

# Safety of Nuclear Power Plants

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1. Nuclear power in China and EU
2. Safety research in China and EU
3. China-EU Collaboration

## NPP in EU



**Units in operation:**

148

**Electricity production**

33%

**Units under construction:**

6

**Population (millions):**

501

**Area (million km<sup>2</sup>):**

4,32

*Status: March 2010*

# NPP in China (Mainland)

*Status: September 2008*

**Units in operation:**

11

**Electricity production**

< 2%

**Units under construction & planning**

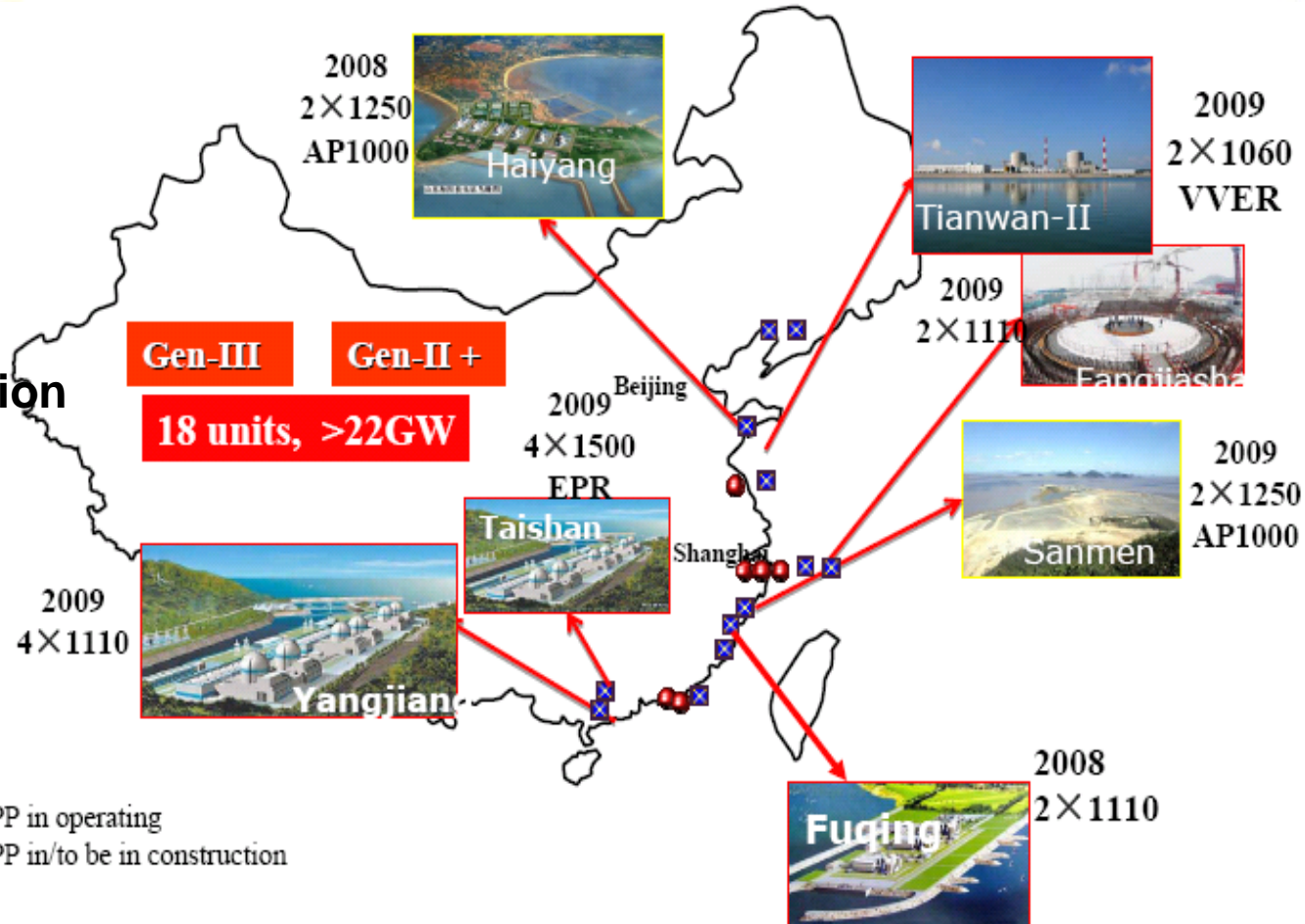
≈ 30

**Population (millions):**

1,330

**Area (million km<sup>2</sup>):**

9.60



### EU

- Nuclear developed region
- nuclear market saturated ?
- rich in experience, infrastructure
- interested in the Chinese market

