SEAKNOT

Validation Data Base Directory

Martin Freitag

First Open Workshop of the SEAKNOT Project

2nd October 2025

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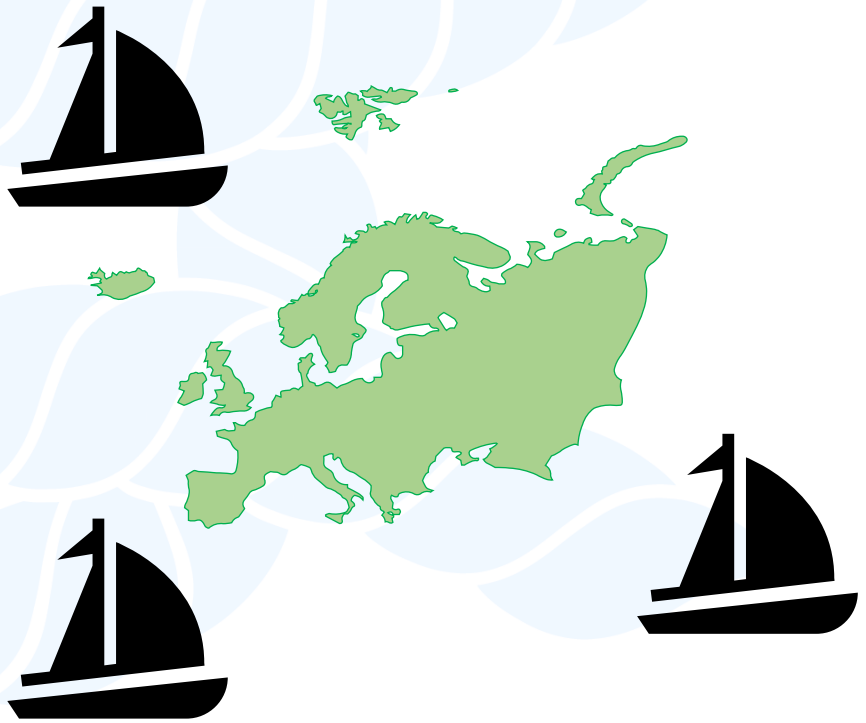
BECKER TECHNOLOGIES

Agenda

- Background and Motivation for VADD
- What is SEAKNOT's VADD
- Our Approach
- Expected Outcome
- Benefit for the Community
- Status and Future Applications



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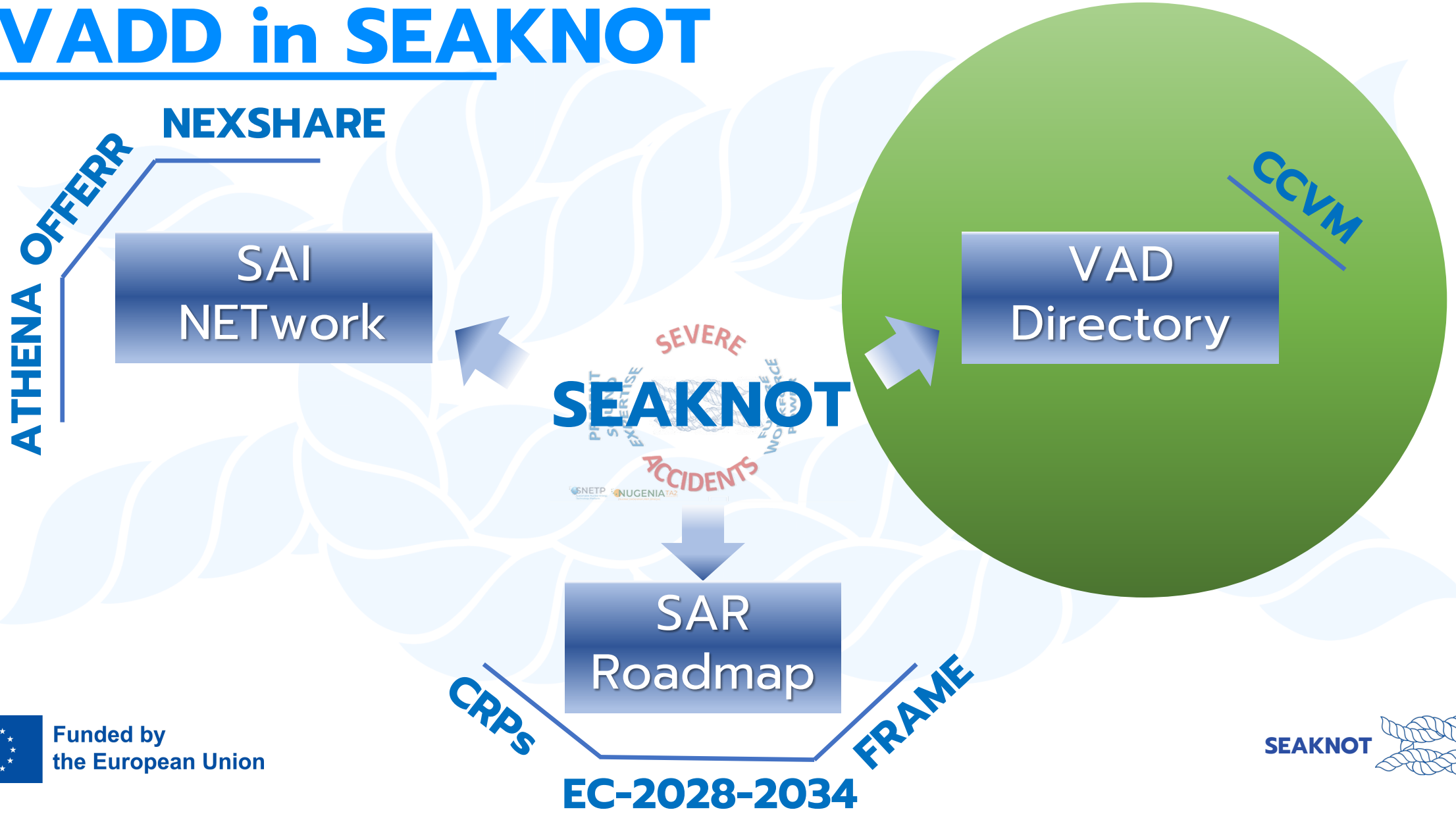
VADD in SEAKNOT



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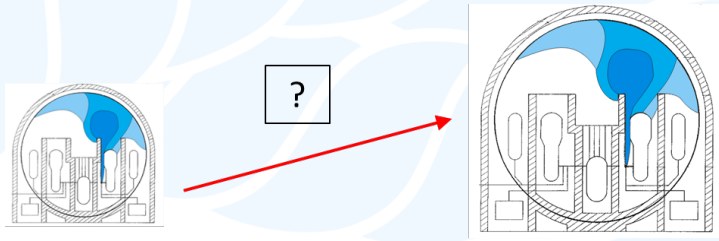
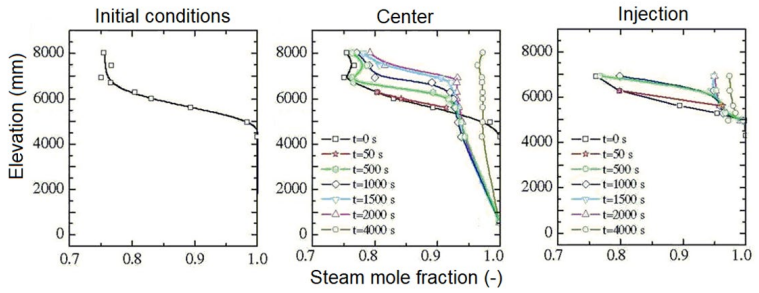
Background

- Mitigation and prevention of severe accidents by code analysis
- Issues and challenges:
  - Adequate models
  - Scaling with length and time
    - spatially resolved and instantaneous description (CFD)
    - lumped-parameter description (averages over control volumes)
  - Adequate data for validation is required
    - Experiments mostly necessary for validation of codes
    - based on steady-state/transient data
    - What data are available?
    - Are data suitable for validation?





