COLLINEAR LASER-SPECTROSCOPY AT ARGONNE NATIONAL LABORATORY (ANL)

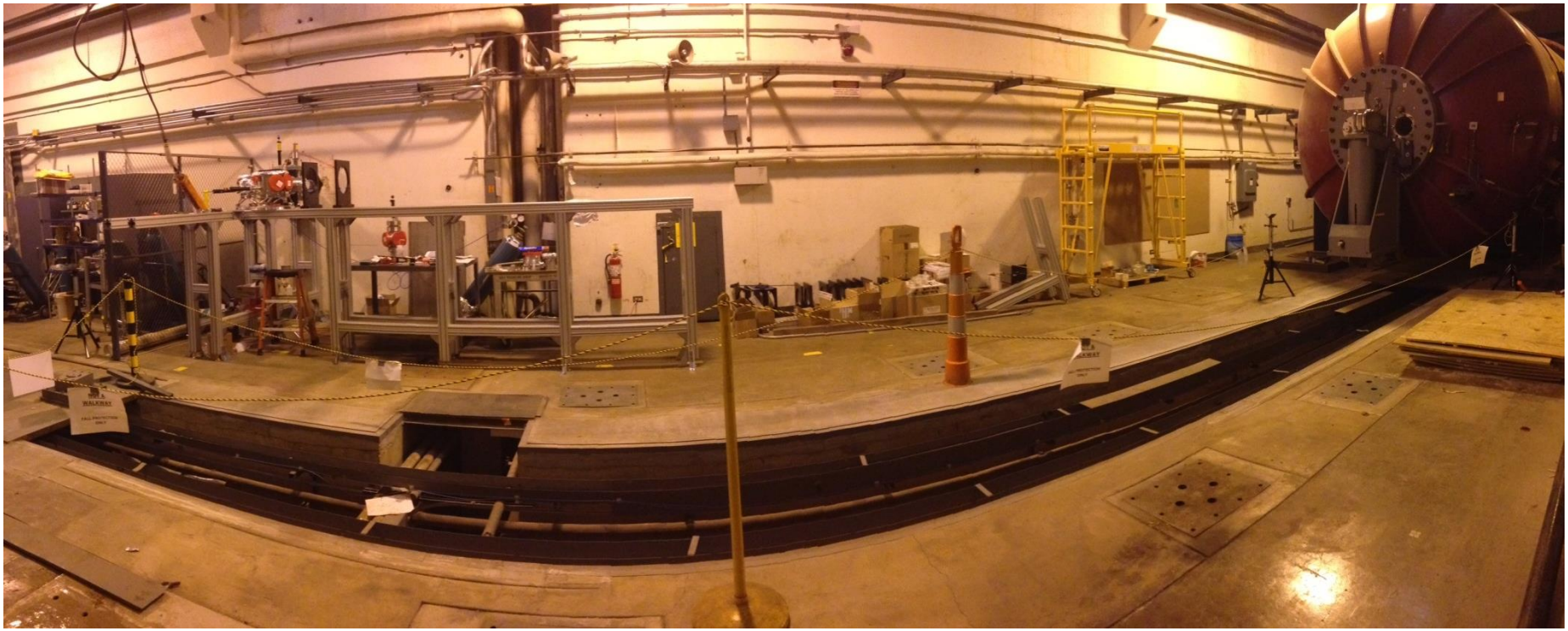
TECHNISCHE UNIVERSITÄT DARMSTADT

Argonne NATIONAL LABORATORY

Status Report of SFB Project A03

Felix Sommer – AG Lasersphere

SFB 1245



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Collinear Laser-Spectroscopy Experiments

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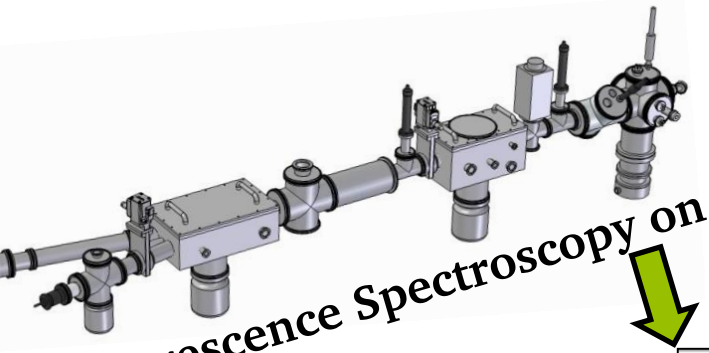
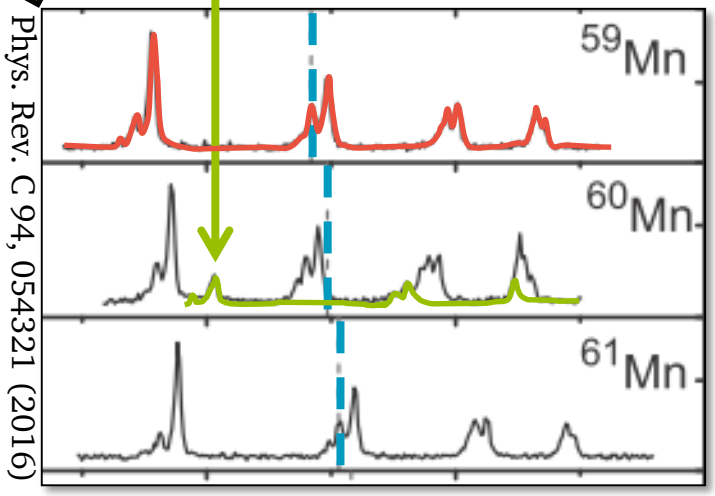
Model independent measurements!



Fluorescence Spectroscopy on fast atomic beam

- **Isomers**



- **Hyperfine structure**
  - ✓ nuclear spins
  - ✓ magnetic dipole moments
  - ✓ electrical quadrupole moments

- **Isotope shifts**
  - ✓ difference of charge radii within an isotopic chain

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Collinear Laser-Spectroscopy Beamline

