Standardization and first lessons learned of the prototype HB650 cryomodule for PIP-II at Fermilab*

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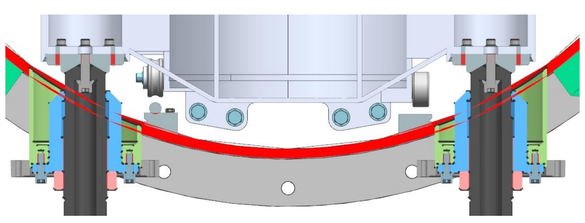
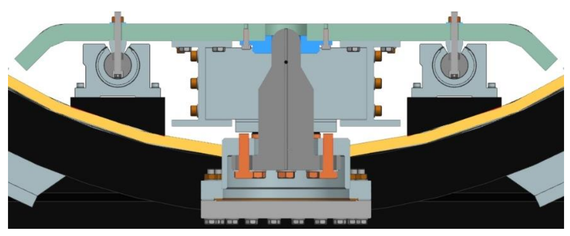
STANDARDIZATION

The PIP-II SSR and 650 cryomodules are designed adopting the Fermilab style cryomodule that uses a room temperature strongback as foundation. Due to the design of the cavities and requirements being different for SSR and 650 cryomodules, the strongback design has been optimized for each cryomodule type.

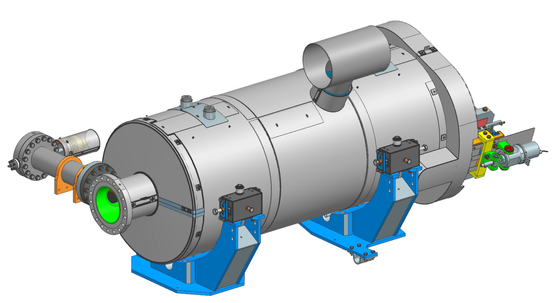


650 VACUUM VESSEL - STRONGBACK INTERFACE

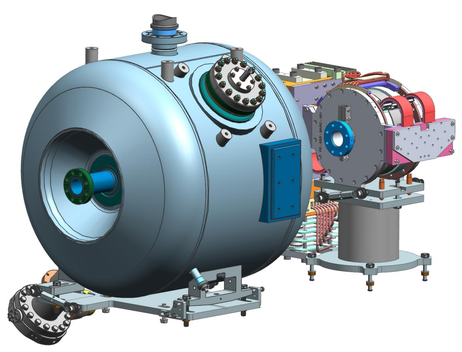


SSR VACUUM VESSEL - STRONGBACK INTERFACE

The 650 cavities are aligned using C-shape brackets at the interface with the cavity lugs, whereas SSR cavities use an alignment plate positioned at the bottom of the cavities.

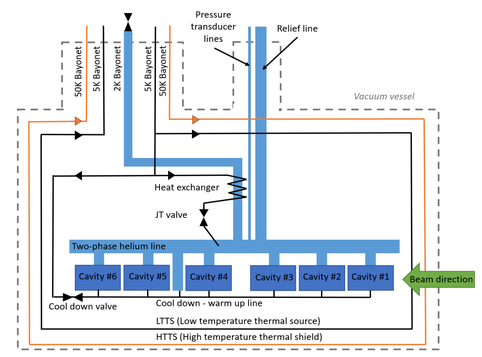


650 C-SHAPE BRACKETS



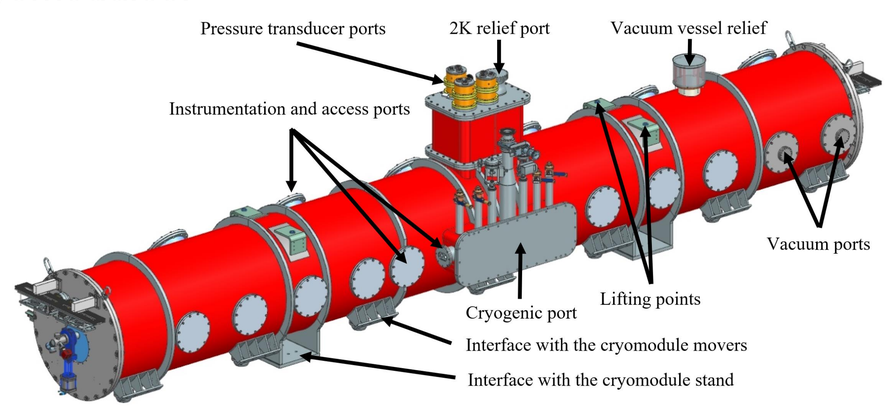
SSR ALIGNMENT PLATE

All SSR and 650 cryomodules share the same cryogenic layout and the size of the cryogenic lines are identical for all cryomodules.



