




# EUROPEAN SPALLATION SOURCE

PLM Road Map™ & PDT EMEA 2022  
*Digital Transformation and PLM – a call for PLM professionals to re-define and re-position the benefits and value of PLM*  
18-19 October

**CIMdata** **eurostep**

Last update: Dec 2021



## ESS the Project

### Using PLM and Virtual Twin to build the world's leading facility for research using neutrons

**Henrik Lindblad, Group Leader PLM & Process Support, ESS**

PLM Road Map™ & PDT EMEA 2022  
*Digital Transformation and PLM – a call for PLM professionals to re-define and re-position the benefits and value of PLM*  
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**CIMdata** **eurostep**





A world leading facility built on partnership 

ESS will welcome scientists from all over the world to come and conduct their experiments, building a deeper understanding of materials and molecules.

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Advancing the frontiers in research 

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## Facts about ESS





 <p>5 MW particle accelerator 2 MW at start</p>	 <p>15 instruments next step is 22</p>	 <p>3 000 guest scientists visiting yearly to conduct experiments</p>	 <p>800 experiments per year</p>	 <p>BREEM Renewable energy &amp; waste heat recovery</p>
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# Unique international project

## How will it be built?



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, Daresbury  
 Elettra – Sincrotrone Trieste  
 ESS Bilbao  
 Forschungszentrum Jülich  
 Helmholtz-Zentrum Geesthacht  
 Huddersfield University  
 IFJ PAN, Krakow  
 INFN, Catania  
 INFN, Legnaro  
 INFN, Milan  
 Institute for Energy Research (IFE)  
 Rutherford-Appleton

Laboratory, Oxford(ISIS)  
 Copenhagen University  
 Laboratoire Léon Brillouin (CEA/CNRS/LLB)  
 Lund University  
 Nuclear Physics Institute of the ASCR  
 Oslo University  
 Paul Scherrer Institute (PSI)  
 Polish Electronic Group (PEG)  
 Roskilde University  
 Tallinn Technical University  
 Technical University of Denmark  
 Technical University Munich  
 Science and Technology Facilities Council  
 UKAEA Culham  
 University of Tartu  
 Uppsala University  
 WIGNER Research Centre for Physics  
 Wroclaw University of Technology  
 Warsaw University of Technology  
 Zurich University of Applied Sciences (ZHAW)



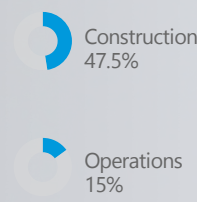
9

# A coalition of 13 European countries

### Host countries

Sweden, Denmark



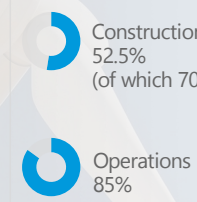
Construction 47.5%

Operations 15%

Budget for construction €1.84 billion  
 Estimated annual budget €140 million

### Non host member countries

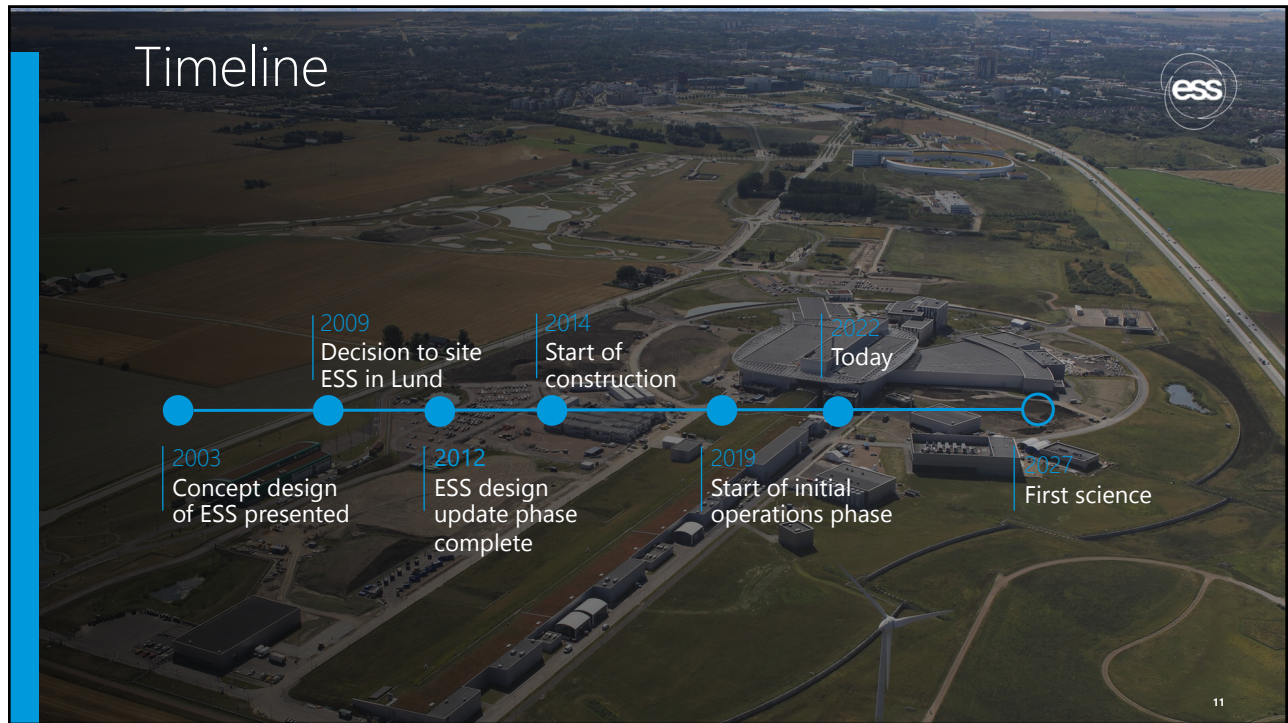
Czech Republic, Estonia, France, Germany, Hungary, Italy, Norway, Poland, Spain, Switzerland, United Kingdom.



Construction 52.5%  
(of which 70% is in-kind deliverables)

Operations 85%

10

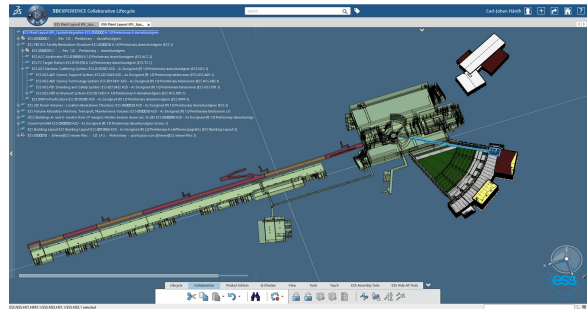


# Using PLM and the digital twin to realize ESS

# Using PLM & Digital twin at ESS



- ESS is using 3DEXperience R2020x for mechanical CAD and PLM
- The EPL (ESS Plant Layout) in 3DEXperience is the CAD master model – the digital twin of the facility
- Buildings design is done in other tools (Revit/Navisworks) and translated and inserted in EPL
- Plant design is done in AVEVA E3D
- Integration and design coordination between all disciplines is done in 3DEXperience



