



Diode Stack for DCM

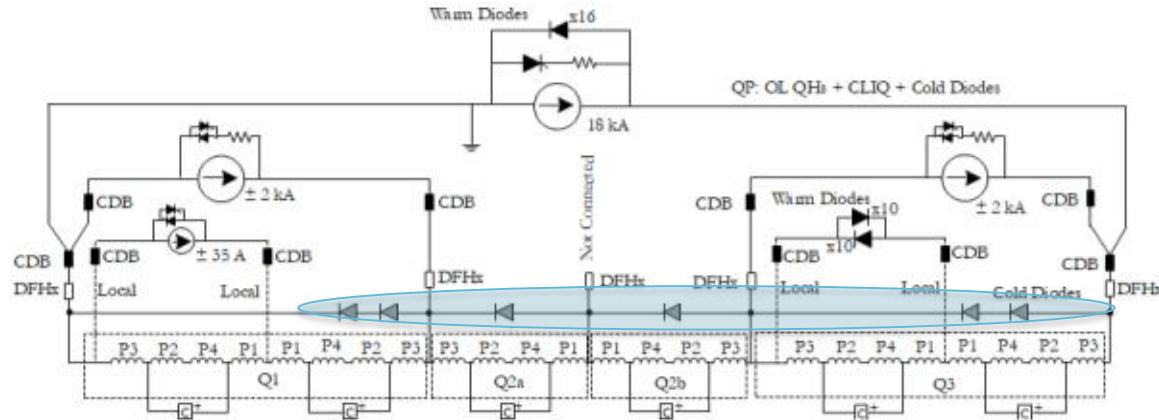
- **Introduction**
- **Specific diodes for HL-LHC**
- **HL-LHC diode stack**
- **Conclusion**



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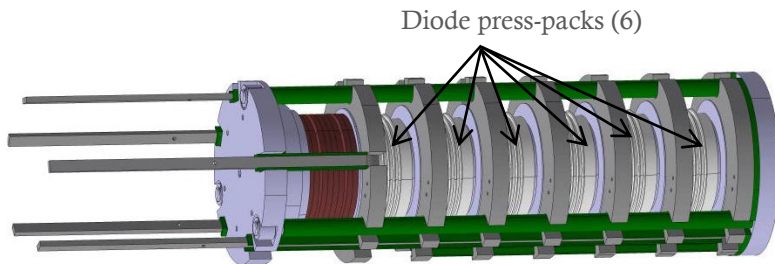
Introduction

- Cold diodes are in the baseline of the powering layout of the main Inner Triplet.

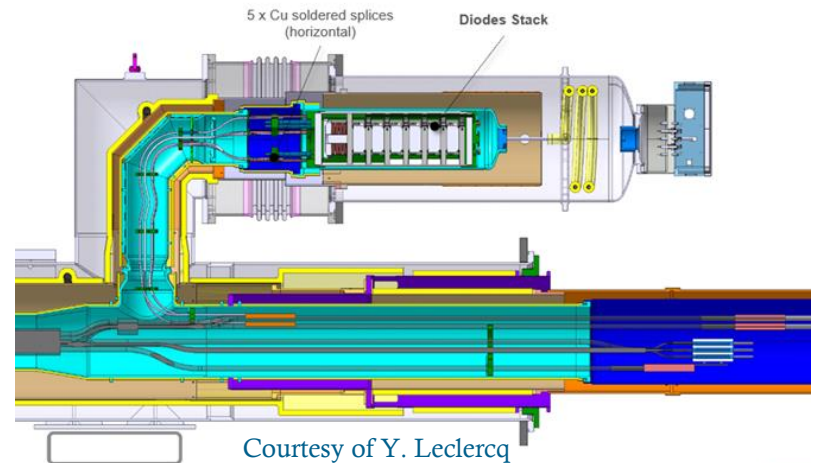


Main Inner Triplet Circuit layout

- The cold diodes are installed on the HL-LHC diode stack which is part of the D1-DFX connection module, called DCM.



Prototype HL-LHC diode stack



Courtesy of Y. Leclercq

Introduction

- Specific prototype diodes produced by Dynex have been qualified in CHARM during 2018 (test irradiation campaign). Dynex has produced and delivered the same type of diodes to be used in HL-LHC diode stack.



First 6 HL-LHC diodes produced

- Updated FLUKA simulation (EDMS 2201836), shows that the HL-LHC diodes would be exposed to a maximum radiation level of: dose: 12 kGy / 3000 fb⁻¹. and 1MeVneq fluence: $5 \cdot 10^{13}$ cm⁻² / 3000 fb⁻¹. for the entire HL-LHC lifetime. Radiation level achieved during test campaign.
- The first HL-LHC diode stack has been designed and produced. Integration within DCM has been discussed with WP3 (Y. Leclercq).

