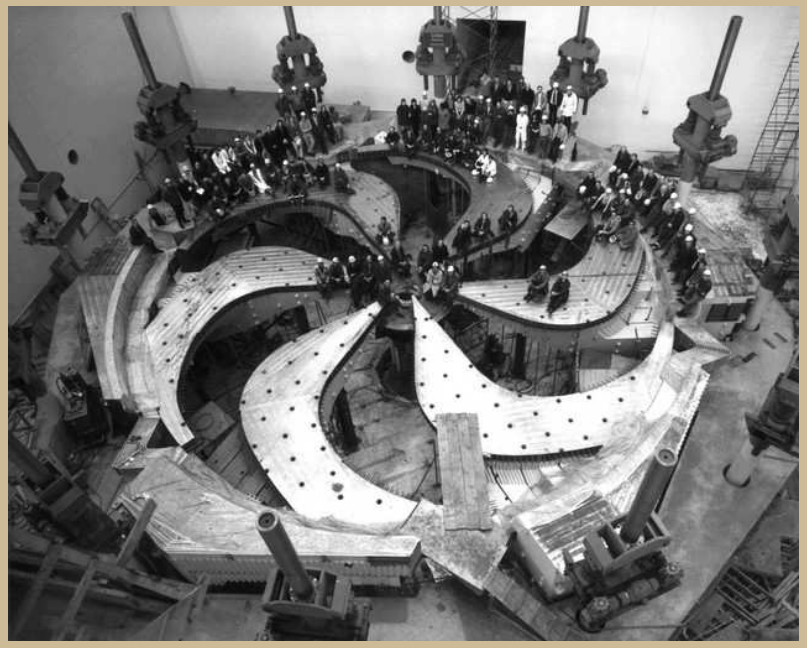
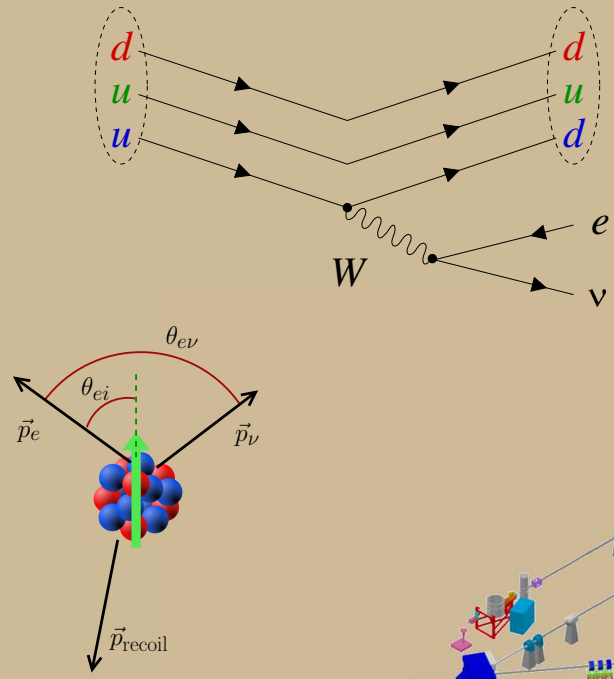
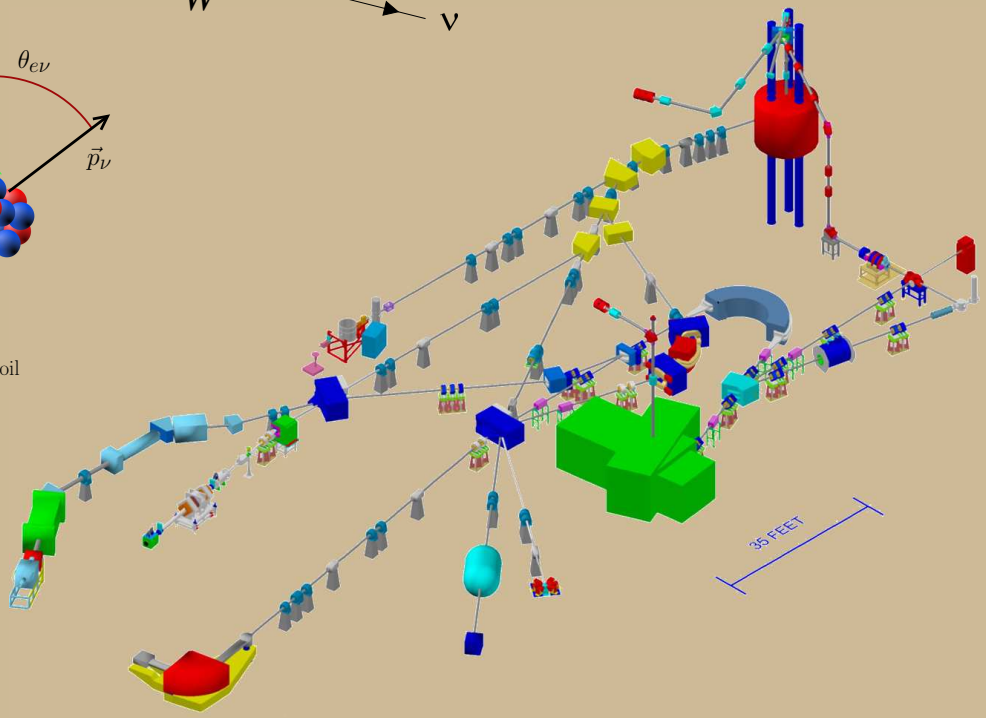
Status of the TAMUTRAP facility at Texas A&M University







Dan Melconian

DNP, Vancouver, Oct 15, 2016

Overview

1. β decay and fundamental symmetries
2. Overview of the TAMUTRAP facility at the Cyclotron Institute
3. Recent progress
4. Future outlook

How β-decay can test the SM?

Start with (part of) the often-quoted **angular distribution** of the decay:

(Jackson, Treiman and Wyld, Phys Rev **106** and Nucl Phys **4**, 1957)

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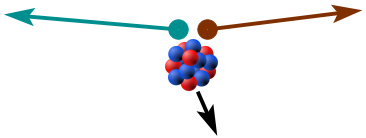

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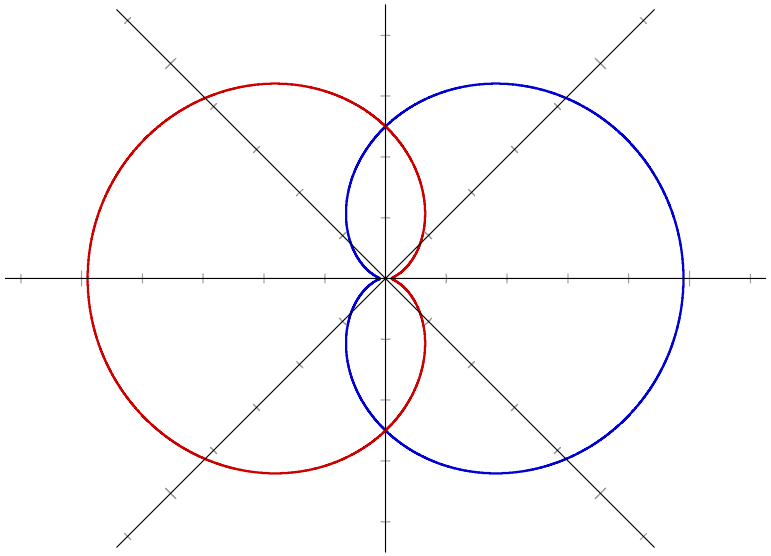

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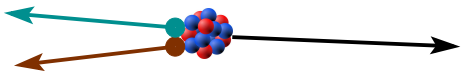

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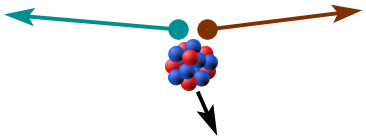

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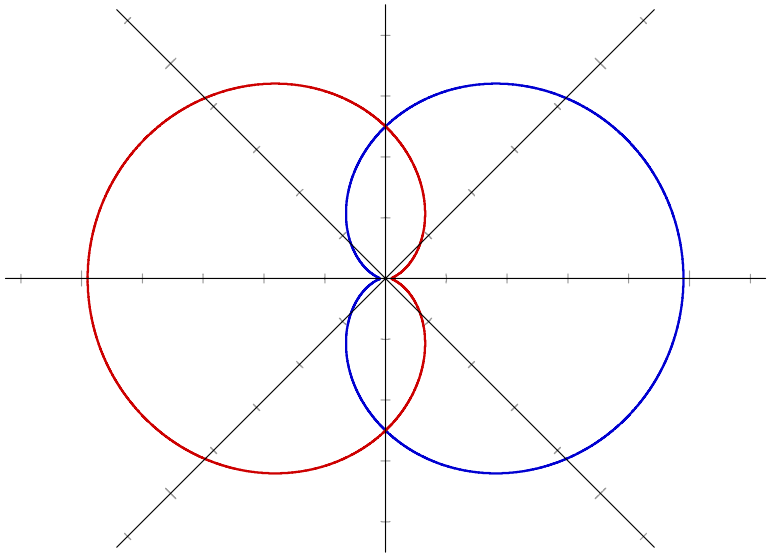

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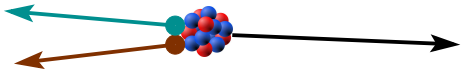

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Th[illegible] the

Goal must be $\lesssim 0.1\%$ to complement LHC

Naviliat-Čunčić and González-Alonso, Ann. Phys. **525**, 600 (2013)
Cirigliano, González-Alonso and Graesser, JHEP **1302**, 046 (2013)
Vos, Wilschut and Timmermans, RMP **87**, 1483 (2015)

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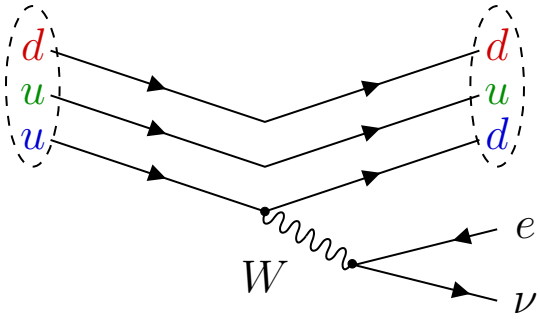
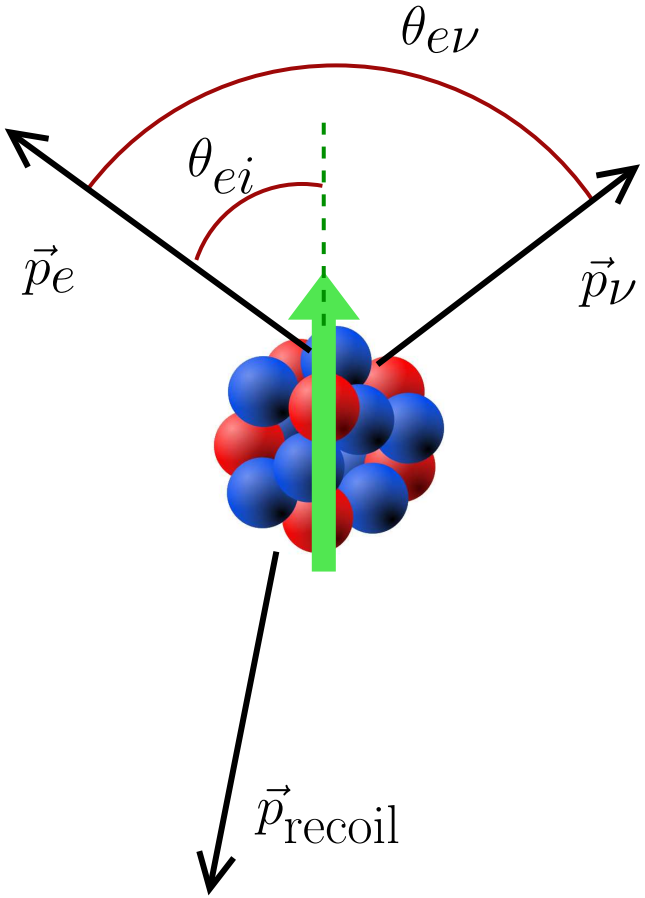
How to acheive our goal?



