

ESS Target

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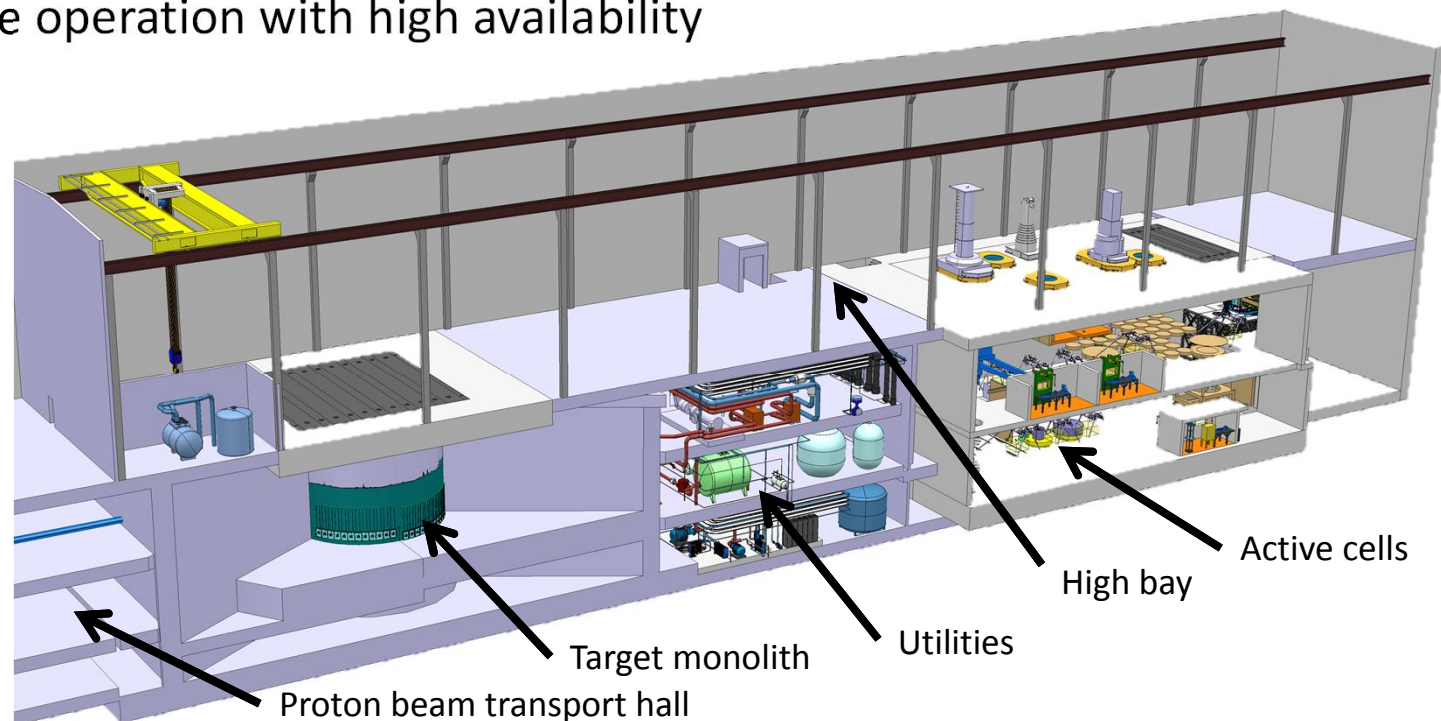
Ankara - October 6, 2015

Outline

- Target Station overview
- Project Scope
- Project Status
- Near Term Plans
- Status of Target In-Kind Contribution (IKC) Packages
- Concluding Remarks

