BEAM INTERCEPTING DEVICES FOR THE HIGH INTENSITY UPGRADE IN CERN'S SPS NORTH AREA FACILITY

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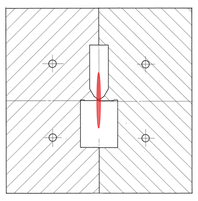
Introduction

- CERN's High Intensity ECN3 project, to commence TDR in 2024 and operate by 2030, will bring a new high-intensity and high-power target system in the 100-350 kW range. Slow-extracted pulses of up to 4.0×10^{13} p+ and spill length as short as 1 s will be delivered to one of two candidates from the Physics Beyond Collider Study Group proposals.
- Besides new high-power targets, beam delivery to the new experiment requires the refurbishment or upgrade of multiple beam intercepting devices (BIDs) in the North Area at CERN.
- This contribution outlines the main BIDs concerned by HI-ECN3, as well as the high-power target possibilities for the new experiment.

Splitter Collimator – TCSC

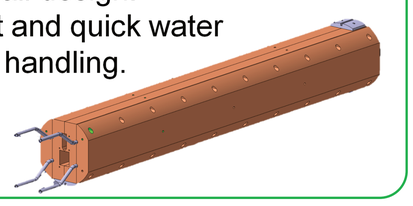
Current Design



- Two **CuCrZr blocks with splitter aperture**.
- Embedded **water cooling .**
- **304L Stainless Steel vacuum tank.**
- 3 feet **plug-in table.**

High Intensity

- Current **core design compatible with high intensity**, **but upgrade required** to improve overall design.
- New supporting table for alignment and quick water connections. Optimized for remote handling.
- Low-Z tank and marble shielding.



Concept design of the new core of the TCSC collimators

Ejection Beam Stopper – TBSE

Current Design

- **Un-cooled Stainless-Steel cylinder.**

High Intensity

- Scarce usage. **No upgrade** required.

Transfer Line Dump – TT20 TED

Current Design

- **Aluminium and Copper core**
- Embedded **water-cooling pipes**

High Intensity

- Complete **new design required.**
- Graphite + CuCrZr core totalling 4 m.
- Heat transfer from core to cooling plates via shrink-fitted or spring-loaded assembly.
- Water cooling in Cu-HIPed stainless-steel pipes.

Shrink fitted concept design of the new core of the TT20 TED

T4 Target

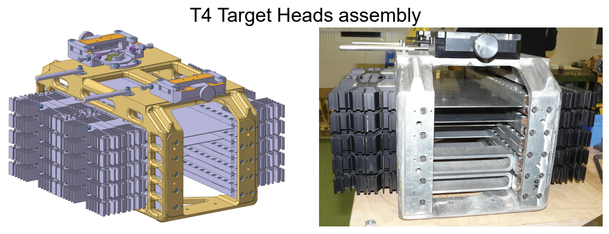
Current Design

- **5 beryllium target plates, 40–500 mm.**
- Clamped in aluminium alloy supports.
- Inside Aluminium alloy chassis.
- Energy dissipated by **conduction towards supports.**
- **Convective cooling fins**, vertical **forced airflow.**
- Beryllium (S-200-F) ➔ low-Z material, good physics performance and thermo-mechanical properties.

High Intensity

- Device will be **by-passed during high intensity injections.**
- Current design capable of withstanding few accidental pulses.

T4 Target Heads assembly



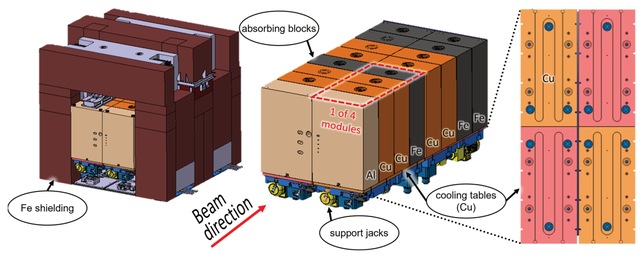
Multipurpose Dump Collimator – XTAX

Current Design

- **4 independently movable modules**, **each of 4 blocks**:
  - **Al** 6082, **Cu** C10300, pearlitic grey **cast iron.**
- Thick iron shielding. Each module rests upon its own **water-cooling table** of **stainless-steel pipes** cast into a **Cu-alloy platform**. Natural convection around blocks.

