EBIS

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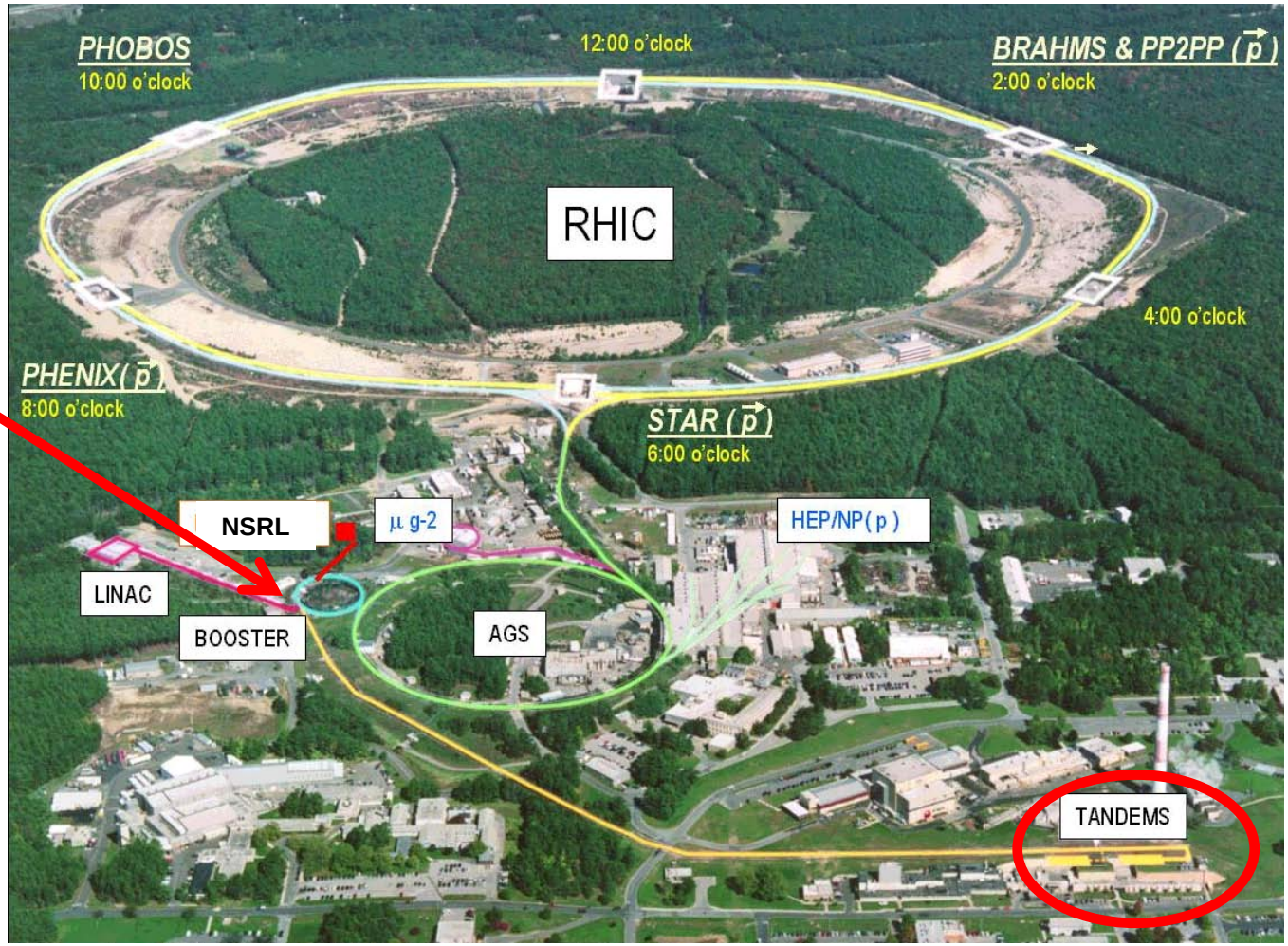
For
EBIS Team