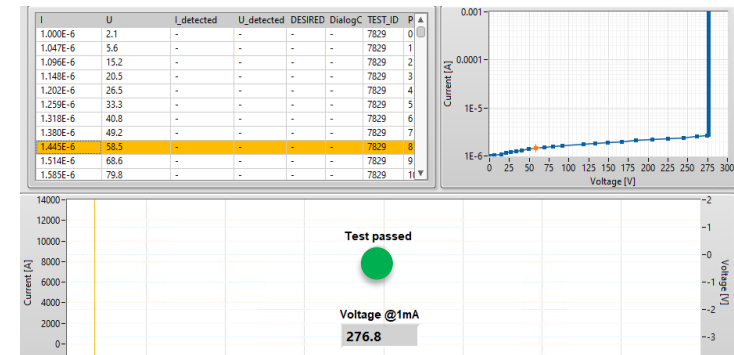
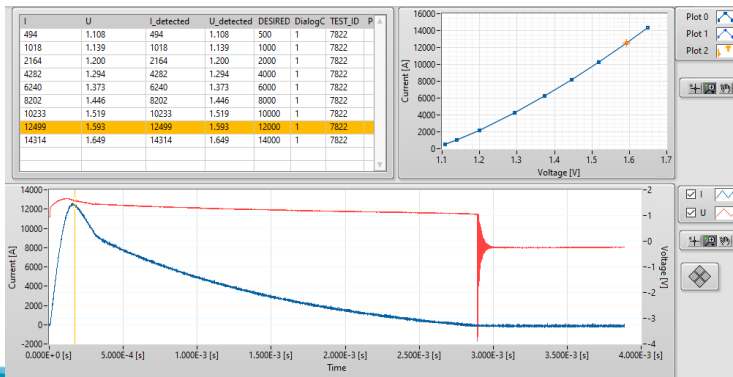
Specific diodes for HL-LHC:

- Dynex has delivered the entire production of specific diodes for HL-LHC Inner Triplet: 60 diodes, very thin base type, chosen by CERN, in December 2020. Last batch of production received in July 2021.
- Each HL-LHC diode produced by Dynex is tested at room temperature, by the manufacturer.
- All diodes have been electrically retested at room temperature and liquid nitrogen temperature (77K) in MPE diode lab, after reception.
 - Their characteristics are in line with the prototype production.



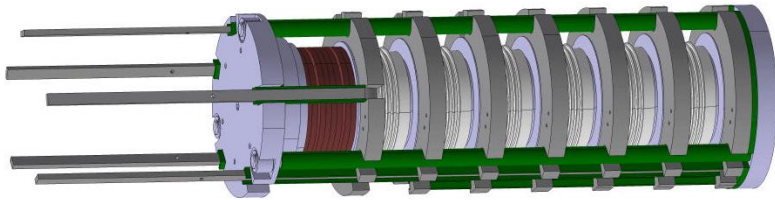
60/60 HL-LHC diodes produced and delivered

- 24 HL-LHC diodes needed for HL-LHC operation (4 HL-LHC diode stacks).
- Remaining diodes (36) as spares.

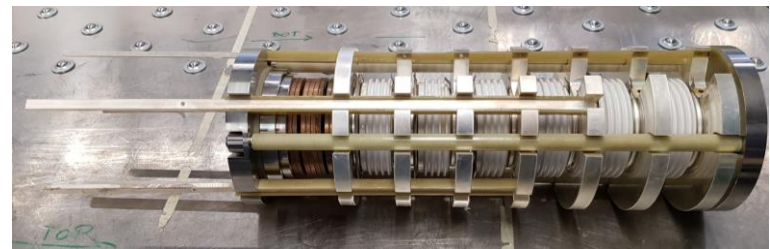


HL-LHC diode stack

- The design of the HL-LHC Inner Triplet (IT) diode stack was launched in Mid 2019, after TCC approval for using cold diodes.
- Design was driven by the powering scheme, including electrical parameters such as peak current, total number of diodes and the environment:
 - 6 diodes per diode stack.
 - No need of large heat sinks since tau is very small: max. peak current of 7kA for ~100 ms.
 - Bus bars cross-section are rather small: 50 mm².
- First prototype diode stack components were produced by the CERN central workshop in 2020.
- Diode stack was assembled in MPE diode lab in Dec. 2020 to verify the mechanical and assembly aspects:
 - Verify assembly procedure.
 - Validate components of the stack.