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Motivation for VADD

- Severe accidents dominate the risk associated with NPPs
- Codes have been developed, merged and maintained
- Research done for decades and large amounts of data generated
- Future of SA research face challenges:
  - Need for archiving and preservation of existing data/knowledge
  - Infrastructure and workforce are « not on the rise »
  - Loss of specialists
  - New modeling approaches being explored (UaSA; AI)
  - New technologies (LW-SMRs; ATFs) shall benefit from the work done
  - Method to be established (what, how & where) with capable workforce

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What is the SEAKNOT mission with VADD

- Data base for validation and code development (w/o data itself)
- Sound analysis of the current knowledge
- Establish standards which are sustainable
- This shall also identify forthcoming research needs
- We strengthen background and skills of young generations

Mission

Efficiently mitigate and practically eliminate SA consequences

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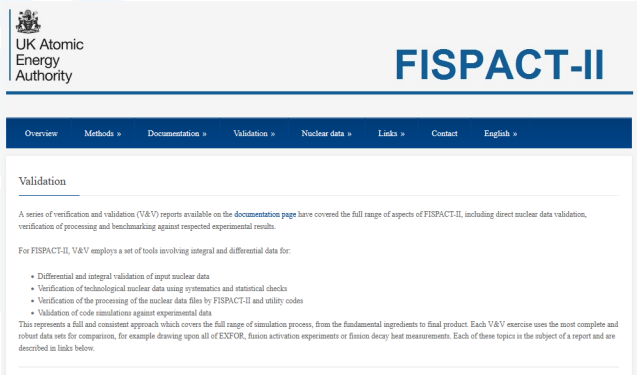
Why are existing databases not enough

- Mostly based on « expert's opinions»
- Need of a soundly supported & integrated roadmap
- Cover the entire Severe Accident Domain
- Vast background needs a pathway through the labyrinth of experiments and data
- Qualified experimentation is in SA research
- Some of the data is outdated
  - Codes and their needs have evolved
- Consider data base to fit innovation
  - ATFs; Light water SMRs



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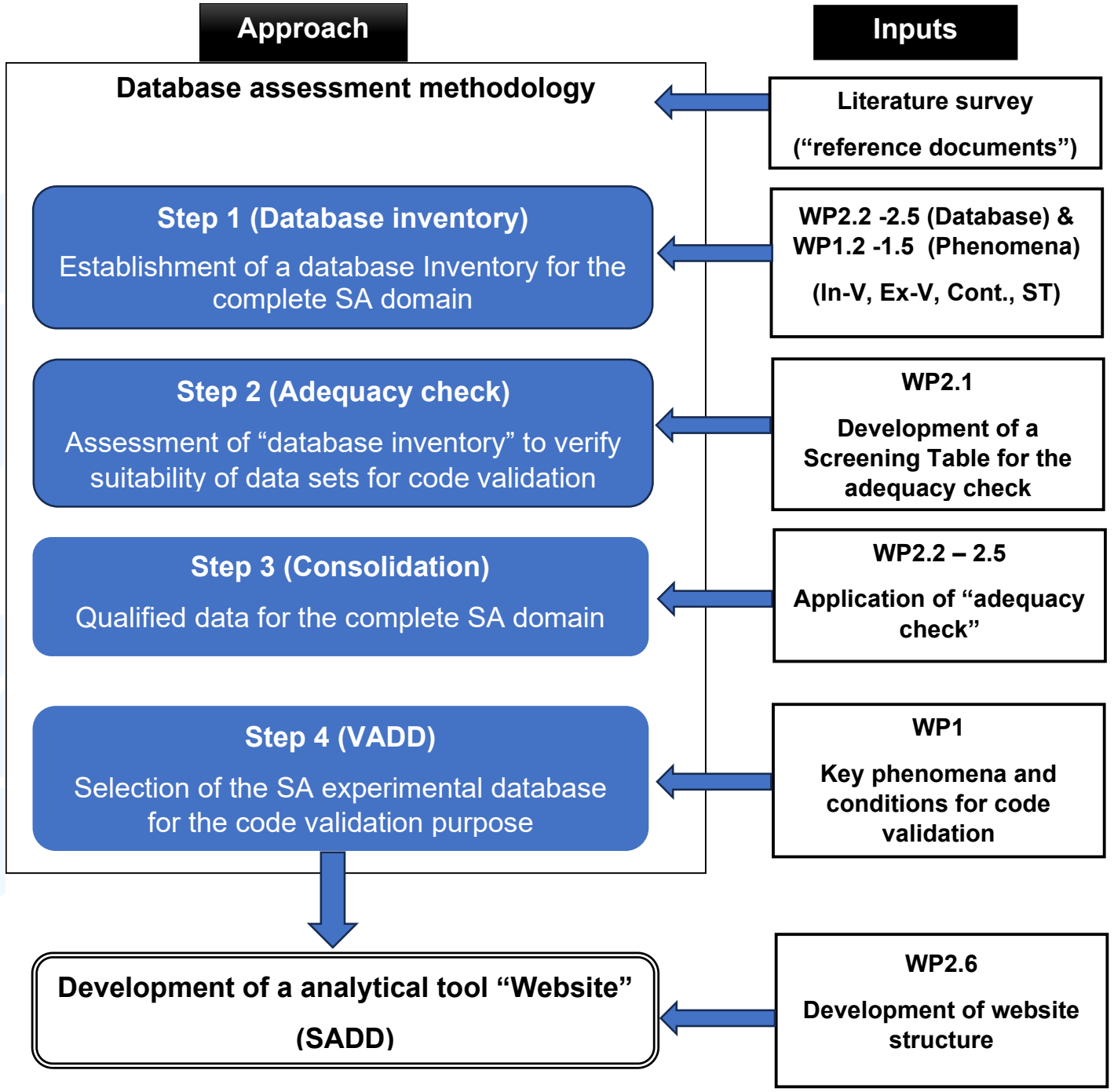
SEAKNOT Approach

- SEAKNOT VADD entries
  - Phenomena
  - Test ID
  - Test facility
  - Validation category
  - Reference
  - Contact information
- Contributors (14):
  - BT, CEA, CIEMAT, ENEA, FRAMATOME, FZJ, ASNR, JSI, KIT, KTH, PSI, UNIPI, UPM, VTT



