



ÚJV Řež, a. s.

# Support of nuclear safety by modeling and study of hypothetical severe accidents of VVER nuclear reactors

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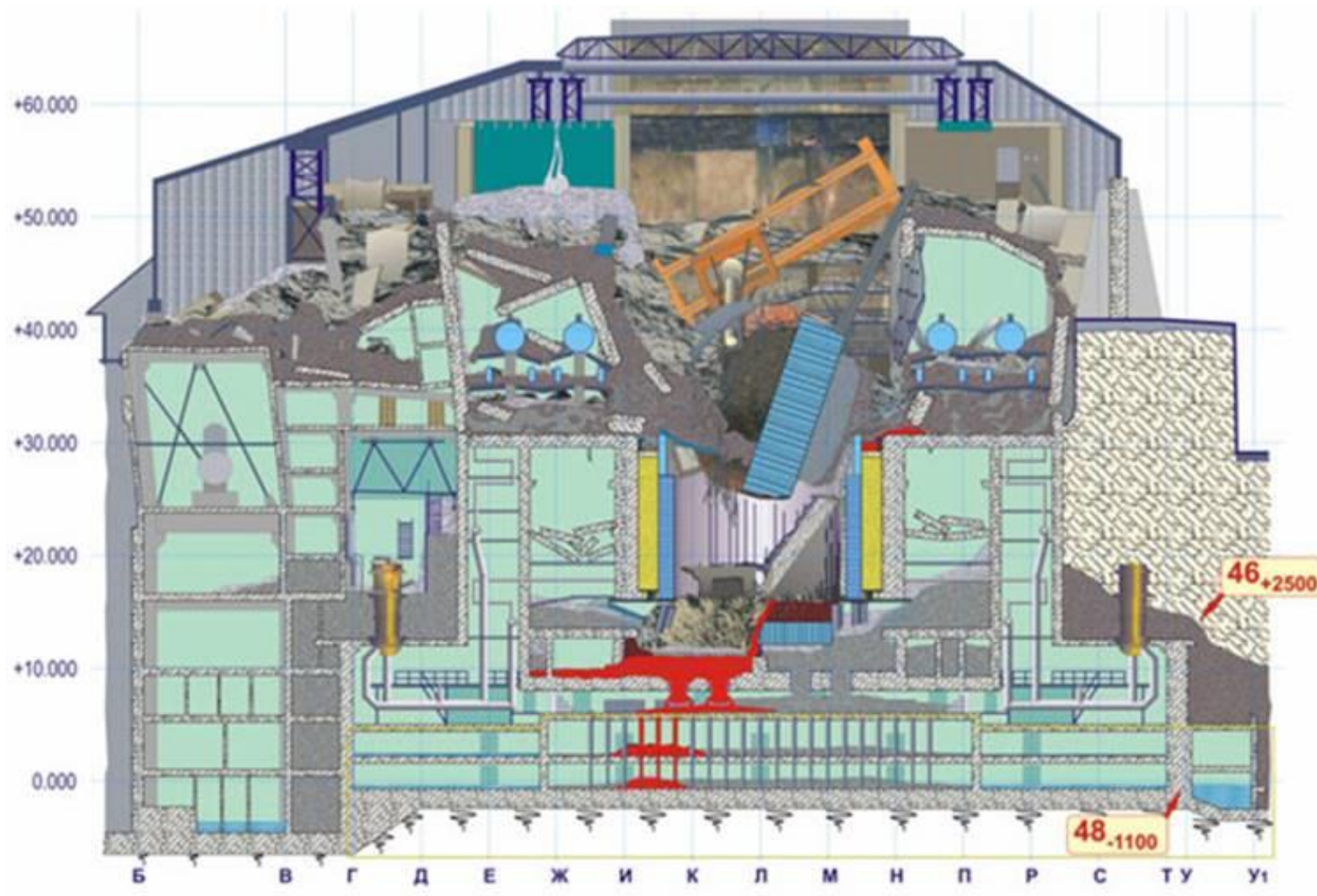
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- **Severe accidents**
  - **Equipment of melt localization (Core catcher)**
  - **Experimental device**
  - **Results**

