



# Conforming to radiation safety regulations, what you need to know when you supply into Research Infrastructures



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# Outline

## Context for Research Infrastructures

### European Spallation Source In-Kind model case

- ◆ Procurement requirements, Quality and ILO network
- ◆ European regulations and legislations
- ◆ Examples of Applications to Accelerator, Target and Instrument

### What you could know about Research Infrastructures...

- ◆ A novel way to learn: ESS Learning Lounge
- ◆ Innovations based on RI
- ◆ Learning more about Physics

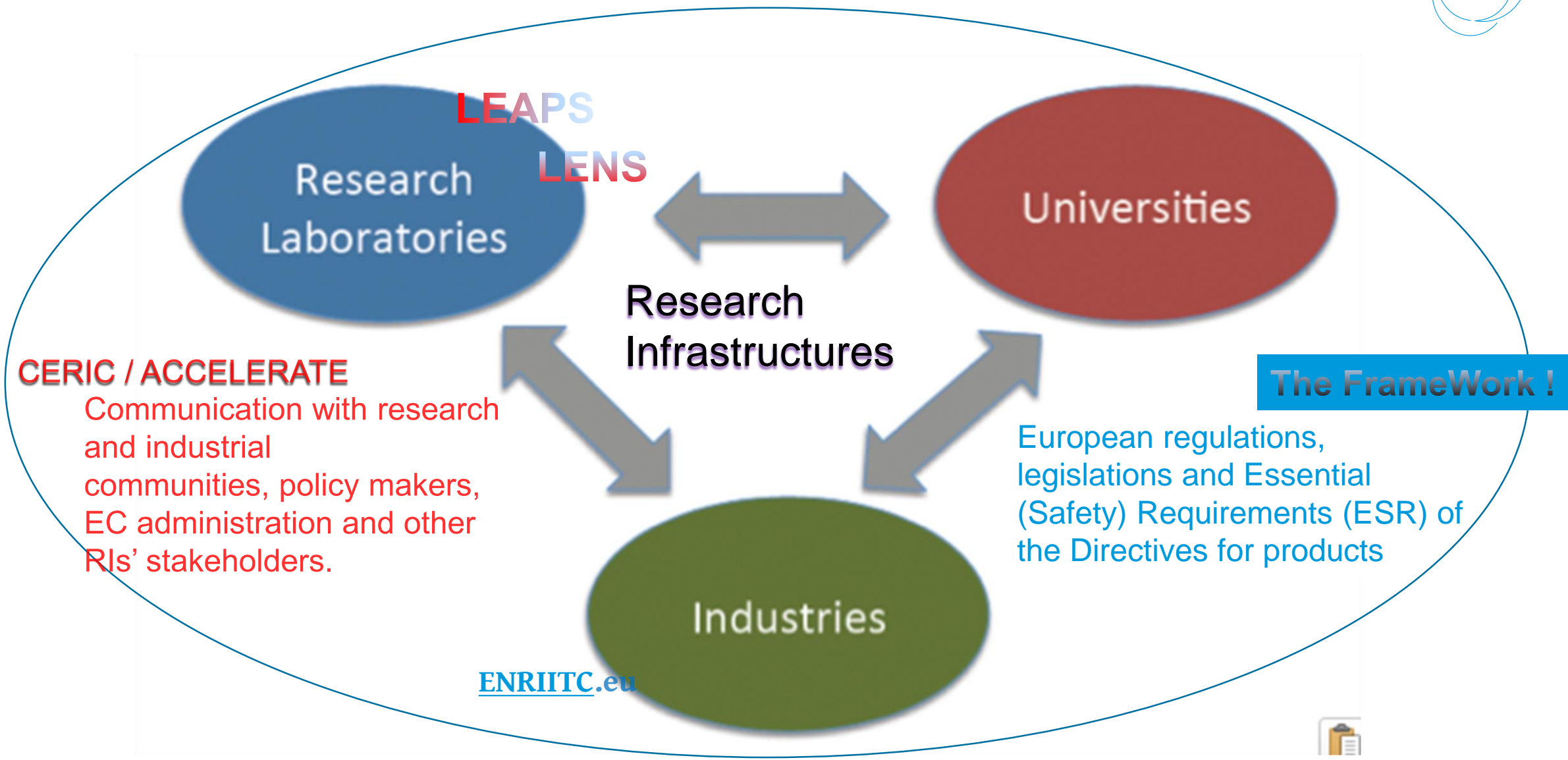
#### **ABOUT ACCELERATE**

ACCELERATE is a Horizon 2020 project, supporting the long-term sustainability of large scale research infrastructures (RIs) through the development of policies and legal and administrative tools for a more effective management and operation of RIs, with a special focus on ERICs and CERIC in particular.

To help secure RIs' sustainability, relevance and effectiveness, the project develops frameworks to improve the offer of tailored services to private and public entities, ensuring outreach to new scientific and industrial communities worldwide and defining common protocols for monitoring and assessing RIs' socio-economic impact.

Finally, a major focus is on capacity building to develop current and future RIs' staff competences in the field of management, Industrial Liaison and Technology Transfer.

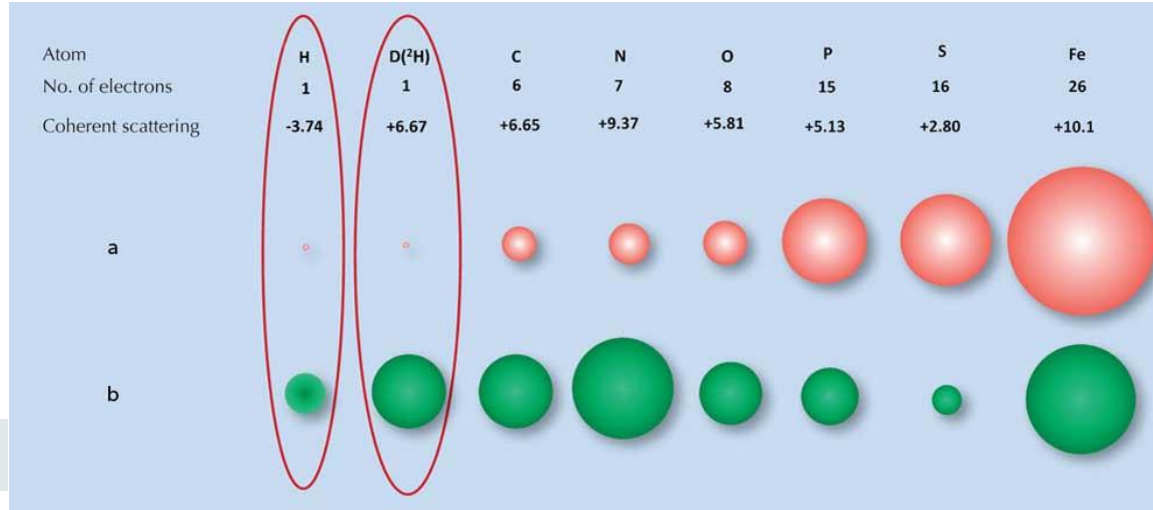
# Ecosystem for LS and NS Communities



# RI with focus on Light and Neutron



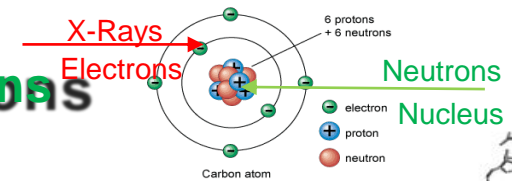
Courtesy Lenny Rivkin/PSI



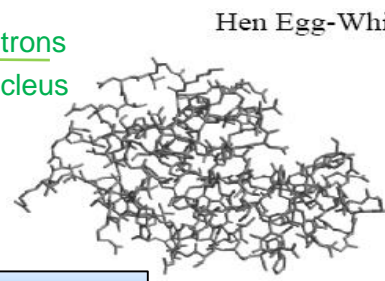
with X-Rays eyes



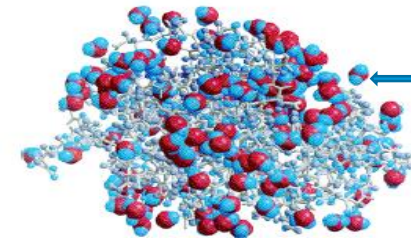
with Neutrons eyes



H atoms make up ~50% of atoms of biological macromolecules (lipids, proteins, nucleic acids, carbohydrates)



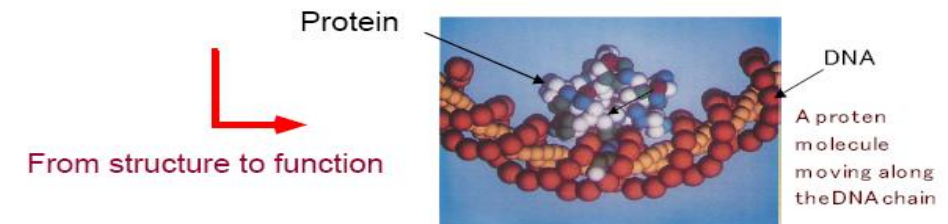
X-rays



Water molecules Observed with neutrons

N. Niimura, et al.

Neutrons



From structure to function





# Light Sources distribution

[See Introduction to synchrotron radiation physics and applications at ASP2016](#)

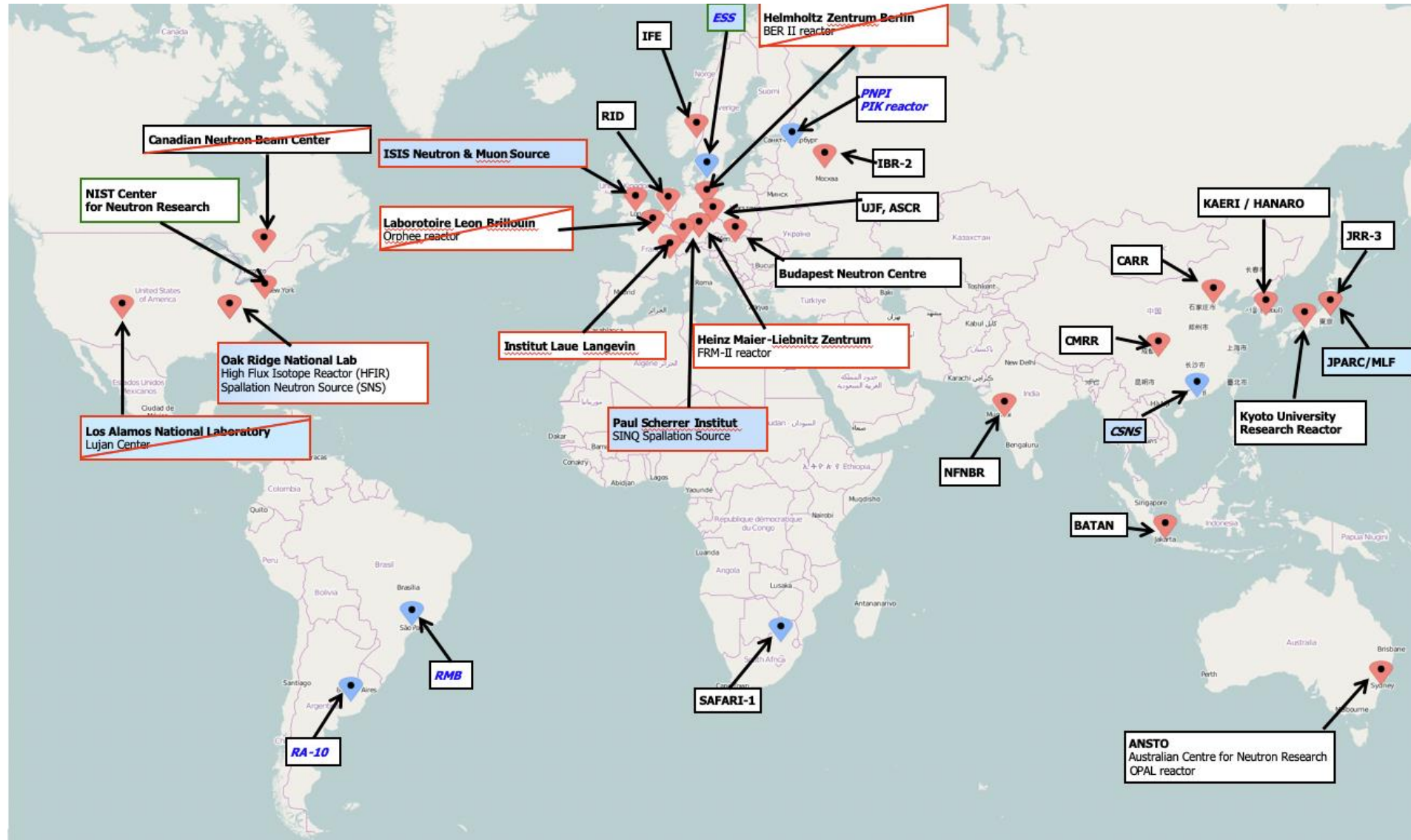


Courtesy Caterina Biscari, ALBA LS Director

# Neutron Scattering Facilities



See [Connecting Industrial R&D Staff to State-of-the-Art Neutron Methods](#)







# Science with Neutrons

## Addressing challenges in energy, materials and health

### HEALTH

With neutrons, we are able to **study the building blocks of the human body** by understanding how proteins, enzymes and other biological material work on the molecular and atomic level.

This includes research on DNA molecules and proteins that control aging and cancer, organs like muscles and teeth, and constructing better medical implants.

### NEW MATERIALS

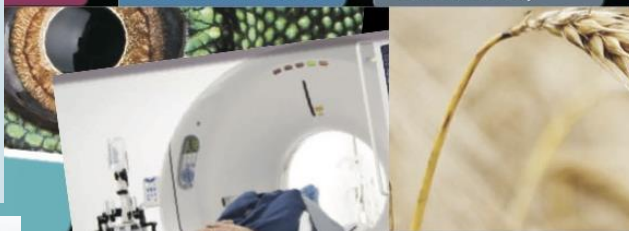
Mobile phone and computer technology are developing fast while new technologies like LED lighting are emerging. **New products full of advanced materials** surround us in our everyday life.