SCHEMATIC OF THE CRYOGENIC LINES

The external interfaces of the cryomodules have been standardized to make simpler the design of the Cryogenic Distribution System (CDS) and to re-use tooling among SSR and 650 cryomodules.



STANDARDIZED INTERFACES ON THE SSR AND 650 CRYOMODULES

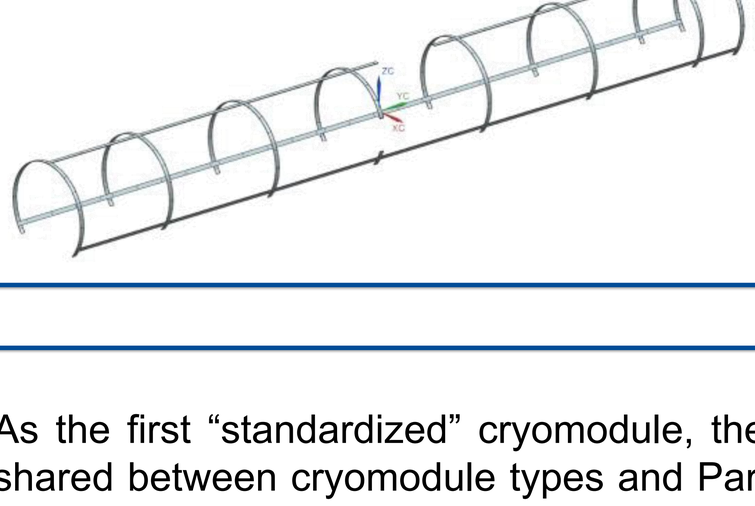
LESSONS LEARNED

VACUUM VESSEL

To reduce the quality controls time and make sure that the quality of production vacuum vessels will be equivalent or better than the prototype vessel, we are requesting the manufacturer to prepare a detailed Manufacturing and Inspection Plan (MIP) that will list the sequence of manufacturing steps including hold points as well as the associated inspections.

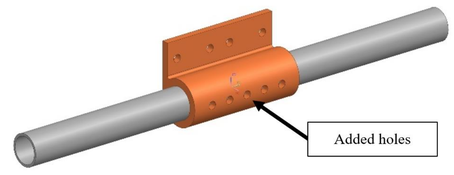
ROOM TEMPERATURE MAGNETIC SHIELD

The bending radius of the vacuum vessel inner frame were significantly off, and a gap was visible in between this frame and the vacuum vessel. This led some thread holes on this frame being off by more than 15 mm.

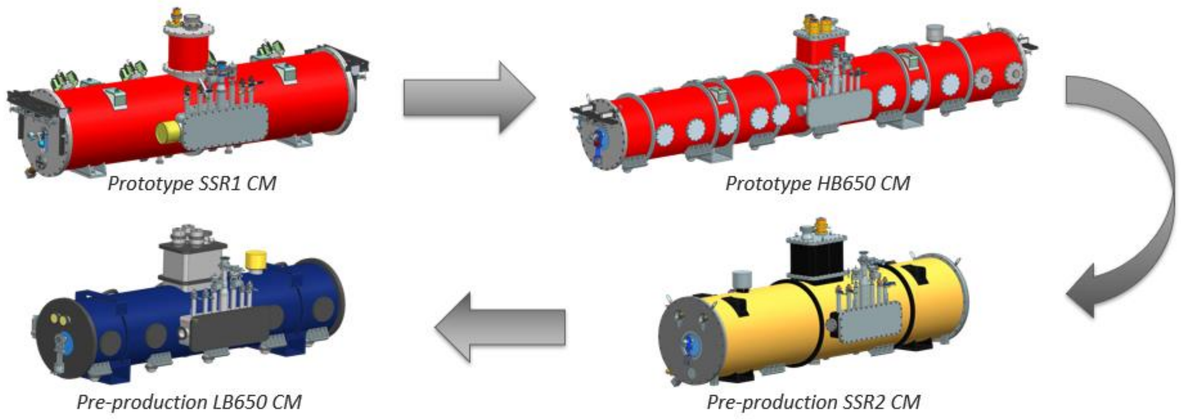


BRAZING

To ensure the efficiency those intercepts, copper blocks are brazed to the stainless-steel cryogenic pipe. To allow the quality controls (i.e. visual inspection) of the brazed joint in terms of continuity and uniformity of the braze material, holes will be added.



CRYOMODULE DESIGN SEQUENCE



CONCLUSION

As the first “standardized” cryomodule, the pHB650 CM has a very big impact on the ppLB650 CM and SSR CMs. Lessons learned shared between cryomodule types and Partners are key elements of the design strategy. In the past months, the design of the ppSSR2 CM and ppLB650 CM already profited from the design of the pHB650 CM. In the coming years, we expect to continue benefiting from the standardization of the several types of cryomodules needed for PIP-II at Fermilab..

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