1st Accelerators Technology Sector Workshop

Engineering Design Tools and Processes
Project Management Methodologies and Tools

Chair: Mike Lamont

Interconnecting knowledge, experience, methods, people & data to foster learning & collaboration

CERN

ATS
Accelerators and Technology Sector

Improving future designs by learning from radioactive waste-management experiences

Jean-Louis Grenard

SY-STI-TCD

ATS
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Technology Sector

Outlook

- Beam Intercepting Devices in a few words
- BIDs design process
- Constraints for final disposal
- ALARA principle
- Return of Experience
- Dry runs and Mock-ups
- Take Home message

Primary Beam Intercepting Devices in a few words

Systems witch intercept beam from a fraction its entirety

Interactions of beam with systems (partial e.g. collimators, full e.g. targets and beam dumps)

- Beam cleaning and control → Collimators, Scrapers, Strippers, Slits
- Particle production → Targets
- Safety functions → Beam Stoppers, Beam Dumps

Devices protect delicate equipment, must withstand operation and accident failure scenarios

Built to receive high energy deposition and subsequent thermal load

Residual radioactivation is a result of the interaction of the beam with the BID systems

CERN's most radioactive equipment

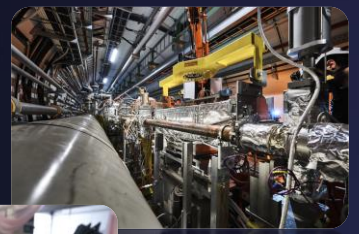

FEATURE SYSTEMS ENGINEERING

INTERCEPTING THE BEAMS

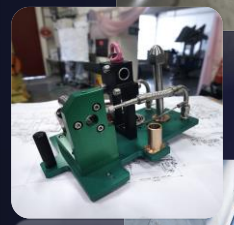
From targets to absorbers, beam-intercepting devices are vital to CERN's accelerator complex.

