

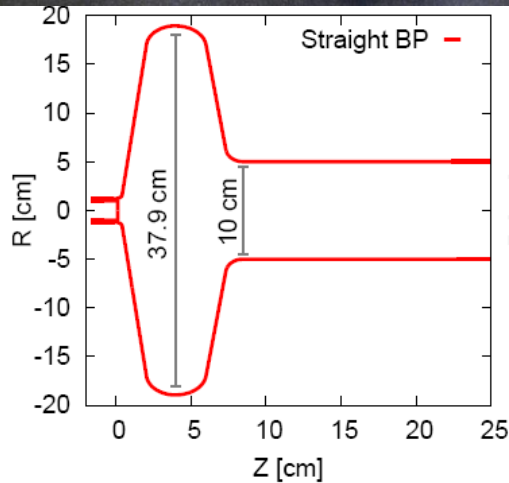
BEAM BREAK-UP ESTIMATES FOR THE ERL AT BNL

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The BNL High-Current R&D ERL

- Aimed at pushing the limits for beam current: 0.5 amperes and developing ERL technologies
- Testing of novel components and techniques:
 - Superconducting electron gun
 - Diamond amplified photocathode
 - Z-bend ERL beam merging
 - High-current SRF cavity at 703.75 MHz
 - Diagnostics and more.
- Collaboration with AES

