

NARSIS

New Approach to Reactor Safety ImprovementS

NARSIS WORKSHOP

"Training on Probabilistic Safety Assessment for Nuclear Facilities"

Warsaw, Poland – September 2-5, 2019

Report

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We would like to acknowledge the Centre for Innovation and Technology Transfer Management of Warsaw University of Technology for providing a facility well suited for the workshop.

Finally, we are grateful to all the speakers and persons involved in the preparation of the lectures. A special thanks go to our 3 external speakers Alexander Duchac (IAEA), Jessica Johnson (FORATOM) and Abhinav Gupta (Center for Nuclear Energy Facilities and Structures, USA). Their contributions have been essential.

1 Introduction

With a consortium of 18 organizations around Europe, the four-year H2020 project "New Approach to Reactor Safety ImprovementS" (NARSIS, Sept. 2017-August 2021) aims at proposing some improvements to be integrated in existing Probabilistic Safety Assessment (PSA) procedures for Nuclear Power Plant Safety (NPPs), considering single, cascade and combined external natural hazards (earthquakes, flooding, extreme weather, tsunamis). The project will lead to the release of various tools together with recommendations and guidelines for use in nuclear safety assessment, including a Bayesian-based multi-risk framework able to account for causes and consequences of technical, social/organizational and human aspects and a supporting Severe Accident Management decision-making tool for demonstration purposes, as well.

Aside from the technical Work Packages (WPs), the project pursues dissemination and communication activities. Some of the missions of these activities are (i) to raise awareness of the project and ensure widespread dissemination, exploitation, take up in practice and mainstreaming of the project research and results and (ii) to provide a continuous resource for communities (scientific, professionals, etc.) involved in Nuclear Safety-related issues and risk management. In order to fulfill these objectives, the organisation of two international workshops has been planned: one at project mid-course and another one at the end of the project as workshops are a good knowledge dissemination means.

The NARSIS Workshop "Training on Probabilistic Safety Assessment for Nuclear Facilities" was the first workshop organised in that context. The workshop was hold on September 2-5, 2019 at the Warsaw University of Technology in Poland. It was structured with a Summer School-type format targeting students and young researchers. Its aim was to provide an introduction to the State-of-the-Art PSA methods and tools dedicated for nuclear installations by providing background and understanding of modern PSA approach. Its main objectives were (i) to reinforce the concepts involved in nuclear safety and (ii) to contribute to a growing awareness on the current needs for improved nuclear safety.

This report provides an overview of the workshop detailing the organisation, participation, content and feedbacks afterward.

2 Organisation

The main funding for the workshop was provided by the NARSIS project. Twenty (20) ENEN+ Mobility Grant of 600€ per person (total of 12 000€) were provided by the ENEN Association. This ENEN+ mobility fund being opened to Master and PhD students as well as young professionals (under 30 years old).

The workshop was organized mainly by the NARSIS partner WUT (Warsaw University of Technology) who hosted the event helped by the CEA (Commissariat à l'Énergie Atomique et aux Énergies Alternatives) and BRGM (Bureau de Recherches Géologiques et Minières) partners. The organising committee was formed by the following NARSIS consortium members:

- Behrooz BAZARGAN SABET (BRGM)
- Piotr DARNOWSKI (WUT)
- Evelyne FOERSTER (CEA)
- Piotr MAZGAJ (WUT)
- Florence RAGON (CEA)

Preliminary work was undertaken during the two last plenary meetings of the project. The workshop target audience was discussed and decided one year in advance (Karlsruhe, September 2018) and the draft agenda with titles and speakers for the lectures was thought out during discussions by groups (Delft, March 2019).

WUT designed a leaflet to advertise the workshop and a website was set up disposing all the workshop information as well as the possibility to register directly online (http://nuclear.itc.pw.edu.pl/narsis-workshop/) (Figure 1).



Figure 1: NARSIS Workshop Leaflet (left) and NARSIS Workshop website homepage (right).

3 Participants



Figure 2: NARSIS Workshop group photo

The workshop's target audience was the students (Master and PhD), the young professionals (engineers and researchers) as well as people starting a career in various field of probabilistic safety assessment for nuclear facilities.

The workshop was well attended with **63 participants from 13 different nations** including 30 students, 15 professionals, 15 speakers/organizers and 3 external speakers (Figure 2 and Figure 3). Participants who wished have received a diploma at the end of the workshop.

Annex 7.2 gives the list of all participants.



