ORISS:
Oak Ridge Isomer Spectrometer and Separator
Construction, Optimization and First Experiments

for
Study of Exotic Decays

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University Radioactive Ion Beam Consortium
UNIRIB

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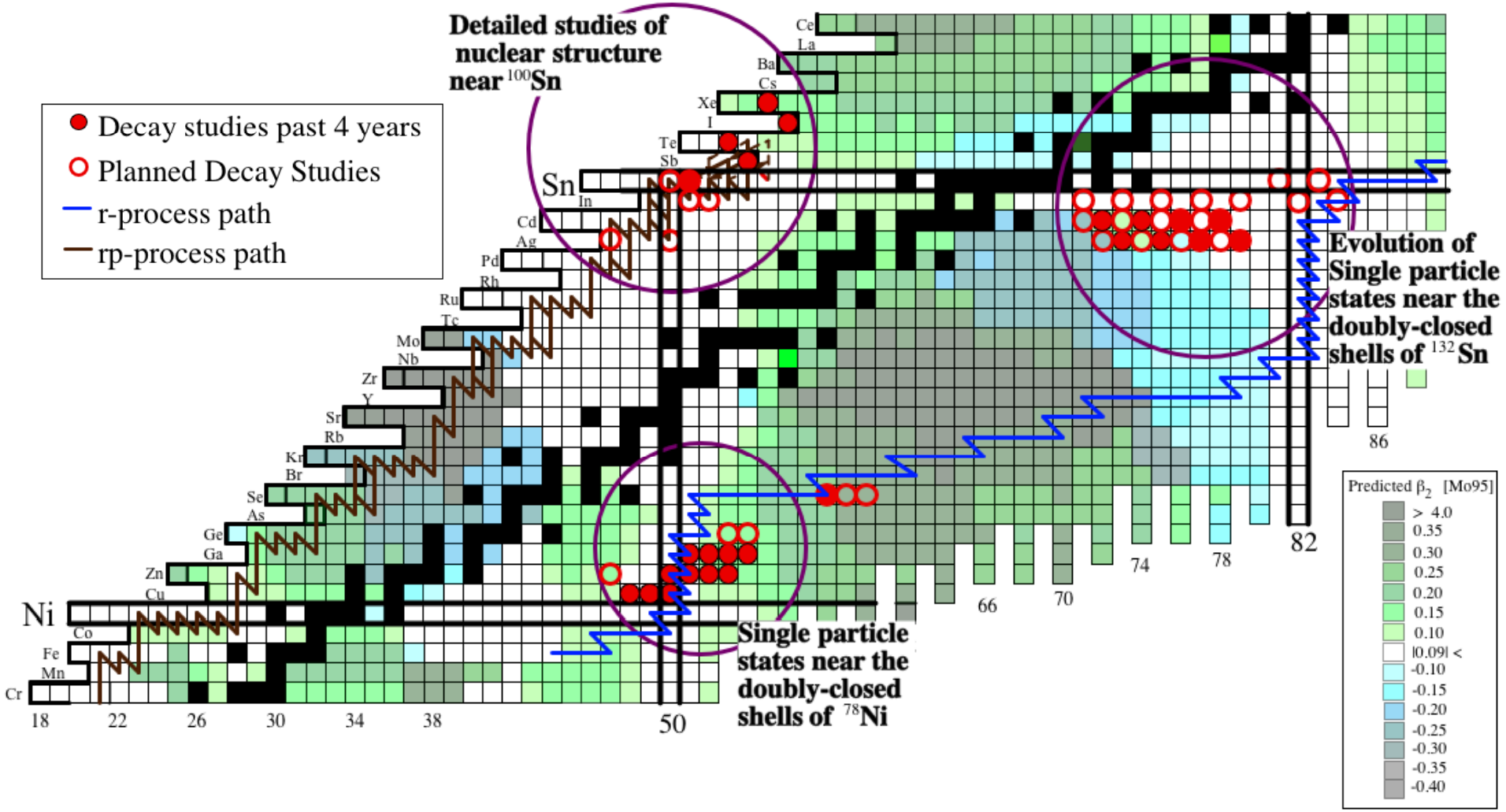
Research Areas