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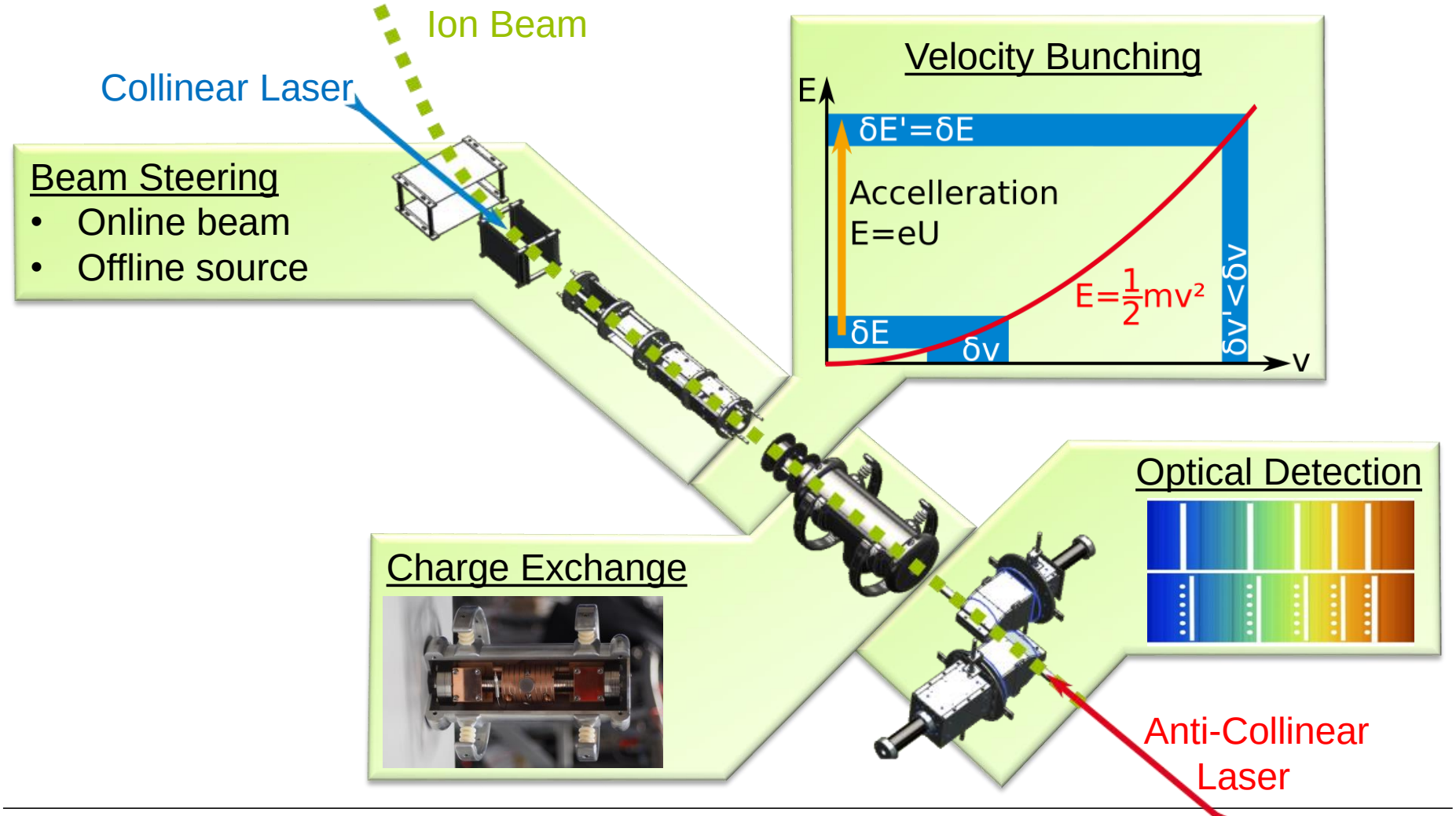

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The Future of TRIGA-Laser

Until 2016 | 2017 – 2025(?) | After 2025 (?)

Argonne National Lab and the ATLAS Facility

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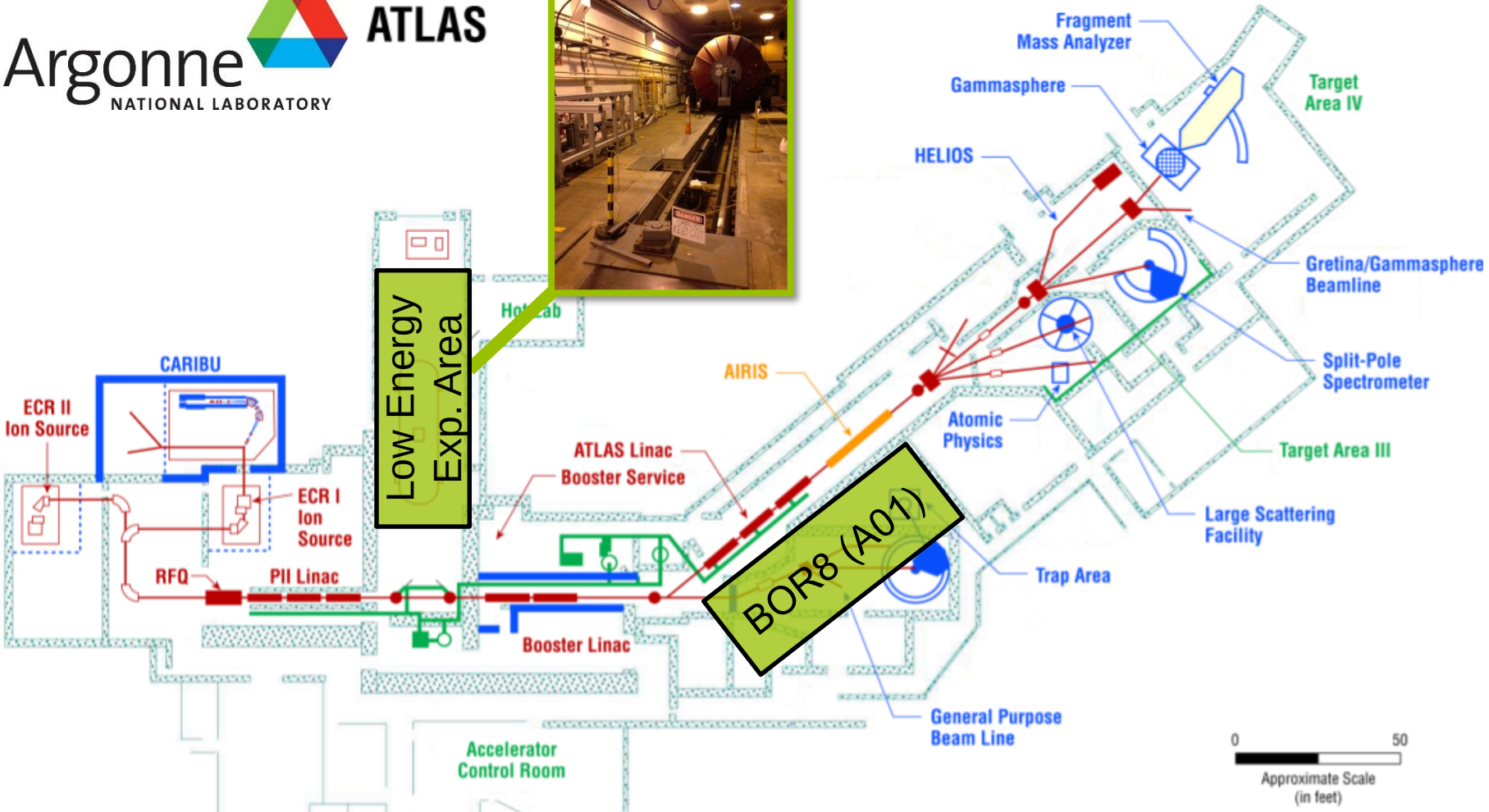
ATLAS



