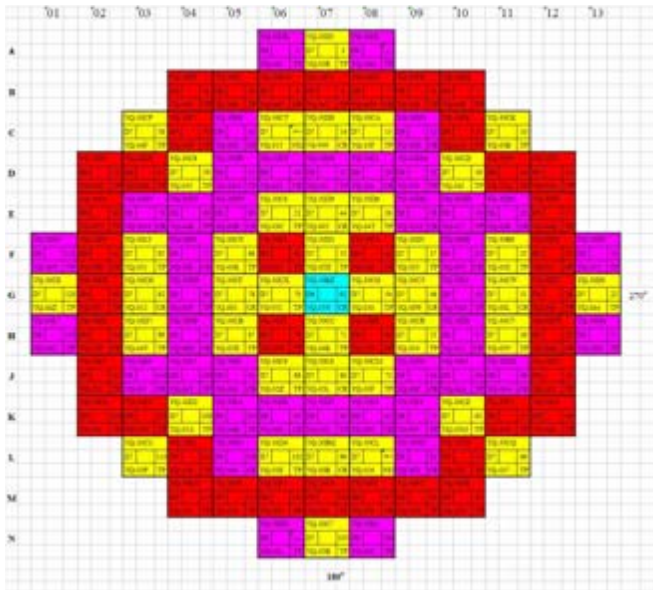
# Research activities

## Present research topics (现有科研方向)

- **Reactor core analysis** (反应堆分析)
- **Nuclear safety & severe accidents** (核安全与严重事故分析)
- **NPP simulation software development** (核电站仿真软件开发)
- **Multi-phase flow and heat transfer** (多相流和传热)
- **3-D thermal-hydraulics analysis** (三维传热流动分析)
- **SCWR related researches** (超临界水冷堆)

# Reactor core analysis

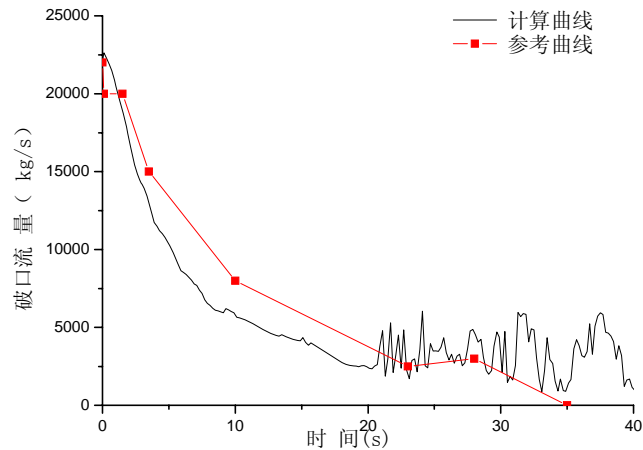
- Fuel management in PWR and CANDU reactors
- Supercritical water cooled reactors



