

# WP7 Target Controls

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December 17, 2015

# Outline



- Highlights
- Schedule performance
- Near-term plans
- Risks and issues
- Concluding remarks

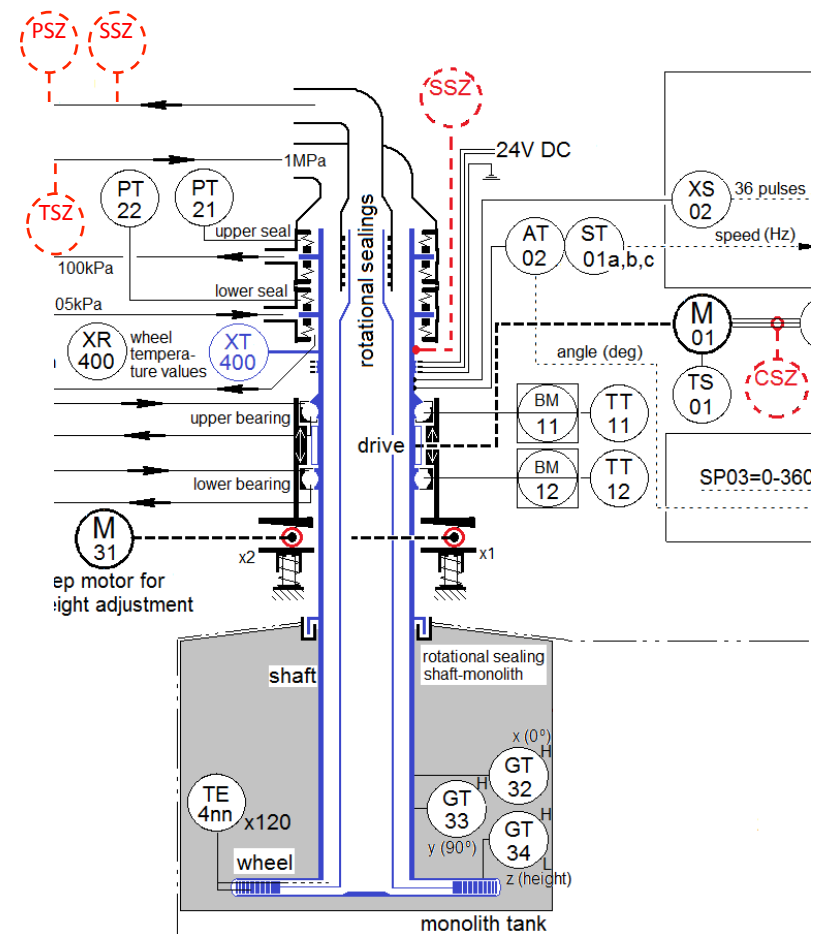
# Highlights – Controls



- **TSS (Target Safety System)**
  - **Concept Specification on TSS document under review for PDR**
    - *In accordance with IEC 61511 lifecycle*
  - **Chose standard for TSS design (IEC 61511) – ‘TSS safety standard selection’ document under review for PDR**
  - **Described Pilot-TSS interfaces – all ICD-R documents under review for PDR**
    - *Target: Target wheel, target helium cooling system*
    - *Accelerator: ion source and bending magnets*
    - *Site Infrastructure, ICS: Control Room & EPICS, Machine Protection*
  - **Completed Pilot-TSS reliability analysis**
  - **Started FMECA for Pilot TSS**
  - **Determined Pilot-TSS trip values for loss of cooling scenarios**
    - *Helium temperature ( $T_{in}$ ), He pressure ( $P_{out}$ ), He flow velocity ( $V_{out}$ )*
- **Target Controls**
  - **Process control schedule under development by ICS (Benedetto Gallese)**
  - **Analysis begun for determination of Target PSS requirements (Stuart Birch)**

