Target Station Design

Dan Wilcox

High Power Targets Group, Rutherford Appleton Laboratory

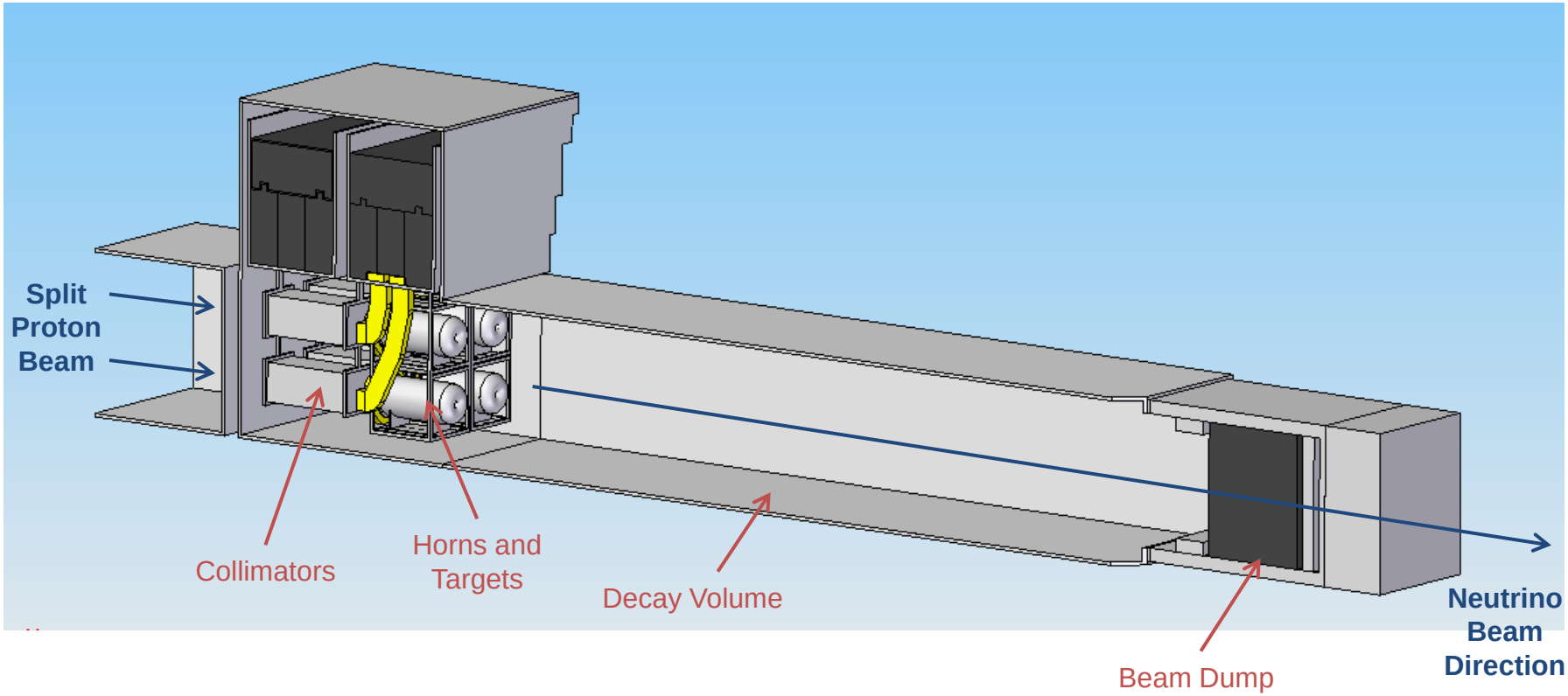
EuroNu Annual Meeting 2012

Contents

- Purpose of the Target Station
- Challenges and Objectives
- Design Overview
- Component Detail
- Conclusions

Purpose of the Target Station

- To contain the targets and magnetic horns
- To contain support infrastructure for these components (maintenance, cooling, etc.)
- For EuroNu, the target station contains the section of beamline shown below;