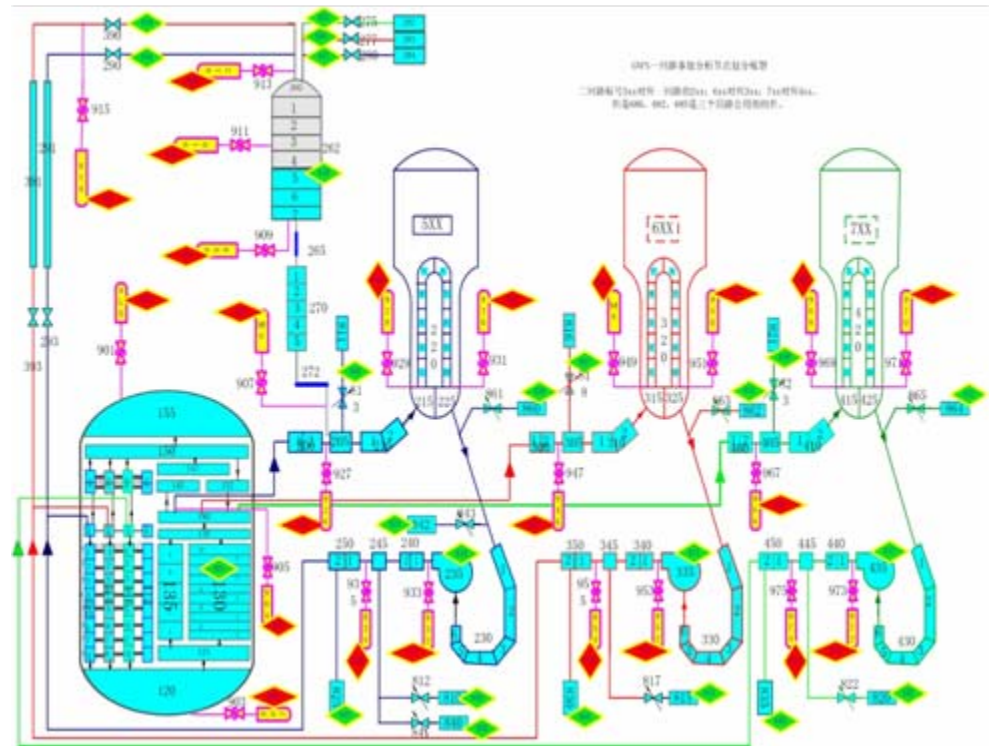
**Fuel management in a PWR reactor core**

# Nuclear safety analysis

- Improvement of existing codes
  - GUI
  - Enlarging applicability (e.g. models, SCWR)
  - Real-time/dynamic simulator (also combined with I&C)
- Application



DAYABEI NPP



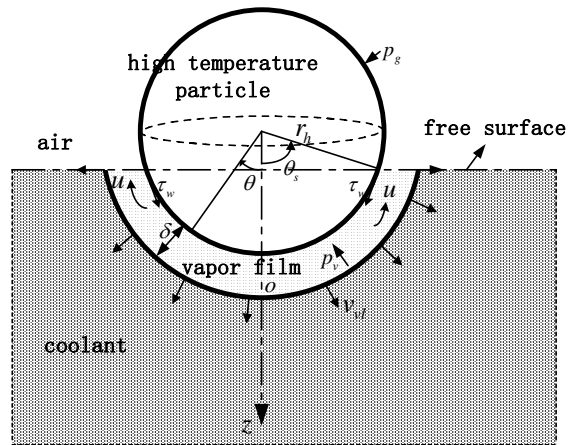
# Severe accident research

- **Fuel and coolant interaction (FCI)**
- **Hydrogen safety research**
- **PSA**
- **Containment thermal-hydraulics**
- **Development and improvement of computer codes**



# Fuel and coolant interaction (FCI)

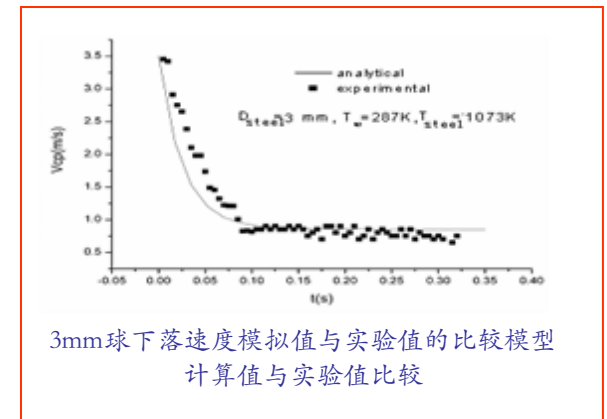
➤ Mechanistic study: theoretical



$$u_h^{tp} = \sqrt{u_h^{0^2} + 4r_h g - \frac{10}{9} \frac{p_g}{\rho_h} \left( \frac{\phi}{v_a} - 1 \right)}$$

Advanced drag model

➤ Mechanistic study: experiment



➤ Code improvement: JASMINE-PRO etc.

