
TAMUTRAP
THE TEXAS A&M UNIVERSITY SYSTEM
1876

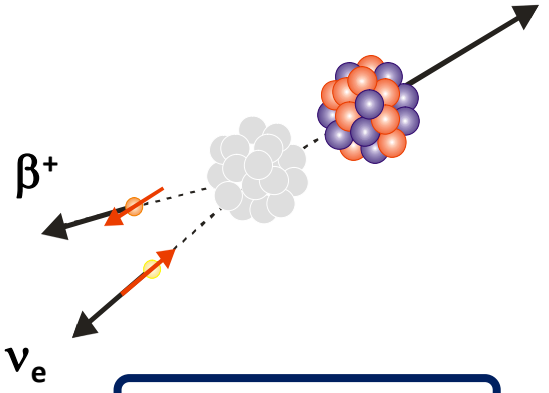
Outline

- Motivation for building a decay trap
- Present status (prototype trap)
- New trap
- To do

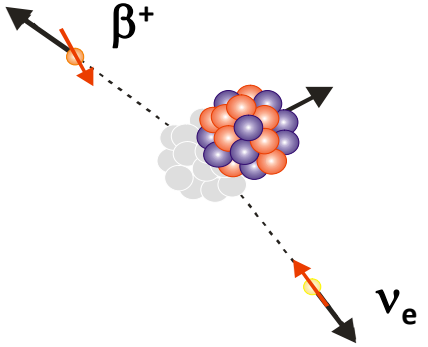
Why we build TAMUTRAP ?

In Standard Model (SM) weak interaction is V-A

Pure Fermi transition



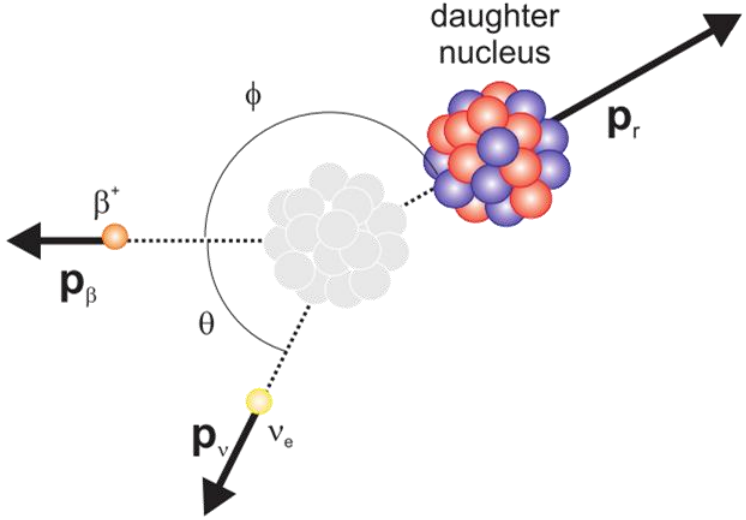
SM Interaction



Non SM Interaction

Correlation parameter

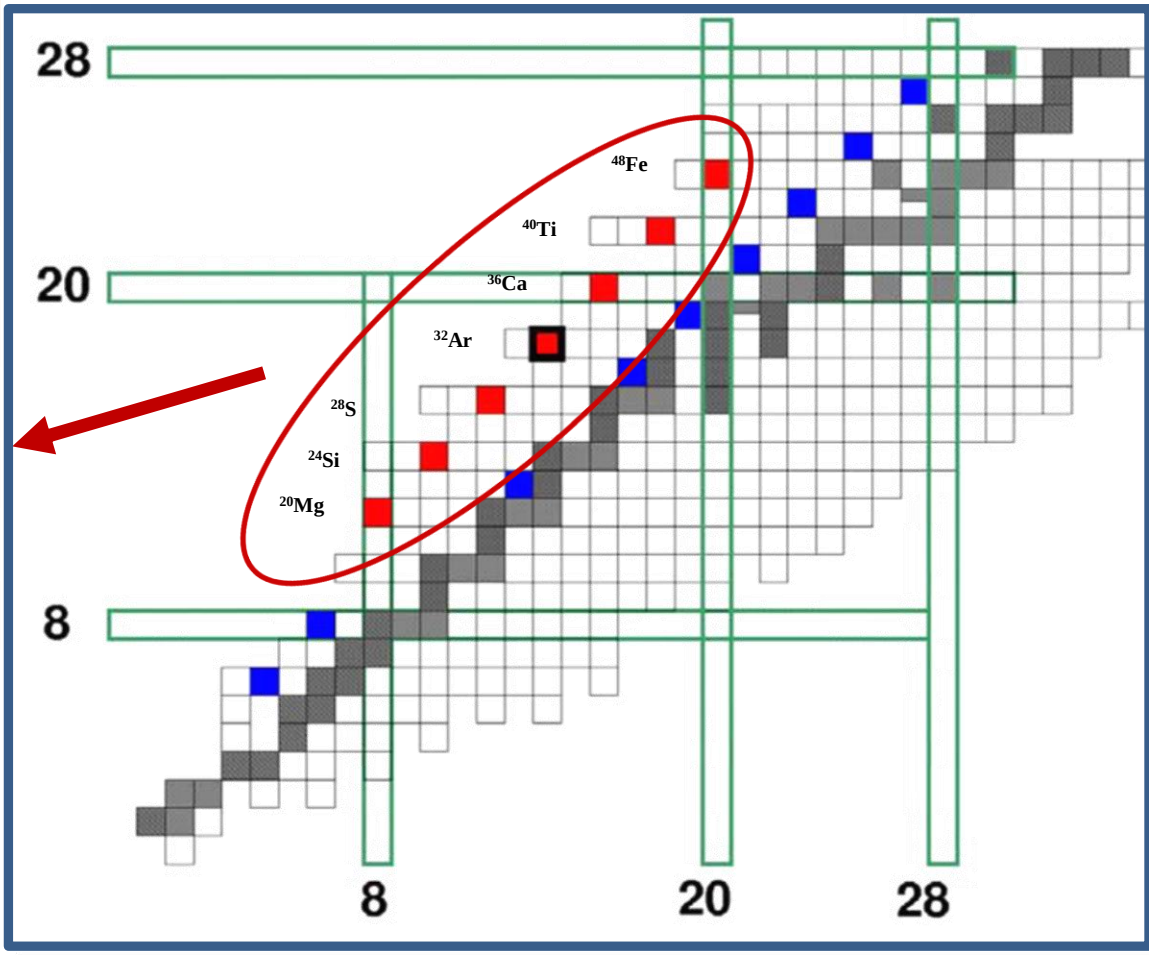
$$W(\theta) \cong \left(1 + a_{\beta\nu} \frac{p_e p_\nu}{E_e E_\nu} \cos\theta_{e\nu} + b \frac{m_e}{E_e} \right)$$

