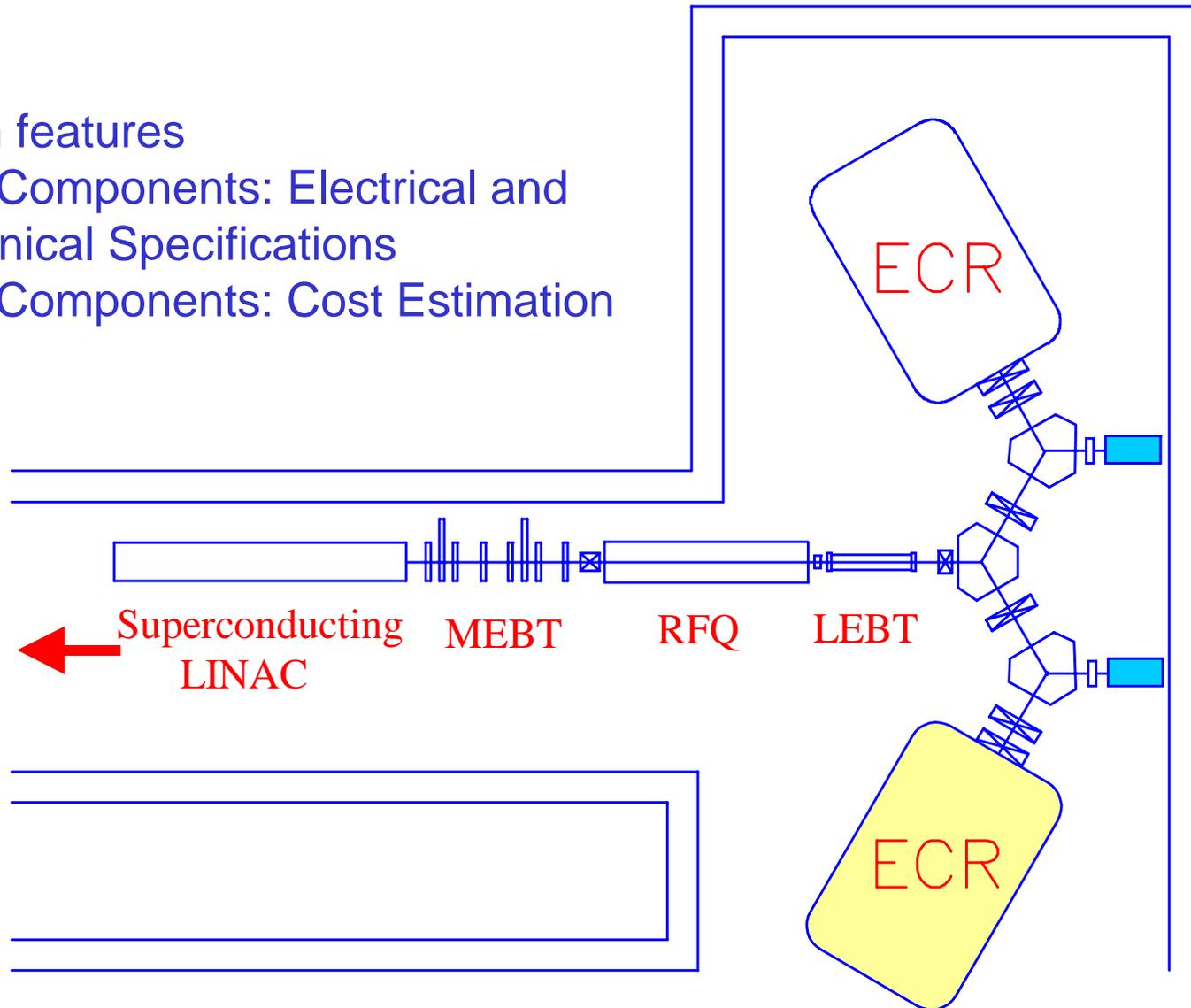

RIA Driver Front End

P.N. Ostroumov, ANL

10-11 January 2001

Front End

- ❑ Design features
- ❑ List of Components: Electrical and Mechanical Specifications
- ❑ List of Components: Cost Estimation

