# US High-Luminosity LHC Accelerator Upgrade Program (AUP)

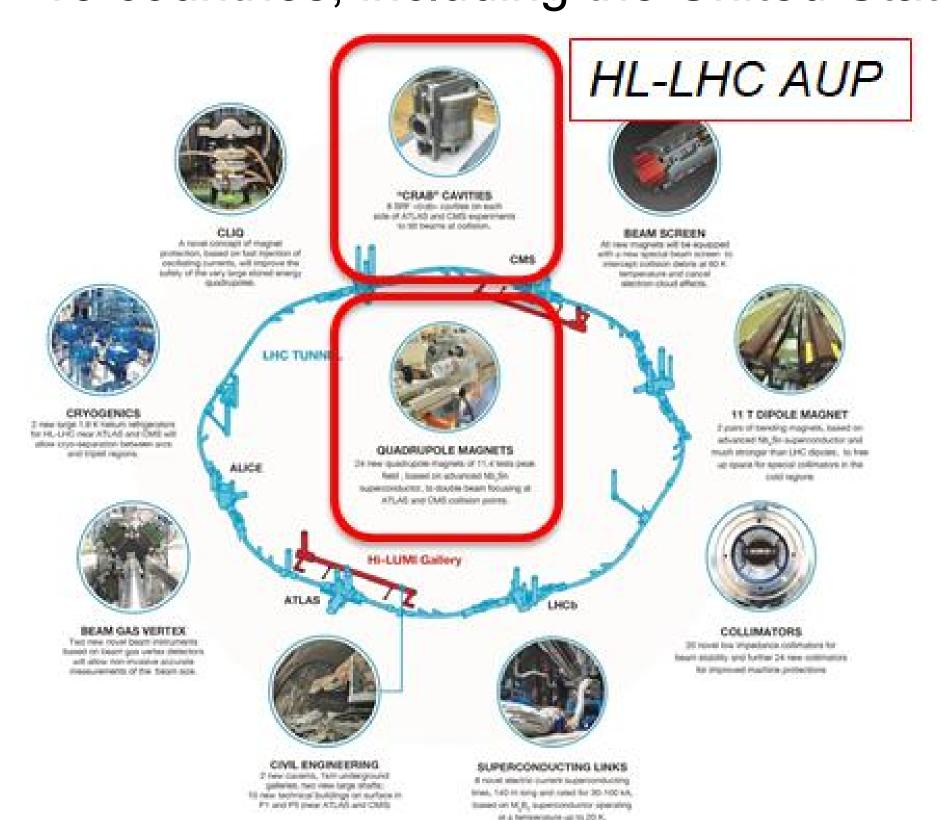
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## **High-Luminosity LHC**

HL-LHC project aims at increasing luminosity from 300 fb<sup>-1</sup> to 3000-4000 fb<sup>-1</sup>. The project is led by CERN with the support of an international collaboration of 29 institutions in 13 countries, including the United States.



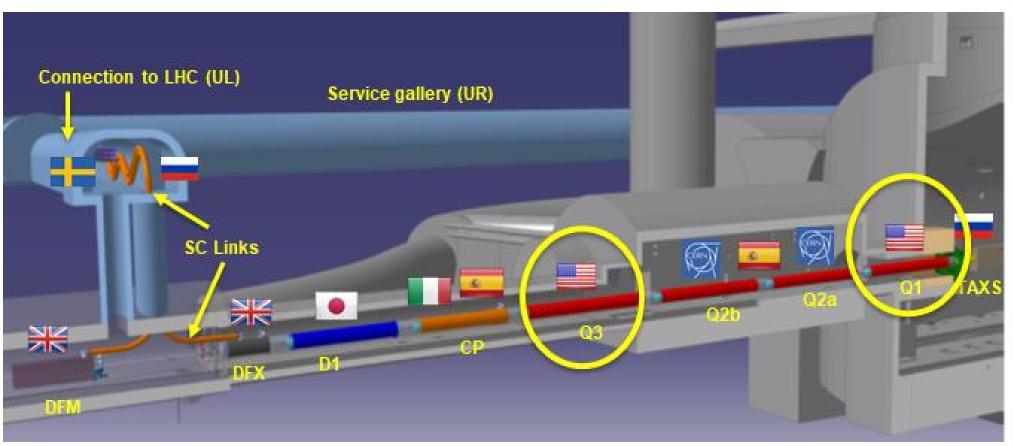
baselined HL-LHC **Project coordinates** US Labs BNL. LBNL with contributions from SLAC, JLAB, ODU & FSU)

responsible of providing 8 "crab" cavities beams at collision, and 10 Q1/Q3 cryo-assemblies. The Cryoassemblies will assembled from LQMQXFA cold Masses built by HL-LHC AUP and Cryostat kits provided by CERN.