- perform a β decay experiment on **short-lived** isotopes



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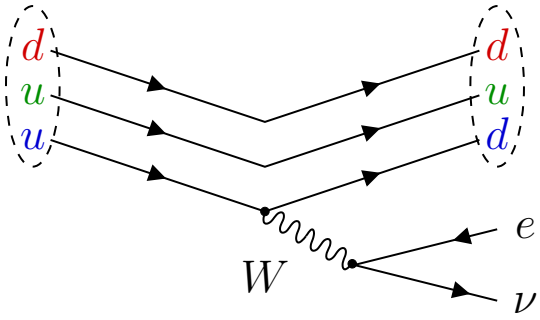

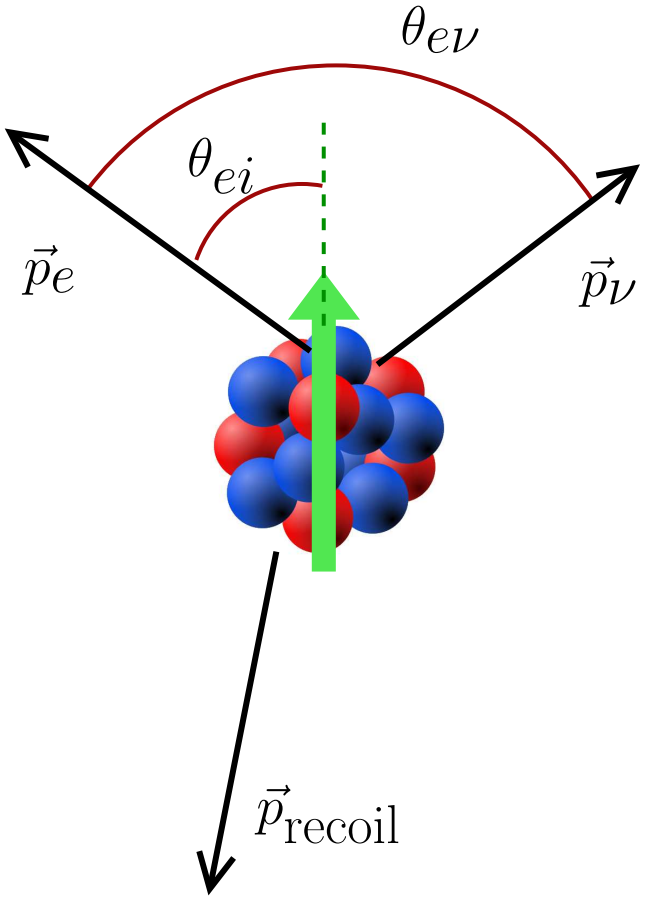

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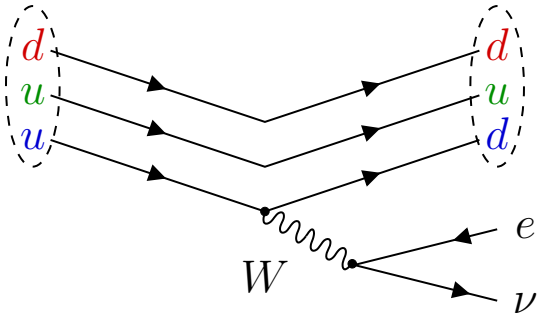

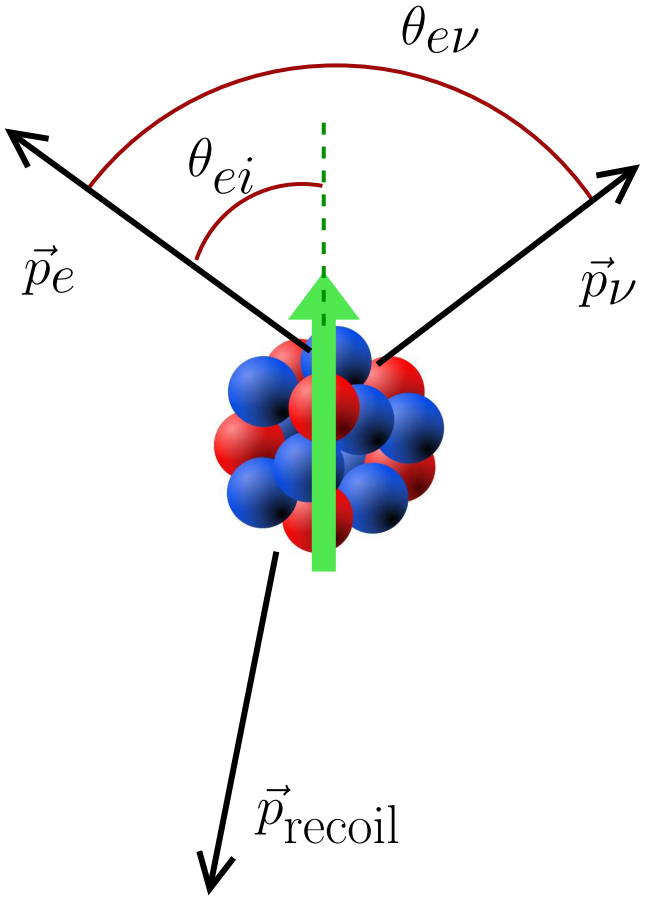

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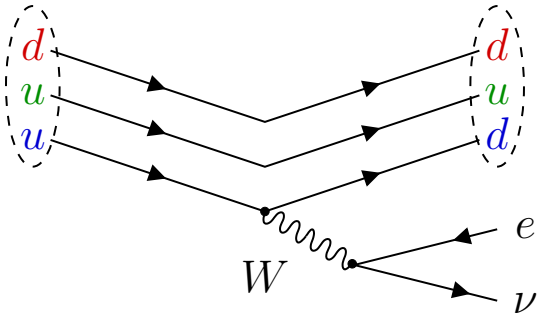

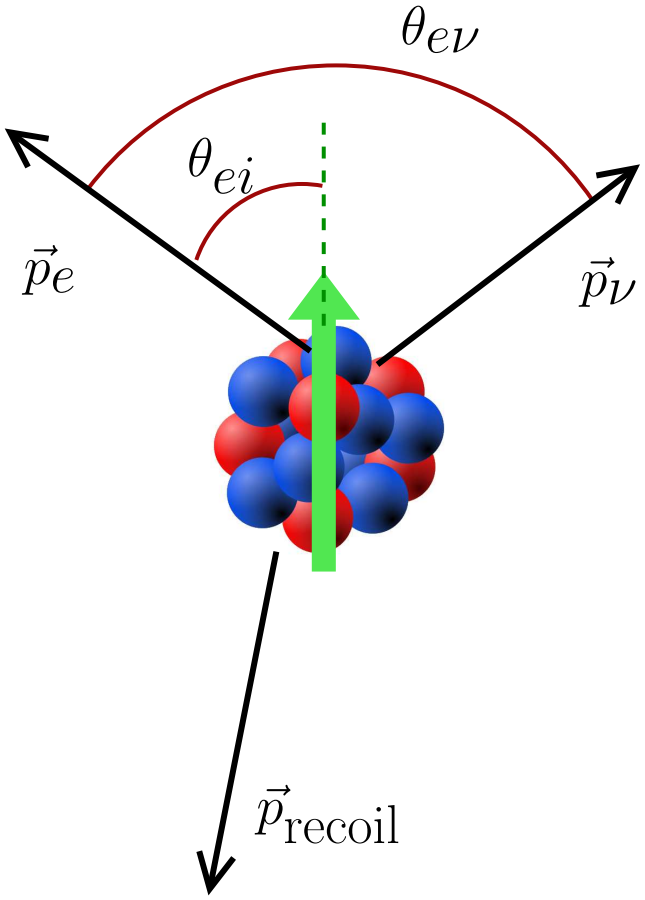

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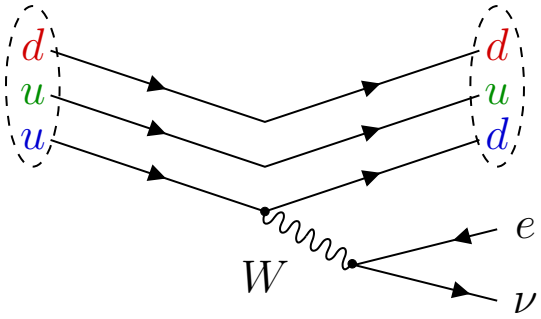

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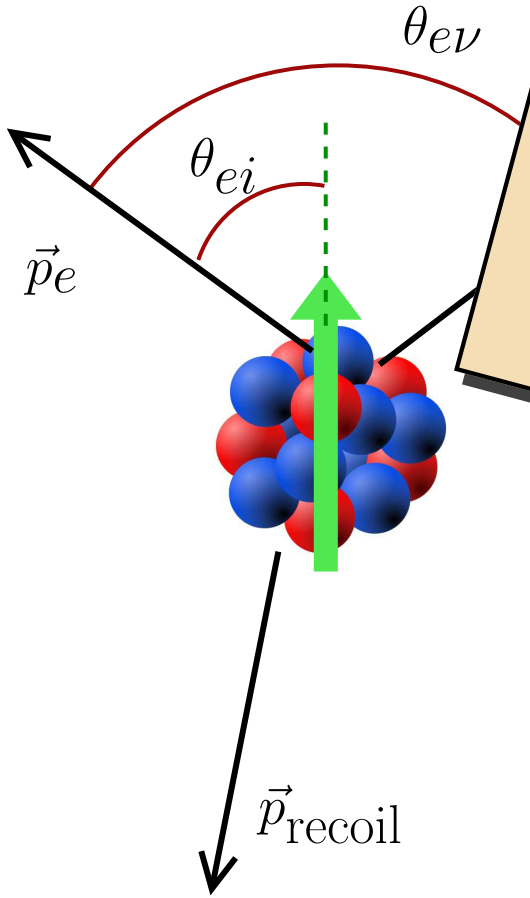

perform a nuclear measurement – often using atomic techniques – to test high-energy theories

SM predictions to obser-

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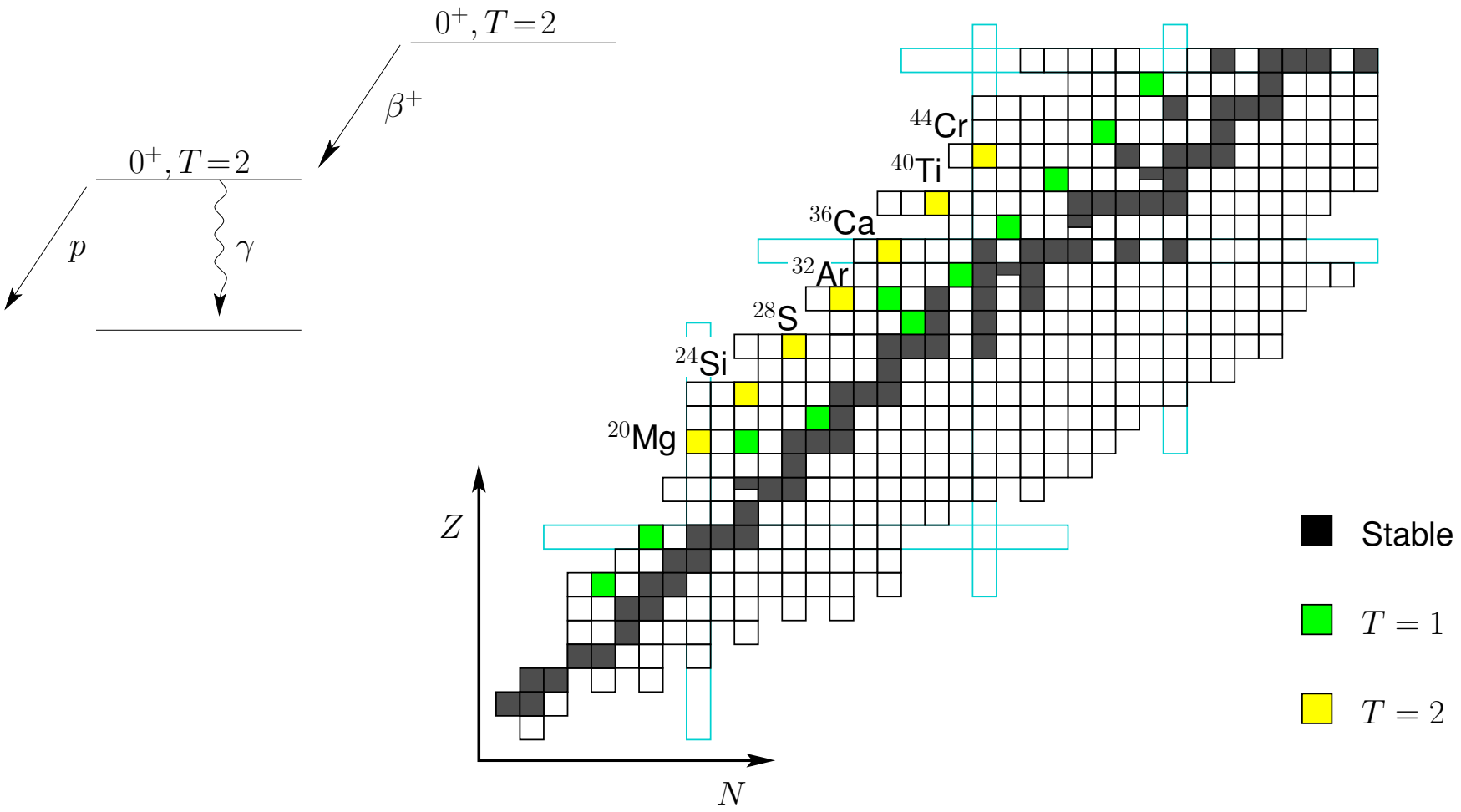
$T = 2$ Superallowed Decays