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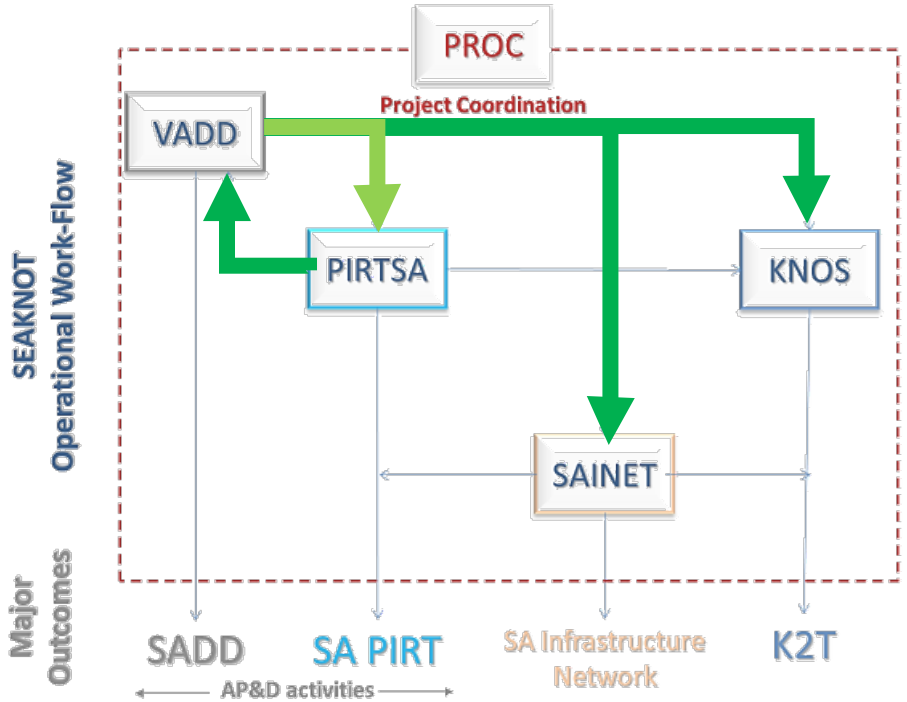
Distribution of Work

- Method development (All)
- Individual data-bases with focus on:
  - In-vessel WP2.2 (responsibility: KIT)
  - Ex-vessel WP2.3 (responsibility: CEA)
  - Containment WP2.4 (responsibility: JSI)
  - Source term WP2.5 (responsibility: BT)
  - SADD WP2.6 (responsibility: UNIPI)
- This deploys high level of expertise by the domain leaders in their major fields
- "Solid method" allowed for parallel execution!!!



WP1 PIRTSA	Phenomena Identification Ranking Table
WP2 VADD	Validation Database Directory
WP3 SAINET	Severe Accident Infrastructure NETwork
WP4 KNOS	Knowledge Spreading
WP5 PROC	Project Coordination

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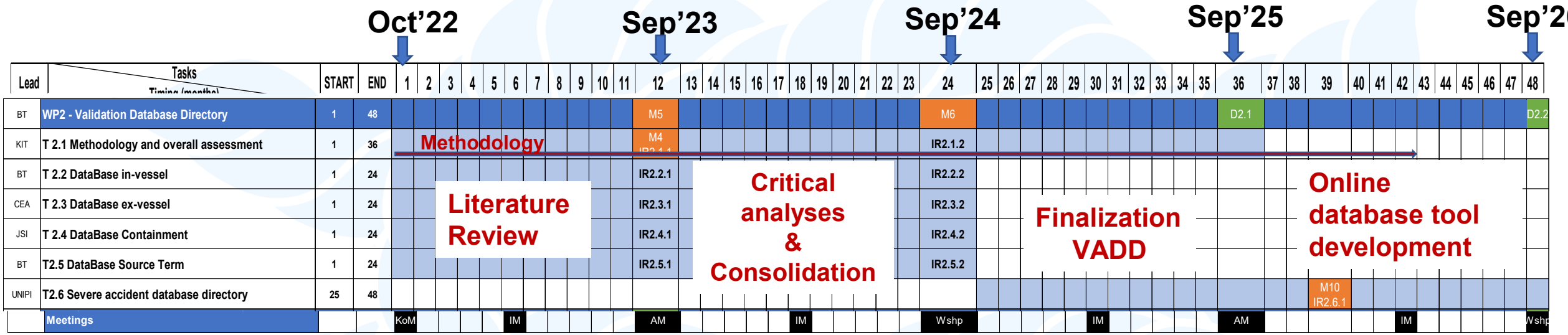
Time schedule



WP 2.1(8): BT, CEA, CIEMAT, ENEA, ASNR, JSI, KIT, UNIPI (completed already)
WP 2.2 (4): CEA, ENEA, **KIT**, KTH
WP 2.3 (5): **CEA**, FRAMATOME, JSI, KIT, KTH
WP 2.4 (7): BT, CIEMAT, FZJ, ASNR, **JSI**, PSI, UPM
WP 2.5 (7): **BT**, CEA, CIEMAT, ENEA, ASNR, PSI, VTT
WP 2.6 (8): BT, CEA, CIEMAT, ENEA, ASNR, JSI, KIT, **UNIPI**

Database Release 2026

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“Methods & Assessment” WP2.1

- Create the database with link to PIRT phenomena
  - allow “easy” access to needs, e.g. code development
- Limit the database from infinite entries
  - high level PIRT are considered primarily
- Data not stored for download, but VADD establishes a link:
  - Reference open access documentation (publication, reports)
  - Existing and operating test facilities and experimental teams/programs
  - Evaluate the adequacy of the data for a given phenomena
- Synchronize/exchange with references (e.g. CCVM, IPRESCA)
  - Prevent duplication of work as best as it gets

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“Methods & Assessment” WP2.1

- Adequacy check for database selection (“Screening Table”)

Test ID:
Test facility:
Organisation name:

Database information	Availability	
	yes	no
1. Availability of documentation		
Publications (journal, conference, etc)		
Worksop/conference proceedings		
Project summary reports (public)		
Confidential		
2. Test facility specific information		
Target design - specific (e.g. reactor type)		
Target design - generic		
Scaling - phenomena		
Scaling - geometry		
No Scaling		
3. Type of experiment		
Separate effect test (SET)		
Coupled effect test (CET)		
Integral test (IT)		

Test ID:
Test facility:
Organisation name:

Database information	Availability	
	yes	no
4. Test specific information		
Clear mention of test initial and boundary conditions		
Test conditions - "representative" for reactor scale		
Test conditions - fundamental aspects		
Availability of the test protocol/procedure		
5. Instrumentation & Measurement Techniques		
Test outcomes - direct measurements		
Test outcomes - estimated parameters from measurements		
CFD-grade data (e.g. high spatial resolution)		
Reporting of measurement uncertainties		
6. Data application		
Model development		
Model validation		
Code-to-experiment benchmarking		
Reactor Analysis		

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WP2.1 Application

- Critical review of consolidated VADD for
  - Completeness
  - Representativeness
- Application:
  - Data covering experiments across a **parameter range of interest for SA modeling** validation considering **WP-1: InV-CONT-ST and ExV-CONT-ST**
  - Data **already part of Verification and Validation (V&V) matrices** of major safety analysis codes or used for code for code-to-experiment benchmark exercises.
  - **CFD-grade data** relevant to phenomena covered in the above-mentioned three categories.
  - Data suitable for validation of **advanced WC-SMRs and near-term ATFs.**