# History of severe accidents

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- Three Mile Island – unit 2 (1979)
- Chernobyl – unit 4 (1986)
- Fukushima I – units 1-4 (2011)

# History of severe accidents



**Fig. 1: Chernobyl unit 4 after failure**

# History of severe accidents



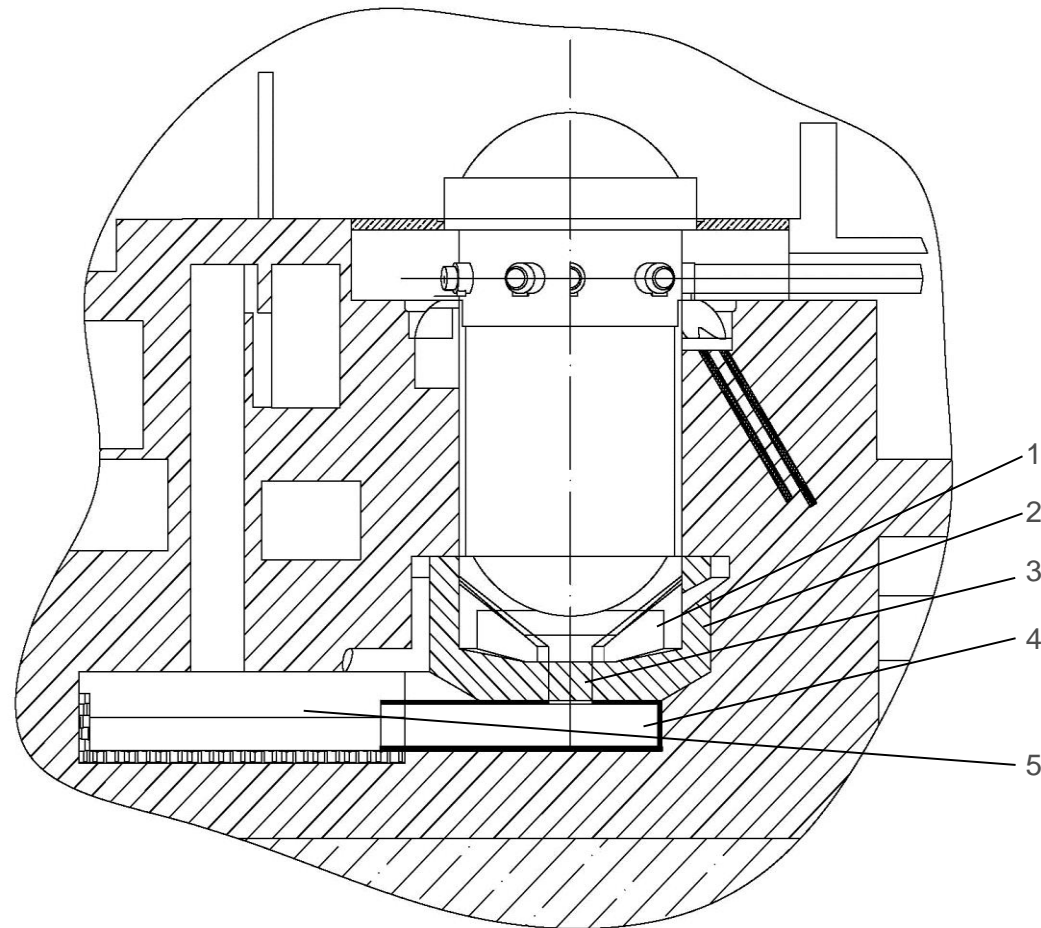
**Fig. 2: Fukushima I severe accident**

# Equipment of melt localization

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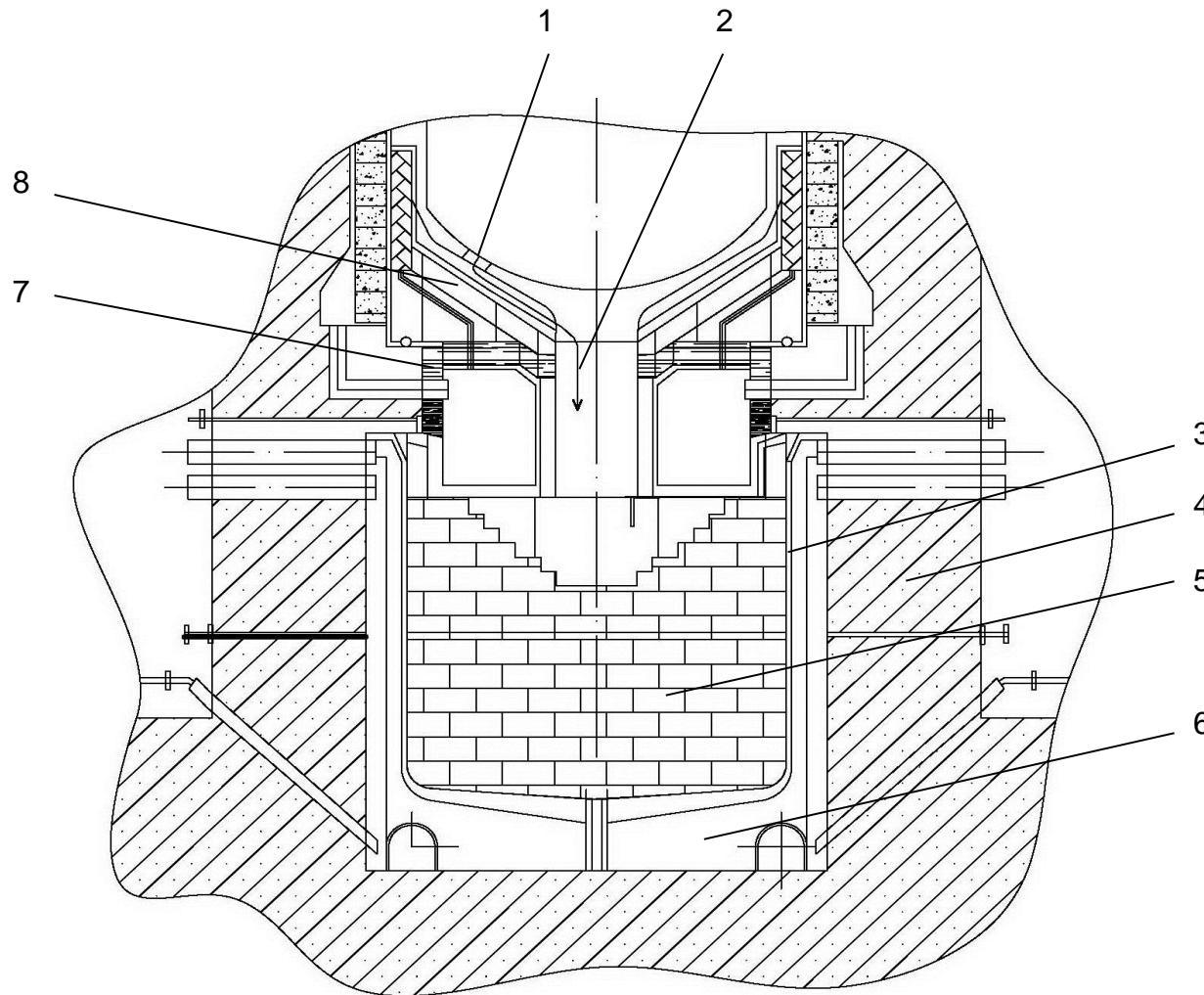