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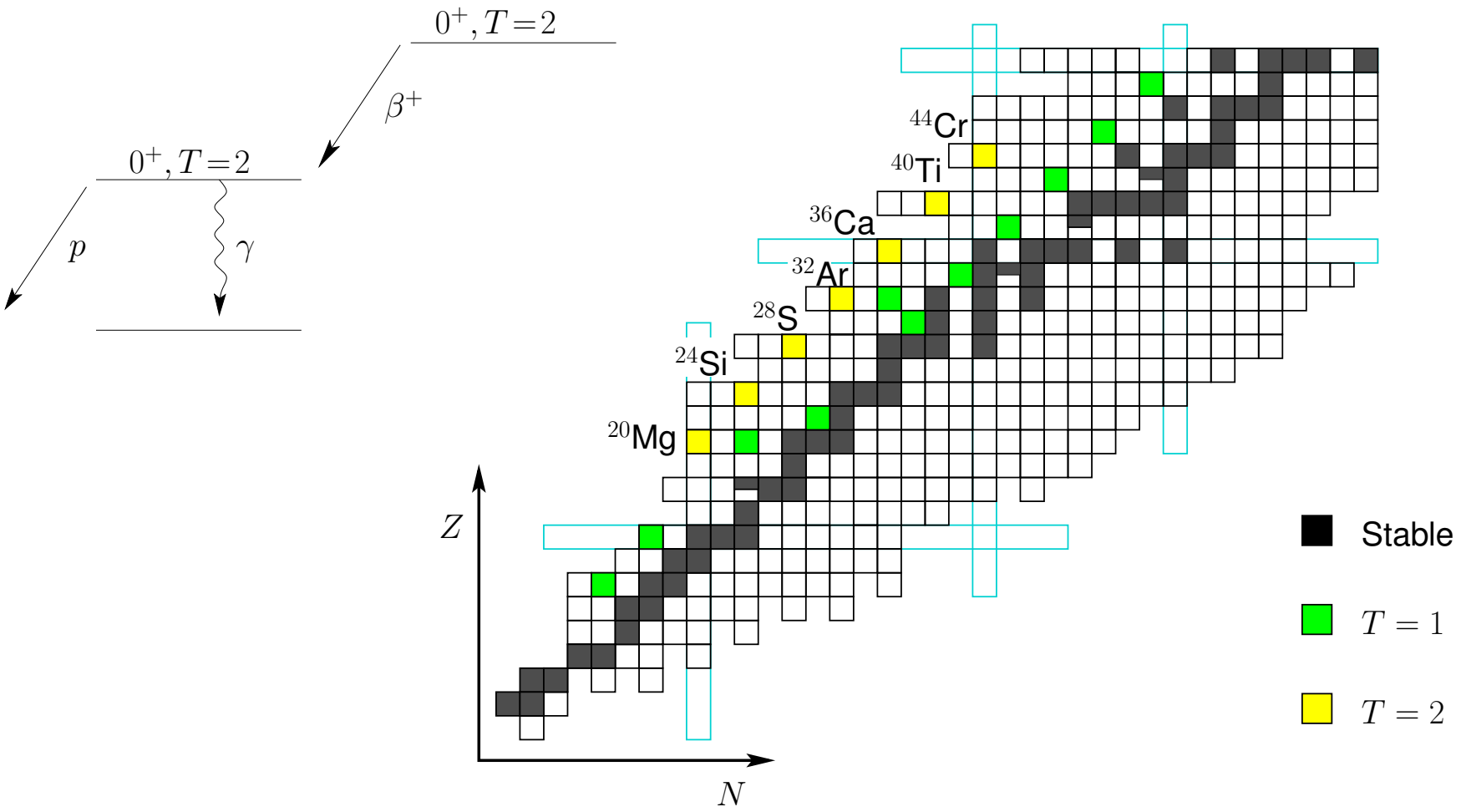

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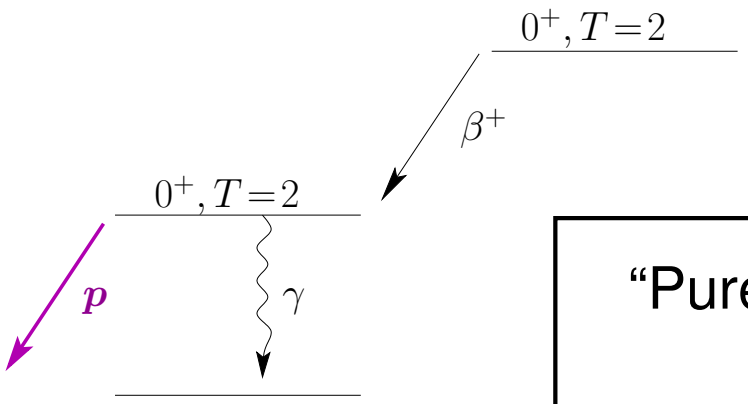

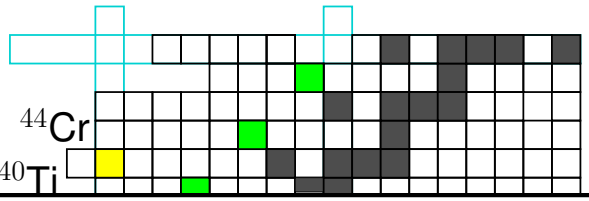

"Pure Fermi decay" $\Leftrightarrow$ minimal nuclear structure effects

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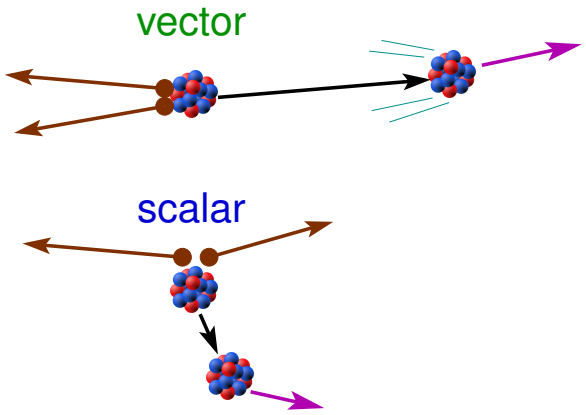

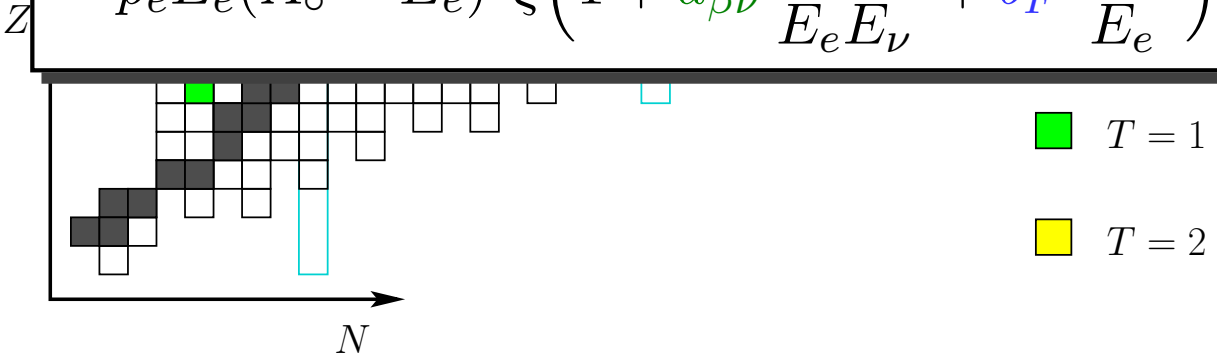

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$\beta - \nu$ correlation from ^{32}Ar

VOLUME 83, NUMBER 7 PHYSICAL REVIEW LETTERS 16 AUGUST 1999

Positron-Neutrino Correlation in the $0^+ \rightarrow 0^+$ Decay of ^{32}Ar

E. G. Adelberger,[1] C. Ortiz,[2] A. García,[2] H. E. Swanson,[1] M. Beck,[1] O. Tengblad,[3] M. J. G. Borge,[3] I. Martel,[4] H. Bichsel,[1] and the ISOLDE Collaboration[4]

[1]*Department of Physics, University of Washington, Seattle, Washington 98195-1560*

[2]*Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556*

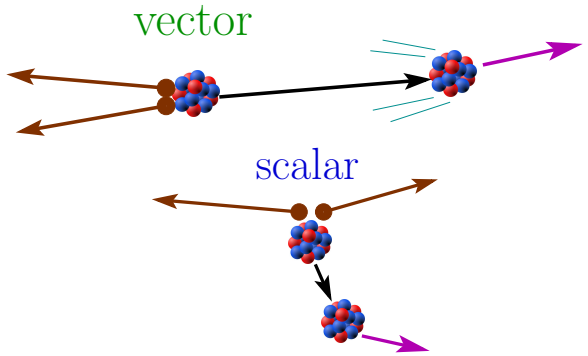
[3]*Instituto de Estructura de la Materia, CSIC, E-28006 Madrid, Spain*

[4]*EP Division, CERN, Geneva, Switzerland CH-1211*

(Received 24 February 1999)

The positron-neutrino correlation in the $0^+ \rightarrow 0^+$ β decay of ^{32}Ar was measured at ISOLDE by analyzing the effect of lepton recoil on the shape of the narrow proton group following the superallowed decay. Our result is consistent with the standard model prediction. For vanishing Fierz interference we find $a = 0.9989 \pm 0.0052 \pm 0.0039$, which yields improved constraints on scalar weak interactions.

Doppler shape of delayed proton depends on $\vec{p}_e \cdot \vec{p}_\nu$!



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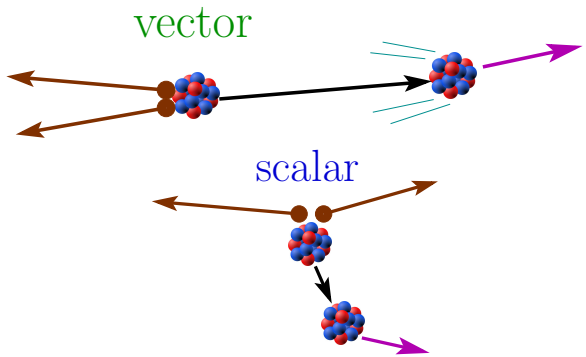

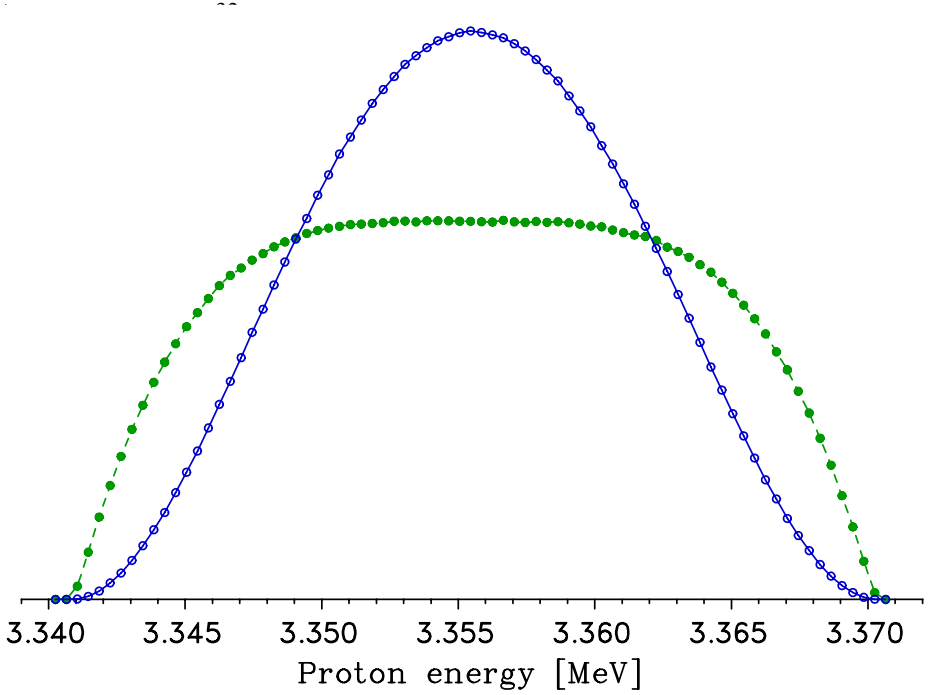

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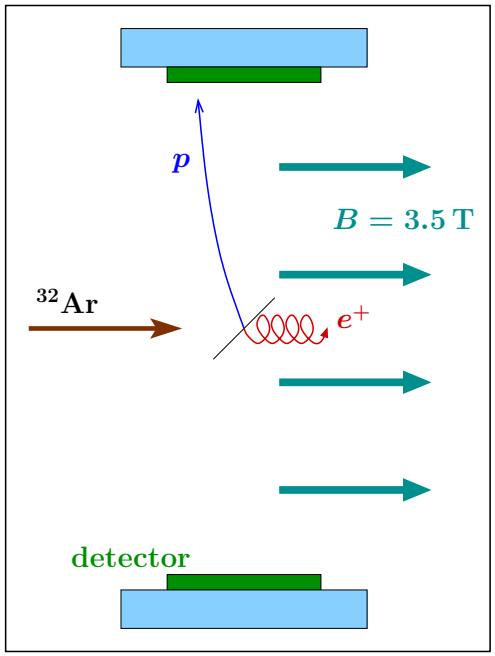

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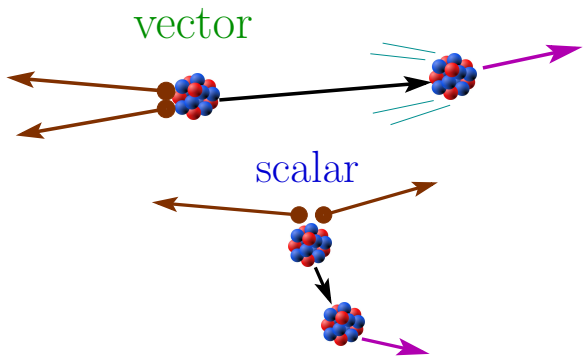