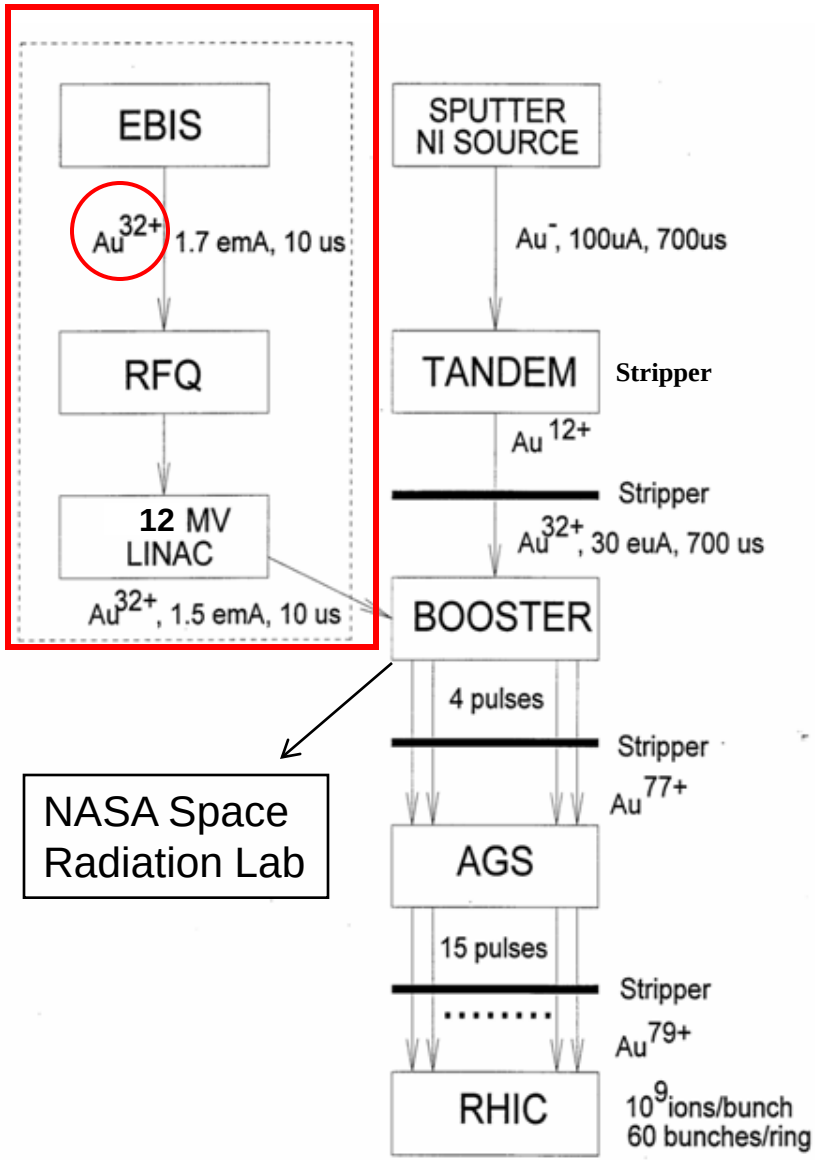
RHIC Retreat
July 17, 2009

Tandems are the present heavy ion preinjectors for RHIC

EBIS going here



860 m long transport line from the Tandems to the Booster

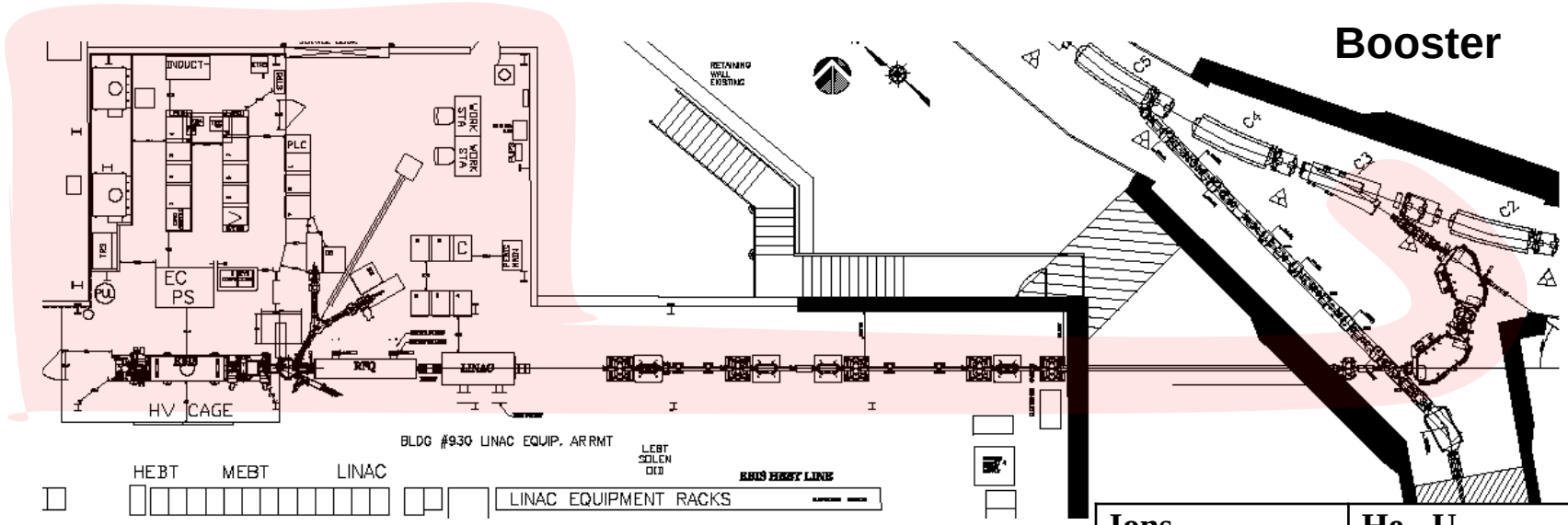


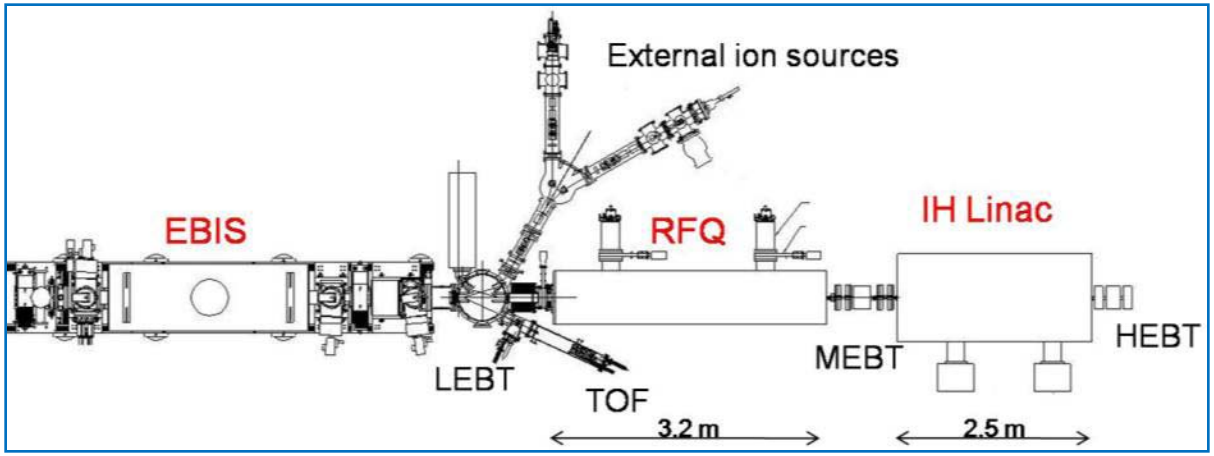
Operation for RHIC requires the preinjector to be available 24/7 for 4-6 months at a time, and the Tandems have done this very well for many years.

Advantages of the new preinjector:

- **Simple, modern, low maintenance**
- **Lower operating cost**
- **Can produce any ions (noble gases, U, $He^3\uparrow$)**
- **Higher Au injection energy into Booster**
- **Fast switching between species, without constraints on beam rigidity**
- **Short transfer line to Booster (30 m)**
- **Few-turn injection**
- **No stripping needed before the Booster, resulting in more stable beams**
- **Expect future improvements to lead to higher intensities**