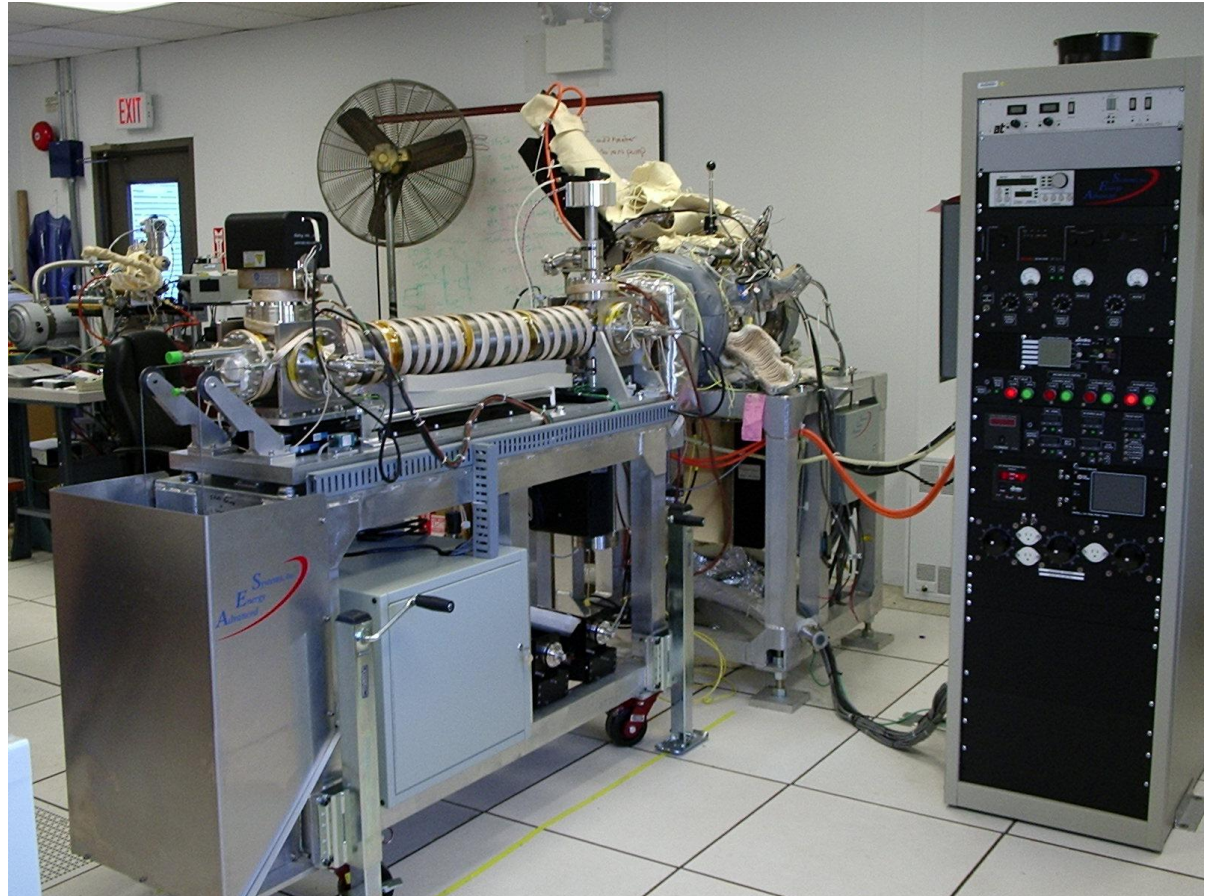
SRF Gun

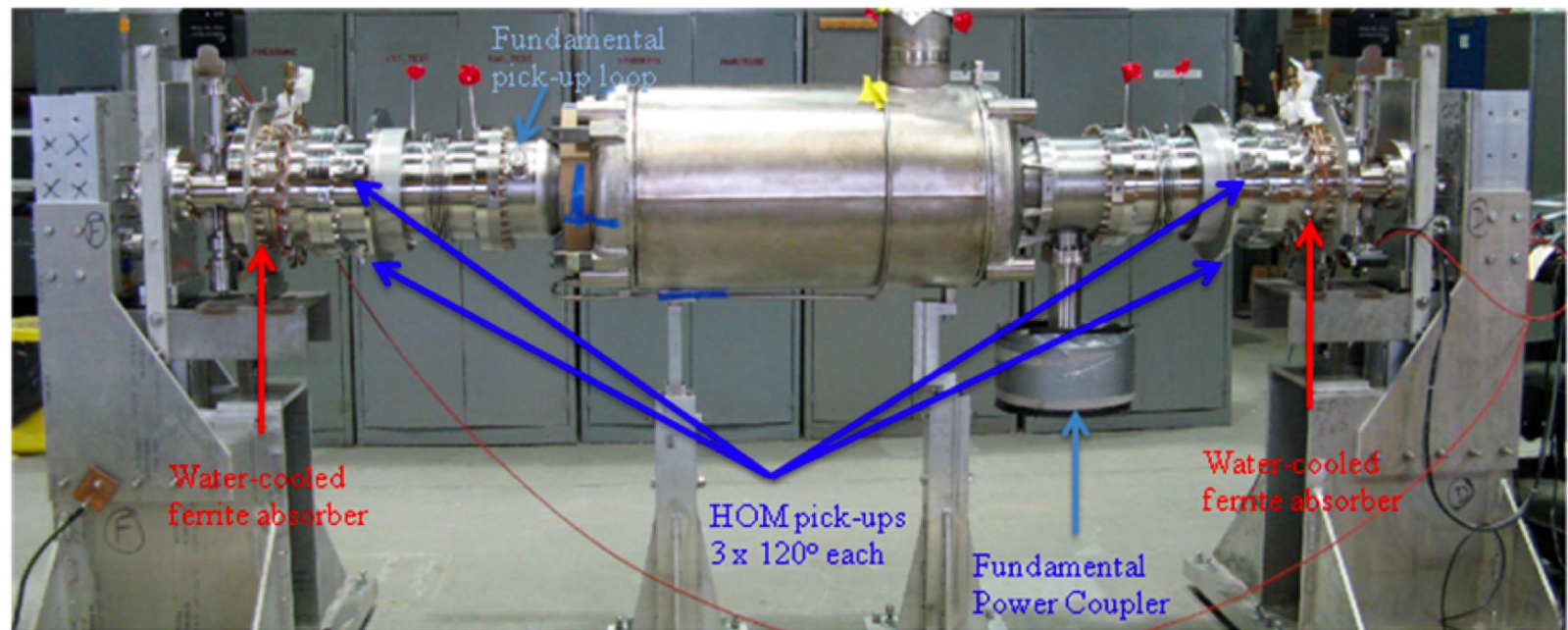
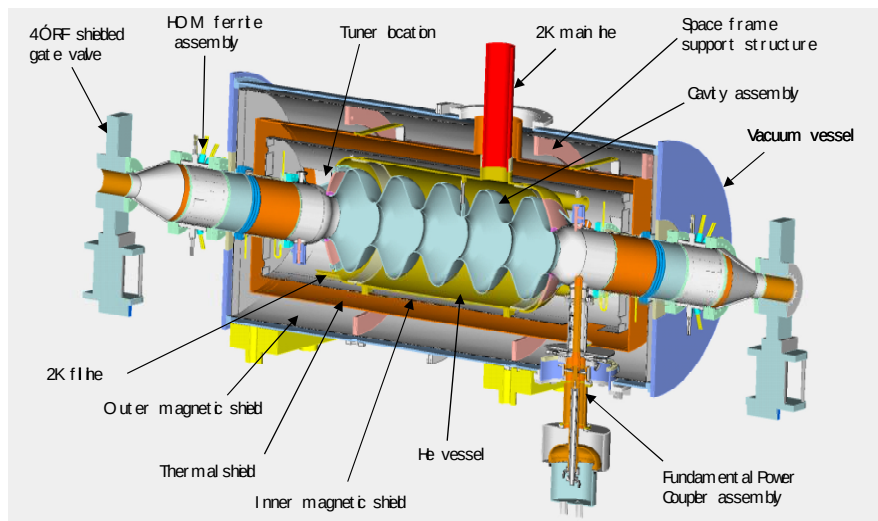