High Intensity

- Device will be **by-passed during high intensity injections.**
- Accident scenario may cause local melting. **Material upgrade** (to CuCrZr) and **beam interlock protection are required.**



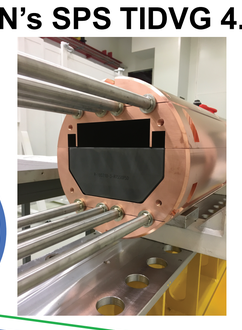
ECN3 injection Dump – P42 Dump

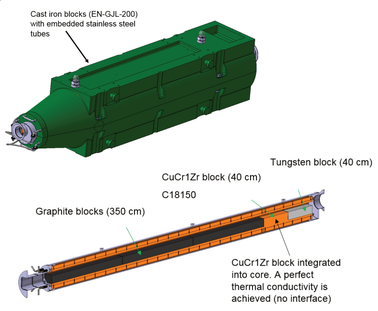
Design

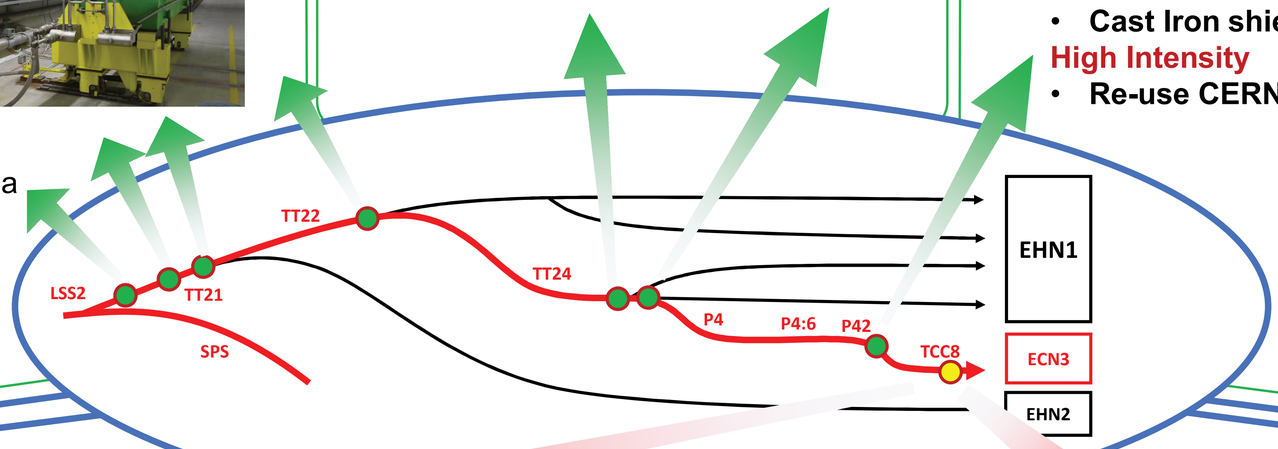
- **Graphite** + **CuCrZr** + **W** core inside seamless 316L tube.
- **Water-cooled** with **clamped SS pipes onto Copper.**
- **Cast Iron shielding.**

High Intensity

- **Re-use CERN's SPS TIDVG 4.**







High Power Targetry in TCC8 - ECN3

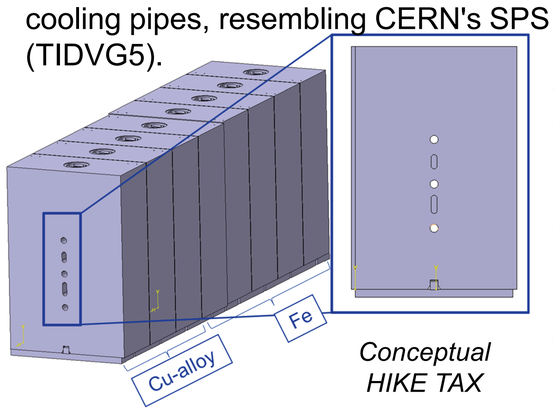
HIKE/SHADOWS

Explore kaon beams and beam dump physics.