Challenges and Objectives

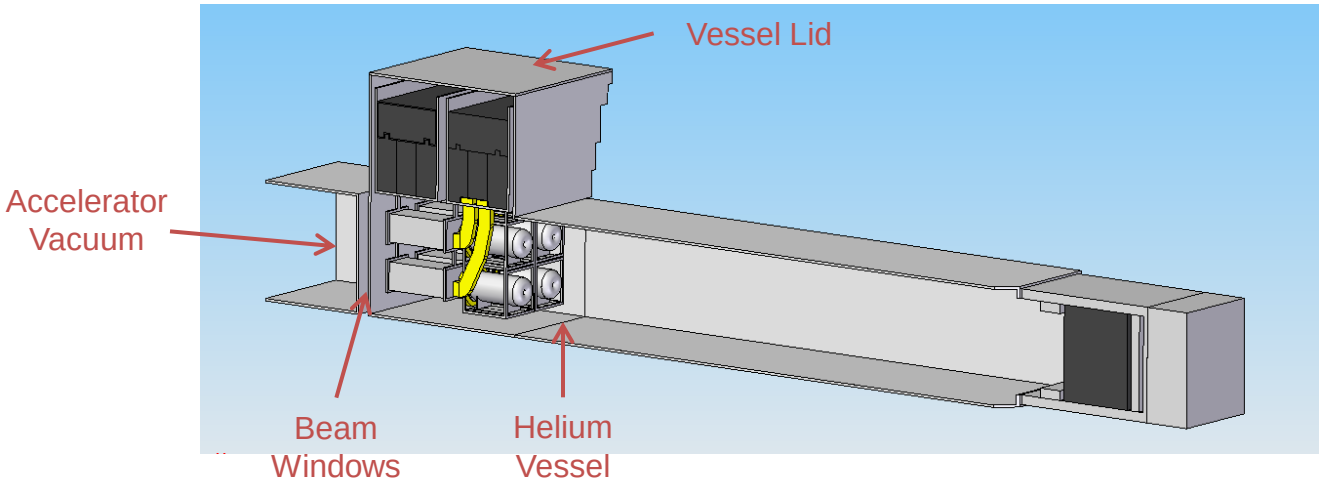
- Technical Challenges
  - High radioactivity of components
  - Limited horn and target lifetimes – failure is expected during the lifetime of the facility
  - Therefore a system is required to replace broken parts remotely
  - Precise alignment of horns and targets required (±1mm)
  - 4 horns means increased complexity and increased target station volume

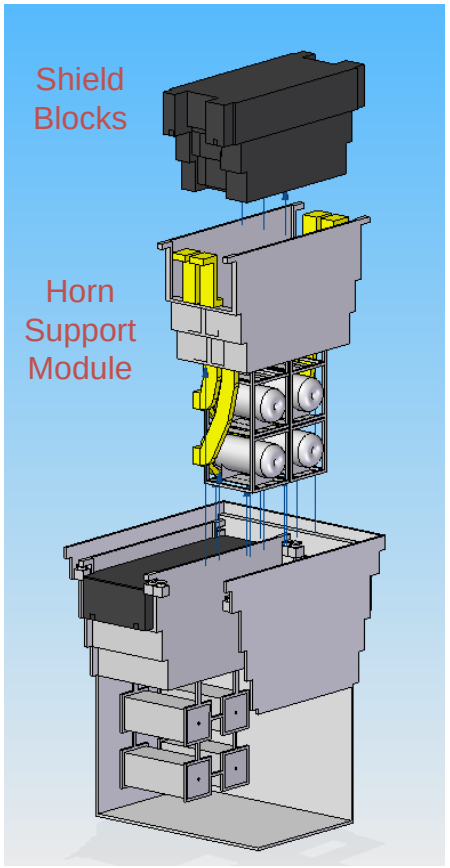
- Main Objectives
  - Ensure Safety
  - Minimise Downtime
  - Minimise Cost

Design Overview

- Solution based on T2K target station
  - Proven concept, designed for comparable beam power and activation
  - Main problem: time taken for repairs