Parameter	Units	Value
Frequency	MHz	703.75
Iris radius	cm	5
Equator Diameter	cm	37.9
Cavity length	cm	25
Beam kinetic energy	MeV	2
Peak electric field	MV/m	35.7
Peak magnetic field	A/m	58740
Stored energy	Joule	8.37
QR_s (geometry factor)	Ω	35.2
R/Q	Ω	96
Q_e (external Q)		37000
Power input	MW	1
Maximum current	mA	500
Emittance at 1.4 nC	$\mu\text{m rms normalized}$	1.4
Cathode recess	mm	1
Cathode spot size	mm diameter	5
Emission phase	Degrees	25
Longitudinal loss factor	V/pC	0.7
Transverse loss factor	V/pC/m	32

Load-lock 3rd Gen Deposition System

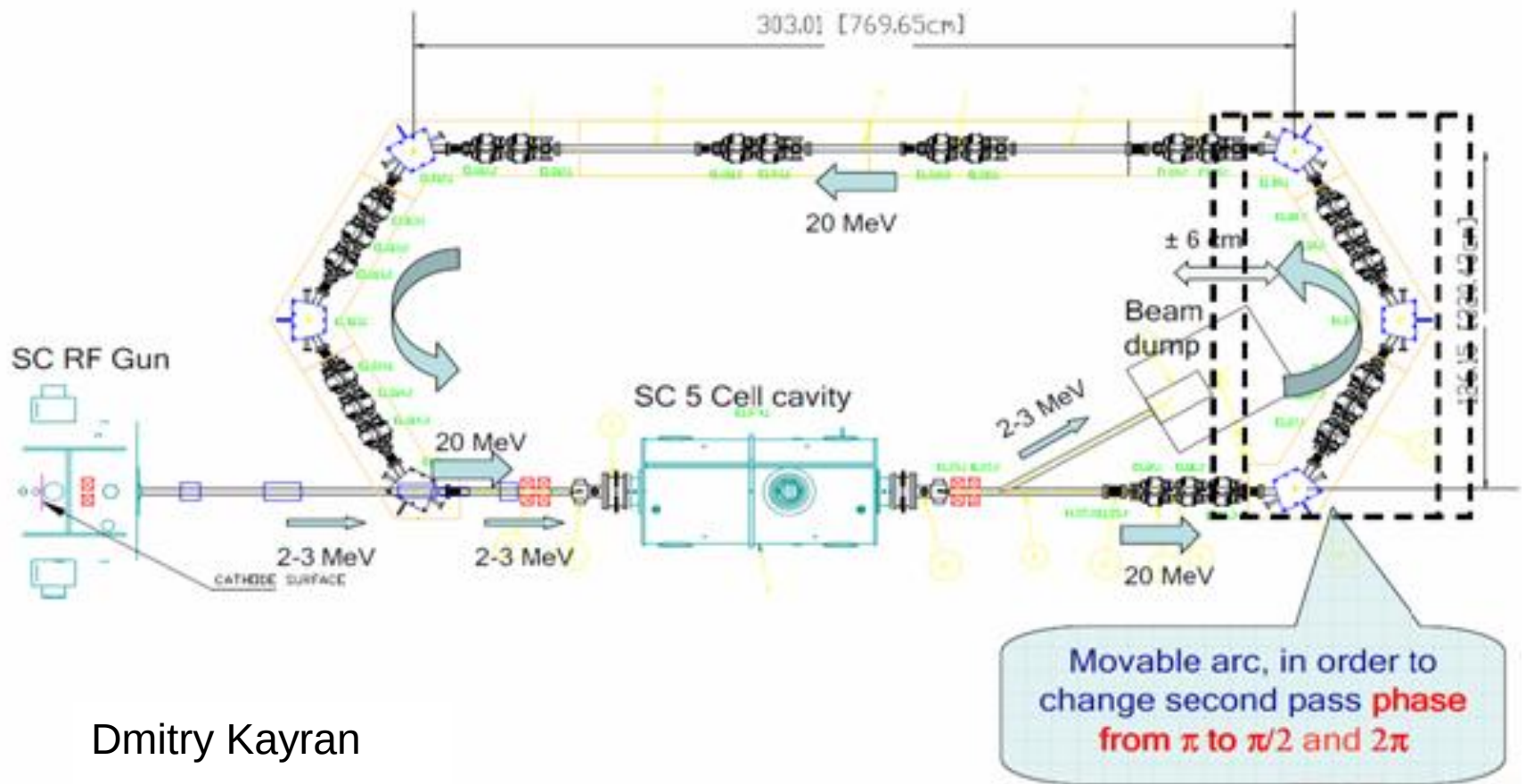
- Multi-alkaline capability
- Base pressure 1×10^{-10} Torr
- System designed to eliminate cross contamination of sources
- Provides for quicker source exchange
- 2 UHV transport systems with LN_2 cooling capability