Figure 3: Distribution of NARSIS Workshop participants

4 Contents



Figure 4: NARSIS Workshop (selection of photos)

4.1 Speakers

All the speakers were involved in the NARSIS project and therefore have practical experience in the field. As many of them are coming from the academic world, they have also teaching experience. Additionally the following **3 external speakers** were invited by the organizers:

- Alexander DUCHAC, Nuclear Safety Officer International Atomic Energy Agency (IAEA), Vienna, Austria;
- Jessica JOHNSON, Communications Director FORATOM, Brussels, Belgium;
- Abhinav GUPTA, Director Center for Nuclear Energy Facilities and Structures (CNEFS), Raleigh, USA.

Out of 36 persons, 20 persons strongly agree and 10 agree with the statement "Overall, I am satisfied with the trainer's presentations (see Annex 7.3.4).

4.2 Program

The workshop took place over a three-day and a half period (Figure 4). Annex 7.1 gives the detailed final program.

4.2.1 Lectures, Keynotes and Specialized lectures

The program of the workshop was structured around the Work Packages (WPs) activities of the NARSIS Project with two lectures planned per WP (Table 1). Beforehand each WP had selected relevant topics for presentation and prepared a collective lecture.

Table 1: "The program of the workshop was structured around the NARSIS Project WPs".

NARSIS Project WPs	Workshop's lectures
WP1: External Hazards Characterization	Introduction to external hazard events - Background, parameters, and interactions Modelling external hazards: Extreme value modelling Example of application of the French directive for Basic Nuclear Installations (BNI)
WP2: Fragility assessment of main NPPs critical elements	Identification of critical elements within NPPs (screening and ranking methods) Methods for the derivation of fragility functions
WP3: Integration and safety analysis	Latent weaknesses and root causes in the feedback of operating experience programmes Uncertainties and risk integration
WP4: Applying and comparing various safety assessment approaches on a virtual reactor	Metamodels for reducing computational costs in probabilistic safety analyses Severe accident assessment with uncertainty and sensitivity analysis
WP5: Supporting Tool for Severe Accident Management	Severe accident phenomenology and management principles of severe accident risk analysis Principles of severe accident risk analysis

In addition to lectures, the following **keynotes and specialised lectures** were also proposed:

- Safety vs Security;
- Risk Assessment Using Bayesian Approach: Risk Informed Validation Framework and Multi-Hazard Risk Assessment;
- Nuclear Power Plant Accidents;
- Human Factors;
- PSA: Main Elements and Role in the Process of Safety Assessment and Verification.

Out of 36 persons, more than half strongly agree that the workshop objectives were adequately addressed (50%), the subjects taught were relevant (64%) and the workshop included examples of evidence-based practices and/or best practices related to the topic (53%) (see Annex 7.3.4).

4.2.2 Group discussion/Round table

Time was also allocated to a round table about "Nuclear Prospective in Europe". The panel of this round table was formed by:

- The 3 external speakers (see 4.1);
- **Ernest STAROŃ** head of department, department of Nuclear Safety, National Atomic Energy Agency (PAA), Warsaw, Poland
- Konrad ŚWIRSKI professor Warsaw University of Technology (WUT), Warsaw, Poland.

The discussions were organized around the following questions:

- Is the nuclear power an ultimate solution to the world growing consumption of electricity?
- How to speak about safety of NPPs?
- Is there any possibility to reduce the costs of construction of NPPs?
- Your forecast for nuclear power in Europe in 2030 and 2040?

The participants started discussing about the necessity of the coexistence of the nuclear power with other types of energy (e.g. batteries) emphasizing the critical importance of energy storage. The discussion then shifted to communicating about the NPPs. As pointed out by the participants, nuclear energy is associated with a negative perception (nuclear weapon, nuclear accidents etc.) and therefore nuclear energy need to be driven by engineers and scientists that are good communicators. Particularly, it is noted that there is a lack of transparency during a crisis and efforts have to be made to manage better crisis communication. Indeed, the general public is not confident anymore to official communication. Then the possibility to reduce cost of the construction of NPPs was addressed. According to the participants, it will be difficult to reduce this cost as every design is different and countries have different regulations. Finally, regarding the forecast for nuclear power, the participants stated that it is difficult to answer but are not very optimistic as the field will have to face several problems including loss of competencies, ageing of NPPs and politics. All agree on saying that the next decade will be a transition period.