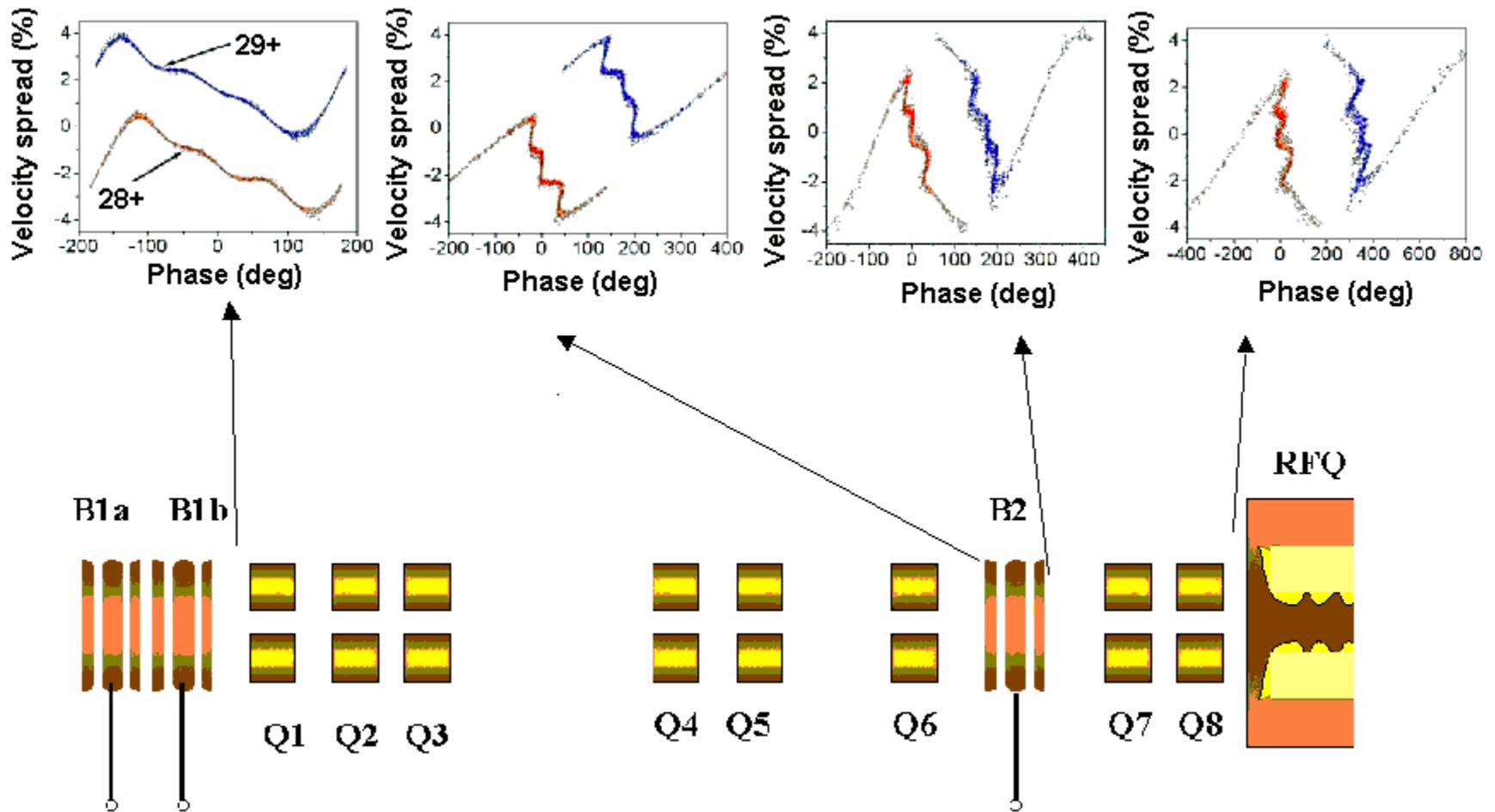


A	I_{ECR} pμA	I_{out} pμA	W_{out} MeV/u	P kW
1	556*	445	900	400
3	232 *	186	720	400
2	416 *	333	600	400
18	54 *	40	550	400
40	29 *	18	550	400
86	15†	9	515	390
136	12 †	6	480	390
238	3†‡	1.6	400	152