triplets are

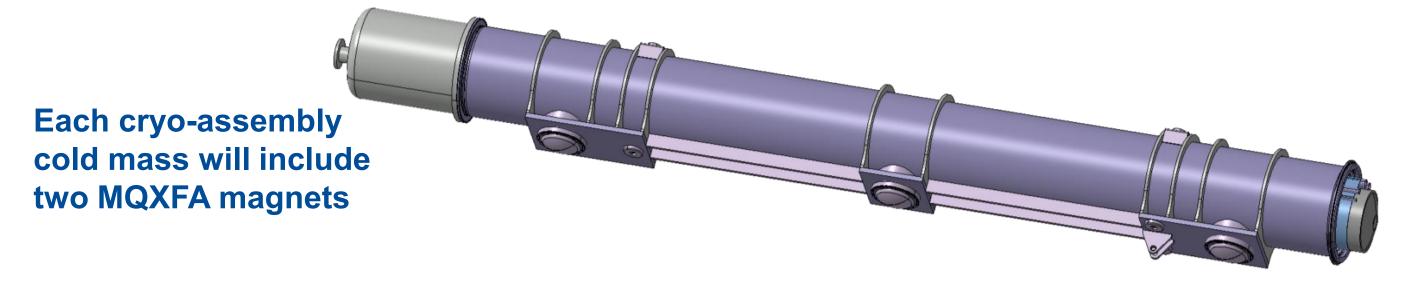
three optical

## Q1 and Q3 cryo-assembly



elements: Q1, Q2, and Q3. Q1/Q3 masses 4.2 m contain two quadrupole magnet which (MQXFA) responsible of focusing HL-LHC the beams in collisions points (ATLAS and CMS).

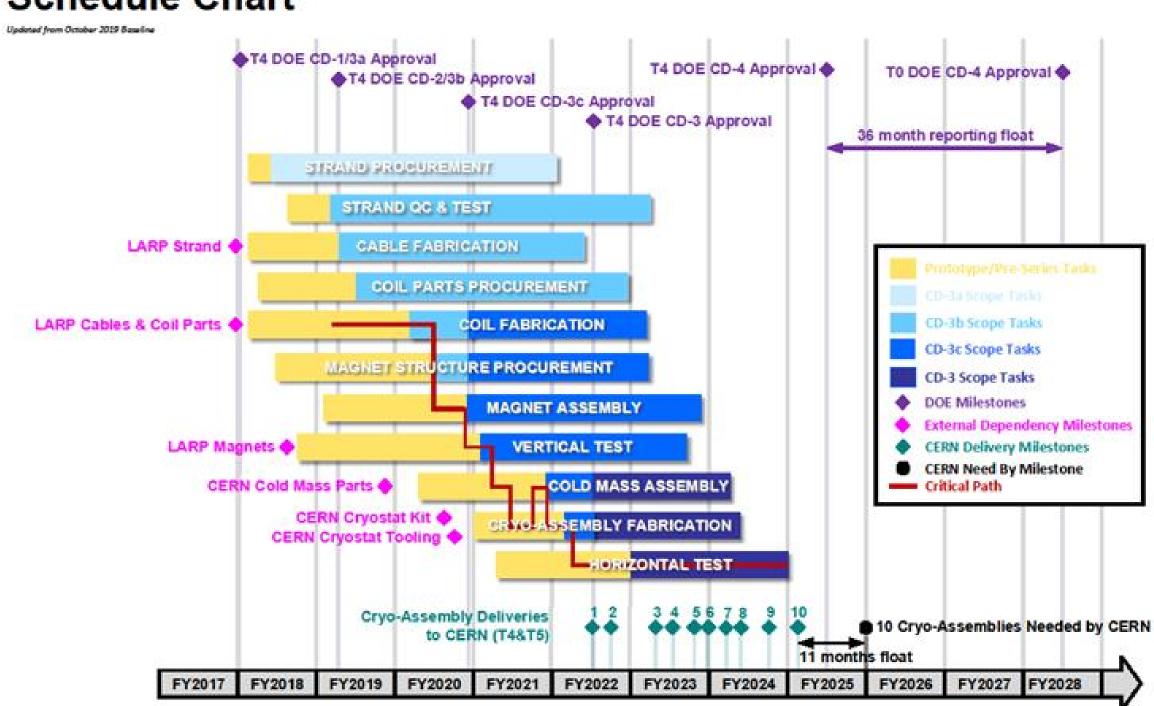
HL-LHC Inner Triplet. Q1 and Q3 magnets will be delivered by