Today's materials must be lighter, stronger, cheaper and sustainable. Neutrons help us not only understand the atomic structure of materials, but also their behavior.



Electronics and IT

Manufacturing and industry



Disease resistant

Super superconductors



Enhanced oil recovery

Infection sensors

### ENERGY

Neutrons enable the potential for **developing more environmentally friendly products** and processes. Fuel cells driven by hydrogen, materials used for solar power, and telephone batteries are some of the areas that benefit from neutron technology.



### FOOD

Consumers demand safe and healthy food, creating a need for companies to understand **the complex structure of food and ingredients**.



Neutrons are used to **study enzyme structures and what happens during chemical processes**. The non-destructive analysis techniques can reveal protein and emulsion structures and reduce energy consumption in food production.

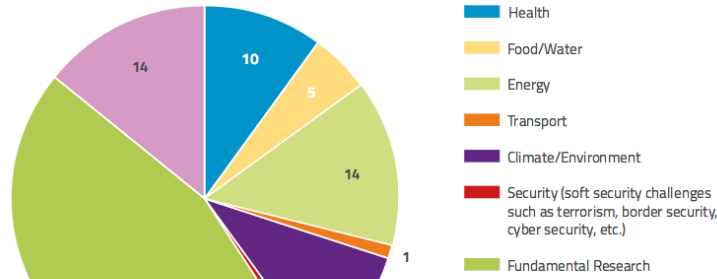
# BrightnESS survey



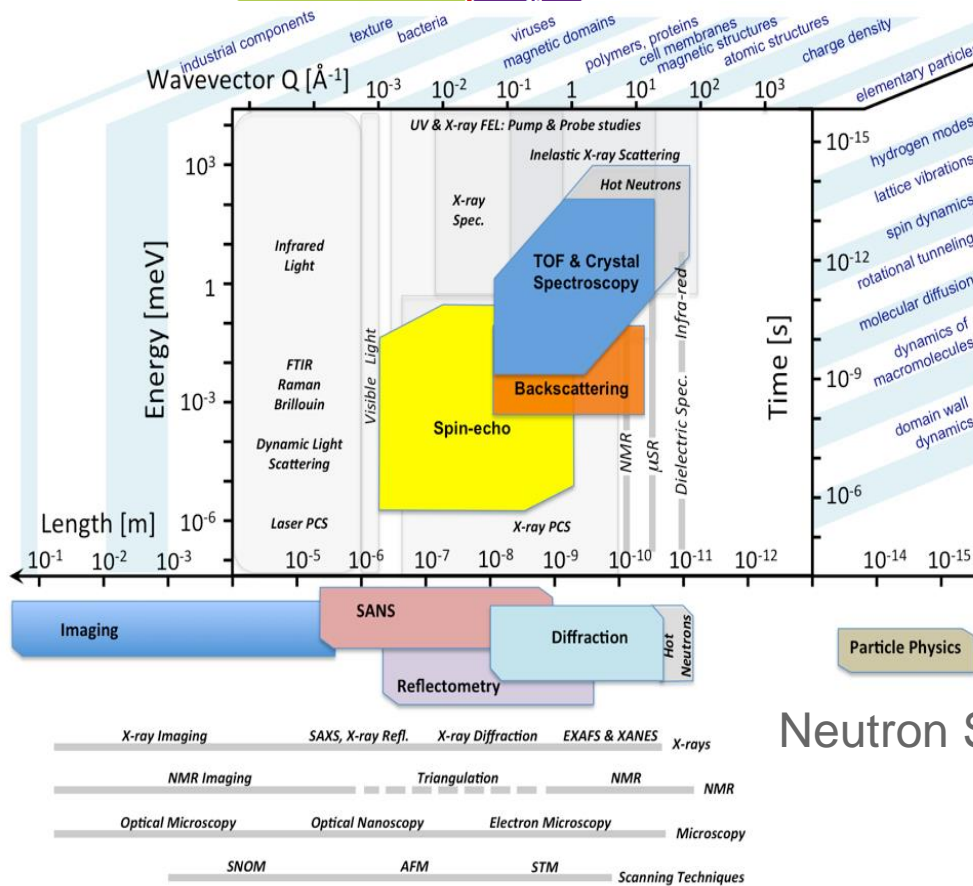
Fig 3.15 Europe: Science fields per method expressed as a percentage of experiments



Fig 3.14 Europe: Horizon 2020 topics and challenges expressed as a percentage of research, averaged over all participating neutron sources



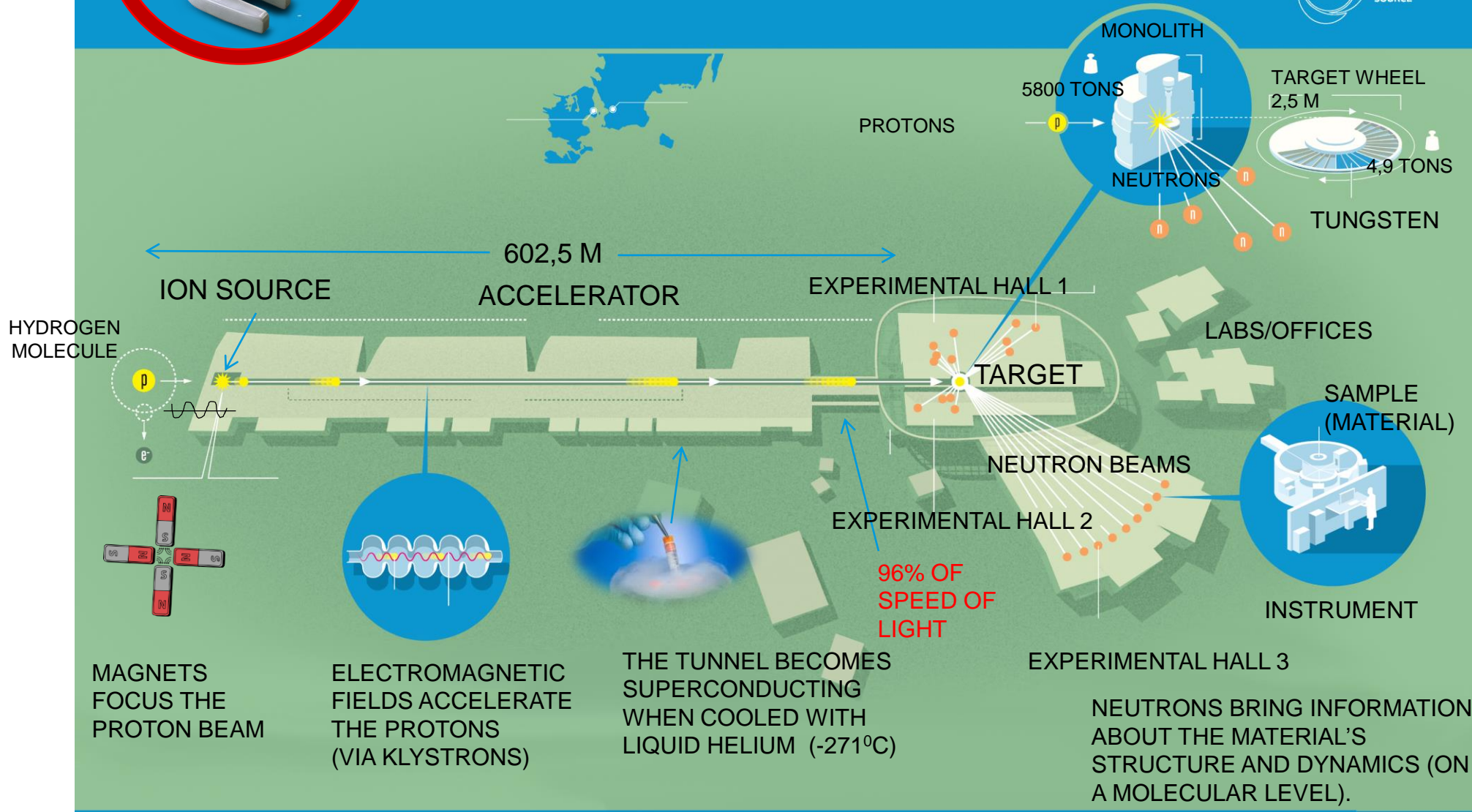
To understand the role of key players in the innovation ecosystem that ESS will foster !



## Neutron Scattering Techniques



# The ESS Machine



# European Spallation Source In-Kind model case

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- ◆ European regulations and legislations
- ◆ Examples of Applications to Accelerator, Target and Instrument





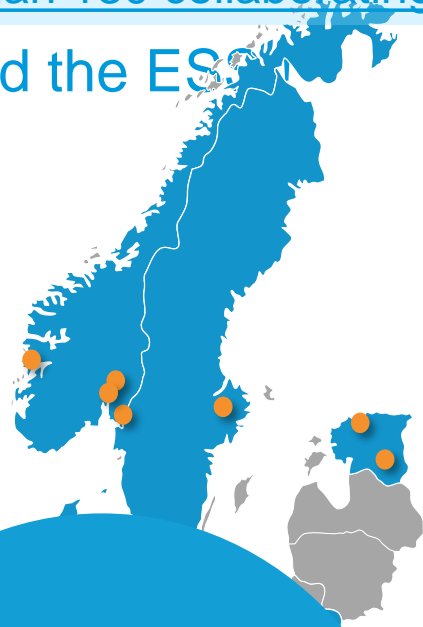
# In-Kind Model

ESS is working with more than 40 European partner institutions, and more than 130 collaborating institutions worldwide under the in-kind model



Partnership and Collaboration to build the ESS

- Aarhus University
- Atomki - Institute for Nuclear Research
- Bergen University
- CEA Saclay, Paris
- Centre for Energy Research, Budapest
- Centre for Nuclear Research, Poland, (NCBJ)
- CNR, Rome
- CNRS Orsay, Paris
- Cockcroft Institute
- Elettra
- ESS
- Fermilab
- INFN
- INM
- Institute of Nuclear Physics, Krakow
- Res
- Rutherford Appleton Laboratory



- Kopenhagen University
- Laboratoire Léon Brillouin (CEA – CNRS – LLB)
- Lund University
- Nuclear Physics Institute of the ASCR
- Oslo University
- Paul Scherrer Institute (PSI)
- Polska Akademia Nauk - PGE
- R

**~516**  
Employees

**~57**  
Nationalities

**> 40**  
Collaborating Institutions





# A Pan-European Project

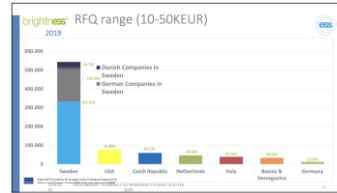
Financing includes cash and deliverables

## The European Spallation Source ERIC

Host Countries Sweden and Denmark

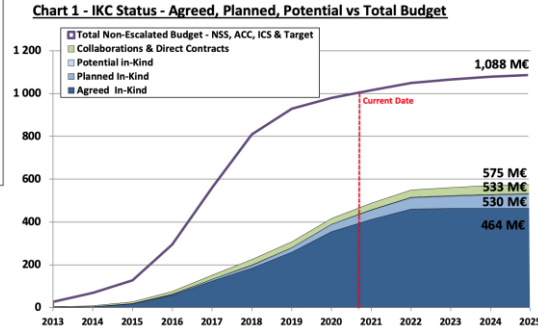
[ERIC legal framework](#) was created by the European Commission in 2009 ([.pdf](#))