Facility name	Facility description	Test identification	SA-related Topics/Phenomena	Measured parameters	Modelling (parameters laws, physics laws, other…)	Simulation code (name of the code, reference case, qualification, other…)	Link to PIRT
	fission product release.			and discrimination, hydrogen, iodine			
Phebus	Phébus facility at Cadarache operated by ASNR and CEA simulating nuclear reactor accidents to study core melt behavior and fission product release.	FPT-1	FP depletion to surfaces under condensing conditions (non-soluble)	T, p, r.H., Gas conc., FP concentrationn and discrimination, hydrogen, iodine	Radioactive materials exiting the bundle were conveyed through a hot line trace-heated at 970 K to a steam generator simulated by a single inverted U-tube (scaling ratio 1/5000 for the number of tubes) and then to model containment through a cold leg trace-heated at 420 K	AC2, COCOSYS, ASTEC, MELCOR, MAAP	WP-1.5 ST-15
WIND	CsI deposition onto the inner surface of a pipe under typical severe	WAVE/WIND	FP depletion to surfaces under condensing conditions (non-soluble)	FP deposition densities at surfaces	FP depletion on surfaces and resuspension	ART	WP-1.5 ST-15
Marviken	Large scale test facility for reactor safety experiments	Marviken-V Test 1,2	FP depletion to surfaces under condensing conditions (non-soluble)	T, p, FP concentrationn and deposition, range from 25 to 1200 °C	Transport and deposition of aerosols and volatile species in a simulated LWR primary circuit	ECART, AC2, MELCOR, ASTEC, MAAP, GOTHIC	WP-1.5 ST-15
THAI	Technical scale containment test facility (thermohydraulic, hydrogen, aerosol, iodine, 2 vessels 80m3)	Iod-9	Gaseous mass-transfer at gas/water surfaces (e.g. iodine, org-I)	T, p, r.H., Gas conc, Steam injection, Condensation rate, I2 concentration, Iodine discrimination	Steam condensation, I2 distribution, I2 depletion, I2 steel reaction	AC2, COCOSYS	WP-1.5 ST-42

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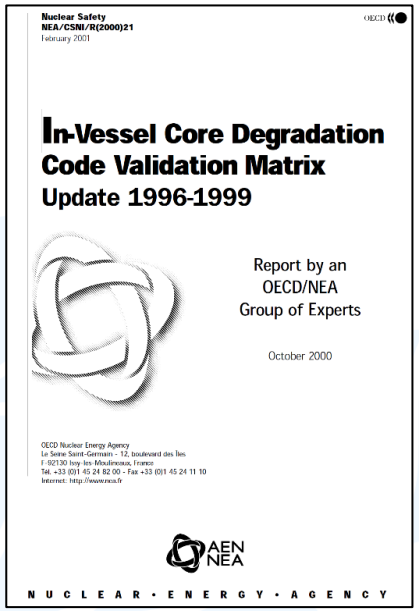
Example of complexity

- The VAAD excel files includes 15(+3) columns
- To handle all complexity many more might be beneficial
  - But typically empty by 70% (Phebus FPT-1 might fill them all…)
- THAI example would be:
  - 254 Test IDs, about 350 indiv. Tests (p, T, gas mixture, water, etc.)
  - more than 25 different configurations (set-ups, internals etc.)
  - ~ 80-100 phenomena addressed
  - 25.000 pages of reports

Facility name	Facility description	Organization/ Localization	Test identification	SA-related Topics/Phenomena	Measured parameters	Modelling (parameters laws, physics laws, other…)	Simulation code (name of the code, reference case, qualification, other…)	Experimental reseach program	IP/copyright situation (accessibility of the test results).	Link to PIRT	References (including open data with internet link if any)	Contributed by	Country	Comments	Facility status
Focus area 3: Fission product chemistry, distribution and remobilization behaviour in containment															
THAI	Technical scale containment test facility (thermohydraulic, hydrogen, aerosol, iodine, 2 vessels 80m3)	Becker Technologies GmbH	AW-2	FP depletion to surfaces under condensing conditions (non-soluble)	T, p, r.H., Steam rate, Condensation mass flux, Aerosol concentration, Size distribution, FP sampling	Rock- and roll model, Condensation model	AC2, COCOSYS, ASTEC	THAI-IV	upon request	WP-1.5 ST-15	Weber et al. IODINE AND SILVER WASH-DOWN MODELLING IN COCOSYS-AIM BY USE OF THAI RESULTS, Proceedings of the International OECD-NEA/NUGENIA-SARNET Workshop on theProgress in Iodine Behaviour for NPP Accident Analysis and ManagementMarch 30, April 1, 2015 - Marseille	M. Freitag	Germany		operating

WP 2.2 In-vessel Status

- A database has been assessed based a rather wide activity on literature review and direct contact with the experimentalists
  - **45 integral- and single effect- test facilities** (ACHILLES, ACRR-DC, ACRR-DF, ACRR-MP, ACRR-ST, ANAIS, BALI, CODEX, COOLOCE, CORA, DEBRIS, FARO, FOREVER, INVECOR, KROTOS, LECA-STAR facility, LHF/OLHF, LIVE 2D, LIVE 3D, NIELS, NRU-FLHT, PARAMETER, PERICLES, PHEBUS, Phebus SFD, POMECO, POMECO-FL, POMECO-HT, Power Burst Facility Severe Fuel Damage (PBF-SFD), PRELUDE-PEARL, PREMIX, QUENCH, RASPLAV-2, RASPLAV-3, SCARABEE, SILFIDE, SIMECO, SIMECO-2, SKODA UJP, SNL Ex-reactor test facility, STYX, TMI-2 reactor, VERCORS, VERDI, VITI)
- A minimum of **220 experiments** have been identified with the corresponding tests conducts


Nuclear Safety
NEA/CSNI/R(2000)21
February 2001

In-Vessel Core Degradation Code Validation Matrix
Update 1996-1999

Report by an OECD/NEA Group of Experts

October 2000

OECD Nuclear Energy Agency
Le Seine Saint-Germain - 12, boulevard des Iles
F-92130 Issy-les-Moulineaux, France
Tel. +33 (0)1 45 24 82 00 - Fax +33 (0)1 45 24 11 10
Internet: http://www.nea.fr

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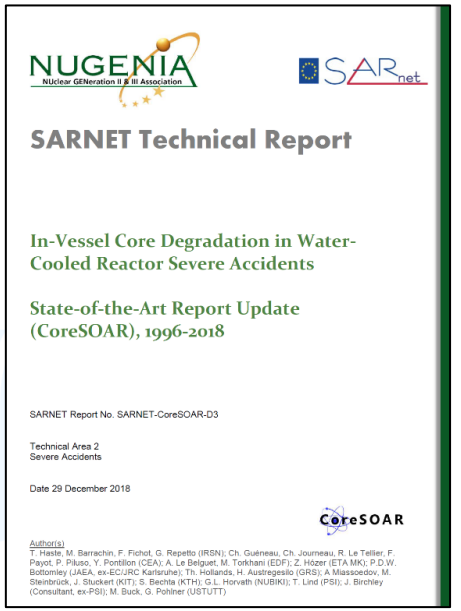

NUGENIA
NUclear GENeration II & III Association

SARnet

SARNET Technical Report

In-Vessel Core Degradation in Water-Cooled Reactor Severe Accidents

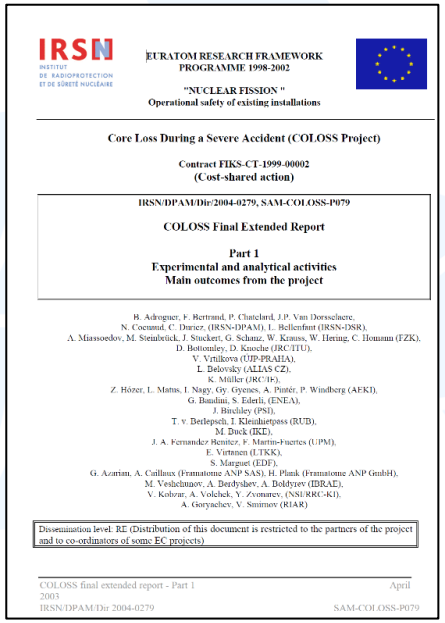
State-of-the-Art Report Update (CoreSOAR), 1996-2018