# Pilot TSS Inputs

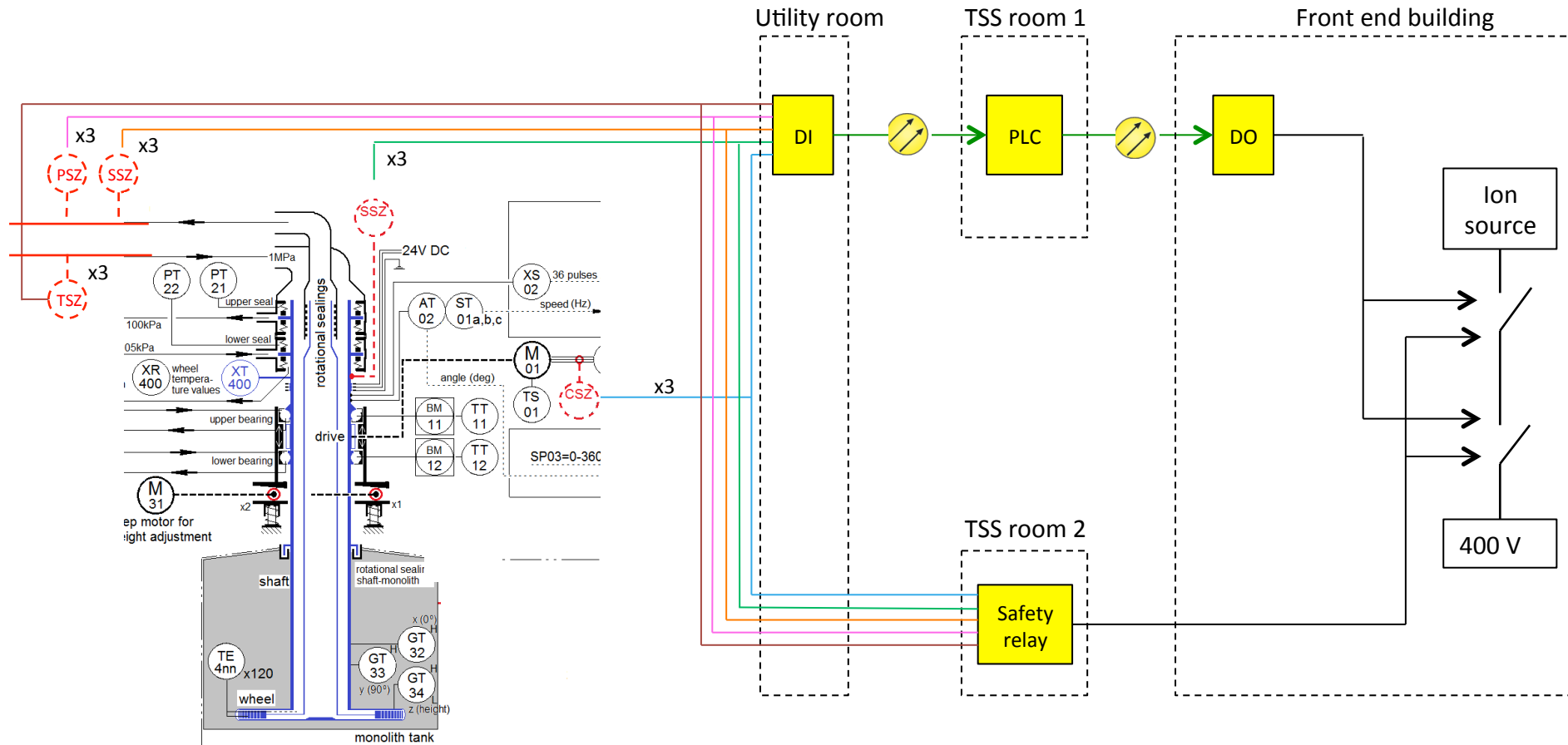
Process variable Event	Outlet velocity	Outlet pressure	Inlet temperature	Target shaft rotational speed
Loss of He cooling flow (blower fail)	X			
Loss of He cooling pressure (leakage)		X		
Loss of He cooling heat exchange			X	
Decrease of wheel rotational speed				X



# Pilot TSS Safety Functions

Function	Normal operation
TSS shall achieve safe state if...	
... target He cooling outlet velocity < 40 m/s	60 m/s
... target He cooling outlet pressure < 7 bar	10 bar
... target He cooling inlet temperature > 80 °C	40 °C
... target shaft rotational speed < 11.6 rpm	23.3 rpm