2022-10-18

# Design data consolidation

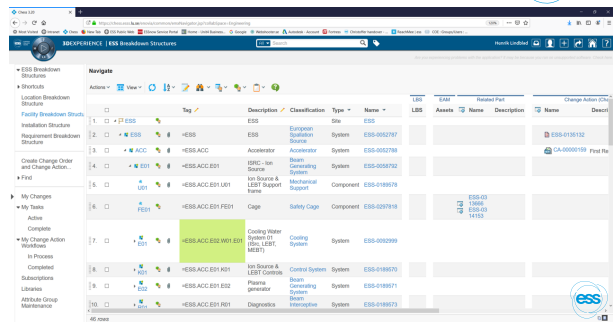


In addition to classical E-bom, ESS is using several break down structures to organize the different types of design data and technical information in 3DEXperience

Functional break down structure & Location break down structures are some examples

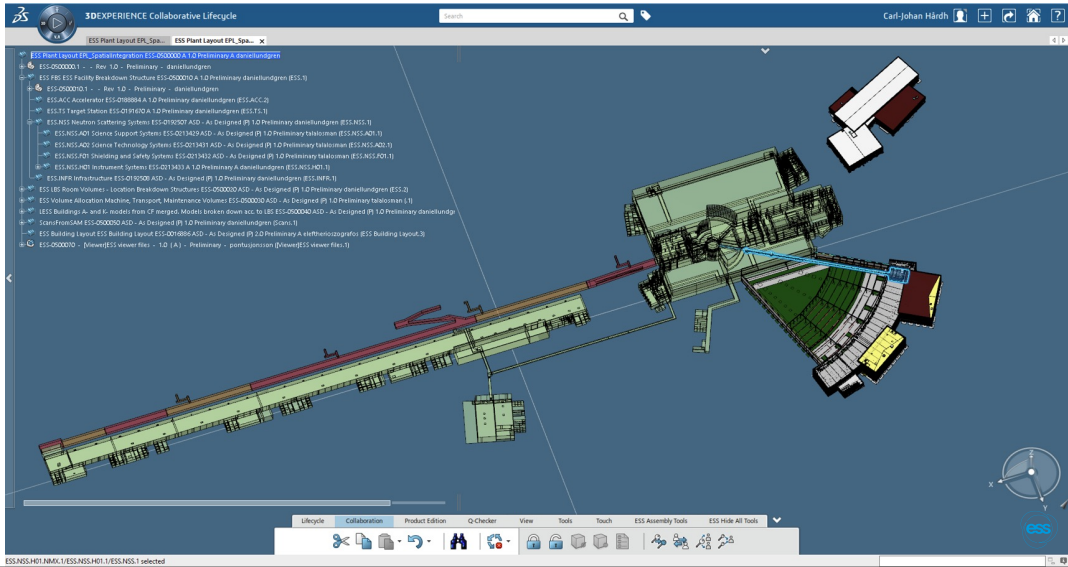
The main features of this is:

- Naming and tagging of items based on structure or physical location
- Top-down release
- Links between structures
- Connection to asset mgmt. system



# ESS Plant Layout – 3D Digital Twin

## Spatial integration

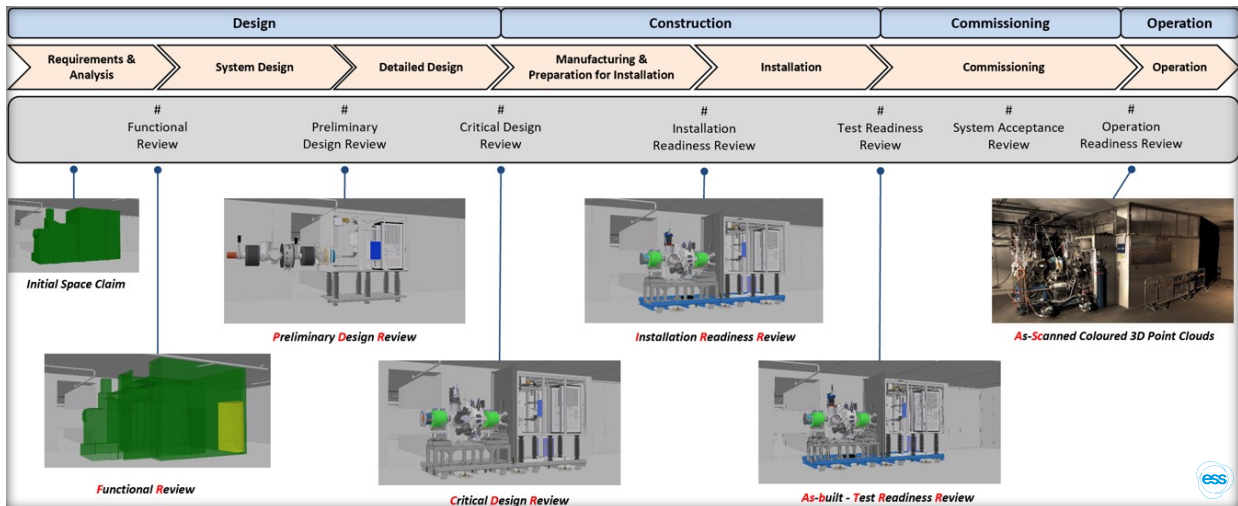


ESS-HS1-AMK-1-ESS-HS1-1-ESS-HS1-1 selected

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# ESS Plant Layout - Spatial Integration

## Defines the spatial boundaries of a tag following the Engineering process

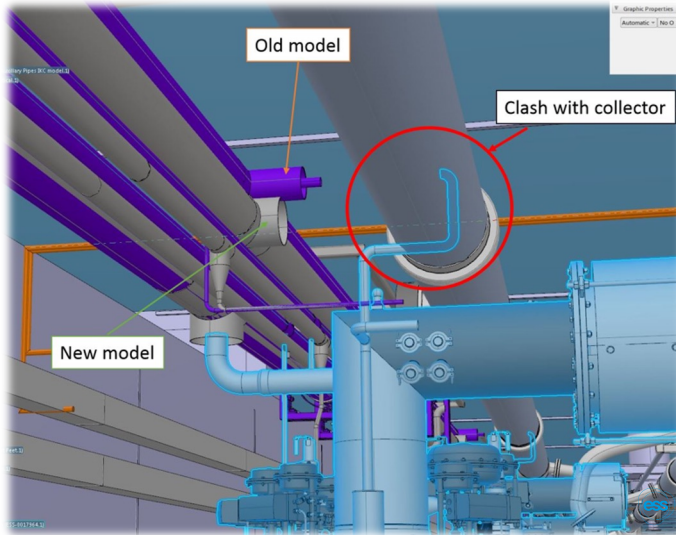


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# ESS Plant Layout - Spatial Integration

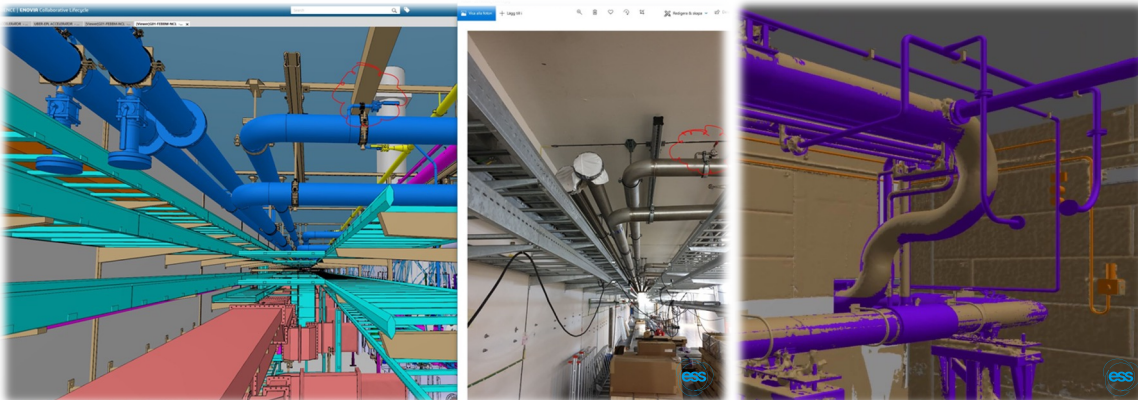
Clash analysis of revised design models



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# ESS Plant Layout - Spatial Integration