Placement of EBIS Preinjector in lower equipment bay of 200 MeV Linac

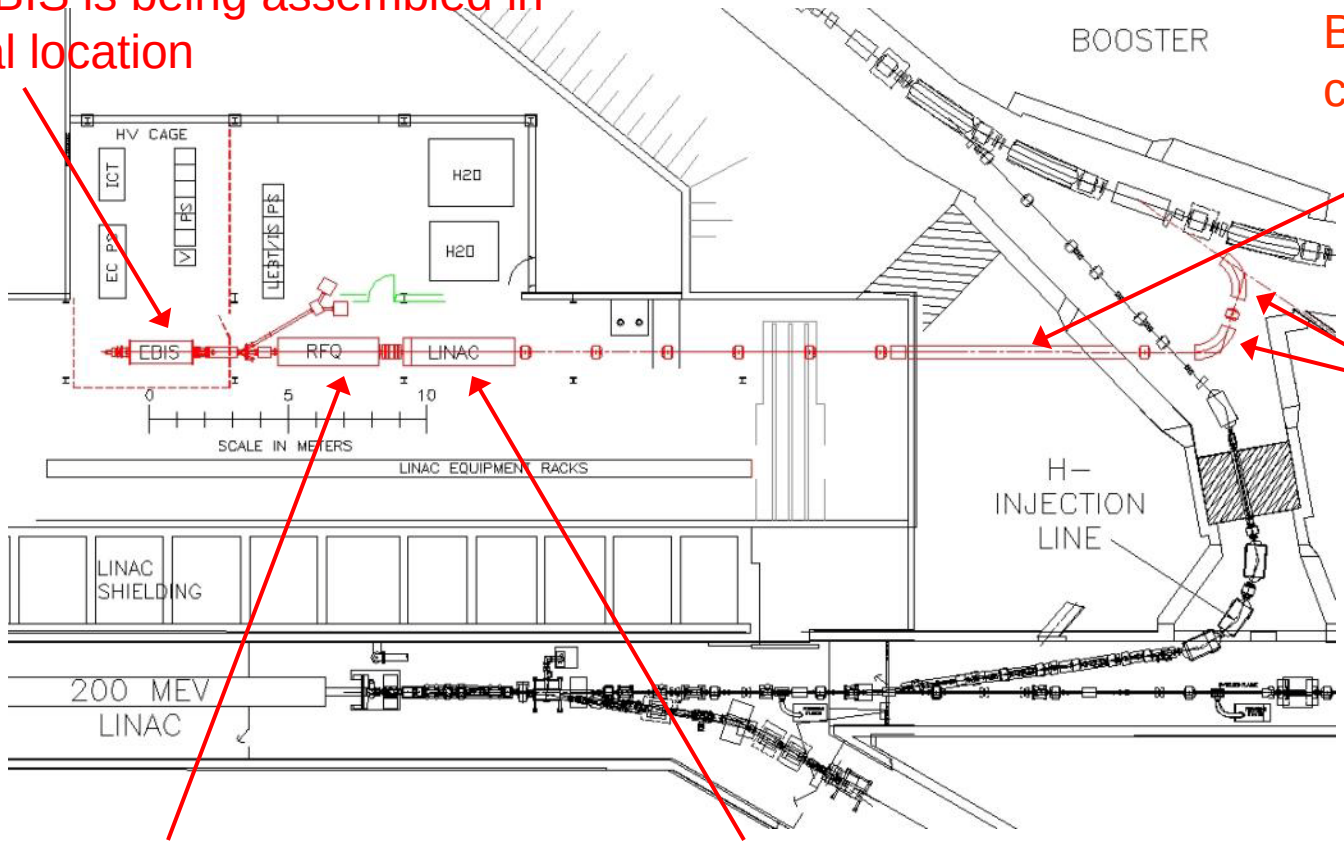




Ions	He - U
Q / m	≥1/6
Current	> 1.5 emA
Pulse length	10 μs (for 1-turn injection)
Rep rate	5 Hz
Output energy	2 MeV / u
Time to switch species	1 second

Status of Major Components

EBIS - SC solenoid is installed, and EBIS is being assembled in its final location



Beam port – completed

Dipoles – delivered and installed last summer. PS hookup this summer.

RFQ – Frankfurt; delivered, being tested with beam on Test EBIS

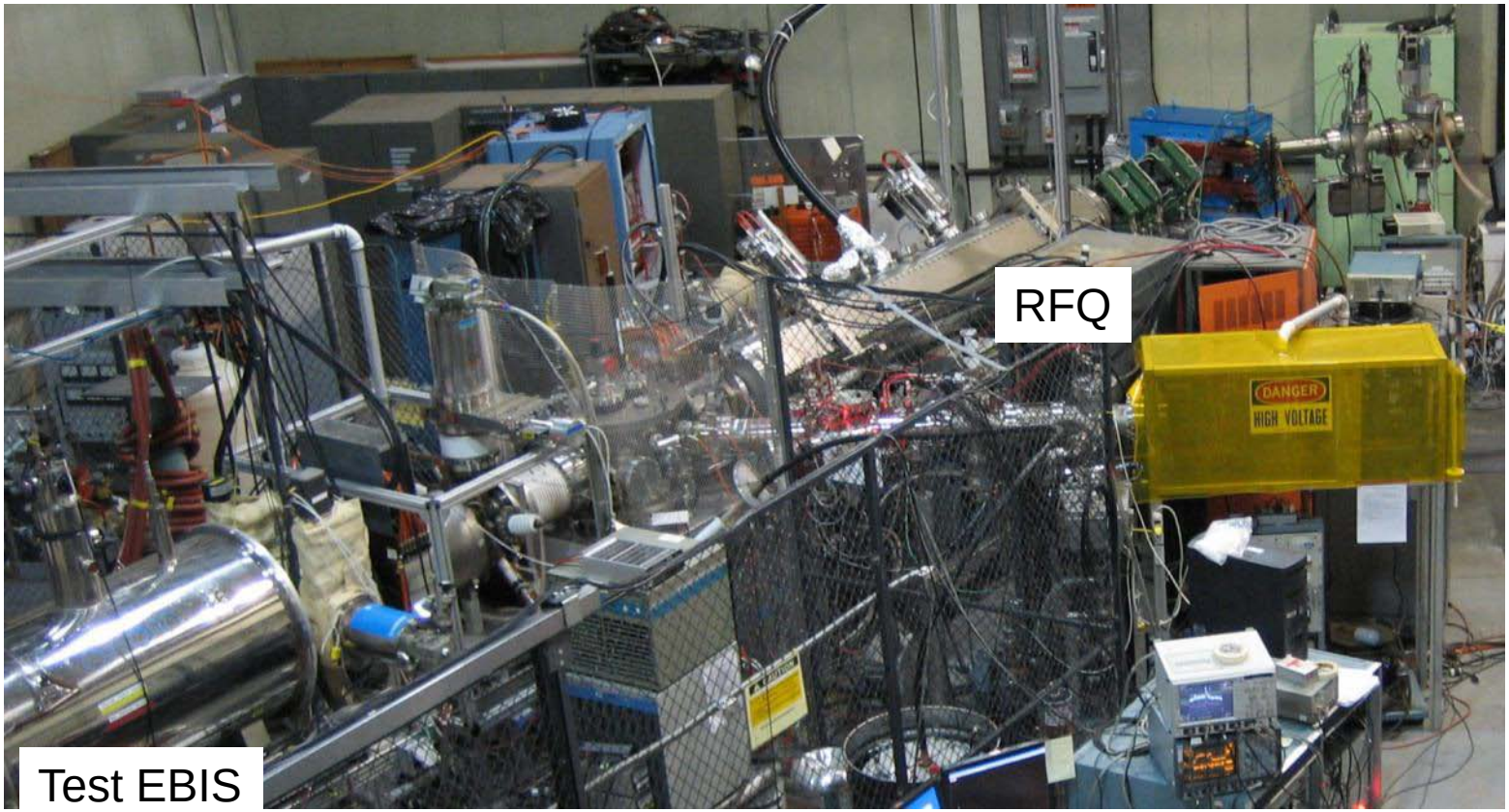
Linac – being manufactured (Frankfurt, 10/09 delivery)