# Pilot TSS Architecture

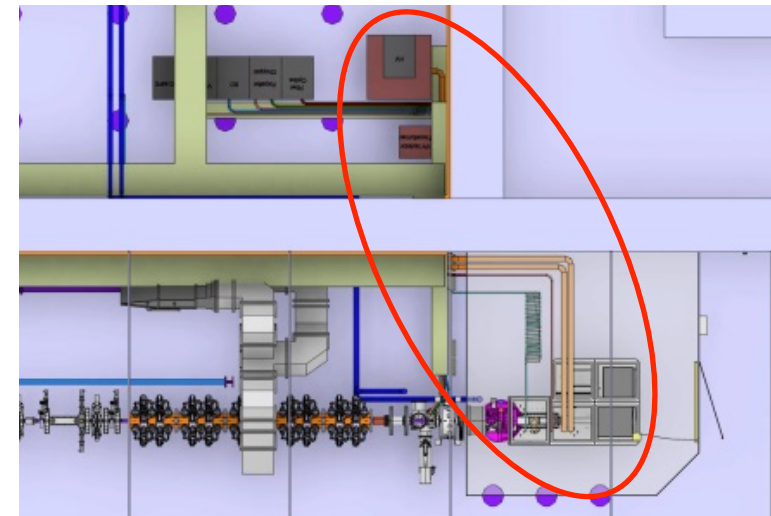


# Pilot TSS System Output

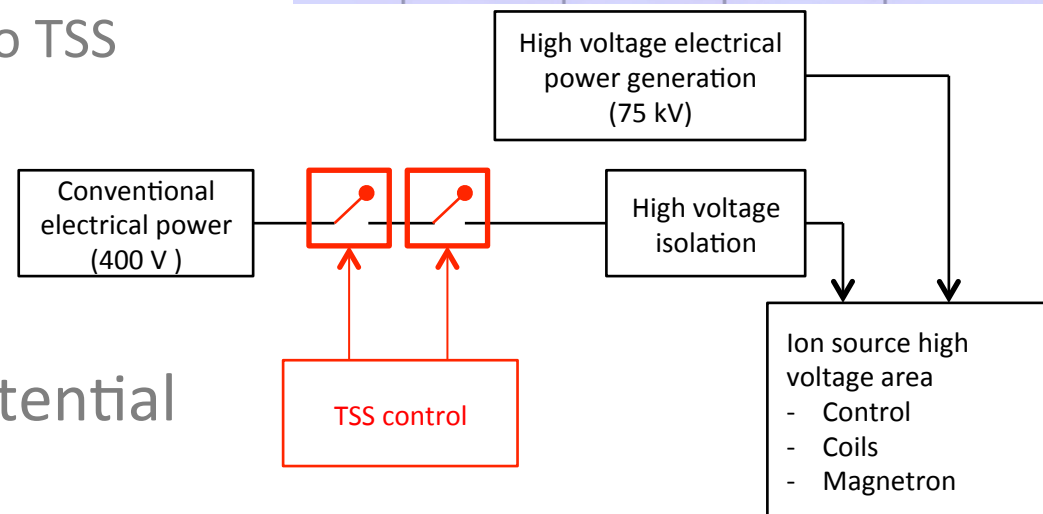
- Purpose = achieve safe state
- Safe state = no beam on target

## 1. Ion source

- Contactors to switch off the 400V electrical power supply to the Ion source
- Contactors dedicated to TSS



## 2. RFQ as a remaining potential redundant solution



# Highlights – Hazard Analyses



- ***‘Radiological Hazard Analysis Process for the ESS Target Station’ document written & under review***
- *Started radiological Hazard Analysis for all Target Station maintenance activities*
  - *Wheel/shaft/drive & helium cooling – DONE*
  - *Shielding & plugs primary water cooling – DONE*
  - *Active liquid purification & storage – DONE*
  - *Intermediate cooling systems for water & helium – DONE*
  - *Primary & intermediate water system drain tanks – DONE*
- ***Started Accident Analyses for 5 of 21 enveloping events***
  - Development of physical parameters for each accident done within each group (ex. Simulation of effects of beam on stopped wheel)
  - Calculate consequence – dose to workers and/or public
  - Target wheel release factors and fluid inventories under review
  - ES&H draft of dose-to-workers process provided