The organization of this round table was well received by the participants. 53% (out of 36) strongly agree that the round table was useful and informative and 50% (out of 36) strongly agree that the participants were well selected (see Annex 7.3.6).

4.2.3 Practical session

A short practical session was organised on the last day. This session covered some basic Bayesian network theory, provided an example problem, and partly solved it in the software program "Netica". The exercise and solution files was provided to the participants via email, during the session, for discussion and for future use.

This practical session was well received by the participants and several would have appreciated more hands-on activities or computer-aided simulations (see Annex 7.3.8).

4.2.4 Visit

For those interested, a visit to the research reactor Maria was planned at the end of the workshop. The Maria reactor is Poland's second nuclear research reactor and the only one still in use. It is a pool type reactor with a power of 30 MW (thermal) being a multifunctional research tool, with a notable application in production of radioisotopes, research with utilization of neutron beams, neutron therapy, and neutron activation analysis.

The feedback on the visit was mixed with 10 persons (out of 24) that strongly agree that the visit was informative and useful against 8 undecided (see Annex 7.3.6).

4.2.5 Social dinner and evening sightseeing tour

On the second and third nights, a social dinner and an evening sightseeing tour were respectively proposed. These social events helped to create a friendly atmosphere between

the participants: 75% (out of 36 persons) strongly agree that the social dinner had created a convivial atmosphere (see Annexes 7.3.2 and 7.3.7).

5 Feedbacks

5.1 From NARSIS participants

After the workshop, time was dedicated during the NARSIS Plenary Meeting in order to collect the feedbacks of everyone involved in NARSIS who attended the workshop (25 persons).

The **positive points** mentioned were:

- the very good attendance;
- the mix of session and diversity of the topics;
- the panel discussion;
- the software session.

The **points to be improved** identified had led to the following recommendations:

- a less busy schedule with more time dedicated to discussions and longer lunch breaks;
- inform the lecturers in advance about the diversity of the audience in order for them to prepare their presentations accordingly;
- questions for the round table designated in a more positive way;
- Organise parallel sessions for the practical sessions.

5.2 From all participants

After the workshop, an anonymous electronic survey has been sent to all participants. Thirty-six of them (36) answered including the 20 participants that benefitted from the ENEN+ mobility fund. All responses are tabled in graph and compiled in Annex 7.3.

The feedback was very encouraging with 22 very satisfied and 12 satisfied participants (Figure 5).

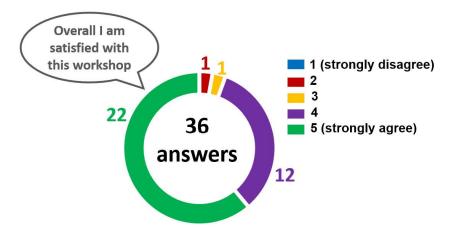


Figure 5: Distribution of the answers "Overall I am satisfied with this workshop".

The **positive points** the most mentioned were (see Annex 7.3.7):

- the organization (18);
- the speakers (10);
- the friendly atmosphere and the venue (9);
- the content (7);
- the agenda (5).

The ways of improvements the most mentioned were (see Annex 7.3.8):

- to provide the presentations beforehand;
- to provide additional introductions to the different topics with a lexical for all the specific terms used;
- more hand-on activities;
- to relax the schedule.

6 Conclusion and Next steps

The NARSIS Workshop "Training on Probabilistic Safety Assessment for Nuclear Facilities" enabled 63 participants from a variety of countries and backgrounds to extend their knowledge on Probabilistic Safety Assessment methods and tools dedicated for nuclear installations. Importantly it provided time for people involved in this community to meet, discuss and exchange. Overall the participants were very satisfied with this training.

The project has committed to make the education and training materials of this workshop available through the NARSIS website (www.narsis.eu/) and to prepare papers related to the workshop lectures (proceedings planned for March 2020). Additionally, in view of the very positive feedbacks, it is considered to organize another event for the students as the project has committed to prepare training materials that could be used for another training.

These education and training efforts will be further strengthened with the Final Workshop planned at the end of the project (around May/June 2021). The audience will be stakeholders and people from regulation in order to obtain feedbacks on NARSIS outcomes.