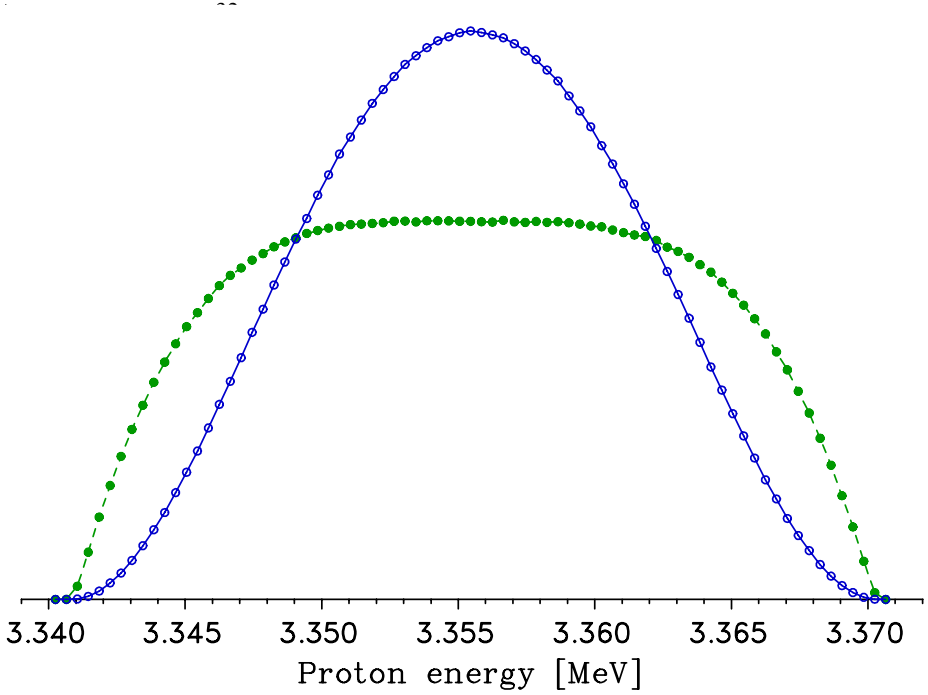

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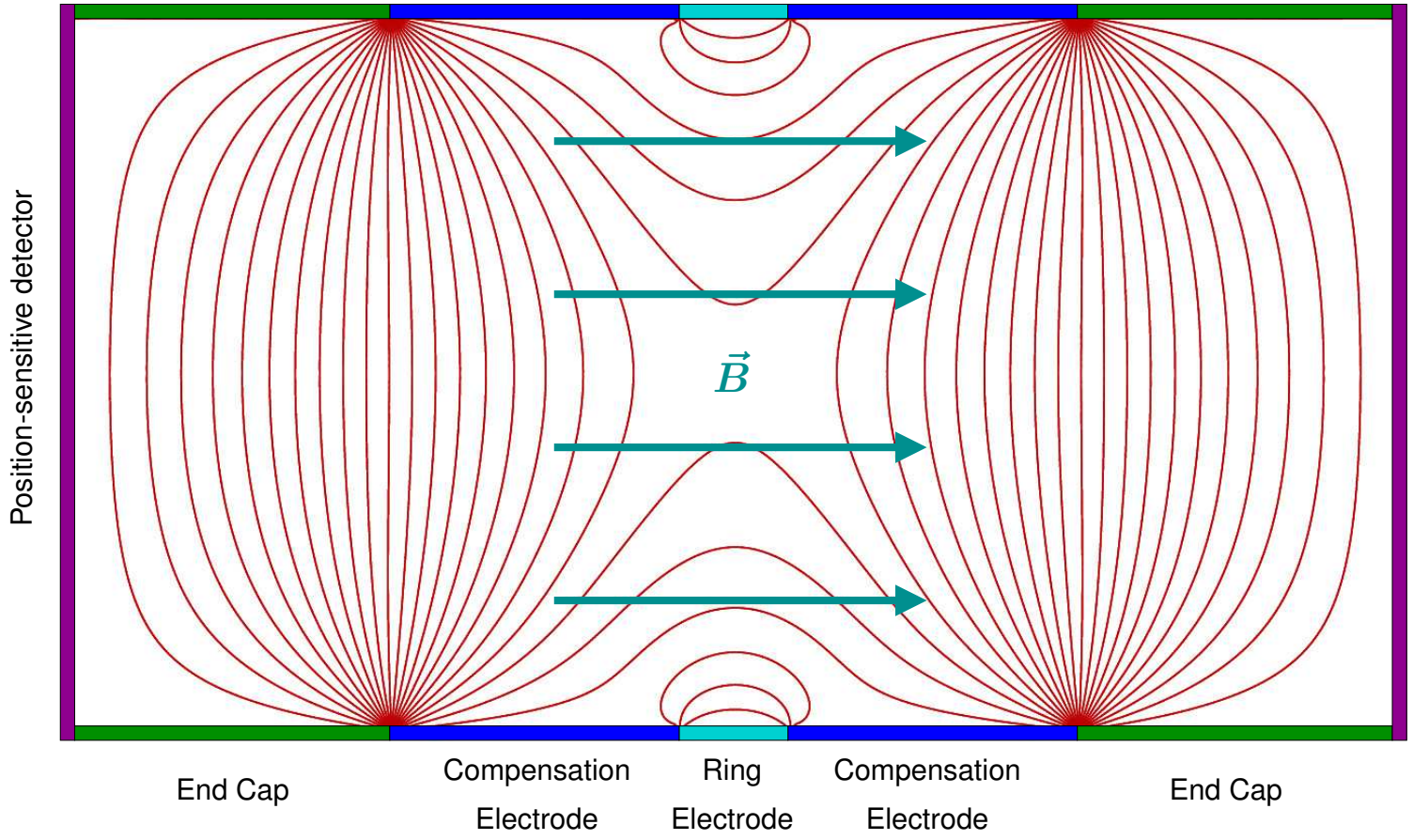
Mehlman *et al.*, NIM **A712**, 9 (2013)



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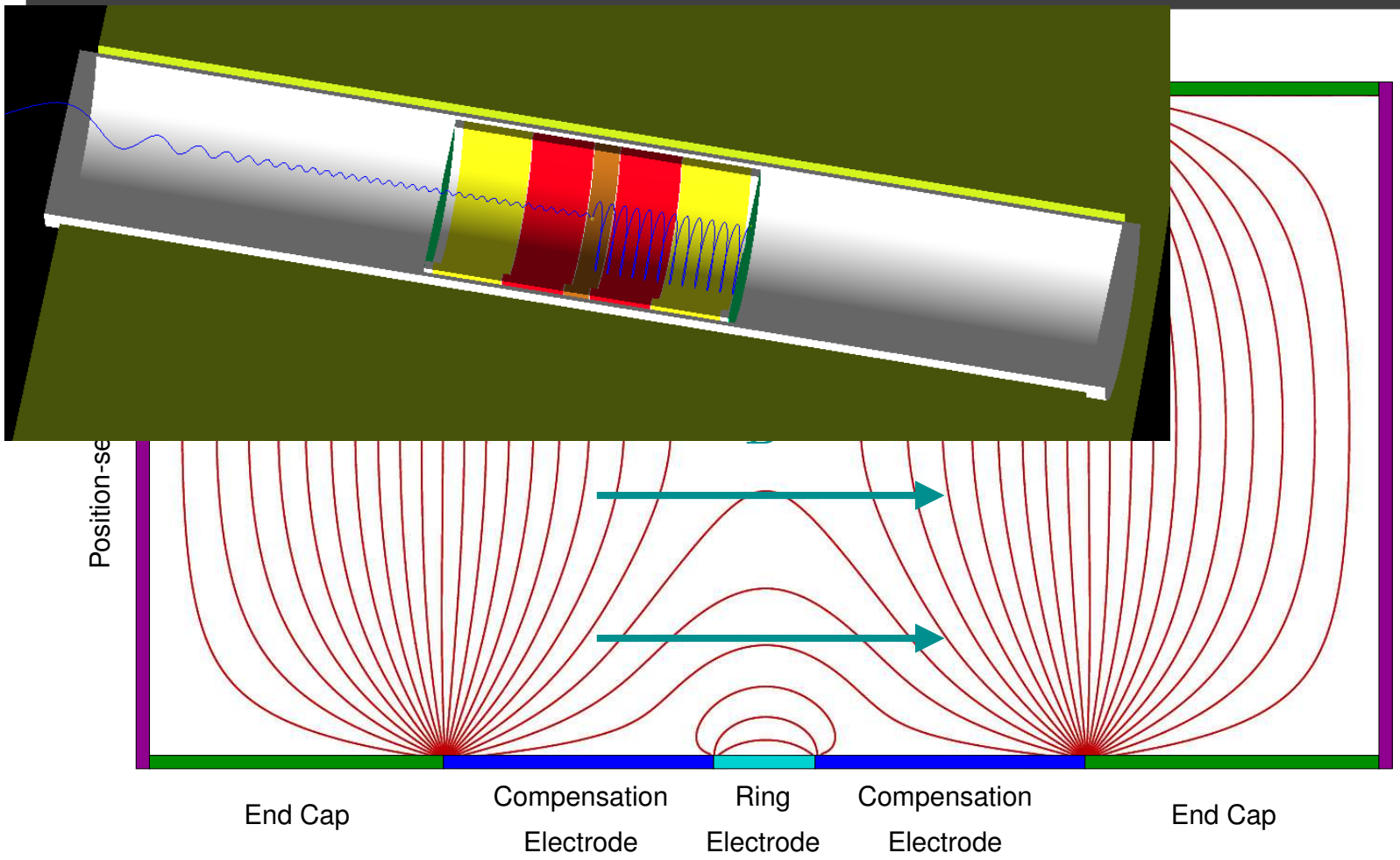

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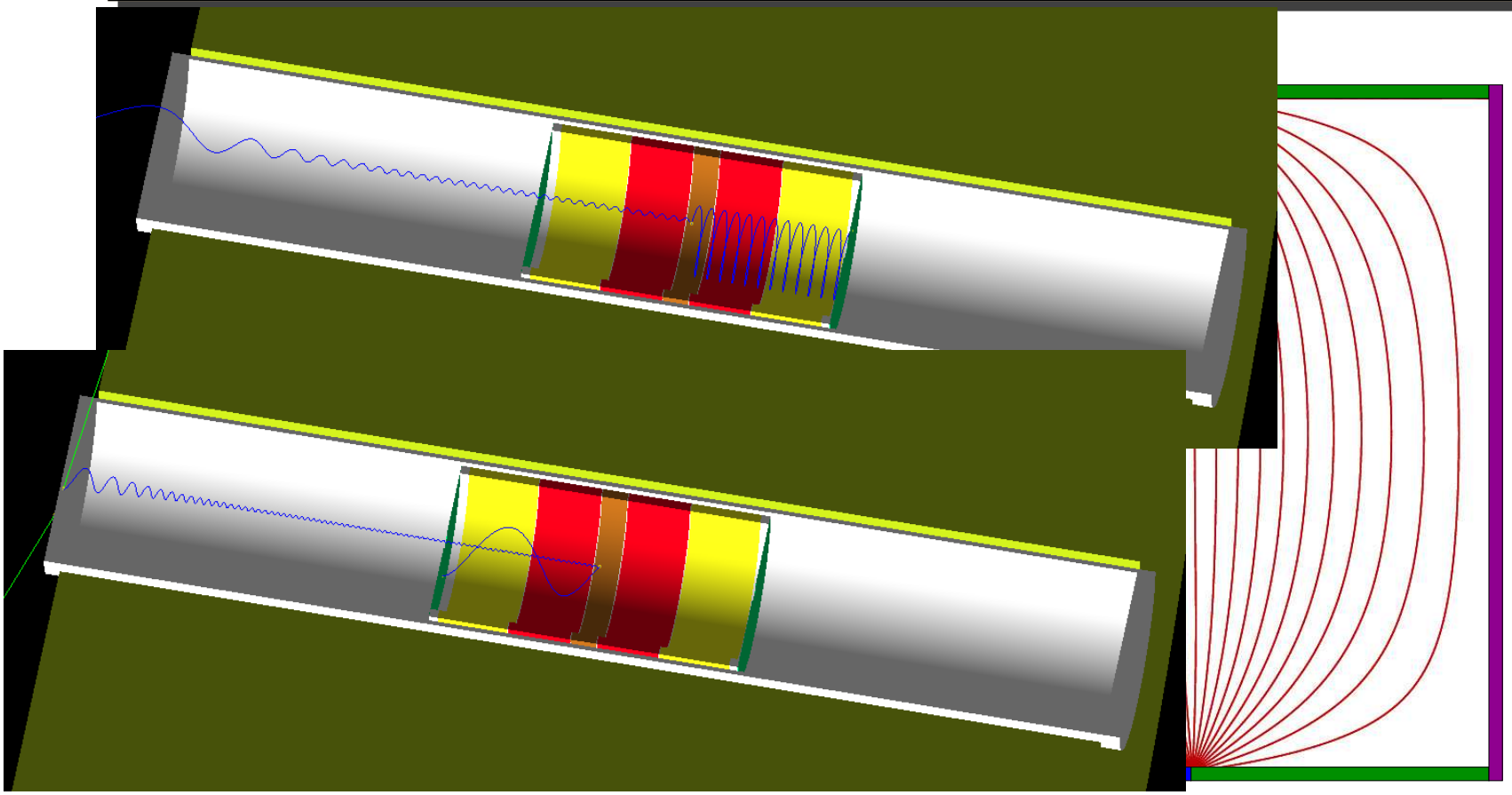

