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# Horizon-2020 ESFR-SMART project on Sodium Fast Reactor Safety: status after 18 months

ESFR-SMART
sodium fast reactor safety


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## Summary

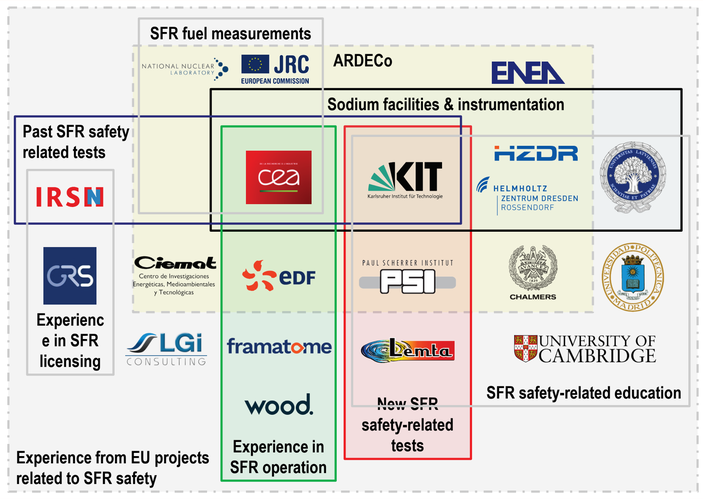

The Horizon-2020 ESFR-SMART project (**European Sodium Fast Reactor Safety Measures Assessment and Research Tools**) aims at enhancing further the safety of Generation-IV SFRs and in particular of the commercial-size European Sodium Fast Reactor (ESFR) in accordance with the European Sustainable Nuclear Industrial Initiative (ESNII) roadmap.

Selected results and milestones achieved during the first 18 months of the project are briefly reviewed.


## Objectives

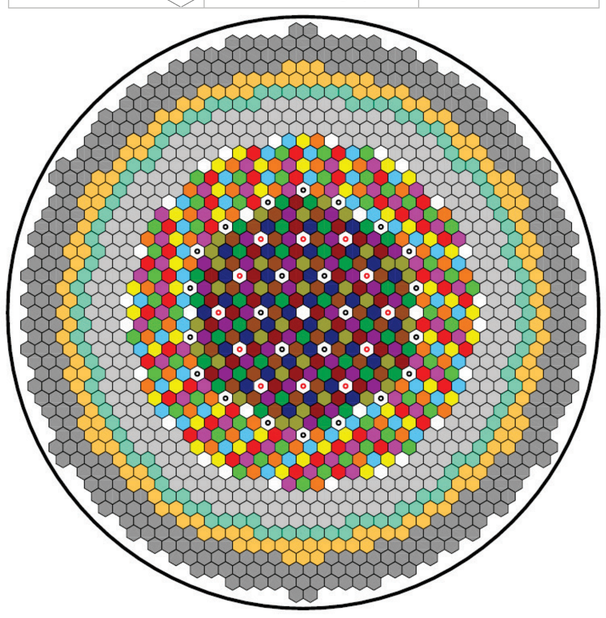
1. Produce new experimental data to support calibration and validation of the computational tools for each defence-in-depth level.
2. Test and qualify new instrumentations to support their use in protection system.
3. Perform further calibration and validation of computational tools for each defence-in-depth level to support safety assessments of Generation-IV SFRs.
4. Select, implement and assess new safety measures for commercial-size ESFR, using GIF methodologies, FP7 CP-ESFR project legacy, calibrated and validated codes and being in accordance with European and international safety frameworks taking into account the Fukushima accident.
5. Strengthen and link together new networks: of European sodium facilities and of European students working on SFR technology.