ERL layout.
Straight section is 7m long



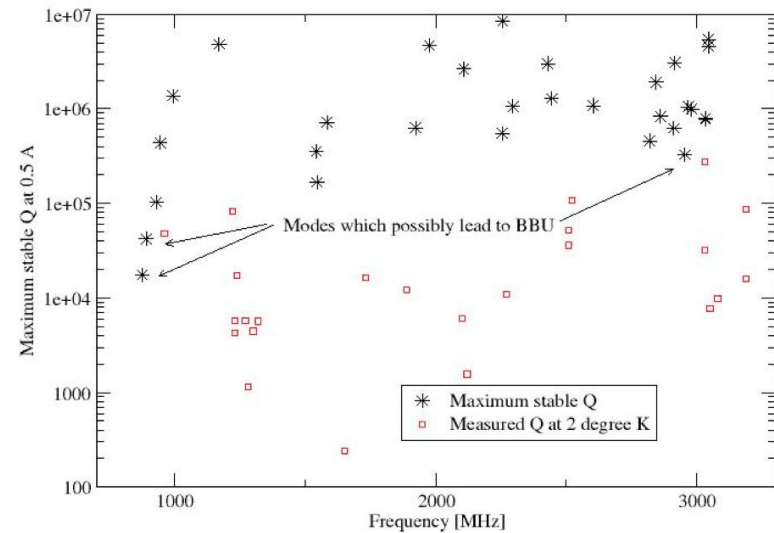
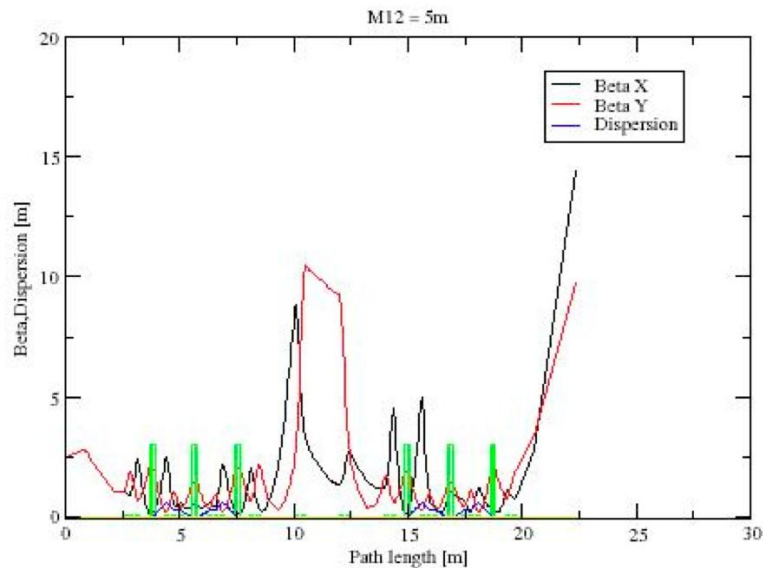


Dmitry Kayran

ERL Beam Design Parameters

	R&D ERL design		BNL ERL projects requirements				
	High Current	High charge	PoP CeC Test *)		Pre-cooling @ 40GeV	MEerHIC	eRHIC 10/20
Charge per bunch, nC	0.7	5	5	5	14 (9x1.56)	5	18/3.5
Energy maximum/injection, MeV	20/2.5	20/3.0	21/3	21/3	21/3	4000/5	10000/5 20000/5
R.m.s. Normalized emittances ex/ey, mm*mrad	1.4/1.4	4.8/5.3	5	5	3	7-73	77
R.m.s. Energy spread, $\delta E/E$	3.5×10^{-3}	1×10^{-2}	1.5×10^{-3}	1.5×10^{-3}	8×10^{-4}	2×10^{-3}	1×10^{-3}
R.m.s. Bunch length, ps	18	31	30	30	30	6.7	30
Bunch rep-rate, MHz	700	9.383	0.078	9.383	9.383	9.383	14.1
Gun/dumped ave. current, mA	500	50	0.4	50	130	50	260/50
Linac average current, mA	500	50	0.4	0.4/50	130	300	2600/500
Injected/ejected beam power, MW	1.0	0.150	0.0012	0.15	0.390	0.250	1.3/0.250
Numbers of passes	1	1	1	1	1	3	5

R&D ERL in mode aiming to cause BBU



Dmitry Kayran, Harald Hahn, Lee Hammons, Jorg Kewisch.