Allows for As-Designed multi discipline view with As-Built comparison



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# ESS Plant Layout - Spatial Integration



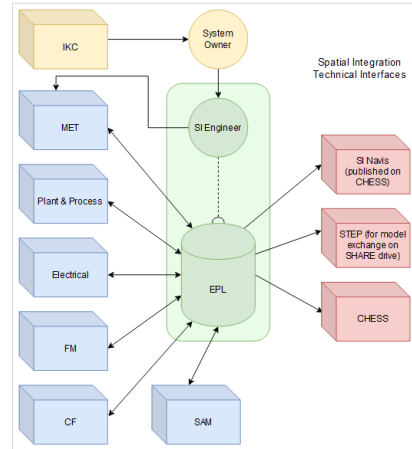
## Multi-CAD setup

The EPL is consisting of data from multiple disciplines and design tools like AVEVA E3D, 3DEXPERIENCE V6, Revit, Tekla and any software from our in-kind partners

Fully managed in 3DEXPERIENCE V6

Spatial Integration setup with 3DEXPERIENCE V6 and Navisworks

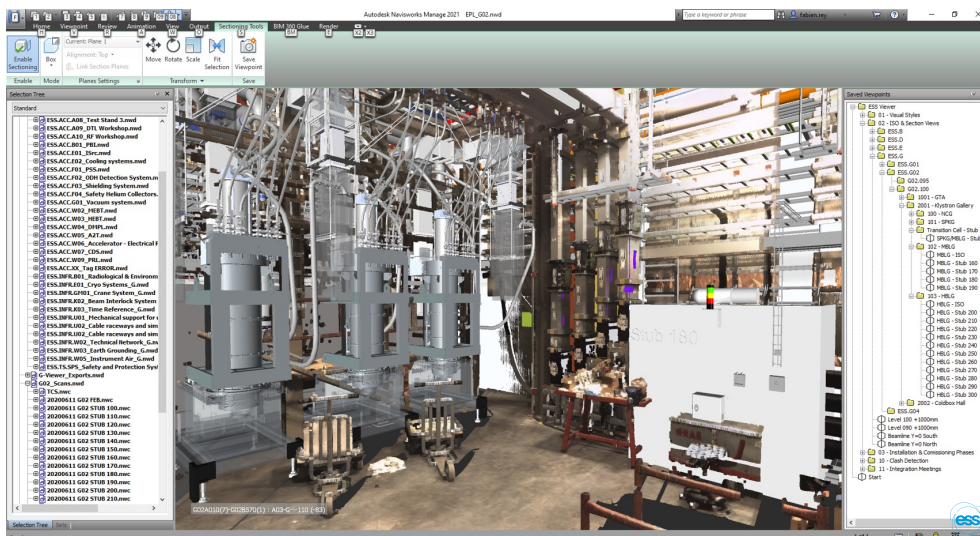
Single point of truth, containing all buildings/systems/components represented in 3D for verification of spatial needs within ESS facilities



# ESS Plant Layout - Spatial Integration



EPL viewer files, Naviswork models, published in PLM and updated daily

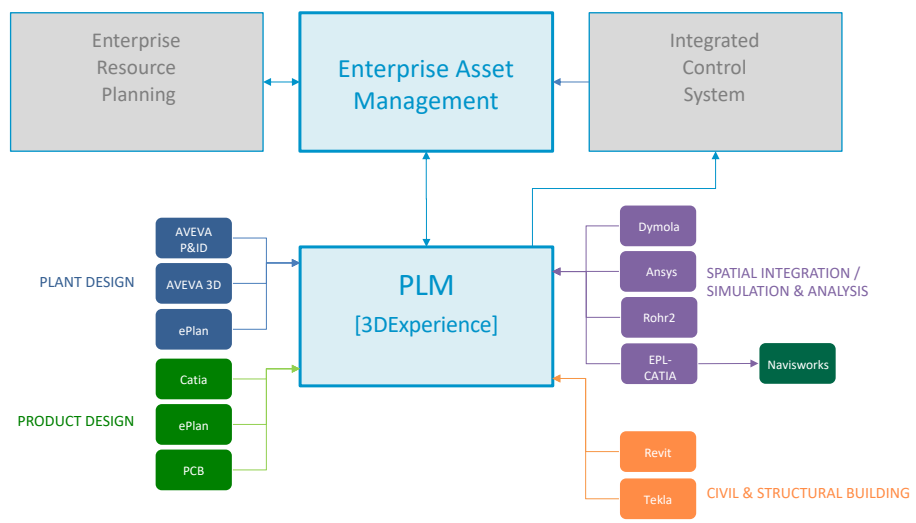




# System landscape

PRESENTATION TITLE/FOOTER

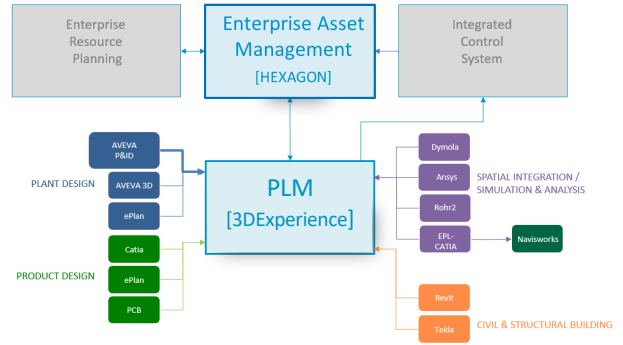
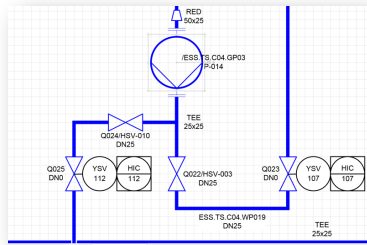
## Our system landscape



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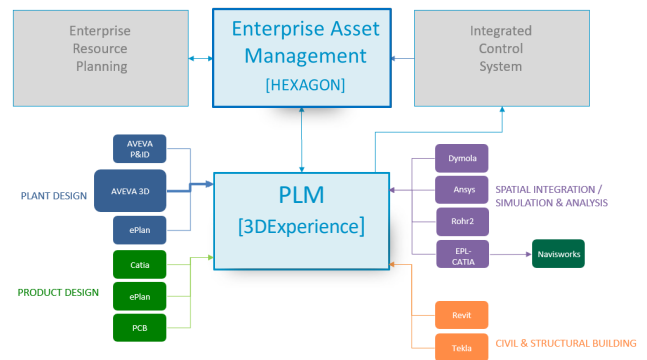
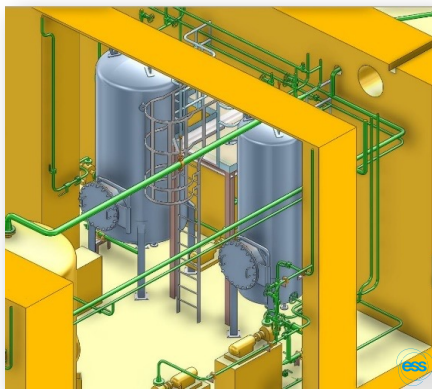
# Our system Landscape