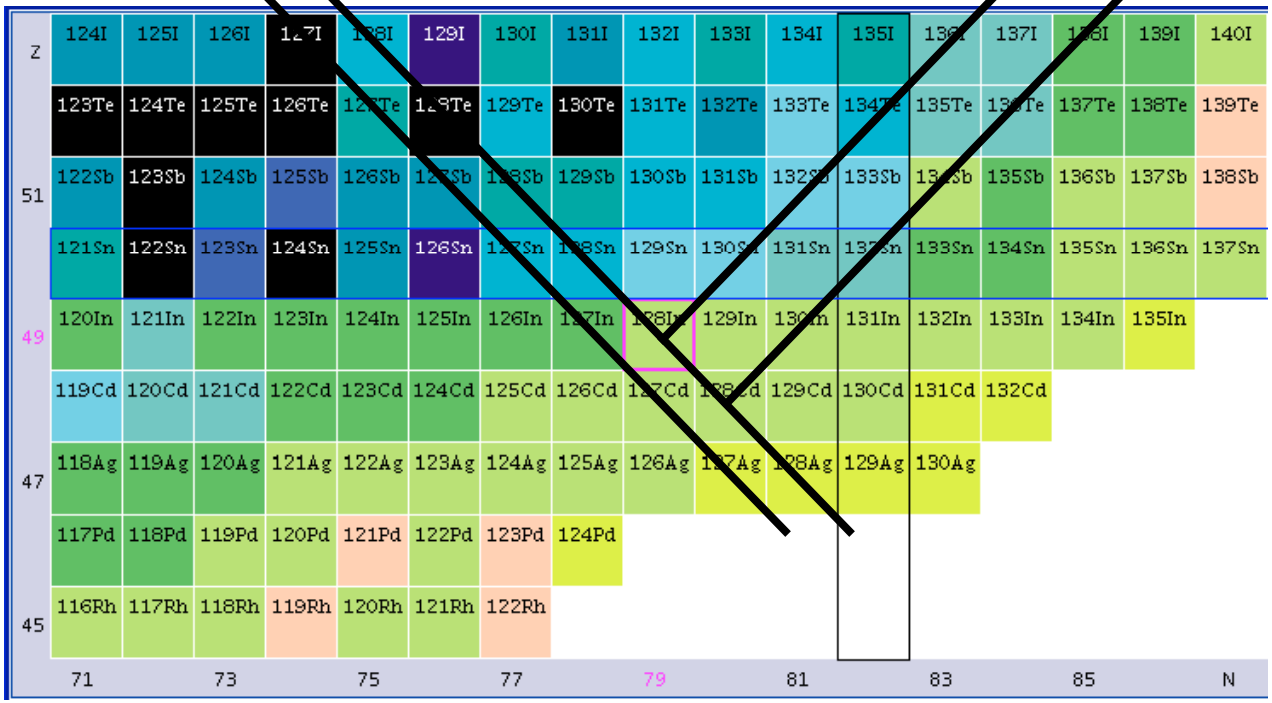


Goals and Deliverables

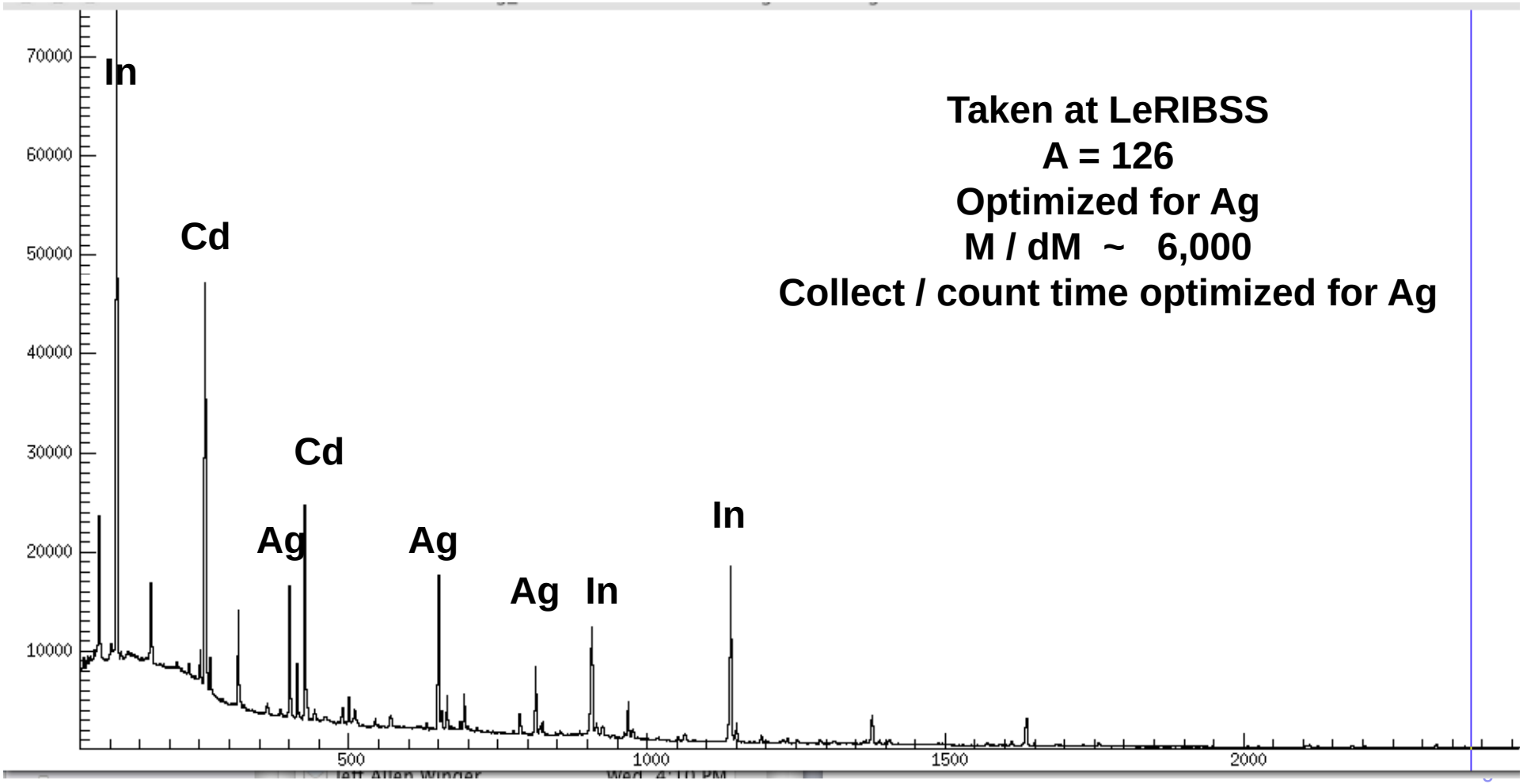