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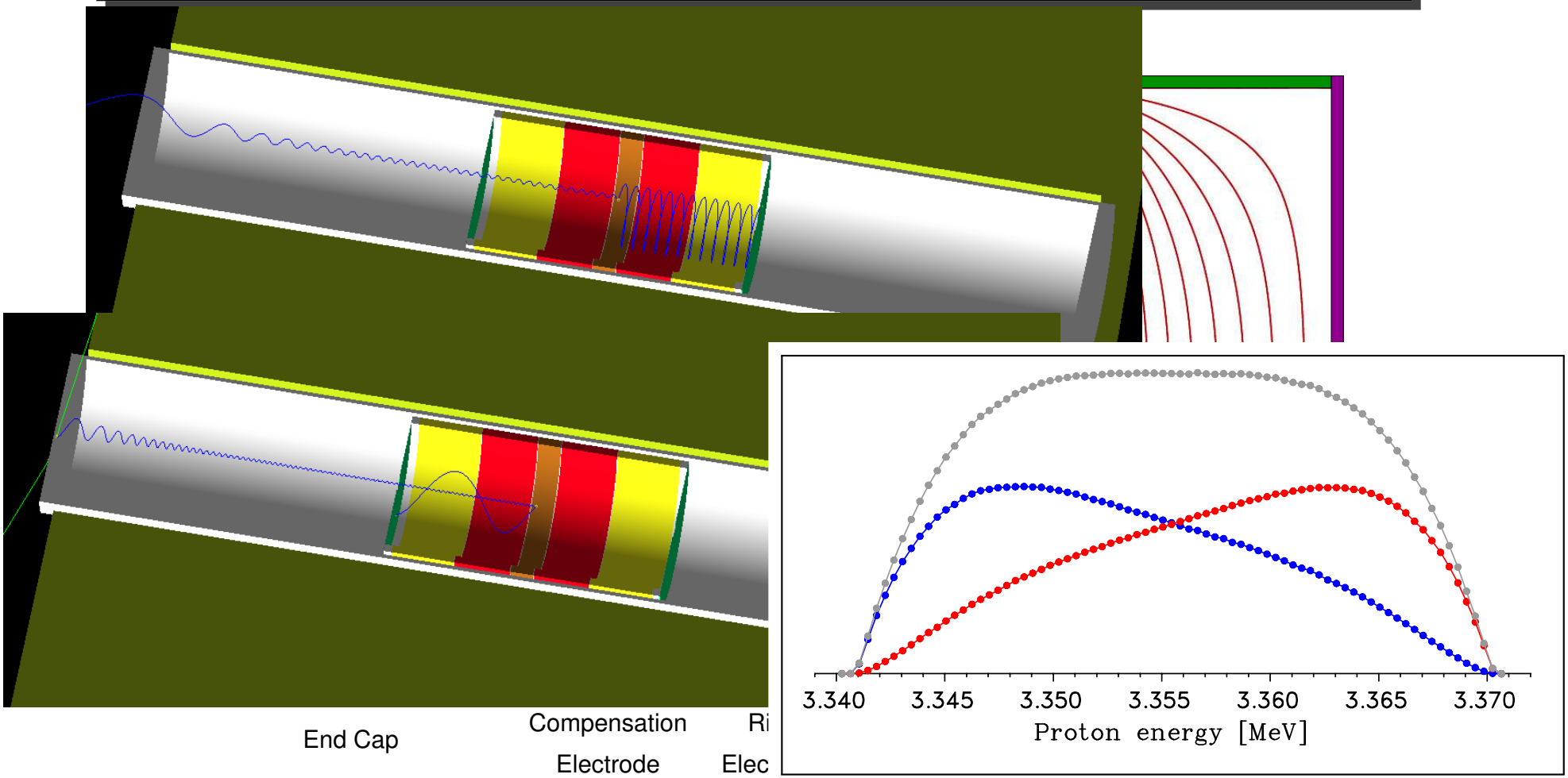
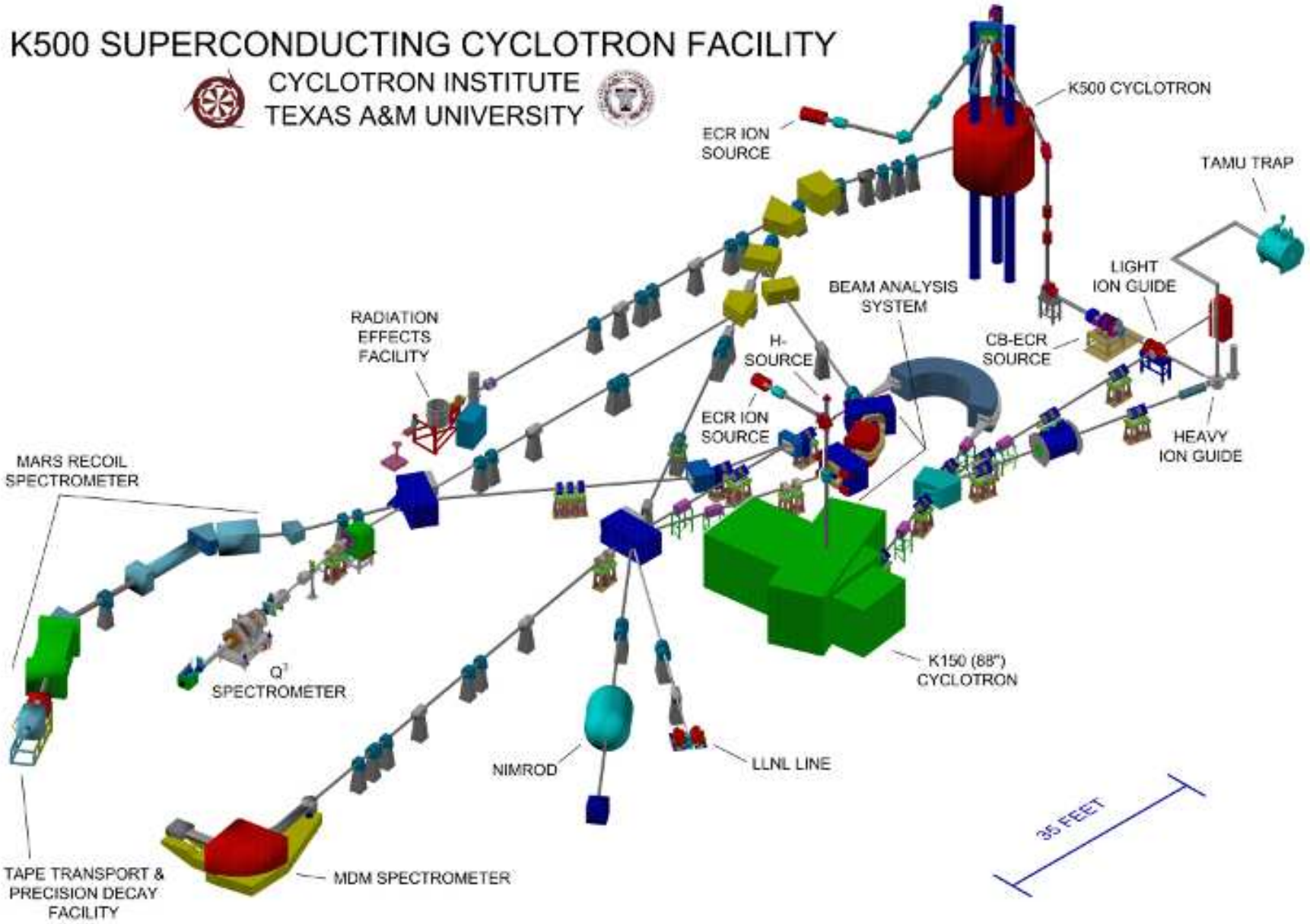


A Penning trap at T-REX CI/TAMU



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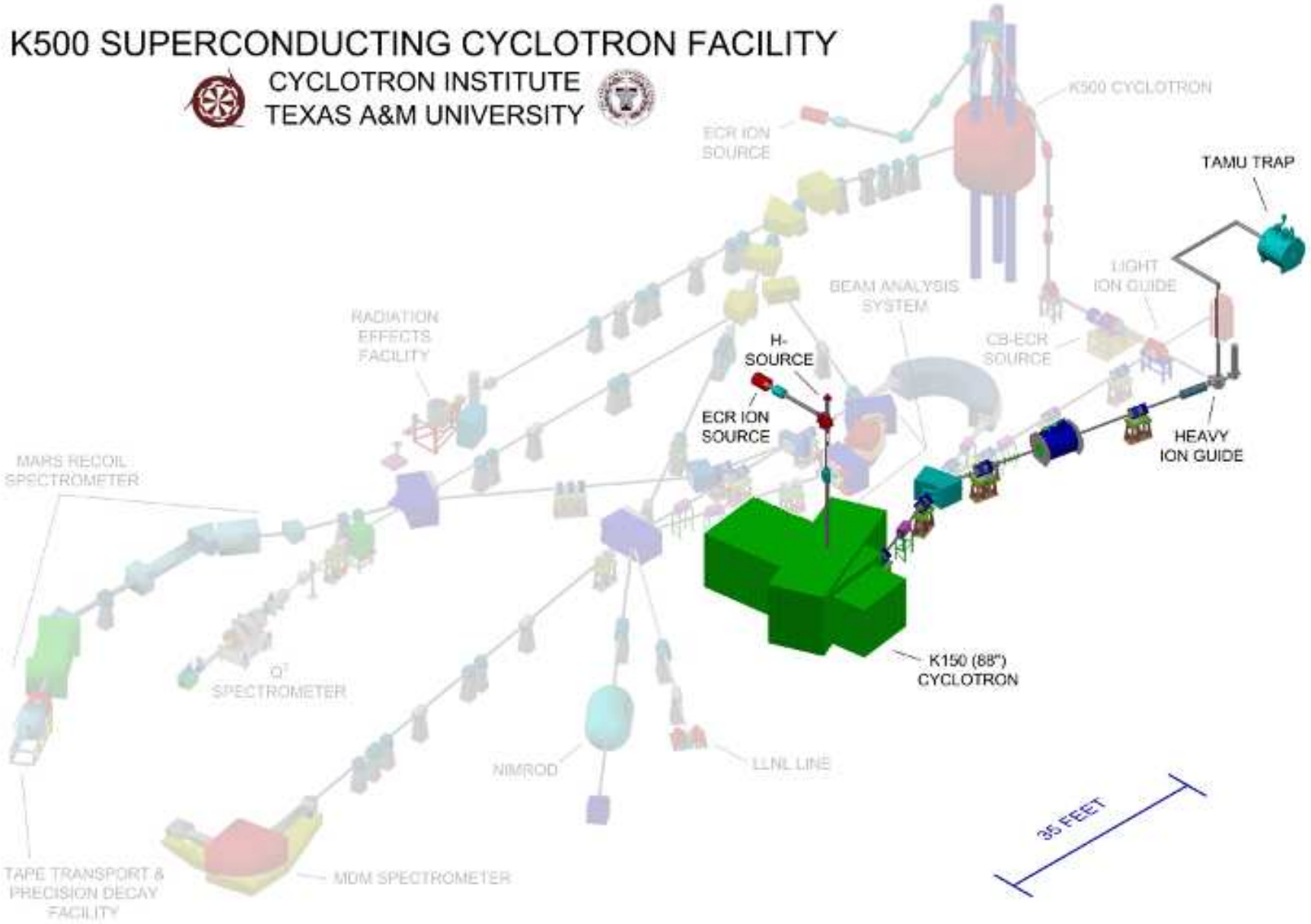
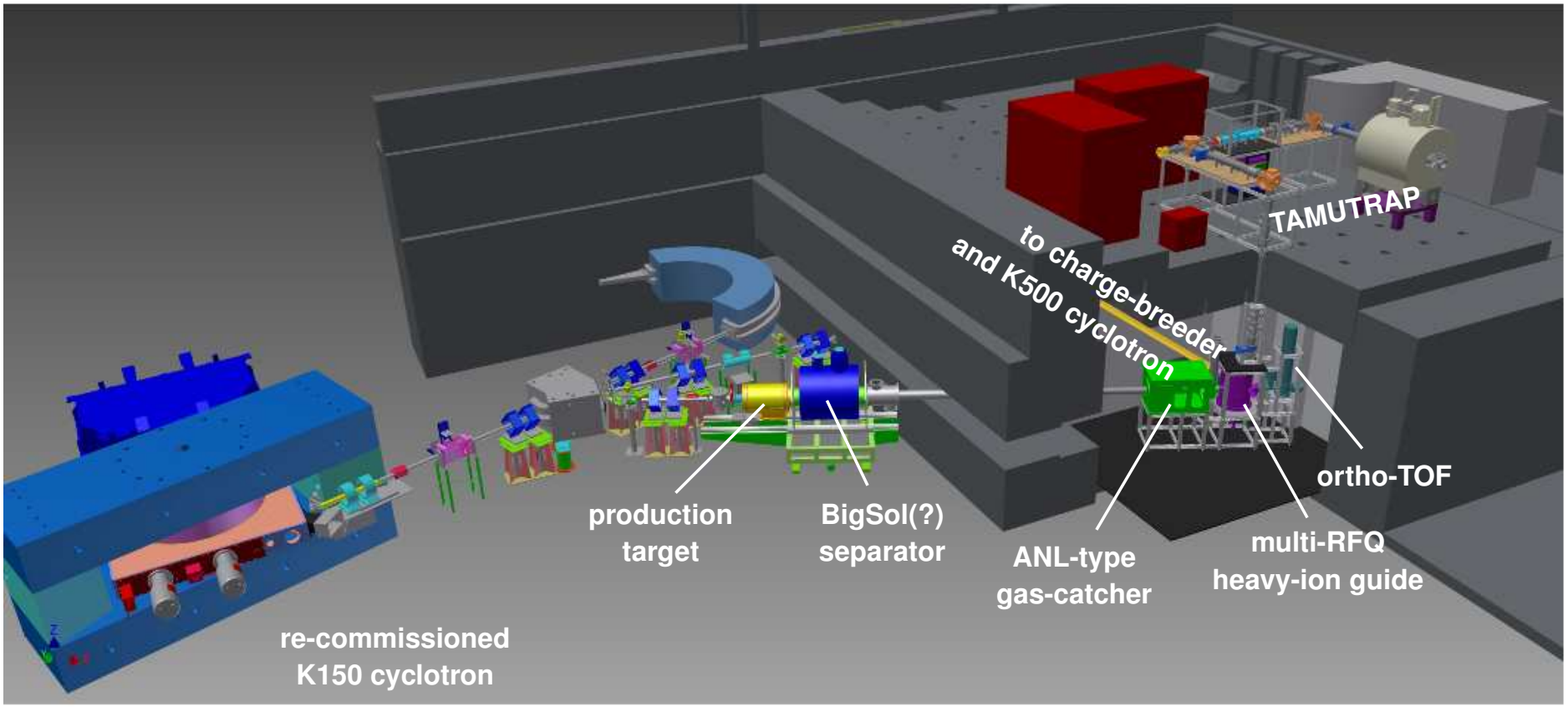


The Texas A&M University Penning Trap

- will be the **world's most open-geometry** Penning trap!
- uniquely suited for studying β-delayed proton decays:
  $\beta - \nu$ correlations, ft values/V_{ud}
- mass measurements, EC studies, laser spectroscopy, ...