* Limited by RF Power in Linac, † Limited by ECR source

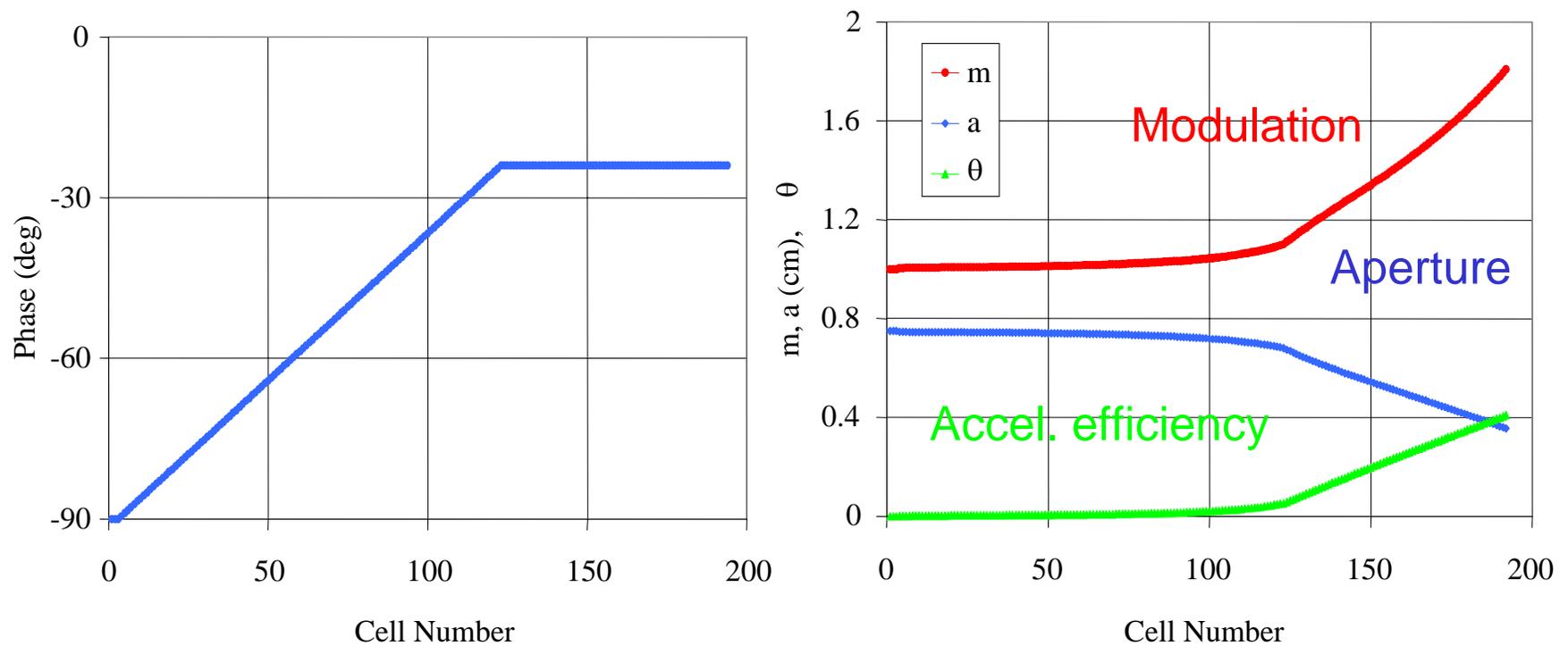
‡ Two charge states

Longitudinal phase space plots of two-charge state uranium beam along the LEBT

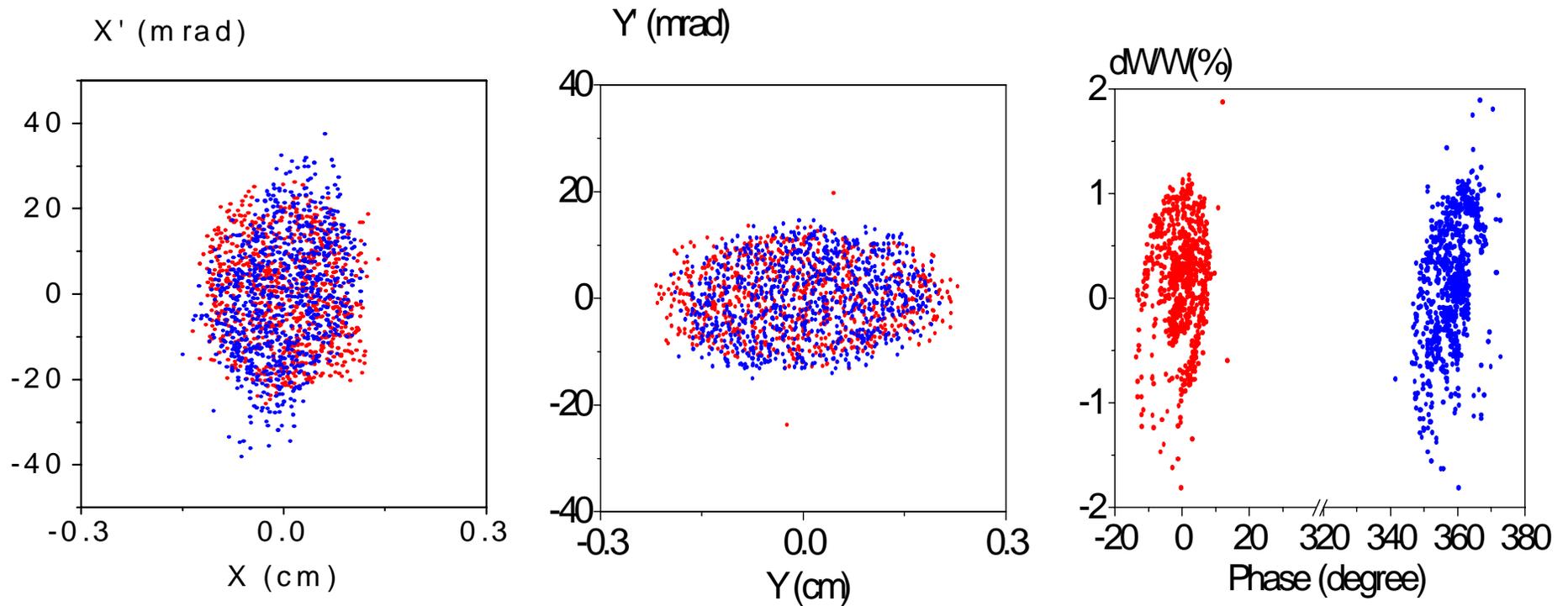


Ion	U^{28+} , U^{29+}
Frequency	57.5 MHz
Design q	28.5
Input energy	12.4 keV/u
Output energy	168 keV/u
Inter-vane voltage	9 kV for protons 75 kV for uranium
Mean radius, R_0	7.5 mm
Required RF power	0.9 kW - 60 kW
Synchronous phase	$-90^\circ/-24^\circ$
Modulation, max	1.7
Focusing parameter, B	5.0
Length	4.0 m
Transmission	83% (each charge state)
Transverse rms emittance, normalized	$0.14 \pi \cdot \text{mm} \cdot \text{mrad}$
Output longitudinal rms emittance	$0.15 \pi \cdot \text{keV/u} \cdot \text{nsec}$
Output longitudinal total emittance (100% of particles)	$1.5 \pi \cdot \text{keV/u} \cdot \text{nsec}$

