

HL-LHC Accelerator Upgrade Project

US CONTRIBUTION TO CERN: RF Dipole Crab Cavities

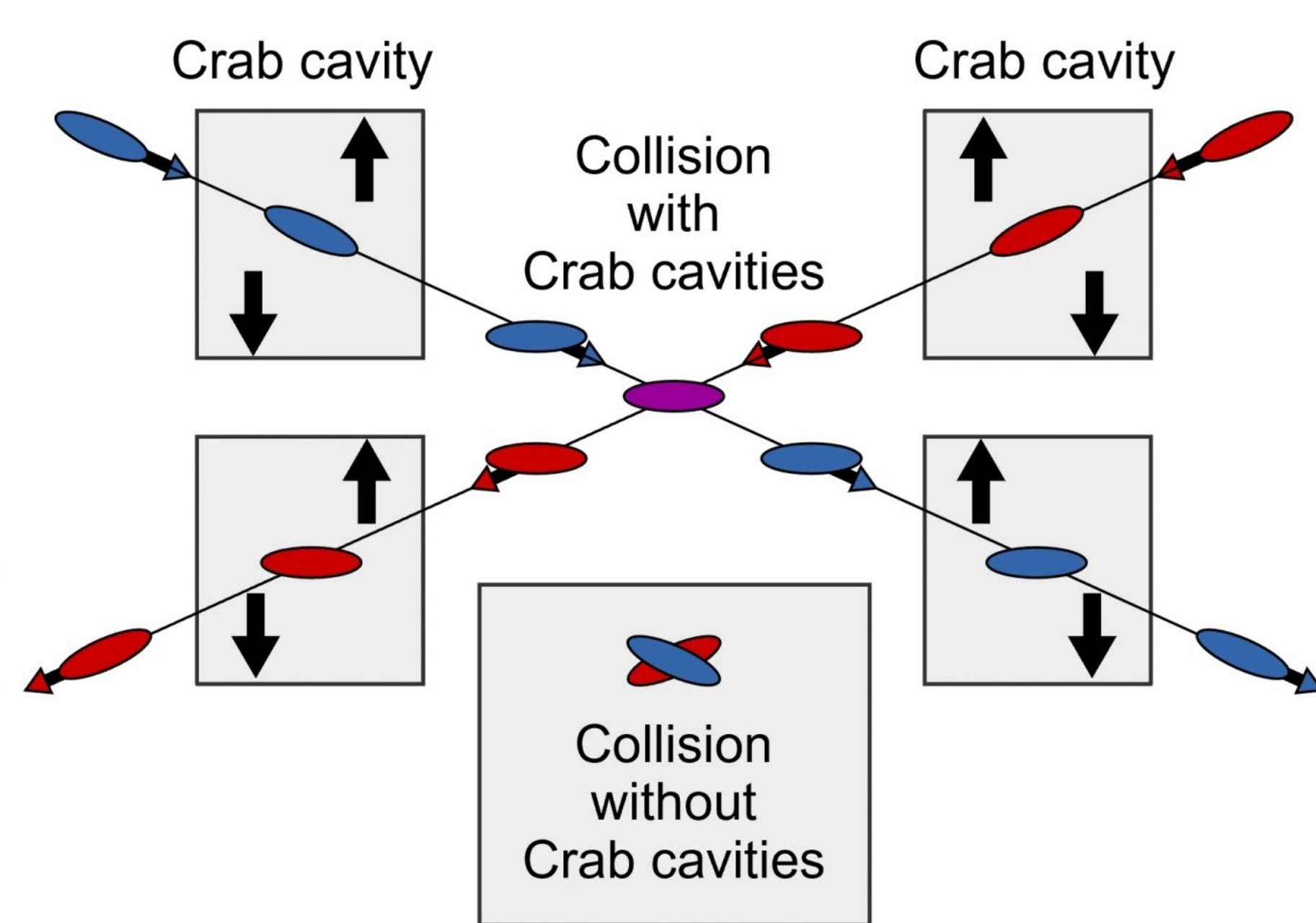
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With contribution from ANL, BNL, JLAB, LBNL, ODU, SLAC

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Introduction

The HL-LHC Accelerator Upgrade Project (HL-LHC AUP), focuses on production of quadrupoles and cavities by sharing the work among a consortium of US Laboratories (FNAL, ANL, LBNL, BNL, JLAB and SLAC) and Old Dominion University, and in close connection with the CERN-led HL-LHC Collaboration.