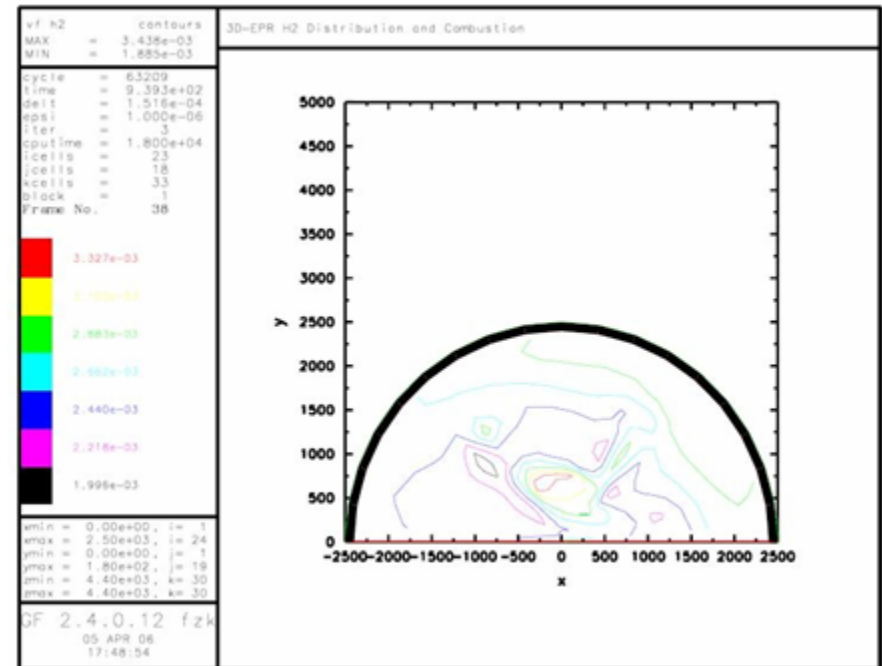
# Hydrogen safety & PSA

## ➤ Hydrogen safety

- GASFLOW User Group Member
- Collaboration partners: FZK

## ➤ PSA

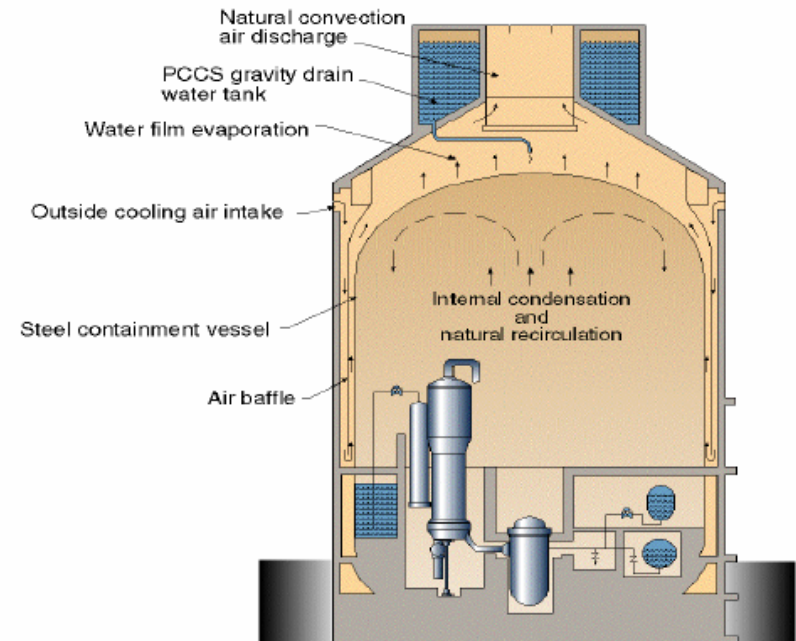
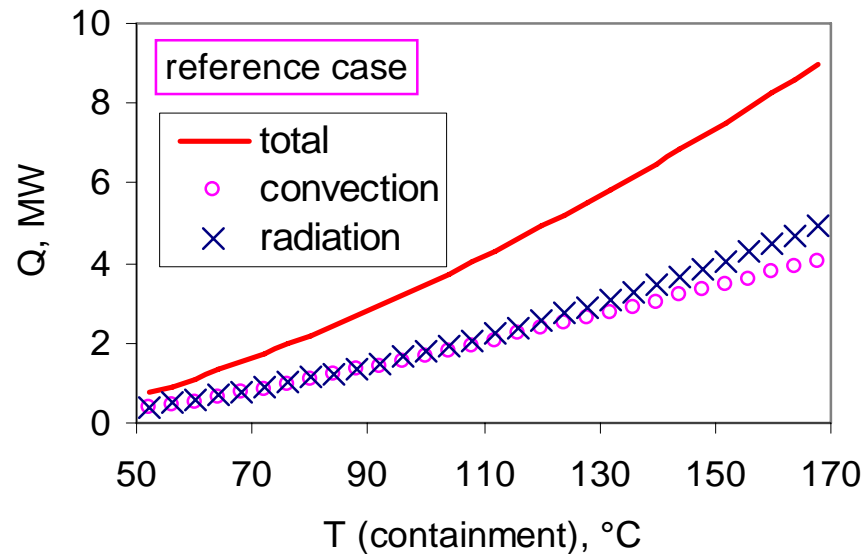
- Development of PSA analysis tools
- Engineering application
- Collaboration partners: CIAE,... etc



