MOPO054

SUPERCONDUCTING 112 MHZ QWR ELECTRON GUN

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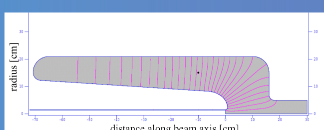
Abstract

Brookhaven National Laboratory and Niowave, Inc. have designed and fabricated a superconducting 112 MHz quarter-wave resonator (QWR) electron gun. The first cold test of the QWR cryomodule has been completed at Niowave. The paper describes the cryomodule design, presents the cold test results, and outline plans to upgrade the cryomodule. Future experiments include studies of different photocathodes and use for the coherent electron cooling proof-of-principle experiment. Two cathode stalk options, one for multi-alkali photocathodes and the other one for a diamond-amplified photocathode, are discussed.

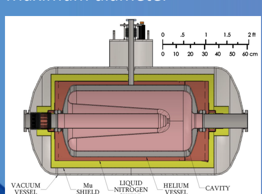
SRF GUN DESIGN & FABRICATION

- Low frequency: long bunches ➔ reduced space charge effect.
- Short accelerating gap: accelerating field is almost constant.
- Superconducting cavity: suitable for CW, high average current beams.
- Cathode does not have to be mechanically connected to SRF structure: flexibility in cathode types.
- Simulated emittance of ~3 mm.mrad at 2.7 MeV



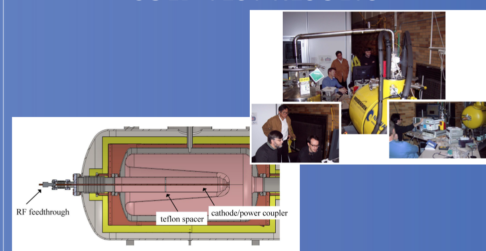
RF parameters of the 112 MHz SRF gun cavity

Frequency	112 MHz
R/Q (linac definition)	126 Ohm
Geometry factor *G*	38.2 Ohm
Quality factor Q_0 w/o cathode insert	> 3.5x10^9
Operating temperature	4.5 K
E_{pk}/V_{acc}	19.1 m^{-1}
E_{pk}/E_{cath}	2.63
B_{pk}/V_{acc}	36.4 mT/MV
Length	1.1 m
Aperture	0.1 m
Maximum diameter	0.42 m

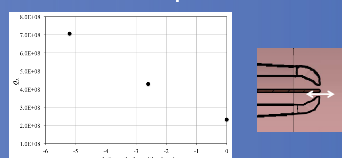


- Nb QWR cavity
- Stainless steel helium vessel
- Superinsulation
- LN2 thermal shield
- Magnetic shield
- Low carbon steel vacuum vessel

COLD TEST RESULTS

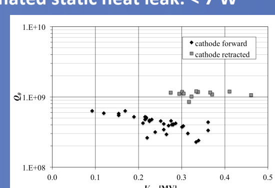


Test setup for RF.

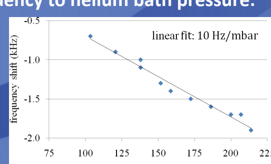


Loaded *Q* vs. cathode position.

- Observed multipacting barriers were easy to process
- Reached about 0.5 MV with Q_0 of 10^9
- Field limited due to radiation safety requirement of <2 mrem/hr (no dedicated radiation shielding around the cryomodule
- Estimated static heat leak: < 7 W



- Measured sensitivity of the cavity resonant frequency to helium bath pressure:



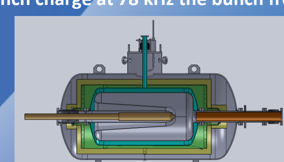
PLANS

The gun will be used for studies of multi-alkali and diamond-amplified photocathodes and to produce high-charge electron bunches for the coherent electron cooling proof-of-principle (CeC PoP) experiment at BNL.

Perform the following gun modifications:

- Replace the low-carbon-steel vacuum vessel with a stainless steel one to meet ASME Pressure Code requirements.
- Design the vacuum vessel with flanges on both ends to allow easy access to inside of the cryostat.
- Add second layer of magnetic shielding.
- Modify the cryogenic stack to interface with the BNL refrigeration system.
- Copper plate stainless steel bellows and beam tubes inside the cryostat to reduce RF losses.
- Design and fabricate cathode stalks, inserts and a load lock for multi-alkali and diamond-amplified photocathodes.
- Design the new FPC of a coaxial beam pipe type with the capability of the cavity frequency tuning.

The frequency tuner will have range of at least 100 kHz. The FPC will provide adjustability of the external quality factor from 3x10^7 to 1.2x10^8 to cover different CeC PoP operating conditions: 1 to 2 MV gap voltage; 1 to 3 nC bunch charge at 78 kHz the bunch frequency.



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