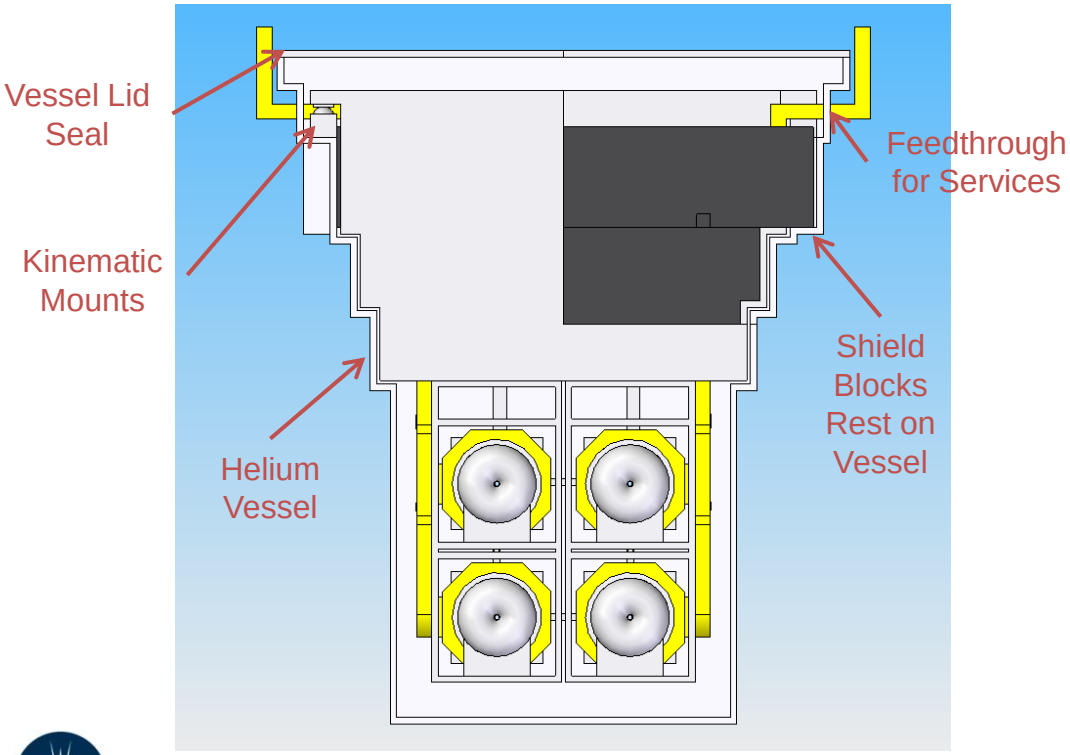
- Key Features
  - Components run in helium environment
  - Gantry crane for remote handling
  - For access, must pump out helium and remove shielding