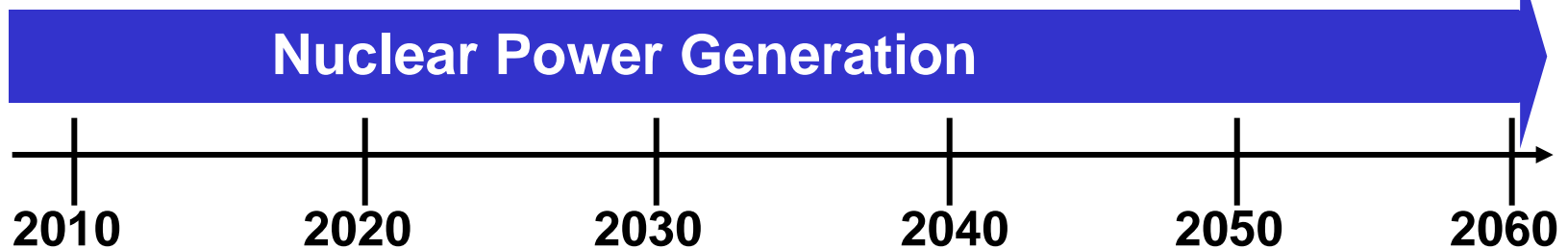
### China

- Nuclear „developing“ country
- huge developing potential
- deficiency in key technologies & research experience
- interested in collaboration with EU

## Nuclear Power Technology

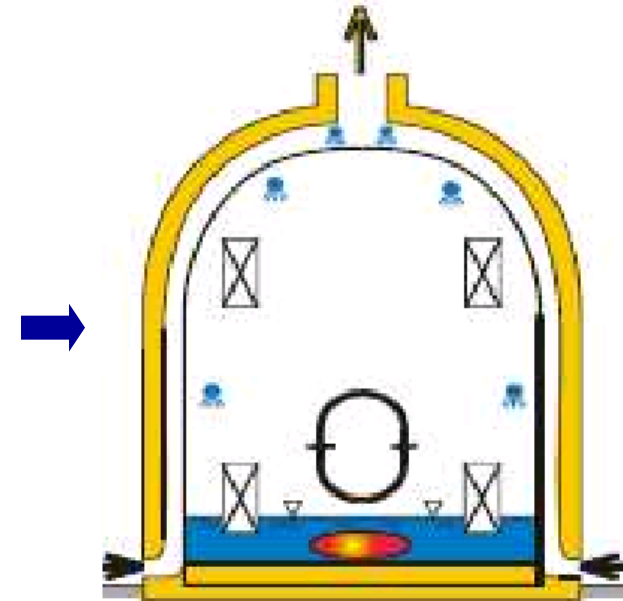
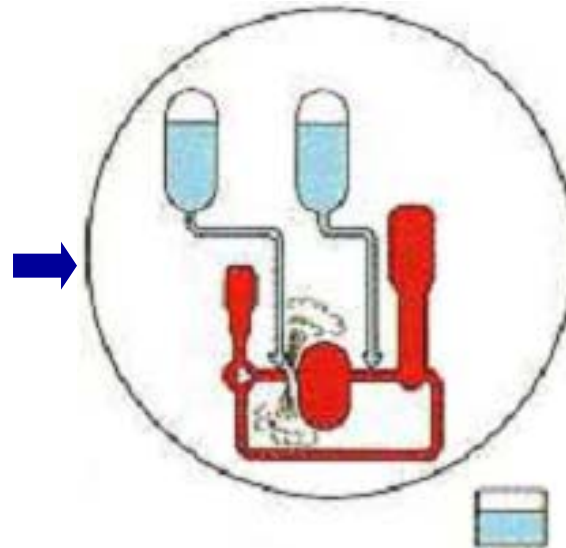
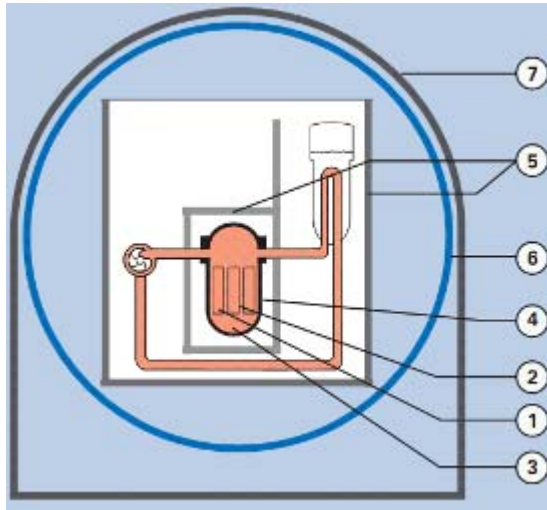