Separator for Decay Spectrocopy

Mass Resolution 40,000 → 400,000

Transmission 50% → ~ 20,000

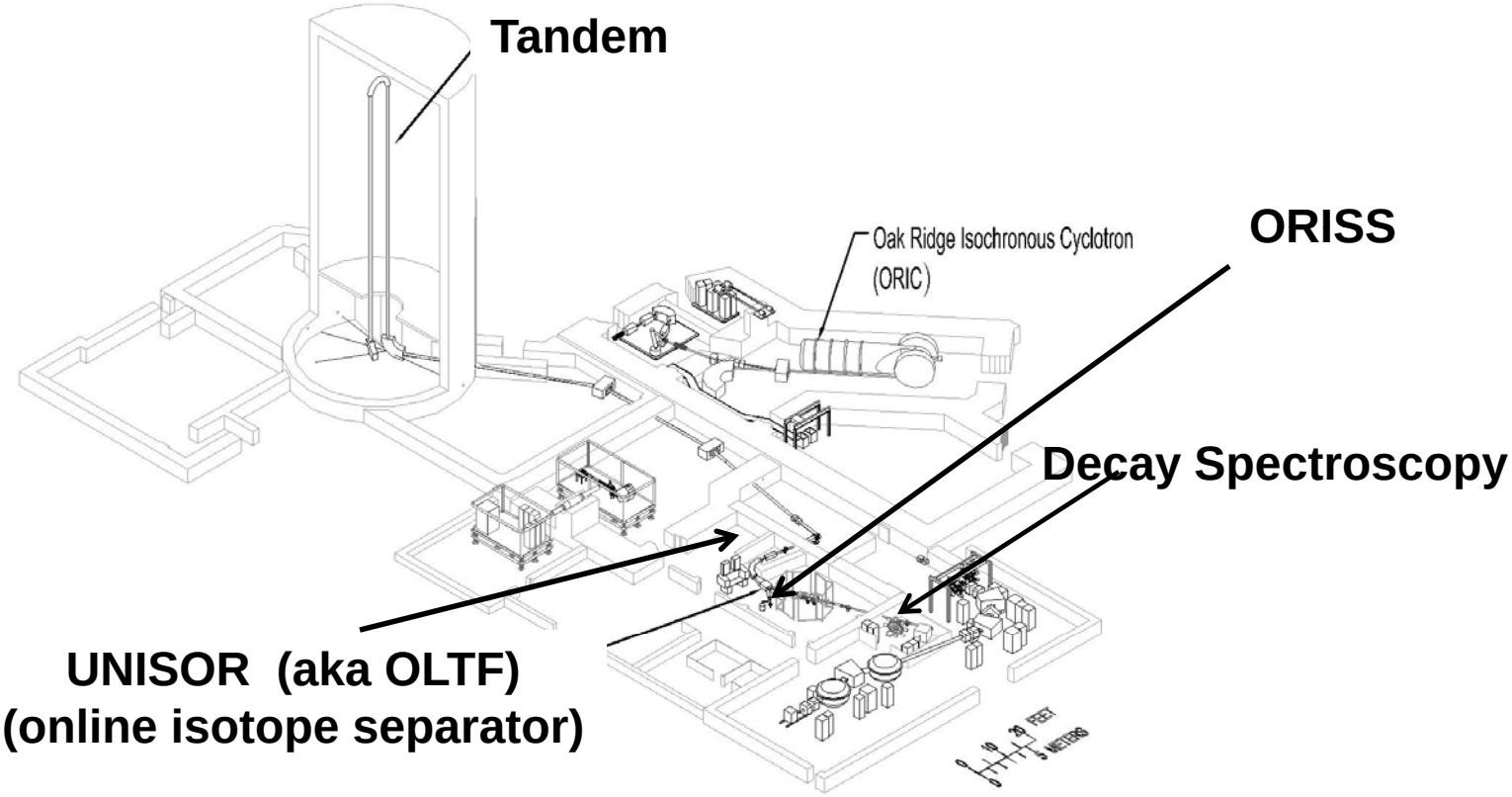


EXAMPLE



Taken at LeRIBSS
A = 126
Optimized for Ag
M / dM ~ 6,000
Collect / count time optimized for Ag