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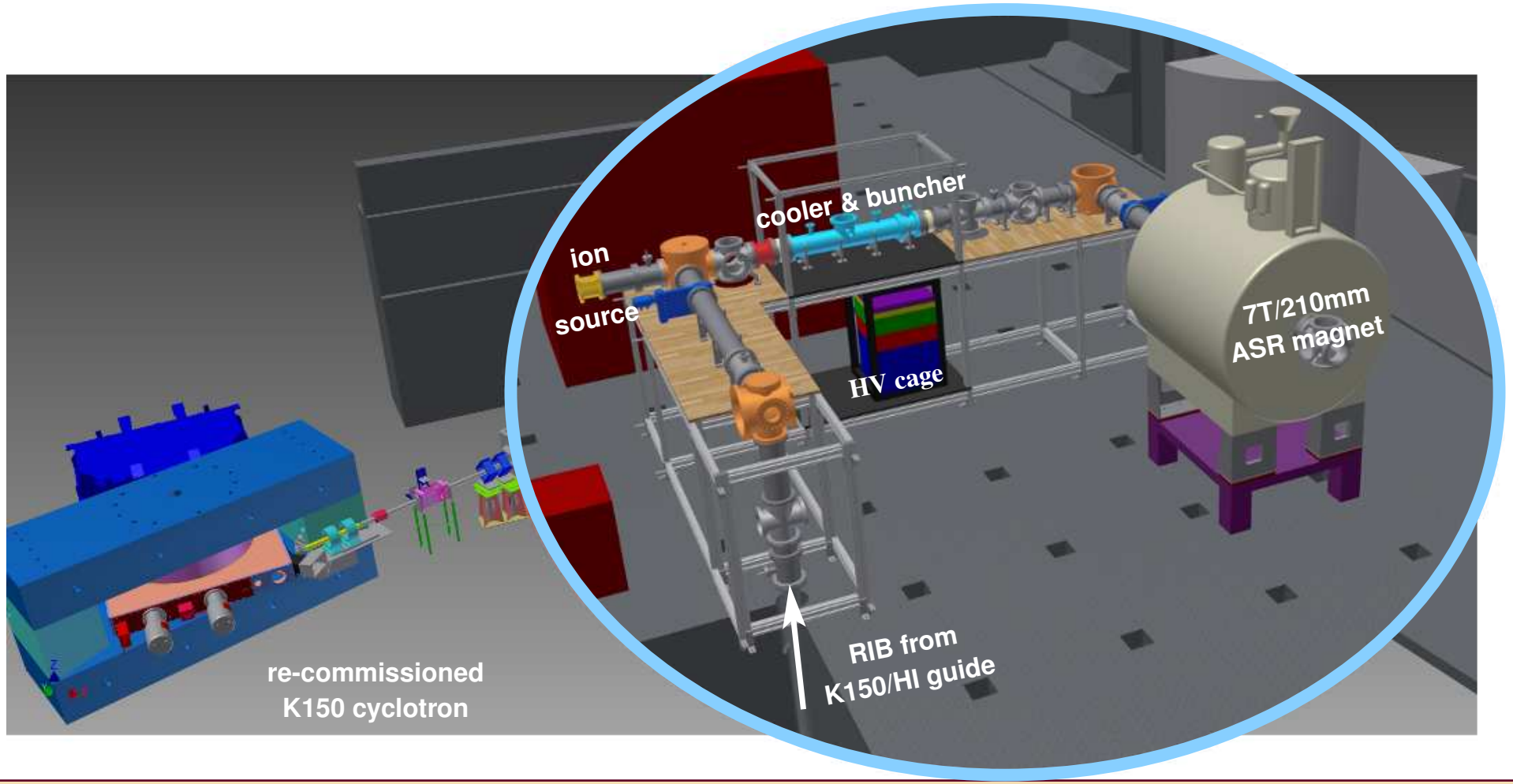
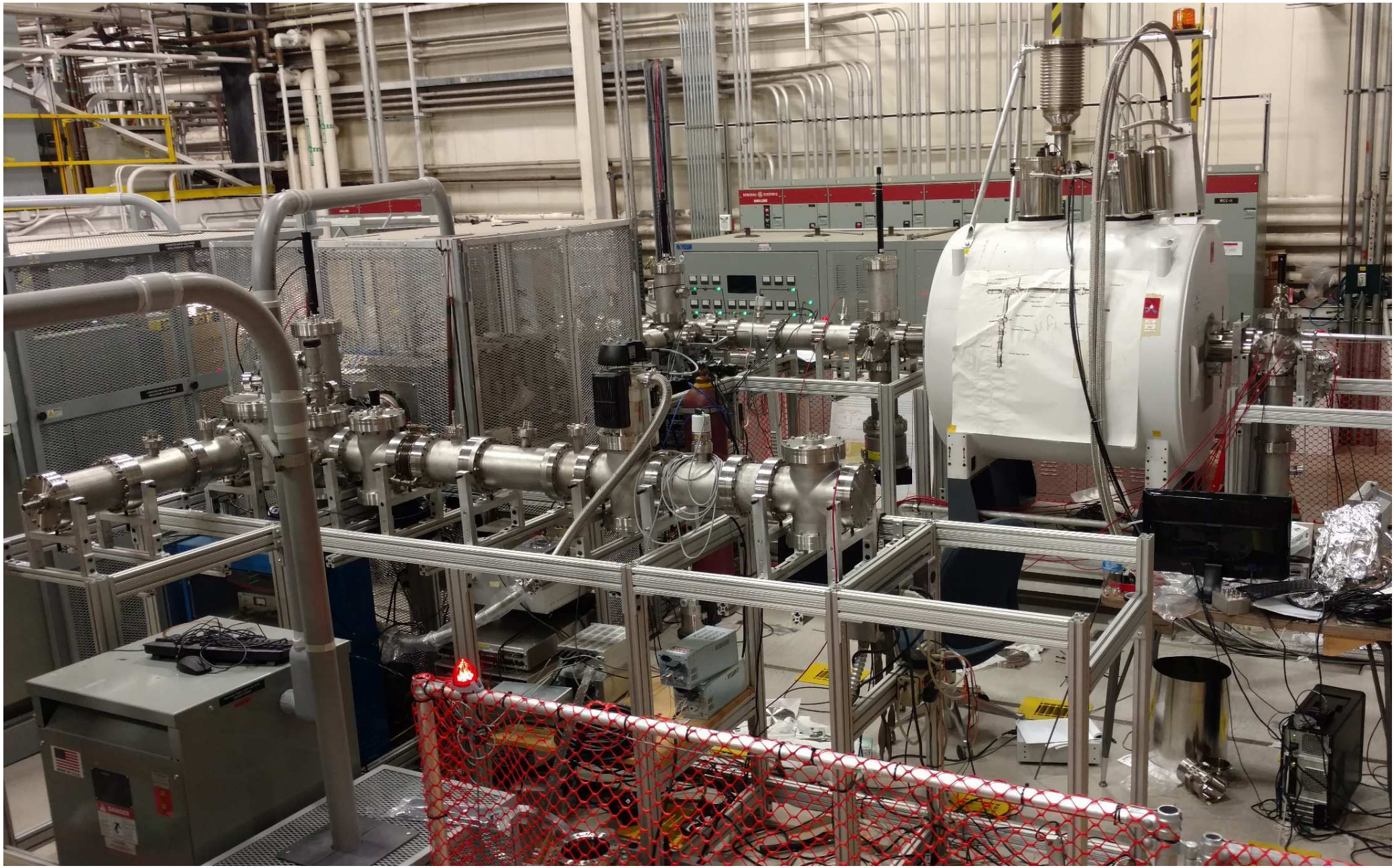


Status in 2013

Current Status



Current Status

Recent Milestones

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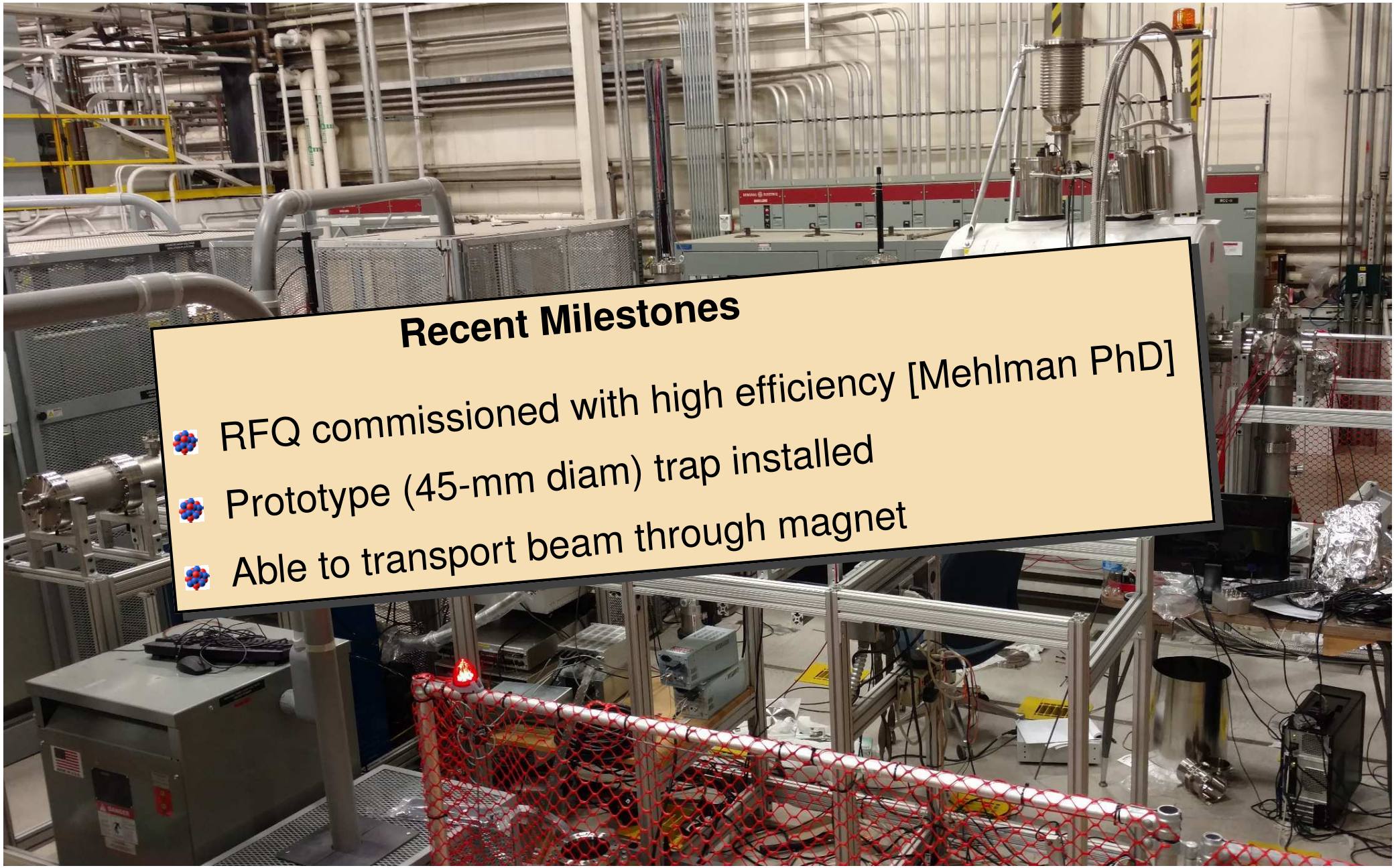

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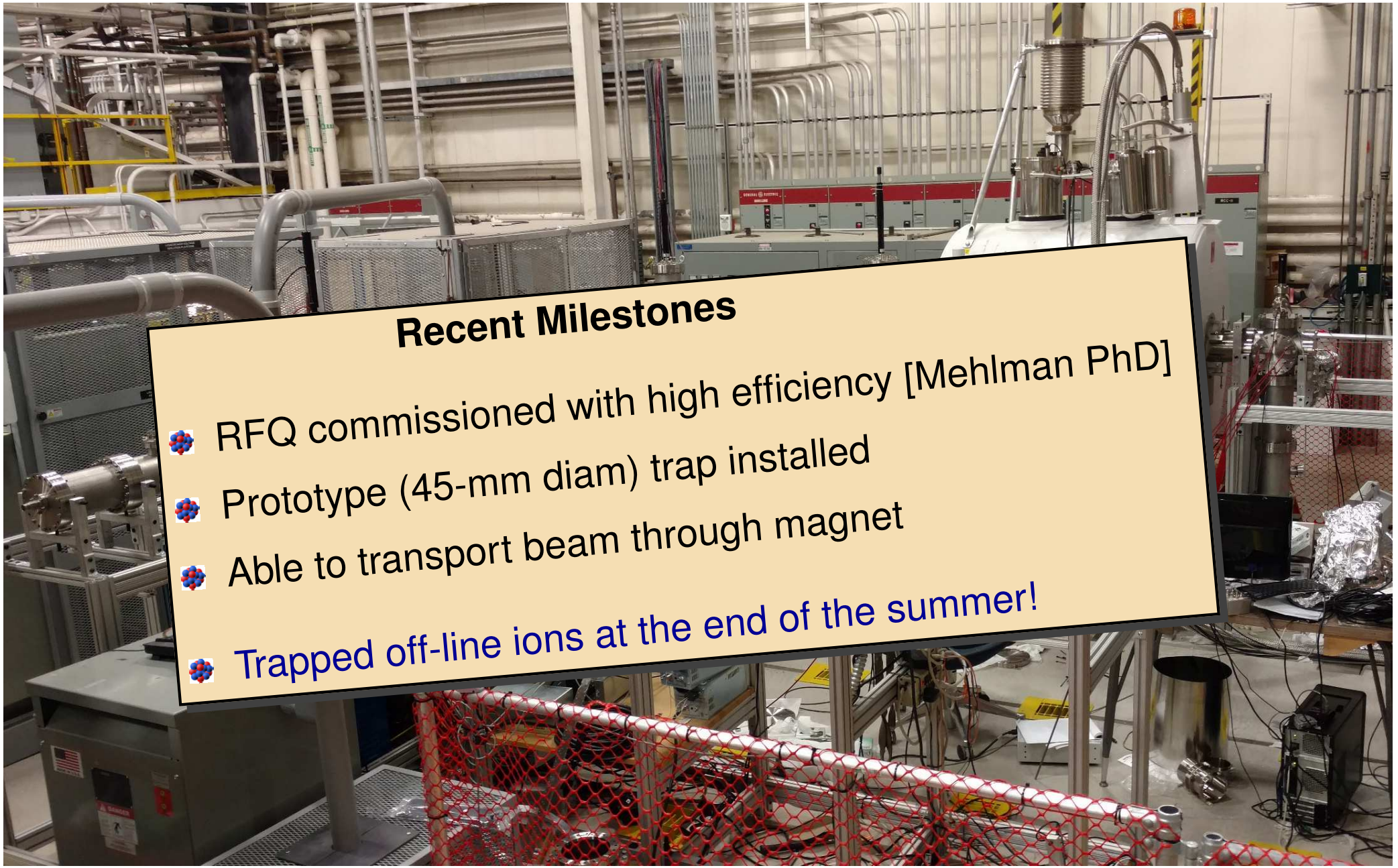