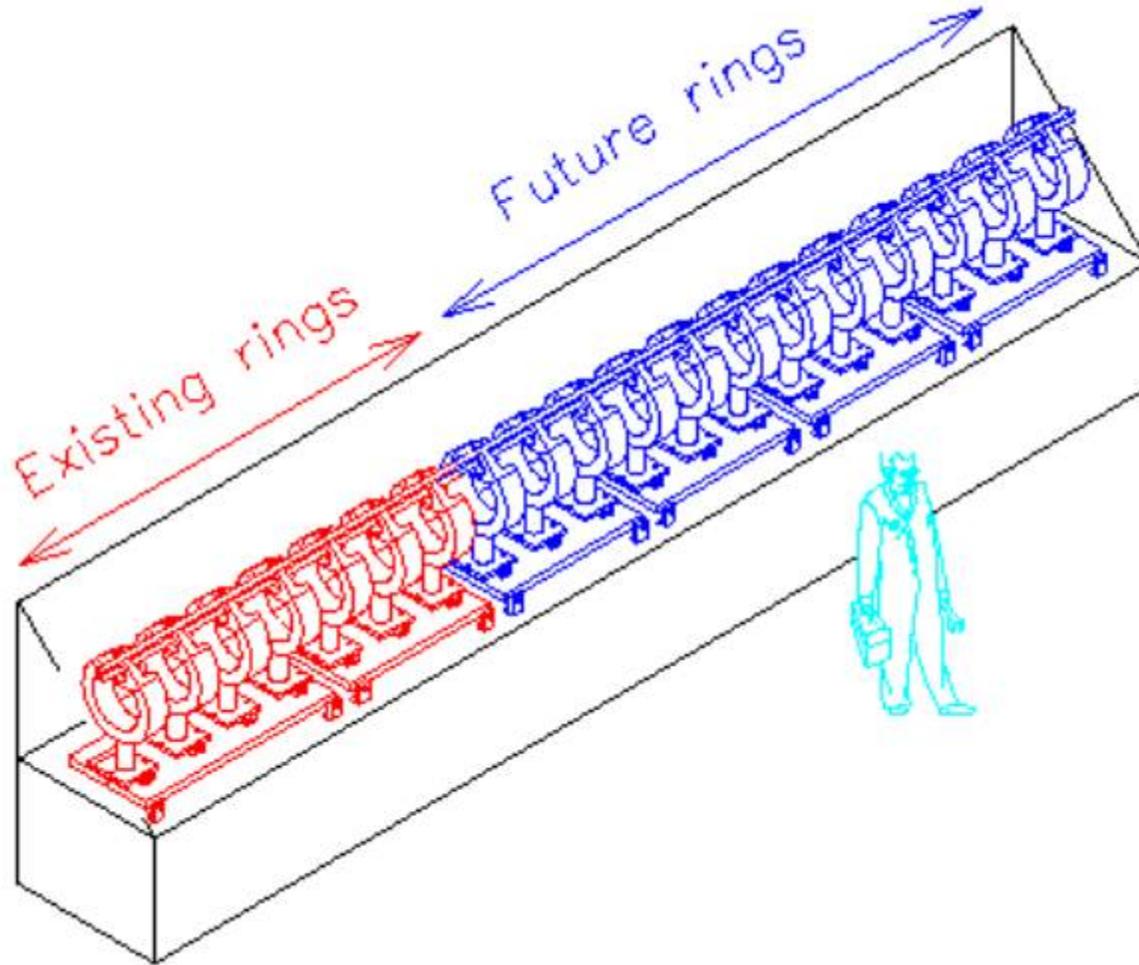
RFQ parameters as a function of cell number
Reference design to obtain low longitudinal
emittance