## Integration AVEVA Diagrams



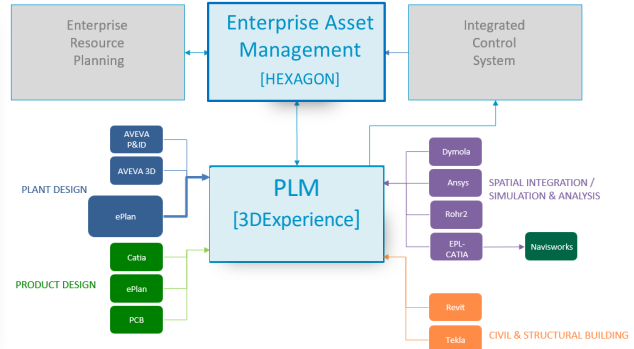
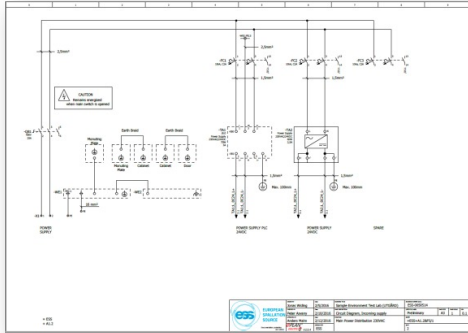
# Our system Landscape

## Integration AVEVA E3D



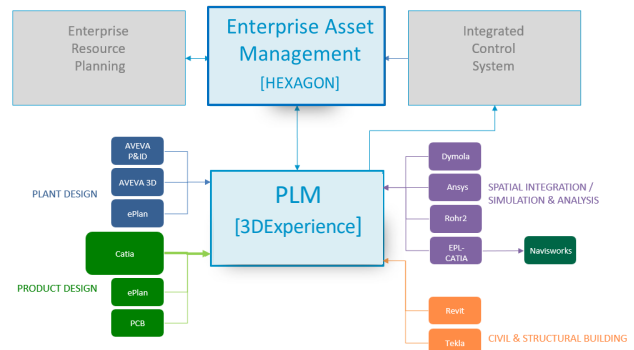
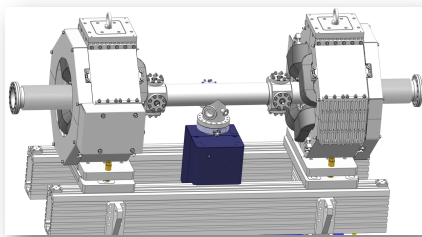
# Our system Landscape

## ePlan for facility electrical infrastructure and electrical design



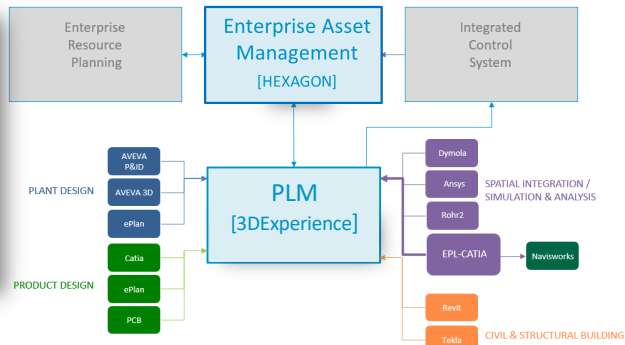
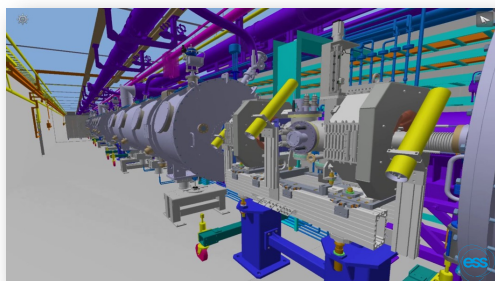
# Our system Landscape

## CATIA for mechanical design



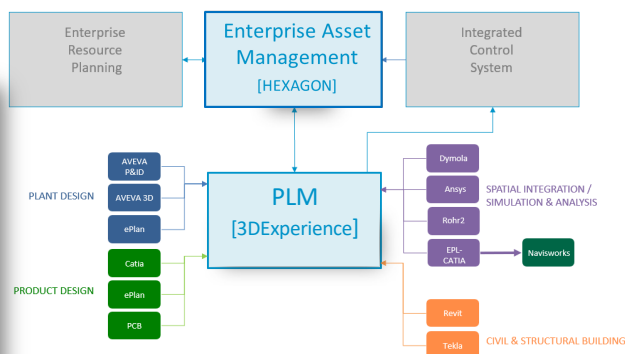
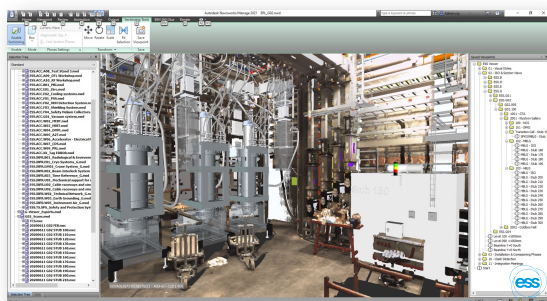
# Our system Landscape

EPL – ESS Plant Layout – 3D master model integrated with FBS



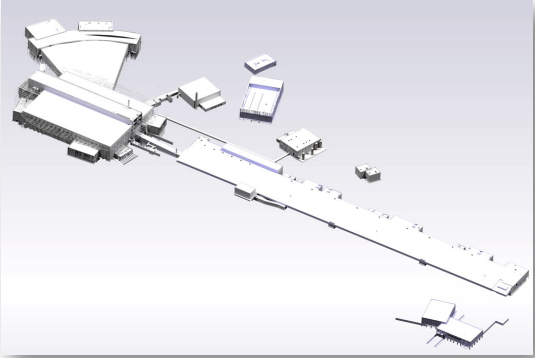
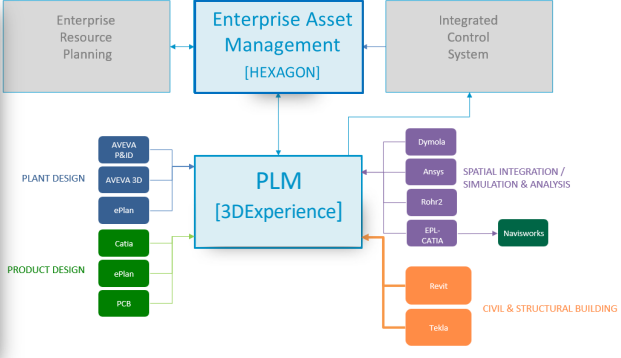
# Our system Landscape

Viewer for all users



# Our system Landscape

## Building Information Model (BIM) incorporated into the EPL

Enterprise Resource Planning ↔ Enterprise Asset Management [HEXAGON] ↔ Integrated Control System

PLM [3DEXPERIENCE]