Construction 47.5% Cash Investment ~ 97%  
Operations 15%

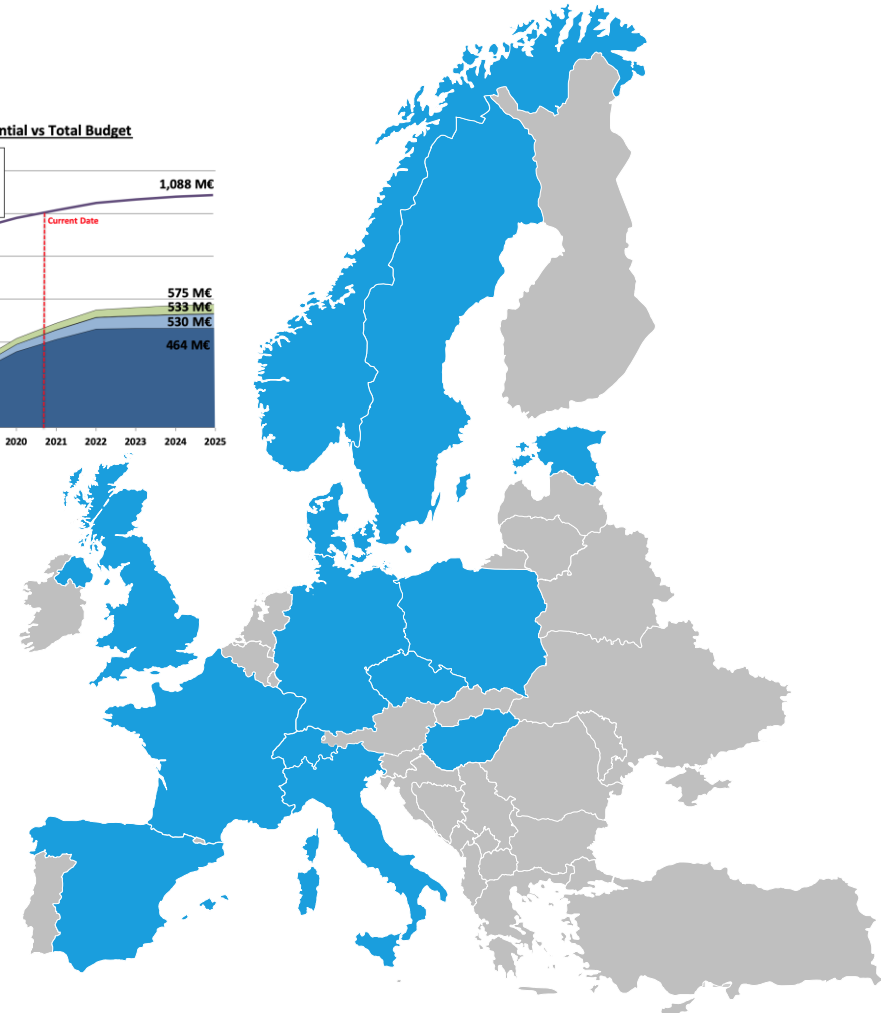


Non Host Member Countries

Construction 52.5% In-kind Deliverables ~ 70%  
Operations 85%



13+2 European Member and Observer Countries



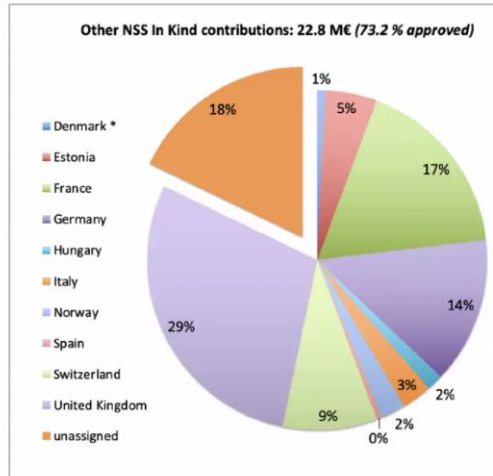
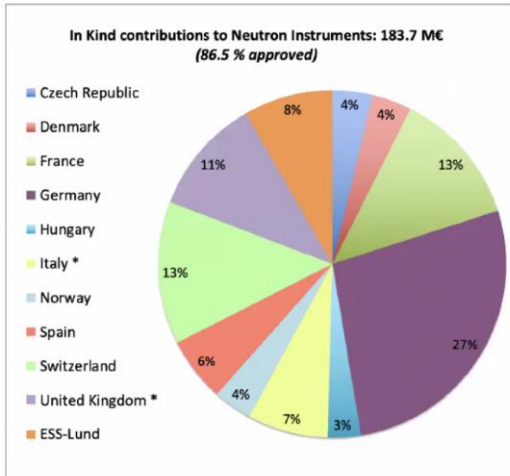
# Procurement for In-Kind and In-House



## Example of Instruments

### In-Kind Contributions: Summary by Country

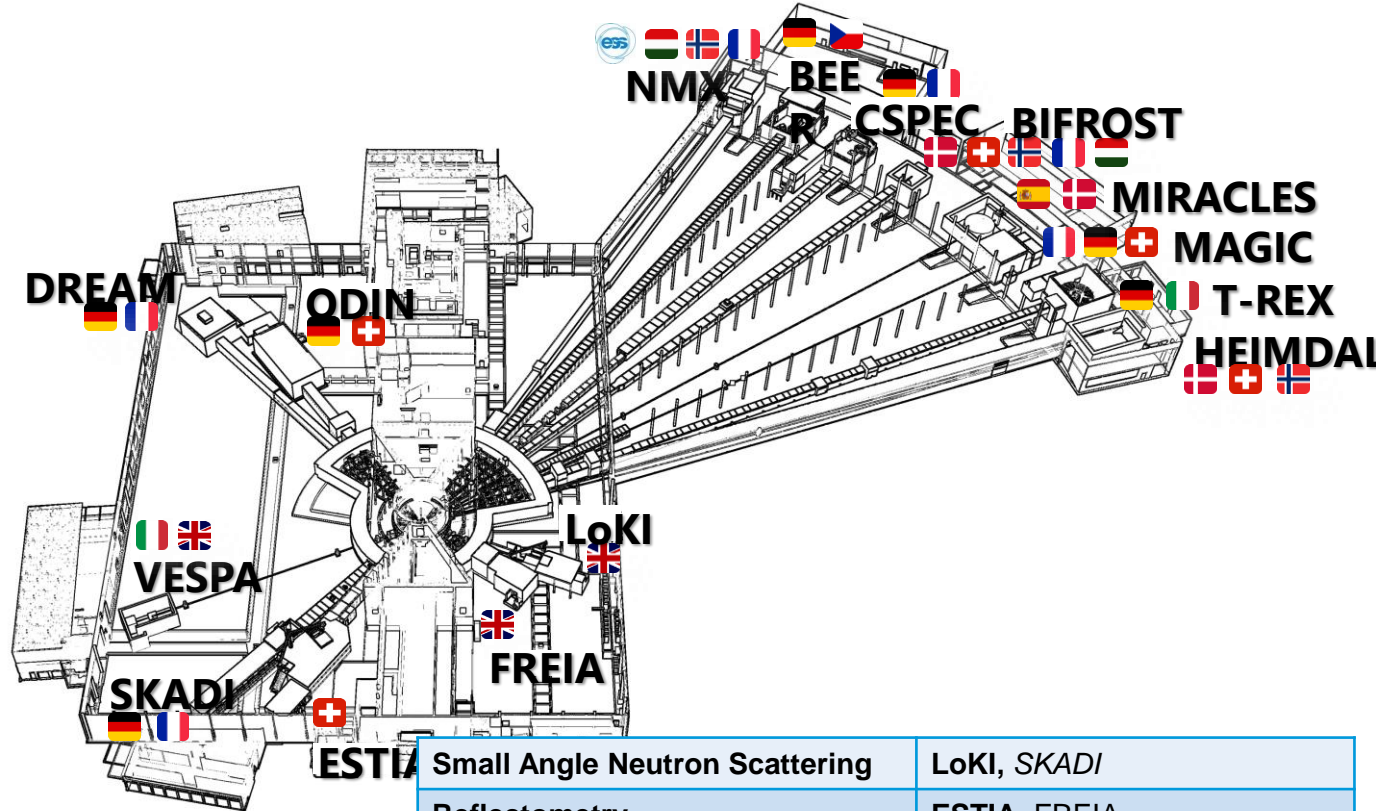
IKC constitutes 60 % of NSS scope



Total IK contributions (approved, planned & potential): 209.4 M€ (92 % of the NSS IK target)

\* Nominal split of IT (90%) & UK (10%) contributions to VESPA under review - could shift delivery further to UK & ESS

May 2020



Small Angle Neutron Scattering	LoKI, SKADI
Reflectometry	ESTIA, FREIA
Single-Crystal Diffraction	MAGiC, NMX
Powder Diffraction	DREAM, HEIMDAL
Imaging & Engineering	ODIN, BEER
Direct-Geometry Spectroscopy	CSPEC, T-REX
Indirect-Geometry Spectroscopy	BIFROST, MIRACLES, VESPA

ESS to drive:

Neutron bunker, radiation shielding, design support for common projects such as choppers, detectors, beam monitors and shutter systems

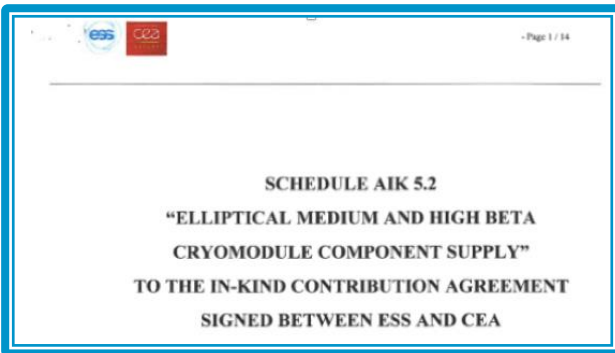
# In-Kind Agreement Process

## .. And complying with European Directives



← Contracts between ESS and In-Kind partners are composed of IKCA and Technical Annexes

- Technical requirement/scope
- Product compliance with European Directives
- National regulation and harmonized standards
- Project Quality Plan



- Methodology supported by ESS Management System and ESS handbooks
- Tools to facilitate data transfer and integration
- Continuous follow up from technical experts from In-Kind partner and ESS



EUROPEAN  
SPALLATION  
SOURCE

Document Type	Document Template
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Date	Feb 7, 2018
Revision	4
State	Released
Confidentiality Level	Internal
Page	1 (15)

### SCHEDULE TECHNICAL ANNEX - GENERIC TO THE IN-KIND CONTRIBUTION AGREEMENT SIGNED BETWEEN ESS AND PARTNER ON DATE

#### 1. SCOPE

This document describes the Scope of Work (SoW) required to complete the <<In Kind name>> contribution to the ESS programme. It is an integral part of the In-Kind Contribution Agreement and is agreed upon by all undersigning Parties. The SoW contains an appropriate level of detail so all parties clearly understand what work is required, the duration of the work involved, the deliverables and the conditions of acceptance. 4

#### 2. RELATED DOCUMENTS

##### 2.1. Applicable Documents

<<Please input all applicable references that will support the execution of the SoW. It should contain technical documentation e.g. a system requirement document provided by European Spallation Source ERIC, applicable templates for the documentary deliverables. This section might refer to an ESS programme management plan.>>

- [CCP] ESS-0001879 Procedure of Change Control of ESS Facility, 27 Feb 2017, Rev.5 Released
- [CMP] ESS-0003688 Configuration Management Plan, 1 May 2016, Rev.2 Released
- [DRP] ESS-0008910 Design Review Standard Operating Procedure, 27 Oct 2014, Rev.1 Released
- [ESM] ESS-0013139 EV-Schedule-Milestone Template and Instructions, 10 Feb 2016, Rev.2 Released
- [IMP] ESS-0002917 Interface Management Plan, 7 Nov 2013, Rev.1 Released
- [ISS] ESS-0017560 TS, AD, NSS and ICS Plan and Implementation Strategy for Hazardous Materials and Sustainability, 8 Feb 2016, Rev.1 Released
- [LOG] ESS-0042559 ESS Logistics Guidelines, 26 Oct 2015, Rev.1 Released
- [OLH] ESS-0048868 ESS Procedure for Offsite Lending of Hardware, 22 Apr 2016, Rev.1 Released
- [PQP] ESS-0037830 ESS Template for Project Quality Plan, 22 Sep 2015, Rev.1 Released

Template: Technical Annex - Generic (ESS-0047398) Rev. 4, Actual date: Feb 7, 2018

Document Type	Document Template	Date	Feb 7, 2018
Document Number	ESS-0047398	State	Released
Revision	4	Confidentiality Level	Internal

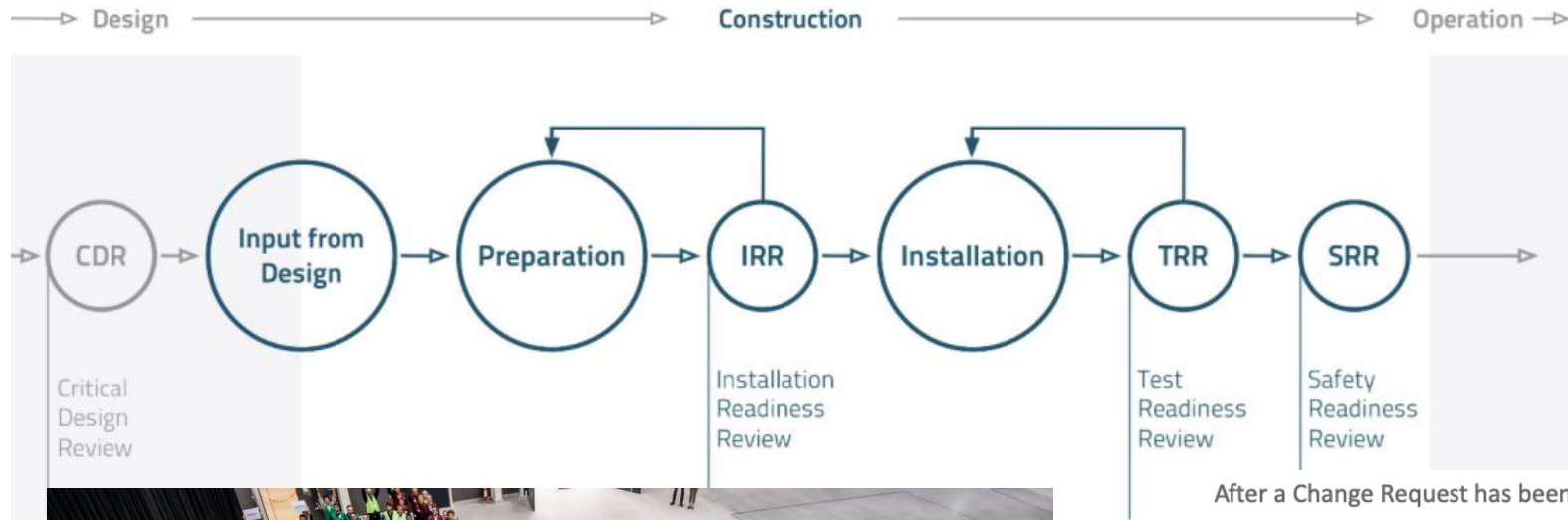
- [RCM] ESS-0127031 ESS Rules for CE Marking, 29 Dec 2017, Rev.1 Released
- [RMP] ESS-0000263 ESS Process for Risk Management Process, 24 Nov 2014, Rev. 4 Released
- [SEM] ESS-0002908 System Engineering Management Plan, 17 Feb 2012, Rev. 1 Released





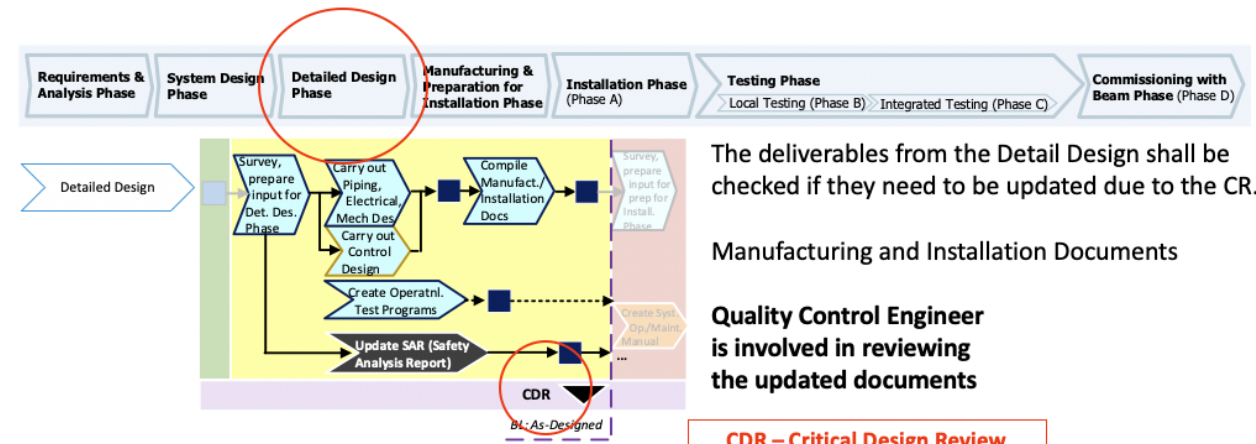
# Work-Packages and Project follow-up

## Engineering Handbook and ESS Guidances (ESS Management System)



After a Change Request has been accepted, the project/WP will go back to the Engineering phase.