SARNET Report No. SARNET-CoreSOAR-D3

Technical Area 2
Severe Accidents

Date 29 December 2018

CoreSOAR


IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

EURATOM RESEARCH FRAMEWORK PROGRAMME 1998-2002

"NUCLEAR FISSION "
Operational safety of existing installations

Core Loss During a Severe Accident (COLOSS Project)

Contract FIKS-CT-1999-00002
(Cost-shared action)

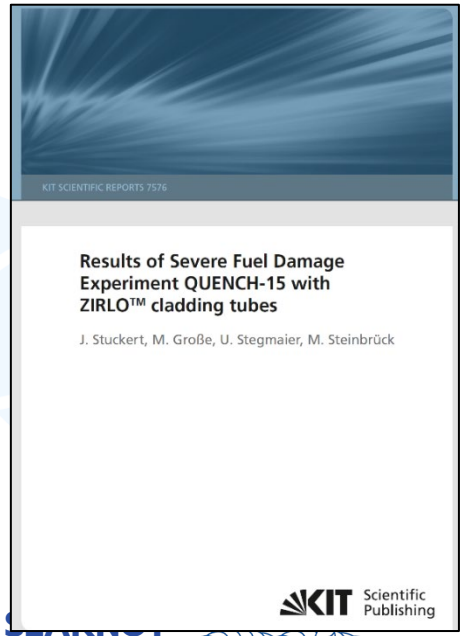
IRSN/DPAM/Dir/2004-0279, SAM-COLOSS-P079

COLOSS Final Extended Report

Part 1
Experimental and analytical activities
Main outcomes from the project

Dissemination level: RE (Distribution of this document is restricted to the partners of the project and to co-ordinators of some EC projects)

COLOSS final extended report - Part 1 April 2003
IRSN/DPAM/Dir 2004-0279 SAM-COLOSS-P079


KIT SCIENTIFIC REPORTS 7576

Results of Severe Fuel Damage Experiment QUENCH-15 with ZIRLO™ cladding tubes

J. Stuckert, M. Große, U. Stegmaier, M. Steinbrück

KIT Scientific Publishing

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WP 2.3 Ex-vessel status

- FCI: 31 experiments – 12 facilities
- MCCI: 32 experiments – 16 facilities
- Spreading: 21 experiments – 12 facilities
- Ex-Vessel Debris Cooling: 6 experiments – 6 facilities
- Corium properties and ATFs: 9 experiments – 6 facilities
- Melt penetration in debris bed: 2 experiments – 2 facilities
  - Links to phenomena are to be included
  - Harmonization with other sub-work packages to be completed

Nuclear Engineering and Design
Volume 223, Issue 1, July 2003, Pages 75-102

Ex-vessel corium spreading: results from the VULCANO spreading tests

Christophe Journeau, Eric Boccaccio, Claude Brayer, Gérard Cognet, Jean-François Haquet, Claude Jégou, Pascal Piluso, José Monerris

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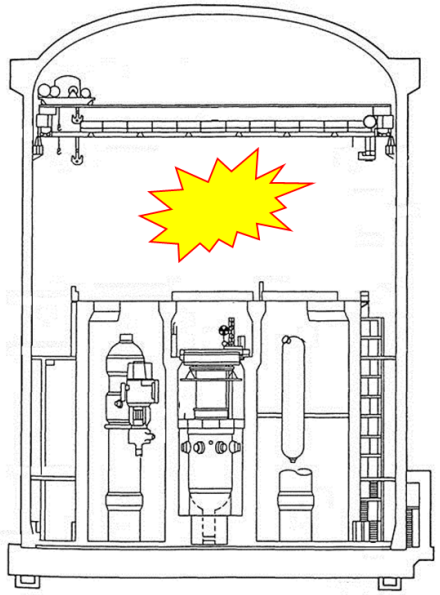
WP 2.4 Containment Status

- 16 experimental facilities listed
- 255 experimental "items" (series or tests) listed
  - Thermal hydraulics, hydrogen, PAR, passive safety systems
- Latest additions to the data-base, e.g.
  - THAI: 21 tests added (e.g. TH1-TH22)
  - TOSQAN: 6 tests added
  - CONAN: 166 tests added



!! e.g. CCVM will not be repeated but will be linked accordingly !!

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WP 2.5 Source Term

- Focus area 1: Fission product release (including in-vessel, ex-vessel)
  - Currently 13 evaluated entries
    - VERDON, VERCORS, Labo UO2, PHENIX SFR, VULCANO, COLIMA RASPLAV
- Focus area 2: RCS Fission product chemistry, transport and remobilization behavior in RCS:
    - Phebus, ASNR lab tests, Chromia (Start, CHIP, STEM, STEM-2), VTT FP transport facility, DEVAP, VERCORDs, VERDON, ARTIST, EXSI, JAERI, TERRA, RUSET

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WP 2.5 Source Term (II)

- Focus area 3: Fission product chemistry, distribution and remobilization behavior in containment:
  - Currently 75 evaluated
    - THAI
    - BMC (VANAM, DEMONA)
    - PHEBUS
    - WIND
    - MARVIKEN
    - POOL
    - BESSEL
    - RASA Lab
    - CSTF (LACE)
    - RTF
    - ACE MCCI
    - CAIMAN
    - AIDA
    - PCC-VTT
    - DESANE
    - EPICUR
    - PITEAS
    - SCRUPOS
    - TRISTAN
    - VICTORIA
    - PANDA
    - MISTRA
    - STRESA
    - BIP
    - STEAM
    - VESPER
- Status of Focus area 4: Mitigation and CNT bypass:
  - Currently 37 evaluated
    - THAI, ARTIST, KAERIS SGTR, PECA SGTR, HORIZON, PSI-CCI FCVS, PSI-miniVEFITA, TYFON, PERSEE and SAFARI, COLIMA, HERZSAN