**GASFLOW results**

# Passive containment cooling

- PCCS cooling capability
- Development of 3-D codes
- Development of engineering models (correlations)



Results example: AP1000 containment (dry condition)

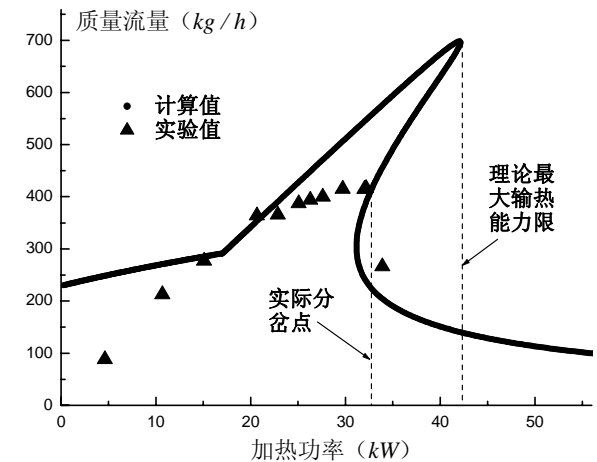
# NPP simulation software development

- **Simulation analyzer of main control room**
- **Accident analyzer of NPP**
- **Digital I&C software of NPP**



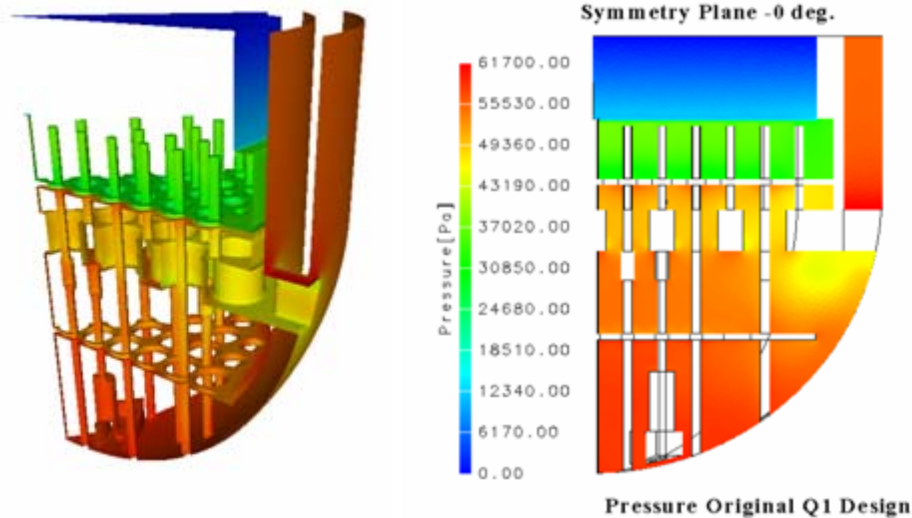
# Multi-phase flow and heat transfer

- Development of multi-phase computational fluid-dynamics
- Two-phase natural convection stability
- Post-CHF heat transfer
- Two-phase flow regimes and void fraction measurement
- Phenomenological studies on high temperature boiling