— GEN-III (and/or) GEN-III+ — GEN-IV — Fusion —  
Transmutation



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2. **Safety research in China and EU**
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# What is “Safety of NPP” ?



## Accident prevention

- design methodology
- quality assurance
- life time extension

## Accident mitigation

- safe shutdown
- safety injection SIS
- decay heat removal

## SA mitigation

- core melt allocation
- core melt cooling
- CV integrity

## Why “Reactor safety” ?



### Direct impacts

- ✓ about 30 death
- ✓ large radioactive release
- ✓ public opinion
- ✓ recession for decades

### Lesson learned

- ✓ extensive safety research
- ✓ international collaboration



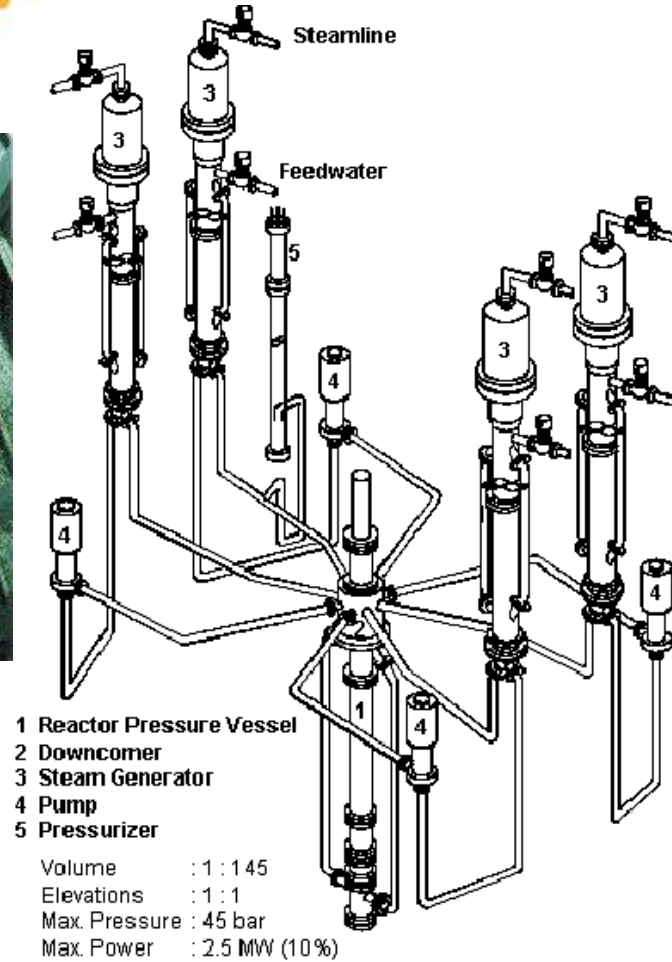
- ✓ Safety plays the most important role in China
- ✓ Interests in bilateral collaboration EU & China