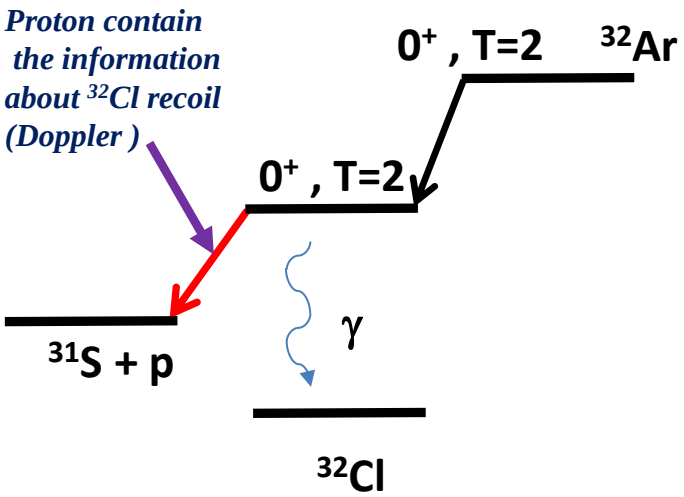


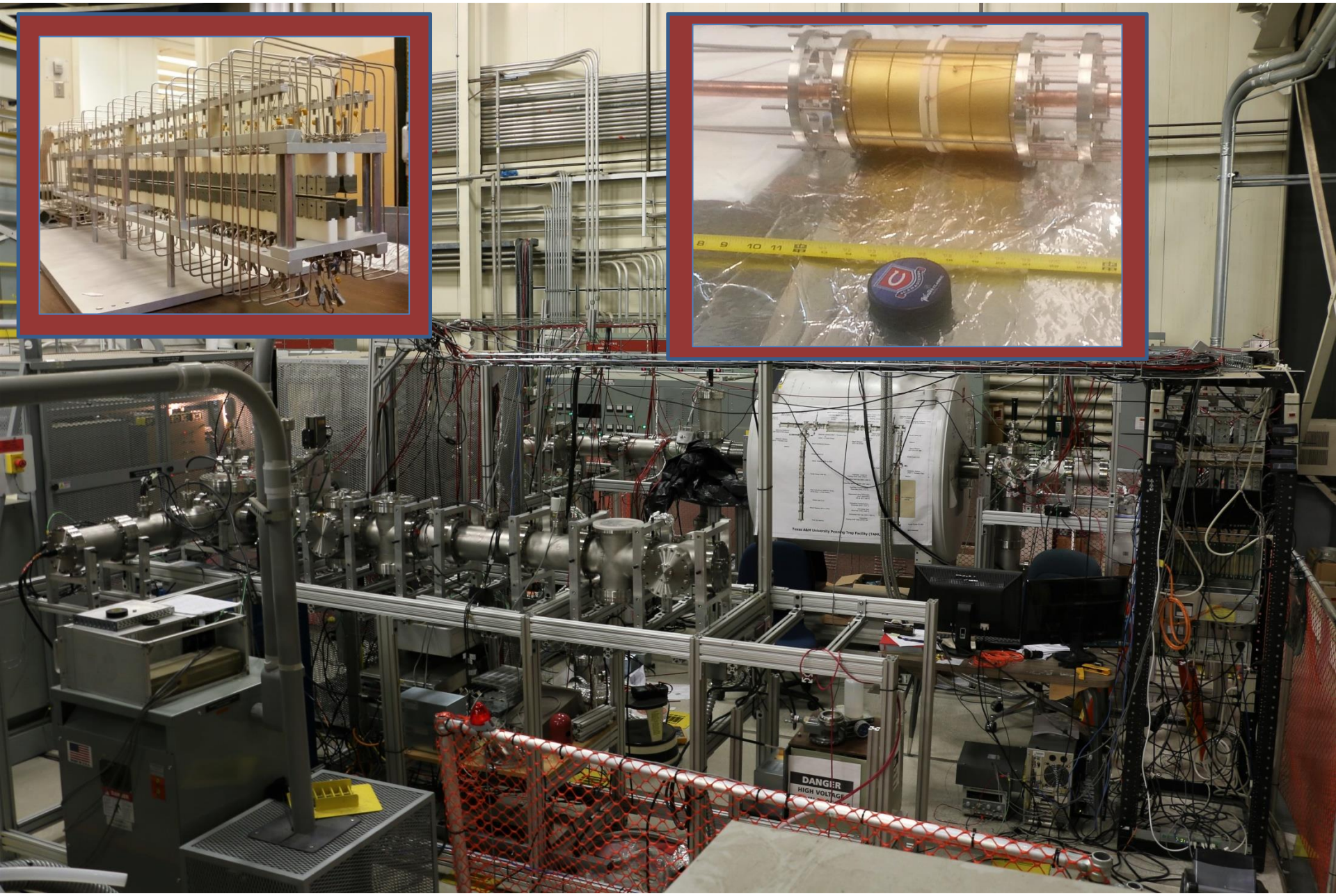
$a_{\beta\nu} \stackrel{?}{=} 1$ ⇒ **Test of SM**