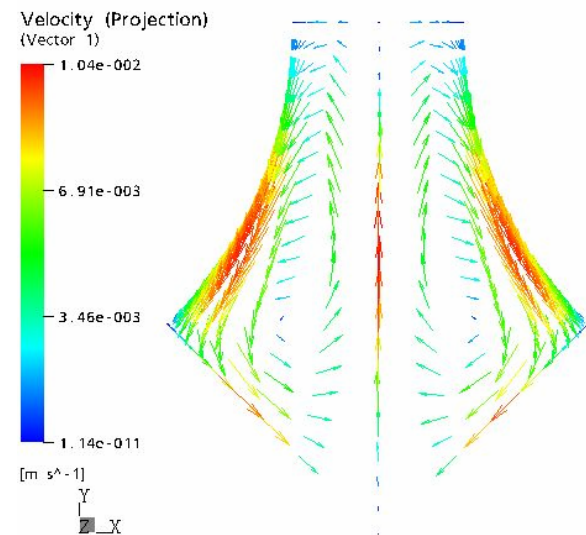


# 3-D Thermal-hydraulics analysis

- Flow distribution and heat transfer in reactor core & in condenser
- Flow and heat transfer in sub-channels



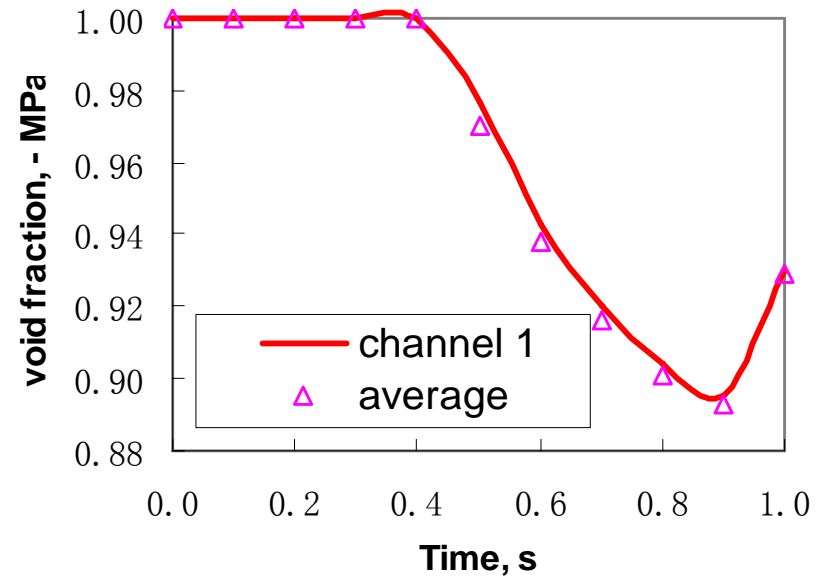
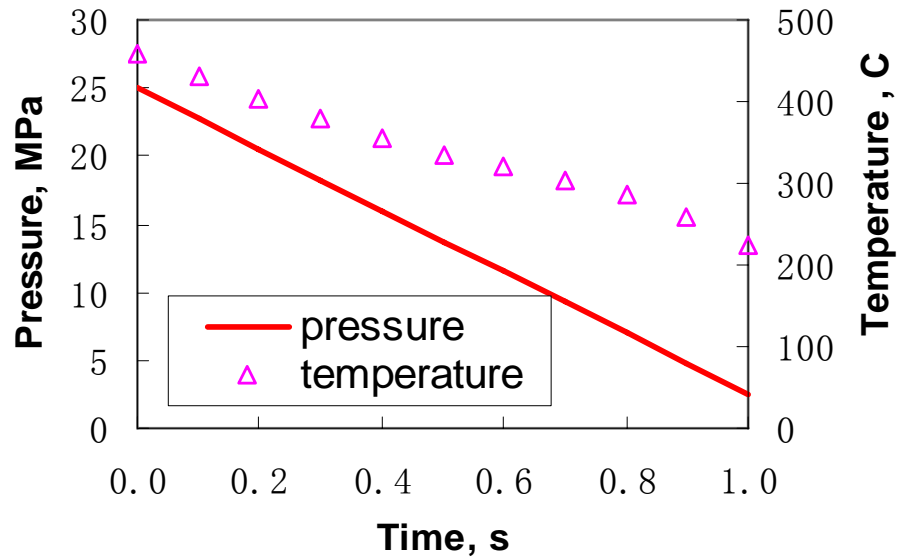
Flow distribution in reactor core