Reference: ESS-0092276 ESS Handbook for Engineering Management



The deliverables from the Detail Design shall be checked if they need to be updated due to the CR.

Manufacturing and Installation Documents

**Quality Control Engineer is involved in reviewing the updated documents**

**CDR – Critical Design Review**  
**Quality Control is part of the review committee**



# Work-Packages and Project follow-up

## Alignment with European regulations, legislations and Essential (Safety) Requirements (ESR) of the Directives for In-Kind products

Identify (safety) Hazard in the following field:

- Electrical
- Chemical
- Biological
- Cryogenic, ODH
- Ionization radiation
- Artificial optical radiation
- Magnetic field/EM waves
- Hazard due to cold/heat/fire
- Mechanical
- Pressure
- Workplace
- Ergonomic

List of potential hazards		Step 1: Identification of hazards		Step 2: Identify applicable legislation and suggest mitigating standards		Step 3: Documentation provided by owner		Step 4: Verification of provided documentation		Comments
Hazard No.	Hazard	Yes	No	Applicable directives	Suggested standards	Further actions and Required documentation	Documentation provided	Status	Final date	
<b>1 Electrical safety</b>										
1.1	Is there any electrical equipment?									
1.2	Is there any voltage $\geq 0$ V ac?									
1.3	Is there any voltage $\geq 6$ V ac but $< 25$ V ac?									
1.4	Is there any voltage $\geq 25$ V ac but $< 50$ V ac?									
1.5	Is there any voltage $\geq 50$ but $< 1000$ V ac?									
1.6	Is there any voltage $\geq 1000$ V ac?									
1.7	Is there any voltage $\geq 15$ V dc?									
1.8	Is there any voltage $\geq 15$ V dc but $< 60$ V dc?									
1.9	Is there any voltage $\geq 60$ V dc but $< 25$ V dc?									
1.10	Is there any voltage $\geq 75$ but $< 1500$ V dc?									
1.11	Is there any voltage $\geq 1500$ V dc?									
1.12	Is there any cable with a voltage $\leq 250$ V?									
1.13	Is there any voltage $\geq 30$ kV?									
1.14	Is there any residual voltage $> 40$ V, more than 1 second after switching off?									
1.15	Is any static electricity present which could present a hazard?									
<b>2 Chemical safety</b>										
2.1	Is there any substance that is of a toxic nature?									
2.2	Is there any substance that is of a flammable nature?									
2.3	Is there any substance that is of a corrosive nature?									

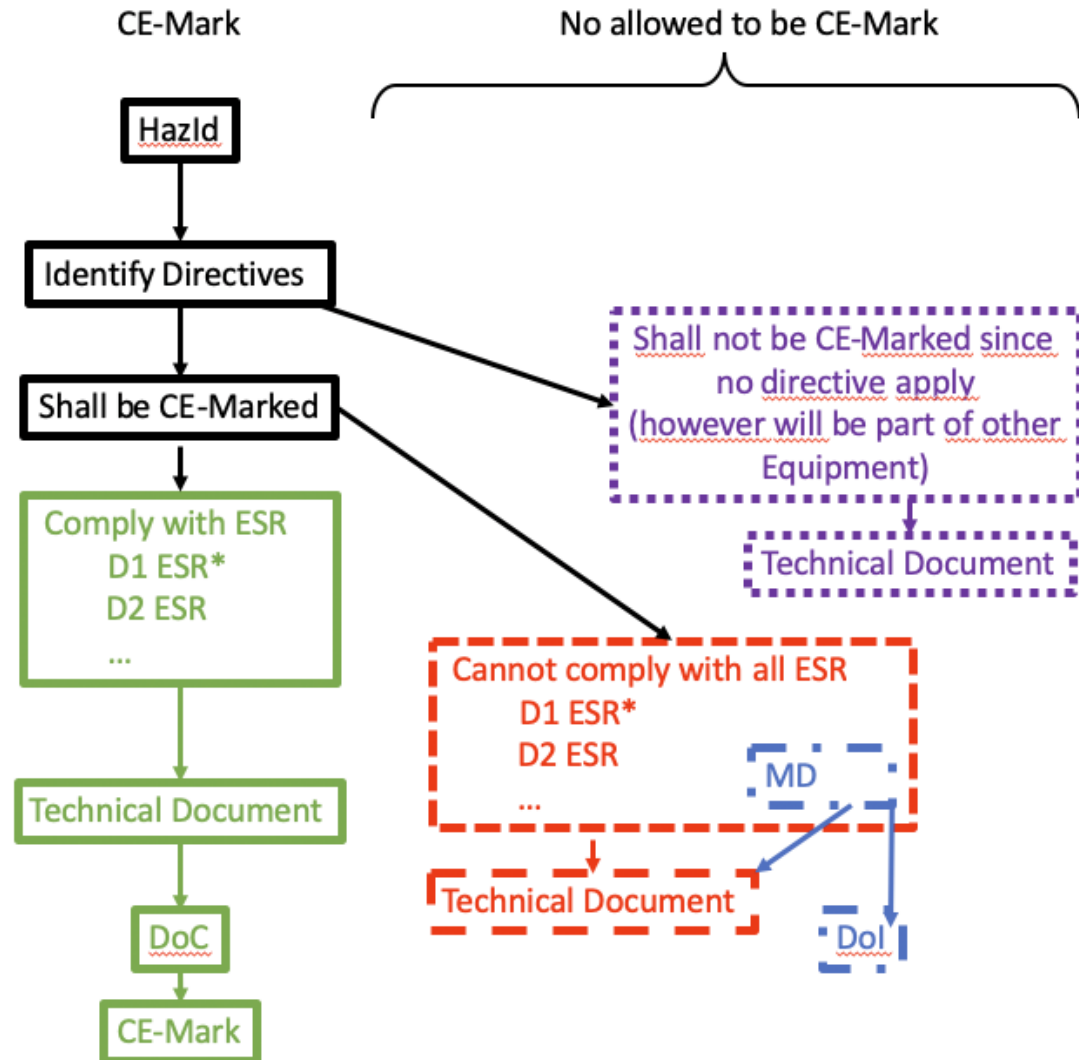
1. Hazard → Directives identified
2. Risk Assessment and proposed mitigations
3. Implement the mitigation
4. **Compile technical documentation**
5. DoC is issued
6. CE-mark is applied to the equipment

e.g. ESS electrical handbook is based on several different standards, among which is EN 60204-1

... in difference to minimum harmonized legislation for installation and use, which is covered by ESS while complying to Swedish laws. The official guidelines to interpret the Product Directives can be found in the Blue Guide.

# Work-Packages and Project follow-up

## Complying with European Directives



Technical Files  
User Instructions

- 1 - No Applicable Directive
- 2 - Directive applicable and complying to ESR
- 3 - Directive applicable and not complying to ESR
- 4 - Partially completed machinery



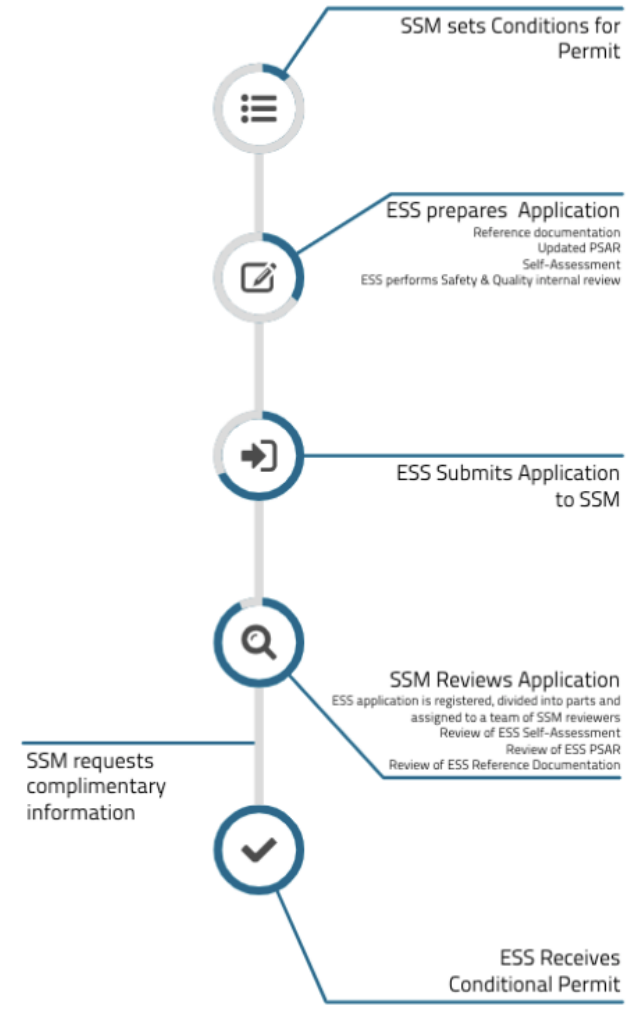
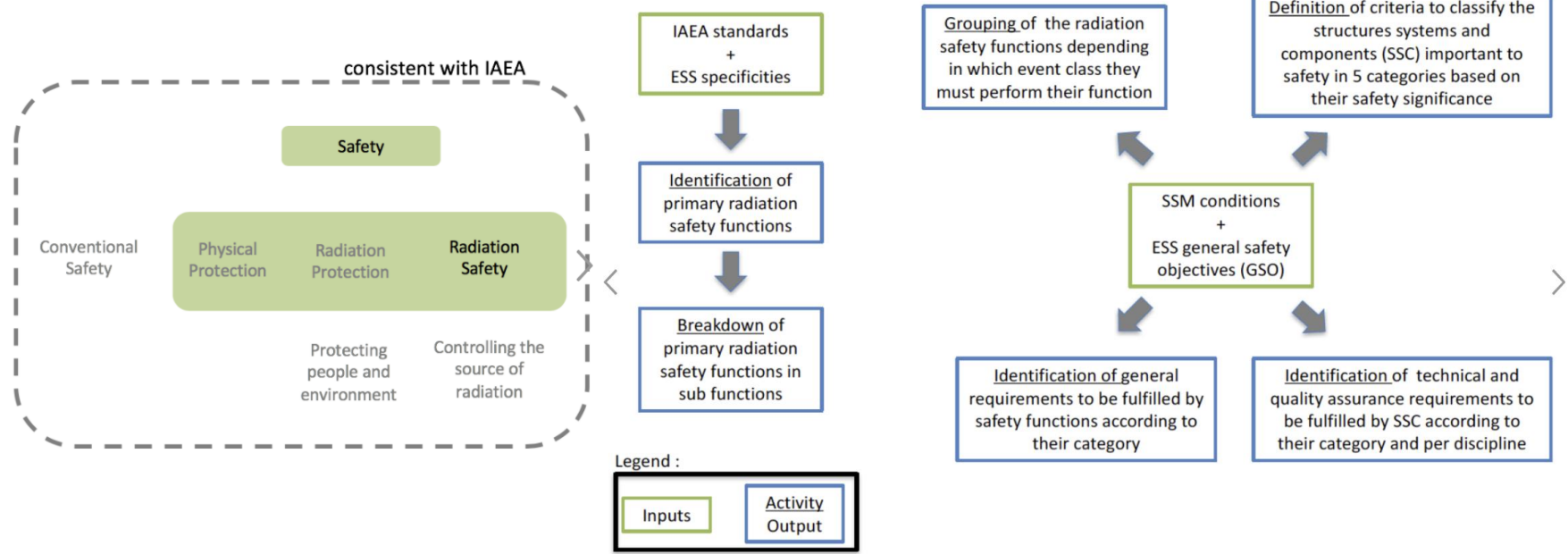


# Safety Radiation and Licensing

## IAEA and National Regulations, Swedish Radiation Safety Authority (SSM)

### The SSM Licensing process at a glance

ESS is not considered as a nuclear facility but as a complex facility which has to comply to special conditions issued by SSM in addition to the relevant parts of the existing regulation.



# Radiological hazard identification



## IAEA and National Regulations

ESS objectives (effective dose)				
Operating conditions and likelihood (per year) of initiating event	Exposed worker with safety task	Exposed worker without safety task	Non-exposed worker	Public (off-site)
Normal operation, H1 (including events with $F \geq 1$ )	Dose limit 20 mSv/year Dose constraints (*) 2 mSv/year	Dose limit 1 mSv/year Dose constraints (*) 0.1 mSv/year	Dose limit 1 mSv/year Dose constraints (*) 0.1 mSv/year	Dose limit 1 mSv/year Dose constraint 0.1 mSv/year
Anticipated events, H2 $F \geq 10^{-2}$	Design criteria 20 mSv/event	Plan protective action based on realistic estimations for typical cases and applying ALARA via a respective ESS committee and an established ESS guideline [6].		Design criteria 0.1 mSv/event
Unanticipated events, H3 $10^{-4} \leq F < 10^{-2}$				Design criteria 1 mSv/event
Improbable events, H4A $10^{-6} \leq F < 10^{-4}$				Design criteria 20 mSv/event
Improbable events, H4B $10^{-4} \leq F$ <small>H2 and H3 combined with CCF</small>		N/A	N/A	Design criteria 20 mSv/event
Highly improbable events, H5 $10^{-7} \leq F < 10^{-6}$	Design criteria 100 mSv/event	Excluded from further evaluation since it is an acceptable residual risk.		Design criteria 100 mSv/event
Extremely improbable events $F < 10^{-7}$	Excluded from further evaluation since it is an acceptable residual risk.			