https://cerncourier.com/a/intercepting-the-beams/

SY-STI Beam Intercepting Devices Overview

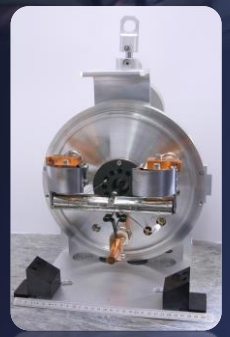


LHC collimators
~120

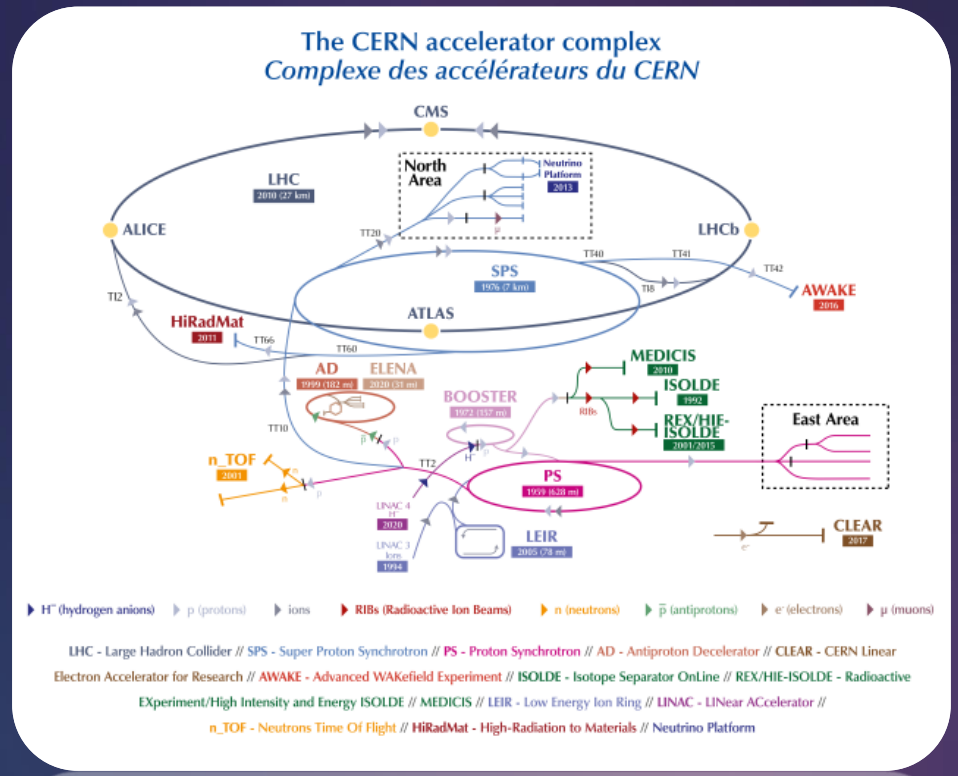


AD target

n_TOF target



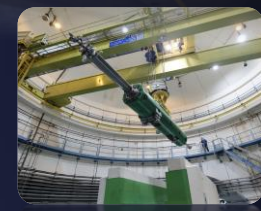
ISOLDE target
~30 targets/years



~300 ASSETs with a large diversity
From a couple of kg to several 10th of tons

LHC Beam Dumps

SPS Beam Dumps



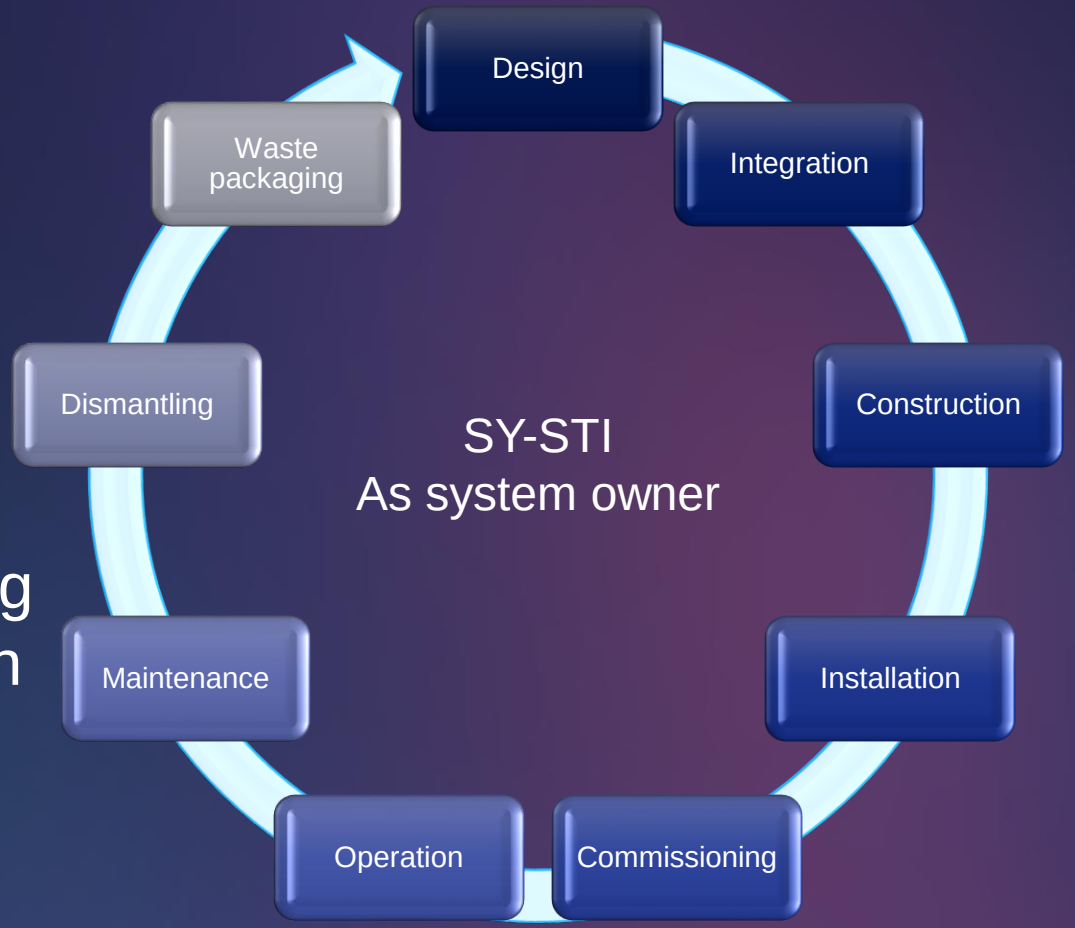
PS Internal Dump

Beam stoppers

Beam Intercepting Devices Lifecycle

Different stakeholders across the lifecycle:

- Design offices
- Workshops
- Control teams
- Installation teams
- Radiation protection
- Transport and Handling
- Cooling and Ventilation
- Operation



Stakeholders brings along the lifecycle:

- Expertise
- Integrate their standard subsystems
- Integrate their return of experience

BIDs design

Functional specification
BE-OP/ABP
SY-ABT
BE-EA

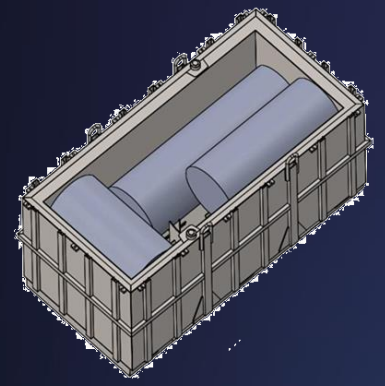
Initial concept
SY-STI

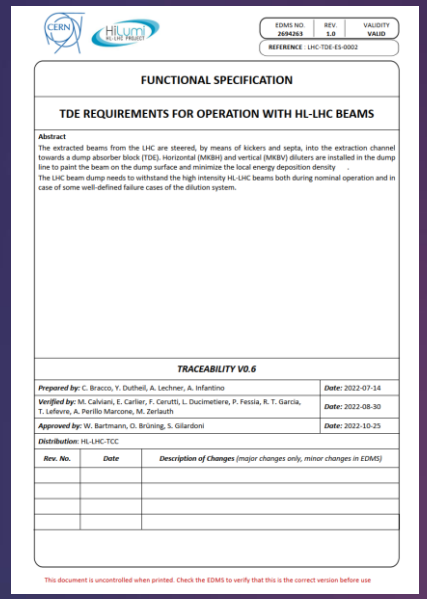
Energy deposition and Thermomechanical studies
SY-STI

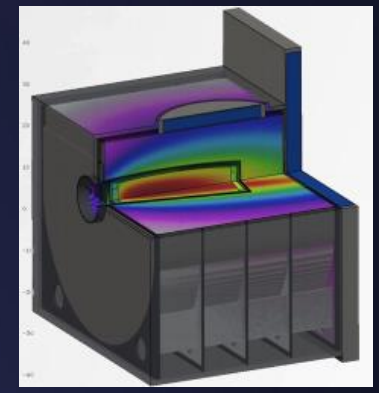
System design
SY-STI
EN-MME

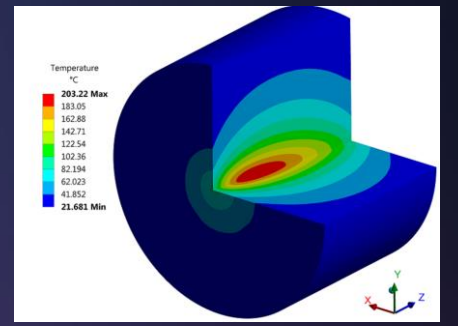
Radiation Protection assessment and optimization
HSE-RP

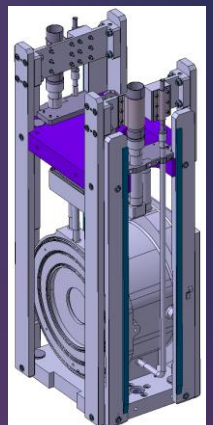
Replacement and Final disposal evaluation
HSE-RP
SY-STI











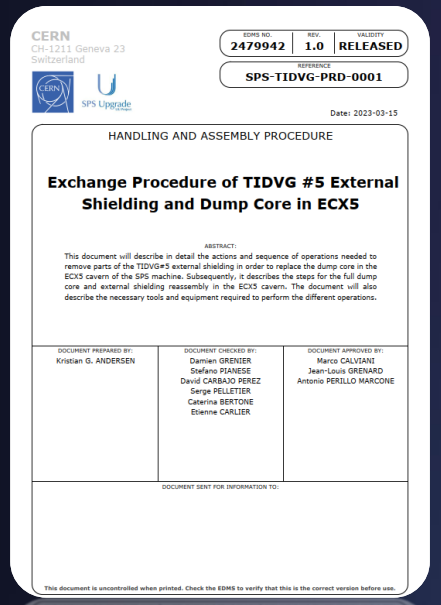
Challenge to keep **coherence between models**