RFQ from IAP, Frankfurt (Schempp)

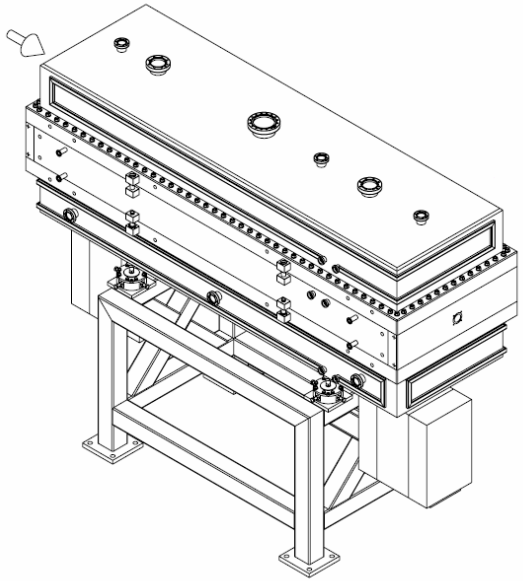
The RFQ has successfully accelerated He, Cu, & Ne from the Test EBIS at BNL.
We are in the process of characterizing the performance.

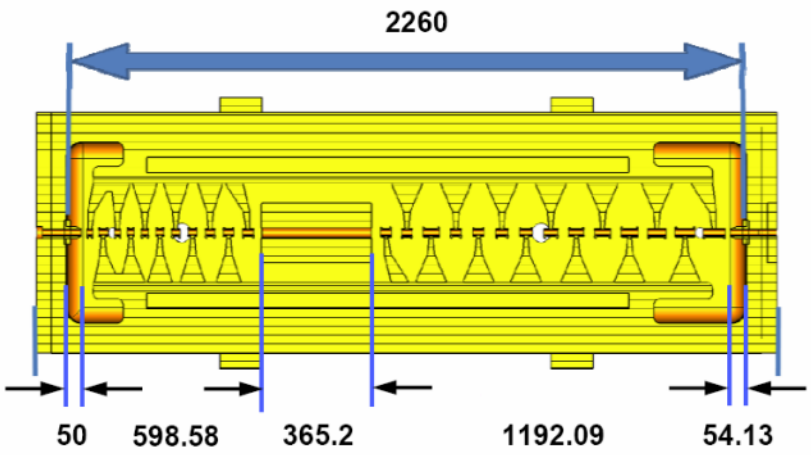
4-rod RFQ; 100.625 MHz

RFQ on Test EBIS



IH Linac from IAP, Frankfurt (Ratzinger)



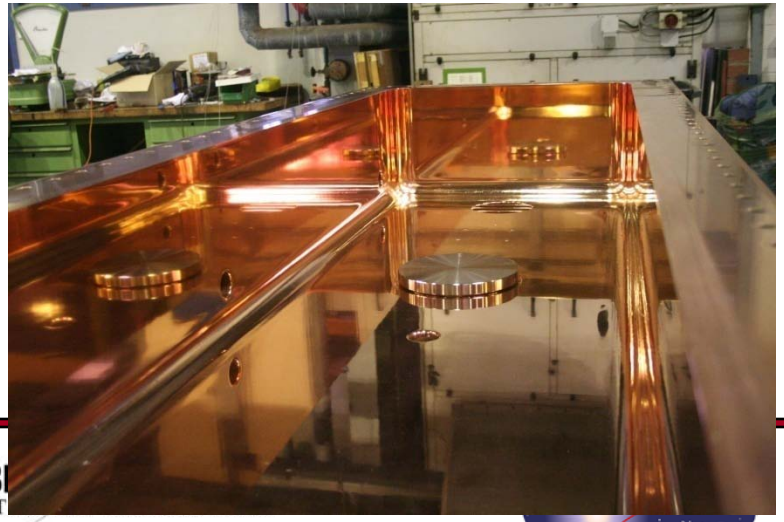


Frequency	100.625 MHz
Input energy	300 keV/u
Output energy	2.0 MeV/u
Mass to charge ratio	6.25
Beam current	10 mA
Out. Energy spread 90%	< ± 2.0 keV/u
Tras. Emittance growth	< 20 %
Transmission	> 90%
RF power	300 kW
Tank length	2.46 m
Gap number	27
Aperture min - max	9 - 15 mm

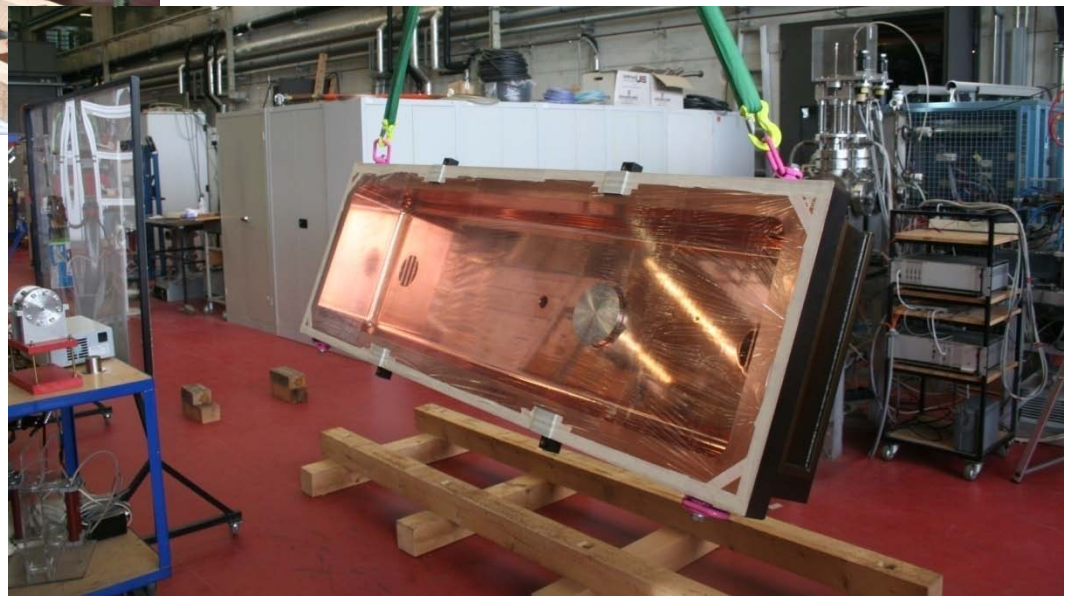
Cavity assembled for rf testing prior to Cu plating.
Internal quads being manufactured by Bruker.