Staging approach under consideration presently: staging all-in tunnel eRHIC:

energy of electron beam is increasing from 5

GeV to 30 GeV by building-up the linacs

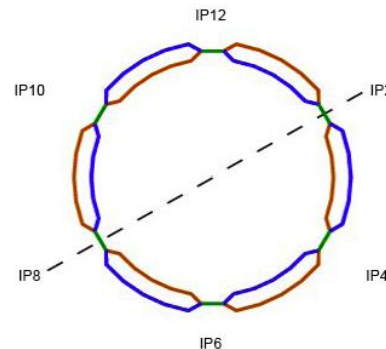
2 SRF linac
1 → 5 GeV per pass
4 (6) passes

eRHIC detector

Luminosity over 1E34

Coherent e-cooler

4 to 6 vertically separated recirculating passes.
of passes will be chosen to optimize eRHIC cost

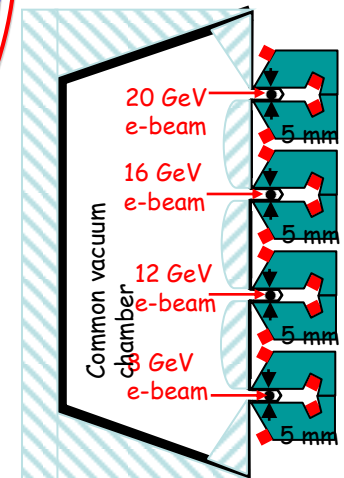


RHIC: 325 GeV p
or 130 GeV/u Au

ePHENIX

eSTAR

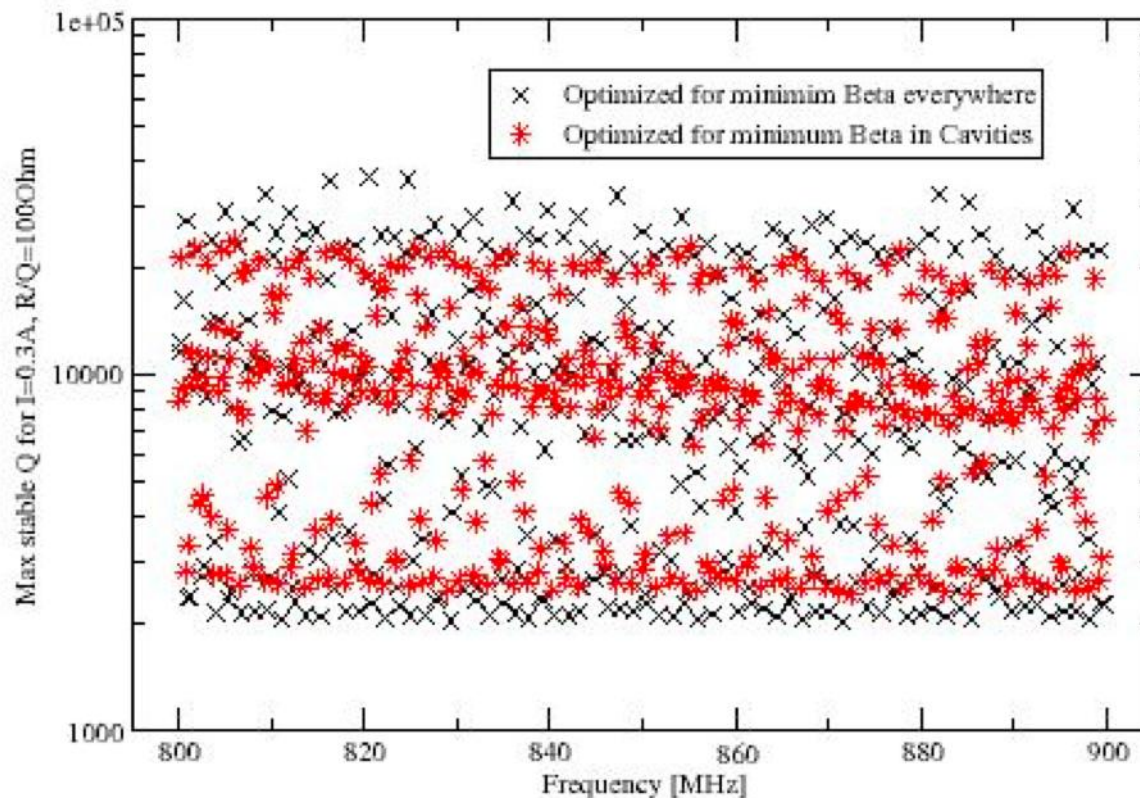
I. Ben-Zvi