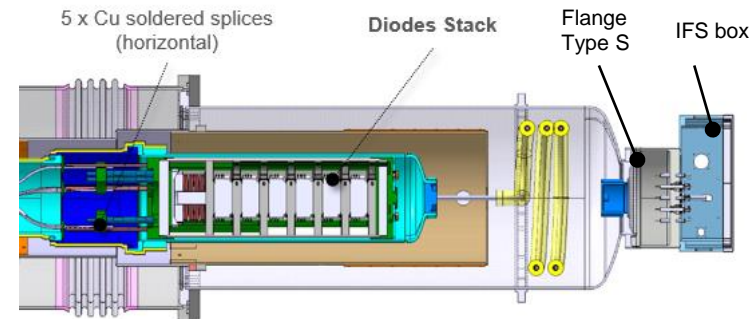
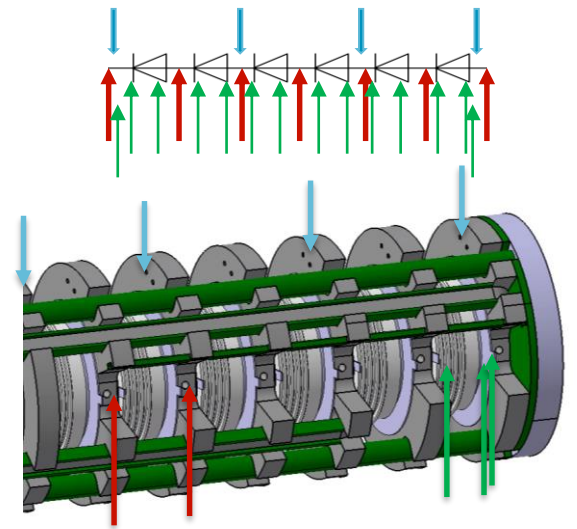
3D model of 1st prototype HL-LHC diode stack



1st prototype HL-LHC diode stack

Electrical connection and Instrumentation

- Electrical connections between the diode stack and the DCM will be done through soldered splices (Cu), WP3 (Y. Leclercq).
- Monitoring of the cold diodes requires specific instrumentation:
 - Diode Voltage taps, anode/cathode (12 + 2)
 - Diode Current taps, on the heat sink (7)
 - Temperatures sensors (4)
- Total number of wires: $21 + 16 = 37$
- Instrumentation wires will be located in a groove and exiting at the base plate.
- All instrumentation wires will go through a capillary tube and exit in a standard HL-LHC flanges type S.
- Signals would be available through HL-LHC IFS box.

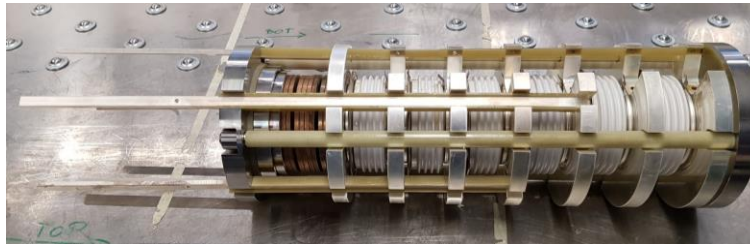


Courtesy of Y. Leclercq (WP3)

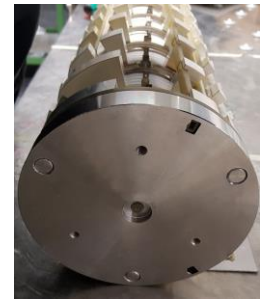
HL-LHC diode stack

- An internal review of the DCM was organized mid April 2021. The HL-LHC diode stack was presented during the review.
- Recommendations will be applied on the first prototype diode stack and future production.
- After some meetings regarding integration and polarities of the diode stack, some modifications have been applied to the first prototype:
 - Fixing plate at the base
 - Bus bar connection
 - Increasing of venting channel to avoid overpressure
 - Details regarding instrumentation of the diode stack.
- No showstopper were identified during the review.

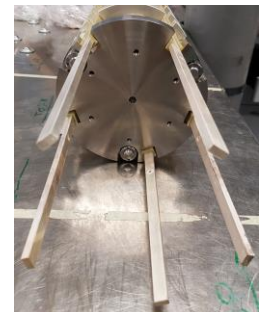
1st prototype HL-LHC diode stack



Base plate of HL-LHC diode stack



Top plate and bus bars of HL-LHC diode stack



Coming steps on HL-LHC diode stack

- Re-assembly of the HL-LHC prototype diode stack after modification.
- Instrumentation of the diode stack: adding V-taps, I –taps and temperature sensors.
- Electrical tests on the prototype diode stack to be performed at 300 K and 77 K in MPE diode lab.
- Validation at liquid He temperature should be organized: test in SM18.
- Integration on the DCM mock-up to be verified together with WP3 (Y. Leclercq).
- Manufacturing of second prototype HL-LHC diode stack after validation of prototype 1.

Conclusions

- Specific HL-LHC cold diodes have been delivered to CERN (60pcs). They have been tested by the manufacturer (300 K) and at CERN (300/77 K).
- The design of the HL-LHC IT diode stack based on the large experience gathered on LHC diode stacks and with the know-how of experts was launched in 2020.
- Integration of the diode stack in the D1-DFX Connection Module (DCM) has been studied, together with WP3 (Y. Leclercq) and some modifications on the first prototype are being applied.
- First prototype HL-LHC diode stack is being reassembled and prepared for electrical tests in MPE diode lab.
- Qualification of HL-LHC diode stack at 4 K, in SM18 test bench, will be prepared.
- HL-LHC diode stack should be available for string in 2022 (prototype 1 or 2).
- Series production could be launched later in 2023.

Thank you for your attention !