Phase space plots of two-charge state
uranium beam at the exit of RFQ
 $W=168$ keV/u



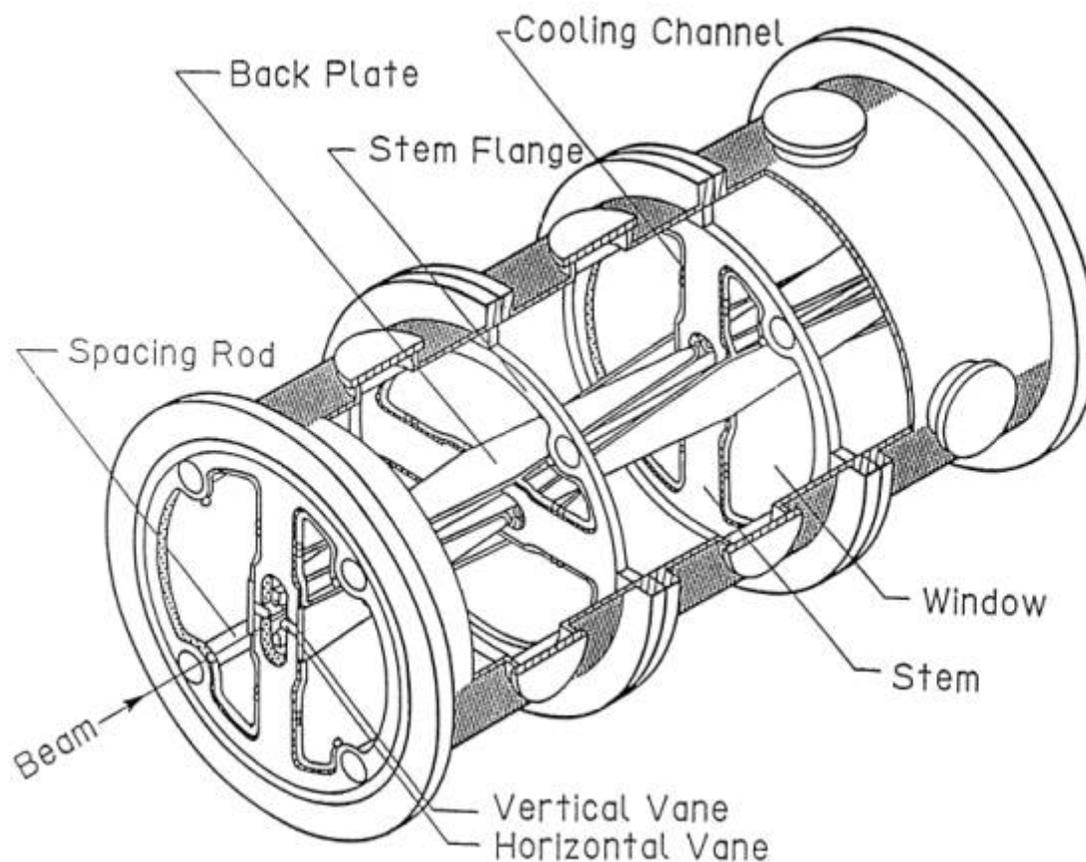
RFQ cost estimation is based on
TRIUMF split-ring RFQ, $f=35$ MHz