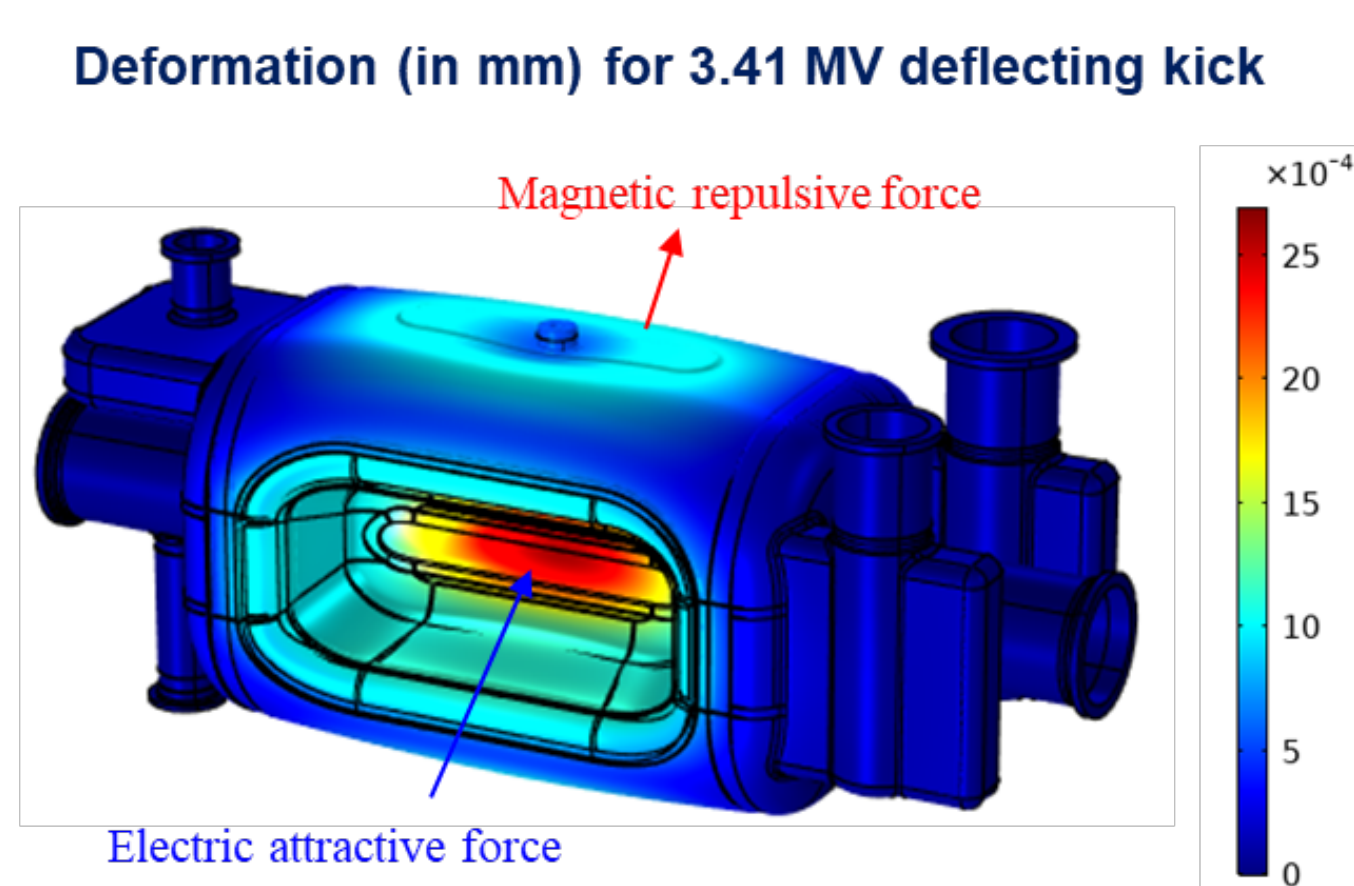
Crab cavities are one of the key technologies enabling the High Luminosity upgrade of LHC by rotating bunches at the interaction point and recovering luminosity lost due to the non-zero crossing angle.