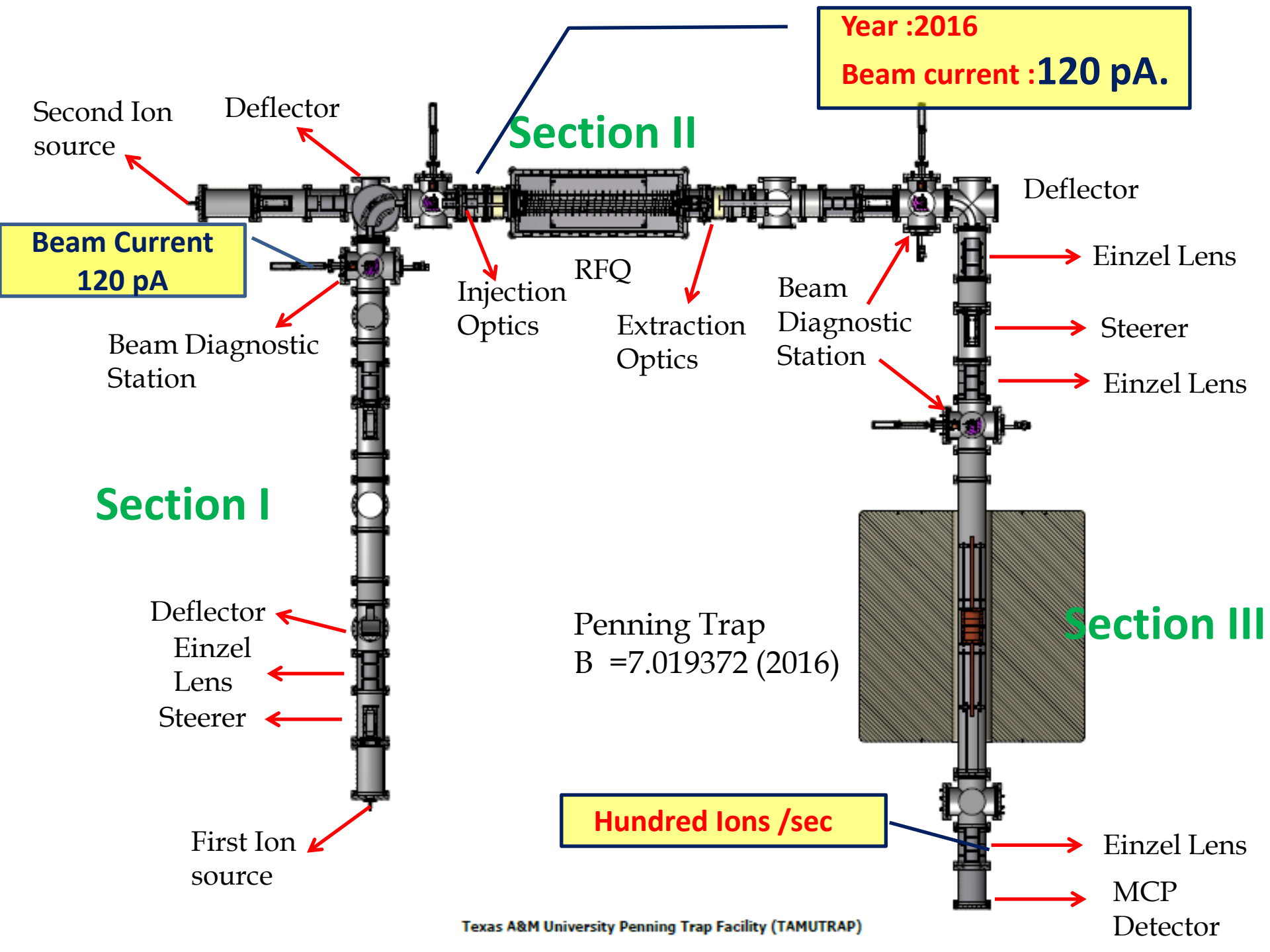
Beta delayed proton emitters

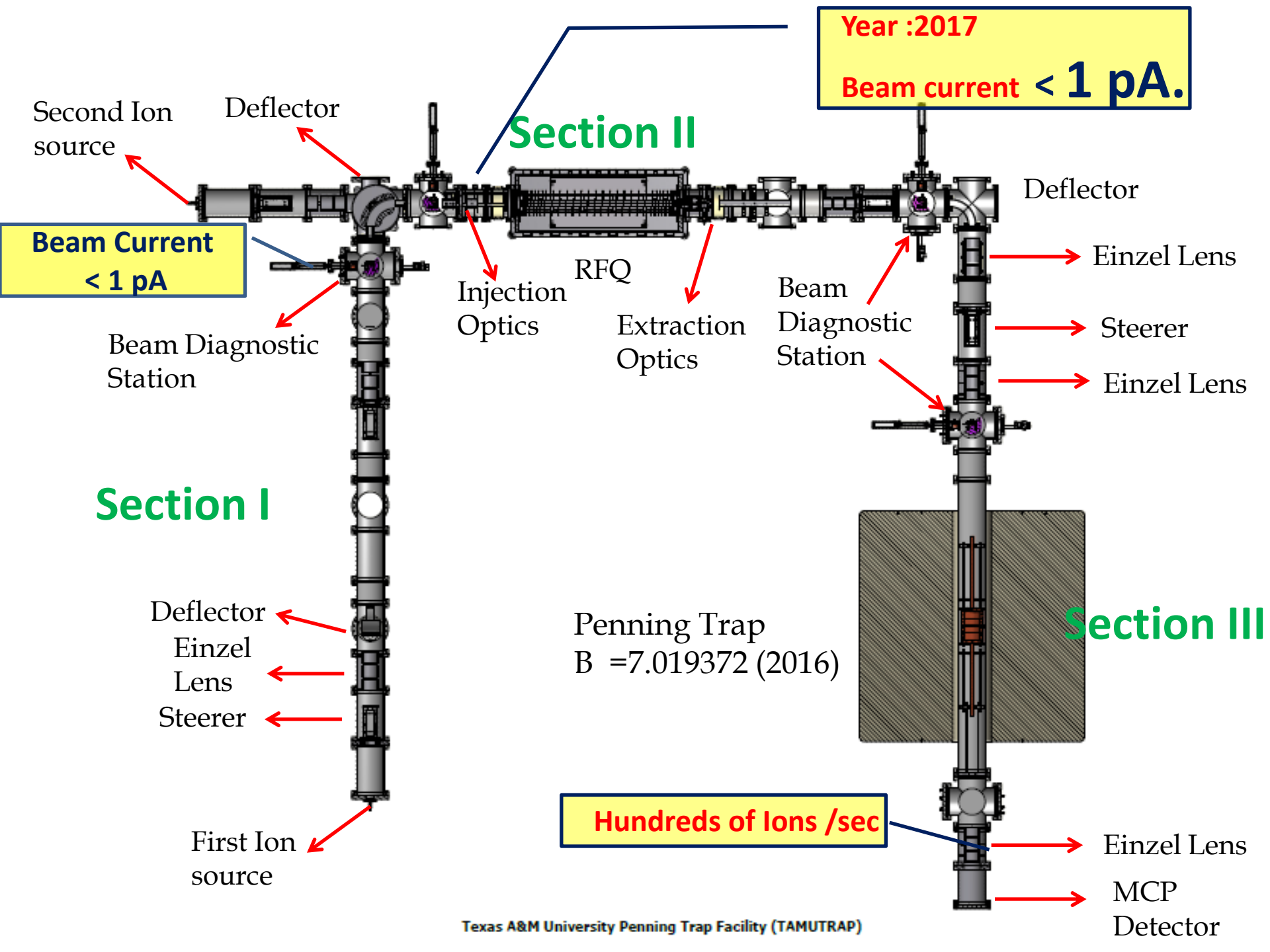
Nuclide	Lifetime (ms)	Proton Energy (MeV)	Larmour radii (mm)
^{20}Mg	137.05	4.28	42.7
^{24}Si	147.15	3.91	40.8
^{28}S	180.33	3.70	39.7
^{32}Ar	141.38	3.36	37.8
^{36}Ca	141.15	2.55	33.0
^{40}Ti	72.13	3.73	39.9
^{48}Fe	63.48	1.23	22.9





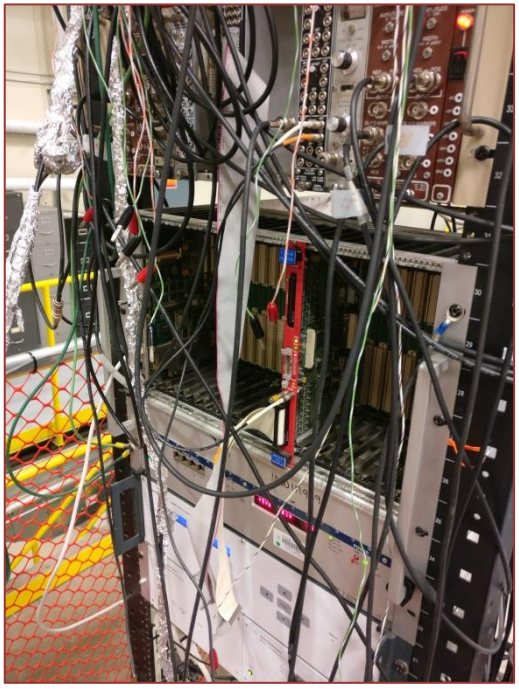

DANGER
HIGH VOLTAGE

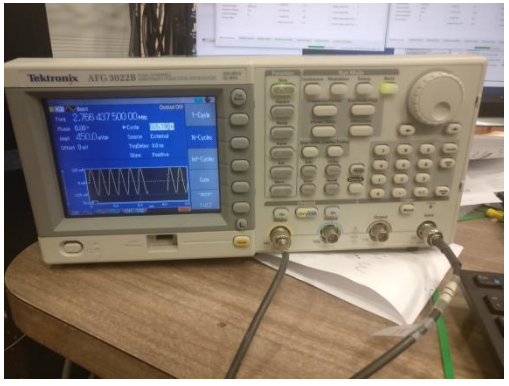

Year :2016
Beam current :120 pA.
Second Ion source
Deflector
Section II
Deflector
Beam Current 120 pA
Einzel Lens
Injection Optics
RFQ
Extraction Optics
Beam Diagnostic Station
Steerer
Beam Diagnostic Station
Einzel Lens
Section I
Deflector
Einzel Lens
Steerer
Penning Trap
B =7.019372 (2016)
Section III
Hundred Ions /sec
Einzel Lens
MCP Detector
First Ion source
Texas A&M University Penning Trap Facility (TAMUTRAP)


Year :2017
Beam current < 1 pA.
Second Ion source
Deflector
Section II
Deflector
Beam Current < 1 pA
Einzel Lens
RFQ
Injection Optics
Extraction Optics
Beam Diagnostic Station
Steerer
Beam Diagnostic Station
Einzel Lens
Section I
Deflector
Einzel Lens
Steerer
Penning Trap
B =7.019372 (2016)
Section III
Hundreds of Ions /sec
Einzel Lens
First Ion source
MCP Detector
Texas A&M University Penning Trap Facility (TAMUTRAP)

Control & Data acquisition:

CAEN 1190B 64 Channel TDC

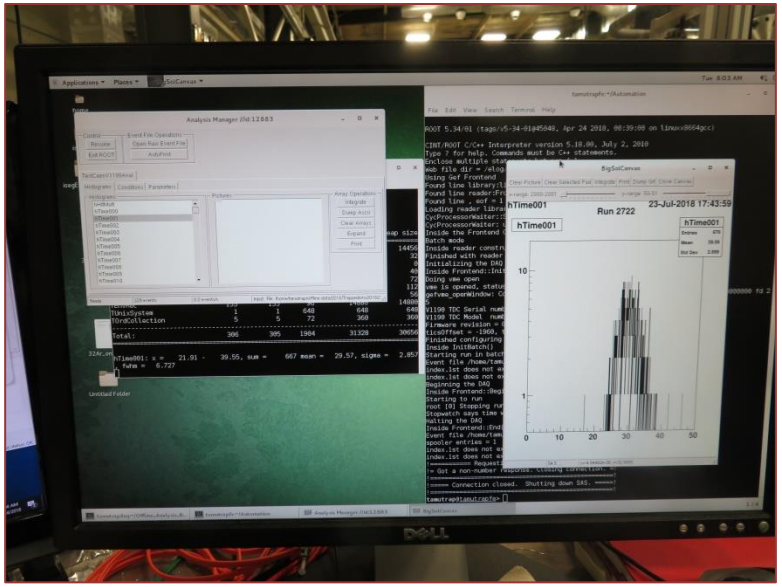




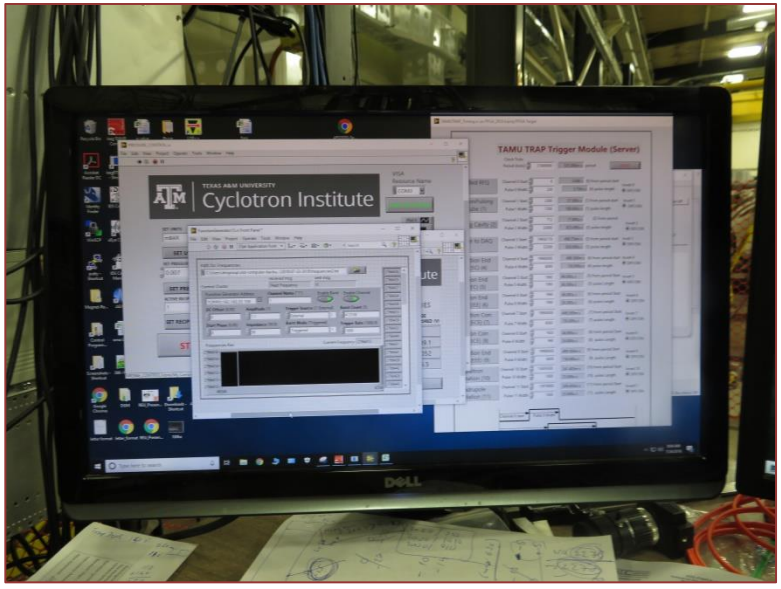
Root talks with FE

Python communicates between Root and RF generator

Root + Python for data acquisition

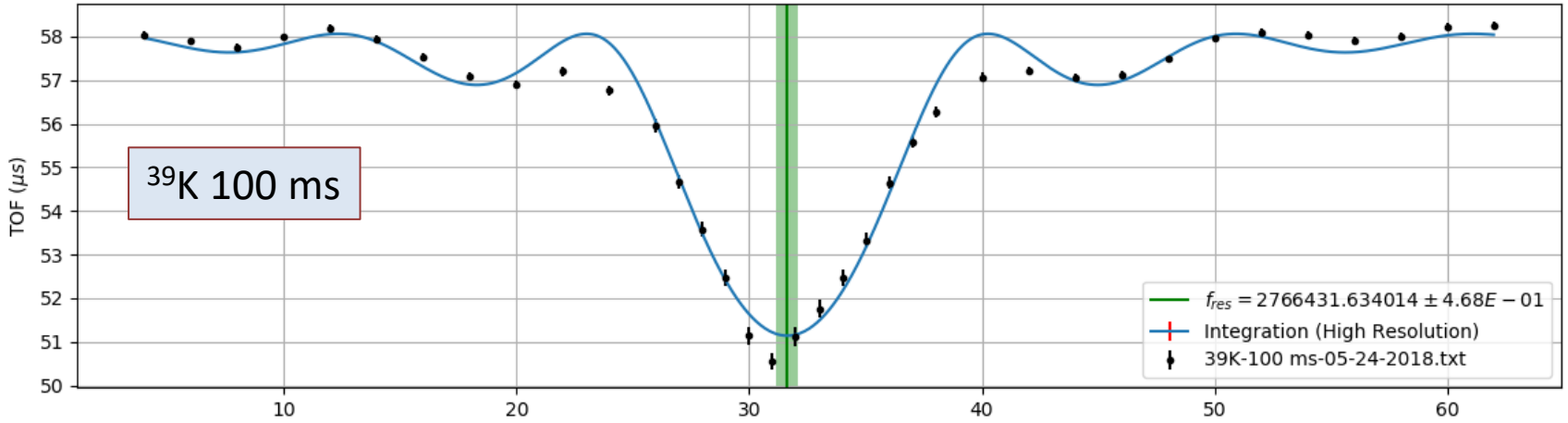


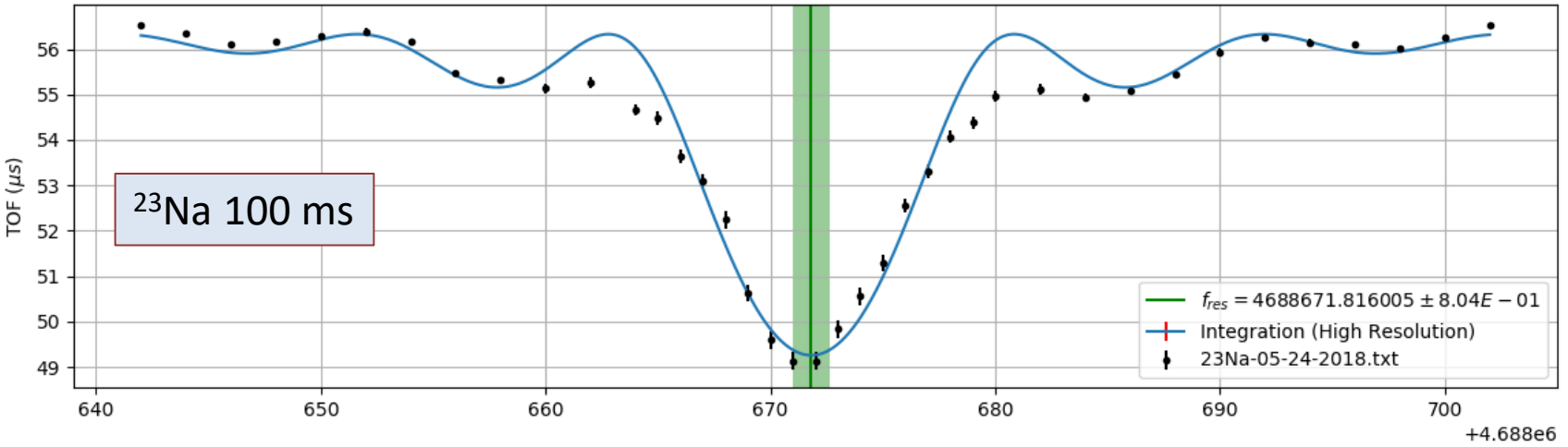
LabVIEW programs for PS control



Python for fitting TOF integral numerically

These resonances are nothing to brag about, but the trap works. The pressure is 1-2*10^{-7} mbar in the trap.