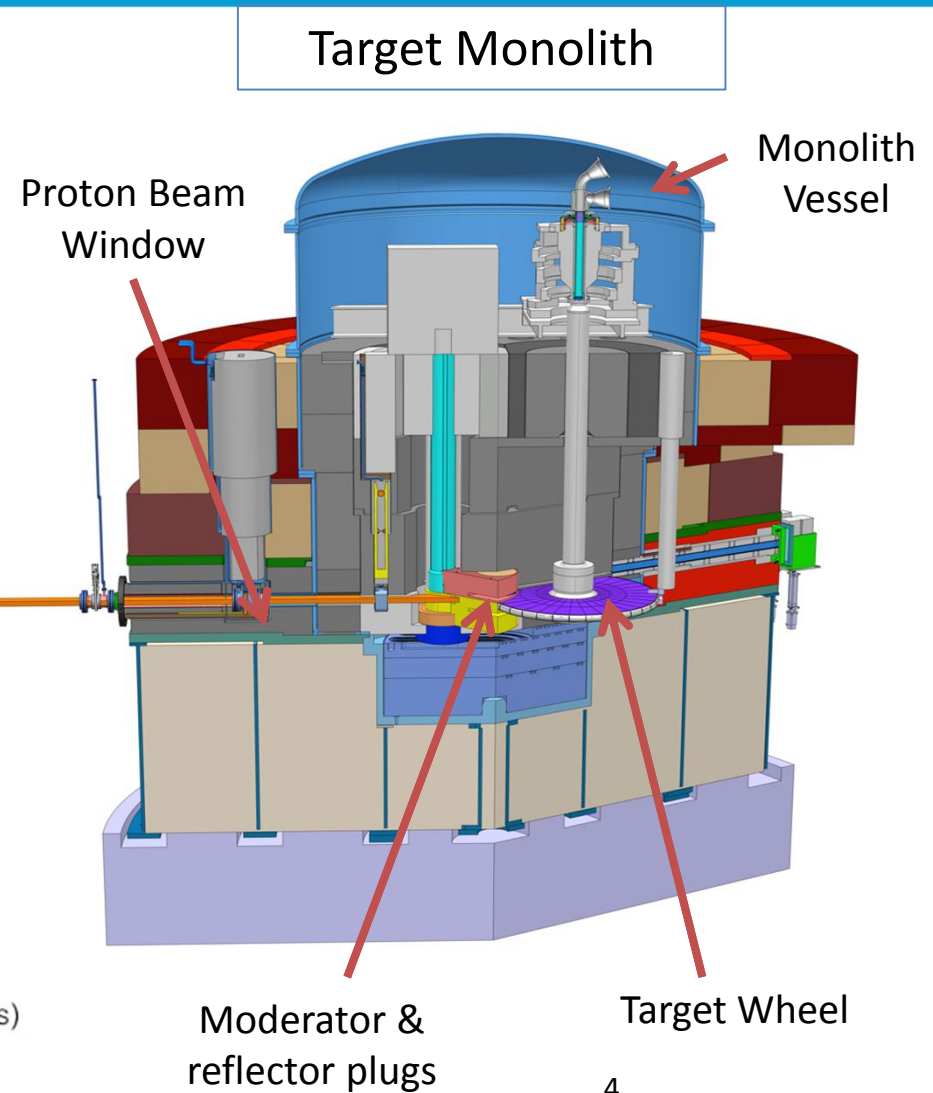
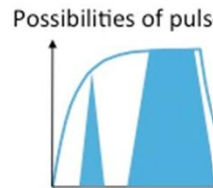
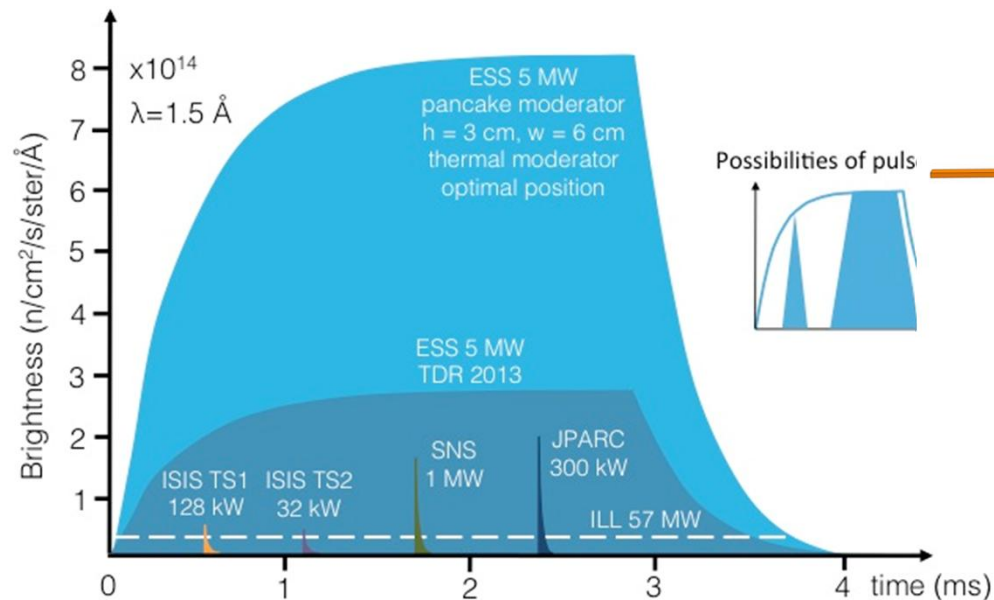
Target Station Overview: - High Level Functions