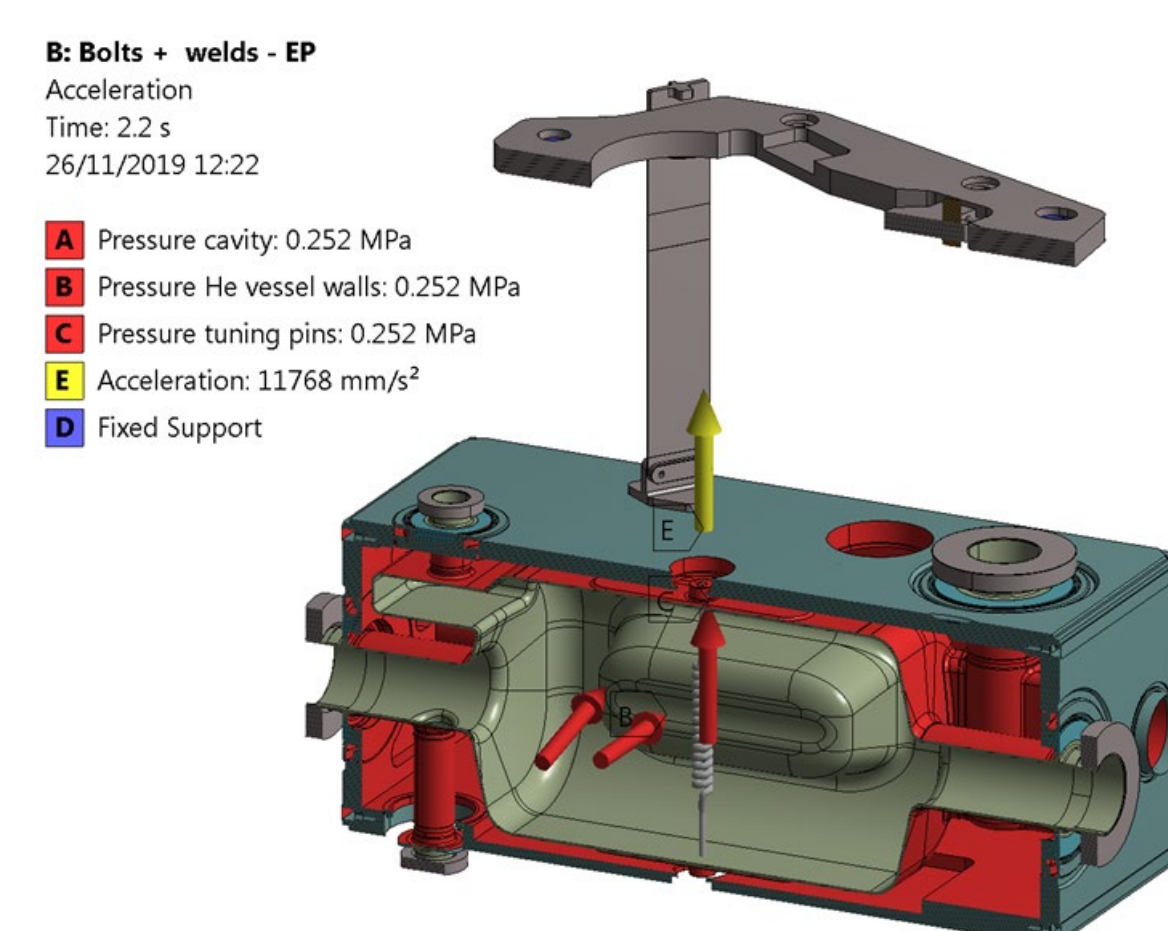
Bunch-rotation at the interaction point

Design

The design was carried out by Old Dominion University in collaboration with SLAC. The RFD design is a compact design with reduced peak surface fields and high shunt impedance. The mechanical design by CERN ensures compliance with European pressure directives.



Electromagnetic design of bare cavity by AUP



Mechanical design of dressed cavity by CERN

Fabrication

AUP has launched fabrication of cavities in industry with a plan to produce 2 prototypes, 2 pre-series, and 10 series cavities. Ultimately, 8 cavities will be installed in the HL-LHC tunnel. A rigorous quality assurance plan is in place to ensure compliance with stringent CERN requirements.



Left – Niobium components of the RFD crab cavity during forming, machining, and electron-beam welding operations. Right – successful forming of Niobium deflecting pole of cavity, the most important component in the cryomodule.