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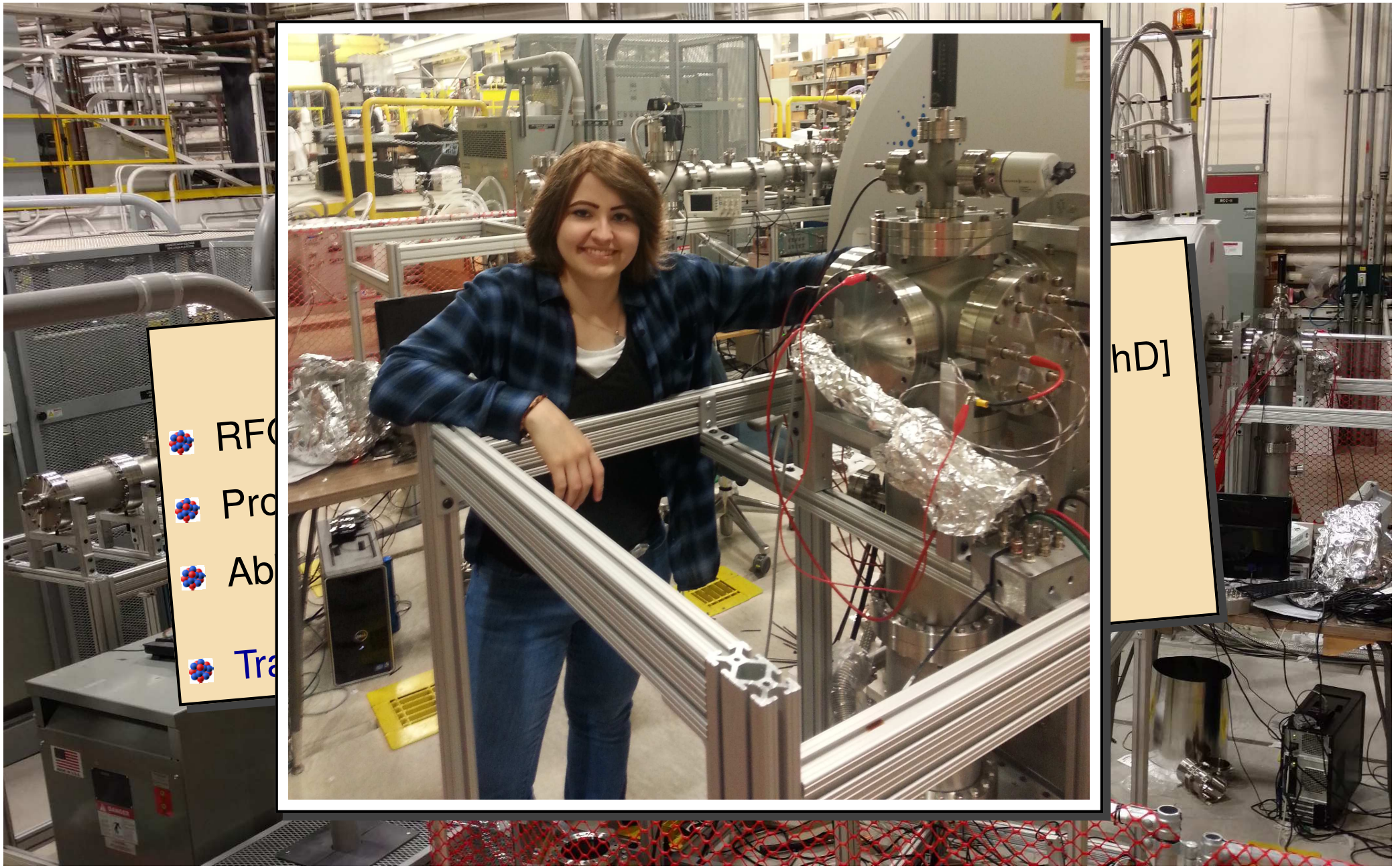

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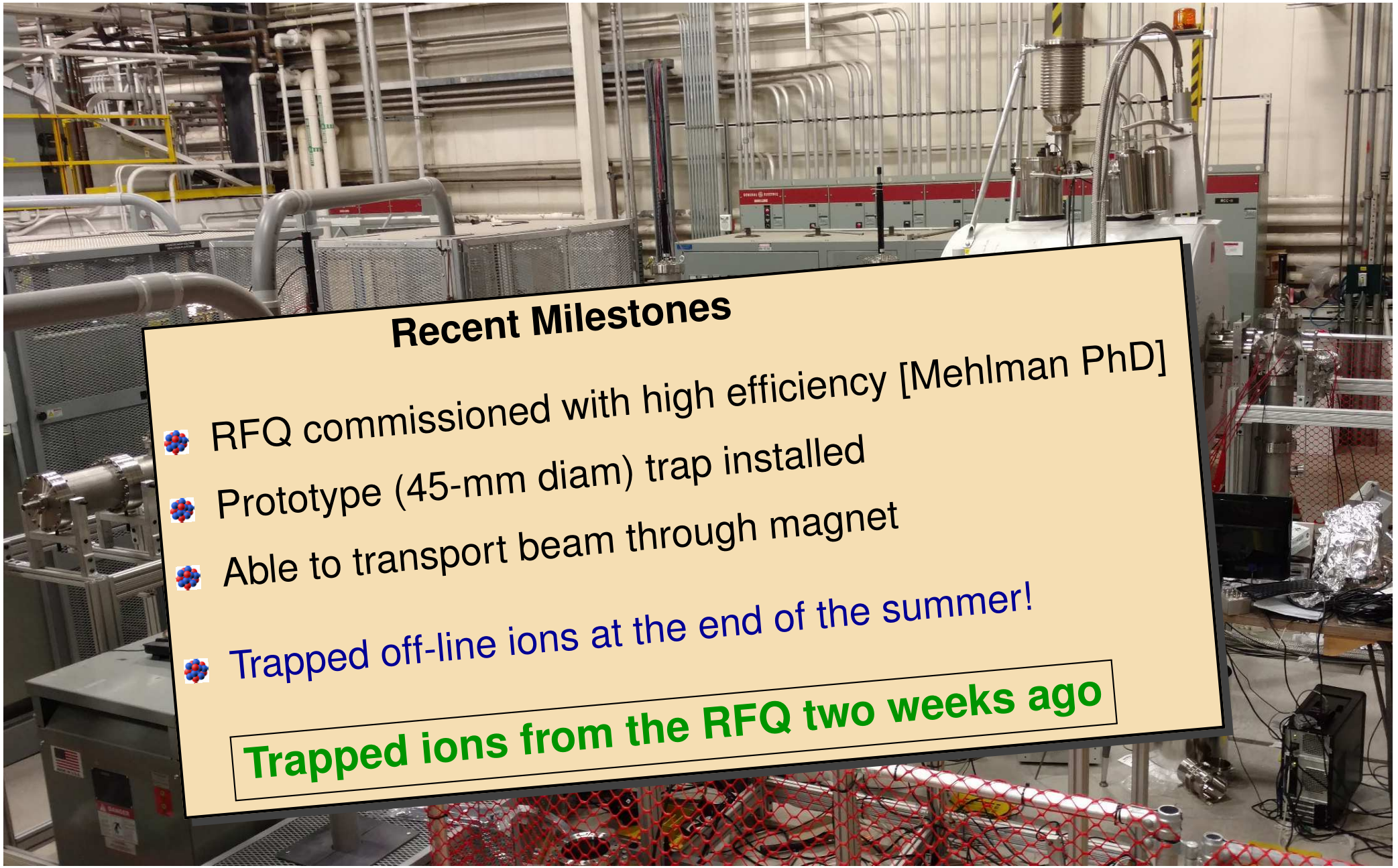

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- Prototype (45-mm diam) trap installed
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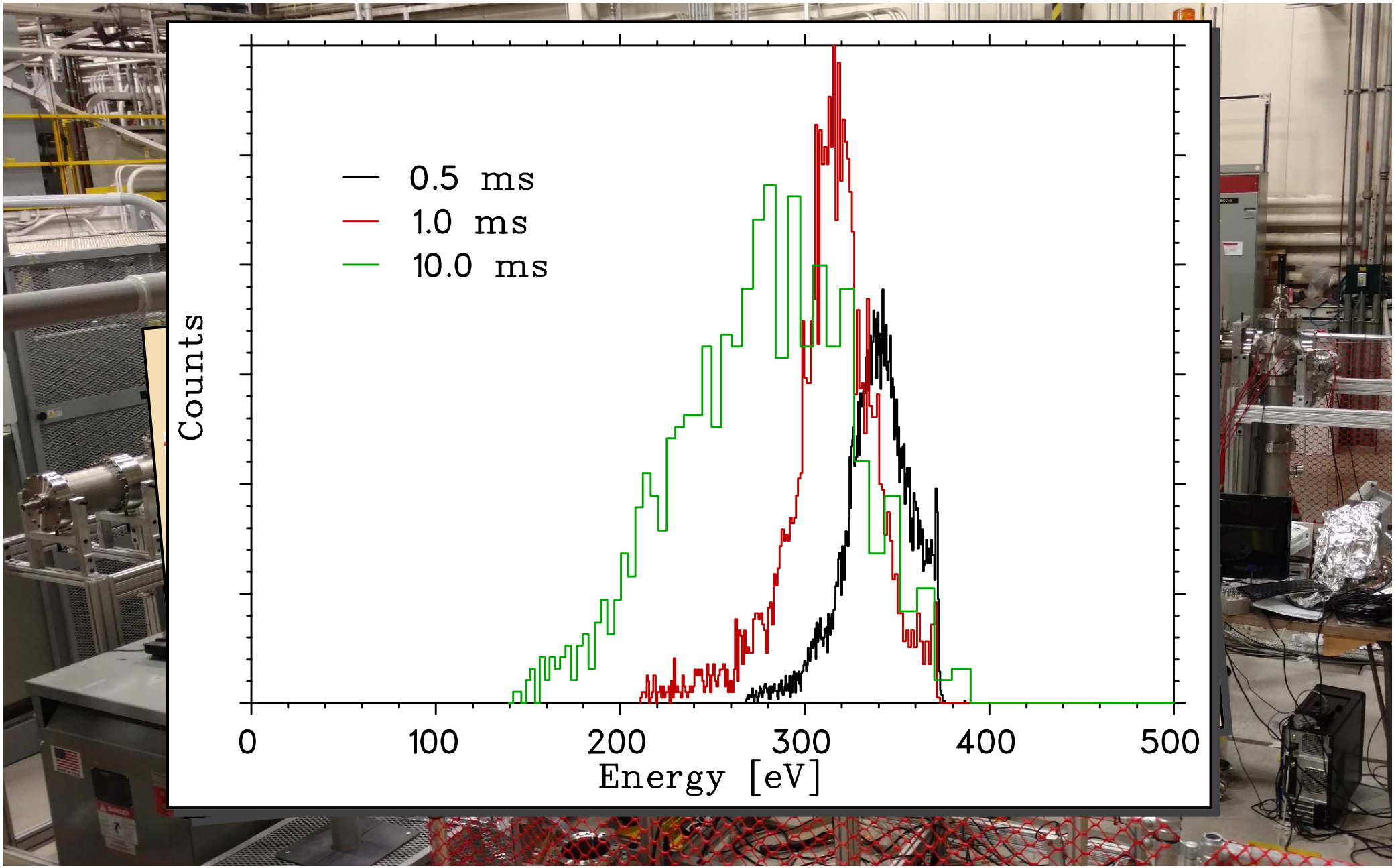
Trapped ions from the RFQ two weeks ago