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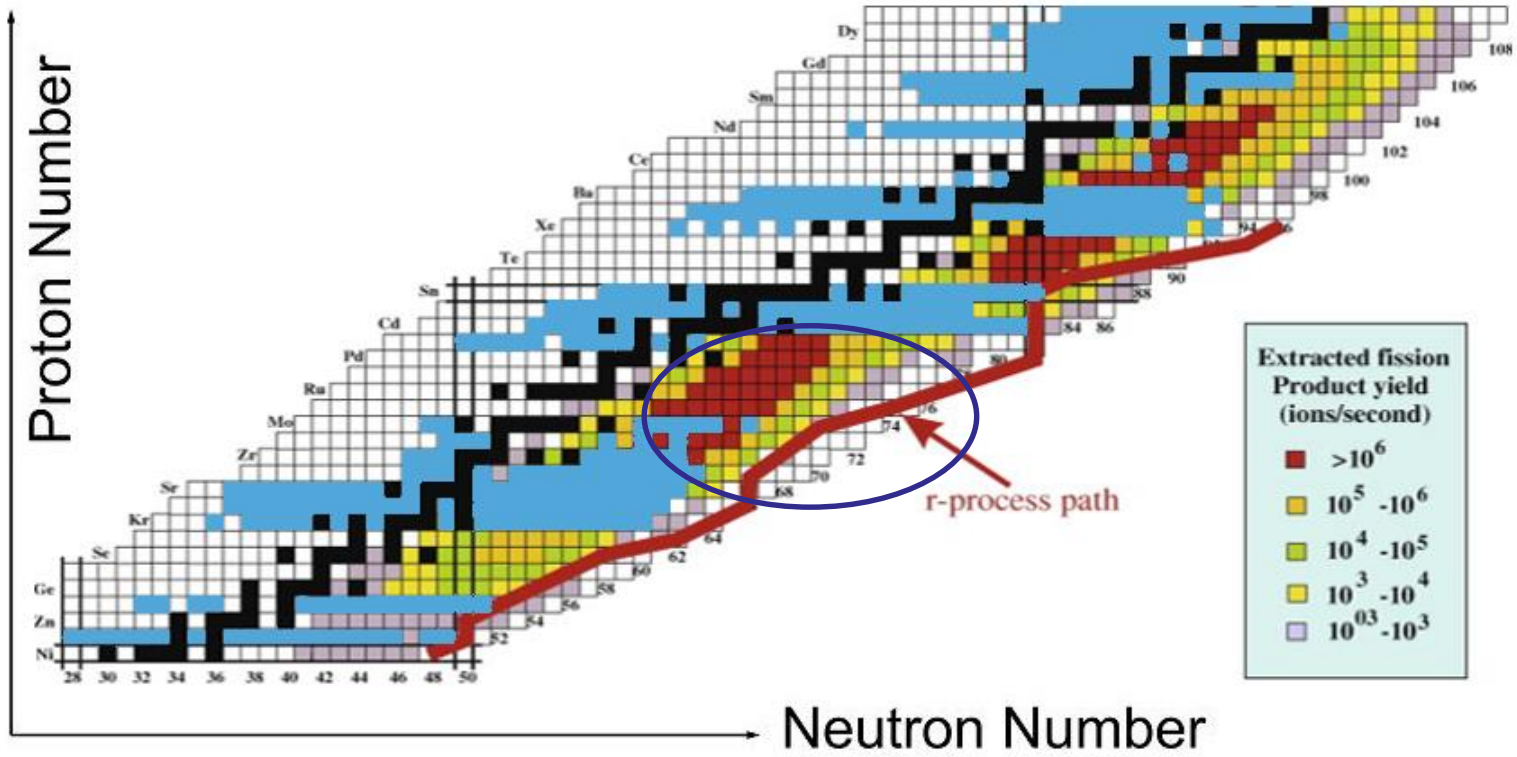
CARIBU Isotope Production



G.Savard et al. Nucl. Instr. Meth. B 266, 4086-4091 (2008) combined with data taken from our oversight on Laserspec

Nuclear Moments of Palladium

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- Nuclear shell model
  - → predicts characteristic linear increase of the el. quadrupole moments along nucleon chain
  - → Observed in Cd (Z=48) even beyond a single subshell
  - → Deeper understanding still missing
- 11/2-isotopes of Pd (Z=46)
  - → Z-dependence of this behaviour

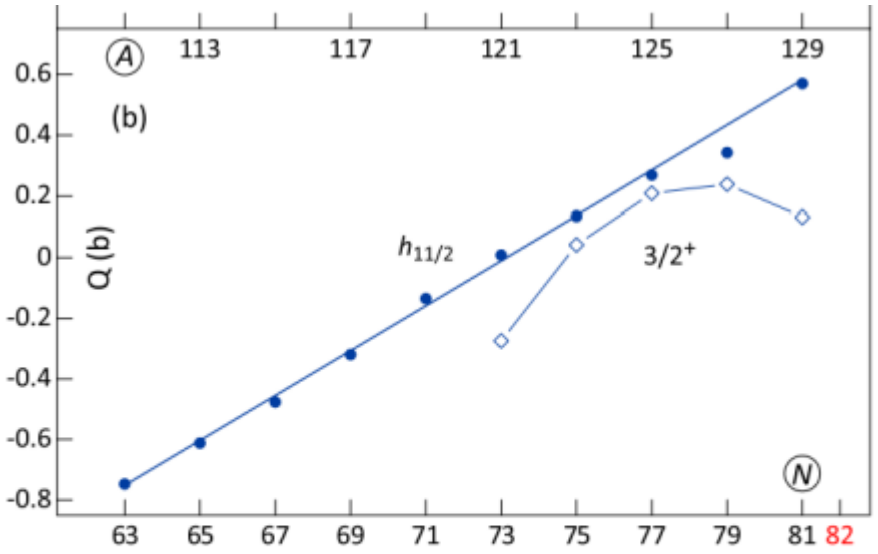

Figure 1: Quadrupole moments of the long-lived 11/2 isomers $^{111m-119m}$Cd (solid dots) and the $3/2^+$ states (open squares). The experimental uncertainties are smaller than the symbols. A straight line was fitted through the data points exhibiting the extremely linear behavior. A small deviation is only observed in ^{127m}Cd, which also exhibits irregular behavior in the B(E2) values.