Constraints for final disposal

By regulations CERN must send radioactive wastes to final repository

- Different requirements from the 2 host states authorities (type, size of containers…)
- Radioactive waste to be sorted safely for very long term (hundreds of years)
- (Chemical) Reactions to be considered between packing and stored material (e.g. water-aluminium cracks creation)
- Very long process (15 years to dispose the n_TOF target #1)
- Requirement to have all documentation attached to ASSET →

ALARA principle



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2479942	1.0	RELEASED

REFERENCE: SPS-TIDVG-PRD-0001

Date: 2023-03-15

HANDLING AND ASSEMBLY PROCEDURE

Exchange Procedure of TIDVG #5 External Shielding and Dump Core in ECX5

ABSTRACT:

This document will describe in detail the actions and sequence of operations needed to remove parts of the TIDVG#5 external shielding in order to replace the dump core in the ECX5 cavern of the SPS machine. Subsequently, it describes the steps for the full dump core and external shielding reassembly in the ECX5 cavern. The document will also describe the necessary tools and equipment required to perform the different operations.

DOCUMENT PREPARED BY:	DOCUMENT CHECKED BY:	DOCUMENT APPROVED BY:
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Time
Procedures, Training, Tools

Distance
Tools, Shielding

Shielding
Concrete, Marble, Iron, Lead

LHC External Dump autopsy

SPS Internal Beam Dump (shielding open)

ALARA BY DESIGN

Return of experience installation / removal

Preparation

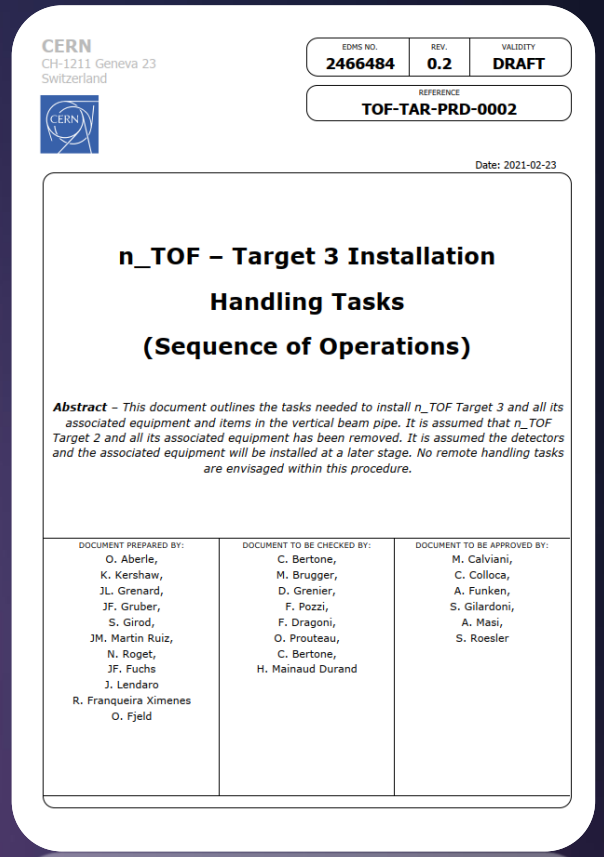
- Simulations
- Definition of a sequence
- Review(s) by internal and external experts

Execution

- Records during the installation

End of activity

- Documentation of Return of Experience
- As built documentation (3d models, procedures)



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2466484	0.2	DRAFT

REFERENCE: TOF-TAR-PRD-0002

Date: 2021-02-23

n_TOF – Target 3 Installation Handling Tasks (Sequence of Operations)

Abstract *– This document outlines the tasks needed to install n_TOF Target 3 and all its associated equipment and items in the vertical beam pipe. It is assumed that n_TOF Target 2 and all its associated equipment has been removed. It is assumed the detectors and the associated equipment will be installed at a later stage. No remote handling tasks are envisaged within this procedure.*