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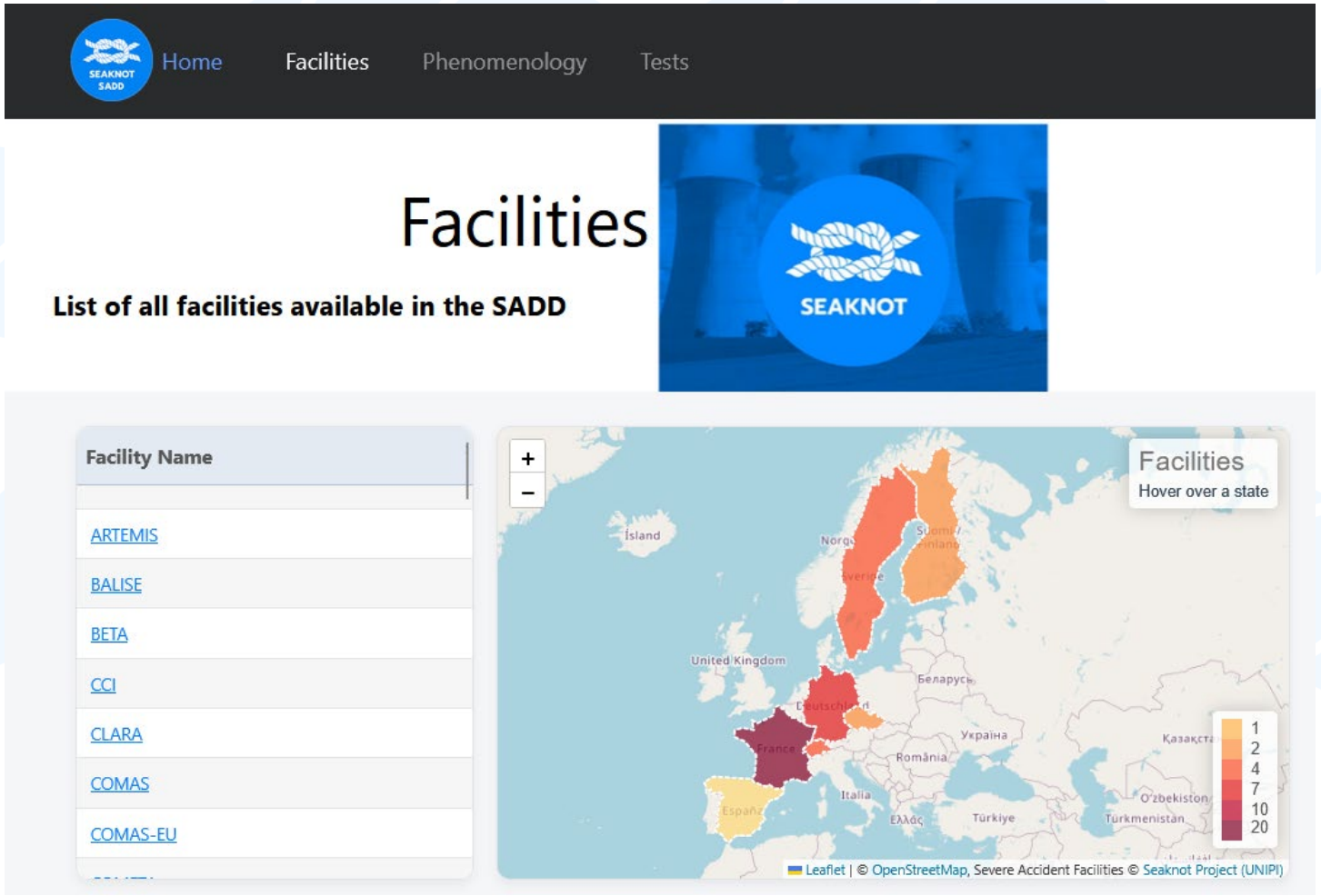
WP2.6 Current status of the Web-interface



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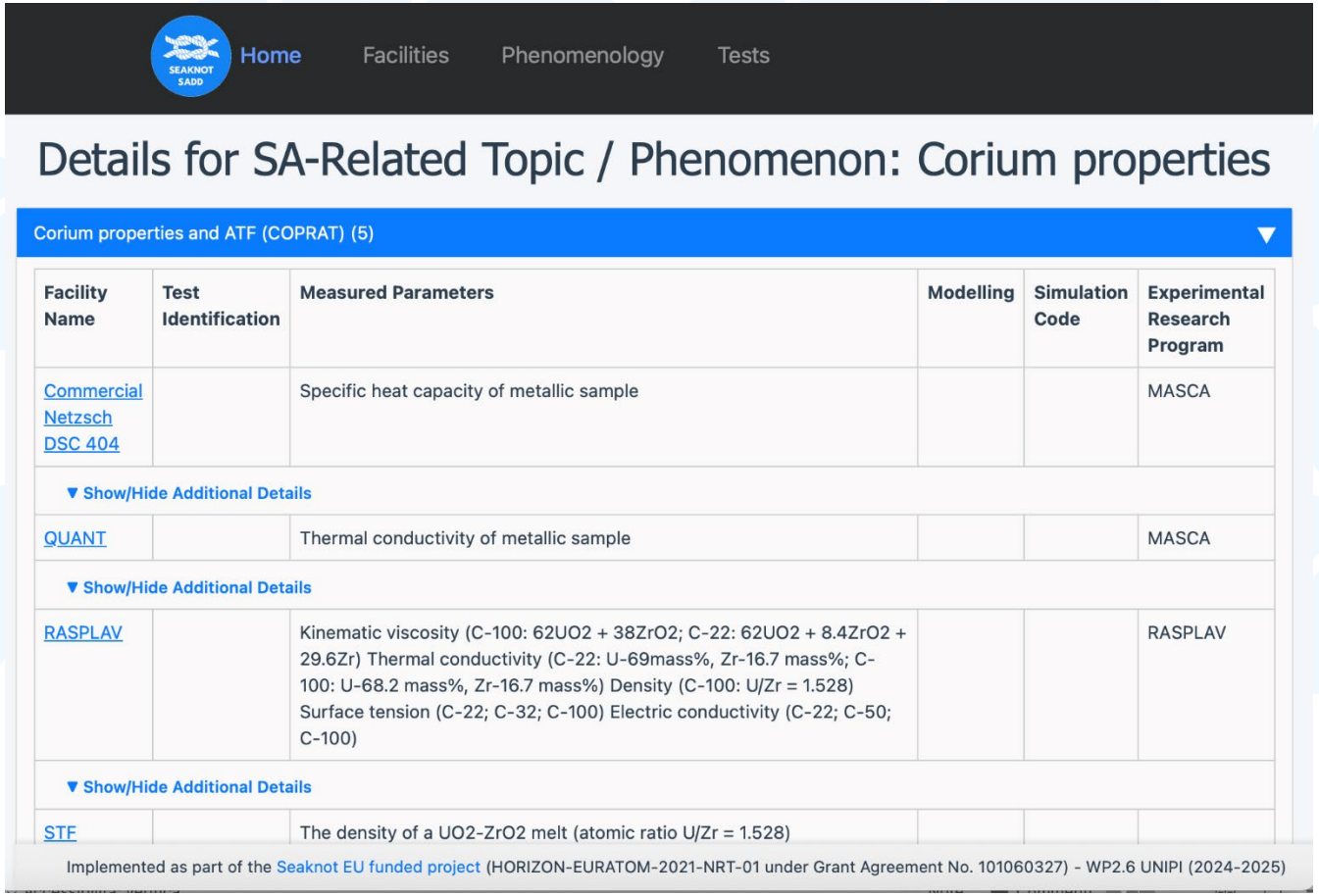

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WP2.6 Current status of the Web-interface

Facility Details: RASPLAV

Description: Different facilities for properties measurements
Organization / Localization: RRC "Kurchatov Institute"
SIA "Lutch"

Corium properties and ATF (COPRAT) (1)

Test Identification:
SA-Related Topics / Phenomena: Corium properties
Measured Parameters: Kinematic viscosity (C-100: 62UO2 + 38ZrO2; C-22: 62UO2 + 8.4ZrO2 + 29.6Zr) Thermal conductivity (C-22: U-69mass%, Zr-16.7 mass%; C-100: U-68.2 mass%, Zr-16.7 mass%) Density (C-100: U/Zr = 1.528) Surface tension (C-22; C-32; C-100) Electric conductivity (C-22; C-50; C-100)
Modelling:
Simulation Code:
Experimental Research Program: RASPLAV

Show/Hide Additional Details ▼

References: V.G. Asmolov, S.S. Abalin, A.V. Merzliakov, V.N. Zagryazkin, Ye.V. Astakhova, I.D. Daragan, V.D. Daragan, Ye.K. D'yakov, A.Yu. Kotov, A.S. Maskaev, Ye.M. Rakitskaja, V.M. Repnikov, V.Yu. Vishnevsky, V.V. Volkov, A.G. Popkov, V.F. Strizhov. 2000. RASPLAV Final Report Attachment C. Properties Studies: Methodology and Results
Contributed By:
IP/Copyright Situation: OECD project