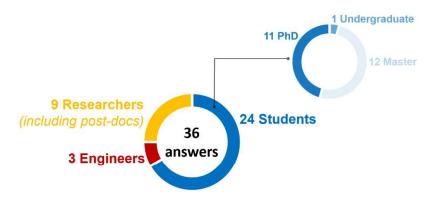
7 Annexes

7.1 Program

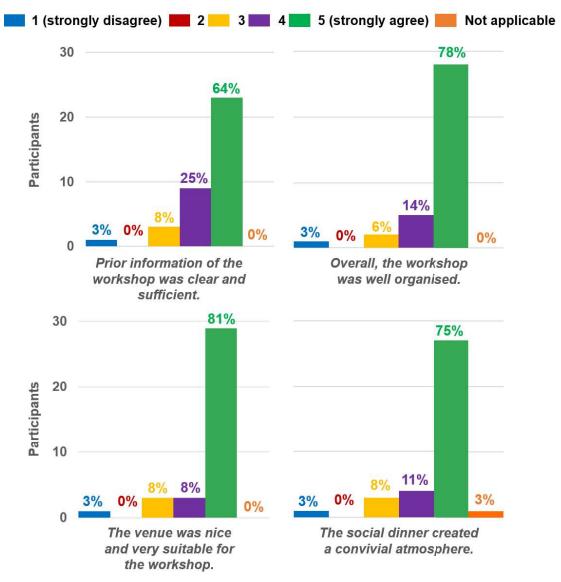
		Control of the Contro		
	Monday, September 2nd	Tuesday, September 3rd	Wednesday, September 4th	Thursday, September 5th
Time	Day 1	Day 2	Day 3	Day 4
08:15		Keynote Lecture - Safety vs Security [Behrooz Bazargan-Sabet, Bureau de Recherches Géologiques et Minières, France)	Keynote Lecture - Nuclear Power Plant Accidents (Alexander DUCHAC, Division of Nuclear Installation Safety, inernational Atomic Energy	Keynote Lecture - Human Factors (Jessica Johnson FORATOM, Belgium)
00:60		Identification of critical elements within NPPs (screening and ranking methods) (Andrej Prosek, Jožef Stefan Institute, Slovenia)	Severe accident phenomenology and management (Luka Strubel, GEN, Slovenia)	Bayesian Networks excercises and software (Varenya Varenya Duvvuru Mohan, Deft University of Technology, Netherlands)
10:00		Coffee Break	Coffee Break	Coffee Break
10:30		Latent Weaknesse and Root Causes in The Feedback Of Operating Experience Programmes (Milorad Dissic, Nucon, Austria)	Keynote Lecture - Probabilistic Safety Analysis (wan Vrbanic, APOSS, Croatia)	Workshop Summary - round table
11:15				
11:30		Methods for the derivation of fragility functions	Principles of severe accident risk analysis (tvica Basic APOSS, Croatia)	Transfer to National Nuclear Research Centre
12:00	Workshop Registration	(Pierre Gehl, Bureau de Recherches Géologiques et Minières, France)		
12:30	1	4	diam'r.	Lunch Break
13:00	LUICE DICAR	Lunch Break	Lunch Dream	
13:30	Introduction and overview of the training	Uncertainties and risk integration (Jeremy Rohmer, Bureau de Recherches Geòlogiques et Minières, France, Varenya Duvvun Mohan - Delit University of Technology, Netherlands)	Severe accident assessment with uncertainty and sensitivity analysis (Piotr Darnowski, Piotr Mazga, Warsaw University of Technology, Poland)	Visit to Research Reactor in National Nuclear Research Centre
14:30	Introduction to External Hazard Events - Background,	Metamodels for reducing computational costs in probabilistic	Group discussion/round table about Nuclear Prospective in Europe	
15:00	Parameters, and Interactions (James Daniell, Karlsruher Institut für Technologie, Germany)		Konrad Świrski - Warsaw University of Technology, Poland Abhinav Gupta, Center for Nuclear Energy Facilities and Structures (CNEFS), Raleigh, USA	Transfer to Warsaw
15:30	Coffee Break	Coffee Break	Jessica Johnson, FORATOM, Belgium	
15:50	Modelling External Events - From Deterministic to Probabilistic -	Multihazard Bayesian Analysis; PSA	Alexander DUCHAC - Inernational Atomic Energy Agency	
16:05	Concepts and NPP State of the Art	(Abhinav Gupta, Center for Nuclear Energy Facilities and	Coffee Break	
16:20	— Modelling External Flooding. The quantification of the Extreme Sea	orructures (CNETS), Hareign, USA)	542	
16:50	Level according to the French flooding guide (ASN n°13) recommendations. (Vito Bacchi, Institut de radioprotection et de aŭretie nucléarie. France)			
		19:30 Social Dinner		