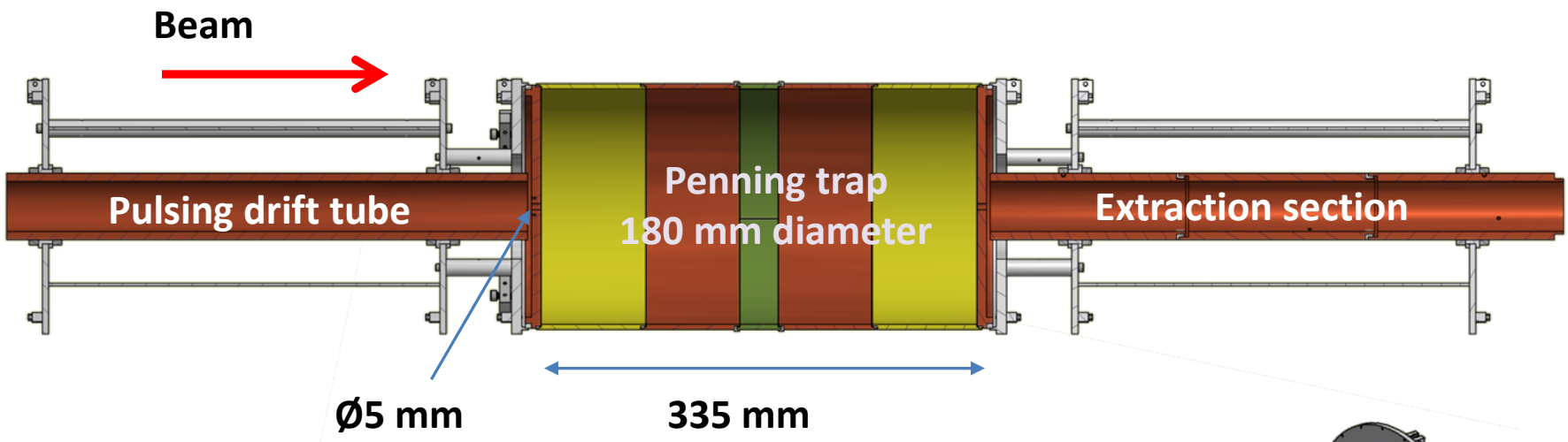


100 ms excitation time

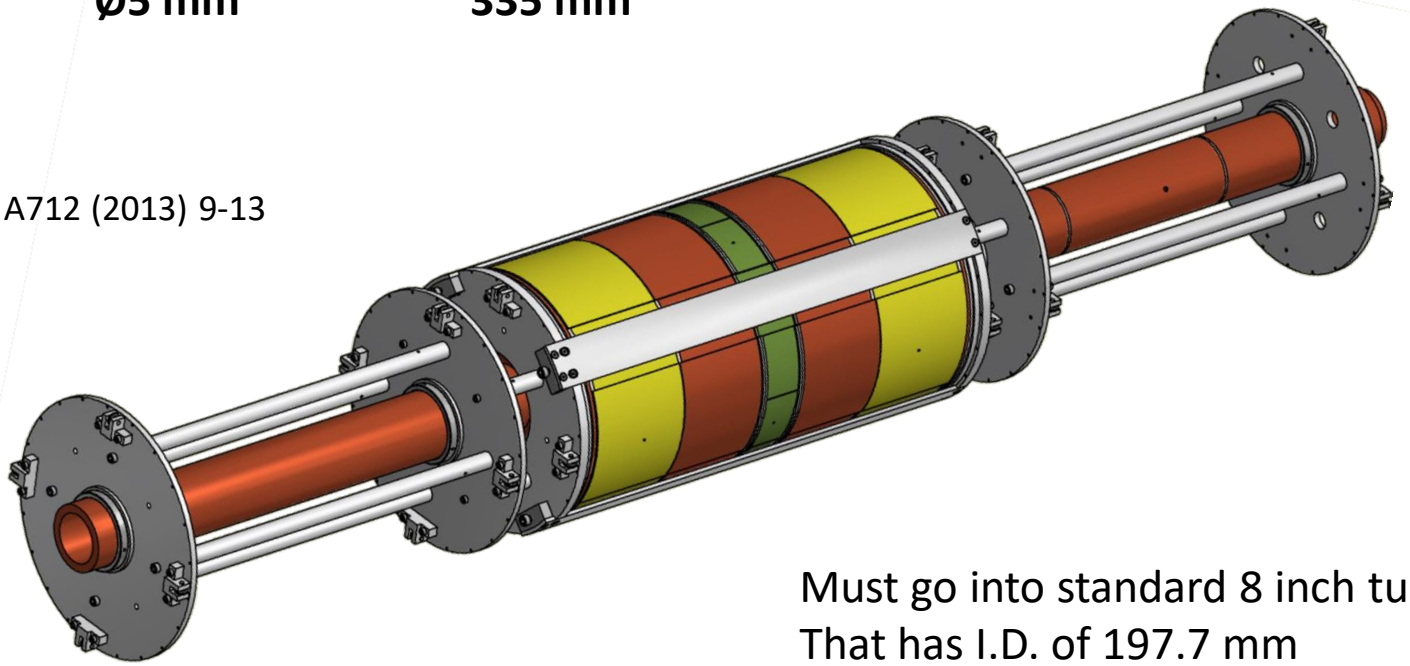
M(23Na)-M(AME)=0.3 +- 3.9 keV

=> Prototype trap works

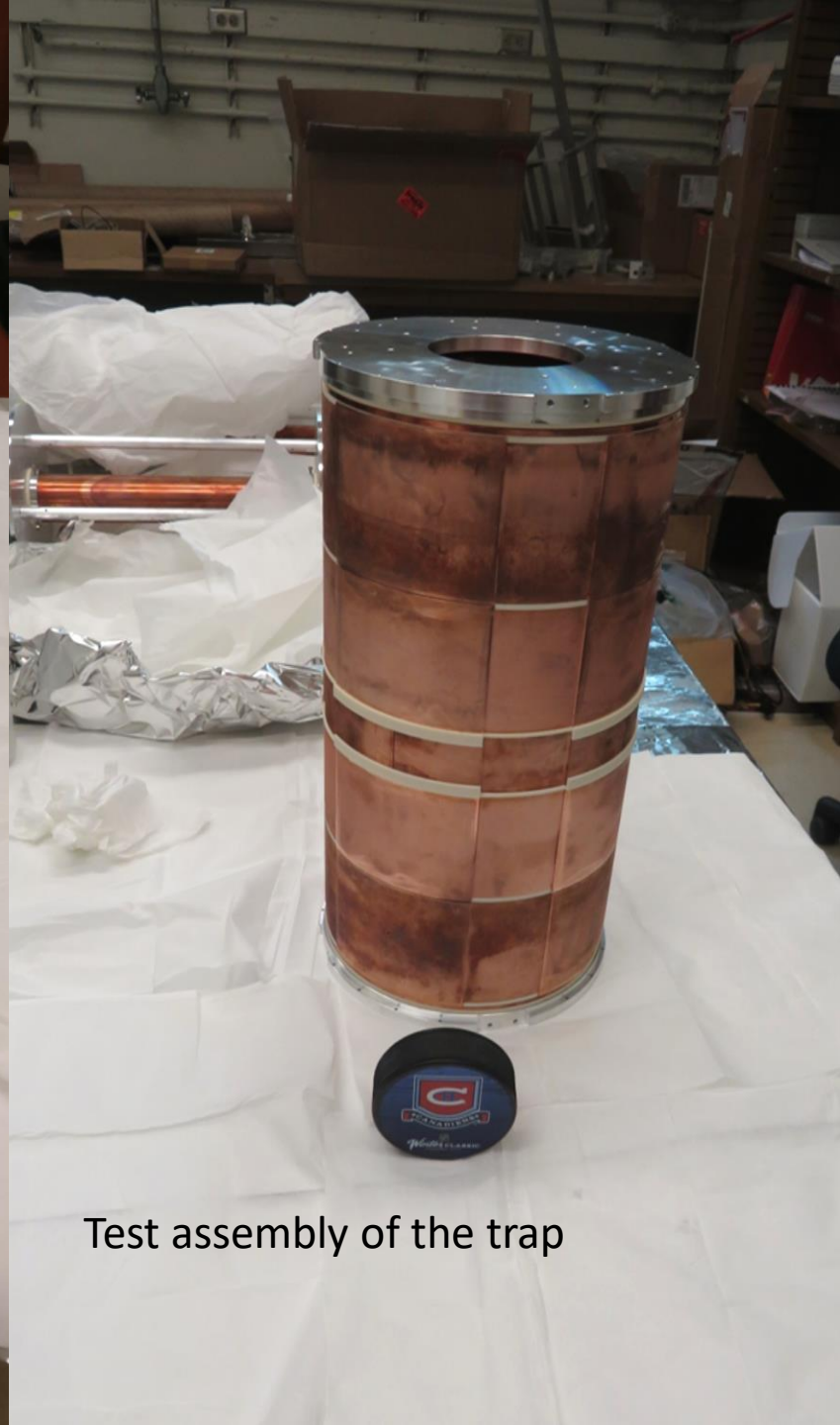
TAMUTRAP Penning trap system (180 mm diameter)