### Schedule

The AUP project covers procurement of conductor and parts, cable and coil fabrication, magnet assembly and vertical test, cryomodule assembly and horizontal test. The 10 cryoassemblies (20 magnets) will be delivered by the end of FY2025

#### **HL-LHC AUP Q1/Q3 Cryo-Assemblies Schedule Chart**

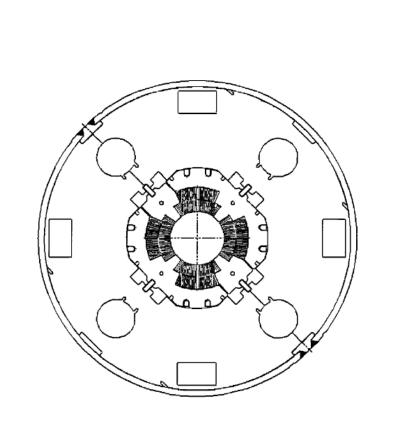


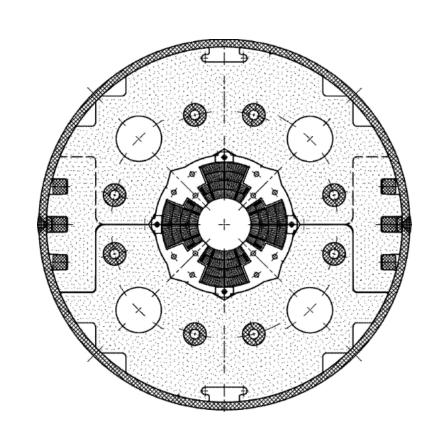
Schedule of the AUP cryo-assemblies delivery



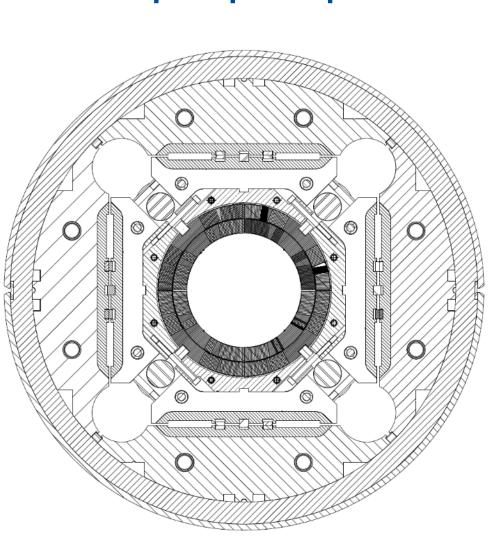


## **MQXFA** magnets





**Cross section of present** LHC triplet quadrupoles



**MQXFA** cross section

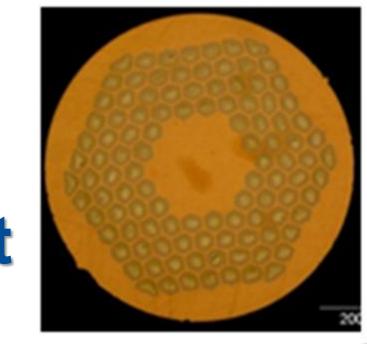
MQXFA magnets are 4.2 m long with a 150 mm aperture, and produce a 132.6 T/m gradient with 11.4 T peak field on coils.

MQXFA magnets will be first superconducting Nb<sub>3</sub>Sn magnets installed in an (together accelerator CERN 11 T dipole magnets). The AUP project and the LARP program before it, have been leading the R&D effort to develop those state of the arts accelerator magnets.

brittleness The the the conductor and large electromagnetic forces (4 to 6 times higher than the present LHC triplet quadrupoles) are technical the some challenges present in the fabrication of Nn<sub>3</sub>Sn coil and assembly of MQXFA magnets.