Flow pattern in sub-channel

# SCWR related activities

## ➤ Core/fuel assembly design

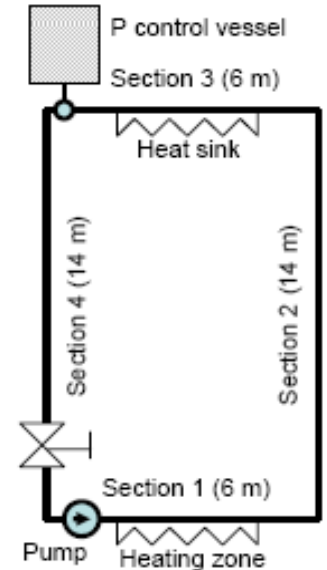
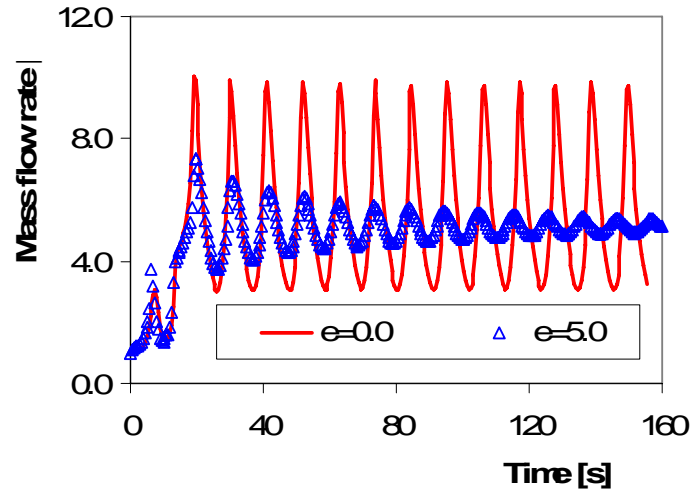


Sub-channels: Transient from super- to sub-critical conditions

# SCWR related activities

- **Thermal-hydraulics**
  - basic heat transfer
  - flow stability

Numerical analysis



Theoretical study



$$\frac{3}{2} \cdot \frac{\pi_q \pi_r}{\pi_\rho \sqrt{\pi_\rho^2 + \pi_r \pi_\rho (1 - \pi_\rho)}} = 1$$