PLANT DESIGN: AVEVA P&ID, AVEVA 3D, ePlan

PRODUCT DESIGN: Catia, ePlan, PCB

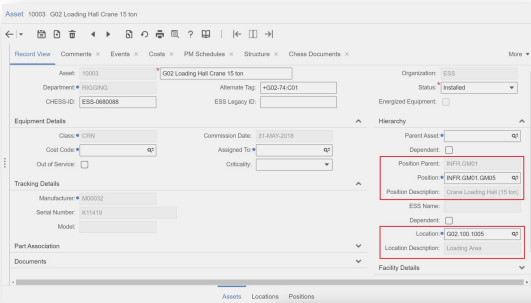
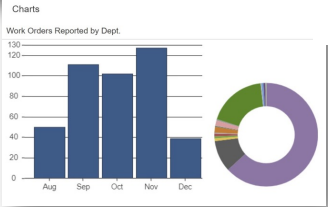
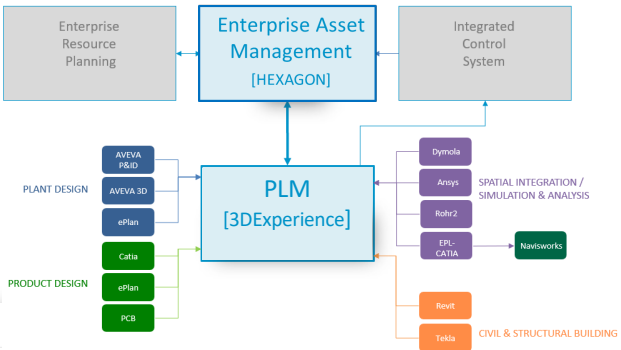
Simulation & Analysis: Dymola, Ansys, Itoh2, EPL-CATIA → Navworks

CIVIL & STRUCTURAL BUILDING: Revit, Tekla

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# Our system Landscape

## PLM integrated with EAM

Enterprise Resource Planning ↔ Enterprise Asset Management [HEXAGON] ↔ Integrated Control System

PLM [3DEXPERIENCE]

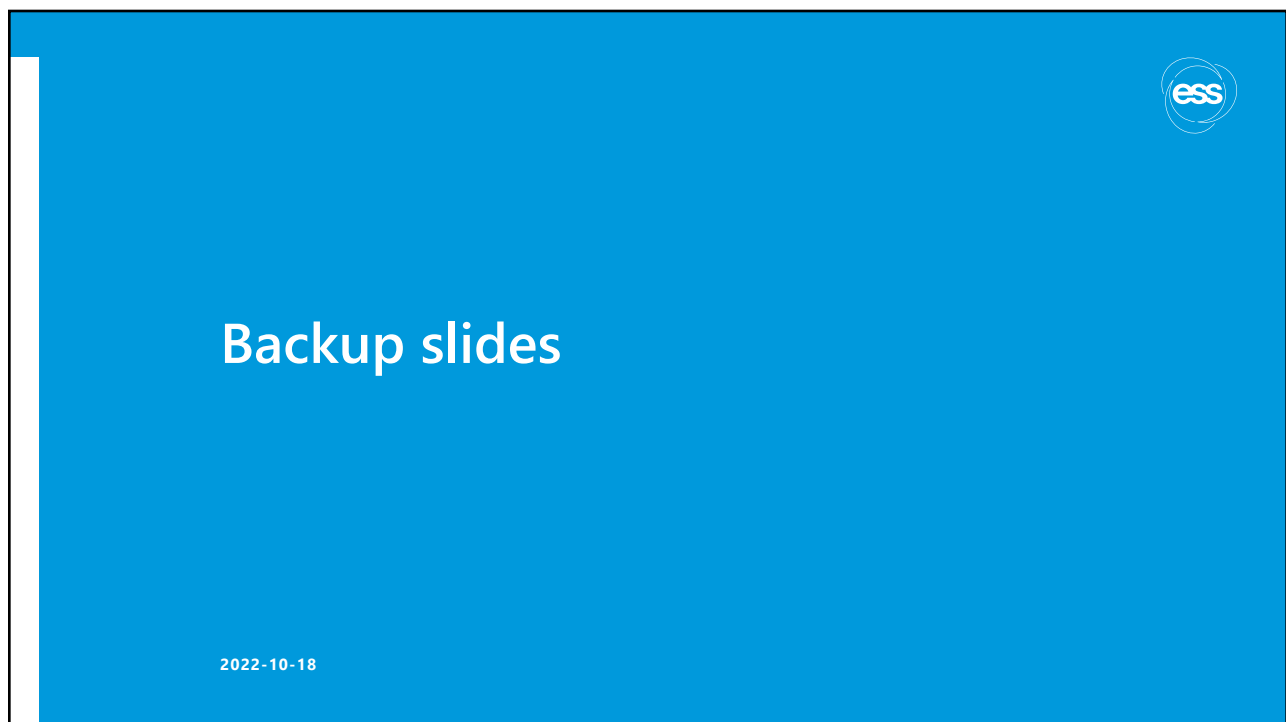
PLANT DESIGN: AVEVA P&ID, AVEVA 3D, ePlan