7.3 Evaluation by the Participants

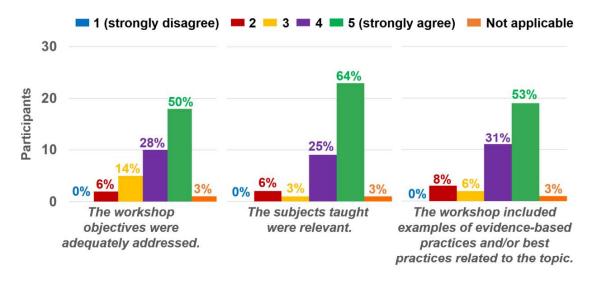
7.3.1 Profile sample



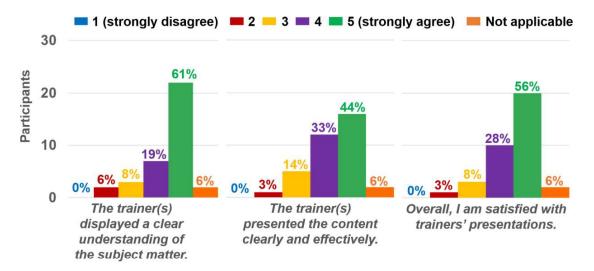
7.3.2 Workshop Organization



7.3.3 Workshop Content



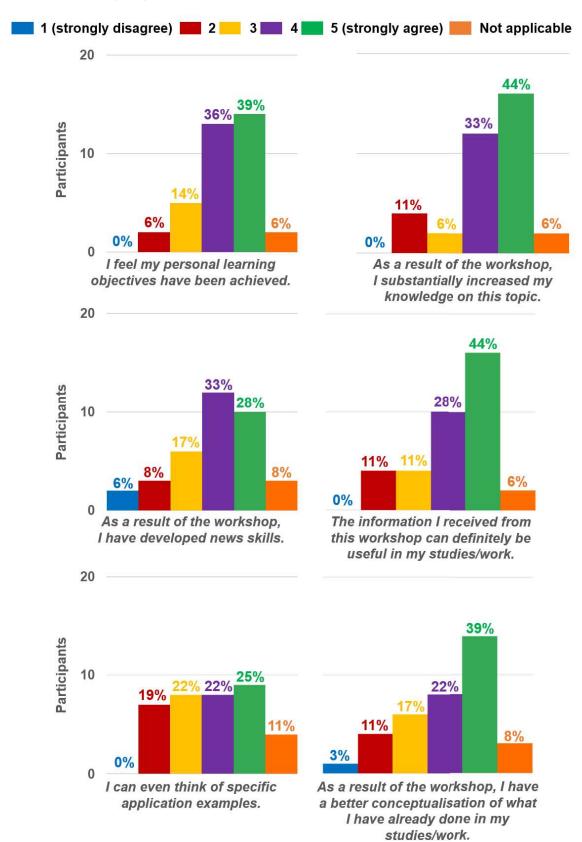
7.3.4 Workshop Trainers and Presentations



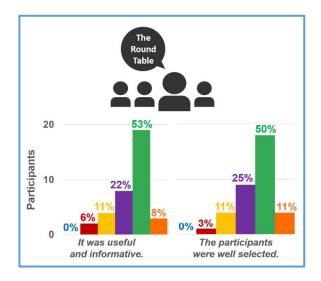
Suggestions of other topics that it would be interesting to add for a future workshop:

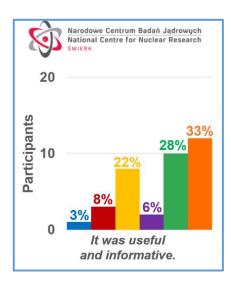
- The PSA for pressure thermal shock of NPP main equipment including reactor.
- The PSA application in HRA (Human Reliability Analysis) in NPP operative conditions and, if any, in decommissioning activities and the human impact on PSA.