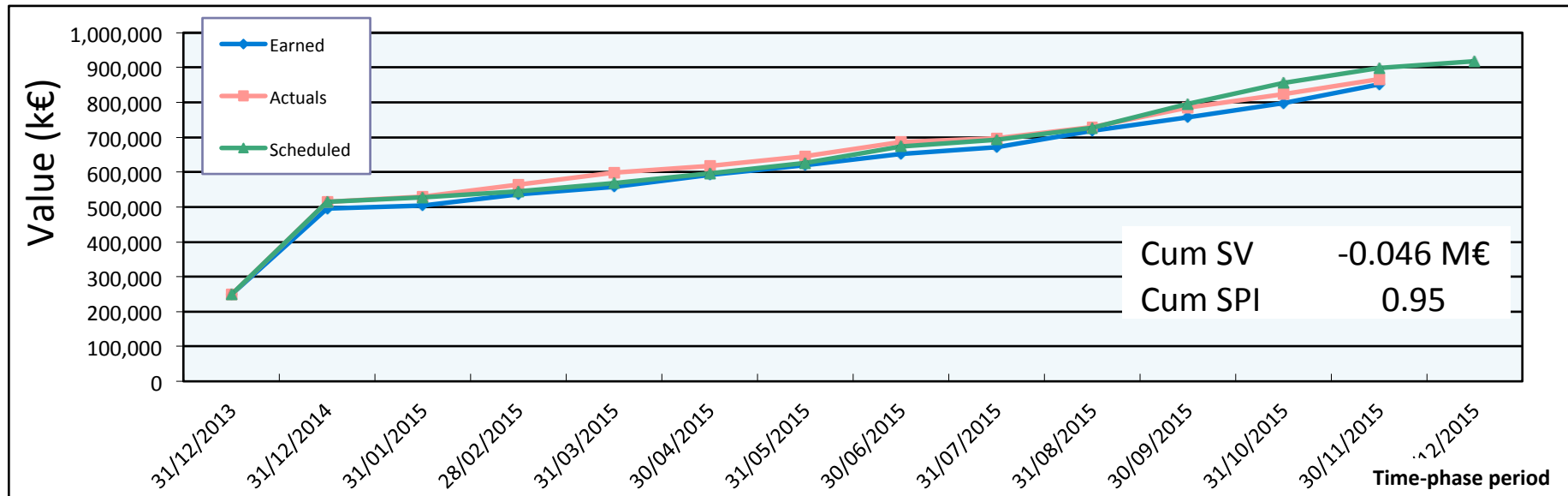
# Accident Analyses – Selected events



1. Target Wheel stop during beam on target
2. Beam Event: Focused and non-rastered beam on target
3. Loss of Target wheel cooling during beam on Target
4. Leakage from Target Cooling circuit into monolith, depressurisation of PCool
5. Clogged W channels, local overheating
6. Loss of He purification function
7. Water leakage from Intermediate Water System into Target He
8. Loss of confinement in Target He system – release into Utility rooms
9. LH2 leakage with explosion/LH2 leakage with local fire
10. Water leakage in monolith (highest contamination level)
11. Water leakage into connection cell and utility rooms
12. NBG/Chopper - missile effect on monolith system
13. Beam dump – high power beam when target in maintenance mode
14. Earthquake scenario Target/monolith
15. Active Cells: Operator inside maint. cell when sliding door unintentionally opens
16. Active Cells: Operator inside process cell next to worst case inventory
17. Active Cells: Operator inside maintenance cell next to worst case inventory
18. Active Cells: Loss of dynamic confinement (loss of HVAC)
19. Active Cells: Loss of confinement process/maintenance – open doors
20. Active Cells: Fire in Maintenance or Process cell
21. Active Cells: Earthquake scenario

# Schedule Performance (1 of 2)

- *EVMS performance from November*



## Variance Analysis:

- Cumulative SV of -0.046 M€ (SPI = 0.95) is primarily due to:
  - Delays in progress on hazard analysis – uncertainty for TSS design
  - More resources devoted to process control development than originally planned
- Accident analysis completion date later than required – *need to bring back on schedule*
- Focus on TSS-pilot design PDR for mitigation of selected events for wheel and helium cooling systems

# Schedule Performance (2 of 2)

- *No milestones achieved since last TTB*
- *Working toward Pilot-TSS design PDR in February 2016\**
- *Current forecast dates for all milestones shown below*