Linac cavity sections while at GSI for Cu plating

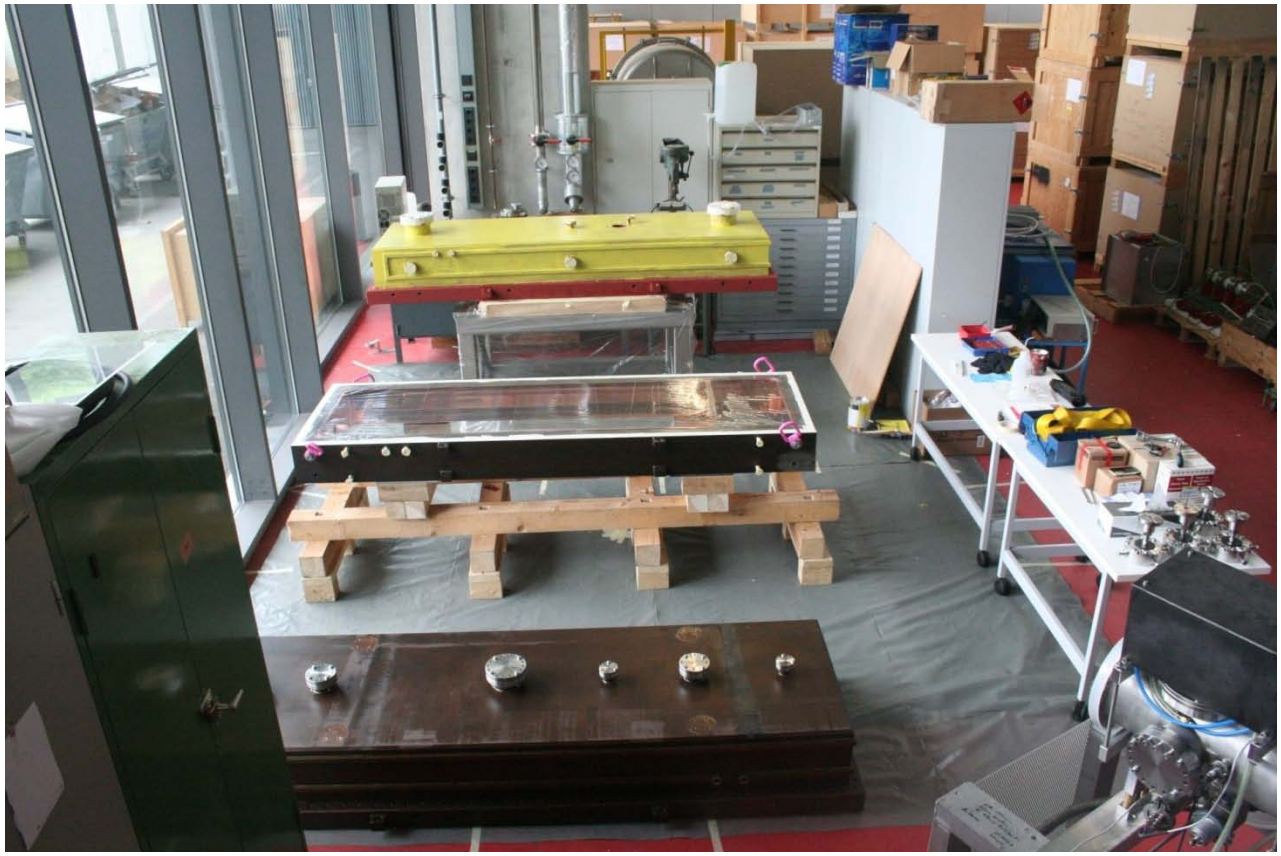
ELECTRON BEAM ION SOURCE



Linac now at IAP

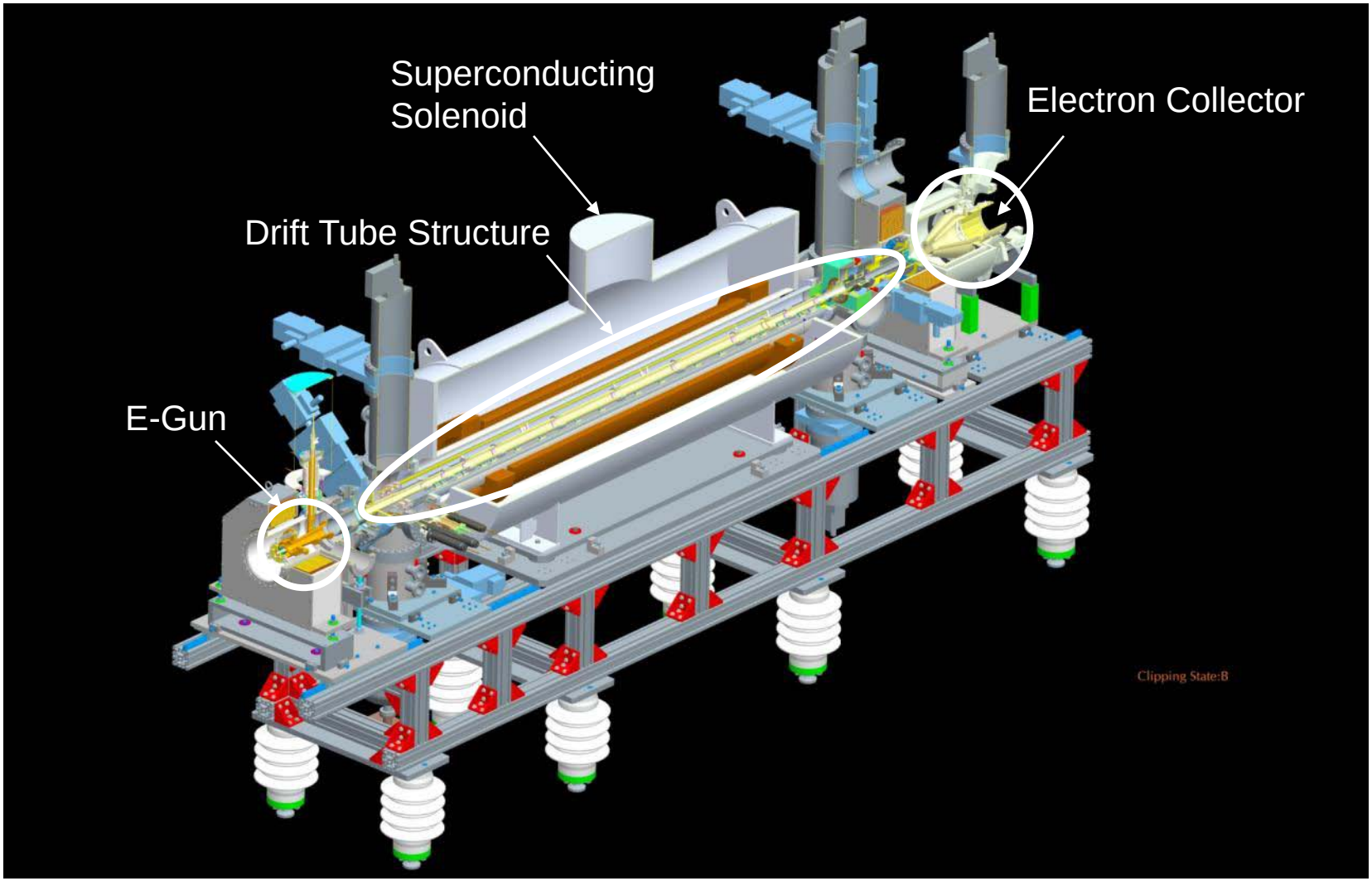


Linac at IAP



RF Testing at IAP scheduled for September.
Delivery to BNL scheduled for October.

Electron Beam Ion Source (EBIS)



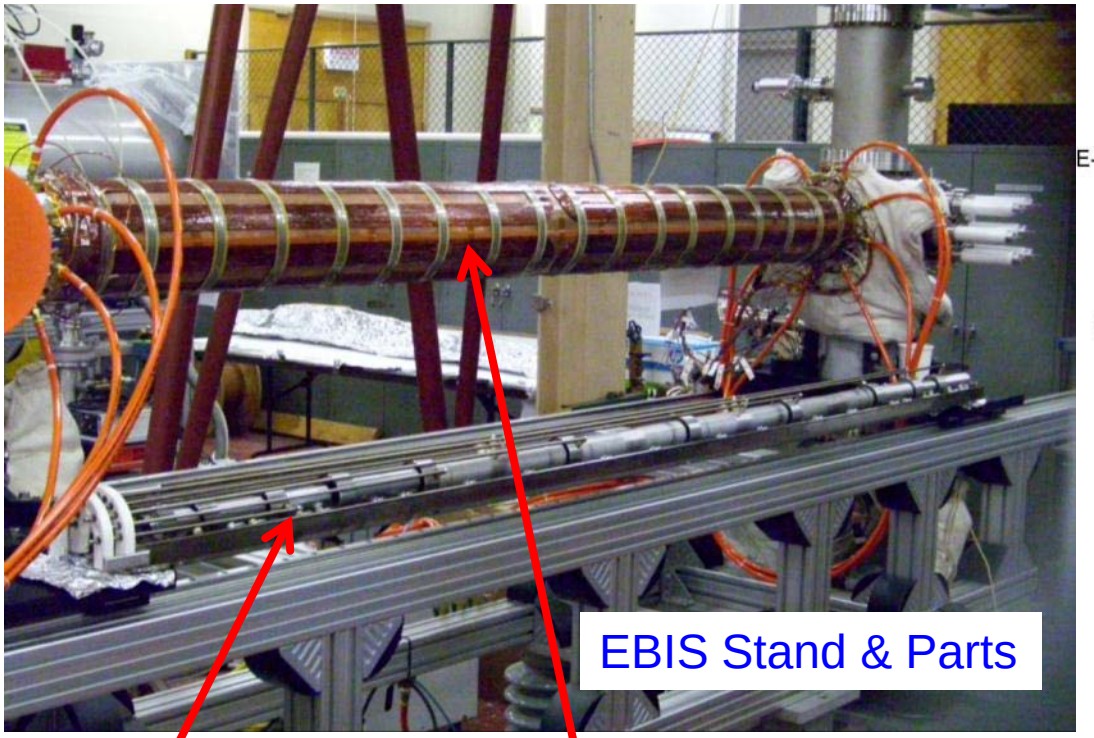