7.3.5 Workshop Expectations



7.3.6 Round Table and Visit





7.3.7 Positive feedbacks

Out of 36 participants, when asked to give 3 positives feedbacks:

- **18 participants mentioned the organization** pointing out the hospitality of the host.
 - "The host Piotr was extremely welcoming and organized."
 - "The organization was impeccable, with every aspect taken into consideration."
 - "As for me, the overall event's organization was perfect."
 - "Pleasant and hospitable organizers."
 - "A special thank you for Piotr since he was very cooperative and helpful."
 - "Many thanks to the local organizing committee"
- 10 participants appreciated the speakers.
 - "Well-chosen speakers."
 - "Lecturers with practical experience (some of them were very interesting not only as professionals, but also as individuals)."
 - "The people were a pleasure to learn from and with."
 - "There were experts giving talks from different perspectives. I learned new knowledge and met with peers and experts."
 - "It was a great Idea to invite a communication expert. I was surprised how interesting PR and communication can be. Being able to ask the presenters all the time was very helpful."
 - "High quality presenters."
 - "Incredible mix of lecturers."
 - "It was useful to get to know representatives of the major organizations in the field. The majority of the presenters had deep understanding of the topic with the ability to address any questions - most lectures were comprehensive and well prepared."
- 9 participants appreciated the friendly atmosphere with participants from different backgrounds.

- "Active interactions between students and with the presenters, throughout the week."
- "It was important to have participants from different backgrounds."
- "It was a pleasing and friendly environment."
- "Enjoyed the social dinner and met some great people."
- 9 participants appreciated the venue as well as the organization of social events.
 - "Nice venue."
 - "A convenient place and city for arrival."
 - "Social dinner was good. Visit of the castle was good. Catering (Coffee breaks) was good."
 - "Very well thought social event."
- 7 participants appreciated the good content of the workshop.
 - "Interesting and useful topics."
 - "Content quality was great."
 - "What I enjoyed the most was related to PSA itself rather than to seismic phenomena, however it was very interesting to get some new information in that area."
 - "Such events are very useful for PhD students."
- 5 participants appreciated the agenda of the workshop.
 - "Excellent management of lectures timetable."
 - "Length of the workshop."
 - "Very interesting round table."
 - "I found the Netica workshop especially educative."

7.3.8 Ways of improvement

- Content of the workshop
 - Topic of the lectures
 - → "It could have been clearer how **Bayesian Inference** is useful for risk modelling."
 - → Comment made by 2 participants
 - "I was expecting an academic talk about **human factors** since it is so important for the nuclear industry. However, at the workshop's human factor session, I only hear a talk about how to promote propaganda of the nuclear industry. It was an amazing talk, but not a scientific talk."
 - → "Please offer more fundamental lectures about PSA methods. I was expecting lectures about overview of PSA methods and its trends in future development, and more informative introductions about certain PSA methods that I could use for my research."

• Complexity of the lectures

→ Comment made by 2 participants

"There should have been an introductory lecture to set the most important terminologies used in the workshop."

- → "Depending on your background, it was hard to follow some presentations due to their topics. A list of things to read in preparation for each field would be helpful for a second workshop."
- → "Some lectures were too specific, giving more general talks at the beginning of the school could be useful."
- → Comment made by 3 participants

"I know the topic is very wide to cover, but I would have appreciated if there was a common thread among the lectures. Sometimes there was a jump between a lecture and the subsequent one."

Hand-on Activities

Comment made by 6 participants

"I'd only suggest to make it more practical. For instance, like adding hands-on activities or computer-aided simulations in order to have a clearer and more complete understanding of the topics involved in the workshop."

Organisation

Schedule

- → "Time schedules were late."
- → "Warm up discussion in the end of day was not provided."
- → "Relax the schedule with longer pauses and less lectures in a day."
- → "Length of the round table (too short)."

Materials available beforehand

- → "Give each participant a list of participants with contacts for quickly finding the right colleagues (this is done on the NUGENIA forum)."
- → "Some kind of notes available online."
- → Comment made by 3 participants
 - "Send annotations of training materials earlier for familiarization and preparation of questions, at the beginning of the meeting."
- → "More time for the participants to make notes, as the text on the slides alone is not sufficient for understanding. Less overview, more details in the presentations."
- → Comment made by 2 participants

"Would be nice to understand background of all participants; the prerequisite knowledge for each session varied, would have been nice to have some expectation of the difficulty level for each session; beginner, medium, advanced etc."

Trainers

"Presentation skills training for lecturers - too much text on slides sometimes."

Visit

Comment made by 2 participants

"The facility visit could be better prepared, the facility was during start up and we weren't able to enter and see the core."

Possibly schedule the visit so that it would be possible to get inside the facility.

Others

- "Invite PhD students (not participating in the project) to the following trainings and working meetings, which will allow sharing experience."
- "More sockets."