## Situation of safety research

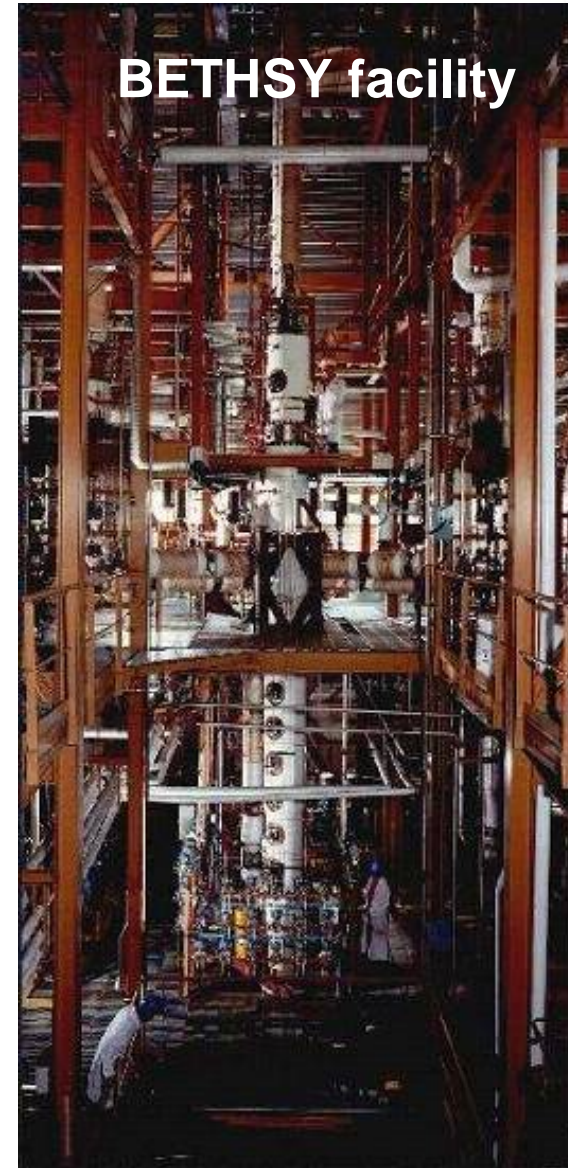
	Accident Prevention	Accident mitigation	SA mitigation
<b>EU</b>	<ul style="list-style-type: none"> <li>- many R&amp;D for GEN-II &amp; III</li> <li>- life time extension as important task</li> </ul>	<ul style="list-style-type: none"> <li>- large amount work in 1980's &amp; 1990's</li> <li>- several integral facilities available PKL, BETHSY</li> </ul>	<ul style="list-style-type: none"> <li>- extensive R&amp;D since 1990's</li> <li>- based on ex-vessel core catcher (EPR)</li> <li>- active systems as key measures</li> </ul>
<b>China</b>	<ul style="list-style-type: none"> <li>- limited R&amp;D in the past &amp; mainly for GEN-II NPP</li> <li>- interests in life time extension</li> </ul>	<ul style="list-style-type: none"> <li>- Technology „imported“</li> <li>- separate &amp; integral test facilities under planning</li> <li>- passive as key systems</li> </ul>	<ul style="list-style-type: none"> <li>- R&amp;D program initiated</li> <li>- based on IVR</li> <li>- passive as key measures</li> <li>- extension to large power NPP</li> </ul>



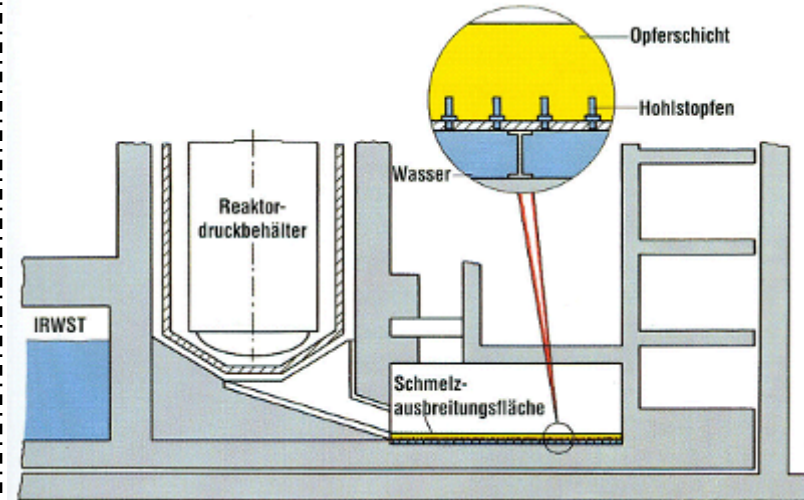
**PKL facility**



**BETHSY facility**



## Some facilities in EU



← KATIS facility

COMET facility →



## Some SA related phenomena

Phenomena	EU	EU / China	China
	How much was done	How much we know	How important
Core melt process	●	●	●
Core melt properties	●	●	●
Melt pool behavior	●	●	●
IVR	●	●	●
ExV Core catcher	●	●	●
FCI	●	●	●
Hydrogen	●	●	●
Containment	●	●	●