- Generate neutrons via the spallation process using protons produced by the accelerator
- Slow the neutrons to energies/wavelengths useful for neutron scattering
- Direct neutrons to neutron scattering instruments
- Safe, reliable operation with high availability



Target Station incorporates unique features

- Rotating W target
- He cooling
- High brightness neutron moderators



In-kind opportunities have been identified within each Target Work Package

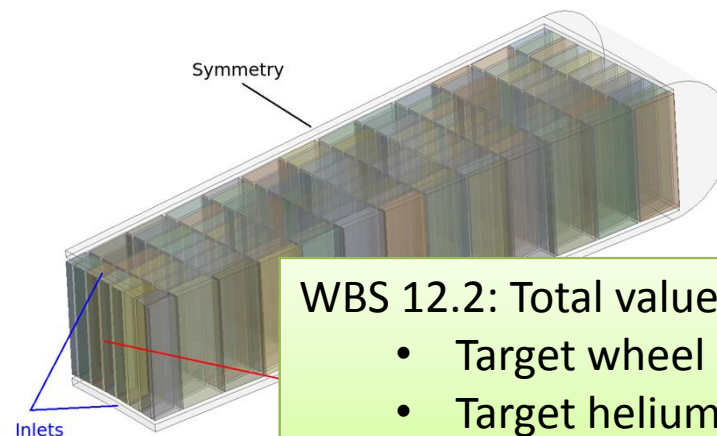
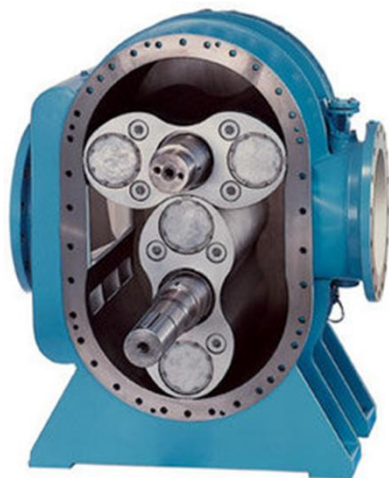
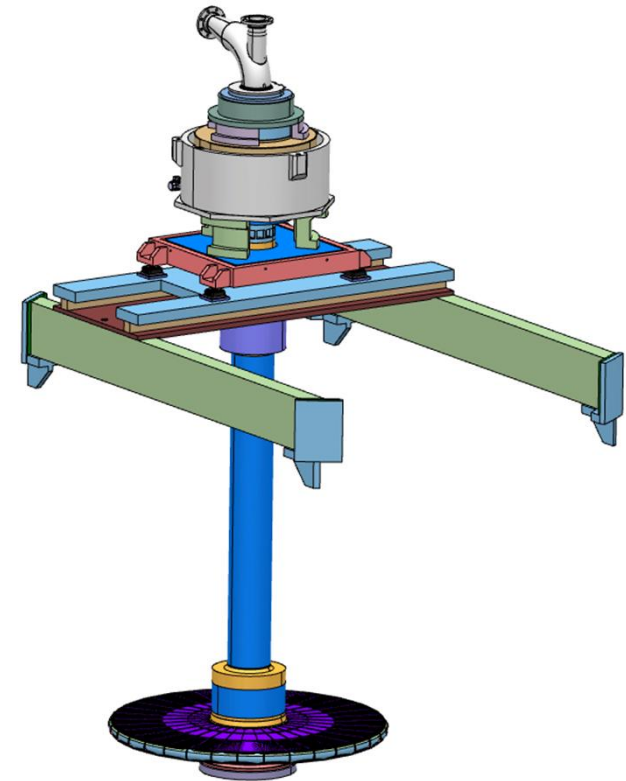
WBS	ID	Cost Book Value (€)	% IK possible	Possible IK (€)
12	Target Station	155,250,254	68	104,823,942
	Prior costs (2013)	4,120,000		
12.1	Management & Administration	5,655,299		
12.2	Target Systems	17,228,606	81	14,040,053
12.3	Moderator and Reflector Systems	22,103,936	88	19,550,046
12.4	Monolith Systems	35,633,853	73	26,031,135
12.5	Fluid Systems	29,075,342	64	18,485,077
12.6	Remote Handling Systems	28,472,148	93	26,517,231
12.7	Controls	7,164,861		
12.8	Physics	5,796,209	3	200,400

The only efforts that will be predominantly performed by the ESS Lund team are:

- Management and integration
- Neutronics design and support
- Safety related work – Safety credited controls, shielding analysis, and interaction with ESS safety, licensing and waste management organization