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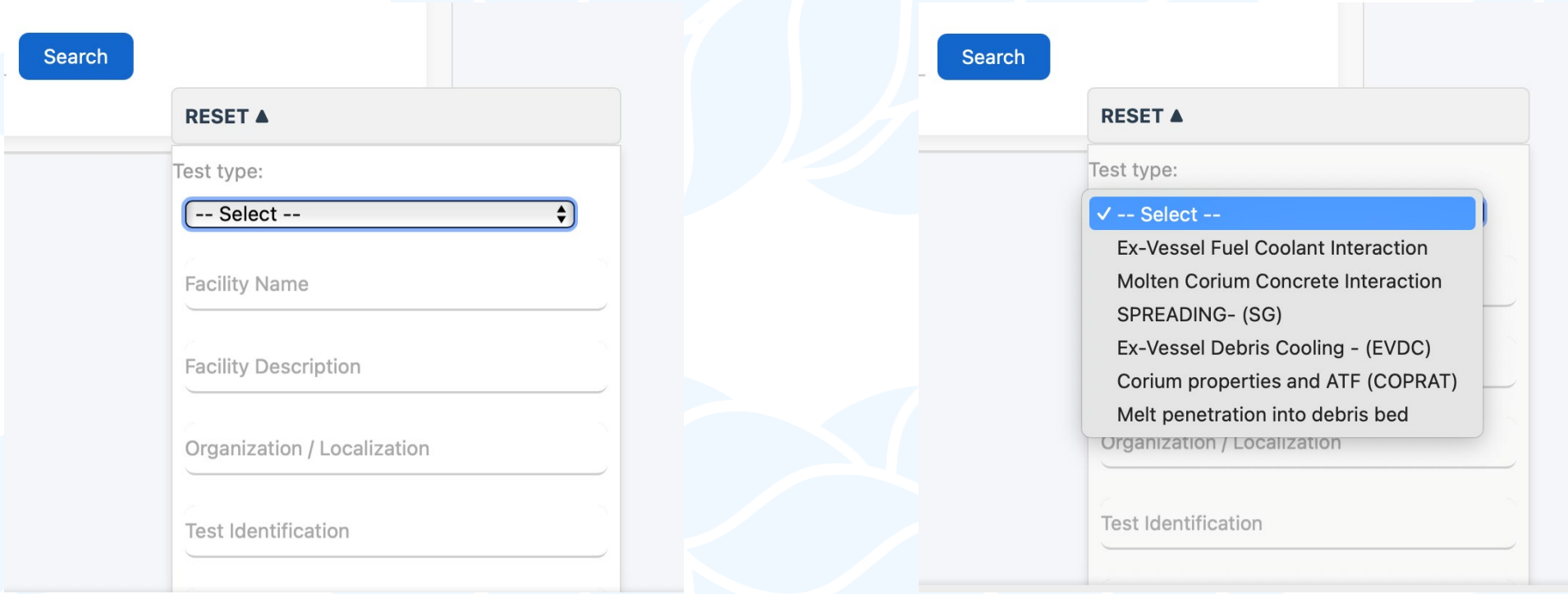
WP2.6 Current status of the Web-interface



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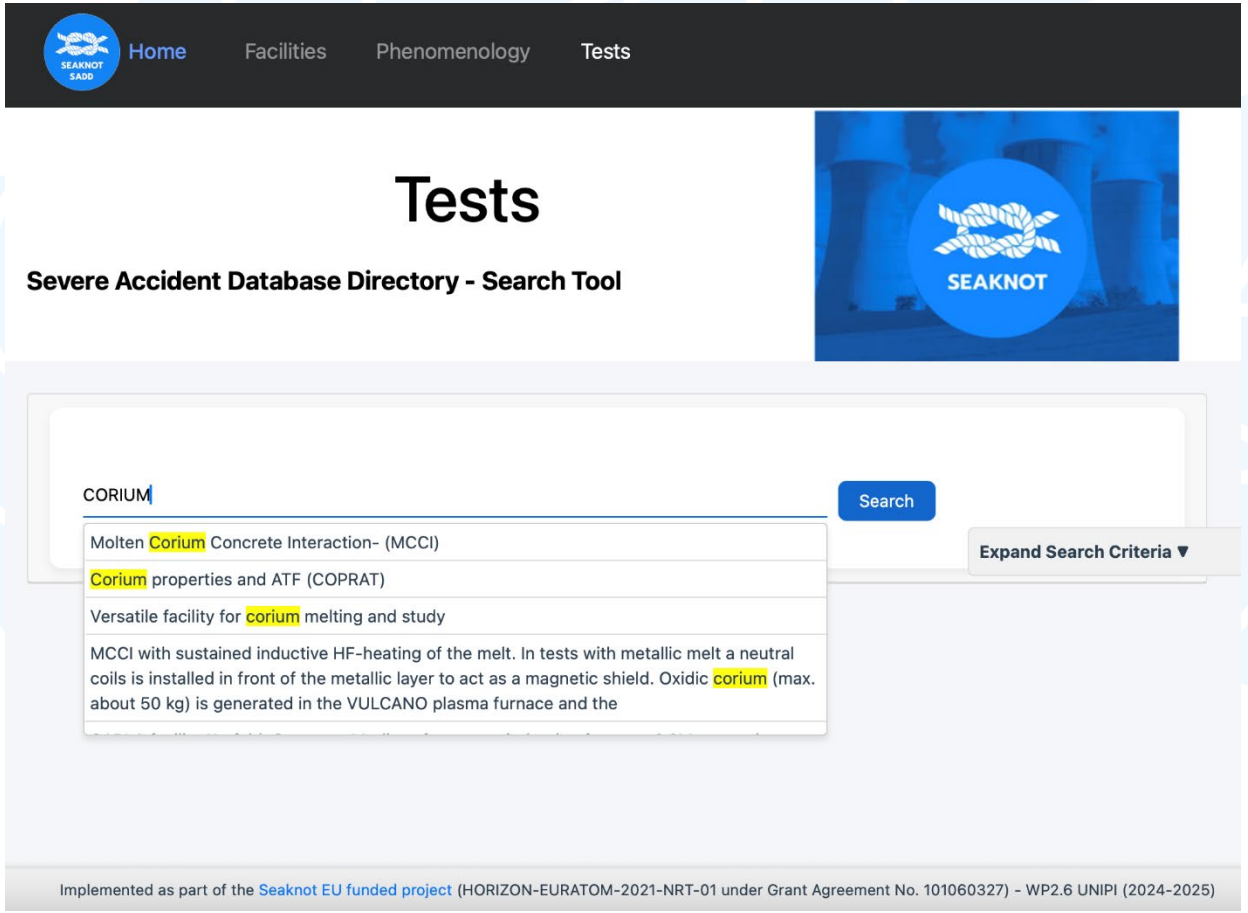