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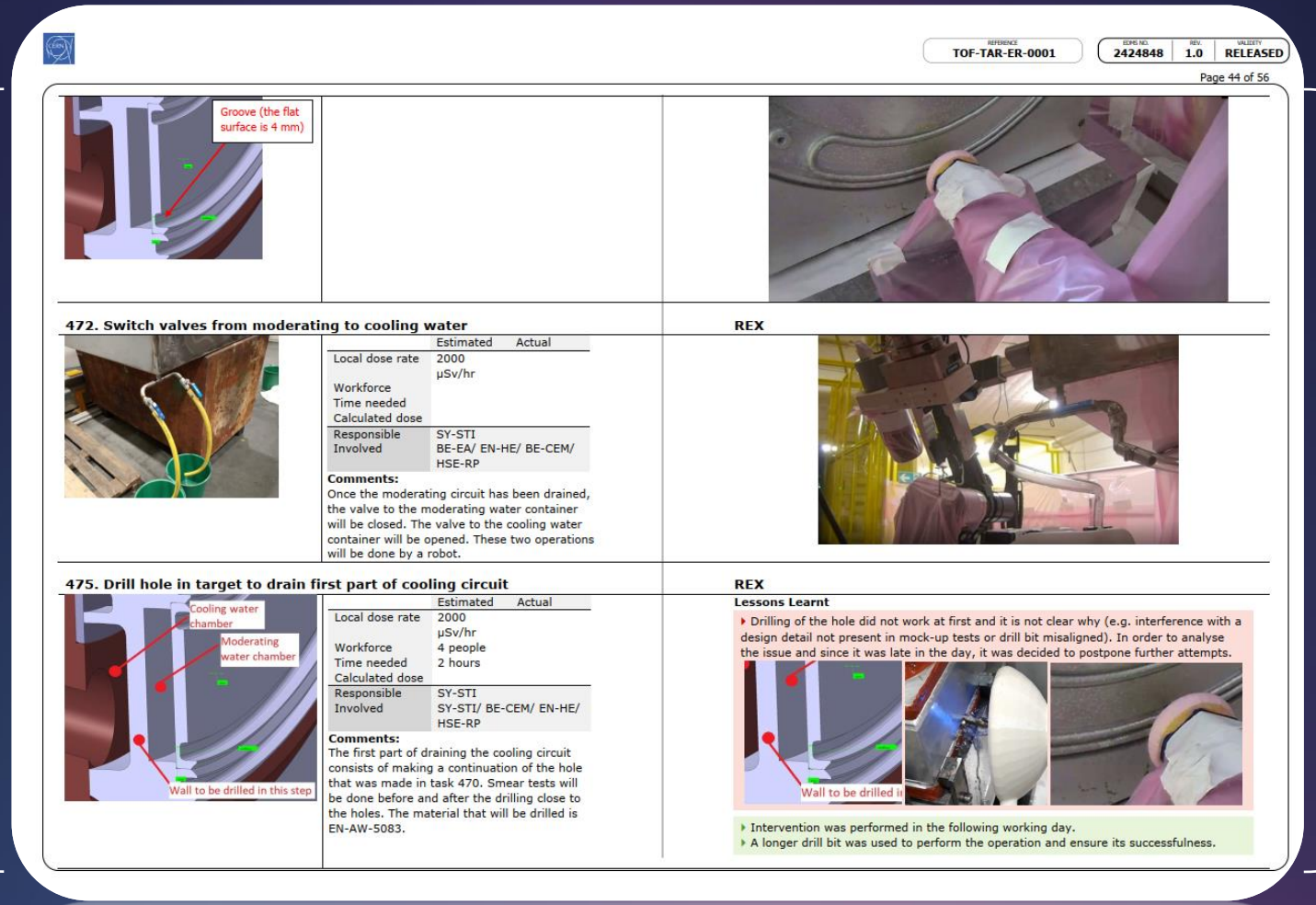
Joint work by different stakeholders

Return of experience installation / removal

Description of foreseen tasks

- Directly used on the field
- Goes on top of Work and Dose Planning
- Part of the ALARA documentation



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Page 44 of 56

472. Switch valves from moderating to cooling water

	Estimated	Actual
Local dose rate	2000 µSv/hr	
Workforce		
Time needed		
Calculated dose		
Responsible	SY-STI	
Involved	BE-EA/ EN-HE/ BE-CEM/ HSE-RP	

Comments:
Once the moderating circuit has been drained, the valve to the moderating water container will be closed. The valve to the cooling water container will be opened. These two operations will be done by a robot.