*Personal opinion*



### Active system

- flexible to realize
- large range of capability
- human factor



### Passive system

- Limited capability
- High reliability
- Minimize human factor

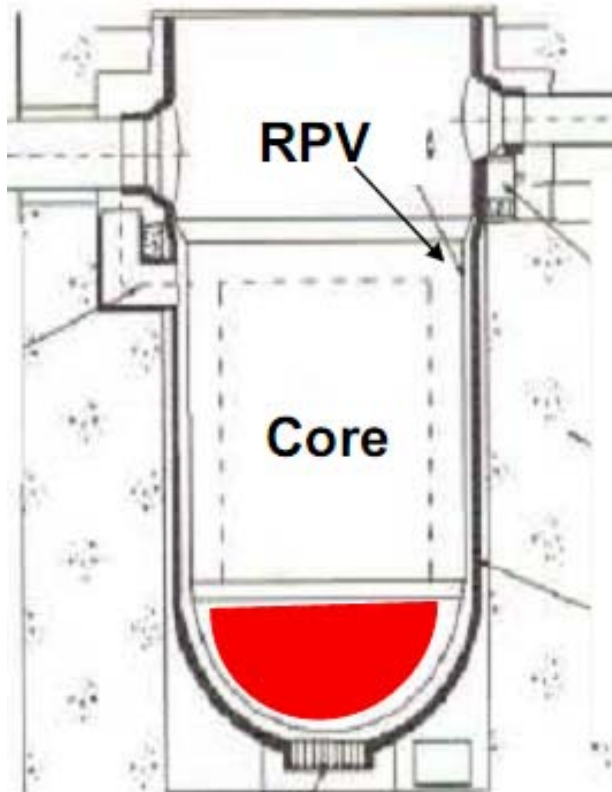
### ➤ Existing activities

- SA fundamental studies, e.g. steam explosion
- SA scenarios and mitigation measures analysis, e.g. IVR
- PSA & Risk monitoring
- SA numerical code & simulator development