RHIC EBIS Superconducting Solenoid (SCS)

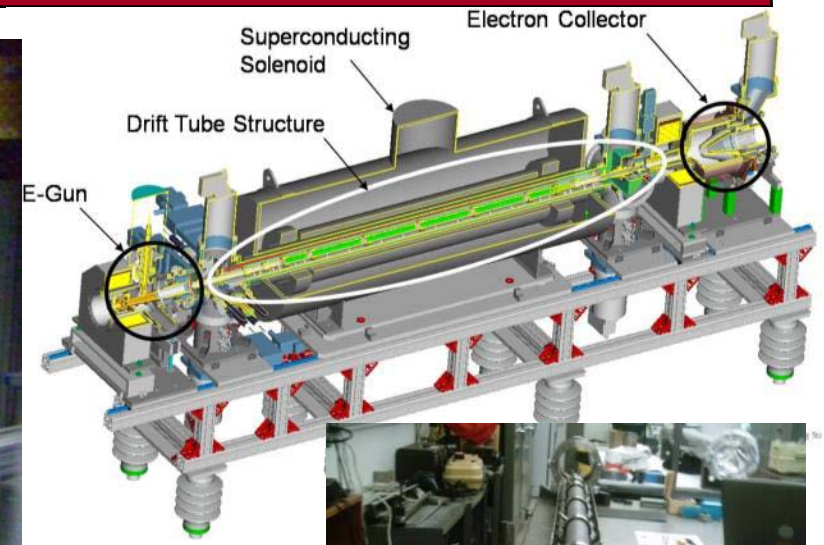
ELECTRON BEAM ION SOURCE

- Length of the SCS coil: 190 cm — Test EBIS: 100cm
- Magnet field: 5 T — Test EBIS: 5T
- Warm bore inner diameter: 204 mm (8”) — Test EBIS: 155mm (6”)
  - 1.7 times increased vacuum conductance
  - more room for HV leads

Made by ACCEL.
The solenoid has passed acceptance tests at BNL.