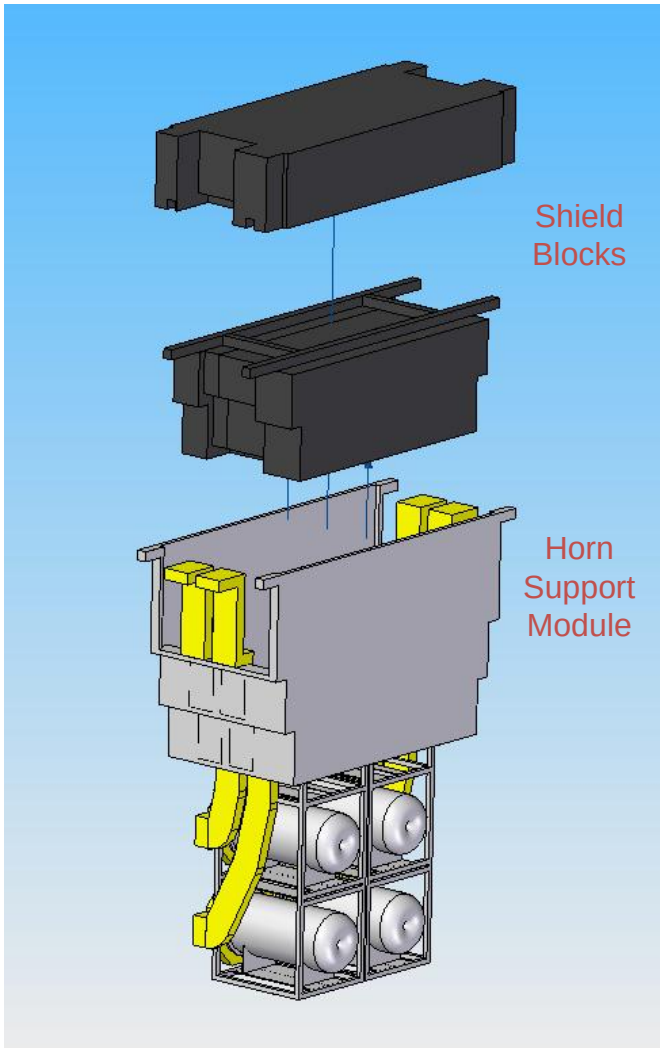




Horn Support

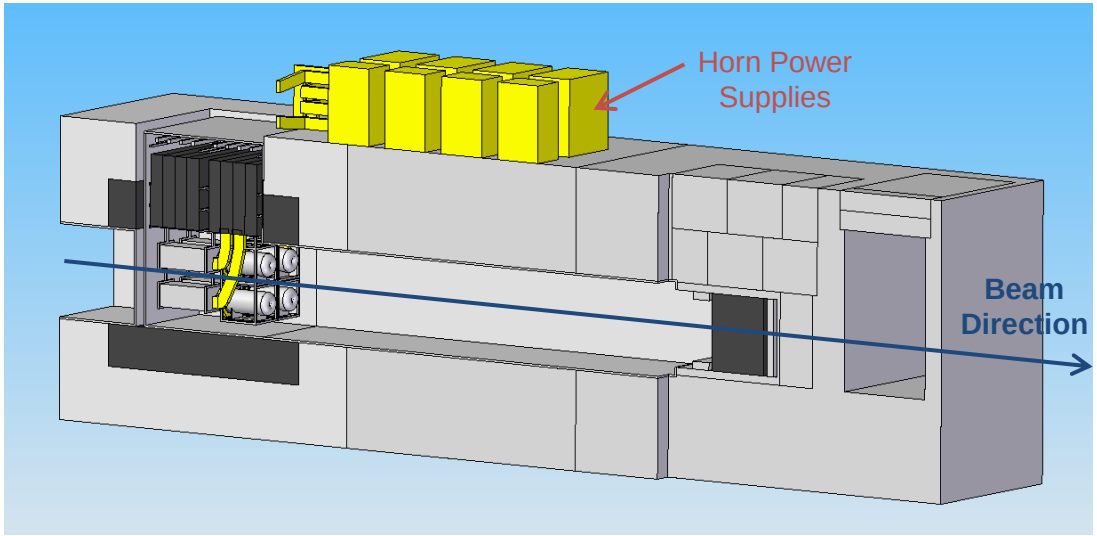
- Kinematic mounts ensure accurate alignment
- Must disconnect services inside vessel
- Removable shield blocks fit inside module
- Labyrinth to prevent radiation shine
- Shielding inside vessel protects kinematic mounts, service connections and lid seal