Risk assessment to define category: Radiation safety objectives expressed as dose limits, dose constraints and design criteria, for each event class, or the different categories of workers and for the public.

Events and circumstances that can affect the facility and its environment are ranked based on their likelihood

The radiation safety functions RSF are the functions implemented to stay below the limits defined for the public

The workers radiation safety functions WRSF are the functions implemented to stay below the limits defined for the workers



The RSF are identified through the radiation safety analysis using deterministic approach and DiD principle

The WRSF are identified through a general risk assessment

# Radiological hazard identification

## TASK FORCE (TF) IN ACTION

Courtesy Francois Javier



The TF is driving the effort to:

- Implement and clarify the ESS approach for radiation safety analysis, RSF/WRSF identification and classification, and categorisation of SSCs
- Confirm and detail the deliverables
- Update existing radiation safety analyses and RSF, WRSF identification
- Execute complementary radiation safety analyses and RSF/WRSF identification
- Update/complement classification of RSF & categorisation of corresponding SSCs

Common and  
consistent ESS  
approach

Explain  
Align  
Train  
Do  
Coordinate  
Deliver

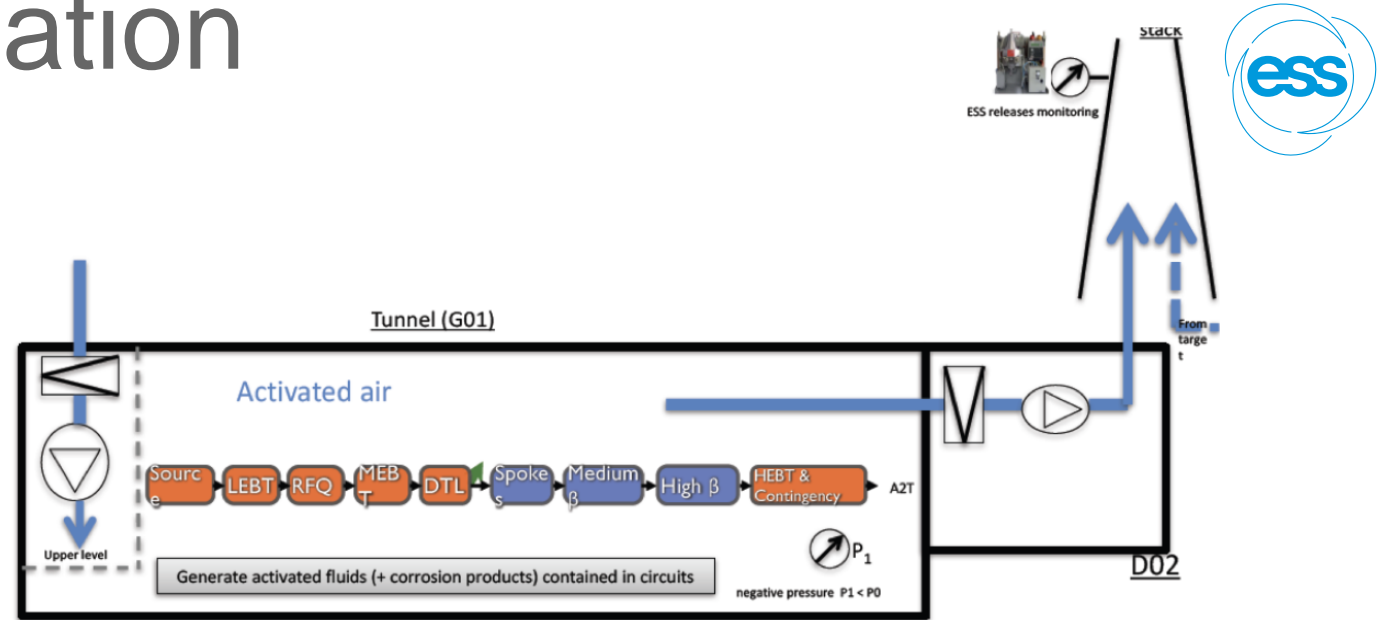


# ESS Safety Radiation

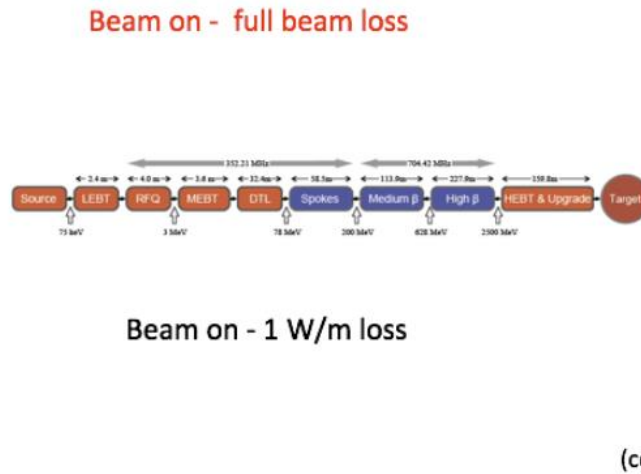
## Accelerator

Radioactive inventory from activated air from prompt radiation with beam losses of 1 W/m

15 DAC (Derived Airborne Contamination) max (14 GBq) in the tunnel during operation and beam on (1 W/m loss) with renewal HVAC = 0 (with rHVAC = 0.5, 10 GBq corresponding to 9 DAC)



## Prompt radiation



400 mSv/h max on berm



2  $\mu$ Sv/h max on berm

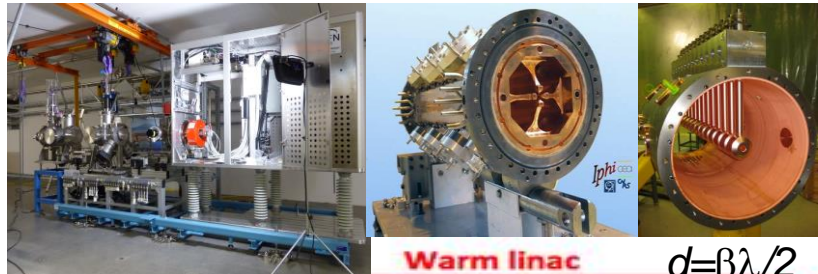
Closest area off site – max 4 mSv/h



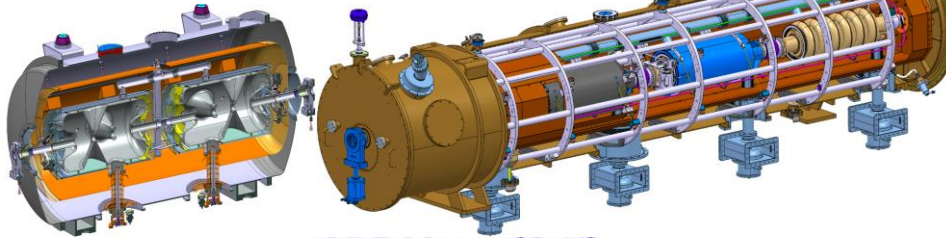
Closest area off site – max 2 nSv/h

# Accelerator ionization radiation

see Episode dating October 10, 2020



Warm linac  $d = \beta\lambda/2$



SRF Linac (2 K)

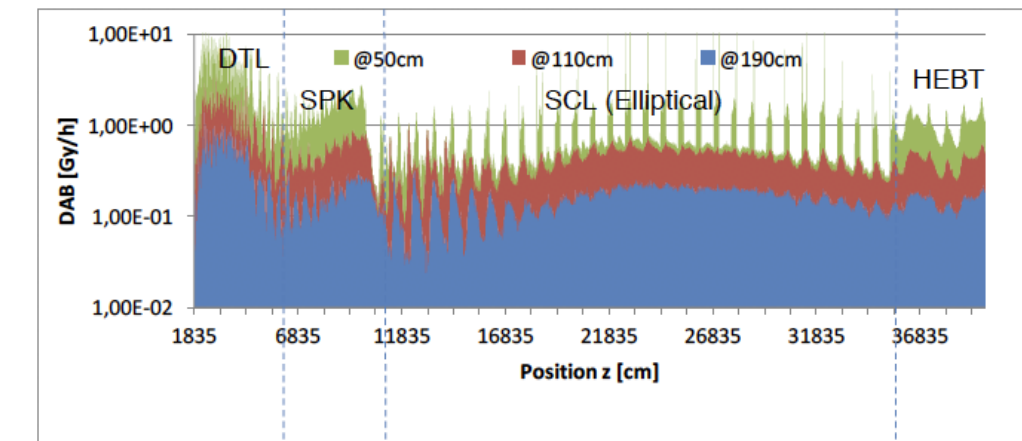
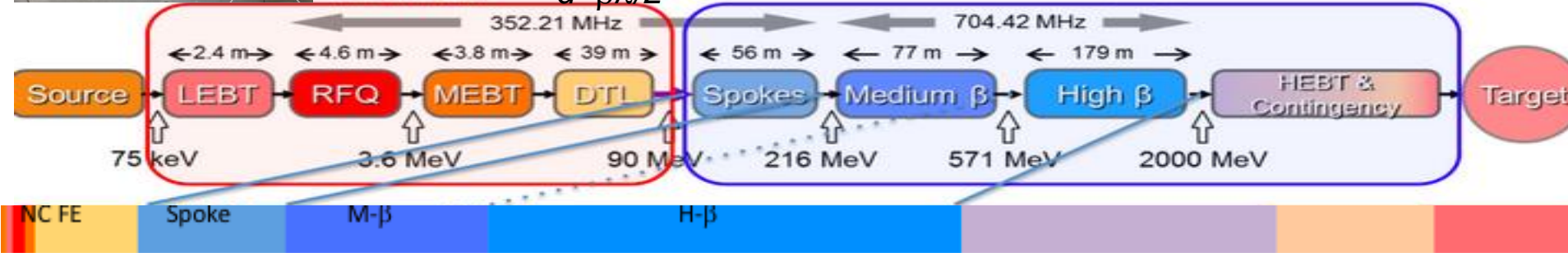
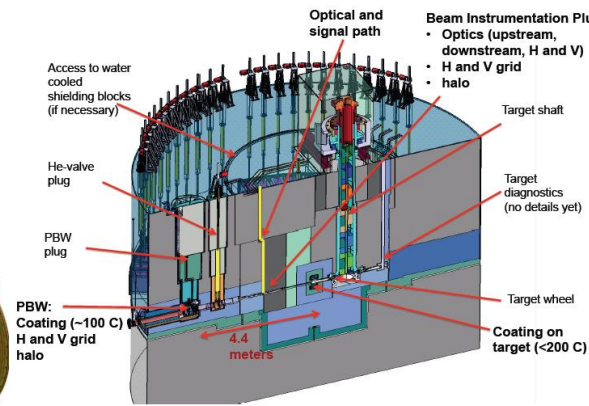


Figure 5 - Absorbed dose maps for 50, 110 and 190 cm from the beam centre [Gy/h]

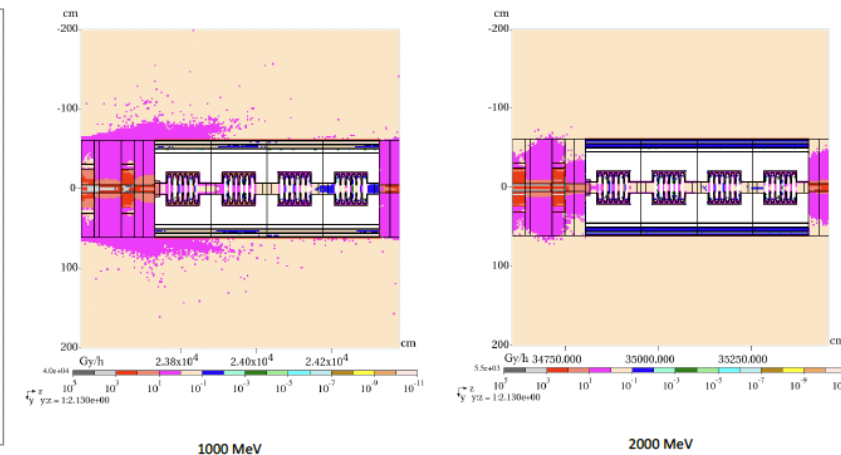


Figure 7 - Dose absorbed at ~ 200, 500, 1000 and 2000 MeV [Gy/h]

Product specification by IK following ESS requirements, e.g.:

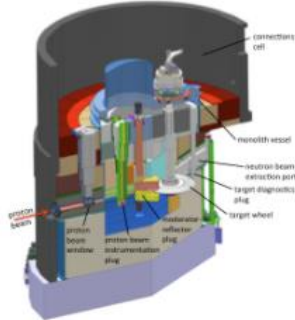
- Radiation-hard (e.g. electronics, materials, instrumentation,)
- Risk Analysis
- Preventive maintenance and monitoring