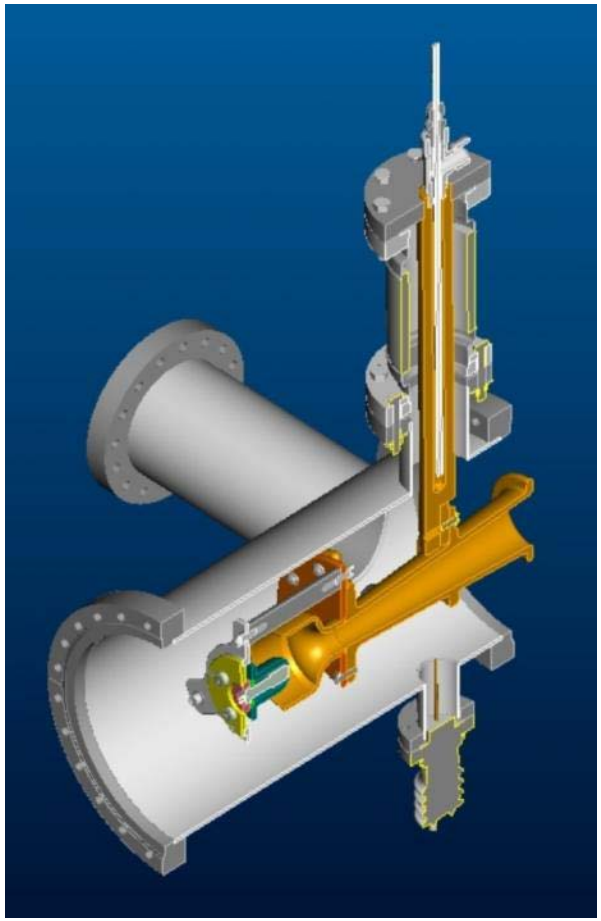
Drift tube structure





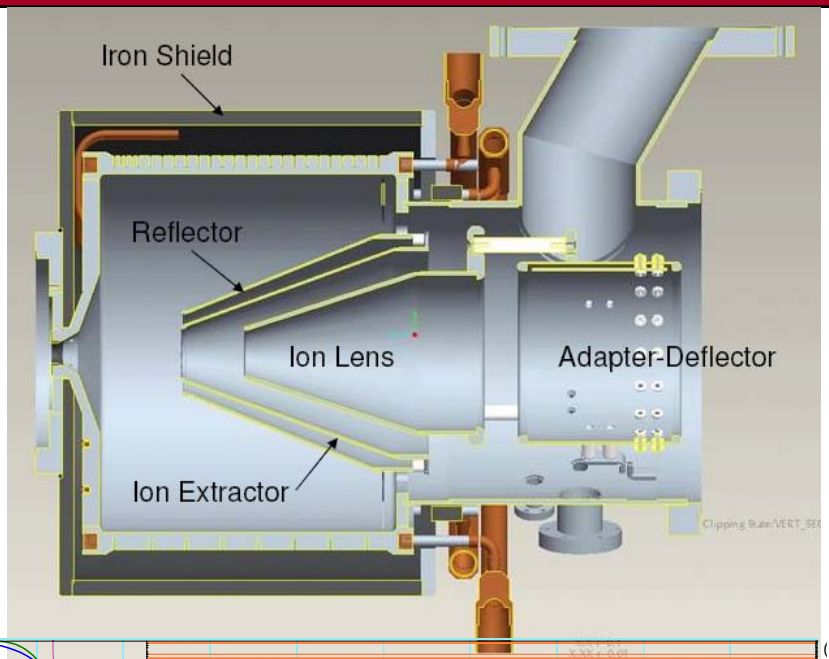
Drift tubes sit inside the central vacuum tube.
Heaters on the outside of the vacuum pipe allow baking to 450 C.
Outside of these heaters, there is a water cooled jacket to keep the magnet bore cool.
Outside the water cooled jacket, there are transverse steering coils.

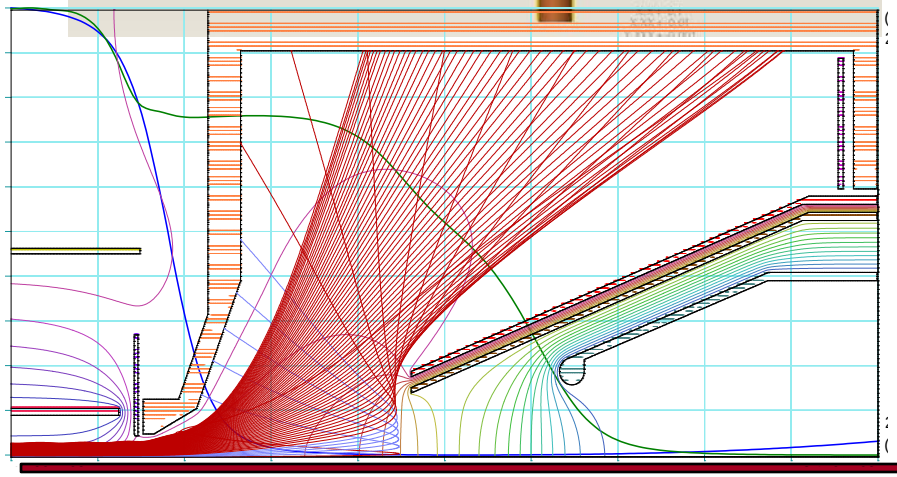
Electron gun assembly in a chamber



The new electron gun with the high perveance anode (~3μPerv) was installed and operated at the Test EBIS to produce electron beams up to 10A.

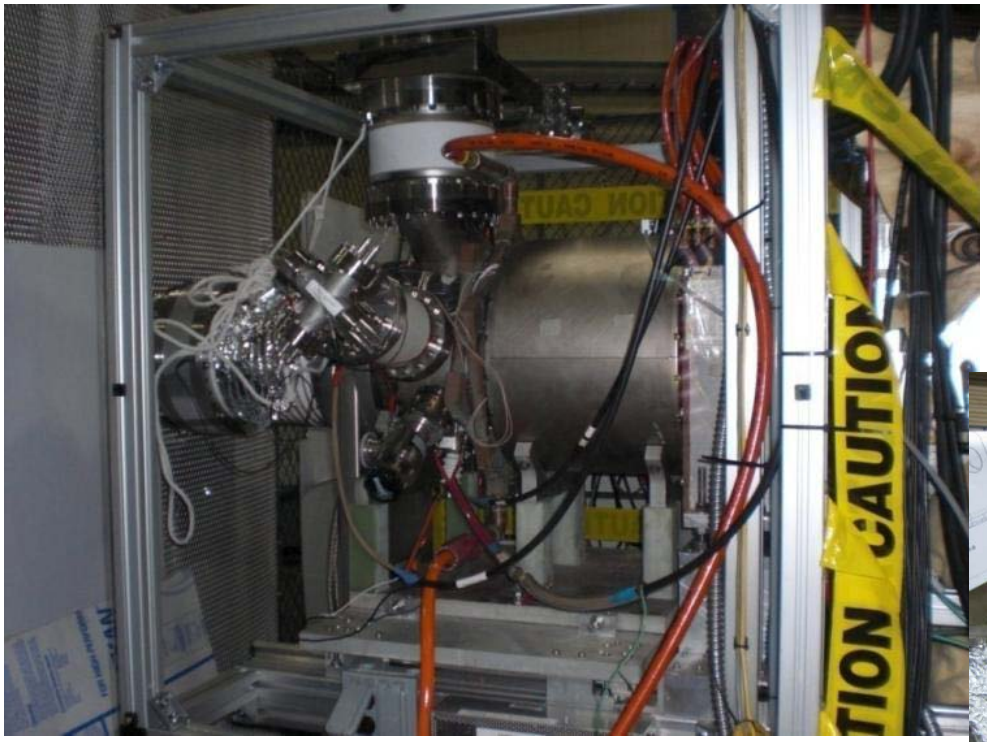
RHIC EBIS electron collector assembly design for pulsed 20 A, 15 kV beam