M. Mehlman NIM A712 (2013) 9-13

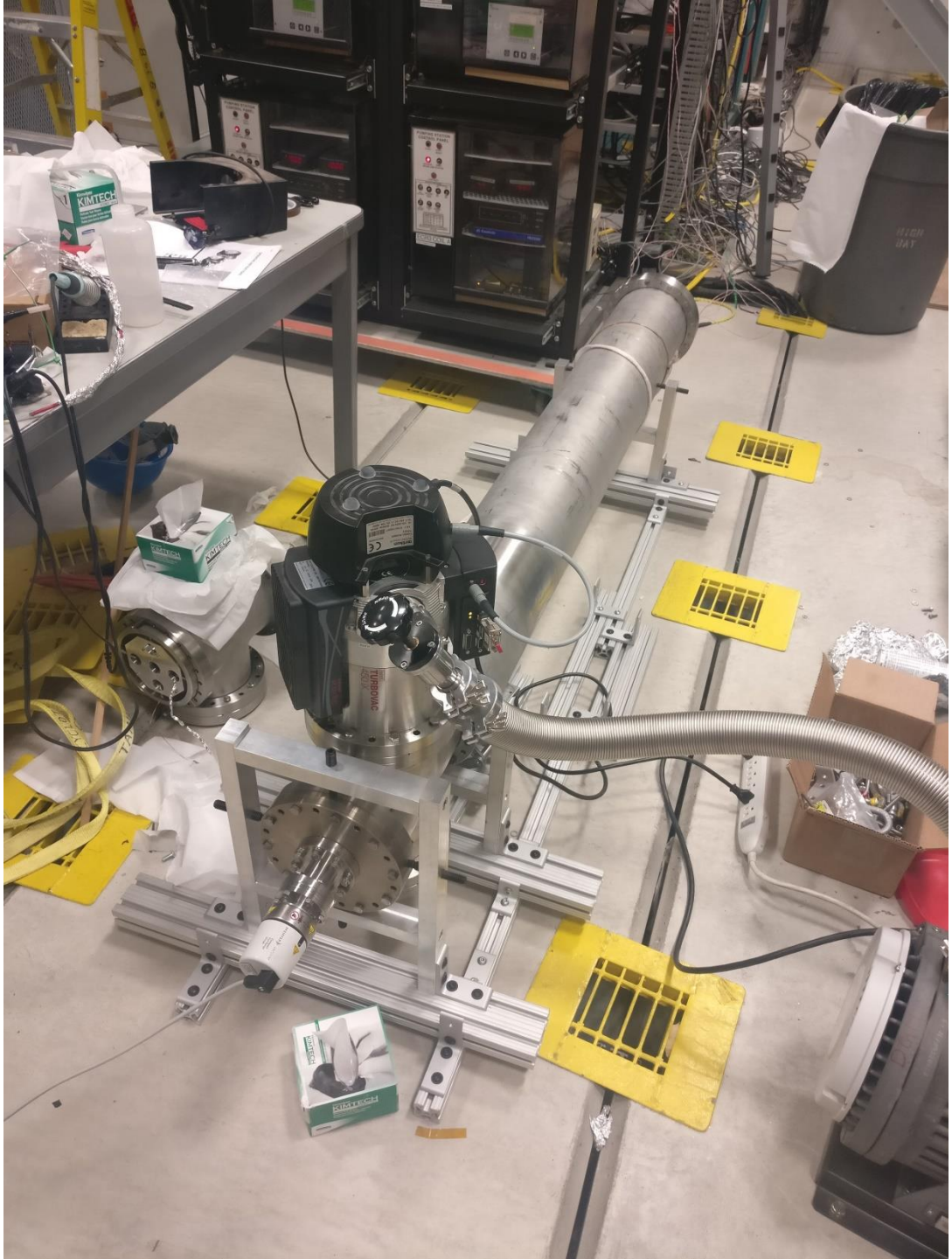


Must go into standard 8 inch tube
That has I.D. of 197.7 mm



Test assembly of the trap

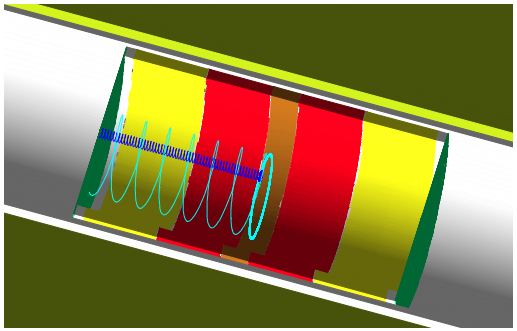
Beam tube vacuum tested

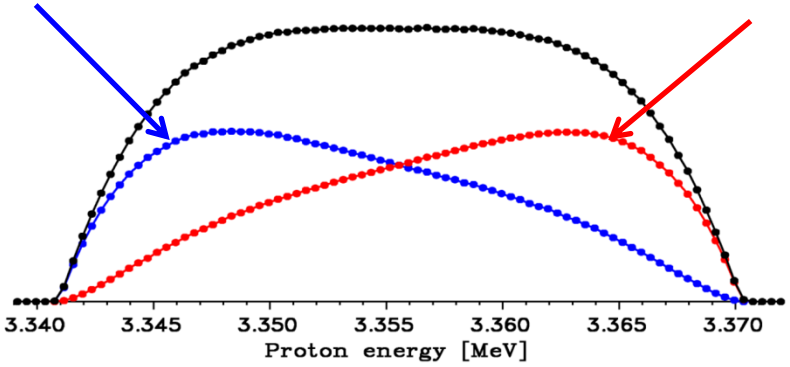


Silicon strip detectors

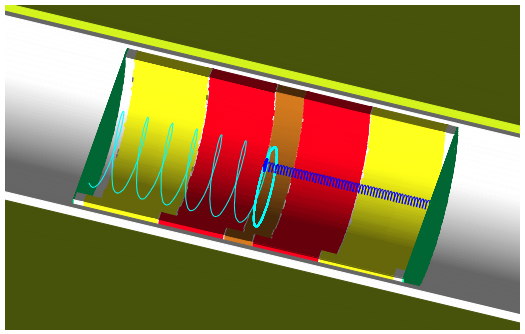
-Will be made of several sectors that have segments radially
-Hole in the center
-500 μm thick or thicker
-Simulations going on
-Discussing with Micron and local group at Texas A&M that can possibly manufacture it