ID	Name	Planned Date	Current Forecast or Actual	Delay (W.Days)
A77370	PDR – Pilot TSS design	2015-12-10	2016-02-15*	- 2 months
A53380	Hazard Analysis for TSS Completed	2015-05-26	2016-04-19	-10 months
A53480	TSS Logic description complete	2015-09-14	2016-05-19	-8 months
A53560	CDR for TSS	2016-06-08	2017-02-22	-8 months
A63480	Acceptance of Factory Test for TSS	2017-10-27	2018-05-29	-7 months
A77850	On-site TSS Testing Starts (end of Installation)	2018-10-15	2018-10-17	0 month
A63580	End of Tests – TSS integrated with Target systems and Accelerator front end	2019-04-29	2019-10-22	-6 months

## Near Term Plans (next 3 months)

- ***Develop Pilot-TSS design → PDR February 2016***
  - *Wheel, Target He cooling system – evaluate options for instrumentation and find suitable options*
  - *Finish safety analysis of Pilot-TSS*
  - *Complete draft of document describing connection between ESS radiation safety classification and IEC61511 design standard for TSS (Zurich)*
  - ***Move Pilot TSS documentation through review/approval process in preparation for PDR***
- ***Prepare for SSM licensing application → due March 2016***
- ***Incorporate final results of Accident Analyses into TSS design***
- ***Coordinate with ICS Division to develop requirements for process controls, machine protection and PSS-Target***

# Near Term Plans (next 3 months)

- **Coordinate execution of accident analyses**
- **March 2016 deadline for all 21 analyses → SSM application**
  - **Minimum of first five analyses finalized by December**
    - *Monolith: Wheel stop* (Wheel, Monolith)
    - *Monolith: LH2 fire/explosion* (Moderator/Reflector, Monolith)
    - *Utility rooms: target Helium release* (Target helium cooling system)
    - **Active Cells: loss of ventilation** (Active Cells)
    - *Active Cells: bi-fold door opens* (Active Cells)
  - **Next priority analyses for TSS design:**
    - *Loss of He cooling* (He cooling, Wheel, Monolith)
      - *Loss of flow, loss of cooling, loss of pressure, leak into monolith*
    - *Unrastered and focused beam* (Wheel, Monolith)
    - *Localized W heating* (Wheel)
    - *Water leak in Monolith* (Moderator, Wheel, Monolith)
    - *Beam Dump – high power beam* (Monolith/Beam Dump)
    - *Active Cells: Fire & Earthquake* (Active Cells)

# Risks and Issues

- *Finalization of TSS system requirements and design depends on completion of accident analysis scenarios*

ID	Risk	Treatment	Status
3	Licensing framework for ESS target station is not well defined, or is changed	<ul style="list-style-type: none"> <li>• Work closely with ES&amp;H division to understand SSM documentation and expectations</li> <li>• Participate in Safety Advisory Group (SAG)</li> <li>• <b>Complete hazards analysis in a timely manner and perform design basis accident analysis</b></li> <li>• Target division engagement in the development of an ESS-wide safety classification methodology</li> </ul>	<ul style="list-style-type: none"> <li>• Attend SAG meetings</li> <li>• Progressing with Hazard Analyses</li> <li>• <b>Progressing with Accident Analyses</b></li> <li>• Documenting Target hazard analysis process</li> <li>• Reviewed proposed content for license 2 SSM application</li> </ul>
43	Design and interface information given to CF too late	<ul style="list-style-type: none"> <li>• Use the formal documents ICD and ICD-R to communicate the requirements</li> </ul>	<ul style="list-style-type: none"> <li>• <b>TSS-CF ICD written &amp; undergoing review for PDR</b></li> <li>• <b>Regularly meet with CF re. TSS</b></li> </ul>
42	Incompatible controls or missing controls or for Target within ICS	<ul style="list-style-type: none"> <li>• <b>ICS and Target agree on interface strategy that defines interface points for controls within each of the Target Work Packages</b></li> </ul>	<ul style="list-style-type: none"> <li>• Clarifying ICS scope for Target</li> </ul>