D.T. Yordanov et al.∼. Phys. Rev. Lett., 110:192501, May 2013.

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Logistics of a Beamline Relocation

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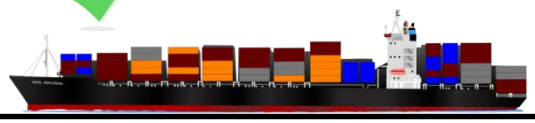
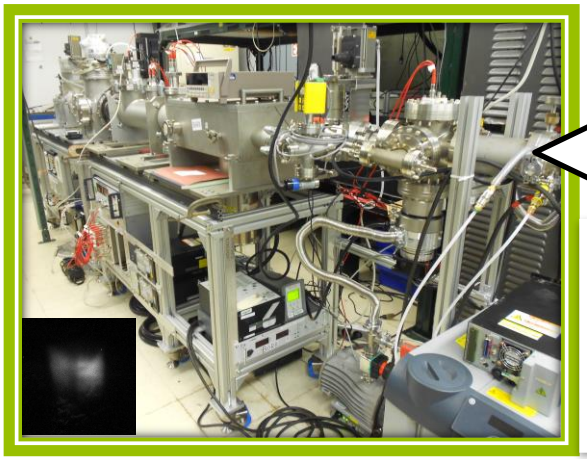
Disassembly

Bureaucracy





Assembly

Packing

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Collinear Laser Spectroscopy at ANL

Engaged scientists:

Felix Sommer, Peter Müller, Wilfried Nörtershäuser , Jason Clark, Jörg Krämer, Bernhard Maaß, Rodolfo Sanchez, Guy Savard

This work is suported by:

Inhalt

TECHNISCHE UNIVERSITÄT DARMSTADT

- Motivation/Übersicht A03
- Laserspektroskopie - Methode, Historie, Erfolge
- Argonne National Lab, CARIBU, ATLAS
- Recent status of the project

The Future of TRIGA-Laser

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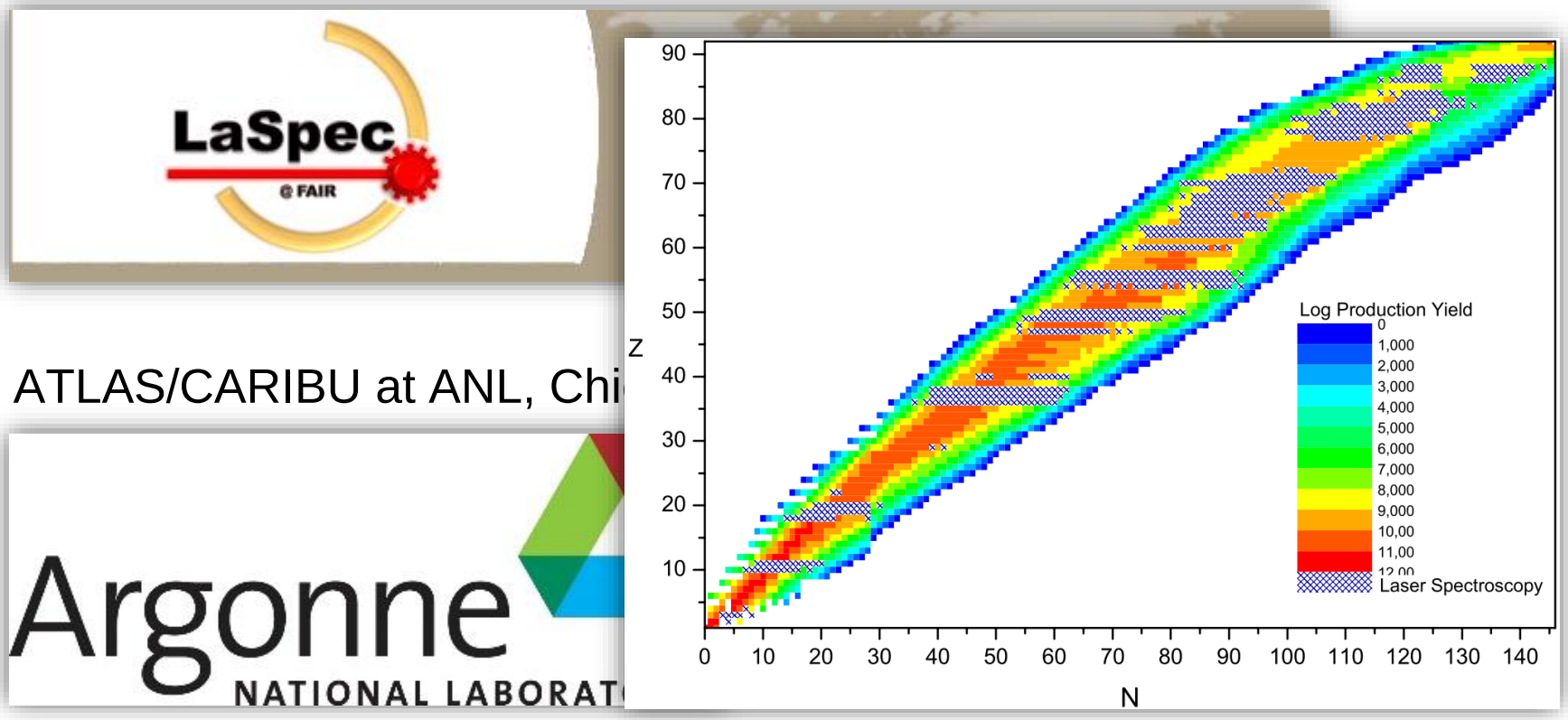
- LaSpec at FAIR, Darmstadt



- ATLAS/CARIBU at ANL, Chi

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LaSpec Proposal: "LASER spectroscopy for the study of nuclear properties", LASPEC Collaboration; corresp. author: W.Nörtershäuser

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A Brief History of Collinear Laser Spectroscopy