Beta & Proton in same hemisphere





Beta & Proton in different hemisphere



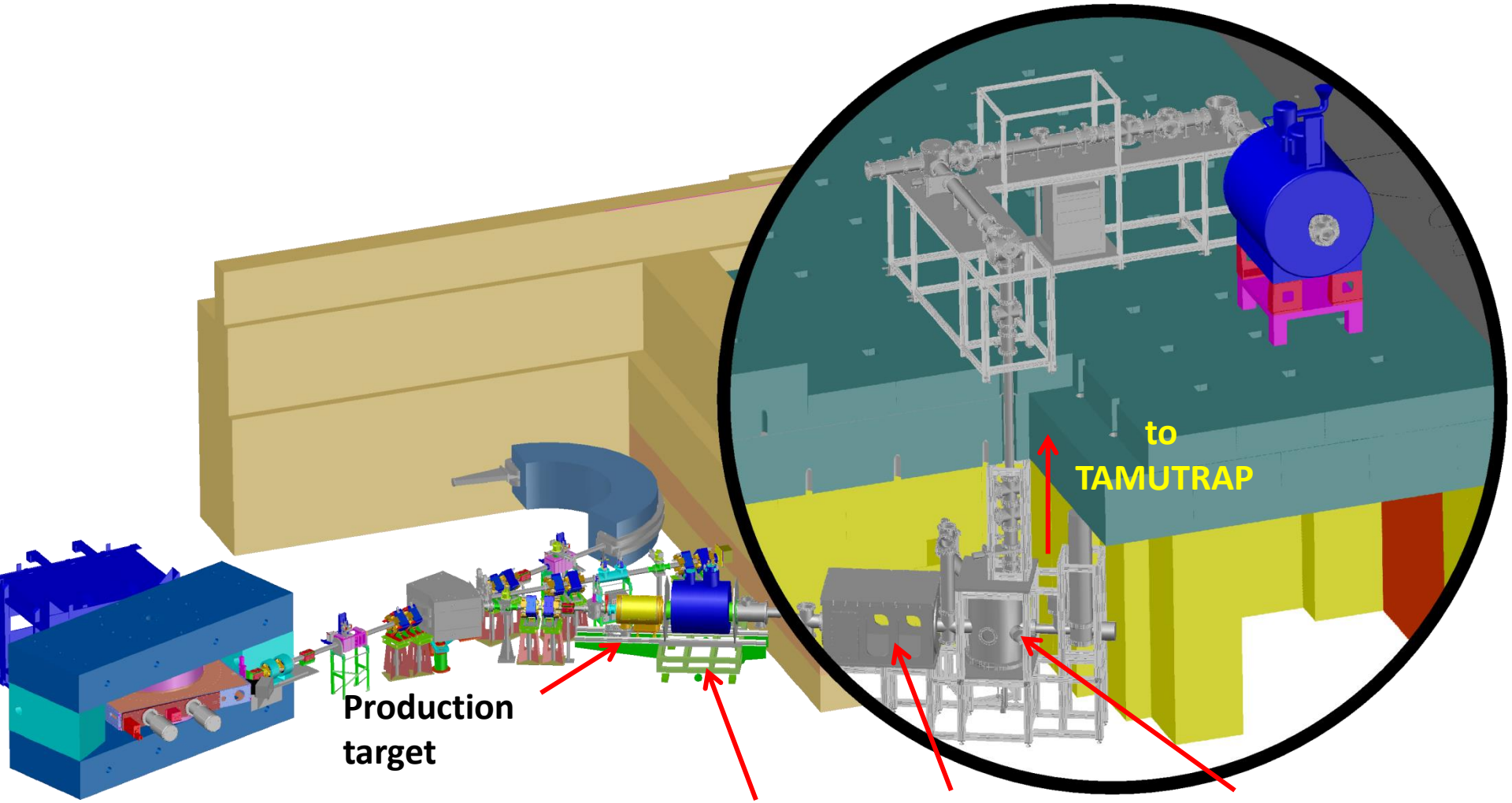
To do list

August 2018:
-Gold coating of electrodes
-Install gate valve between RFQ and magnet/Penning trap
-Replace Viton rings with copper gaskets
-Alignment of the RFQ section

September-December 2018:
-Impedance matching for RFQ
-Bake the beam tube
-Final assembly of the trap
-Beam tube into the magnet
-Trap into the tube
-Beam transport test
-Trapping tests
-Excitations

2019:
-Modify trap that silicon strip detectors can be mounted
-Electronics for detectors

Coupling of T-REX to TAMUTRAP facility 2020

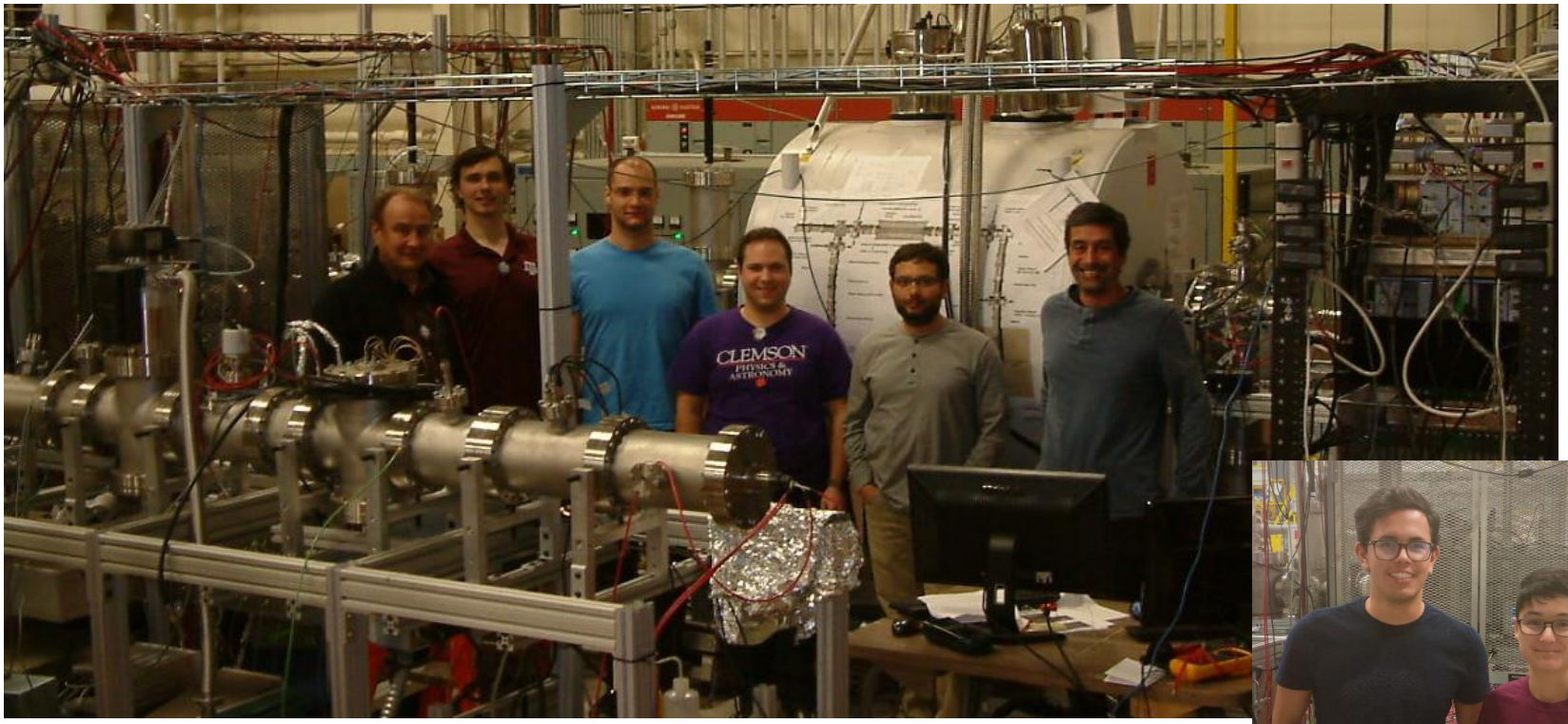


BigSol, Separator; Gas-catcher; multi-RFQ

Or

Light Ion Guide; 90^0 bending magnet (purification)

THE BOYS and THE REU STUDENTS



THANK YOU

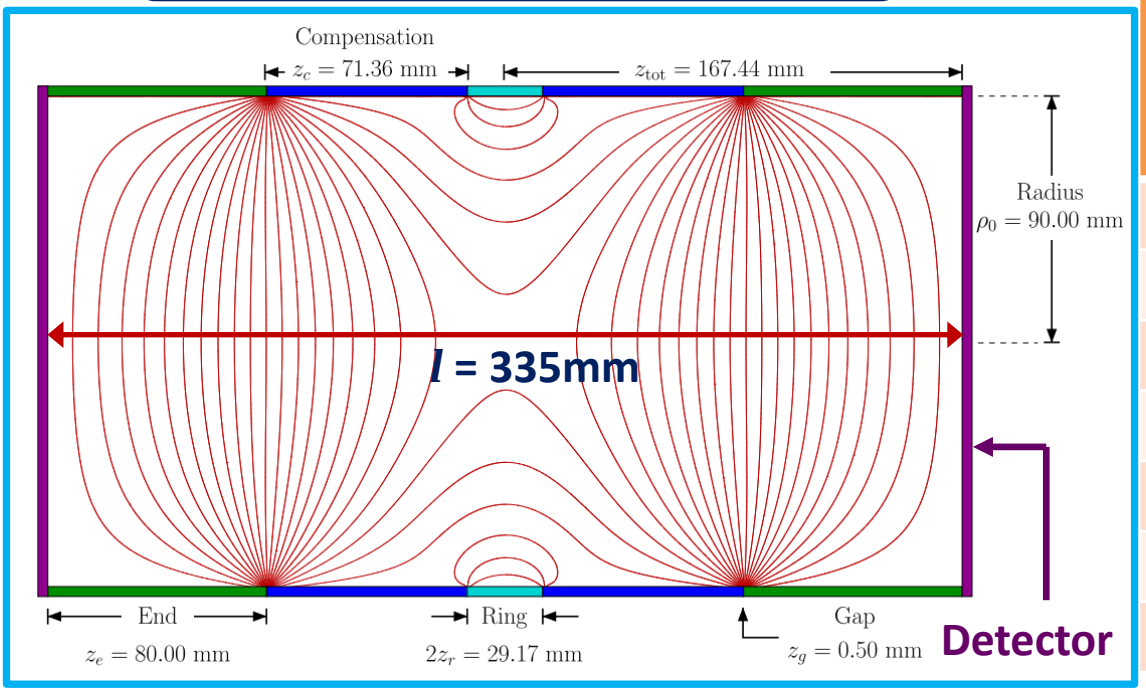
ACKNOWLEDGEMETS:

U.S. Department of Energy Grant
No. DE-FG02-93ER40773

Extras

TAMUTRAP: Penning Trap

Cylindrical Penning Trap



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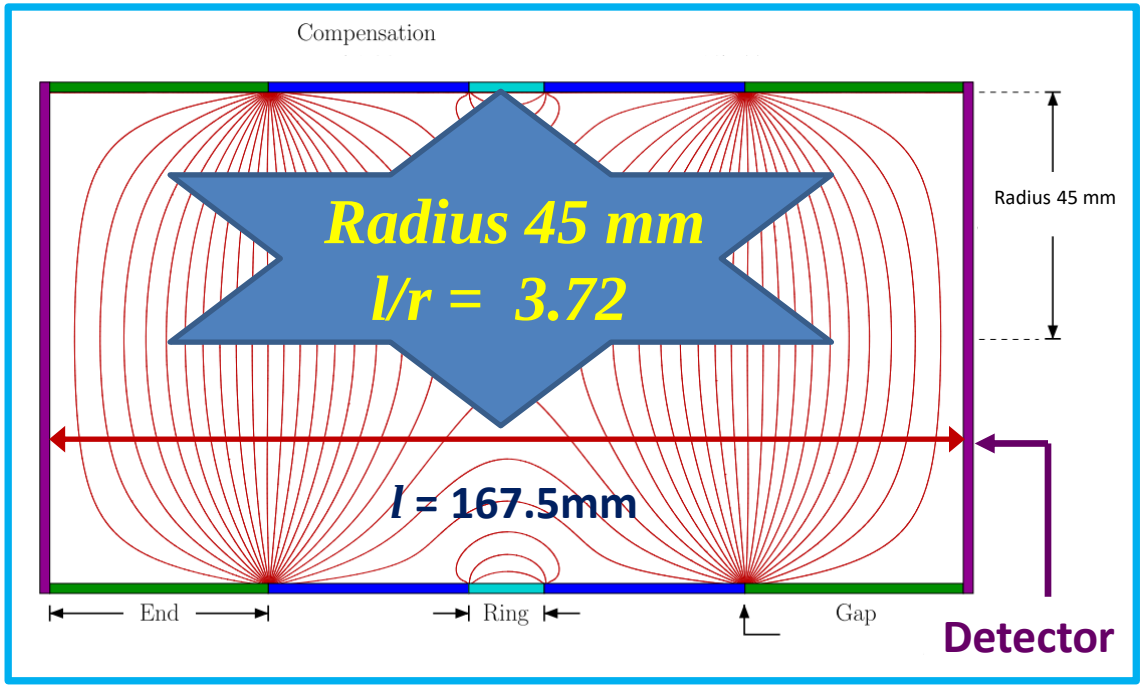
*M. Mehlman et al. NIMA **712** (2013) 9*

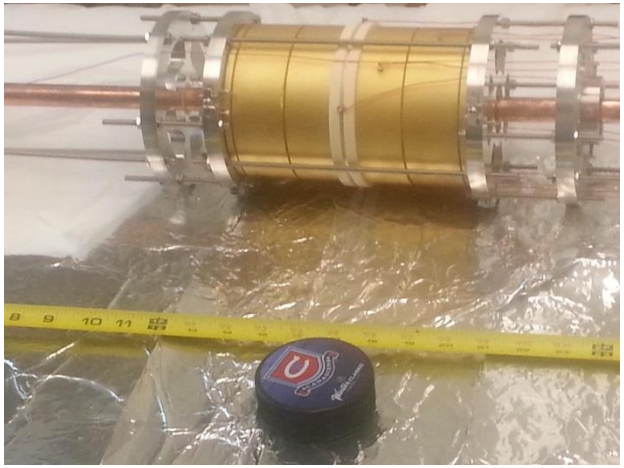
Other existing Cylindrical Penning Trap

Radius : 90 mm
l/r = 3.72

l/r = 11.75

Prototype Penning Trap(Commissioned)

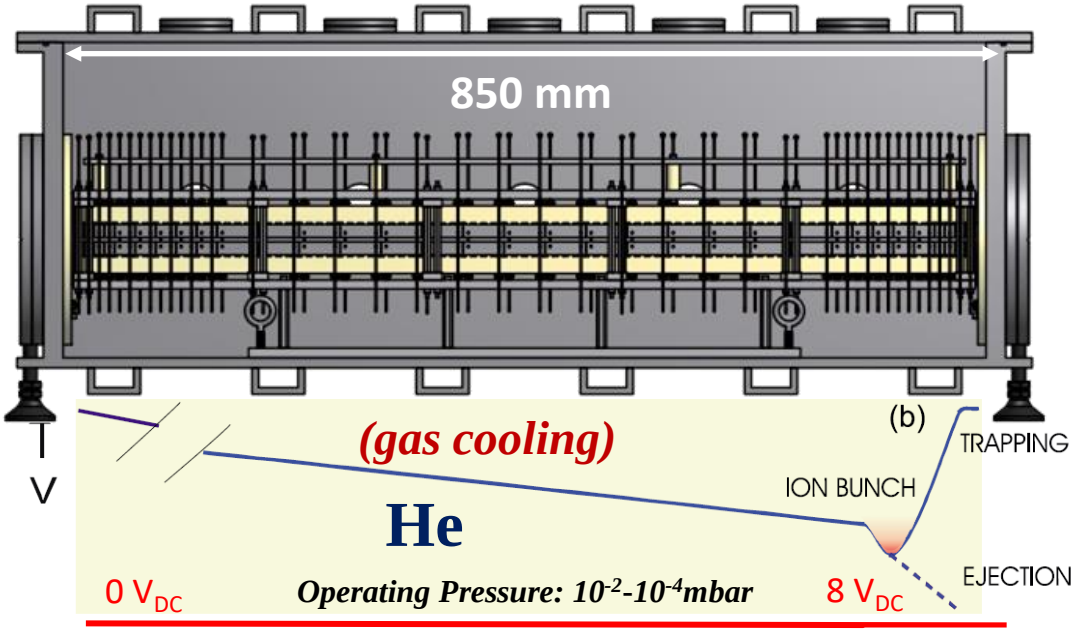




C_i	TAMU Analytic	TAMU Simulated	TITAN Analytic	PENTATRAP Analytic	LEBIT Simulated
C_0	-5×10^{-1}	-5×10^{-1}	-	-	8×10^{-1}
C_2	5×10^{-1}	6×10^{-1}	-	-2×10^{-2}	1
C_4	-7×10^{-6}	9×10^{-4}	-7×10^{-6}	4×10^{-6}	2×10^{-3}
C_6	6×10^{-6}	-3×10^{-3}	5×10^{-5}	2×10^{-7}	-4×10^{-3}
C_8	-4×10^{-2}	-4×10^{-2}	-	-1×10^{-1}	3×10^{-3}

Table 6.1: Expansion coefficients are compared for the optimized `TAMUTRAP` measurement trap when tuned (analytic and simulated) and three other existing Penning traps: TITAN (calculated analytically as in Ref. [11]), PENTATRAP (calculated analytically as in Ref. [45]), and LEBIT (simulated using `SIMION` as in Ref. [47]).

TAMUTRAP: Cooler/Buncher



M. Mehlmann (Ph.D. Thesis)

$E_{(FWHM)} = 5\ eV$
$TOF_{(FWHM)} = 1.2\ \mu s$

V_{RF} = 100 - 150 V
f_{RF} = 0.75 - 1 MHz

70 % efficiency

32 segments, R= 7 mm and gap $2R_0$=12 mm