WBS 12.2: Target Systems

- Features:
 - He-cooled tungsten plates integrated in a wheel
 - ~ 60 n/p for 2 GeV p on W
 - 2.5 m diameter wheel on 5 m long shaft with rotational speed ~ 0.4 Hz
 - Lifetime ~ 5 years (@ 5 MW)
- Project Status: Preliminary Design Reviews (PDRs) held for Target wheel and He Cooling System
- In-Kind Status:
 - ESS-Bilbao team has taken responsibility for Target Wheel, Drive & Shaft scope
 - Nuclear Physics Institute of the Czech Academy of Sciences (UJF) recently selected as partner for Target Helium Cooling System



WBS 12.2: Total value of in-kind: 14 M€

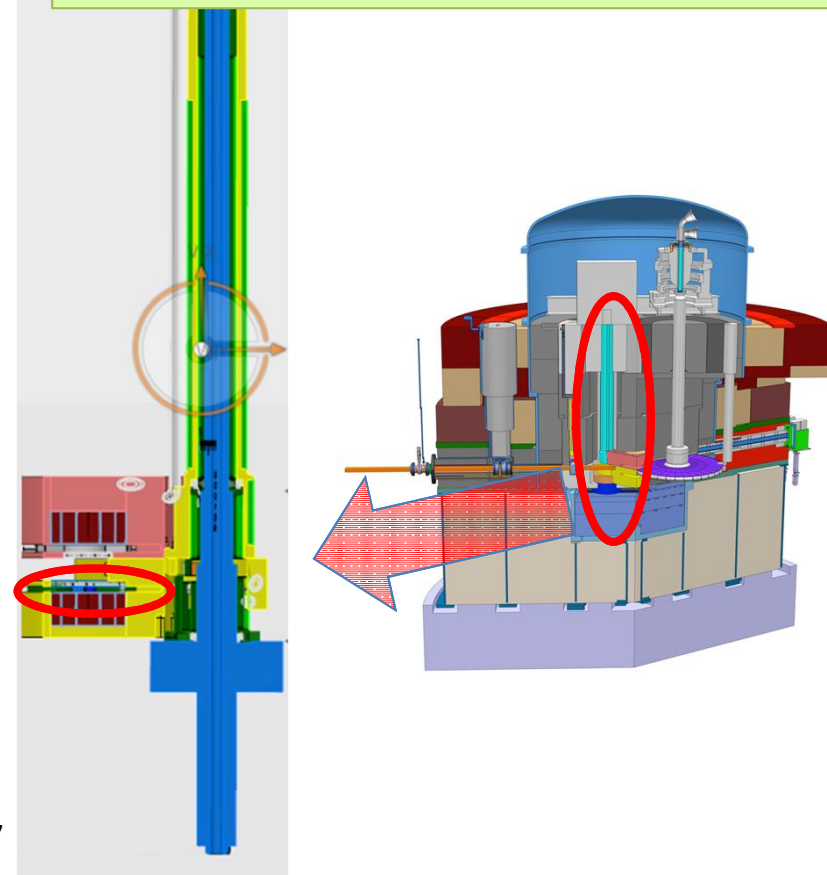
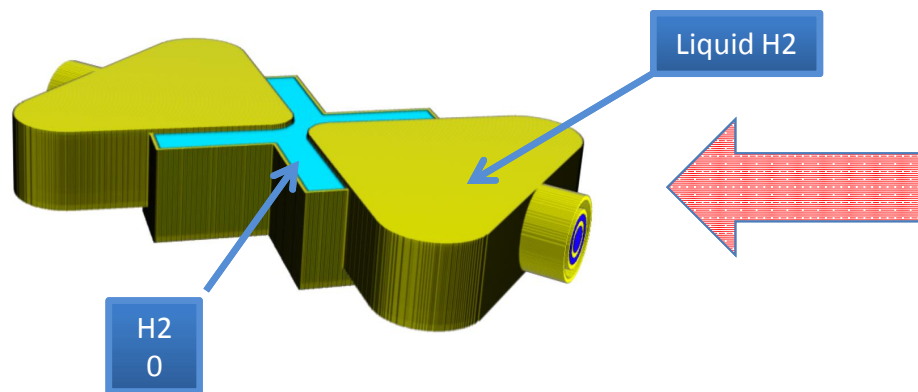
- Target wheel including tungsten plates
- Target helium cooling

WBS 12.3 Moderator and Reflector Systems

- Features:
 - Cold moderators - Supercritical hydrogen at 20 K
 - Thermal moderators – water
 - Al alloy vessels with beryllium reflector
 - New moderator concepts increase cold and thermal neutron source brightness by > 2x
 - Radiation damage limits lifetime to ~ 1 year at 5 MW
- Project Status: Preliminary Design Reviews in June 2015
- In-kind status: Forschungszentrum Jülich selected as partner