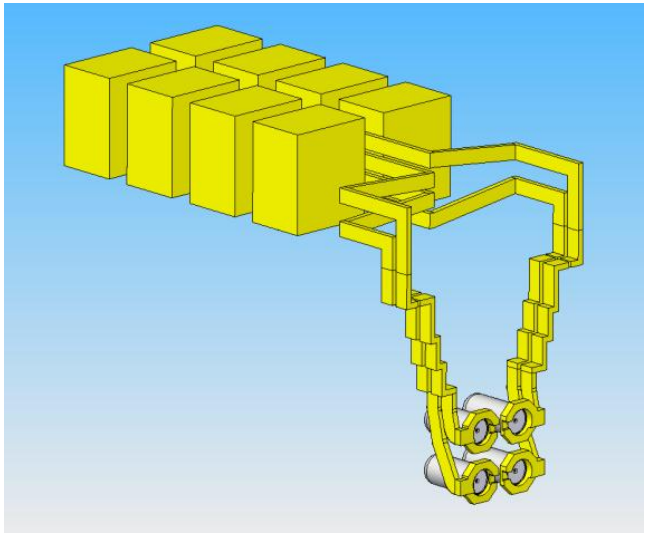




Power Supply

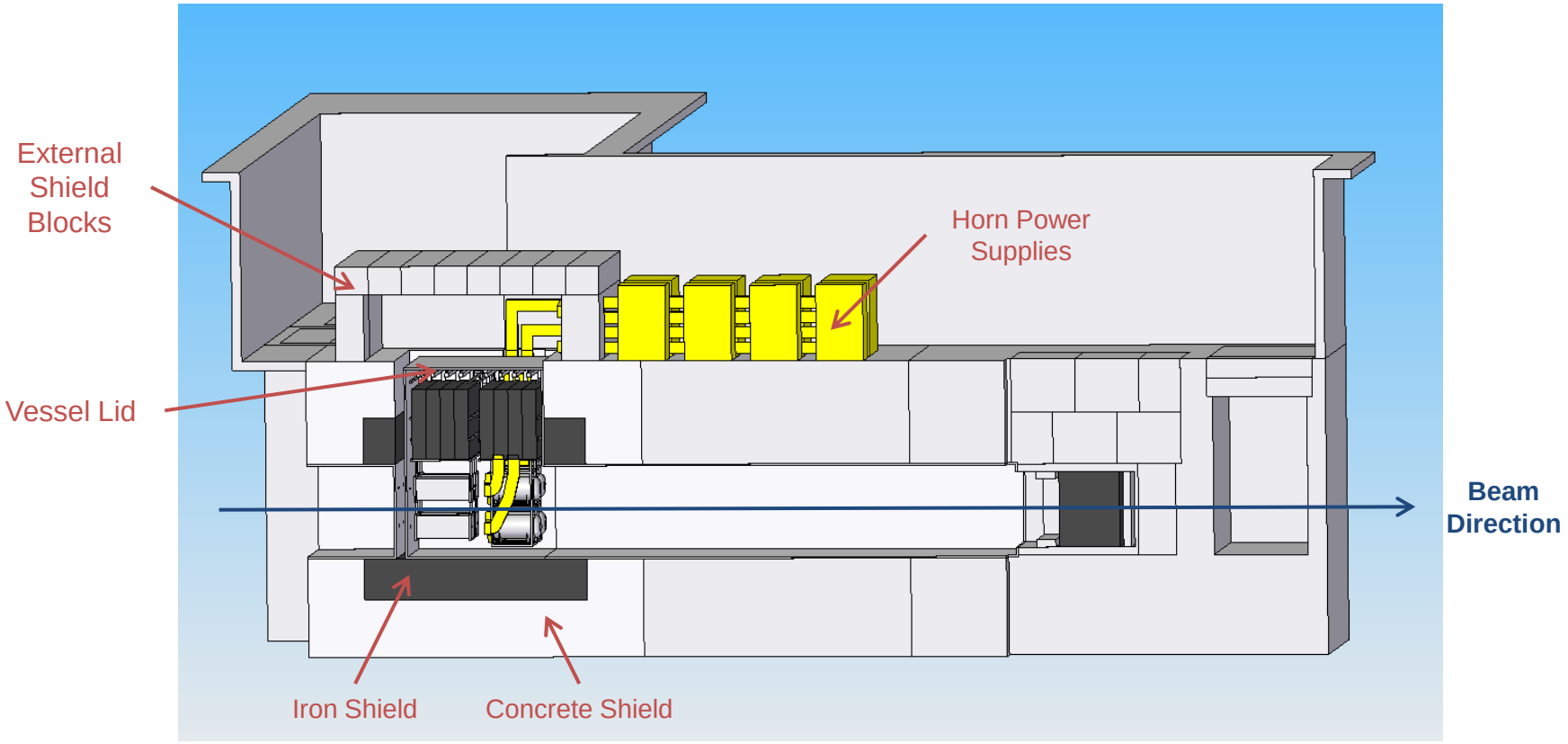
- Horn power supplies located on top of decay volume shielding
- Power fed to horns via striplines
- Stripline length must be minimised, without compromising shielding thickness
- Need equal stripline length to each horn