TRIUMF split-ring RFQ, $f=35$ MHz



Split-coaxial RFQ. INS (Tokyo) $f=25.5$ MHz



Best candidate for RIA Driver RFQ

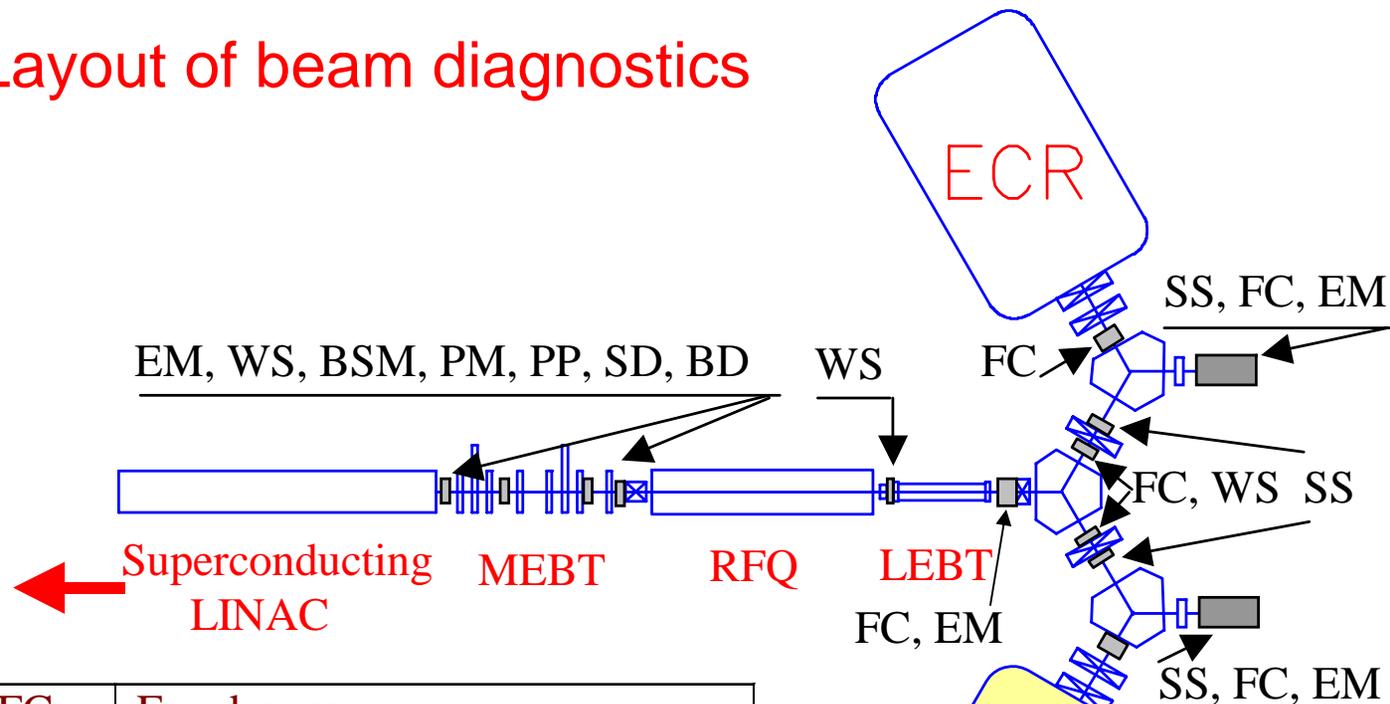
Component List

Element	Characteristic	QTY
ECR-1	Heavy ions (new)	1
ECR-2	Light ions (existing)	1
HV Platform	~200 kV	2
LEBT		
2×60° Dipole	$B \approx 0.4 \text{ T}, \rho = 0.6 \text{ m}$	3
RT Solenoid	0.8 T	2
Magnetic quad	Large aperture	3
Electrostatic quads	$ V < 8 \text{ kV}$	8
Four-harmonic buncher	$V_{\text{eff } 1,2,3,4} < 1.5 \text{ kV} \quad f=28.75 \text{ MHz}$	1
Buncher #2	$V_{\text{eff}} < 5 \text{ kV} \quad f=28.75 \text{ MHz}$	1
SC Solenoid	$B=2.5 \text{ T}, L_{\text{eff}}=10 \text{ cm}$	1

