T-2-4-2

Preparations to Investigate Charge Multiplication via the 1^+-n^+ Scheme in a Large Volume ECR Ion Source

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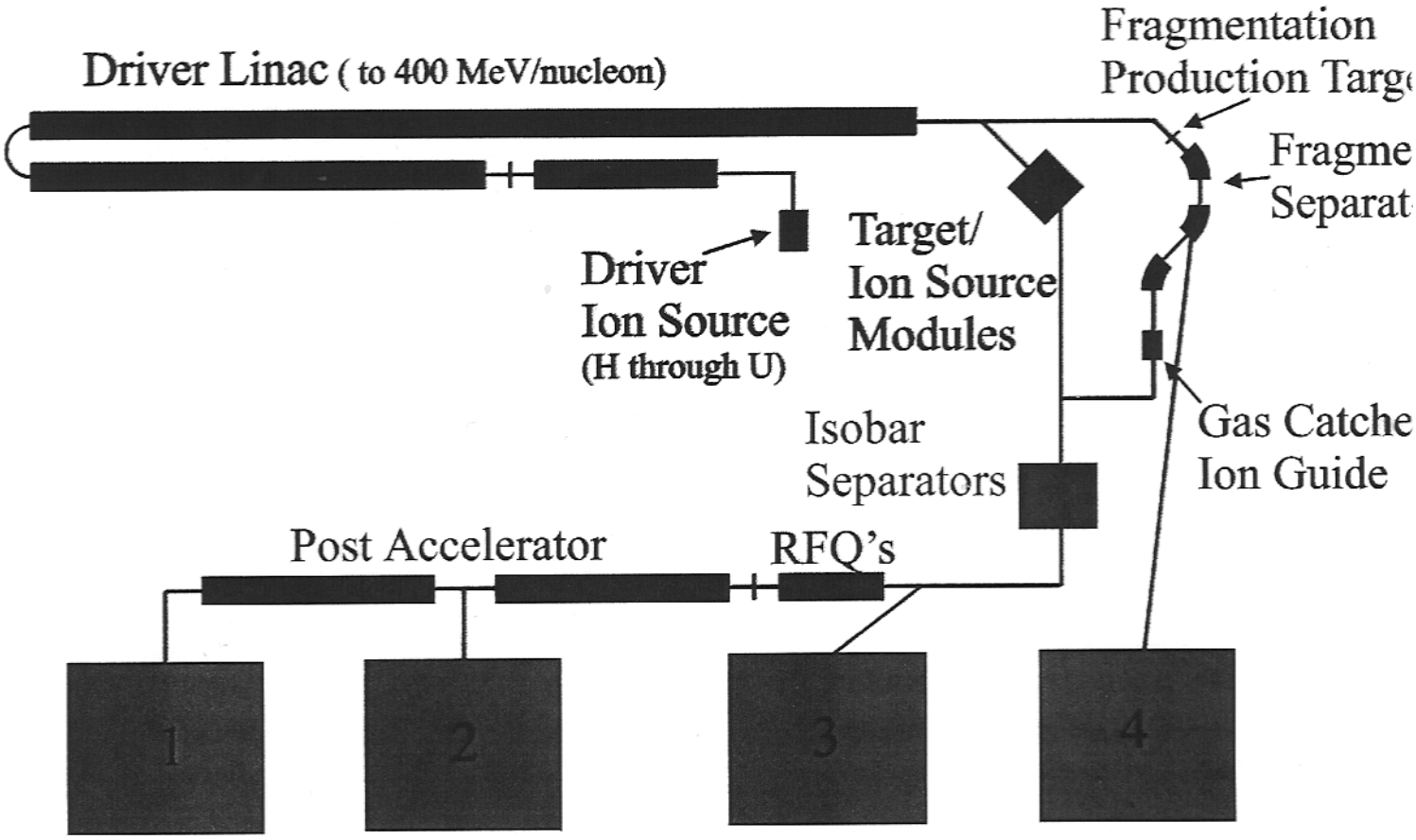
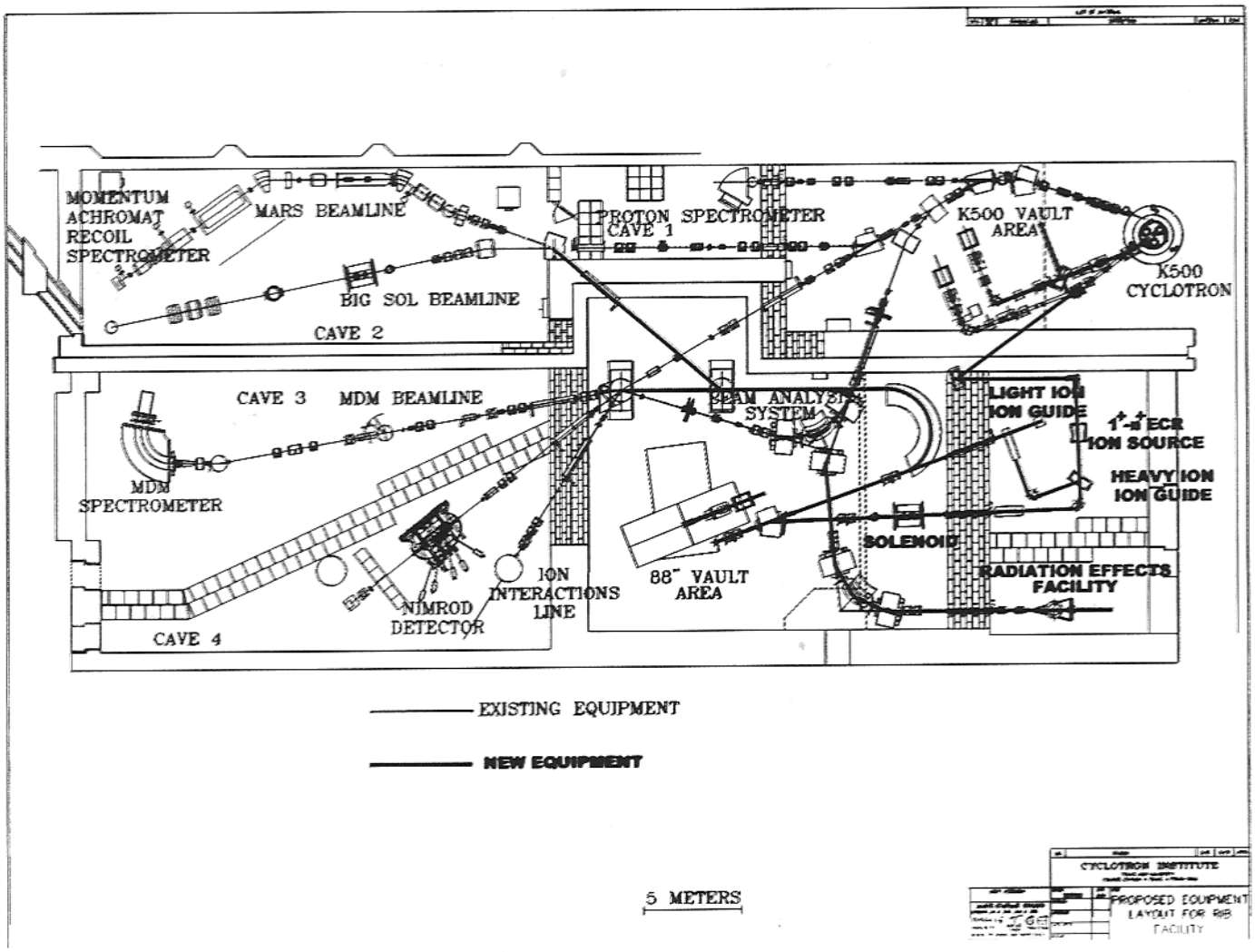
Simplified Schematic Layout of the Rare Isotope Accelerator (RIA) Facility