PRODUCT DESIGN: Catia, ePlan, PCB

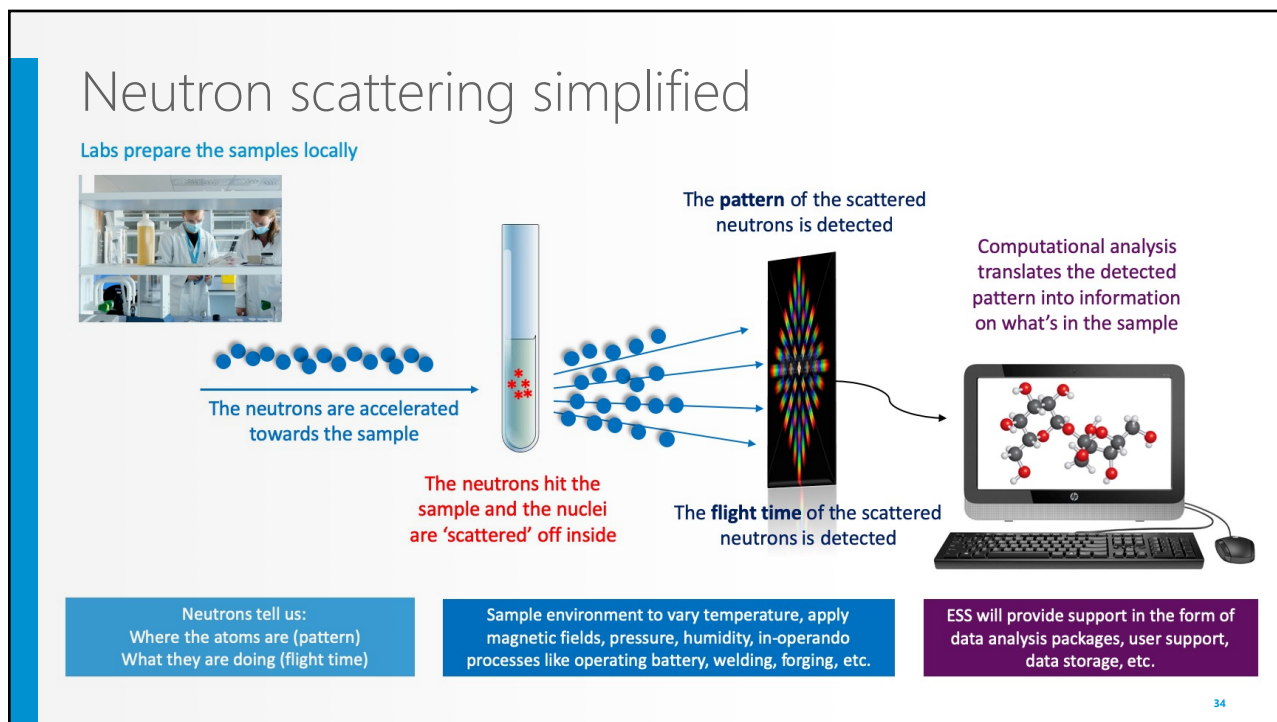
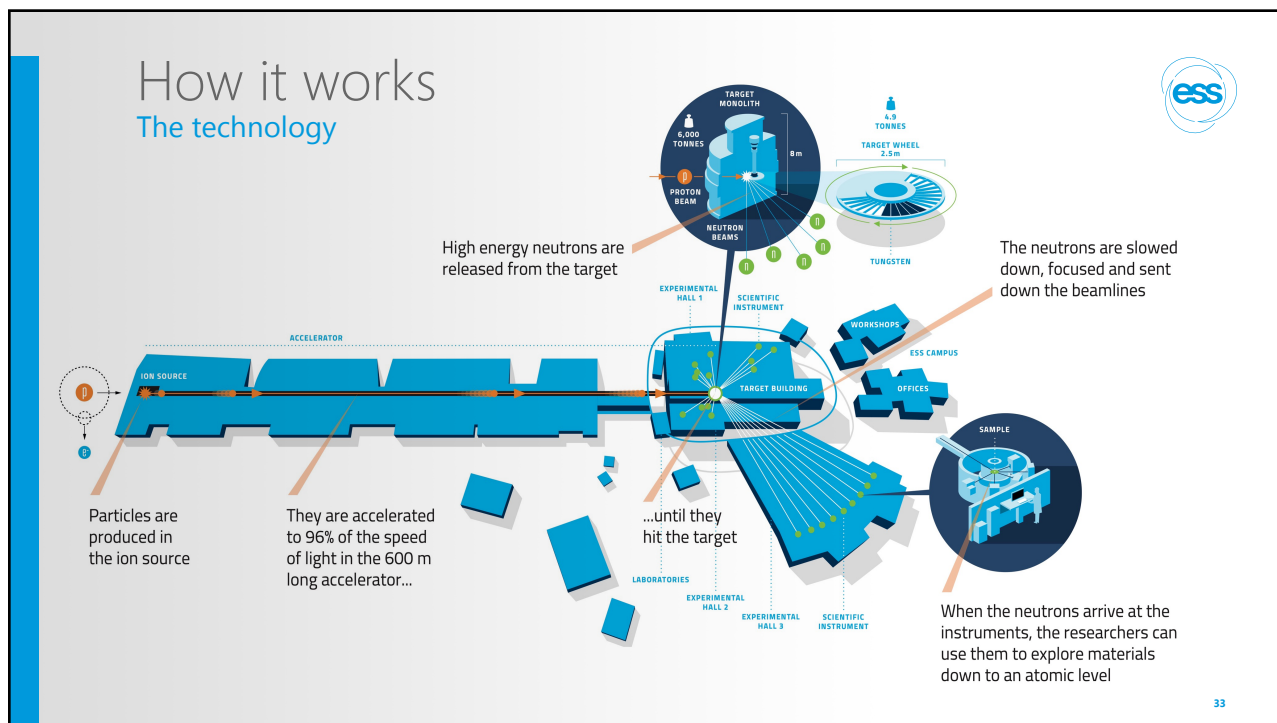
Simulation & Analysis: Dymola, Ansys, Itoh2, EPL-CATIA → Navworks

CIVIL & STRUCTURAL BUILDING: Revit, Tekla

30







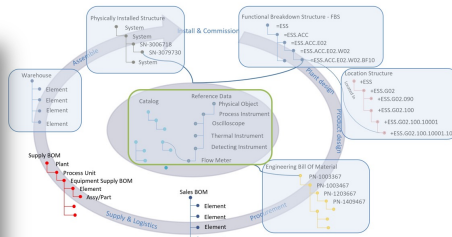
# Our system Landscape

Integrations enabled by Reference Data across entities and systems



1.	<input type="checkbox"/>	<input type="checkbox"/>	Physical Object
2.	<input type="checkbox"/>	<input type="checkbox"/>	Fluid Regulator
3.	<input type="checkbox"/>	<input type="checkbox"/>	Valve
4.	<input type="checkbox"/>	<input type="checkbox"/>	Angle Valve
5.	<input type="checkbox"/>	<input type="checkbox"/>	Backflow Valve
6.	<input type="checkbox"/>	<input type="checkbox"/>	Backpressure Regulator Valve
7.	<input type="checkbox"/>	<input type="checkbox"/>	Ball Sector Valve
8.	<input type="checkbox"/>	<input type="checkbox"/>	Barstock Valve
9.	<input type="checkbox"/>	<input type="checkbox"/>	Bi-Directional Valve
10.	<input type="checkbox"/>	<input type="checkbox"/>	Bleed Valve
11.	<input type="checkbox"/>	<input type="checkbox"/>	Blending Valve
12.	<input type="checkbox"/>	<input type="checkbox"/>	Block Valve
13.	<input type="checkbox"/>	<input type="checkbox"/>	Blow Down Valve
14.	<input type="checkbox"/>	<input type="checkbox"/>	Blow Off Valve
15.	<input type="checkbox"/>	<input type="checkbox"/>	Bypass Valve
16.	<input type="checkbox"/>	<input type="checkbox"/>	Check Valve
17.	<input type="checkbox"/>	<input type="checkbox"/>	Choke Valve
18.	<input type="checkbox"/>	<input type="checkbox"/>	Conduit Valve
19.	<input type="checkbox"/>	<input type="checkbox"/>	Cone Valve
20.	<input type="checkbox"/>	<input type="checkbox"/>	Control Damper
21.	<input type="checkbox"/>	<input type="checkbox"/>	Control Valve
22.	<input type="checkbox"/>	<input type="checkbox"/>	Cryogenic Valve