BROOKHAVEN
NATIONAL LABORATORY

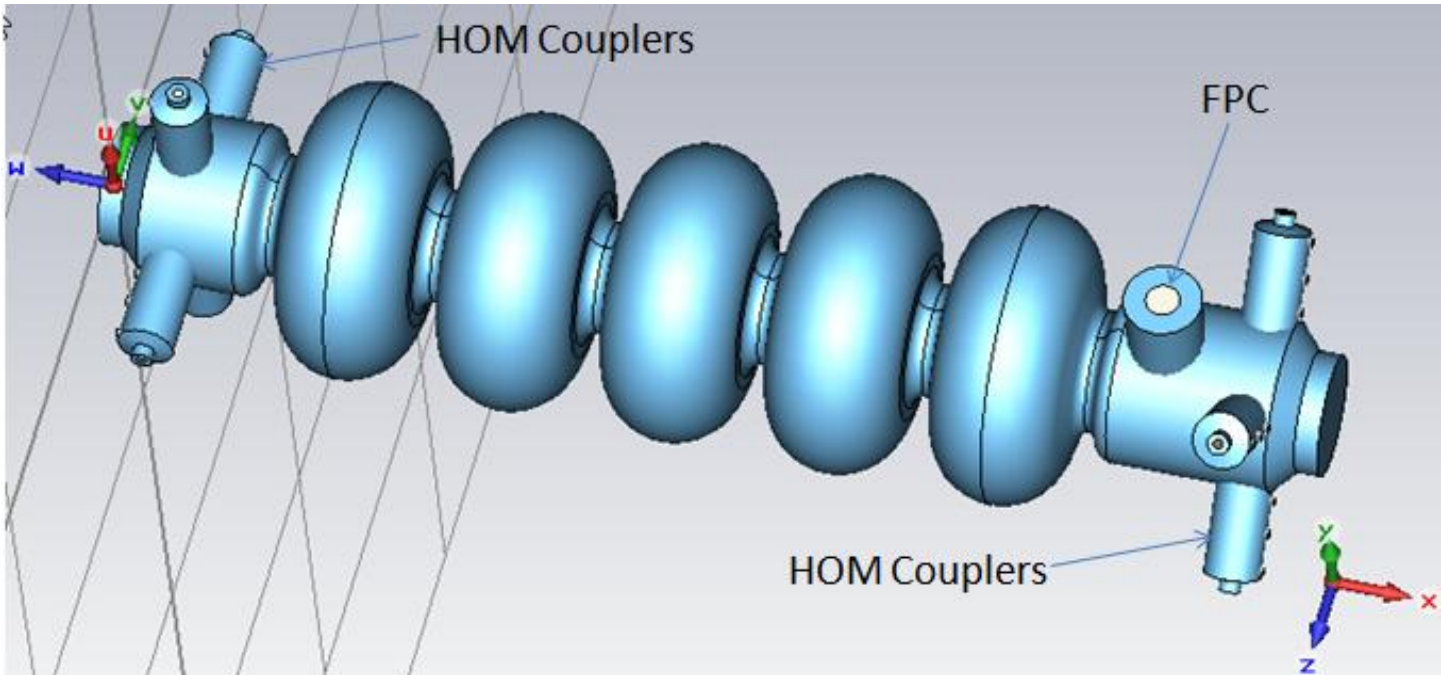
The most
cost
effective
design

Maximum stable Q in 4 GeV 3-pass ERL, at 0.3 A and a single dipole HOM with $R/Q=100\ \Omega$. These numbers are arbitrarily selected to demonstrate the application of the BBU code. Jorg Kewisch.



Design of new ERL cavity

Wencan Xu



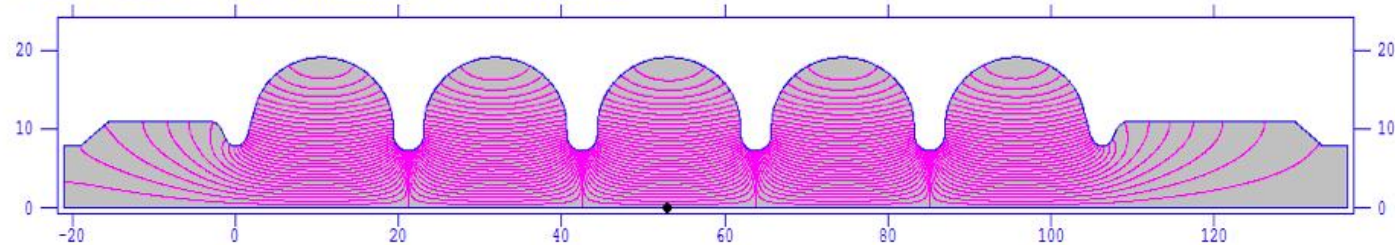
Hallmarks: Improved SRF properties and HOM damping.
Use pick-up probes rather than ferrites or waveguides.
HOM power conducted through coax lines to room temperature loads.