Experimental Areas:
1: < 12 MeV/u 2: < 1.5 MeV/u 3: Nonaccelerated 4: In-flight fragme


MOMENTUM ACHROMAT RECOIL SPECTROMETER
MARS BEAMLINE
BIG SOL BEAMLINE
CAVE 2
PROTON SPECTROMETER CAVE 1
K500 VAULT AREA
K500 CYCLOTRON
CAVE 3
MDM BEAMLINE
MDM SPECTROMETER
BEAM ANALYSIS SYSTEM
LIGHT ION ION GUIDE
1+-n+ ECR ION SOURCE
HEAVY ION ION GUIDE
SOLENOID
RADIATION EFFECTS FACILITY
88" VAULT AREA
ION INTERACTIONS LINE
NIMROD DETECTOR
CAVE 4
EXISTING EQUIPMENT
NEW EQUIPMENT
5 METERS
CYCLOTRON INSTITUTE
PROPOSED EQUIPMENT LAYOUT FOR RIB FACILITY

R. Geller 1997 ECR Workshop
Mini MEFIOS

Experiments have been performed on several elements: rare gases, alkali, metallic [3, 4] and non-metallic. The results are given in table 1.

Element	$1^+ \rightarrow n^+$	η	η_G
$_{84}Kr$	$Kr^{1+} \rightarrow Kr^{11+}$	11 %	40 %
$_{40}Ar$	$Ar^{1+} \rightarrow Ar^{8+}$	9 %	40 %
$_{85}Rb$	$Rb^{1+} \rightarrow Rb^{15+}$	5.5 %	35 %
$_{208}Pb$	$Pb^{1+} \rightarrow Pb^{22+}$	4.5 %	35 %
$_{64}Zn$	$Zn^{1+} \rightarrow Zn^{9+}$	3.5 %	23 %
$_{56}Cr$	$Cr^{1+} \rightarrow Cr^{11+}$	3.5 %	21 %
$_{32}S$	$S^{1+} \rightarrow S^{7+}$	2.5 %	11 %

Table 1: *$1^+ \rightarrow n^+$ breeding efficiencies for various elements.*

5 A $1^+ \rightarrow n^+$ dedicated source: PHOENIX booster

The results presented in the previous sections are limited by the 15 years old MINIMAFIOS source. Now, we are building a $1^+ \rightarrow n^+$ dedicated high performances ECRIS: PHOENIX booster (see Figure 6).