WBS 12.3: Total value of in-kind: > 20 M€

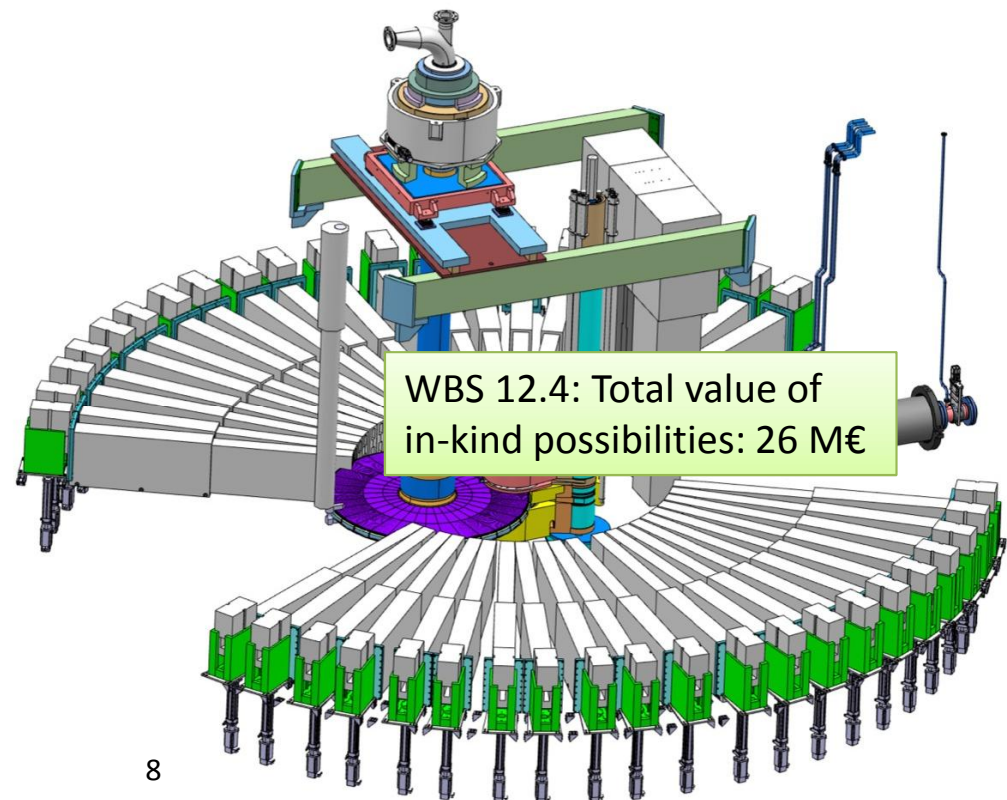
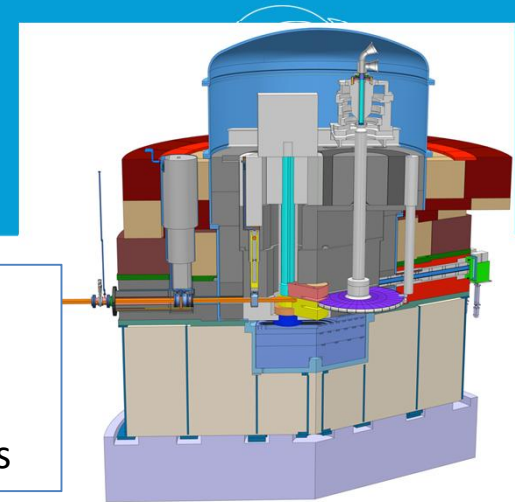
- Moderator and Reflector Plug
- Supercritical hydrogen loop
- Helium refrigerator