- Retention of active zone melt in reactor vessel
- Spreading of corium melt on a large horizontal area out of concrete reactor pit with consecutive melt cooling (EPR design)
- Retention of corium melt in water-cooled metallic vessel situated in concrete pit under the reactor space (VVER design)



**Fig. 3: EPR design of core catcher**

1 – space of concrete shaft situated under-reactor spreading room; 2 – sacrificial material; 3 – fusible plug; 4 – inclined channel ; 5 – space of melt localization



**Fig. 4: VVER design of core catcher**

1 – assumed point of reactor vessel break; 2 – direction of the corium movement; 3 – body of EML; 4 – concrete pit; 5 – sacrificial material; 6 – heat exchanger; 7 – thermal-insulating shield; 8 – reinforced concrete slab



# Study of hypothetical severe accident

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## Cometa facility

- High temperature melting device
- Cold crucible
- Induction heating
- Maximum 3000 °C of sample
- Maximum output power 60 kW
- Maximum frequency of generator 4,5 MHz



**Fig. 5: Cometa facility**



**Fig. 6: Cold crucible**



**Fig. 7: Cold crucible with final product**

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## Previous

- ECOSTAR – International (EU) *1999-2003*
- BARRANDE – International (Czech-France) *2006-2007*
- ECONET – International *2008-2009*
- SARNET – International (EU) *2004-2008*
- SARNET 2 – International (EU) *2009-2013*
- KONTAKT – National (Czech) *2007-2010*

## Present

- KONTAKT 2 – National (Czech) with the Russian cooperation *2012-2015*

## Future

- NUGENIA – International (EU) *2014?*

# Studied systems

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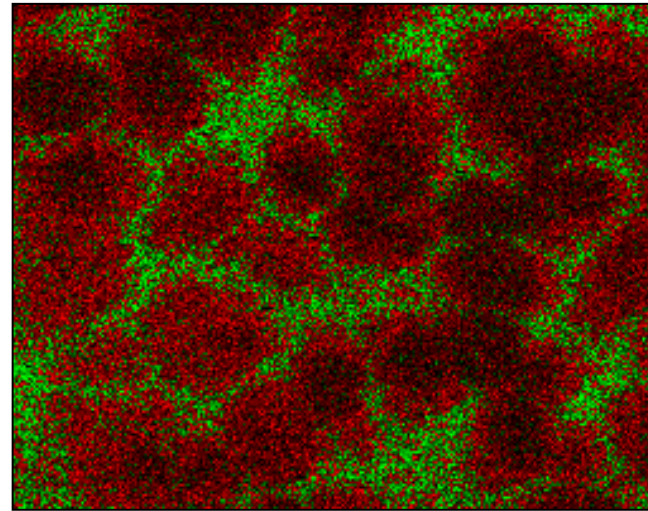
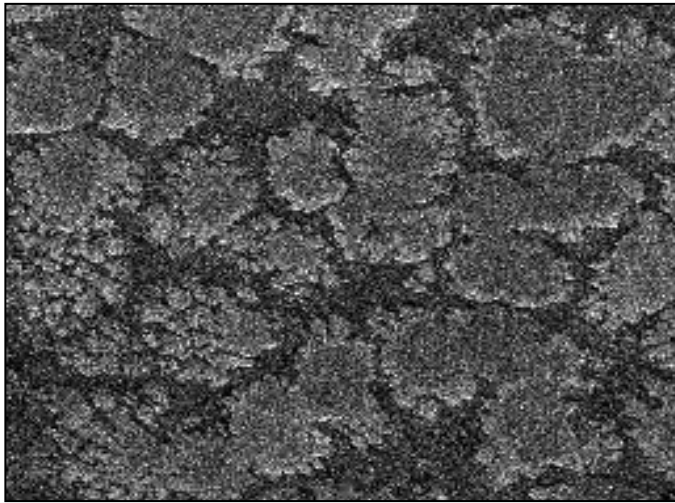
- U-O
- U-Zr-O, U-Si-O, U-Fe-O
- U-Zr-Fe-O
- U-Zr-Fe-Cr-O, U-Zr-Fe-Ca-O
- U-Zr-Fe-Ca-Si-O
- U-Zr-Fe-Ca-Si-Al-O