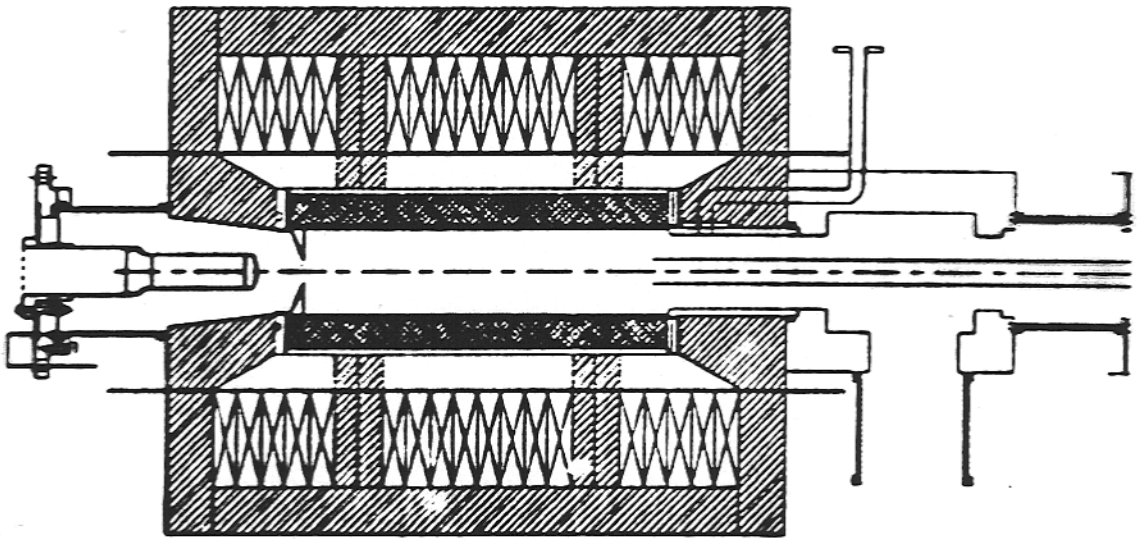


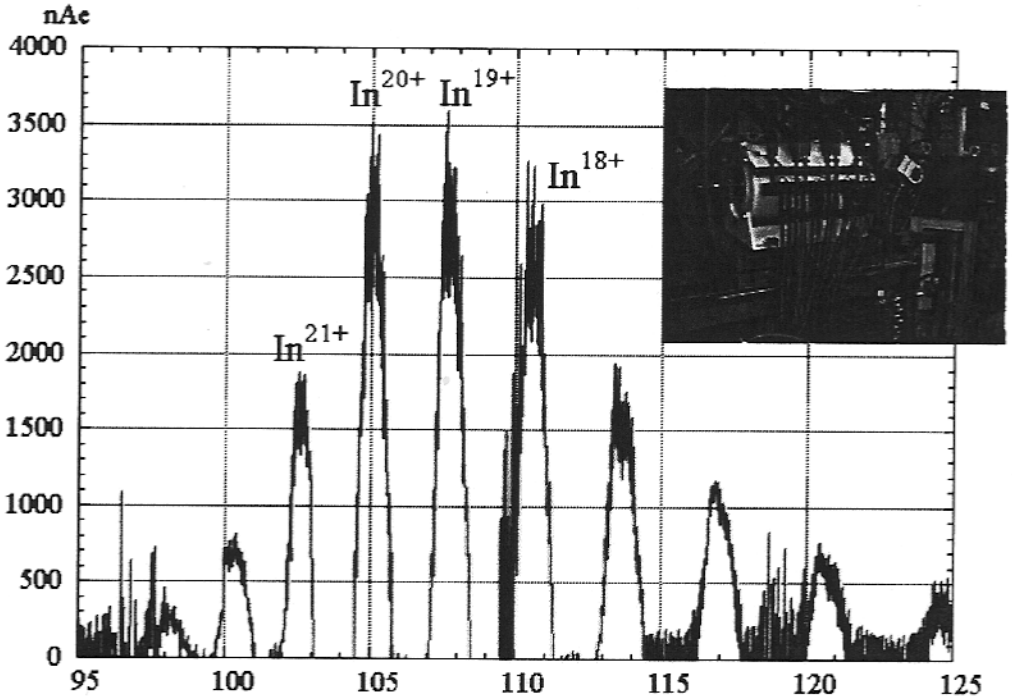
Figure 6: *The PHOENIX booster source.*

This new source will have several advantages: a conception well adapted for the R&D studies, a good high voltage insulation to work at 60 kV, an hexapole of 1.1 T (which can be easily changed for an octupole) that allows to inject R.F. power from 10 to 18 GHz, a modular axial magnetic field as shown in Figure 7.

Don May

From: Sortais <sortais@isn.in2p3.fr>
To: <undisclosed-recipients:;>
Sent: Friday, January 12, 2001 6:51 AM
Subject: Best wishes from SSI/ISN/IN2P3

In^{20+} 3000 nAe for 1300 nAe of In^{1+} injected
so 11.5 % of efficiency (65 % global) with PHOENIX "Booster" 14 GHz



We have started the year 2000 with the first beam of PHOENIX "booster".
This new Millenium brings us a first charge breeding efficiency never attained before with PHOENIX, now working at 14 GHz