# SCWR related activities

## ➤ Numerical tools

### ✓ System analysis

**SASC** – home made

**SPROD** – collaboration with Uni. of Tokyo

**RELAP** – home improved

### ✓ Sub-channel analysis

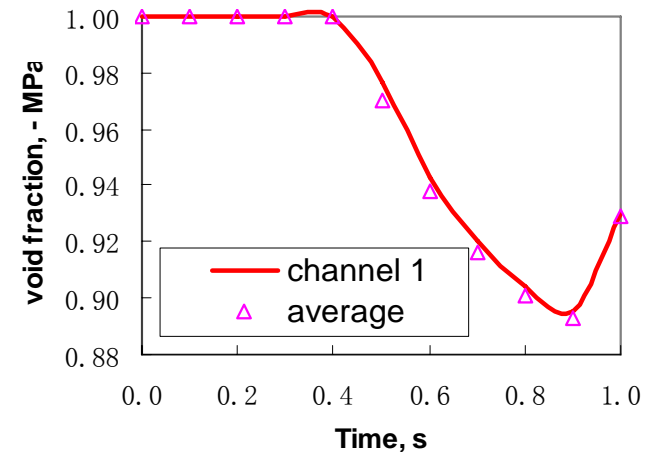
**MATRA** – collaboration with KAERI →

### ✓ CFD

**ANSYS** – commercial

**???** – home made, under development

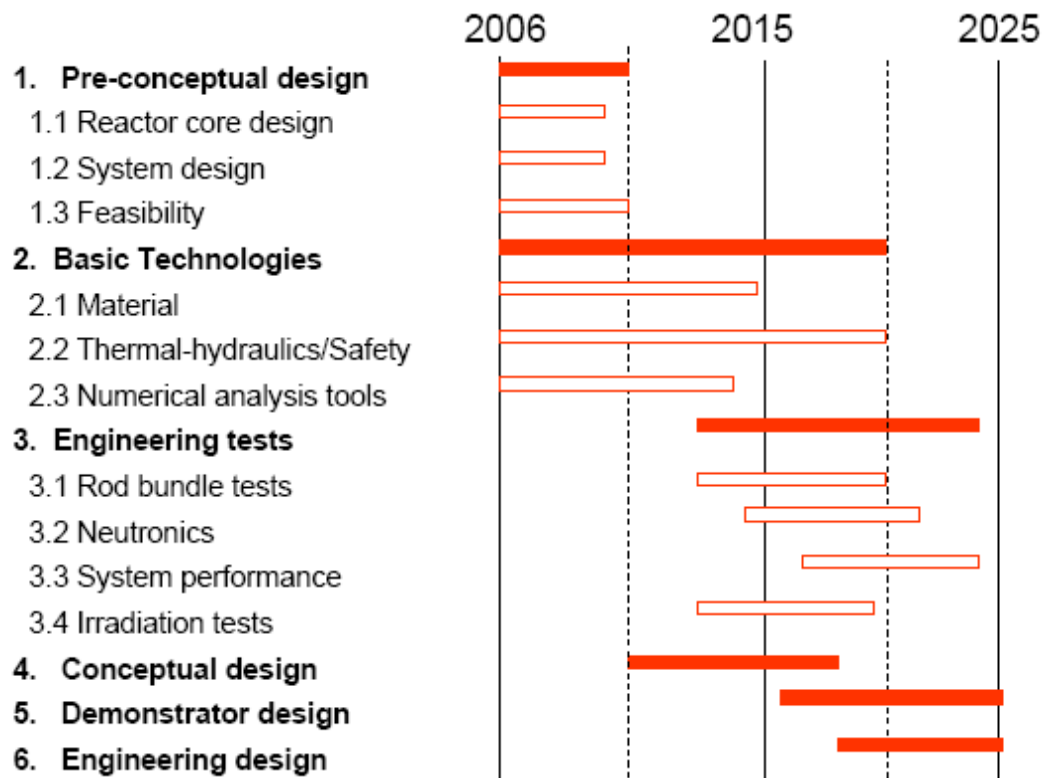
### ✓ Coupling



# SCWR related activities

## ➤ Organization of national projects (ongoing)

- The first common proposal to MOST with 7 partners
- Establishing “Chinese SCWR Technical Working Group”
- Preparation of further proposals



**Roadmap of  
Chinese SCWR development  
proposed by SNSE/SJTU**

# Summary

- **SNSE will strongly enhance his nuclear education and research activities, to fulfill the growing requirement of the Chinese society;**
- **SNSE is playing a crucial role in training nuclear engineers, becoming one of the most important education bases in China;**
- **SNSE has much experience in nuclear R&D, especially in water cooled reactors, and will make important contribution to Chinese nuclear R&D community;**
- **SNSE is going to tighten national & international collaboration;**
- **SNSE is going to play a bridging role in the information exchange and collaboration of the Chinese nuclear community with international partners.**