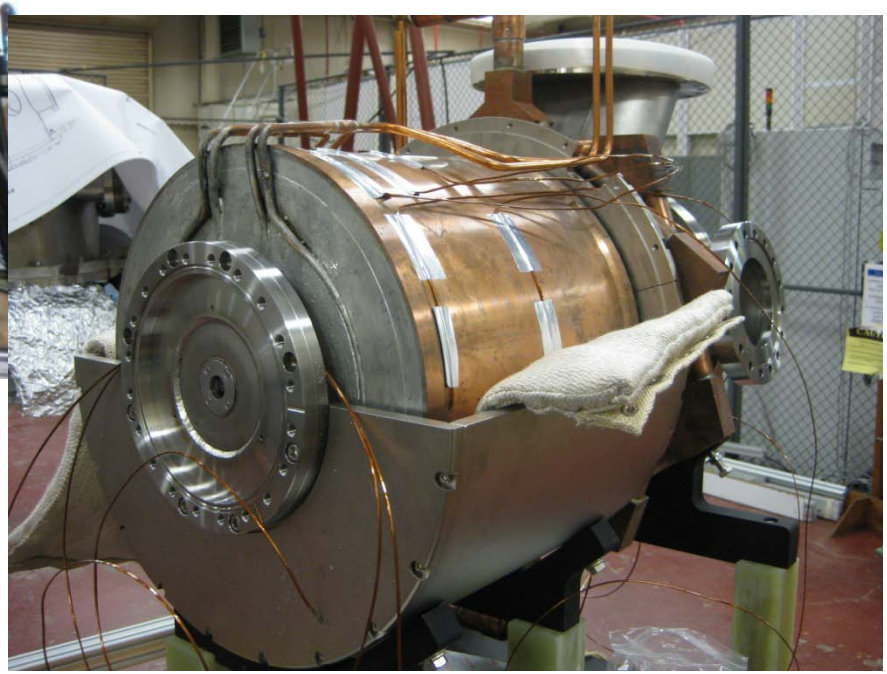




- Designed to dissipate P_{el}= 300 kW peak power (20 A, 15 kV e- beam)
- Calculated power density on EC surface (for 300 kW):
  P = 200 W/cm^2 , during the pulse
- Outer surface of collector is at atmosphere (no internal cooling lines).
- One collector is Hycon 3 HP (Brush-Wellman). This high conductivity BeCu was chosen because it provides longer fatigue lifetime.
  However, due to difficulties in electron beam welding of this material, we have also built a second collector from a Zr-Cr-Cu alloy. This is now in use on the Test EBIS.

RHIC EBIS electron collector assembly, now in use on the Test EBIS





ELECTRON BEAM ION SOURCE

EBIS is now in its final location, and is being assembled.

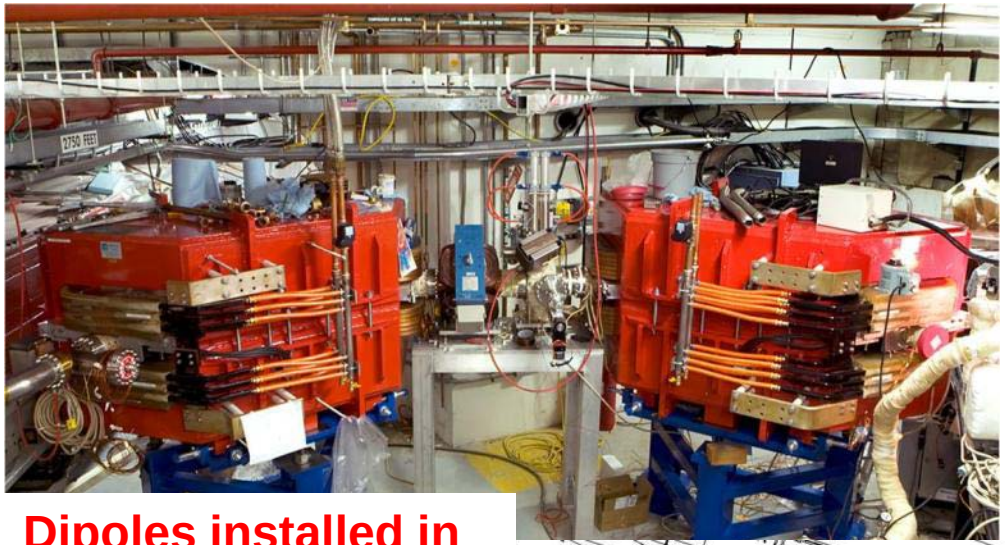
HEBT quads have been put in place and surveyed

Preparing MEBT buncher for rf testing at BNL

We hope to have the buncher which gets installed in the Booster tunnel in time to install before the end of the shutdown.

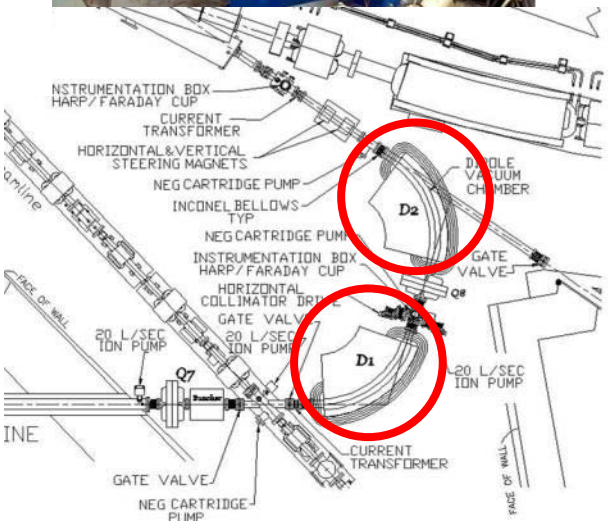
Many other components in place

EBIS power supplies are being installed on the 100 kV platform



Dipoles installed in Booster (Sigmaphi)

350 kW, 100 MHz RF amplifiers



Conclusions

• The Test EBIS has been used for RHIC EBIS component testing (electron gun, electron collector, HV acceleration section, LEBT), and is now being used for RFQ beam tests.

•Commissioning of the RHIC EBIS should start in August.

•The RFQ and Linac are scheduled to be in place by December of 2009.

•Beam commissioning (through the dipoles in Booster) is scheduled to begin in January, 2010.

•In Spring, 2010, some tests of Booster injection could begin, but we would still be in the stage of debugging and working on reliability.

•CD-4 date for the project is September, 2010.