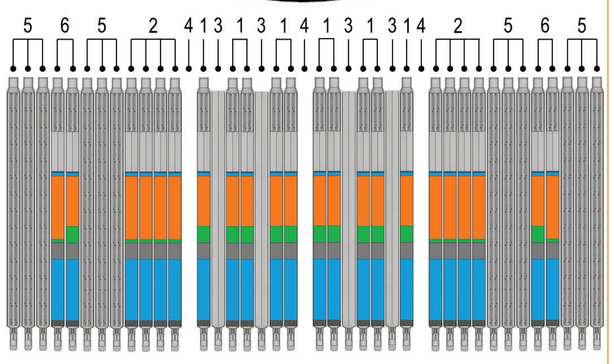
## Partners and relevant expertise




## WP1.1&1.2 New core design: done

| | | |
|---|---|---|
| 1 2 3 4 5 6 | Inner zone SA | 6 batches×36 = 216 |
| 1 2 3 4 5 6 | Outer zone SA | 6 batches×48 = 288 |
| | CSD / DSD | 24 / 12 |
| R1 R2 R3 | Reflector rings | 66 / 96 / 102 |
| S1 | Spent inner fuel storage | 3 batches×36 = 108 |
| S2 | Spent outer fuel storage | 3 batches×48 = 144 |
| | Corium discharge path | 31 |