# Performing analyses

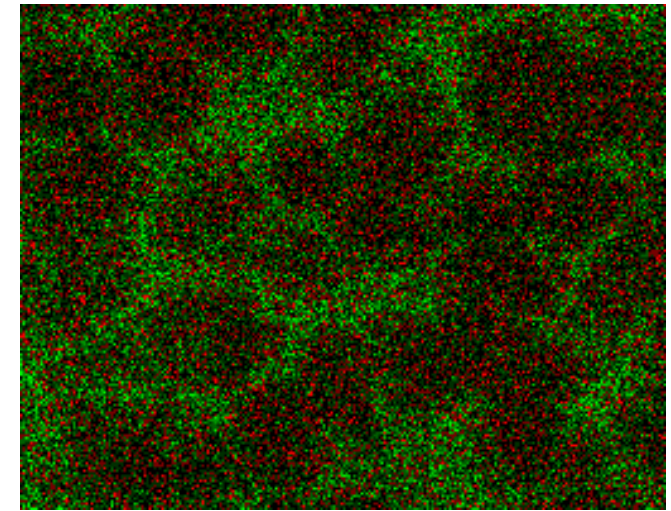


## SEM EDX

(mapping)

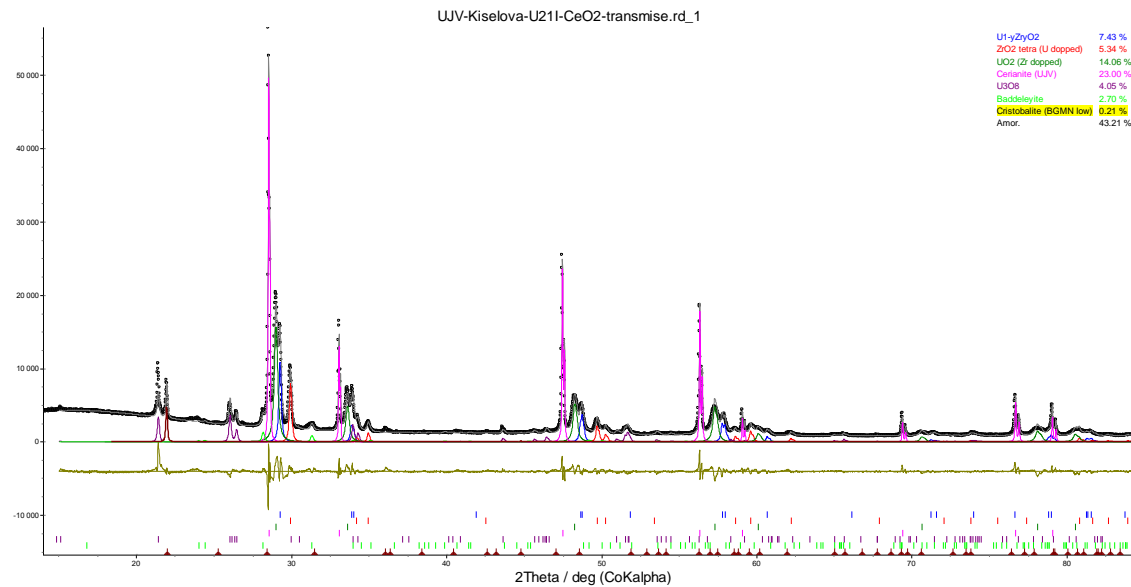


U - Si



Fe - Ca

## X-ray



## The aims of our studies

- **Obtaining of new data within the research of hypothetical severe accidents**
- **Interpretion of non-standard phenomena observed during the experiments**
- **Construction of phase diagrams of multicomponent systems**

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**Thank you for your attention**