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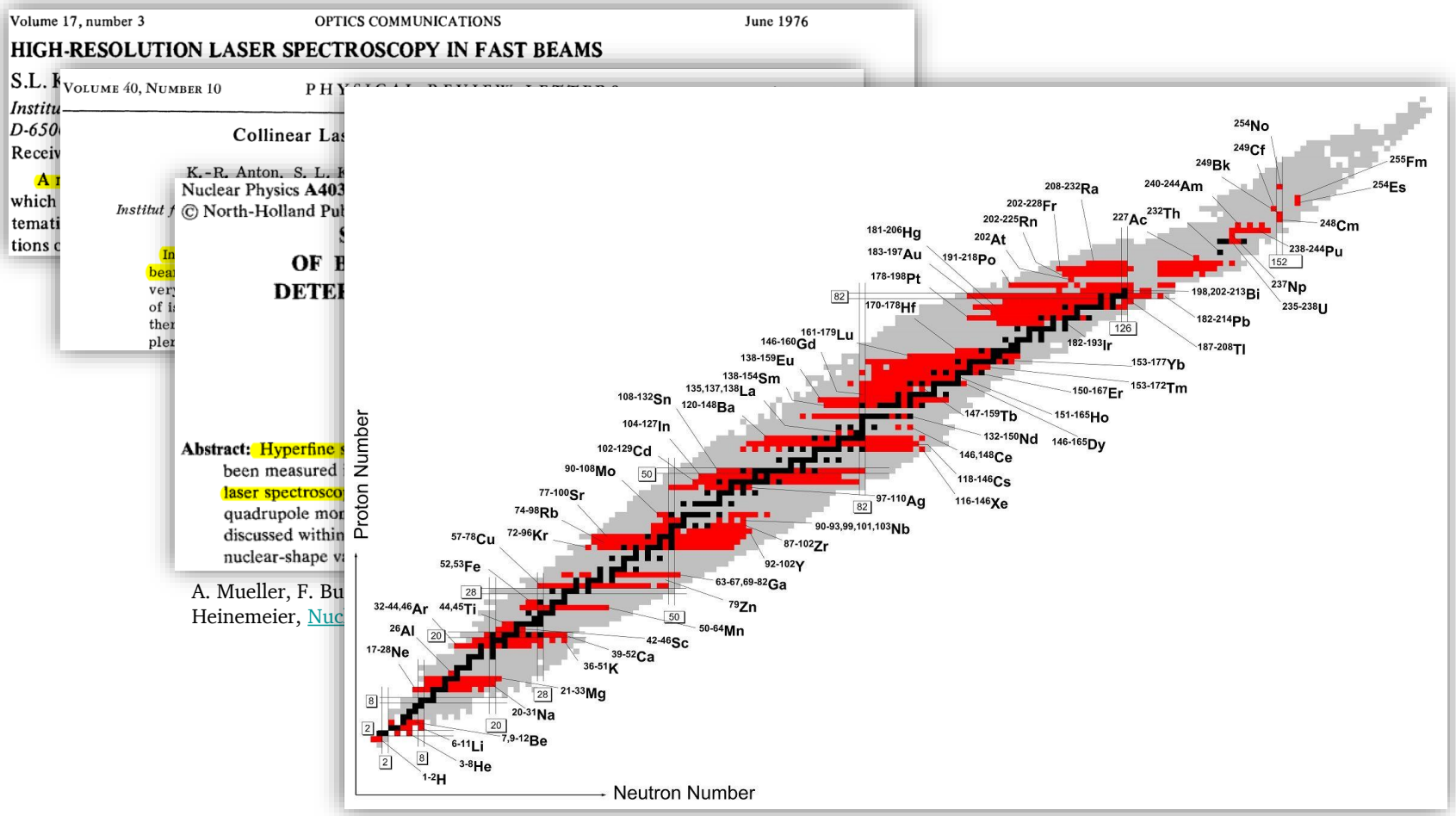

Laser spectroscopy survey. Graphic, references and articles available online:
http://www.ikp.tu-darmstadt.de/gruppen_ikp/ag_noertershaeuser/research_wn/exotic_nuclei_wn/uebersicht_2/laserspectroscopy_survey.de.jsp

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Hidden Secrets in the Optical Spectrum

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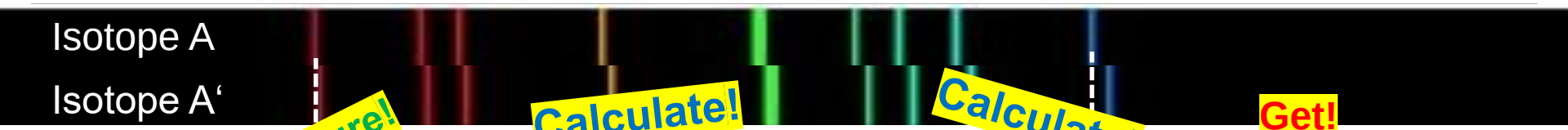
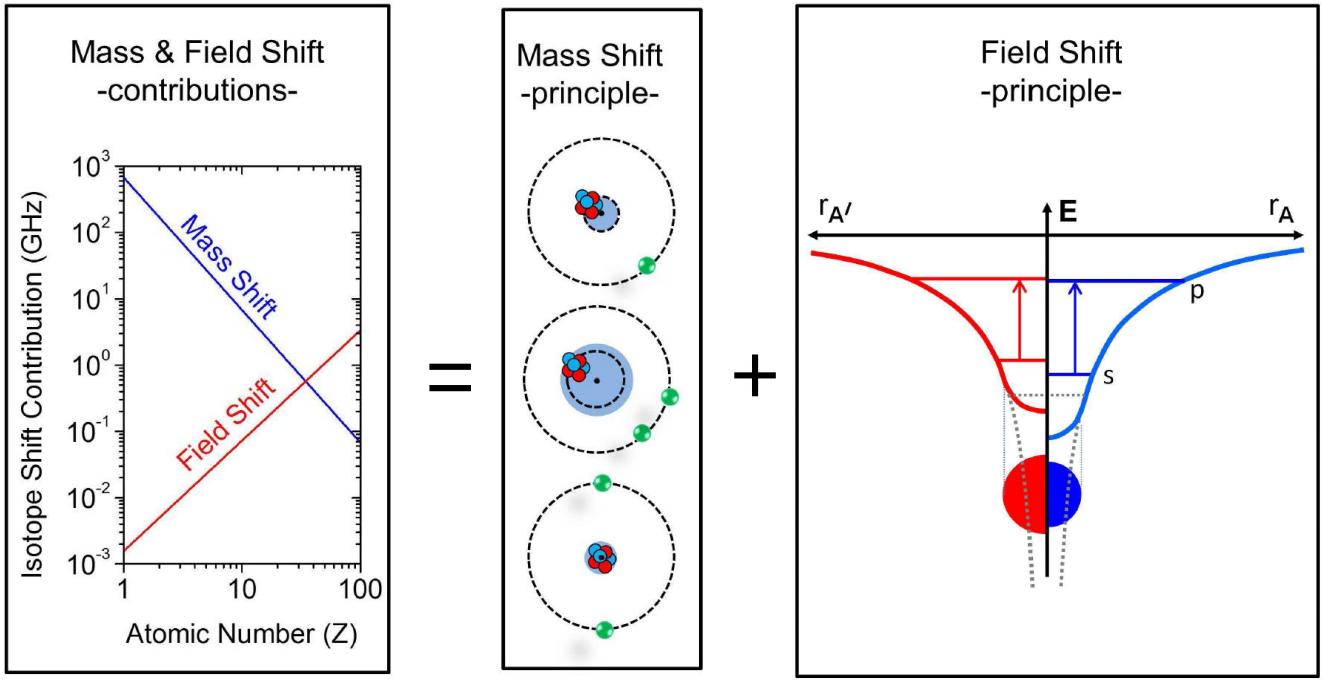


Measure! Calculate! Calculate! Get!