Pure Beams for Nuclear Physics



Goals and Deliverables

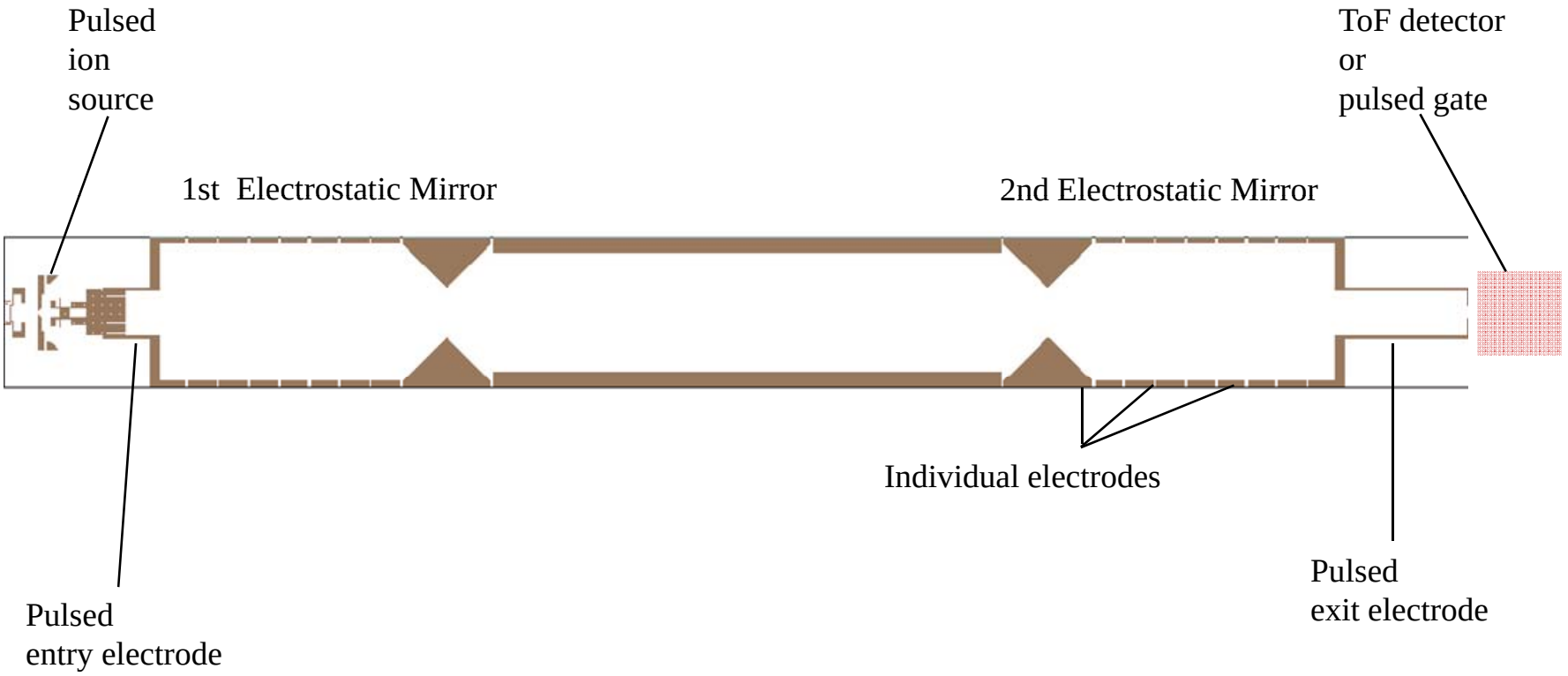
Separator for Decay Spectroscopy

- Mass resolution of 400,000

  (pure beams based on one parameter – mass)
- Transmission of 50 %

Concept to obtain desired resolution

Multi-pass Time-of-Flight system: concept



Ion Optics Solution

ToF aberrations up to the 5th order are minimized by optimization of electrode geometry and voltage settings

Program Input:
Full description of the geometry of the system
Initial set of electrode voltages
Initial ion cloud parameters (r.m.s. values)

Program Output:
Set of optimized electrode voltages
Residual ToF aberrations
An estimate of the mass resolving power

V. Shchepunov and H. Wollnik, in: Proc. of the Particle Accel. Conf., May 16-20, 2005, Knoxville TN

Code also established system requirements
Stability of High Voltage Power Supplies, mechanical tolerances, other basic parameters

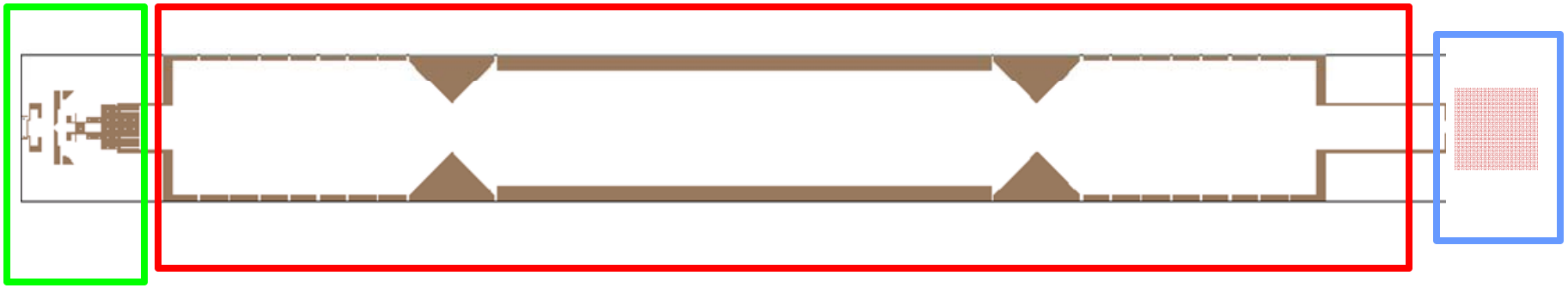
2.5 ppm r.m.s. stability is required to achieve 1/400,000 absolute mass stability