88 rows



ISO 15926

Classification  
Ball Hand Operated Valve

Valve

Body Material

Connection Inlet Size

Connection Inlet Type

Connection Outlet Size

Connection Outlet Type

Design Pressure Pa

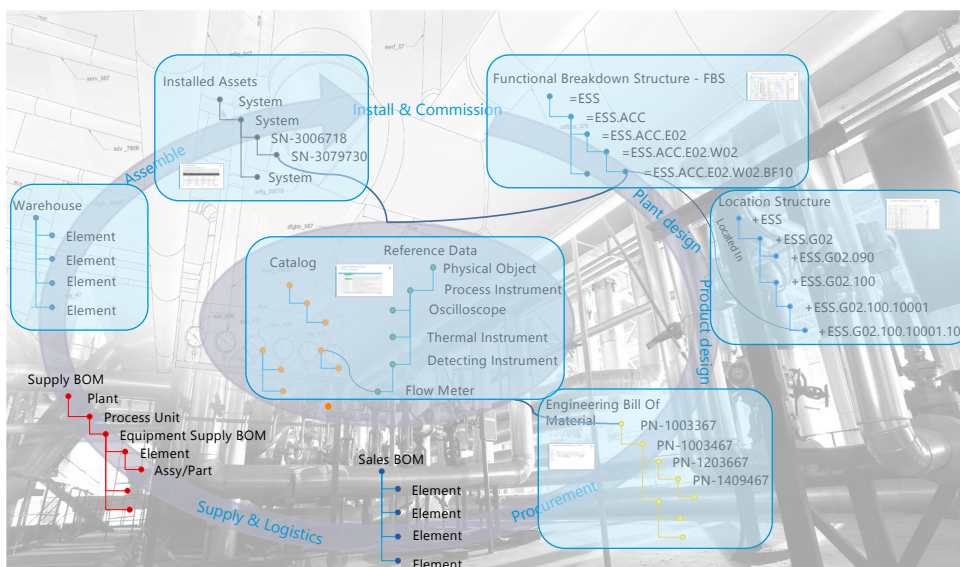
Design Temperature Maximum K

Design Temperature Minimum (ess) K

Disc Material

Flow Rate

# What does it look like at ESS?



# Single entry to all Facility information



Navigate

Actions View

Structural information

Access to all tag documents

Access to detailed tag information

		Description	Classification	LBS	EAM	State	Related Part
				LBS	Assets		Name
1.	ESS	ESS				Exists	
2.	ESS	=ESS	European Spallation Source			Released	
3.	ACC	=ESS.ACC	Accelerator			Released	
4.	A01	=ESS.ACC.A01	RFQ - Radio Frequency Quadrupole			Released	
5.	A02	=ESS.ACC.A02	DTL - Drift Tube Linac			Preliminary	
6.	A01	=ESS.ACC.A02.A01	DTL-010			Preliminary	
7.	A02	=ESS.ACC.A02.A02	DTL-020			Preliminary	
8.	A03	=ESS.ACC.A02.A03	DTL-030			Preliminary	
9.	A04	=ESS.ACC.A02.A04	DTL-040			Preliminary	
10.	A05	=ESS.ACC.A02.A05	DTL-050			Preliminary	
11.	C01	=ESS.ACC.A02.C01	DTL intertank 1			Preliminary	ESS-0734388
12.	C02	=ESS.ACC.A02.C02	DTL intertank 2			Preliminary	ESS-0734389
13.	C03	=ESS.ACC.A02.C03	DTL intertank 3			Preliminary	ESS-0734390
14.	C04	=ESS.ACC.A02.C04	DTL intertank 4			Preliminary	ESS-0734391
15.	C05	=ESS.ACC.A02.C05	DTL intertank 5			Preliminary	ESS-2973054
16.	E05	=ESS.ACC.A02.E05	Water Cooling System (DTL)			Preliminary	
17.	B01	=ESS.ACC.A02.E05.B01	Water cooling monitoring system			Preliminary	
18.	G01	=ESS.ACC.A02.E05.G01	DTL Skid			Preliminary	
19.	K01	=ESS.ACC.A02.E05.K01	DTL Water Cooling Control System			Preliminary	
20.	WG070	=ESS.ACC.A02.E05.WG070	cavity water manifold			Preliminary	
21.	W01	=ESS.ACC.A02.E05.W01	CWM-CWS04.Vtrc-PT-900			Preliminary	
22.	K01	=ESS.ACC.A02.K01	DTL Cavities Control System			Preliminary	
23.	K02	=ESS.ACC.A02.K02	DTL High-Level Control System			Preliminary	
24.	U01	=ESS.ACC.A02.U01	DTL Control Racks			Preliminary	
25.	U02	=ESS.ACC.A02.U02	RF Waveguide Support			Preliminary	
26.	A03	=ESS.ACC.A03	SPK - Spoke Linac			Preliminary	

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# Single entry to all Facility information



Navigate

Actions View

Access to all tag documents

No title

Data Grouped By Node Name Relationship type Document type

Name	Type	Rev	Description
=ESS.ACC.A02 (42)			
Specification (20)			
SE Management Plan (1)			
System Architecture Descripto (more) (1)			
Requirement Specification (12)			
ESS-0055456	Requirement Specification	1	Approved Level 2 requirements by ESS/INFN for the DTL
ESS-0055588	Requirement Specification	1	Agreed Interface requirements PBI-VAC by ESS/INFN
ESS-0055454	Requirement Specification	1	Agreed Interface requirements for water (cooling) ESS/INFN
ESS-0055447	Requirement Specification	1	Approved Interface requirements by ESS-INFN for the LLRF for the DTL
ESS-0055457	Requirement Specification	1	Agreed Interface DTL-PBI requirements by ESS/INFN
ESS-0050103	Requirement Specification	1	Requirements for the DTL
ESS-0050110	Requirement Specification	1	Requirements for the DTL
ESS-0055455	Requirement Specification	2	Agreed VAC L3, L4 EMR and interface requirements for the DTL with ESS/INFN
ESS-0050112	Requirement Specification	1	Requirements for the DTL
ESS-0035494	Requirement Specification	3	Scope of work, Legnaro, PBI, General technical scope of INFN Legnaro in-kind on DTL diagnostics for ESS
ESS-0055386	Requirement Specification	1	Agreed interface requirements ESS-INFN for RFDS-DTL
ESS-0055418	Requirement Specification	1	Approved interface requirements by ESS-INFN
Description (2)			
Drawing file (1)			
Interface Description (1)			

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# Single entry to all Facility information



Actions View [refresh] [undo] [redo] [print] [export] [help]

Tag description Reference Data class Status

PI	Tag	Description	Classification	LBS	EAM	State	Related Part
	ESS	ESS	European Spallation Source			Exists	
	ACC	=ESS ACC	Accelerator			Released	
	A01	=ESS ACC A01	RFQ - Radio Frequency Quadrupole			Released	
	A02	=ESS ACC A02	DTL - Drift Tube Linac			Preliminary	
	A01	=ESS ACC A02 A01	DTL-010			Preliminary	
	A02	=ESS ACC A02 A02	DTL-020			Preliminary	
	A03	=ESS ACC A02 A03	DTL-030			Preliminary	
	A04	=ESS ACC A02 A04	DTL-040			Preliminary	
	A05	=ESS ACC A02 A05	DTL-050			Preliminary	
	C01	=ESS ACC A02 C01	DTL intertank 1			Preliminary	ESS-0734388
	C02	=ESS ACC A02 C02	DTL intertank 2			Preliminary	ESS-0734389
	C03	=ESS ACC A02 C03	DTL intertank 3			Preliminary	ESS-0734390
	C04	=ESS ACC A02 C04	DTL intertank 4			Preliminary	ESS-0734391
	C05	=ESS ACC A02 C05	DTL intertank 5			Preliminary	ESS-2973054
	E05	=ESS ACC A02 E05	Water Cooling System (DTL)			Preliminary	
	B01	=ESS ACC A02 E05 B01	Water cooling monitoring system			Preliminary	
	G01	=ESS ACC A02 E05 G01	DTL Skid			Preliminary	
	K01	=ESS ACC A02 K01	DTL Water Cooling Control System			Preliminary	
	W01	=ESS ACC A02 W01	Drainage water manifold			Preliminary	
	WG070	=ESS ACC A02 WG070	WML-CWS04-WtrC-PT			Preliminary	
	K01	=ESS ACC A02 K01	DTL Cavities Control System			Preliminary	
	K02	=ESS ACC A02 K02	DTL High-Level Control System			Preliminary	
	U01	=ESS ACC A02 U01	DTL Control Racks			Preliminary	
	U02	=ESS ACC A02 U02	RF Waveguide Support			Preliminary	
	A03	=ESS ACC A03	SPK - Spoke Linac			Preliminary	