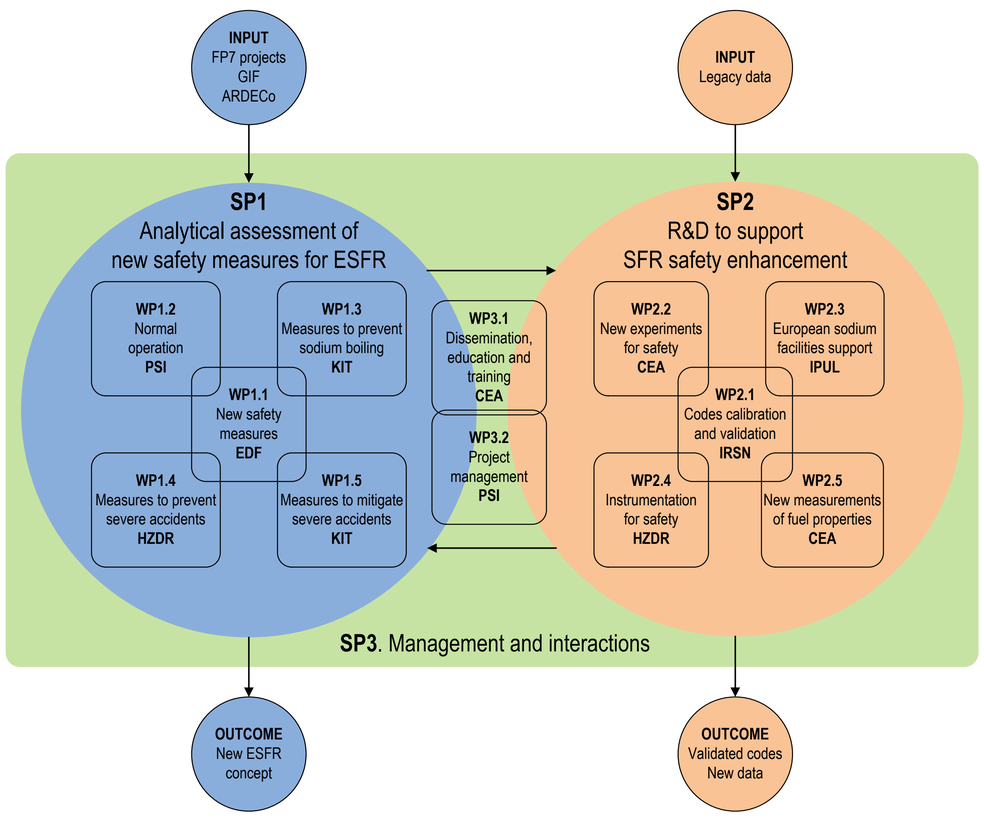




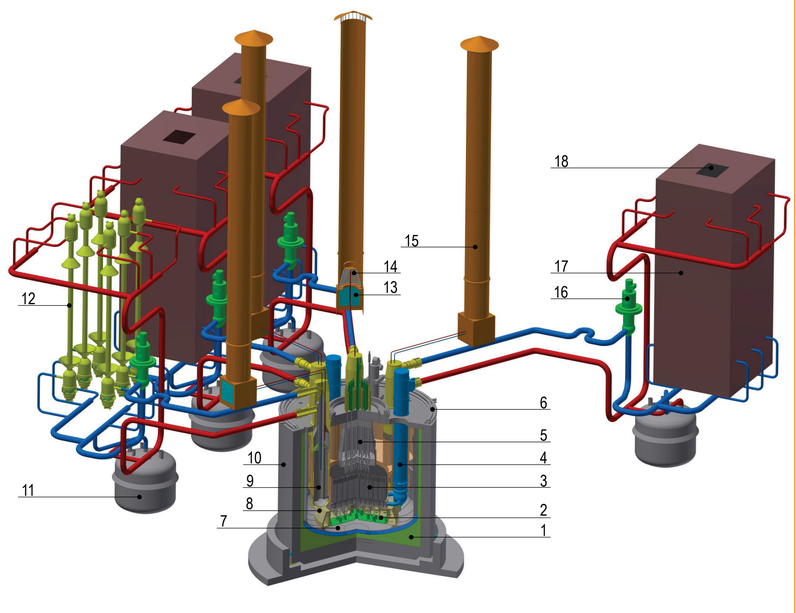

1 – Inner zone SA
2 – Outer zone SA
3 – Control assembly
4 – Corium discharge path
5 – Shielding SA
6 – Internal spent fuel storage

Fissile fuel (~18% Pu content)
Fertile blanket
Steel blanket
Fission gas plenum
Sodium plenum
Shielding (absorber)

- Fissile fuel with the same Pu content
- Pan-cake shape and large sodium plenum (low-void)
- Perfectly symmetric
- 6-batch mixed reloading scheme (no reshuffling)
- Internal spent fuel storage for 50% of core loading
- Corium discharge channels
- Curie-point activated locks for all safety (DCD) rods



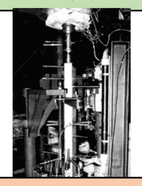
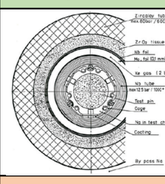
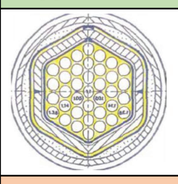
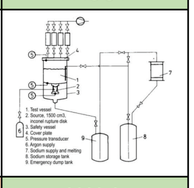
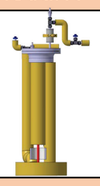
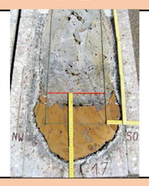
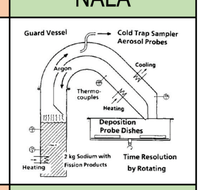
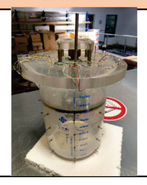
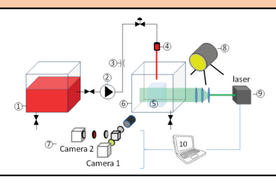
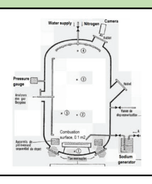