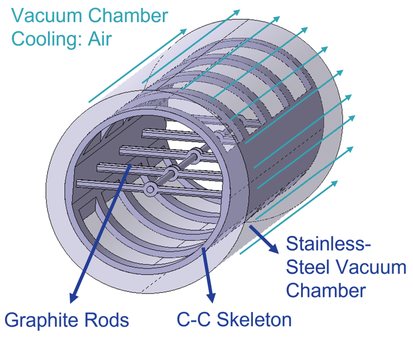
- **100 kW** range target complex (~1kW thermal on Target system. Up to ~100kW on TAX).
- **2.0×10^{13} ppp at 400 GeV/c every 14.4 s**.

Production Target & TAX

- **Radiation-cooled graphite target or He-cooled beryllium** for the production of hadrons.
- **TAX** (Target Attenuator for eXperimental areas) system. **Series of Cu-alloy and Fe blocks**, designed with various aperture configurations and the capability to serve as a beam dump or collimator, depending on the operational setting.
- TAX **requires enhanced cooling system**, possibly a CuCrZr absorber with SS Hot-Isostatically-Pressed (HIPed) cooling pipes, resembling CERN's SPS Internal Dump (TIDVG5).



Conceptual HIKE TAX



Conceptual HIKE Target

Systems

- ALARA driven, shielding volume about **150 m³ of cast iron and 600 m³ of concrete** and marble, **spanning about 27 m**.
- Possibility of **reusing** already activated **blocks** from different spent CERN facilities, aligning with CERN's sustainability goals.
- Maintenance and handling capabilities, including **full remote handling** of components.

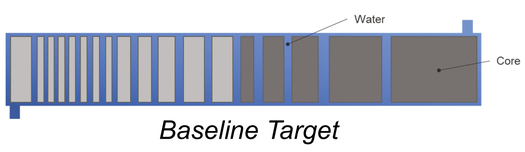
BDF/SHiP

Production of charmed mesons and other weakly interacting particles for hidden sector physics.

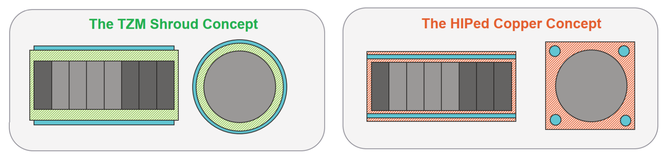
- **350 kW range beam dump / production target**. (~300kW thermal power on target)
- **4.0×10^{13} ppp at 400 GeV/c every 7.2s. 4.0×10^{19} p/year**.

Production Target

- Refractory core made of discs of **TZM (Mo-alloy) and W**.
- (***Baseline design***) Discs **cladded with Ta2.5W via HIP** to avoid erosion, corrosion, and embrittlement when in contact with the water cooling.
- Target housed in a **He-filled vessel** for leak detection.
- (***Alternative designs***) Ongoing studies aiming at **maximising the amount of tungsten** in the core. Possibly compact configuration where cooling is done on the outer diameter via an external mechanically robust shroud. Besides advantage of reduced target length.



Baseline Target



Alternative concepts

Systems

- Hadron absorber and magnetic muon shield positioned downstream of the target to minimise background particles to the experiment.
- The overall shielding assembly incorporates about **180 m³ of cast iron and 360 m³ of concrete and marble**. Special effort to **reuse activated blocks** at CERN.
- Both the target and the proximity shielding inside the tank can be **remotely extracted via a trolley system.**
- **Proximity shielding and target are housed within a primary vacuum tank** to reduce air activation and radiation-accelerated corrosion.

Conclusions

- The next few years will see a new high power target facility and the refurbishment of multiple BIDs in CERN's North Area beamlines.
- Different material combinations, cooling strategies, shielding requirements and handling methods will be needed, imposing an exciting physics and engineering endeavour at CERN.
- Extensive design and engineering studies are being ramped-up, covering multiple concerned devices.

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