REX

475. Drill hole in target to drain first part of cooling circuit

	Estimated	Actual
Local dose rate	2000 µSv/hr	
Workforce	4 people	
Time needed	2 hours	
Calculated dose		
Responsible	SY-STI	
Involved	SY-STI/ BE-CEM/ EN-HE/ HSE-RP	

Comments:
The first part of draining the cooling circuit consists of making a continuation of the hole that was made in task 470. Smear tests will be done before and after the drilling close to the holes. The material that will be drilled is EN-AW-5083.

REX

Lessons Learnt

- Drilling of the hole did not work at first and it is not clear why (e.g. interference with a design detail not present in mock-up tests or drill bit misaligned). In order to analyse the issue and since it was late in the day, it was decided to postpone further attempts.

- Intervention was performed in the following working day.
- A longer drill bit was used to perform the operation and ensure its successfulness.

Description of as executed including changes and lessons learnt

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Dry runs and Mock-ups

As part of ALARA principle

- Demonstrate feasibility
- Assess methodology
- Additional chance to further optimize process
- Teams training
- Demonstrate remote handling capability
- Check recovery plans

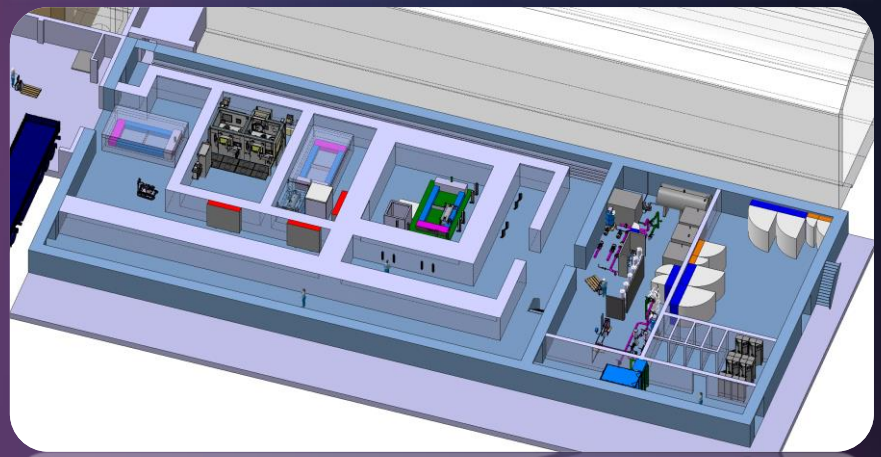
Implementation of the Return of Experience in new designs

How are we going to implement this for future facilities?

The case of HI-ECN3 Beam Dump Facility Project

- Design jointly merging functional requirements with requirements of the Host States authorities for final disposal
- Design ready for material separation & waste packaging
- Infrastructure for waste packaging foreseen as part of target complex
- Remote handling largely implemented as per dose rates increases

BDF target handling in case of replacement



BDF target complex building with service cell

Take Home message

- Design of the systems should be integrated around the lifecycle in its entirety
- ALARA principle must be included in the design from the beginning
- Integration of different stakeholders in the Return of Experience
- Waste packaging for final disposal to be considered from the beginning of a Project
- Methodology for the handling of radioactive objects required for whole lifecycle
- Full set of documentation to be kept along lifecycle of the systems

Design and Lifecycle:
The 2 keys parameters to handle radioactive systems

THANK YOU

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SPS Internal Beam Dump (shielding closed)

Remote Handling Design guidelines

Several CERN modules developed

- Handling life cycle
- Checklist
- Fasteners
- Guides systems

American Nuclear Society - Design Guides

Remote Handling - ITER code of Practice

More to come with ongoing projects

All those to ease dismantling once radioactive