WBS 12.4: Monolith Systems

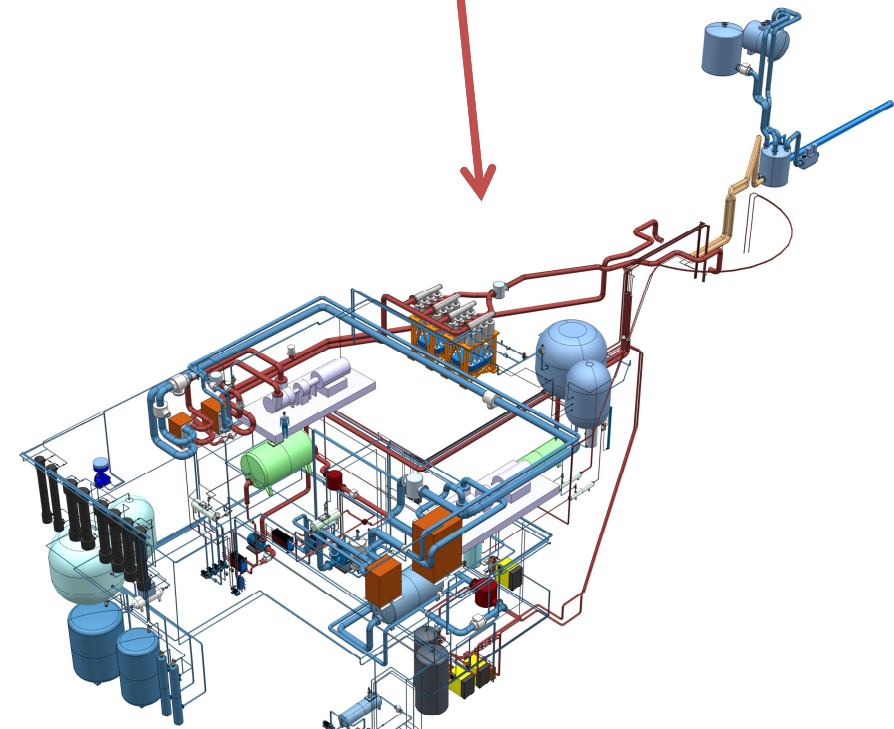
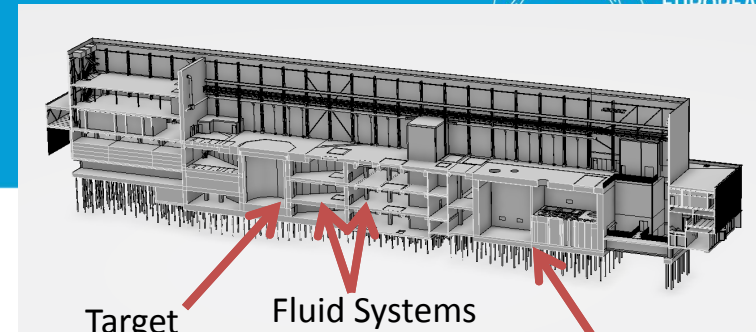
- Features:
 - Monolith internals:
 - Proton beam window (PBW)
 - Diagnostics inserts
 - Neutron extraction system
 - Shutters
 - Monolith vessel
 - He atmosphere in vessel
 - Shielding
 - Tuning beam dump
- Project status: PDRs for all systems planned for 2015
- In-kind status: Secured partner for six In-Kind Contributions
 - ESS-Bilbao has responsibility for PBW, Proton Beam Instrumentation Plug, Monolith Vessel, Tuning Beam Dump, and Neutron Beam Windows
 - CNR (Italy) has irradiation module
 - Seeking partner for He atmosphere system

- 11 m diameter
- 6,000 tons of steel shielding
- 42 neutron beam ports



WBS 12.5: Fluid Systems

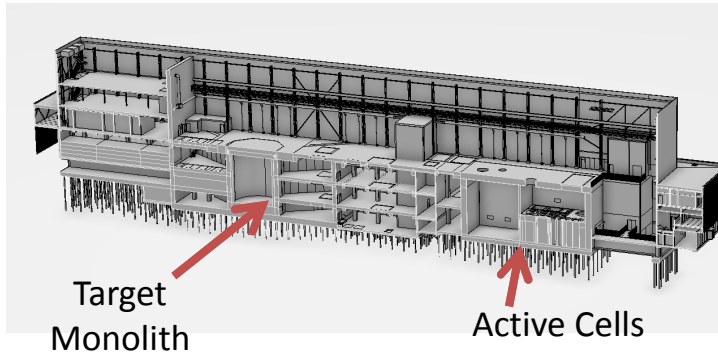
- Features/scope:
 - Primary and secondary water cooling systems
 - Helium purification system
 - Helium cooling for Proton Beam Window (PBW)
 - Target Station (nuclear grade) ventilation system
- Project Status: Completed Preliminary Designs for all systems except PBW cooling
- In-kind status: **Seeking partners for Primary and secondary water cooling systems and ventilation system**