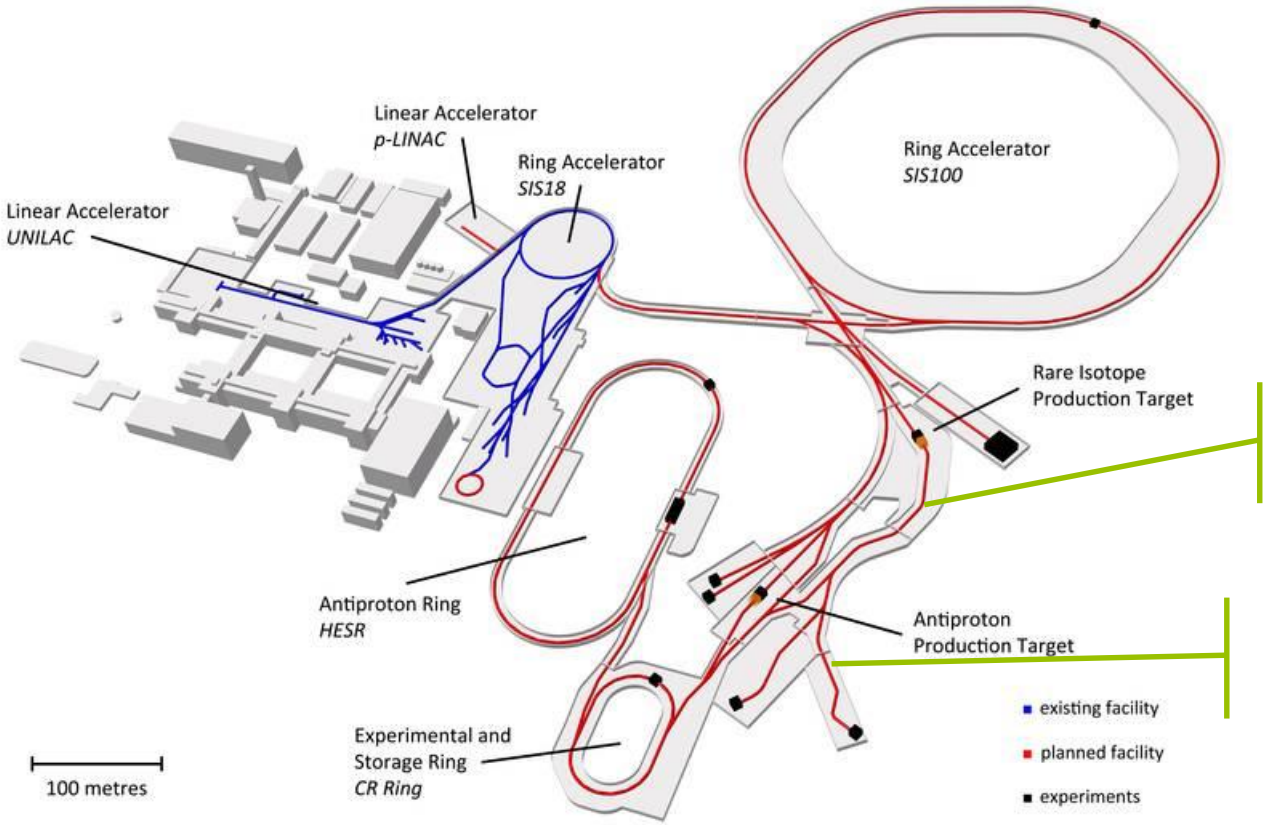
$$\delta\nu_{\mathrm{IS}}^{AA'} = K_{\mathrm{MS}} \cdot \frac{M_{A'} - M_A}{M_A M_{A'}} + \frac{2\pi Ze}{3} \Delta \left|\Psi(0)\right|^2 \delta \left\langle r^2 \right\rangle^{AA'}$$

Mass Shift (center-of-mass motion) Field Shift (finite size)



W. Nörtershäuser and C. Geppert, The Euroschool Lectures on Physics with Exotic Beams Volume IV, Lect. Notes Phys., **879**, 233-292 (2014)