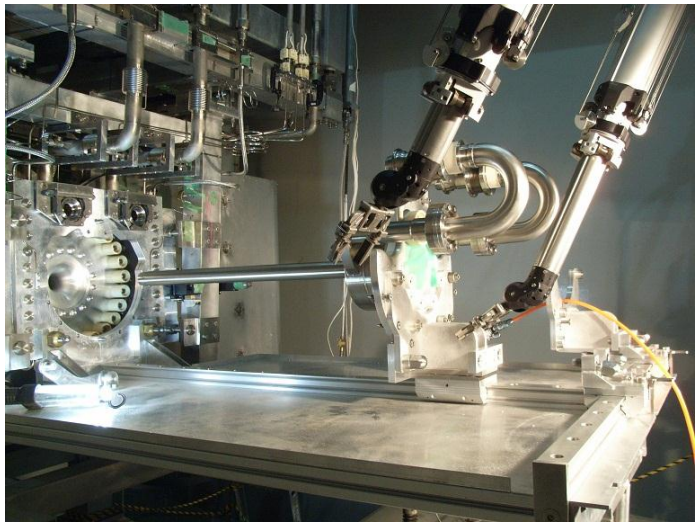
Shielding

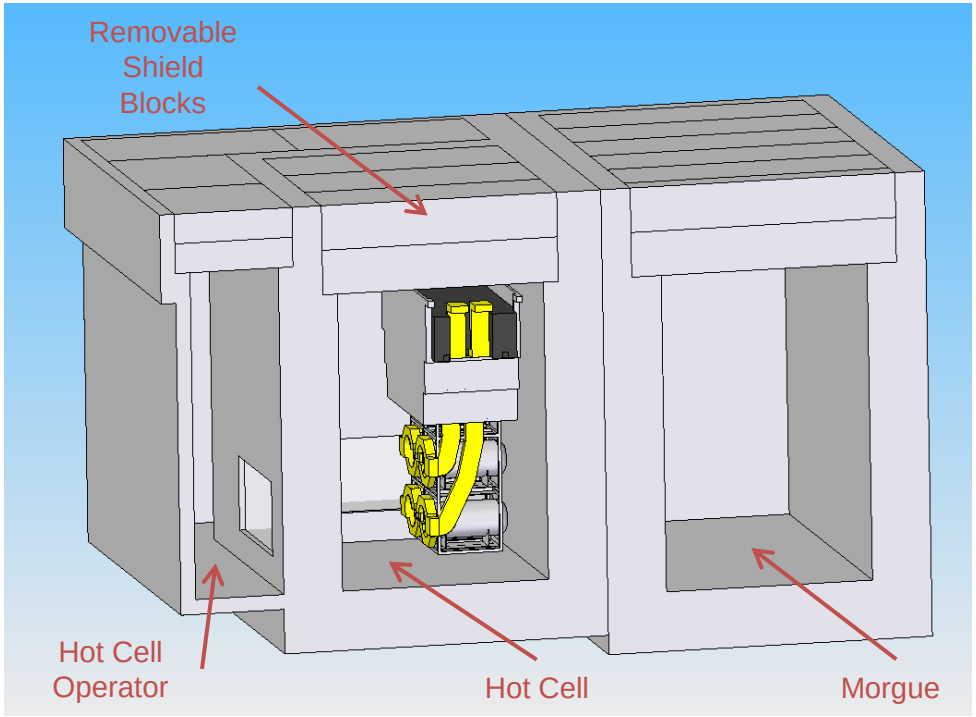
- Beamline shielded by concrete, target station also has an iron inner shield
- Movable shield blocks allow the horn assembly to be removed
- Vessel also has external shielding to reduce dose in main hall and power supplies