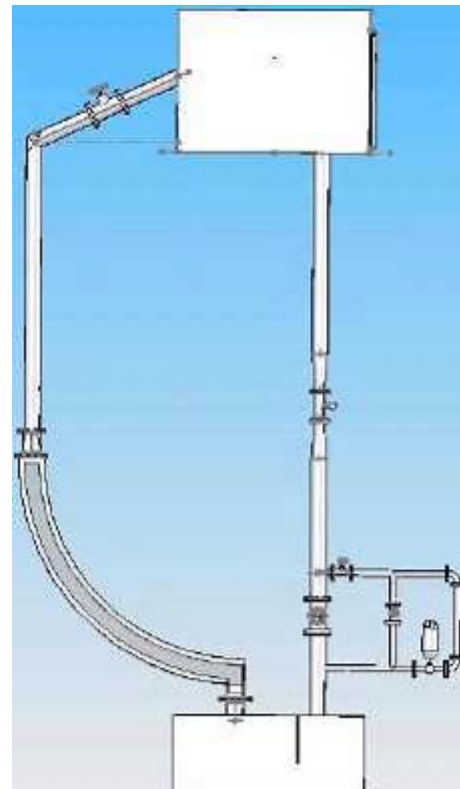
### ➤ Future activities

- Large national programs initiated
- New PSX technology for large scale PWR

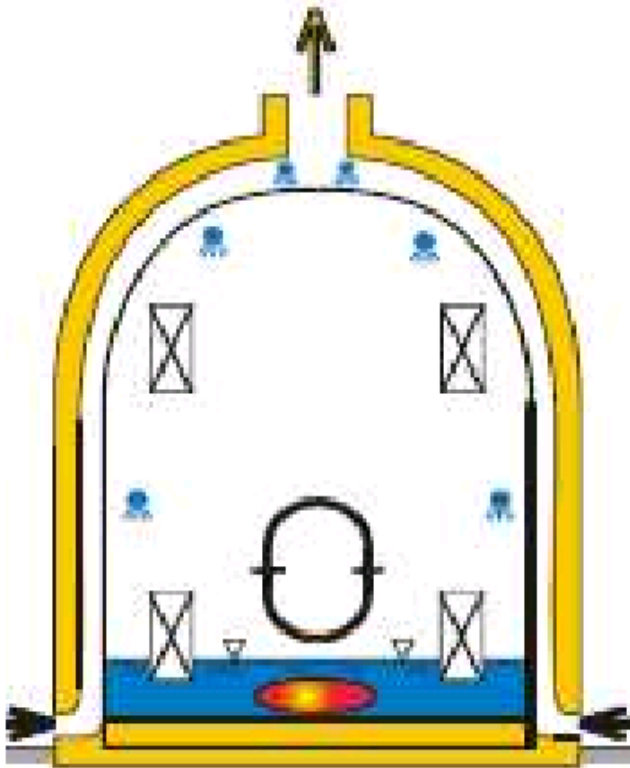
## IVR of advanced PWR



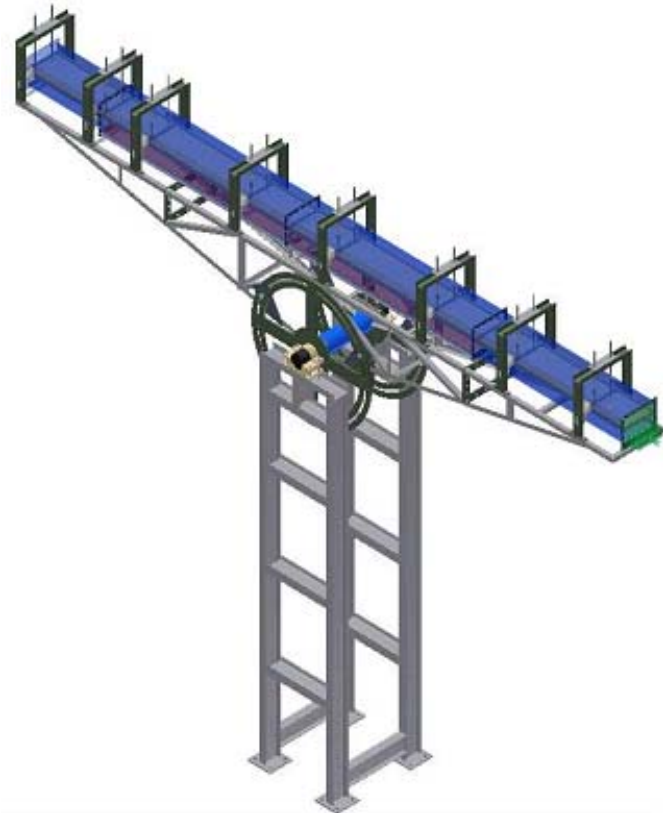
## REPEC facility at SJTU



## PCCS of advanced PWR



## MICARE facility at SJTU



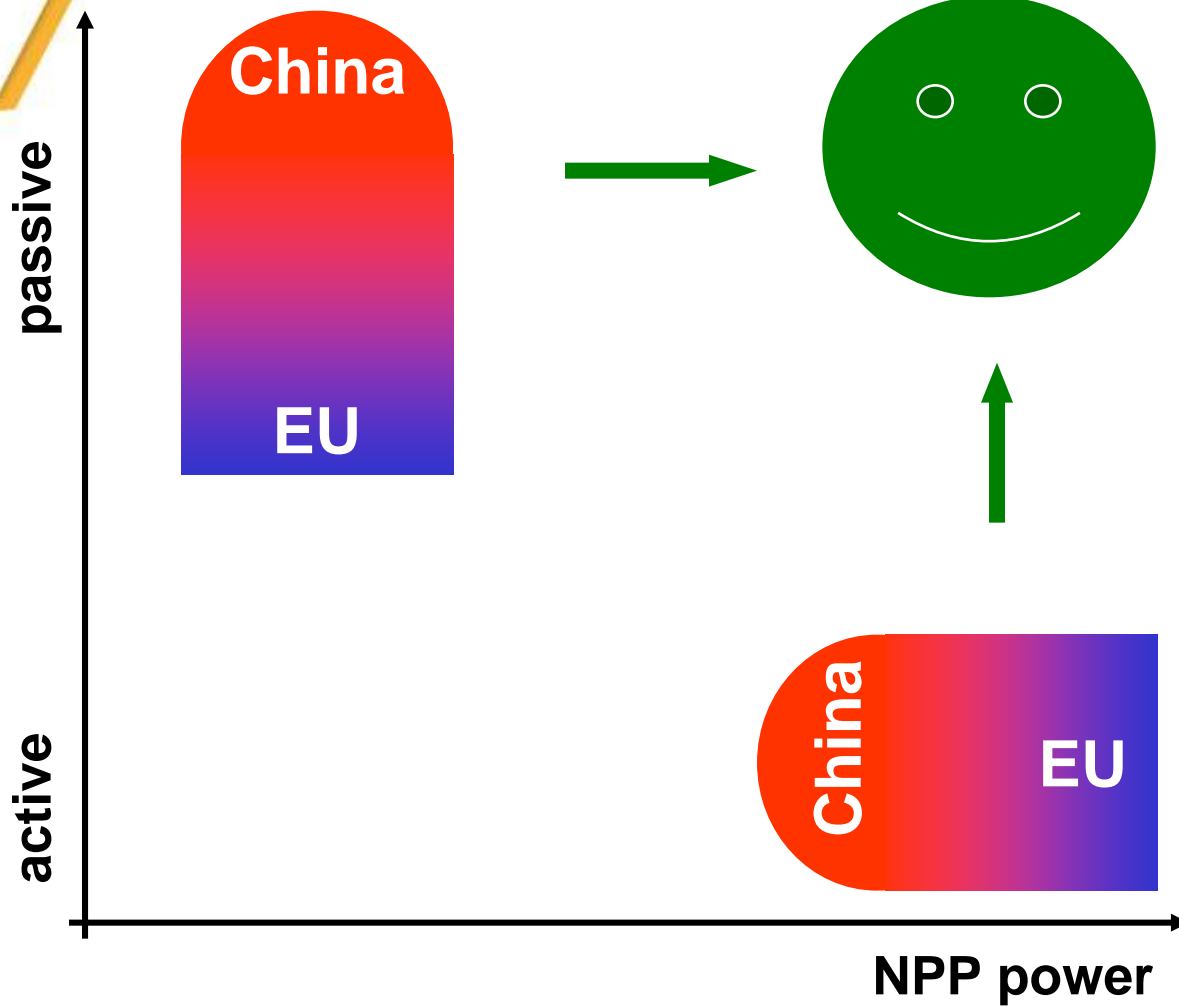
## WAFIP facility

## MICARE facility



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## Future collaboration





## China-EU collaboration

- ✓ **Agreement between CAEA and EURATOM:**
  - April 2008
- ✓ **Workshops on bilateral collaboration:**
  - February 2009 in Beijing & Shanghai
  - March 2010 in Beijing & Chengdu
- ✓ **Topics identified in the 1st phase:**
  - Level 2 PSA and severe accident management for GEN-III
  - Emergency management for the medium and late phase
  - Coupled code validation
  - Access to large Infrastructures in China and Europe



## Co-organized Workshop

- **International workshop on Passive Safety Systems in Advanced PWRs , Shanghai , April 28-30, 2008**

**Co-organized by**



**International Workshop on Passive Safety Systems in Advanced PWRs (IPASS' 08)**  
April 28–30, 2008, Shanghai Jiao Tong University , Shanghai, China





## In the frame of international exchange

- **8<sup>th</sup> International Topical Meeting on Nuclear Thermal-Hydraulics, Operation and Safety, Shanghai , October 10-14, 2010**

### Some highlights related to “Safety”:

- Total number of papers:  $\approx 300$
- Number of papers in topic “Safety”:  $\approx 100$
- Papers from EU:  $\approx 65$
- Panel session: “Challenges in Safety Research”  
with European panellists
- Keynote Lectures from European Union  
“Nuclear safety research & challenges”  
“Overview on research programme in European Union”

***Welcome to NUTHOS-8 !!***



*Thanks !*