WBS 12.5: Total value of in-kind possibilities: 13 M€

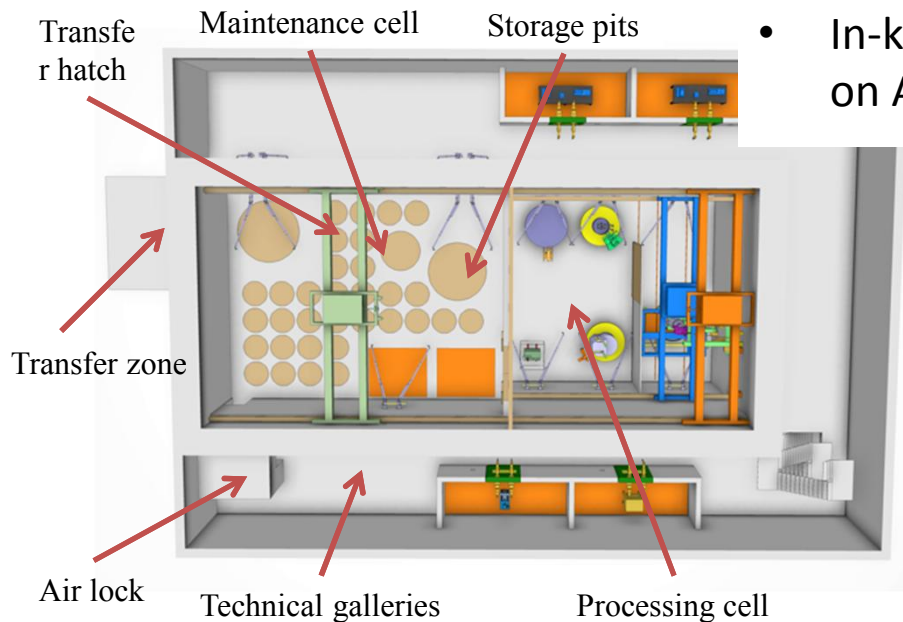
WBS 12.6 Remote Handling Systems

WBS 12.6: Total value for in-kind possibilities: 26 M€

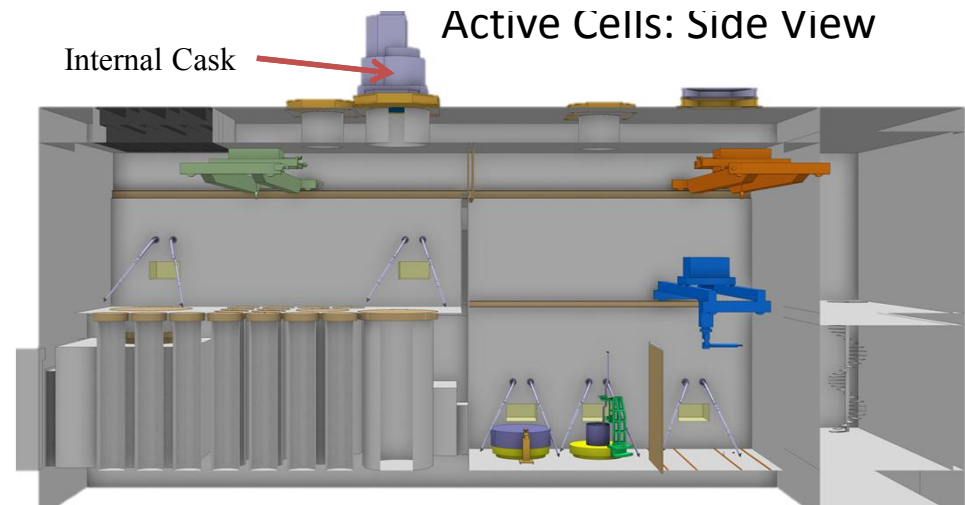


- Features/scope:
 - Provide capability to handle activated equipment
 - Remove/replace, store, and process for disposal spent targets, moderator/reflectors, proton beam windows, ...
 - Active Cells: Hot Cells with infrastructure and tooling
 - Internal transport casks and handling devices for transport between monolith and active cells
 - Mock-ups, test and training facility
- Project Status: PDR for Active Cells held in Dec 2015
- In-kind status: Partnering with STFC/UKAEA Culham on Active cells

Active Cells: Top View



Active Cells: Side View



Target Project – Status

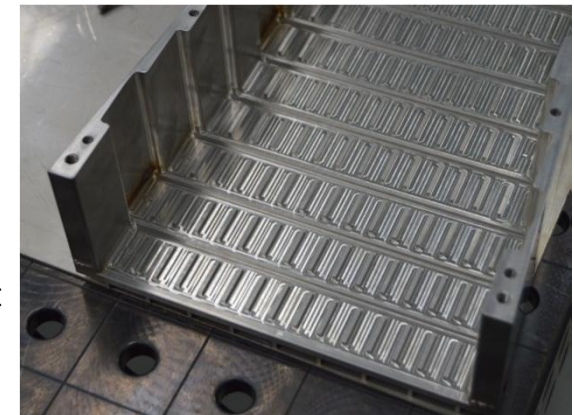
- 10 of 25 Preliminary Design Reviews held
- Beginning to move from design to hardware (prototypes)
- Good progress on nuclear safety evaluation process
 - Working with SE/ES&H/Quality Divisions in establishing safety and quality classification processes
 - Qualitative hazards analyses for all systems nearly complete
 - Bounding safety cases being identified and evaluated