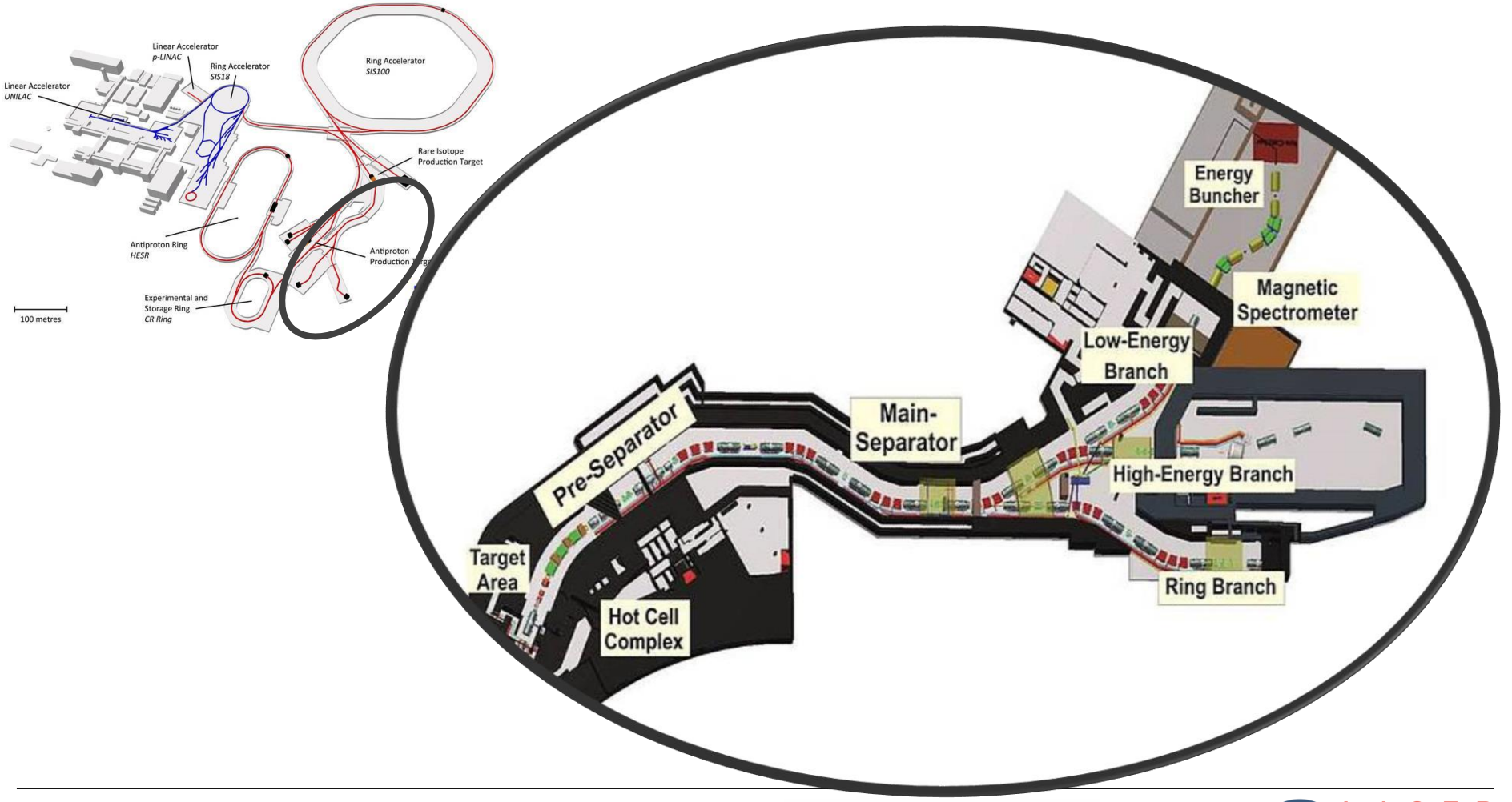
Laspec at FAIR



Super Fragement Separator (SFRS)

Low-Energy Branch

Super Fragment Separator (SFRS)



CARIBU (CAlifornium Rare Isotope Breeder Upgrade)

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Production: Spontaneous fission of ^{252}Cf. 10^9 fission recoils per second

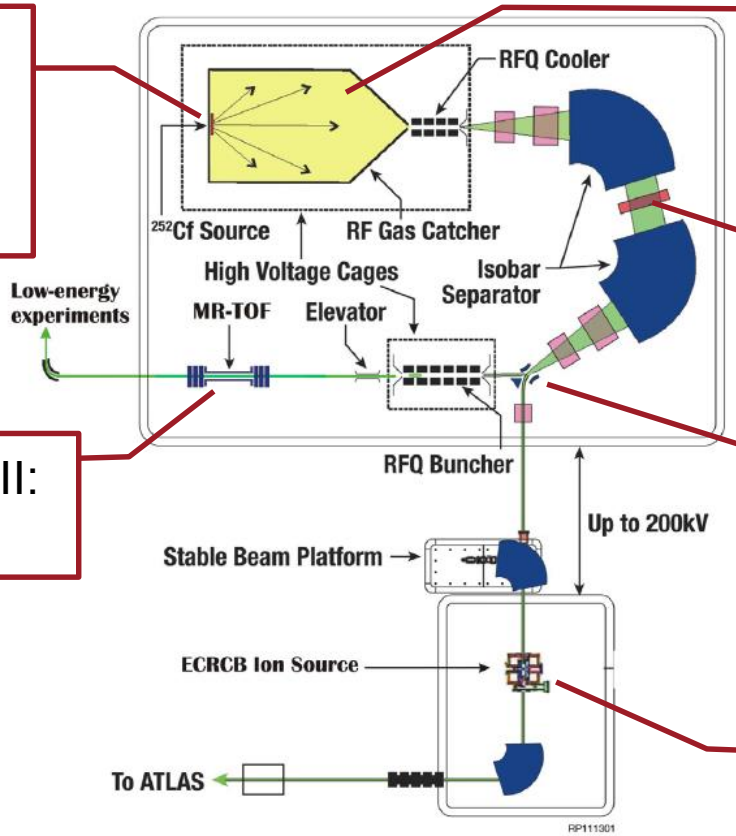
Stopping of recoils in RF gas catcher

Mass separation I: Resolution 10^4

Mass separation II: Resolution 10^5

Switchyard

Charge Breeding



*G.Savard et al. Nucl. Instr. Meth. **B** (2016), http://dx.doi.org/10.1016/j.nimb.2016.02.050*