Comparison: New and original ERL cavities

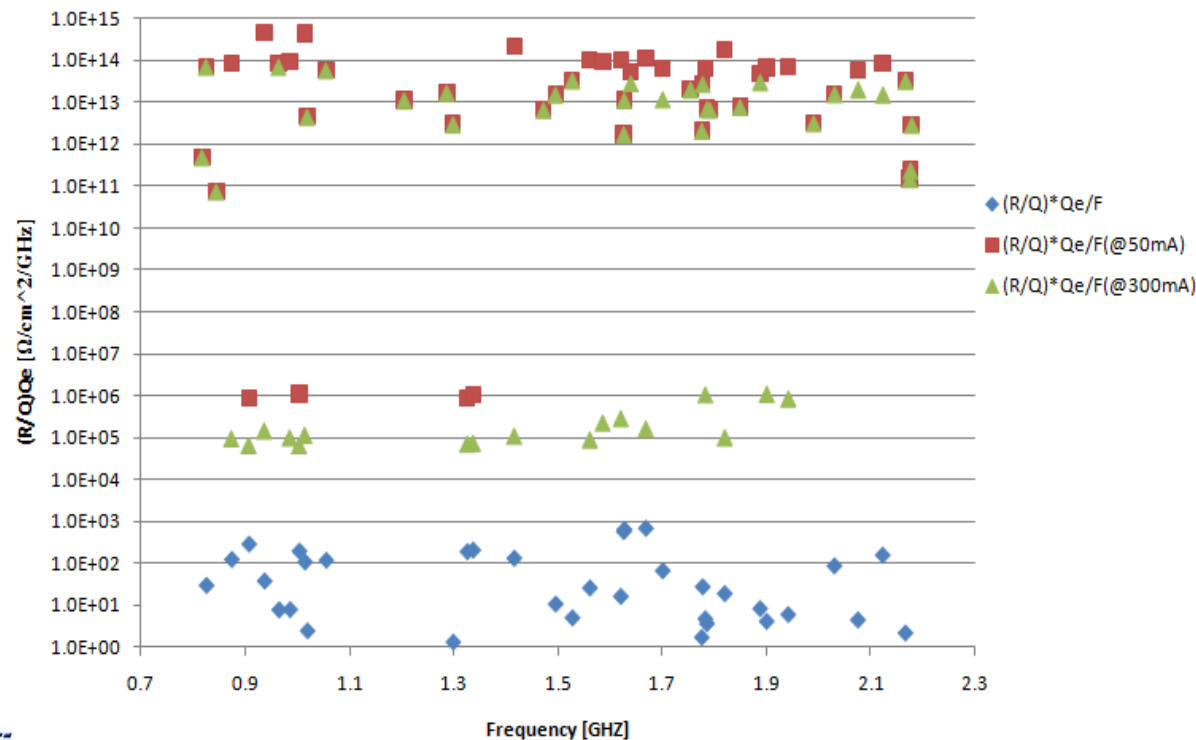
Parameters	BNL I	eRHIC
Frequency [MHZ]	704	703.79
beta	1	1
Cells No.	5	5
Geometry Factor	225	283
(R/Q)/cell [Ω/cell]	80.8	101.26
E _{peak} /E _{acc}	1.97	2.46
B_{peak}/E_{acc} [mT/MV/m]	5.78	4.27
Coupling factor [%]	3.00	3.02

