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Innovative collaring concept for MQYY superconducting quadrupole magnets of HL-LHC Insertion Region

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Sigmaphi participated to QUACO PCP whose objective was to propose an innovative solution for MQYY superconducting quadrupole magnets of HL-LHC Insertion Region. QUACO project was divided in three phases: a feasibility study, a detailed study including mock-ups and the manufacturing of a MQYY first-of-a-kind based on an innovative concept.

The innovation proposed by Sigmaphi concerns the collaring which is based on thick half aluminum collars assembled around the coils thanks to a press. The azimuthal stress through the coils is applied by stainless steel pole parts inserted in coil poles with a second press and maintained in position thanks to the aluminum collars. This collaring concept presents the main advantage to maintain the azimuthal stress through the coils during cool-down: it makes unnecessary to apply a large azimuthal stress at room temperature. This collaring solution might be particularly interesting for superconducting magnets made of conductor much more sensitive to stress than Nb-Ti such as Nb₃Sn or HTS.

Sigmaphi manufactured successfully nine superconducting coils and performed modulus measurements on these coils. Two quadrupole apertures have then been collared according to the process defined by Sigmaphi thanks to an intensive mock-up program. The azimuthal stress through the coils is measured with 120 cryogenic strain gauges and the target of 55 MPa is reached on both apertures. The two apertures have finally been surrounded by iron yoke laminations and the MQYY magnet has been delivered at CERN in mid-June 2021. The magnetic performances at warm and low current have been checked by CERN. The next step consists in cooling down and energizing at nominal current this MQYY prototype in CEA's test station.

This success story has been possible thanks to Sigmaphi's strong investment in design and prototyping and thanks to the intensive and pertinent implication of QUACO's technical experts at Sigmaphi's side.

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