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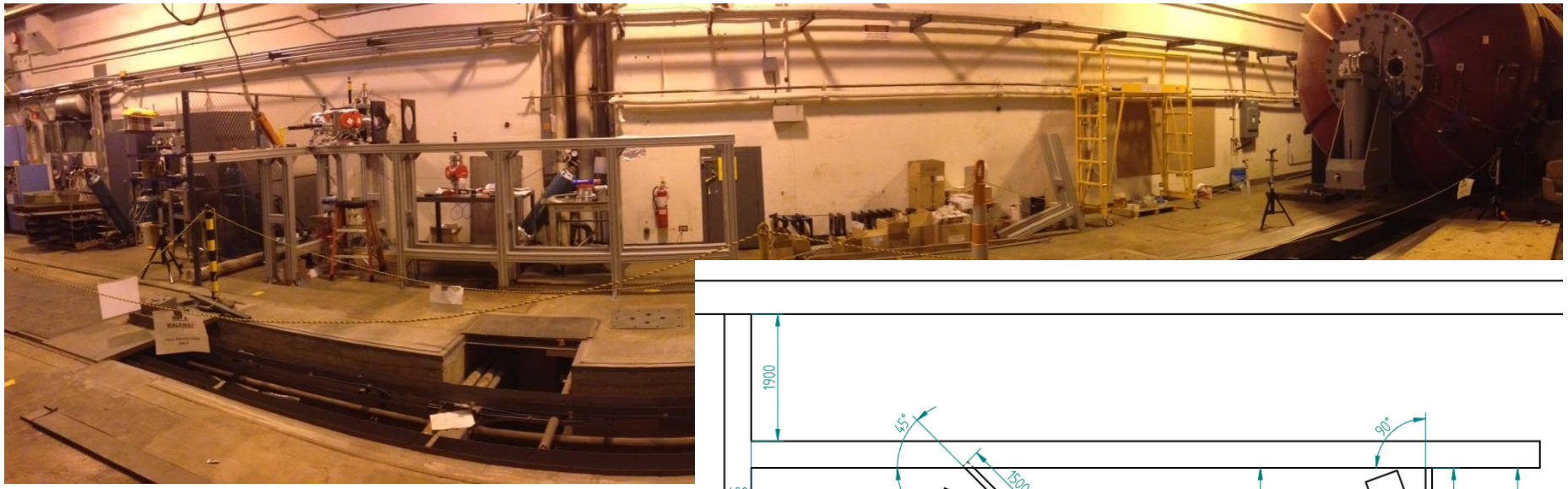
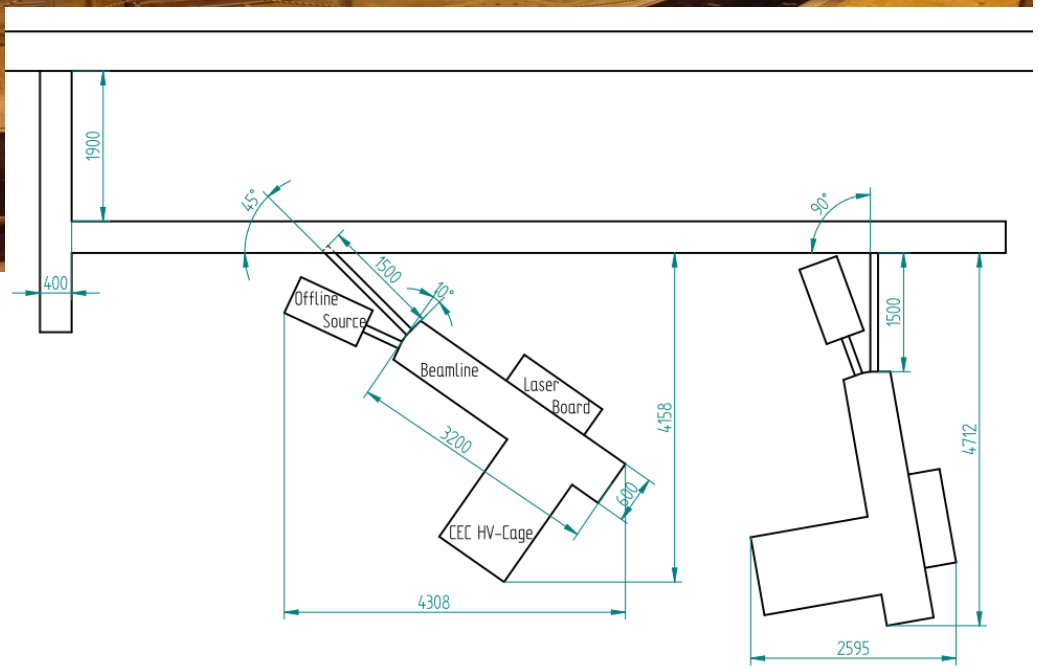
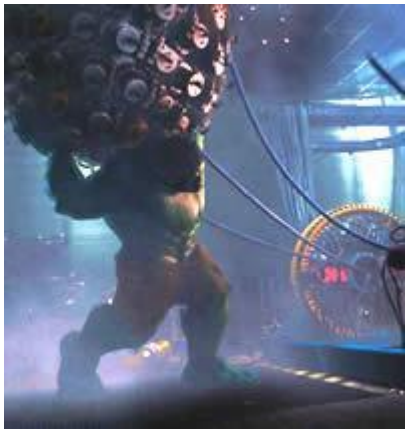
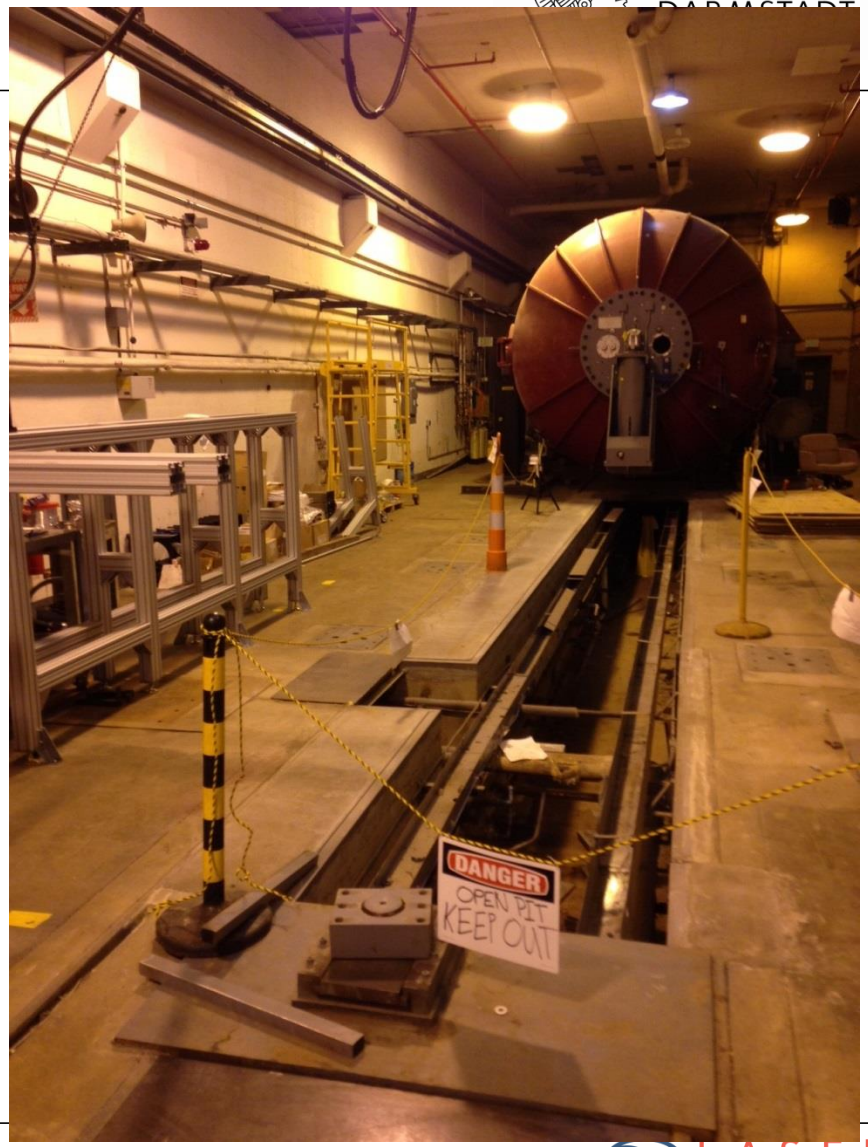



1900
45°
400
1500
10°
Offline
Source
Beamline
Laser
Board
3200
4158
CEC HV-Cage
4308
90°
1500
4712
2595




DANGER
OPEN PIT
KEEP OUT