# ESS Safety Radiation and Target

## Radioactive inventory

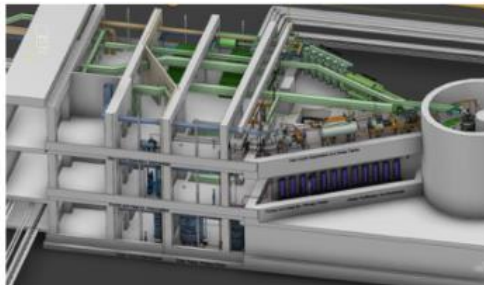
## Prompt and residual dose rate

### Monolith area



$\sim 4.10^{17}$  Bq

### Utility area

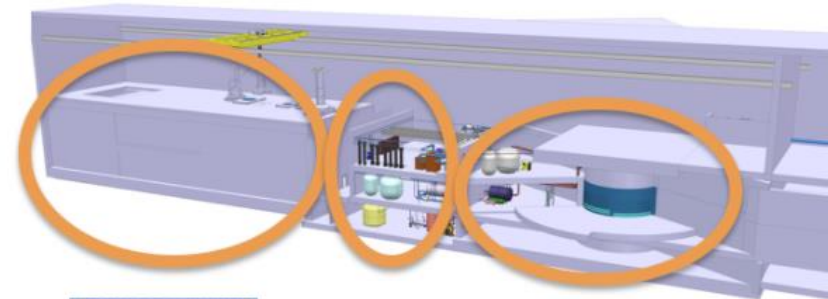


$\sim 4.10^{12}$  Bq

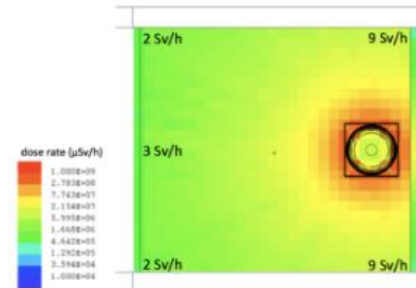
### Active cells facility



$\sim 8.10^{16}$  Bq



Designed to attenuate with a criterion of  $3 \mu\text{Sv/h}$



Dose map of the target wheel (irradiated 5 years + 14 days of cooling time) in the active cell. ( $2000 \text{ Sv/h}$  contact)

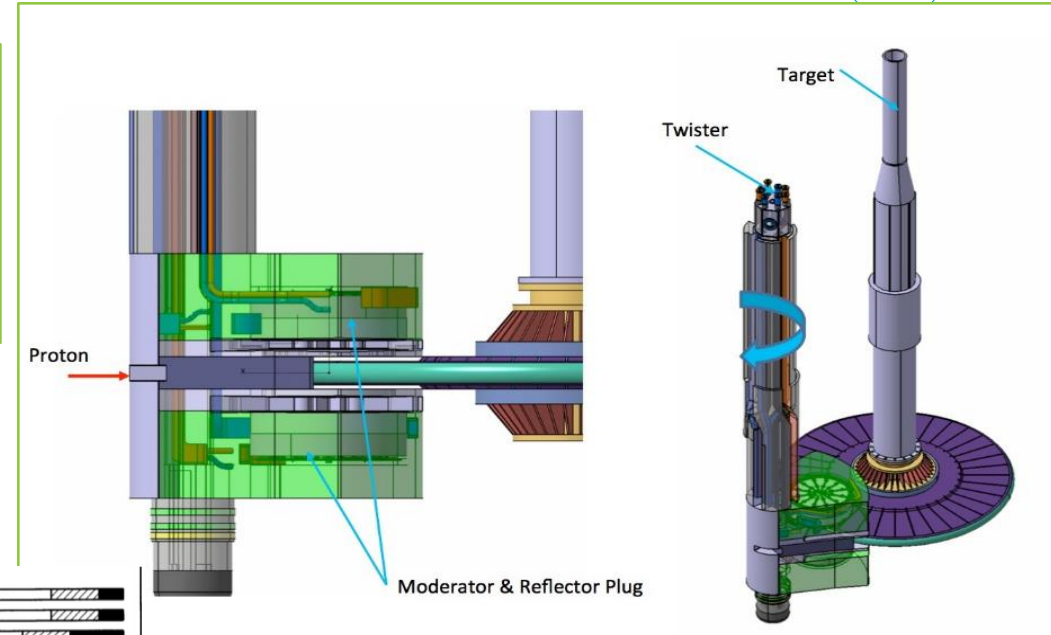
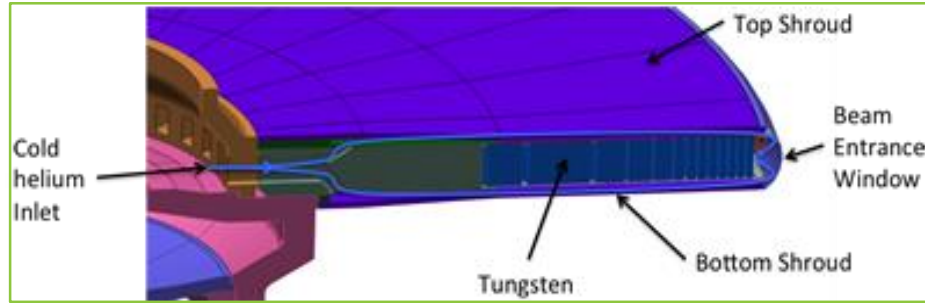
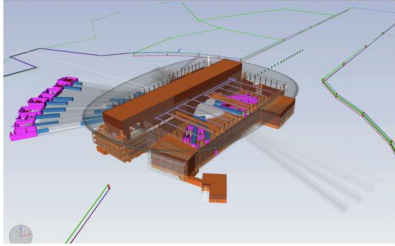


# Target design

## Materials specification

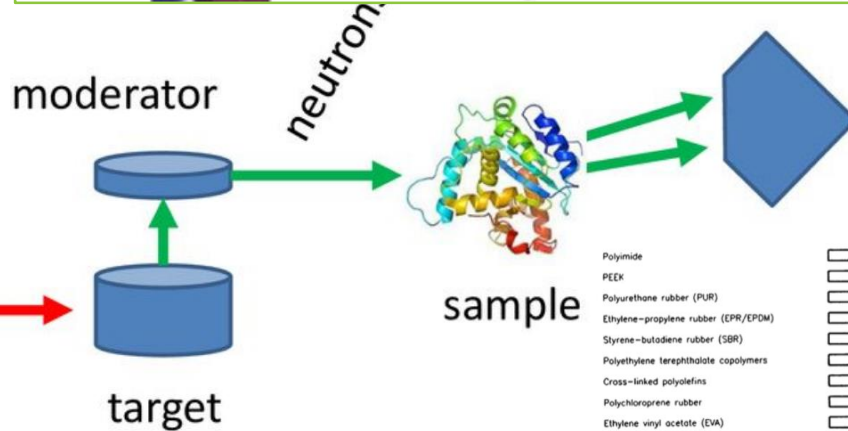
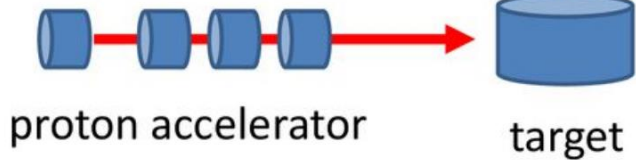
### ESS Materials Handbook

ESS Document Number: ESS-0028465



Editor: Yong Joong Lee, Target Division  
 Authors: Yong Joong Lee, Target Division; Monika Hartl, Scientific Activities Division  
 Reviewers: Günter Muhrer, Group Leader, Spallation Physics Group  
 Approver: Rikard Linander, Head of Target Division

Last Update on July 9, 2020  
 towards Revision 6



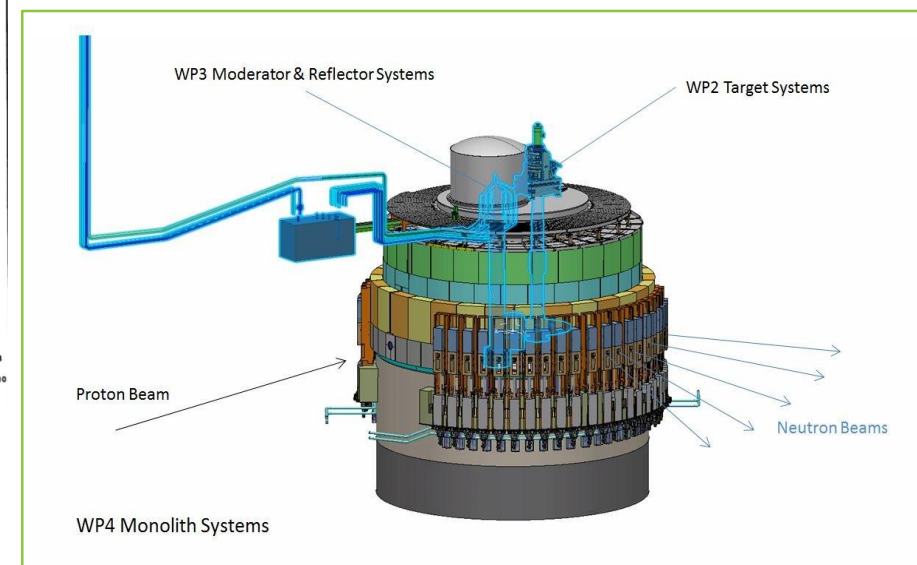
Polyimide	██████████
PEEK	██████████
Polyurethane rubber (PUR)	██████████
Ethylene-propylene rubber (EPR/EPDM)	██████████
Styrene-butadiene rubber (SBR)	██████████
Polyethylene terephthalate copolymers	██████████
Cross-linked polyolefins	██████████
Polychloroprene rubber	██████████
Ethylene vinyl acetate (EVA)	██████████
Polyvinylchloride (PVC)	██████████
Chlorosulfonated polyethylene	██████████
Acrylonitrile rubber	██████████
Polyethylene/Polyolefin (e.g. PE/PP/PO)	██████████
Acrylic rubber (EAR, EEA)	██████████
Silicone rubber (SIR)	██████████
Butyle rubber	██████████
Perfluoroethylene-propylene (FEP)	██████████
Polytetrafluoroethylene (PTFE)	██████████

DOSE IN GRAY: 10<sup>-3</sup>, 10<sup>-4</sup>, 10<sup>-5</sup>, 10<sup>-6</sup>, 10<sup>-7</sup>, 10<sup>-8</sup>  
 DOSE IN RAD: 10<sup>3</sup>, 10<sup>4</sup>, 10<sup>7</sup>, 10<sup>8</sup>, 10<sup>9</sup>, 10<sup>10</sup>

Examples of specification transmitted to suppliers:

- Steel, iron (and Cobalt content) (Test @ ISOLDE and analysis @ DTU)
- Be, lead (and antimony content)
- Maximum grain size for Beryllium (20um) and Niobium (0.064 mm)

Appreciation of Damage	Elongation	Utility	Legend
Incipient to mild	75-100 % OF IN VALUE	Nearly always usable	██████████
Radiation index area	25-75 % OF IN VALUE	Often satisfactory	██████████
Moderate to severe	< 25 % OF IN VALUE	Not recommended	██████████



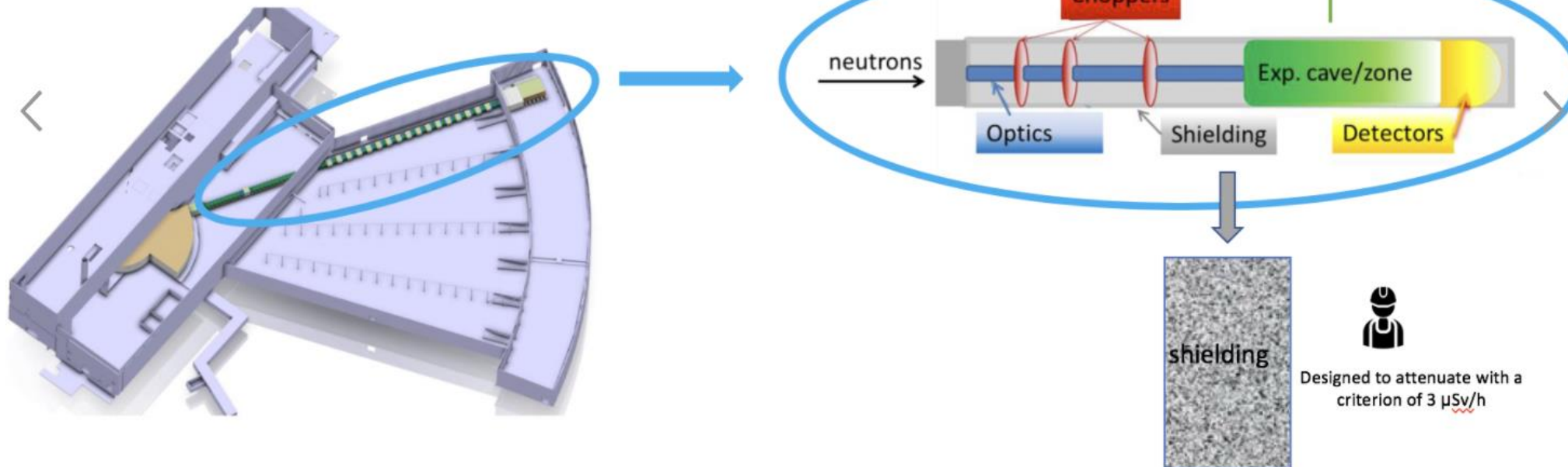
# ESS Safety Radiation and Instrument



## Radioactive inventory and prompt radiation

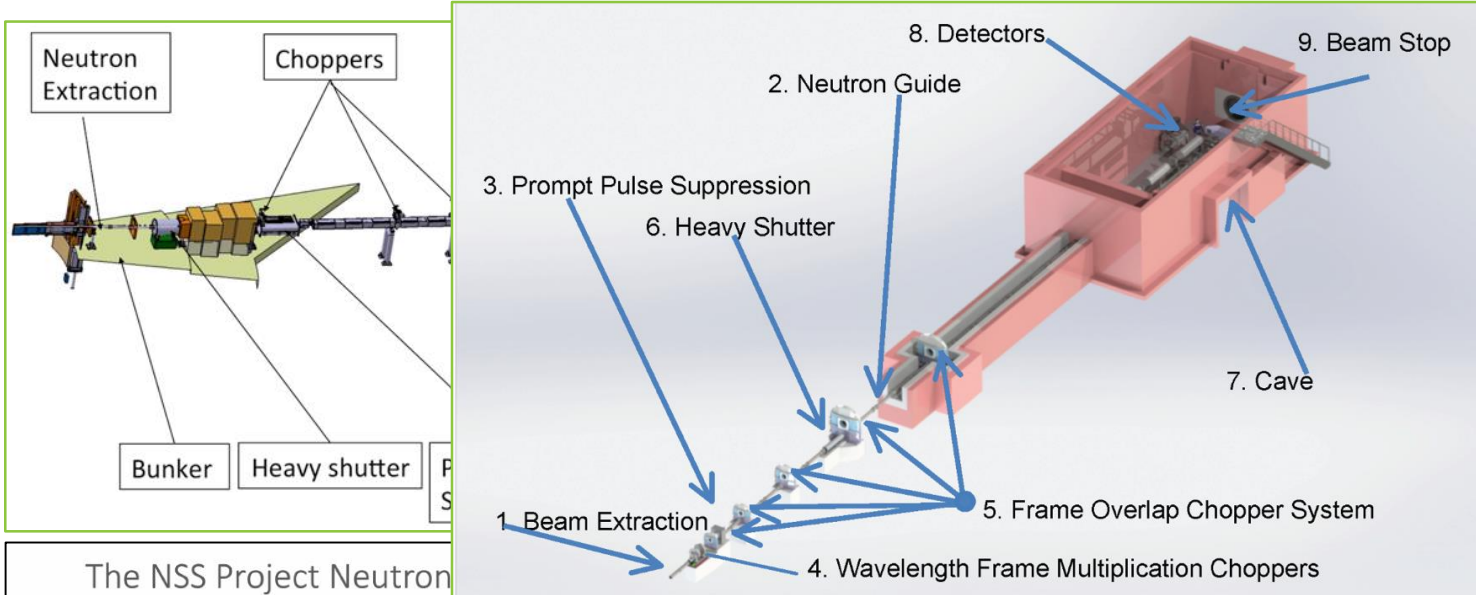
Key technologies and common projects:

Neutron bunker, radiation shielding, choppers, detectors, beam monitors and shutter systems



# Procuring Equipment for Instrument

## Example of Common chopper



### The NSS Project Neutron

Including contribution common shielding and common chopper projects

Neutron Instrument	Common		Partners (% includes ESS common projects)
	Shielding Project	Chopper Project	
LOKI (Broad band SANS)	12.85	●	ISIS (81%) + ESS (19%)
SKADI (General Purpose SANS)	11.50	●	FZJ (50%) + LLB (50%)
ESTIA (Focusing Reflectometer)	11.80	●	PSI (100%)
FREIA (Liquids Reflectometer)	13.20	●	ISIS (78%) + ESS (22%)
DREAM (Bispectral powder diffractometer)	13.66	●	FZJ (76%) + LLB (20%) + ESS (4%)
HEIMDAL (Hybrid diffractometer)	13.55	●	Aarhus U. (30%) + PSI (35%) + IFE (25%) + ESS (10%)
MAGIC (magnetism single xtal diffraction)	13.10	●	LLB (52%) + FZJ (24%) + PSI (16%) + ESS (8%)
NMX (Macromolecular crystallography)	11.67	●	ESS (24%) + WU/IER(53%) + Bergen (22%) + LLB (7%)
BEER (Engineering diffractometer)	14.99	●	NPI (50%) + HZG (50%)
ODIN (multi-purpose imaging)	11.76	●	TUM (60%) + PSI (36%) & ESS (4%)
BIFROST (extreme environment spectro.)	13.45	●	DTU/KU (23%) + PSI (27%) + IFE(14%) + LLB (20%) + ESS (16%)
C-SPEC (cold chopper spectrometer)	16.50	●	TUM (50%) + LLB (40%) + ESS (10%)
T-REX (bispectral chopper spectrometer)	16.85	●	FZJ (75%) + Perugia U. (25%)
VESPA (vibrational spectroscopy)	12.00	●	CNR (100%)
MIRACLES (backscattering spectrometer)	13.4	●	ESS-Bilbao (89%) + KU (2%) + ESS (9%)
<b>200.28</b>			

August 2020 7

86.7 % of Instrument IK scope is in signed TAS

Confirmed (racks only) Potential

ESS Common Shielding saves time and > 2.5 M€

ESS Common Choppers saves time and ~ 1.5M€

### Common chopper CE-Marked Adaptation to Instrument:

1. HazId → Directives identified
2. Risk Assessment and proposed mitigations
3. Implement the mitigation
4. Compile technical documentation
5. DoC is issued
6. CE-mark is applied to the equipment

### Project Status

#### Heavy Shutter

Task no.	TA ID	Deliverables – Project Results	Delivery Date	Status
WU 03	2-8	Heavy Shutter*	Oct 2021	Tender Sep 2021

In-Bunker main components:

- Installation window: 11.8.21 – 25.2.22
- Heavy shutter (TUM):
- Design constraints
  - Pillars + Roof beams + Expansion gap (floor)
  - Max length required: 1.6m
  - Dose requirement: max 3μSv/h in Cave, and 25μSv/h in FOC5 pit
  - Safety factor: 2
- Stopper preliminary design ready:
  - Total thickness 1.2m ✓
  - Maximum attenuation: 1cm B4C + 24cm Steel + 96cm Copper
  - Total Dose: 0.5μSv/h (Cave) and 1.4μSv/h (FOC5 Pit) ✓
  - Guide vacuum vessel: scope of Axilon/SNAG ✓

\* Item agreed to be procured by ESS for TUM



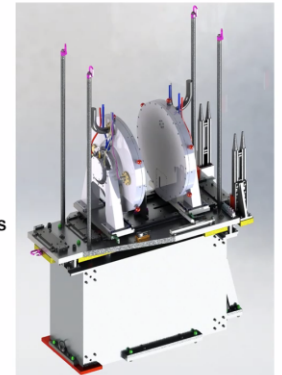
### Project Status

#### Choppers

Task no.	TA ID	Deliverables – Project Results	Delivery Date	Status
WU 05	16-25	Choppers*	Jun 2021	subTG3 accomplished ok

In-Bunker main components:

- Installation window: Jun 21 – Feb 22
- Choppers (TUM)
  - Contract signed with AIRBUS in June 2019
  - subTG3 done Aug 2020 ✓
  - FAT scheduled in March 2021
  - SAT: July 2021
  - Pedestals, WFMC Motion Table and Alignment Interfaces designed and procured by TUM.
  - Choppers on schedule ✓
- Status OK



\* Item agreed to be procured by ESS for TUM



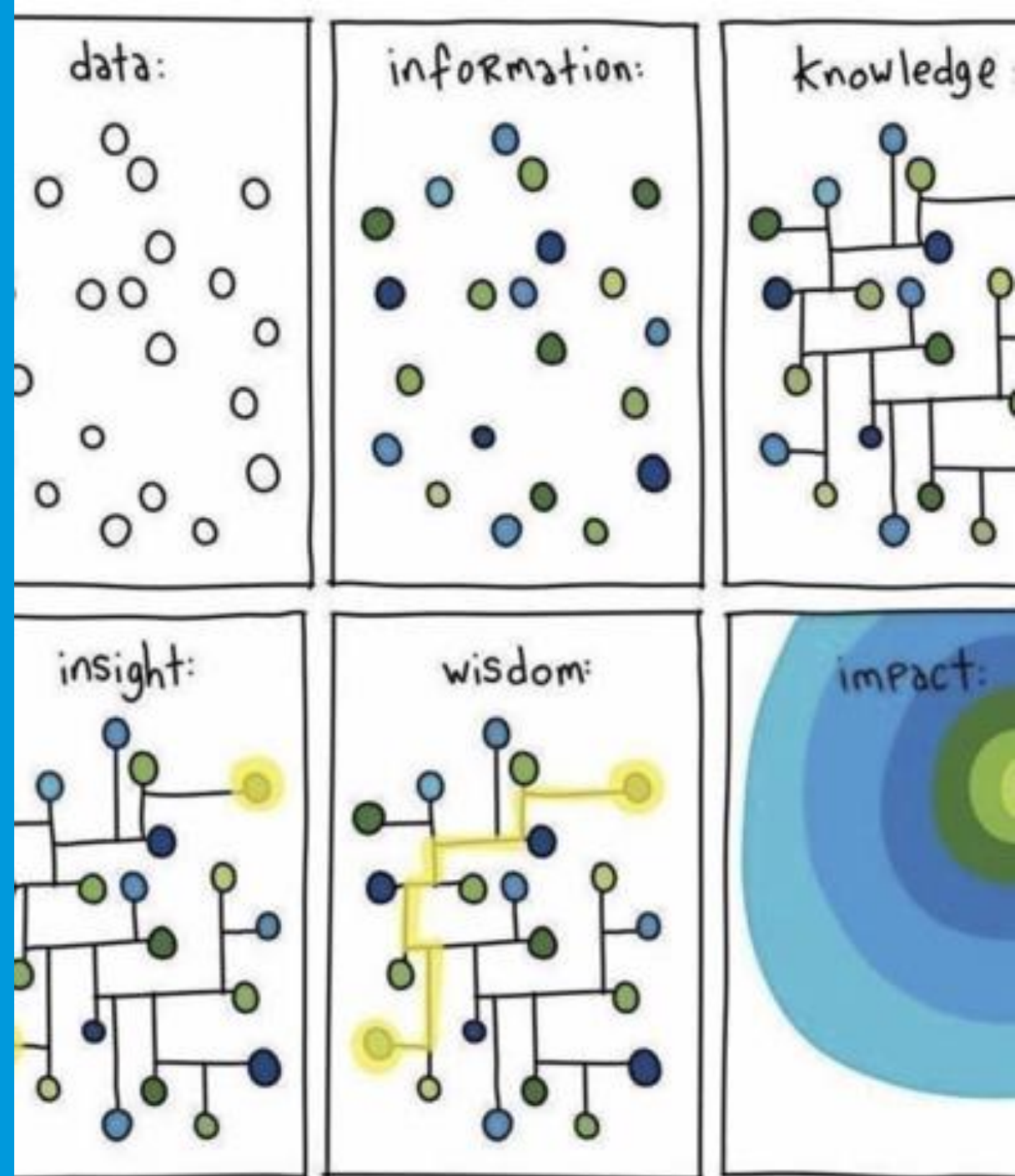
# What you could know about Research Infrastructures...

- ◆ A novel way to learn: ESS Learning

Lounge (LMS)

- ◆ Innovations based on RI

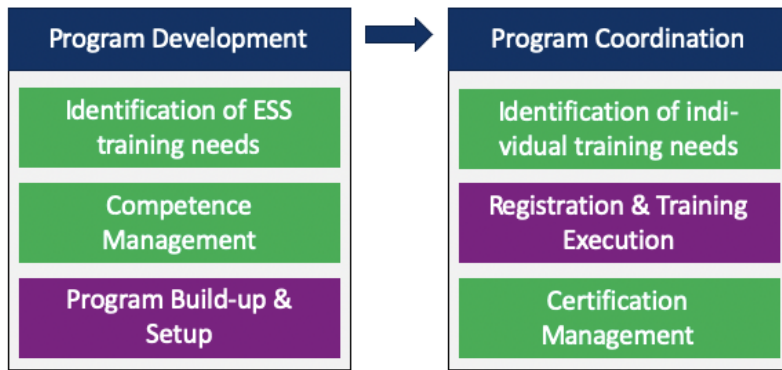
- ◆ Learning more about Physics



# A novel way to learn

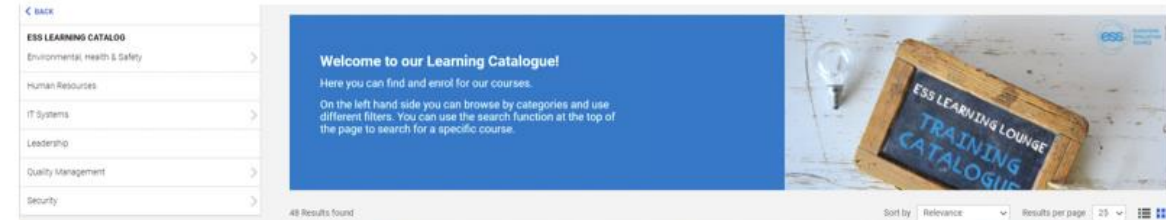
## ESS Learning Lounge

Courtesy Lars Aprin



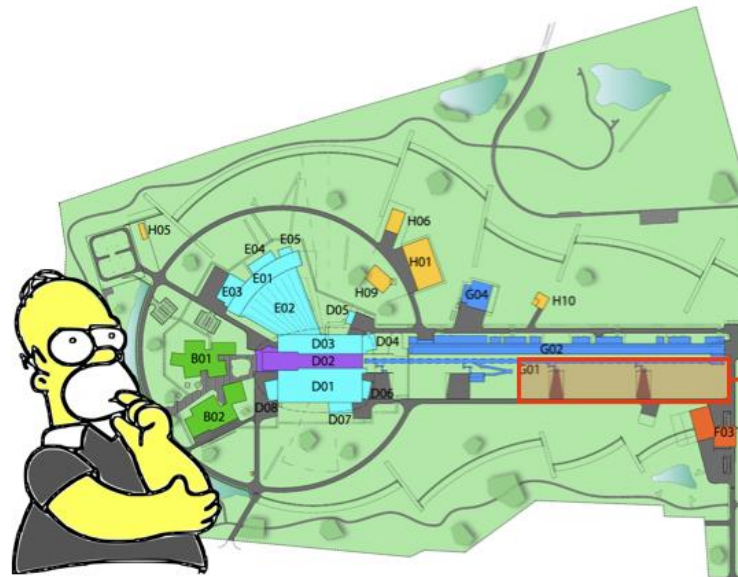
### A glimpse into our LMS

Visit us at <https://ess.sabacloud.com>



### Training plans based on roles

Tell me what your role is, and I'll tell you what trainings you need.



**Role: Electrical Work at G01**

Implementation is being done in LMS (Learner & Supervisor)  
Association between "role" and "curriculum" is based on SME knowledge

Location	Curriculum
G01: warm linac	G01 Training
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...	...