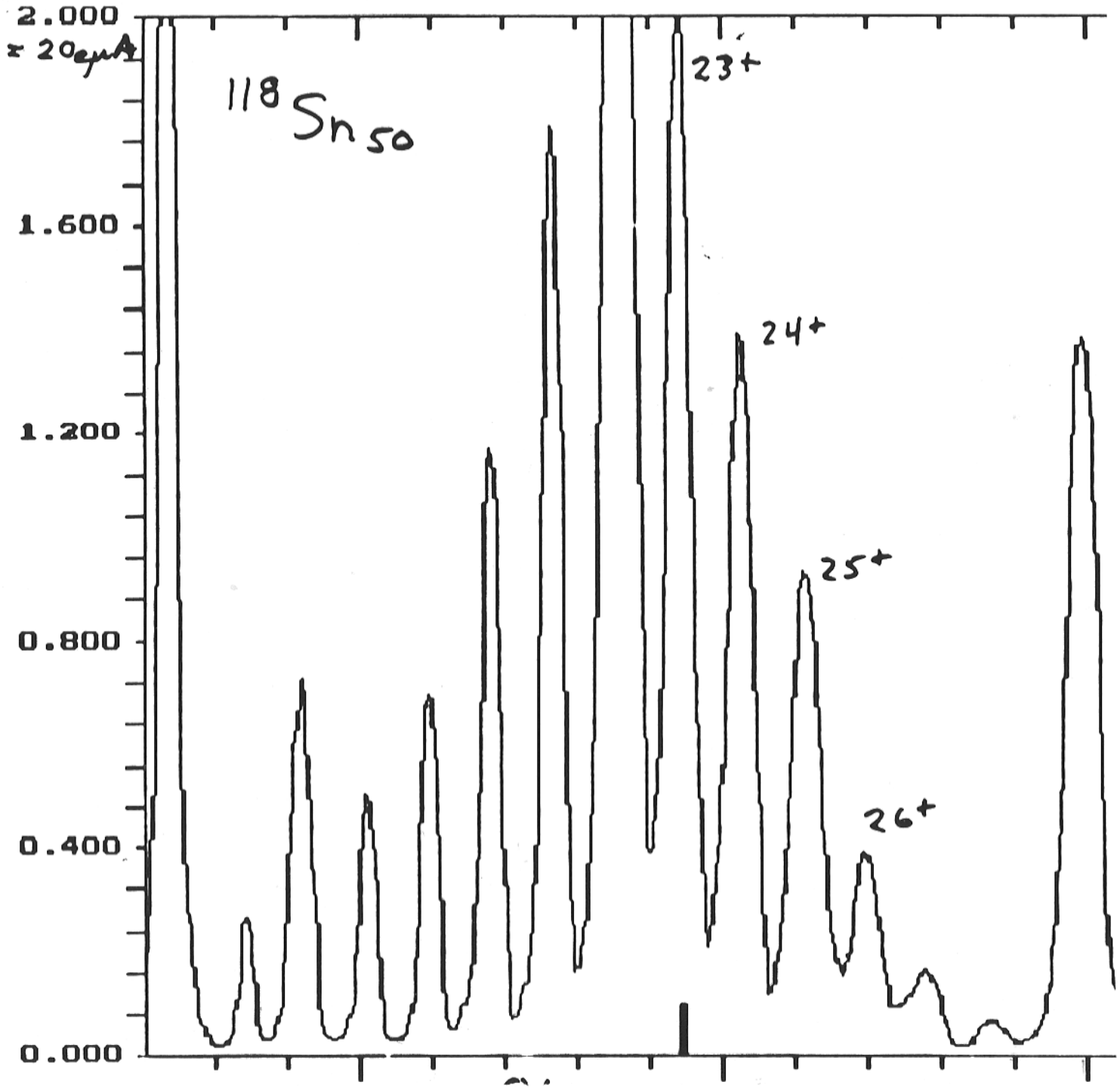
The Ion Source Service from ISN Grenoble is...
... sending you best wishes for happiness in the New Year.