Repair and Disposal

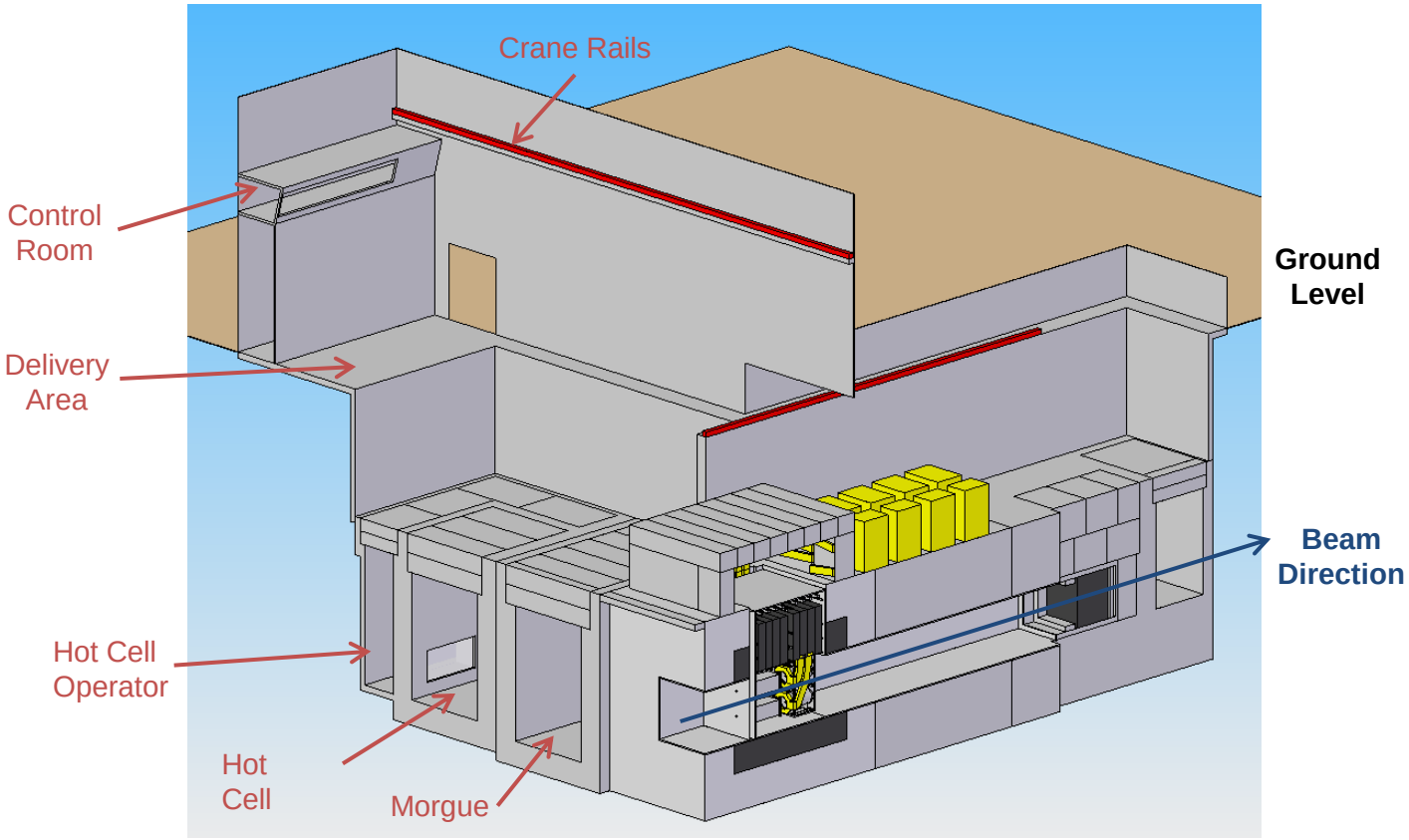
- Hot cell allows activated components to be repaired or dismantled
- Morgue stores broken components in steel casks until activity reduced for disposal
- Hot cell operator uses remote manipulators, with cameras and lead glass windows for visibility
- Replace targets within horns. Hope to replace individual horns from the support module?
- Morgue and hot cell covered by removable concrete shield blocks