This approach is about to start very soon.  
First prototypes: Test Stand 2, First Responders, G buildings

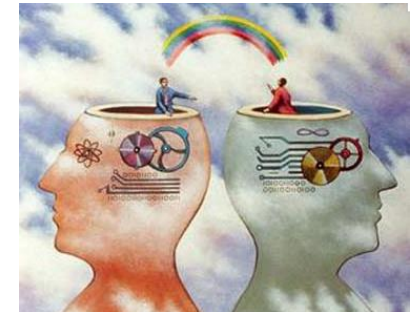


# Innovations based on RI

## Technology and knowledge transfer

State-of-the-art equipment by specifications:

- Research to develop improved materials - radiation hardness, halogen free, cryogenics
- Extreme Sample Environment conditions - high pressure, high temperature
- In-Kind model and Technology Demonstrators
- Directives and their applications - MD, Explosive environment ATEX
- Data - Fastest electronics, DMSC, AI and ML
- Quantity – superconductors, exotic materials
- Novel ways to communicate – WWW, VR, AR



Fractality and entanglement

Networks - LEAPS, LENS, ENRIIC, Big Science Business Forum

Reasons of being of Research Infrastructures: Discovery Science

→ See [Connecting Industrial R&D Staff to State-of-the-Art Neutron Methods](#)



*The EDUSAFE integrated safety system uses a camera mounted on the helmet to monitor the working area.*





# Tools to guide industries and beyond

## Innovative Platforms to learn more and better – The diverse audience / Users

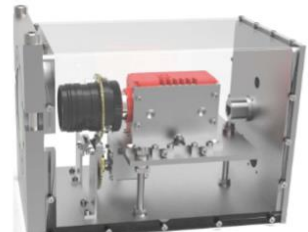
- Industrials to know what relevant equipment to procure
- Industrials to benefit from state-of-the-art researches
- In-Kind - quality, training, legacy
- Academic Users – How to use instrument, training (LSM)
- Public and High school teachers and their learners
- Unified users community: LS and NS
- Politicians and Sponsors - show societal challenges and sustainability
- Universities to train professor and their students
- Tax payer - Return on Investment


### More Innovations:

- Communication tools - MOOC, Zoom webinar
- Virtual and Augmented Realities - safer assembly and repair
- Build data-base, On-line courses ...

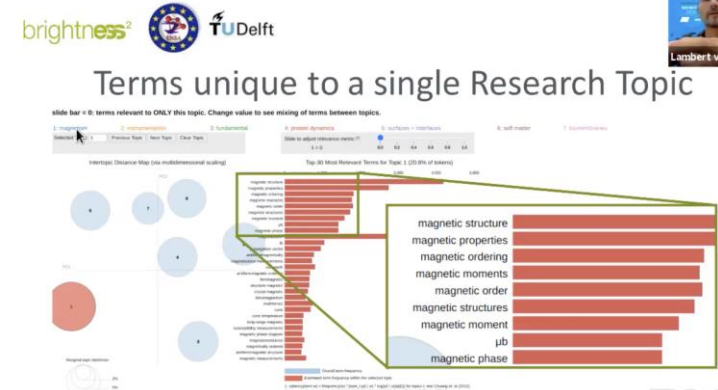
**brightness<sup>2</sup>**  
**Harvesting example**


- A Beam Diagnostics Physicist has invented a Non-invasive Profile Monitor (NPM)
- It will be installed on three crucial positions on the beam to optimise beam focus
- The scientific development has been published
- A French company wish to initiate serial production
- IP shall secure ESS lifelong support
- De-risk through larger user community



**brightness<sup>2</sup>** 


brightness<sup>2</sup> is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 823867




**brightness<sup>2</sup>**  ESS - European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 823867

**Innovation procurement example**

- Complex Integrated Control System
- Artificial Intelligence, Machine Learning, Deep Learning need to be accessed and implemented as much as possible
- ESS act as user and “Living Lab” for international experts in “Sandbox” projects
- First iteration: Alarms processing on collaboration with Lund University



**ICS** 

brightness<sup>2</sup> is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 823867

# Learning and surviving

## The new connected Brave New World ...



- ASP - <https://www.africanschoolofphysics.org/online-lecture-series/> ; e.g.
  - BNL / Light Sources: ["Synchrotron based methods for materials characterization" Part \(1\)](#)
  - Diamond: ["ASP Online Seminars: Synchrotron and neutron based diffraction and spectroscopic techniques \(Part 1\)"](#)
- [Diamond LS](#) – Twitter, Materials science w/ scattering & diffraction [#TheLightStuff](#)
- [International Association of Physics Students](#) – Facebook
- Nordic Particle Accelerator Project: Massive Open-Online Courses: [www.npap.eu](http://www.npap.eu)

And still the old fashion way... Publications and Journals:

- [ESS - What do neutrons tell us:](#)
  - ["The instrument suite of the European Spallation Source", NIMS](#)
  - ["The European Spallation Source Design", Physica Scripta](#)

A screenshot of the 'OnlineLectures' website. The header includes the 'indico' logo and navigation links: Home, Create event, Room booking, My profile. Below the header is a breadcrumb trail: Home > Schools, Seminars and Courses > Schools > Other Schools > African School of Fundamental Physics > OnlineLectures. The main content area is titled 'OnlineLectures' and shows a list of events. A summary box at the top indicates 'There are 5 events in the future. Hide'. The events are categorized by month: November 2020 and October 2020. Each event entry includes a date, a speaker name, and a title, with some entries marked as 'NEW'.

Month	Date	Speaker	Title	Notes
November 2020	24 Nov	Andrew Harrison	"ASP Online Seminars: Synchrotron and neutron based diffraction and spectroscopic techniques (Part 1)"	NEW
November 2020	12 Nov	Ketevi Adikle Assamagan	"ASP Online Seminars: The ASP Mentorship Program"	
November 2020	10 Nov	Simon Connell	"ASP Online Seminars: Nuclear energy in the mix—Can it power Africa Sustainably ? (I)"	
November 2020	05 Nov	Peter Denton, Yves Kini	"ASP Online Seminars: Ultra-High-Energy Tau Neutrino Cross Sections with GRAND and POEMMA"	
November 2020	03 Nov	Simon Connell	"ASP Online Seminars: Nuclear energy in the mix—Can it power Africa Sustainably ?"	
October 2020	29 Oct	Christian Morel	"ASP Online Seminars: A challenge on the mythic 10 ps frontier for time-of-flight positron emission tomography"	
October 2020	27 Oct	CATHY CUTLER	"The United States Department of Energy Continues to Play a Key Role in Isotope Production by Making Significant Upgrades to its Facilities and Expanding its Collaborations"	NEW
October 2020	22 Oct	Marco Gersabeck	"ASP Online Seminars: Flavor Physics at the LHCb"	
October 2020	20 Oct	Monica Pepe-Altarelli	"ASP Online Seminars: Flavor Physics"	
October 2020	15 Oct	Uli Raich	"ASP Online Seminars: A course on the Internet of things at the University of Cape Coast, Ghana"	

# Summary

Beyond Safety Radiation.. building capacity



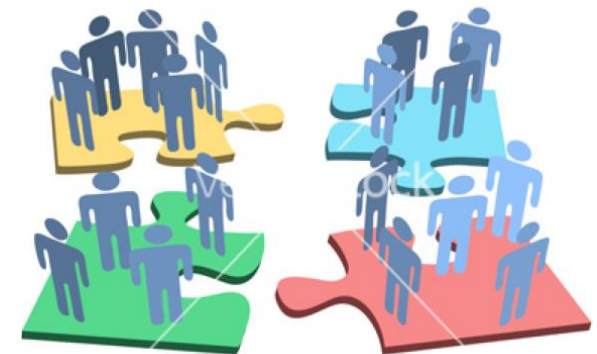
Research Infrastructures are safe and in compliance with European Directives

Transfer of Knowledge & Technology and Return on Investment as a synergy for Industry

RI encourage novel methodologies and tools to support sustainable and SMART projects



Thank you for your attention!







# Any Questions? Want to know more?

Website : <http://cdarve.web.cern.ch>

Contact me : [Christine.darve@ess.eu](mailto:Christine.darve@ess.eu)

## Accelerate Webinar Series

### Radiation Safety and Quality at Research Infrastructures

### Connecting Industrial R&D Staff to State-of-the-Art Neutron Methods



4<sup>th</sup> November : Nanoscale to Microscale Structural Analysis with Neutrons  
Dr. Judith Houston

11<sup>th</sup> November : Neutron protein crystallography reveals molecular details of inhibitor binding to clinical targets.  
Dr. Zöe Fisher

25<sup>th</sup> November : Non-destructive testing with neutrons: Revealing (micro-) structural properties and providing unique contrast inside large samples and assembled components  
Dr. Robin Woracek

# Legal dose limits and dose constraints established at ESS

## ESS Supervised Area



	Limit Cat A	Limit Cat B	Constraint (set by ESS GSO, ESS-0000004)
Effective dose	20 mSv <sup>(1)</sup>	6 mSv	<b>As Low As Reasonable Achievable</b> , and in any case less than: Individual dose $\leq$ 2 mSv <sup>(2)</sup>
Equivalent dose to the lens of eyes	20 mSv <sup>(1)</sup>	15 mSv	$\leq$ 15 mSv
Equivalent dose to the skin	500 mSv	150 mSv	$\leq$ 50 mSv <sup>(2)</sup>
Equivalent dose to hands, feet	500 mSv	150 mSv	$\leq$ 50 mSv <sup>(2)</sup>

<sup>1</sup> New dose limits in accordance with European directive 2013/59, new Swedish regulations from February 2018.

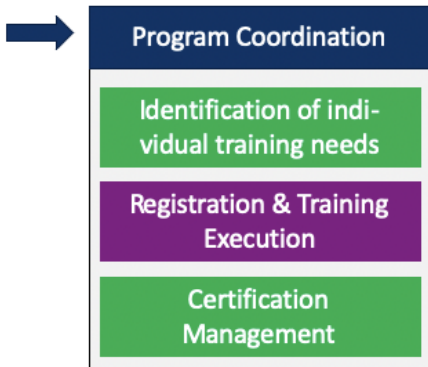
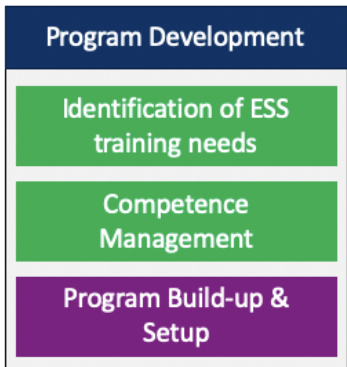
<sup>2</sup> ESS objective is 10% of dose limit

# A novel way to learn

Courtesy Lars Aprin

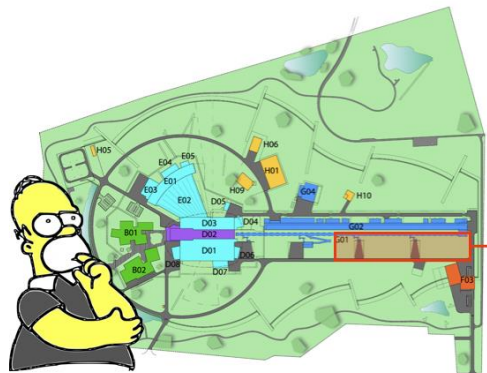


## ESS Learning Lounge



### Training plans based on roles

Tell me what your role is, and I'll tell you what trainings you need.



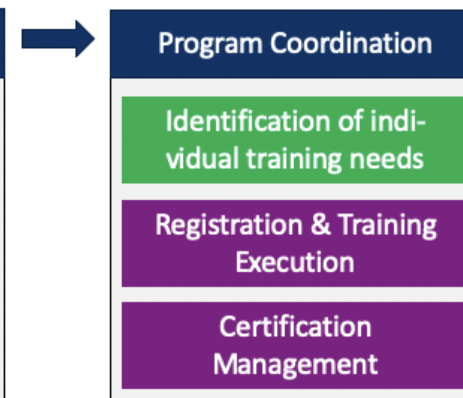
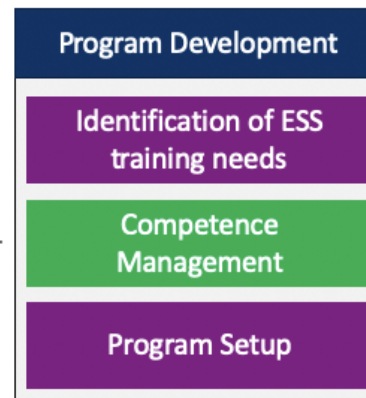
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G01: warm linac	RP Awareness
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...	...

This approach is about to start very soon.  
First prototypes: Test Stand 2, First Responders, G buildings

- I. Identification of targets groups (roles) per domain
- II. Identification of competences per role
- III. Identification of curricula per role



- I. Assignment of role(s) to the learner
- II. Automatic enrolment to curricula linked to role(s)

(See next slide)

## A glimpse into our LMS

Visit us at <https://ess.sabacloud.com>

**Welcome to our Learning Catalogue!**  
Here you can find and enrol for our courses.  
On the left hand side you can browse by categories and use different filters. You can use the search function at the top of the page to search for a specific course.

48 Results found

**LEARNING EVENT TYPE**

- Class/Course (53)

**DELIVERY TYPE**

- Web-Based (15)
- Blended (10)

**CATEGORY**

- ESS Learning Catalog (33)
- Environmental, Health & Safety (34)
- Building & Installation Safety (12)
- IT Systems (6)
- Quality Management (3)
- more

**LANGUAGE**

- English (25)

**Live-introduction to the ESS Learning Lounge**  
Version: 1  
Course (3 classes)  
The purpose of this training is to familiarise (participants, but not only) line managers & team leaders with our new learning management system, the ESS Learning Lounge. In addition to a short introduction to the functionalities of the system, there ...  
more

**Way of Working Area "Manage Documented Information"**  
Version: 1  
Course (1 class)  
The aim of this ...



### The role of Training in the Safety Process

Safety Training is Risk Mitigation.