## WP1.1&1.3 New reactor design: done



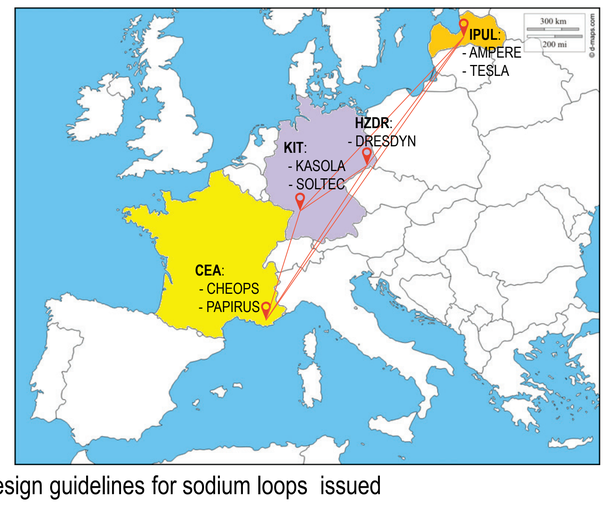

1: Insulation with steel liner
2: Core catcher
3: Core
4: Primary pump
5: Above-core structure
6: Pit cooling system (DHRS-3)
7: Main vessel
8: Strongback
9: IHX
10: Reactor pit
11: Secondary sodium tank
12: Steam generator
13: Window for air circulation (DHRS-1)
14: Sodium-air HX (DHRS-1)
15: Air chimney (DHRS-1)
16: Secondary pump
17: Casing of SGs (DHRS-2)
18: Window for air circulation (DHRS-2)

- Core catcher with corium discharge tubes
- Hydraulic diodes at the pump outlet
- DHRS-1 connected to IHX and using secondary sodium as working fluid
- Use of passive thermal pumps in secondary and DHRS-1 circuits
- DHRS-2 uses air circulation through openings in SG casing and heat removal from the SG surfaces
- Suppression of reactor dome and safety vessel
- Insulation with metallic liner on it instead of safety vessel
- Minimization of the reactor vessel-pit gap, still large enough for inspection
- Two reactor pit concrete cooling systems (oil and water) suitable for decay heat removal (DHRS-3)

## WP2.1 & 2.2 Legacy and new tests: on-going

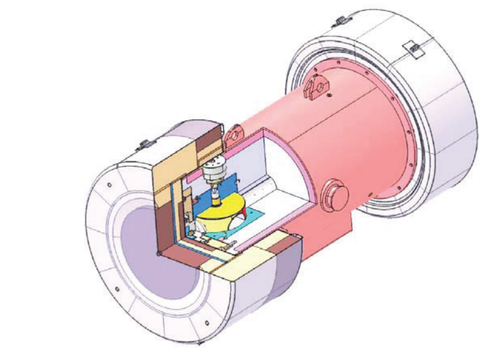
| Normal operation | Sodium boiling | Severe accident (SA) management | | SA mitigation |
|---|---|---|---|---|
| Superphenix | KNS-37 | CABRI | SCARABEE | FAUST |
|  |  |  |  |  |
| KASOLA | KARIFA | LIVE | JIMEC | NALA |
|  |  |  |  |  |
| ECFM | CHUG | HAnSOLO and JEDI | | FANAL |
|  |  |  | |  |

## WP2.3 Network of EU sodium loops: ongoing




- Design guidelines for sodium loops issued

## WP2.5 Fuel transportation: done



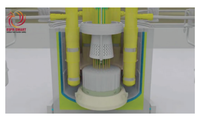
Transportation of fresh and irradiated fuel samples from CEA Cadarache to JRC-ITU with casks TNBGC and IR100.

## WP3.1 & 3.2 Education & management: on-going

- 140+ people working together
- Two project meetings: kick off in Brussels and progress in Riga
- Workshop in Rome “Sodium facilities design and safe operation”
- ~40 technical meetings
- 8 PhD studies on-going
- 3 MS thesis done

Project website
http://esfr-smart.eu


Project video:
https://youtu.be/Blay03wdoTI



LinkedIn:
https://www.linkedin.com/groups/8643038/

Twitter:
https://twitter.com/ESFR_H2020

## Conclusions

Project is ongoing according to the work program: 13 deliverables issued, 12 milestones reached, 14 conference papers and 3 MS thesis published.


The project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 754501