Chemical Processing and Qualification

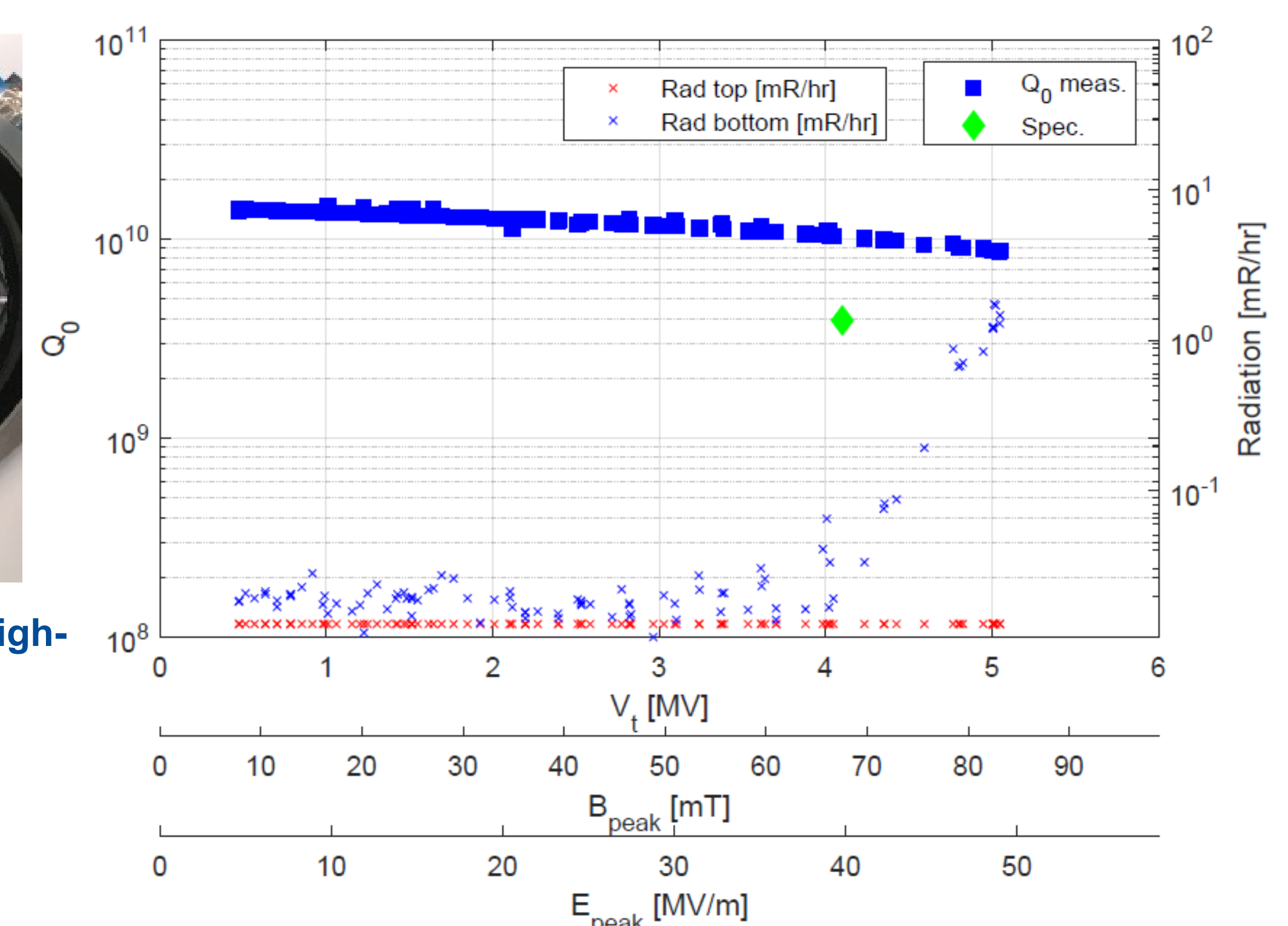
A dedicated rotational chemical processing tool was developed at ANL and validated thanks to LARP prototypes, later inherited by AUP. Fermilab facilities were utilized for the heat treatments and cold tests of the RFD cavities.



RFD bare cavity preparing to enter the high-temperature treating oven at Fermilab.



Left – Bare cavity ready for the 120°C low-temperature bake. Right – Bare cavity ready for a cold test in VTS.



LARP prototype #1 exceeded HL-LHC requirements at Fermilab thanks to the successful validation of dedicated facilities and procedures



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