Pascal Sortais, Jean-Luc Bouly, Jean-Claude Curdy,
Richard Geller, Ana Lacoste, Thierry Lamy, Marie-Louise Lombard
Patrick Sole, Thomas Thuillier, Jean- Louis Vieux-Rochaz

Service des Sources d'Ions (SSI)
Institut des Sciences Nucléaires de Grenoble
CNRS-IN2P3 / Université Joseph Fourier

Texas A&M 6.4 GHz ECRI source

eta	1.000
	10.3 kV
0	34.400
1	0.000
2	1.030
3	0.000
0 rng	2(-3) Amp
0 sel	001
1 rng	2(-3) Amp
1 sel	002
cn st	0.04000 Q/M
cn sp	0.54000 Q/M
xp st	0.12000 Q/M
xp sp	0.27000 Q/M
rs loc	0.19450 Q/M
rs cur	1.930 crg
rs lev	0
90 p/s	ALPHA p/s
90	78.0 amps
sol	86.7 amps
cr cur	0.000 crg
CAN	YES
RAW	NO
ARK	NO
EXPAND	YES
oil_A	555 amps
oil_B	475 amps
oil_C	287 amps
oil_D	218 amps
oil_E	0 amps
oil_F	346 amps
oil_G	334 amps
oil_H	467 amps
oil_I	481 amps
XTRv	9.96 kV
XTRc	1.78 mA
LI601	3.2E-07
LI602	1.6E-07
10:43	10-03-1997



Comparisons

	Freq.	ID	Hex length
Minimafios	10 GHz	5.3 cm	26 cm
Phoenix	14-18 GHz	6.2 cm	27 cm
TAMU ECR1	6.4 GHz	13.2 cm	57 cm
TAMU ECR2	14-6.4 GHz	13.0 cm	57 cm

The 1^+-n^+ Project – things to do

1. Assemble new ECR1 beamline and move ECR1 (Glaser lens, 1:1 focus).

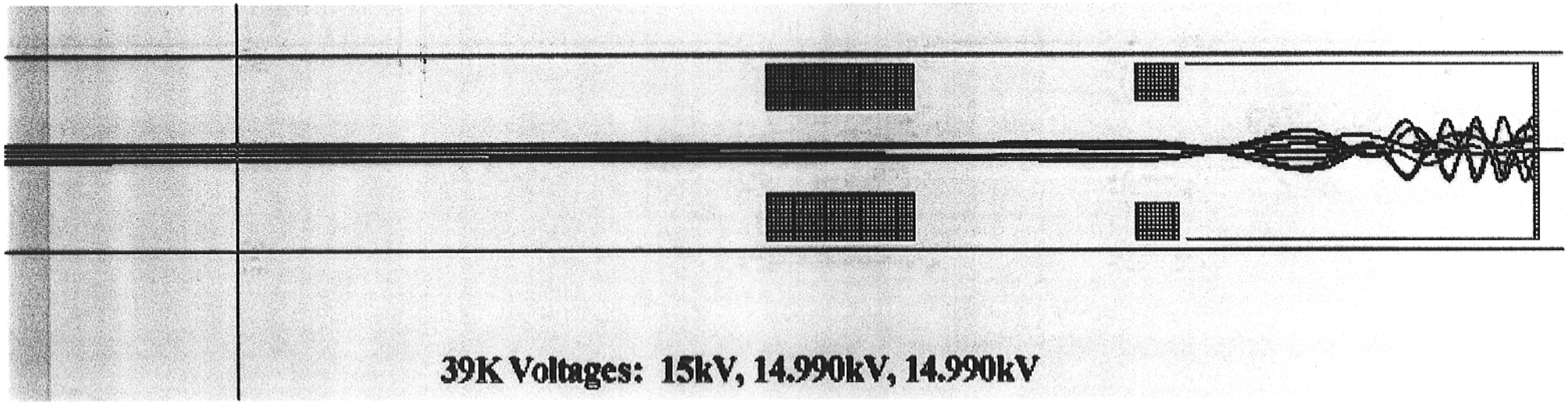
2. Fabricate new steel end plug for ECR1 and 1^+ beam-line.