Embedded support
prototype for
Active Cell liner



Prototype vessel for water
pre-moderator (FZJ)



Cassette structure prototype for
holding W target bricks (ESS-Bilbao)

Target Project – Near Term Plans

- Complete Preliminary Design Reviews and hold first set of Critical Design Reviews
- Award contracts for schedule-critical items including:
 - He Cryoplant used to cool the LH2 moderators
 - Embedded supports and liner for Active Cell
 - Monolith civil structure embedments
- Analyze bounding accidents (quantitative hazards analysis) and identify safety-credited systems, structures, and components by May 2016 SSM submittal
- Finalize detailed installation, testing, and commissioning plan and integrate with others, especially CF
- Bring In-Kind partners onboard/transition work to partners where appropriate

Summary of Status of Target Project IKCs

Work Package	In-Kind ID	In-Kind Contribution	Last Call Date	Cost Book Value (M€)
2 Target Systems	TIK.2.1	Target Wheel		8.4
	TIK.2.2	Target He Cooling system		5.6
3 Moderator & Reflector Systems	TIK.3.1	Moderator & Reflector Plugs		4.7
	TIK.3.2	Cryogenic Moderator System (LH2)		4.4
	TIK.3.3	Cryoplant		14.3
4 Monolith Systems	TIK.4.1	Target Monitoring Plug	15-Jan-16	0.5
	TIK.4.2	Proton Beam Instrumentation Plug		0.5
	TIK.4.3	Irradiation Module		0.2
	TIK.4.4	Proton Beam Window		0.9
	TIK.4.5	Monolith Vessel		4.6
	TIK.4.6	Neutron Beam Windows		0.5
	TIK.4.7	He Atmosphere System	15-Jan-16	1.2
	TIK.4.8	Monolith Shielding Systems	15-Jan-16	15.1
	TIK.4.9	Tuning Beam Dump		2.5
5 Fluid Systems	TIK.5.1	Primary Water Cooling Systems	1-Oct-15	2.5
	TIK.5.2	Intermediate Cooling Systems	1-Oct-15	2.0
	TIK.5.3	Ventilation & Confinement	1-Oct-15	7.6
	TIK.5.4	Proton Beam Window Primary Cooling System	15-May-16	0.6
6 Remote Handling Systems	TIK.6.1	Active Cells		21.5
	TIK.6.2	Internal Casks and Handling Devices	15-Feb-16	3.4
	TIK.6.7	Remote Handling Support	15-Feb-16	1.2
8 Physics	TIK.8.1	Tungsten Release Factors		0.2

Target Project has 22 in-kind work elements:

- Partner selected for 13 work elements
- Soliciting partners for 5 others
- Last Call dates set for all remaining elements
 - “Last Call” - Announcement to stakeholders that we must have partner or we will use cash to self-perform

Highly Qualified Partners onboard for Thirteen IKC Packages

In-Kind ID	WBS #	In-Kind Contribution	Cost Book Value (M€)	Partner
TIK.2.1	12.2.2-3	Target Wheel	8.4	ESS Bilbao
TIK.2.2	12.2.4	Target Helium Cooling System	5.6	UJF – Czech Rep.
TIK.3.1-3	12.3.2-4	Moderator & Reflector Systems	23.4	FZJ - Germany
TIK.4.2	12.4.2.2	Proton Beam Instrumentation Plug	0.5	ESS Bilbao
TIK.4.3	12.4.2.3	Irradiation Module	0.2	CNR - Italy
TIK.4.4	12.4.3.1	Proton Beam Window	0.9	ESS Bilbao
TIK.4.5	12.4.3.2	Monolith Vessel	4.6	ESS Bilbao
TIK.4.6	12.4.3.3	Neutron Beam Windows	0.5	ESS Bilbao
TIK.4.9	12.4.5	Tuning Beam Dump	2.5	ESS Bilbao
TIK.6.1	12.6.2	Active Cells	21.5	STFC/UKAEA
TIK.8.1	12.8.5.1	Tungsten Release Factors	0.2	DTU - Denmark

Six partner institutes so far
Value of awarded packages = 68.4 M€

Concluding Remarks

- Target Station Project team is focused on 2019 completion date
 - For most of the target station components, Preliminary Design will be completed in 2015 and Final Design in 2016
- Most Target Station hardware systems and associated design and development efforts are identified as possible in-kind partnerships
- Partnering process is well established
 - We have secured highly qualified partners for our first 13 work elements
 - Actively seeking partners for 5 more now
 - Need to identify partners for the remaining 4 elements by mid-2016

**Thank you
for your attention!**