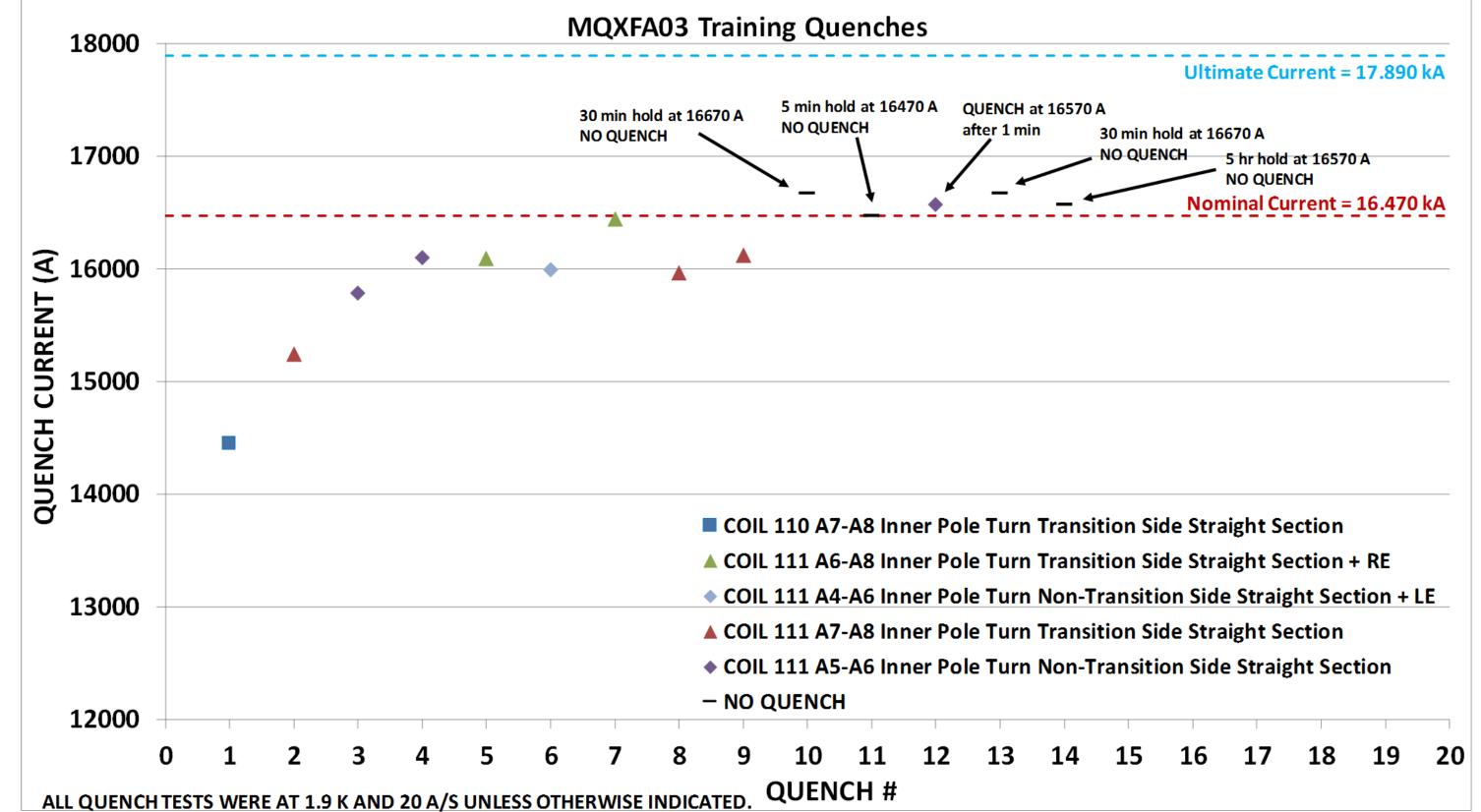
MQXFA magnets are the result of ~20 years development and represent the maturity of Nb<sub>3</sub>Sn accelerator technology.

## **Test of the first** deliverable magnet



The first MQXFA series magnet has successfully met all the requirements during vertical test @BNL. Prior to that several tests on 4 short models MQXFS and 2 full length MQXFA prototypes have been performed.





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