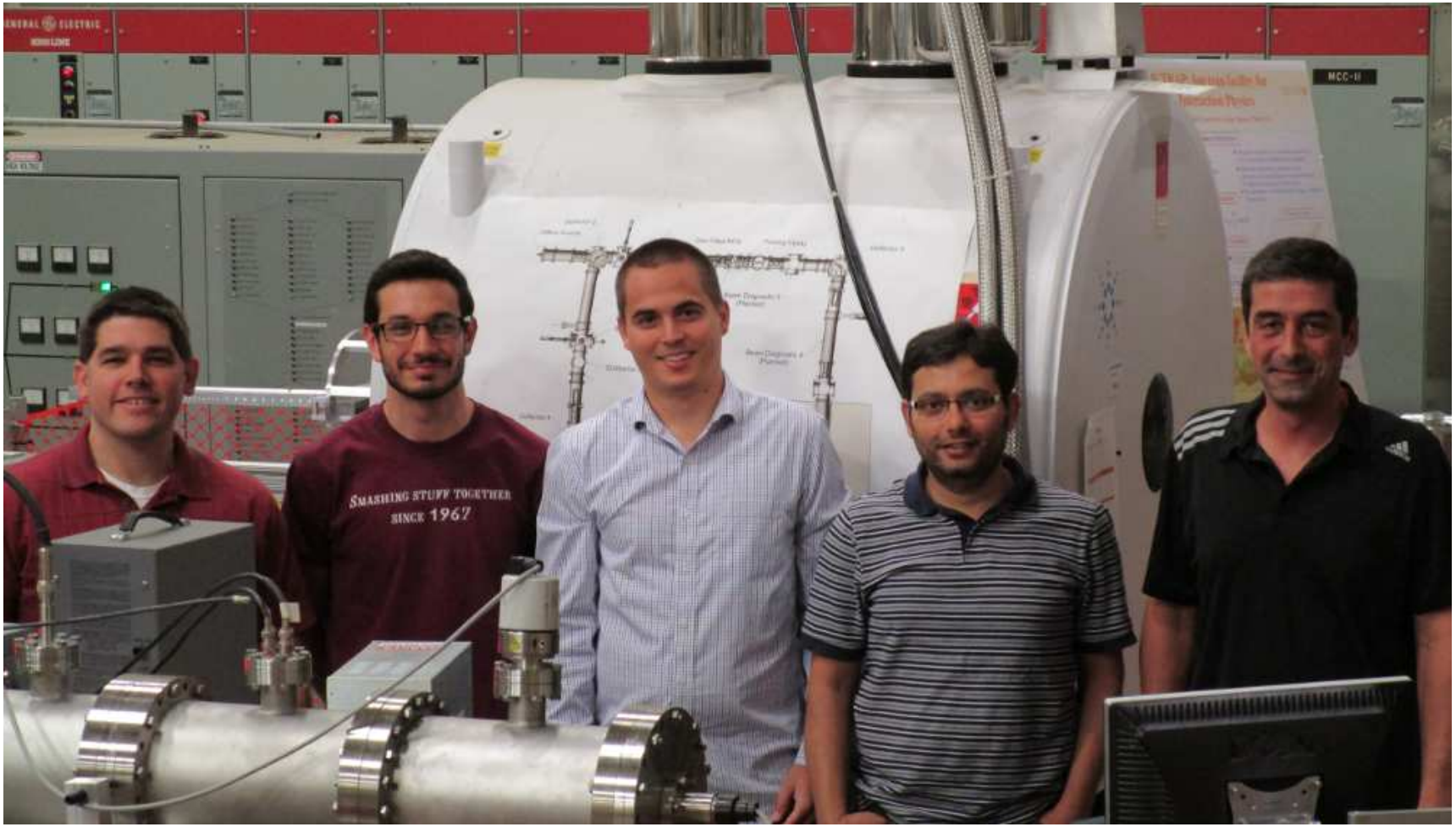
Current Status



The next steps

- Optimize loading of trap and develop DAQ
- Mass measurement by Christmas
- Align beamline axis with $\vec{B}$ field of magnet
- Couple to heavy-ion guide (summer?)
- Design and build 180-mm diameter trap and detectors

Contributors/Thanks



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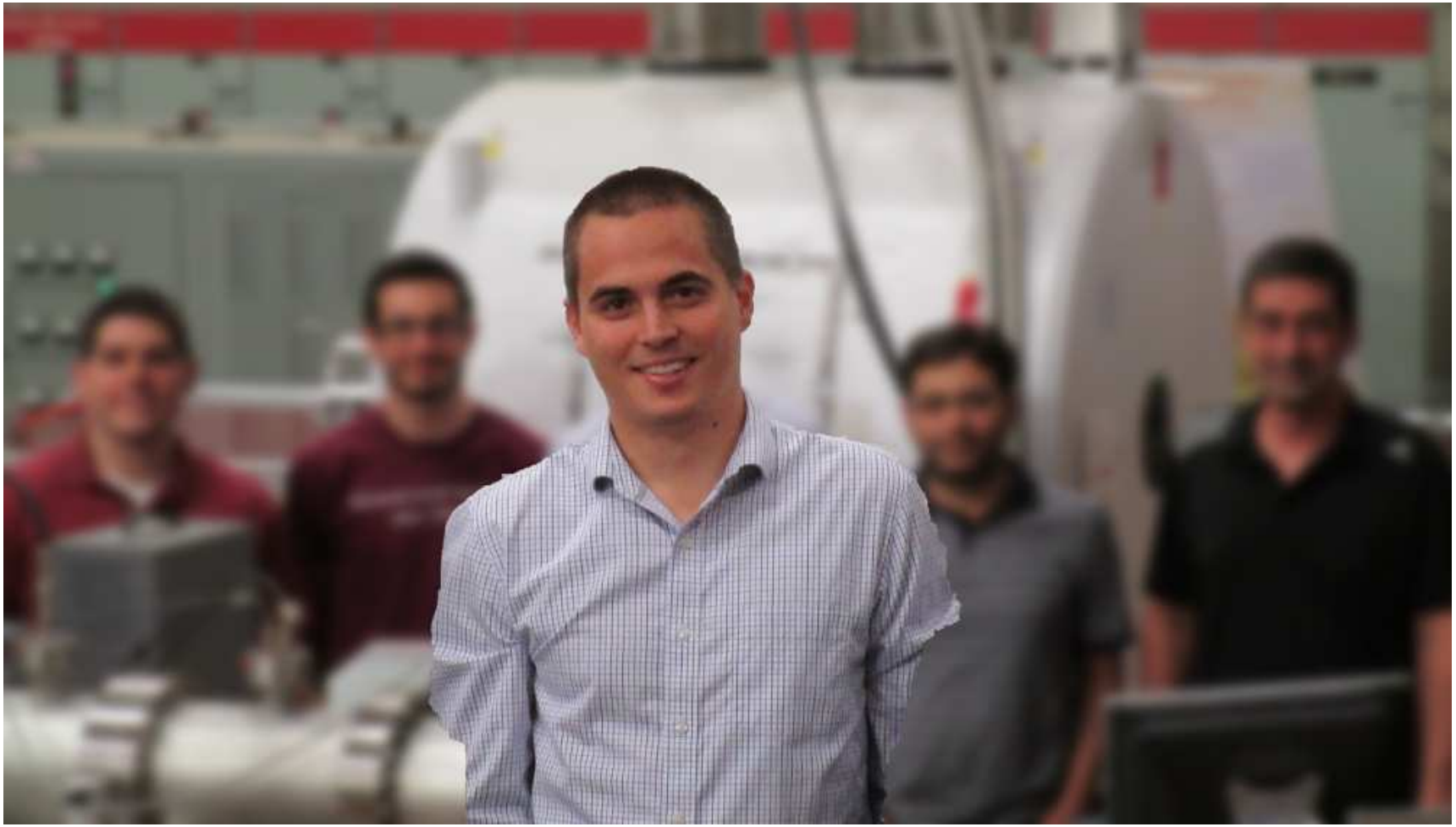

A_β result at 11:42 today!

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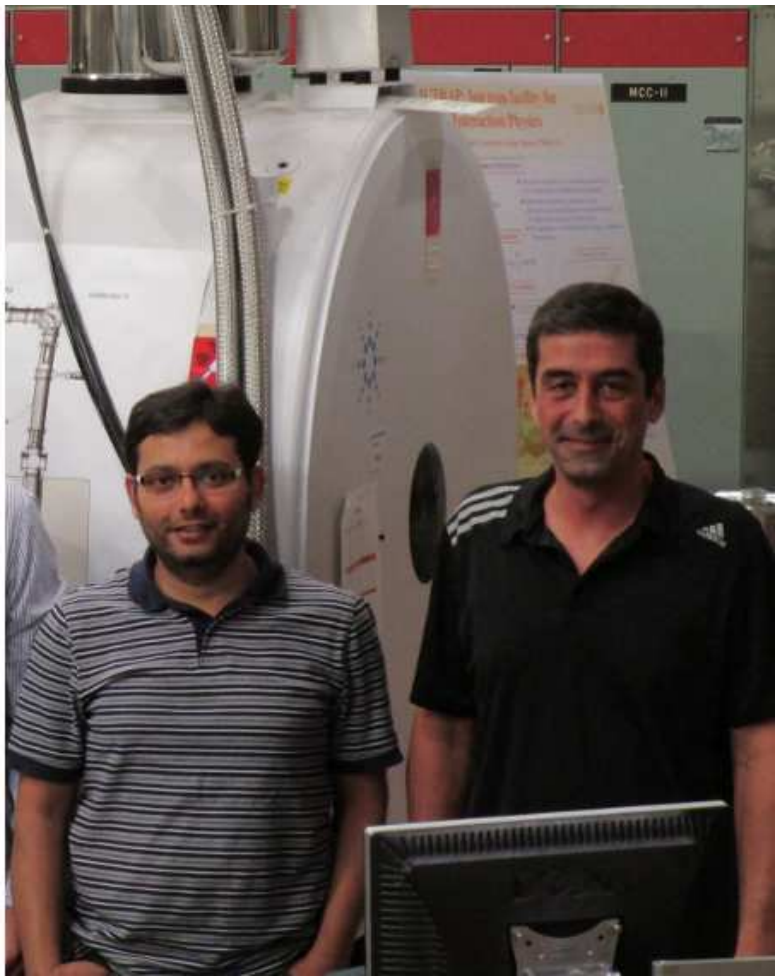

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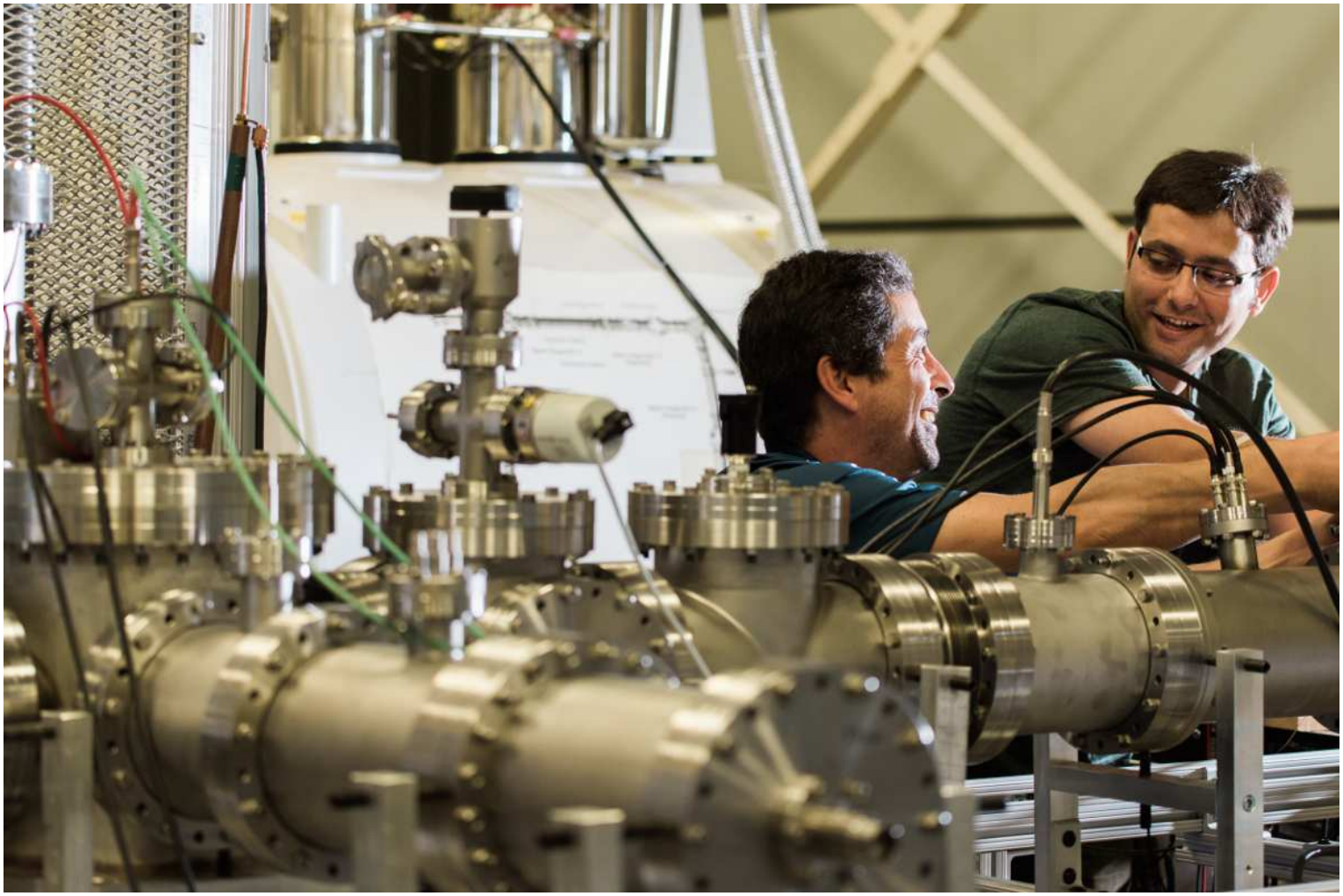

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E. Bennett
M. Mehlman

3 TAMU undergrads
4 REUs
2 international interns

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Special thanks to

T. Eronen, R. Ringle, G. Savard,
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