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# FBS vs product design (EBOM)



The FBS structure is released in a top down fashion

Discipline centric data for a tag including specifying documentation must be released prior to the tag's release

The Engineering Bill Of Material is released in a bottom up fashion

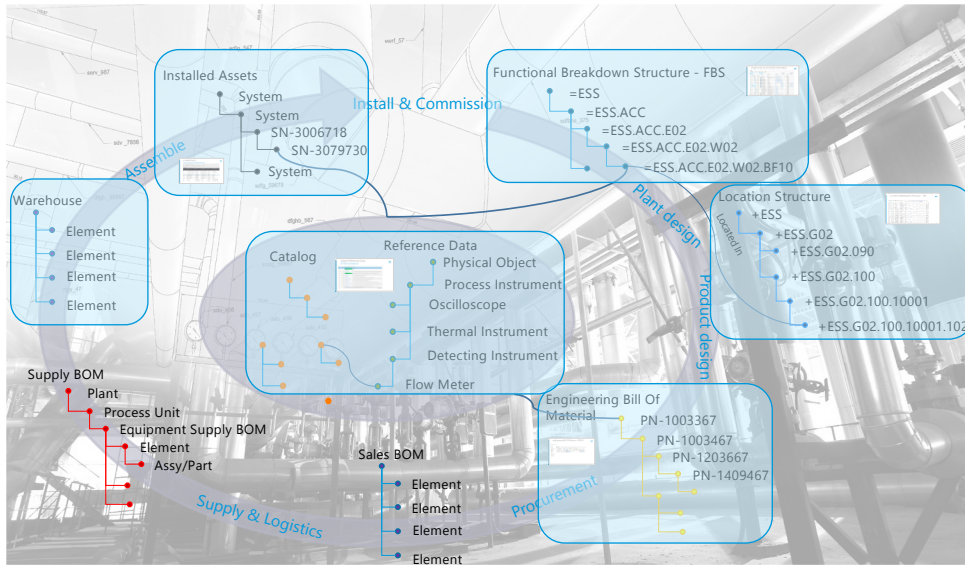
Tag	Description	Classification	State
ESS	ESS	European Spallation Source	Released
INFRA	ESS INFRA	Infrastructure	Released
W04	ESS INFRA W04	Water Cooling	Released
W01	ESS INFRA W04 W01	CWH - Cooling Water High	Released
G01	ESS INFRA W04 W01 G01	CWH - Medium Beta Substation	Released
G02	ESS INFRA W04 W01 G02	CWH - Low Beta Substation	Released
G03	ESS INFRA W04 W01 G03	CWH - High Beta Substation	Released
W01	ESS INFRA W04 W01 W01	CWH - Piping System - G02	Released
W02	ESS INFRA W04 W01 W02	CWH - Piping System - G04	Released
W03	ESS INFRA W04 W01 W03	CWH - Piping System D-building	Preliminary
Q01	ESS INFRA W04 W01 W03 Q01	Hand Valve	Preliminary
Q02	ESS INFRA W04 W01 W03 Q02	Hand Valve	Preliminary
Q03	ESS INFRA W04 W01 W03 Q03	Hand Valve	Preliminary
Q04	ESS INFRA W04 W01 W03 Q04	Hand Valve	Preliminary
Q05	ESS INFRA W04 W01 W03 Q05	Hand valve	Preliminary
Q06	ESS INFRA W04 W01 W03 Q06	Hand valve	Preliminary
Q07	ESS INFRA W04 W01 W03 Q07	Hand valve	Preliminary
Q08	ESS INFRA W04 W01 W03 Q08	Hand valve	Preliminary
Q09	ESS INFRA W04 W01 W03 Q09	Hand valve	Preliminary
Q10	ESS INFRA W04 W01 W03 Q10	Hand valve	Preliminary
Q11	ESS INFRA W04 W01 W03 Q11	Hand valve	Preliminary
Q12	ESS INFRA W04 W01 W03 Q12	Hand valve	Preliminary
Q13	ESS INFRA W04 W01 W03 Q13	Hand valve	Preliminary
Q14	ESS INFRA W04 W01 W03 Q14	Hand valve	Preliminary
Q15	ESS INFRA W04 W01 W03 Q15	Hand valve	Preliminary
Q16	ESS INFRA W04 W01 W03 Q16	Hand valve	Preliminary
Q17	ESS INFRA W04 W01 W03 Q17	Hand valve	Preliminary

Actions [refresh] [undo] [redo] [print] [export] [help]

Item	Qty	UoM	Name	Rev	LoM	Type	Tag	Description	State
			ESS-1838309	1	P	Part		Moderator_reflector_flag	Approved
			ESS-1838315	1	P	Part		Shaft-Insert-A8	Approved
			ESS-1838314	1	P	Part		MBSP-Brake_4	Approved
			ESS-1838312	1	P	Part		Shaft-Insert-A6	Approved
			ESS-1838310	1	P	Part		Shaft-Insert-B	Approved
			ESS-1838313	1	P	Part		Shaft-Insert-C	Approved
			ESS-1838316	1	P	Part		Shaft-Insert-C	Approved
			ESS-1838311	1	P	Part		RG-Radiolab_Rising	Released
			ESS-1838332	1	P	Part		Master-E2-Radiolab	Released
			ESS-1838334	1	P	Part		adjustment_screw_M05x1	Released
			ESS-1838328	1	P	Part		radial_bearing_flange	Released
			ESS-1838333	1	P	Part			Released
			ESS-1838322	1	P	Part		washer	Released
			ESS-1838320	1	P	Part		stopper_ring	Released
			ESS-1838321	1	P	Part		Nut_ISO_4032_M5x1	Released
			ESS-1838325	1	P	Part		screw_ISO_4017_M5x12	Released
			ESS-1838335	1	P	Part		adjustment_plate_B	Released
			ESS-1838327	1	P	Part		BG-Radiolab_springs	Released
			ESS-1838329	1	P	Part		BG-Int_spring	Released
			ESS-1838326	1	P	Part		BG-torque_bracket	Released
			ESS-1838324	1	P	Part		targeted_adjustment_dia	Released
			ESS-1838323	1	P	Part		screw_ISO_4032_M10x40	Released
			ESS-1838331	1	P	Part		stopper	Released
			ESS-1838330	1	P	Part		BG-torque_bracket-B	Released

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# What does it look like at ESS?



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# Engineering Bill Of Material - EBOM



ESS-0330298 Rev 1

Navigate										
Actions										
<input type="checkbox"/>	F/N	Type	Name	Rev	LoM	Description	Qty	UoM	State	
<input type="checkbox"/>		Part	ESS-0330298	1	✓	P		EA (each)	Released	
<input type="checkbox"/>	387901724	Part	ESS-0330299	2	✓	P		1.0 EA (each)	Released	
<input type="checkbox"/>	399112712	Part	ESS-0240205	7	✓	P		6.0 EA (each)	Released	

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# Specifying Documentation – MCAD model



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- Navigate
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- Part Overview
- Lifecycle

**Specifications**

Actions ▾ Table ▾

	Name ▾	Type ▾	Revision	Description	Title	Owner	State	Released Date
1. <input type="checkbox"/>	ESS-0242479	Physical Product	1.0		Level 125	Inigo Ruiz de Olano Claver	Release	