MEBT		QTY
Electromagnetic quad	$G=60.0 \text{ T/m}$ $\phi=20 \text{ mm}$	3
SC solenoid	6.0 T	6
Rebuncher	$V_{\text{eff}}=85 \text{ kV}$, $\phi=20 \text{ mm}$, 57.5 MHz	2
Steering el. st. plates H&V	$\pm 5 \text{ kV}$	4
RF chopper	$V_{\text{eff}}=6 \text{ kV}$ $f=28.75 \text{ MHz}$	1

BEAM DIAGNOSTICS	QTY
Movable FC, water cooled	5
Wire scanner	6
Slit-collector emittance monitor	4
Charge selection slits	3
Beam dump	1
Bunch shape monitor	1
Residual gas profile monitor	2
Phase probe	2
Silicon detector	1

Layout of beam diagnostics



FC	Faraday cup
WS	Wire scanner
EM	Slit-collector emittance monitor
SS	Charge selection slits
BD	Beam dump
BSM	Bunch shape monitor
PM	Profile monitor
PP	Phase probe
SD	Silicon Detector

Cost Estimation (without contingency)

List of Institutions and Vendors

- ATLAS (ANL)
- TRIUMF (Vancouver, Canada)
- LBNL
- LLNL
- DANFISIK (Through GMW Associates)
- American Magnetics, INC
- BERGOZ (Through GMW Associates)
- MAGNAVOLT TECHNOLOGIES, INC

Cost Estimation (without contingency)

LEBT systems	QTY	Cost, k\$
2×60° Dipole	3	240
Solenoid	2	40
Magnetic quad	5	200
Electrostatic quads	8	176
Buncher #1	1	60
Buncher #2,	1	40
SC Solenoid	1	55
Vacuum system	1	90
Beamline, girder, alignment	1	120
Total		1021

RFQ	QTY	Cost, k\$
Materials, \$180 K per meter	4.5	810
Water temperature control system	1	200
Man-power, professionals (man-year)	6	1290
Man-power, technicians (man-year)	12	1800
Total		4100
Prototyping (including manpower)	1	800

RFQ materials

- Electrodes
- Electrode support
- Vacuum tank
- Vacuum system
- Tuners
- Coupling loops
- Tank support
- Alignment equipment
- Heaters, thermocouplers

Additional equipment for RIA RFQ

Water temperature control system

MEBT	QTY	Cost, k\$
Electromagnetic quadrupoles	3	90
SC solenoid in individual cryostats	6	330
Rebuncher	2	200
Steering el. st. plates H&V	4	80
RF chopper	1	50
Vacuum	1	80
Girder, alignment (\$15K/meter)	1	75
Total		905

RF Systems	QTY	Cost, k\$
RF amplifiers for LEBT Bunchers. P < 1 kW, 28.75 MHz, 57.5 MHz, 86.25 MHz, 115 MHz	5	200
RFQ rf amplifier, 60 kW, 57.5 MHz	1	354
RF amplifiers for MEBT Bunchers, 10 kW, 57.5 MHz	2	276
RF amplifiers for MEBT Chopper, 1 kW, 28.75 MHz	1	100
Total		930

Diagnostics	QTY	Cost, k\$
Movable FC, water cooled	5	35
Wire scanner (WS)	6	72
Slit-collector emittance device	4	120
Charge selection slits	3	33
Beam dump	1	10
Bunch shape monitor (BSM)	1	80
Residual Gas Profile Monitor	2	64
Phase probe	2	14
Silicon Detector	2	40
Total		468

TOTAL COST (without contingency)

FRONT END	Cost, k\$
ECR-1	3100
ECR-2	Existing
HV Platform	250
LEBT	1021
RFQ	4100
MEBT	905
Subtotal	9376
RF systems	930
Beam Diagnostics	468
Controls	1970
Total	12744
R&D, Prototyping	1800

Other systems	Cost, k\$
Systems Design	1600
ES&H and RCS	655
Project Management	3468
Total	5723
Commissioning (pre-operation)	9918