Performance in terms of BBU

700MHz 5-Cell Nb Cavity by Wencan Xu F = 703.82018 MHz

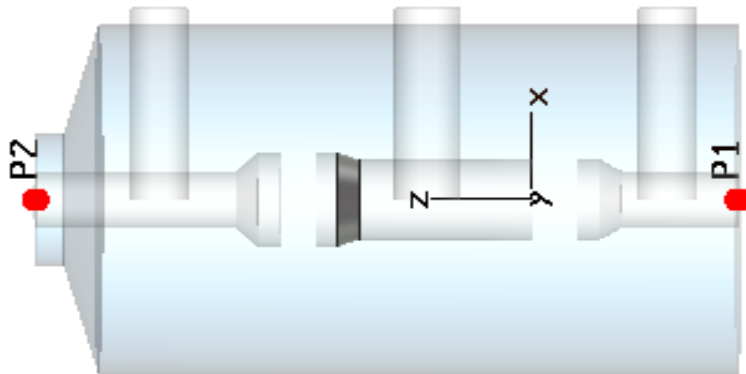


Dipole modes damping requirement and capability

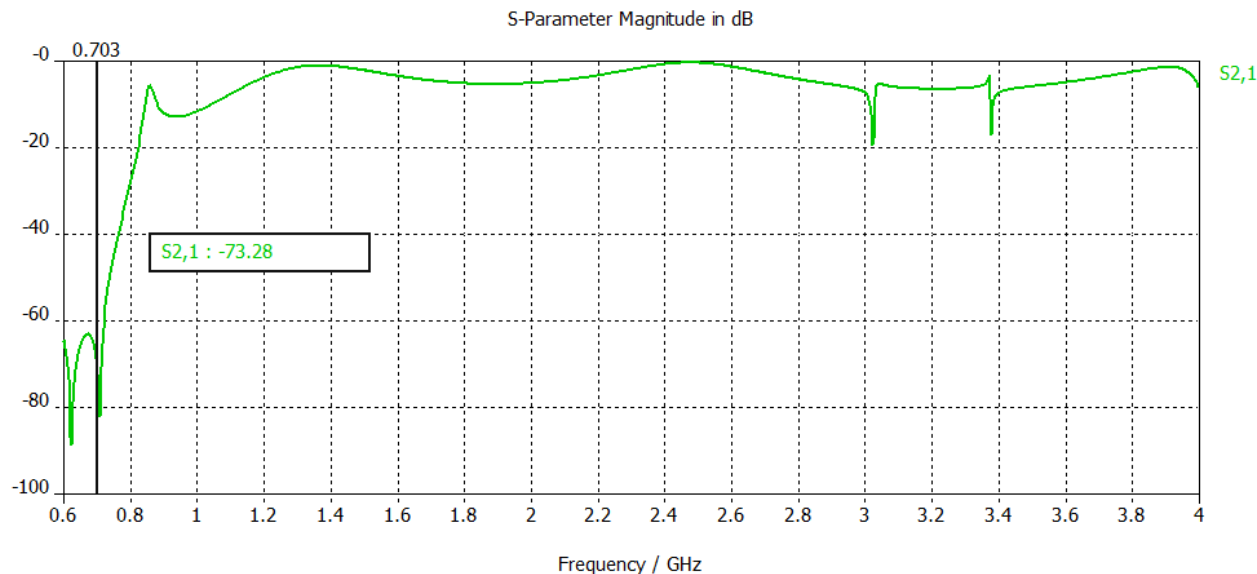


Band-stop filter design

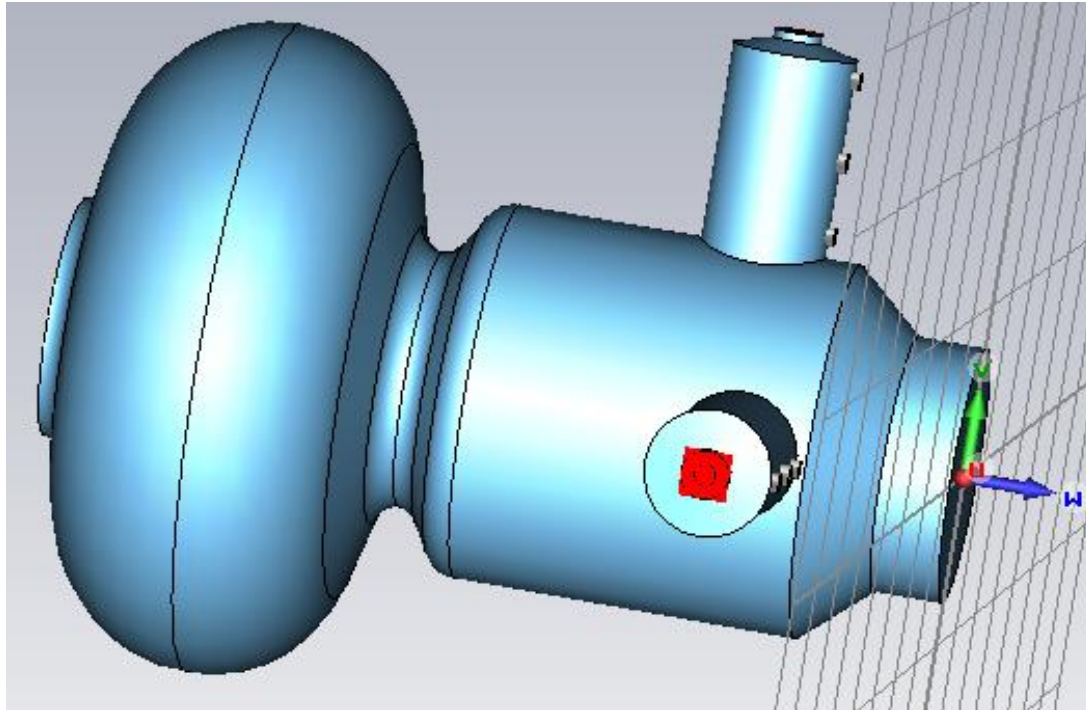
Wencan Xu



A band-stop filter is simpler and safer than a notch filter.



Single cell with band pass filter



Mode	two HOM on beamtube BE with BP port	
	Frequency	External Q
F-mode	0.7037	3.460E+10
D-mode	0.8318	7.754E+03
	0.831826	4.404E+03
	0.92358	3.808E+02
	0.925749	3.854E+02
	0.9838	3.876E+03
	0.9847	2.711E+03
Q-mode	1.19535	1.305E+03
	1.19583	1.403E+03
	1.19659	1.242E+06
	1.1967	2.790E+05
	1.2636	8.843E+04

SUMMARY

- A new R&D ERL is in advanced construction
- ERL is a test-bed for new ERL technologies
- Development of new ERL cavity
- New features:
 - Better SRF performance
 - Probe with coax line and band-stop filter
- The new cavity will serve in high current, multi-pass ERLs such as eRHIC.