Remote Handling

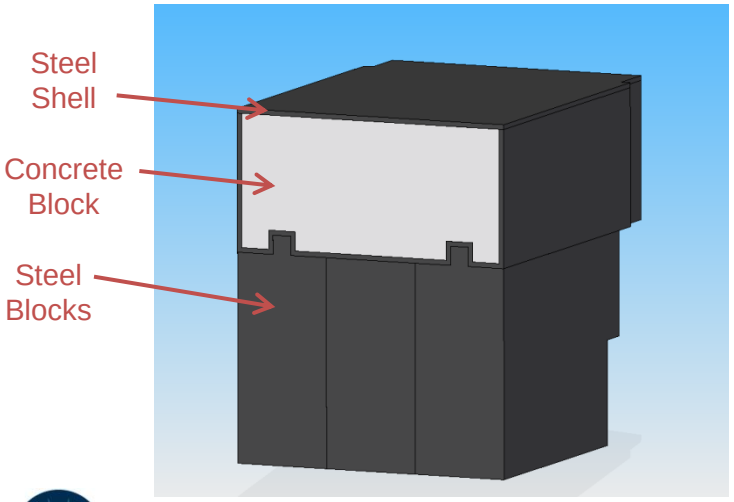
- Gantry crane covers helium vessel, morgue, hot cell and delivery area
- Second, smaller crane to move power supply units
- Pit to reduce radiation shine while moving horns
- Two assemblies of four horns will be used – one is running while the other is being repaired

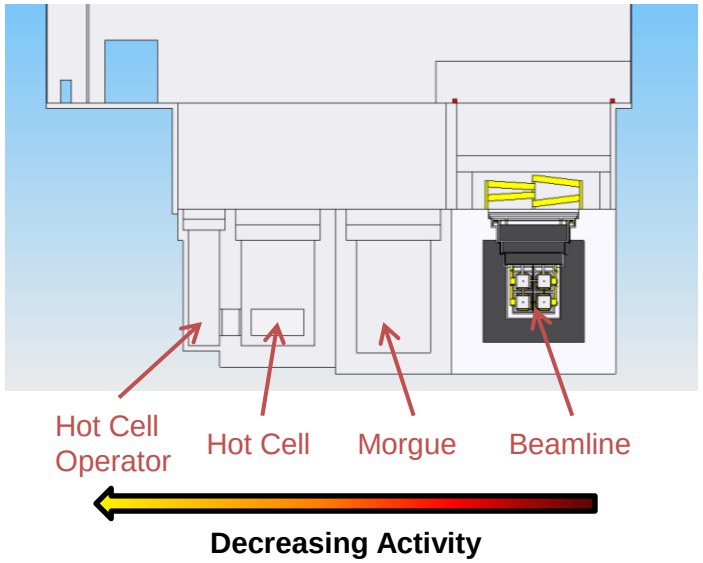


Reducing Downtime

- Factors contributing to T2K's long shutdown times;
  - Large helium volume to pump out
  - Tritium generated in concrete shielding in helium vessel
  - Repairs impossible while beam is running (hot cell too close to beamline)

- Proposed Design;
  - Large helium volume unavoidable
  - Concrete shielding in the helium vessel will be encased in a steel shell
  - Main hall layout designed to minimise dose to hot cell operator





Conclusions

- 4 horns require a large volume of shielding – a significant cost
- Remote handling requirement can be met by using a gantry crane to move components and shield blocks
- Well equipped hot cell required for complex repair operations
- Accurate horn alignment can be achieved using kinematic mounts
- Downtime can be reduced by having a spare horn assembly

- **Have demonstrated a feasible target station design for a 4MW superbeam, which builds on practical experience from T2K**