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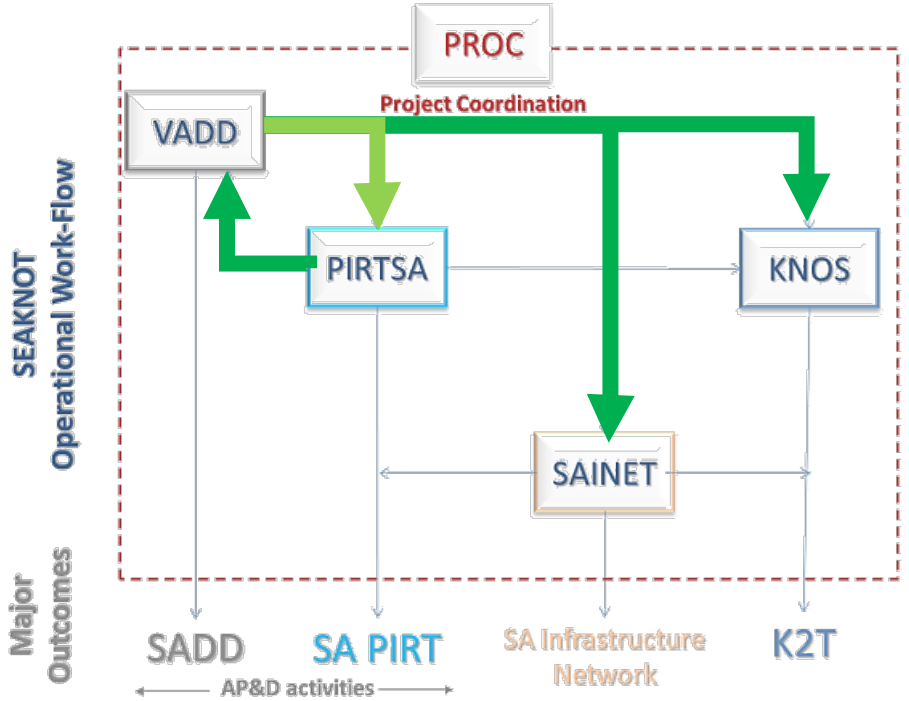
Where we are with the VADD

WP1 PIRTSA	Phenomena Identification Ranking Table
WP2 VADD	Validation Database Directory
WP3 SAINET	Severe Accident Infrastructure NETwork
WP4 KNOS	Knowledge Spreading
WP5 PROC	Project Coordination

- VADD reached quite the level of technical completion
  - In-vessel WP2.2
  - Ex-vessel WP2.3
  - Containment WP2.4
  - Source term WP2.5
  - Web-app created and tested WP2.6
- PIRT outcome considered
  - Ranking considered for data selection
  - Cross-link of VADD to PIRT



« Where we are »

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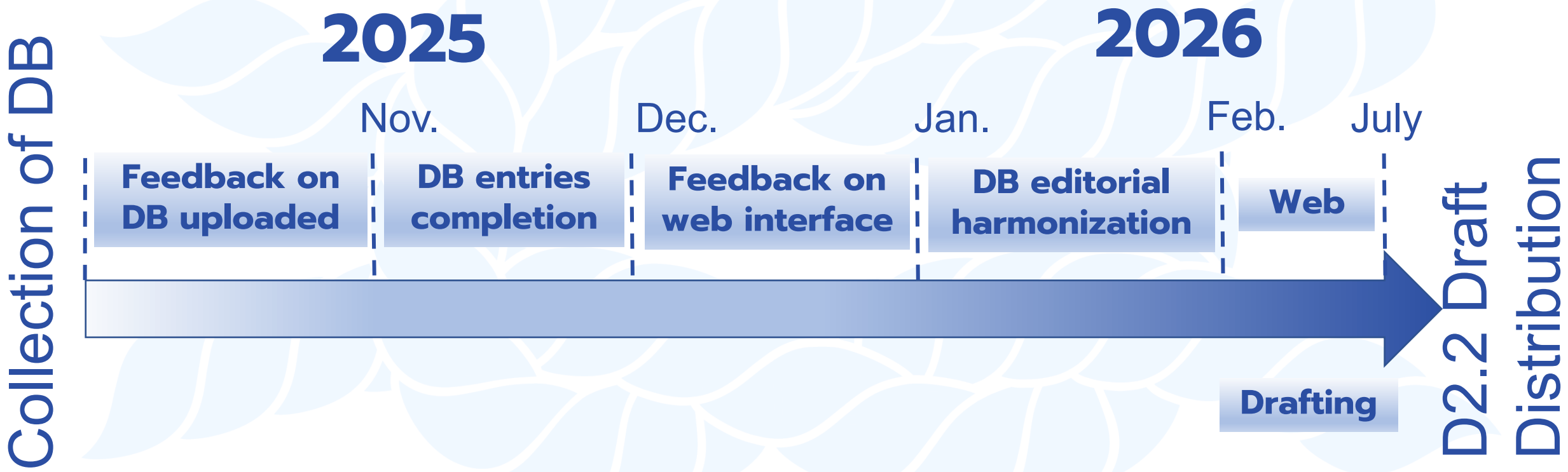
Remaining Work plan WP2



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What is ahead in WP2 (VADD)

- Finalize VADD by reaching:
  - level of editorial completion
  - Synchronize with the need of SAINET
  - Define strategies for long term validity
- Provide to SAINET and KNOS
  - Finalized VADD of all subdomains
- Feedback of VADD to PIRT
  - Verify ranking by consolidated VADD
    - Each domain
      - In-Vessel and Ex-vessel
      - Need of new experimental data

WP1 PIRTSA	Phenomena Identification Ranking Table
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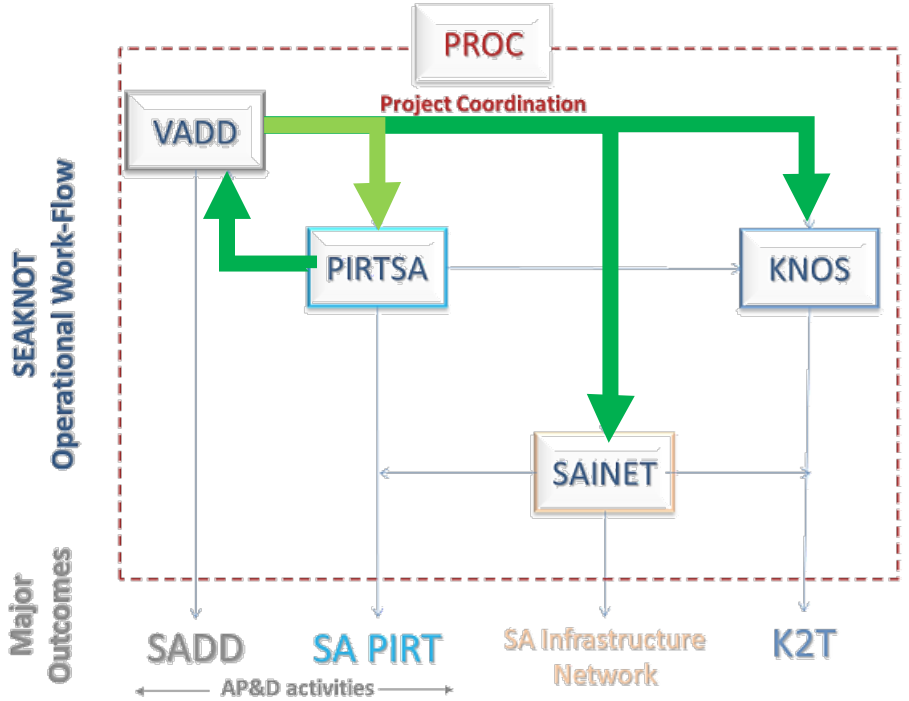

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Dr. Martin Freitag
Becker Technologies GmbH
Neckarstraße 12-14
65239 Hochheim
Germany

Phone: +49 6146-52897-17
Mail: freitag@becker-technologies.com

THANK YOU!

Get in touch for more information

All of the reports of the project will be available for download on the SEAKNOT website: **www.seaknot-project.eu**

Project coordinator: Luis Enrique Herranz, CIEMAT
Contact us: **contact@seaknot-project.eu**

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