3. Perform experiments with ECR1.

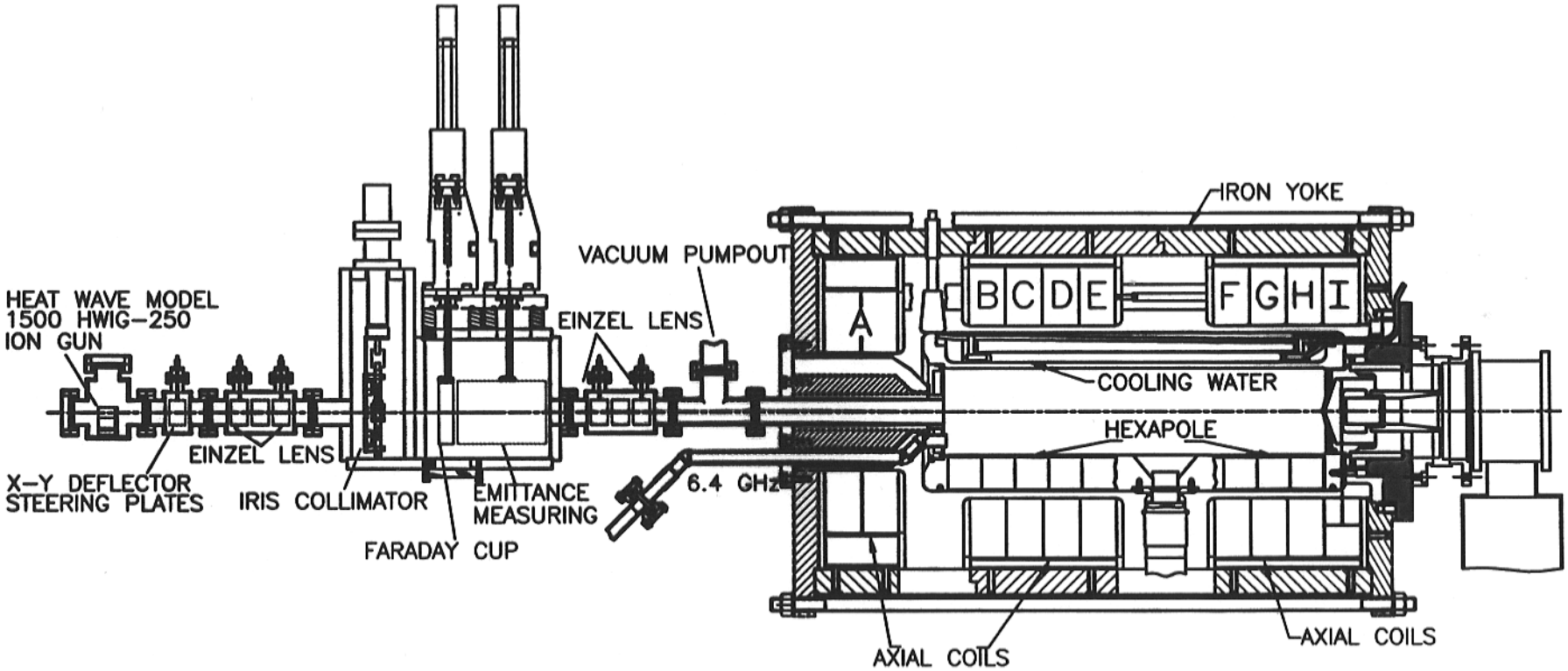
4. Fabricate new plug for ECR2 (14.5 GHz) and perform experiments.

5. Add second frequency to ECR2 (~ 10 GHz) and compare.

6. Design and build ECR ion source specifically for charge multiplication (SBIR project?).



39K Voltages: 15kV, 14.990kV, 14.990kV



LONGITUDINAL CROSS SECTION THRU TAMU ECR 1 ION SOURCE IN $1^+ - n^+$ CONFIGURATION

Questions to answer:

I. What is the efficiency of conversion to n^+?

II. How does the dispersion, the emittance and the species of the 1^+ beam affect the efficiency?

III. What maximum n^+ can be expected?

IV. What is the hold-up time in the ECR to get n^+?

V. Do microwave frequency, chamber size, etc. matter?