# Concluding Remarks

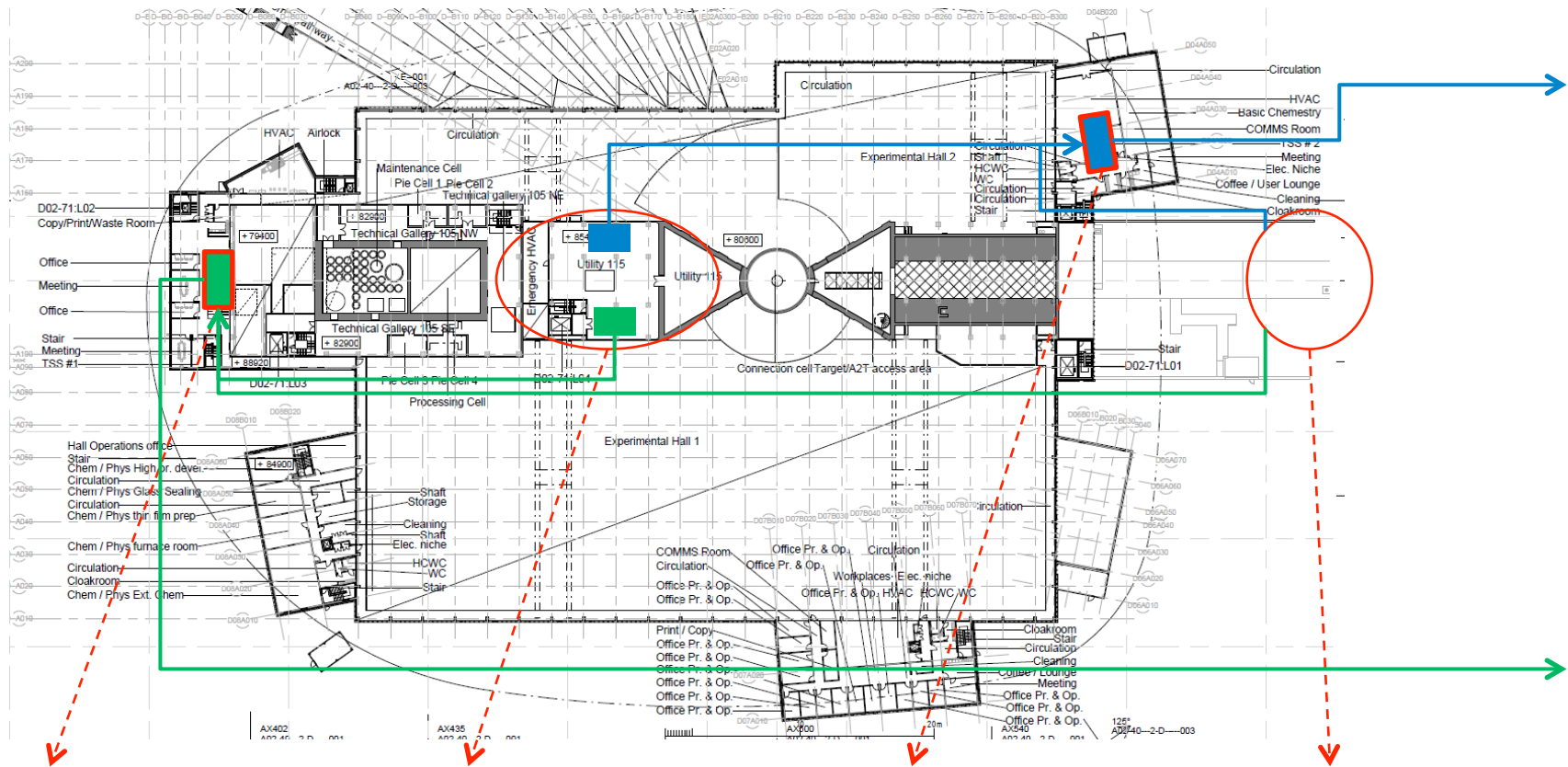


- WP7 focus is on development of Pilot-TSS design for PDR
- **Timely completion of accident analyses critical for establishing TSS requirements and identifying global target station safety certified equipment**
  - Analyses depends on effort within all Target system groups, in-kind partners, and ES&H
  - *Accident analyses results may impact safety requirements for Target systems*
  - *Results from accident analyses may require new interfaces between TSS and additional target systems*





# Pilot TSS Infrastructure



## TSS room 1

- Control equipment
- CPU

## Utility room

- Process measurements
- Distributed I/O

## TSS room 2

- Control equipment
- CPU

## Bending magnet

- Process measurements
- Distributed I/O