Mirror alignment requirements:	**0.2 mm, 0.2 mrad,**
Initial ion cloud parameters in the buncher (r.m.s.):	**0.3 mm, 0.025 eV,**
Transversal beam emittance in the drift tube (r.m.s.):	**~ 1.4 π mm mrad ,**
Isochronous transversal acceptance of MTOF:	**~ 40 π mm mrad ,**
Isochronous energy acceptance of MTOF:	**~ 4%**
Cooling time in buncher:	**6 – 10 ms**
Flight time (A = 77, 100 laps, M /dM = 270,000)	**10.6 ms**
Calculated optical limit for m/dm for infinite number of laps without the space charge:	**3,400,000**

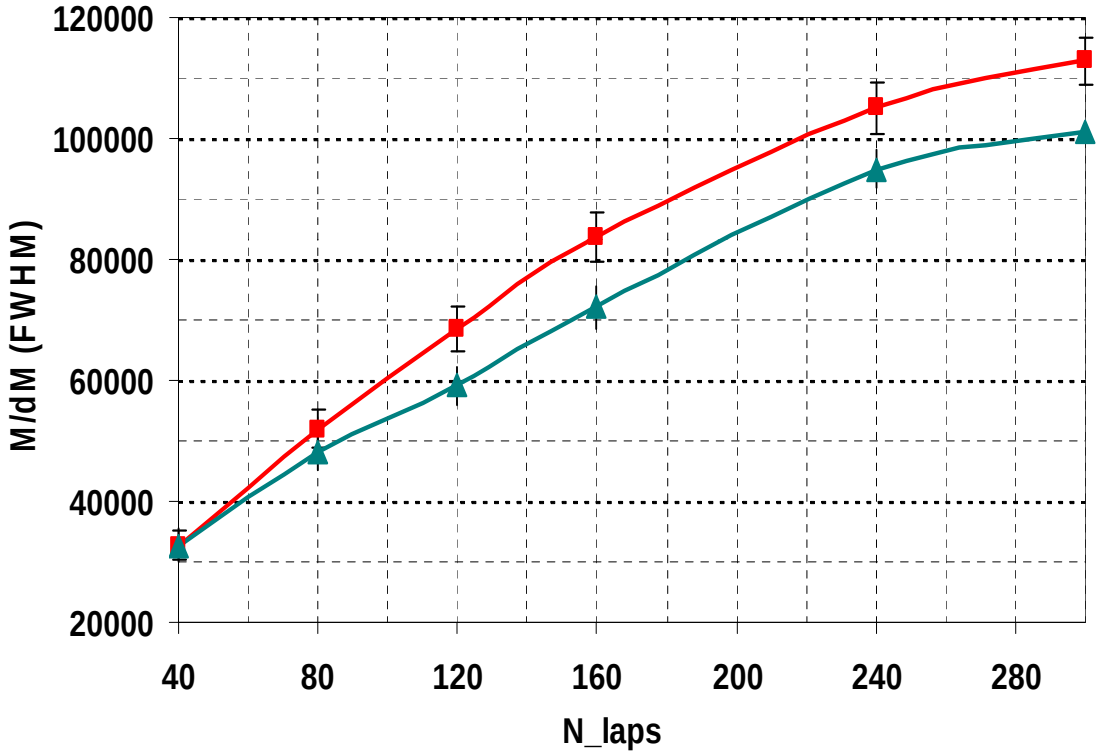
Status and results

Results

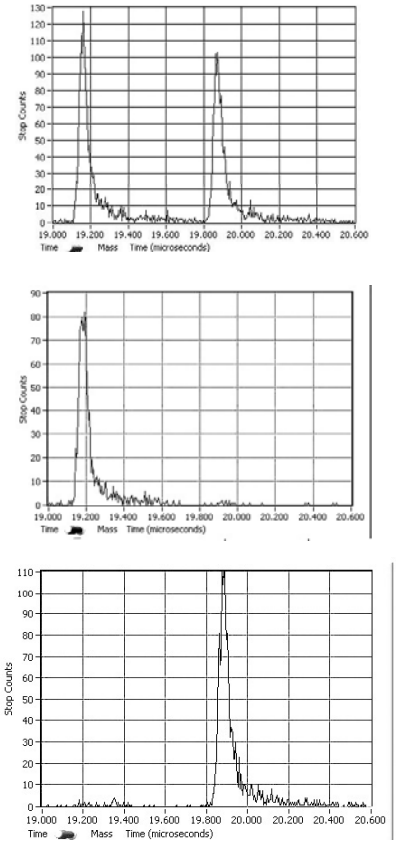
- Three major components tested separately and meet specifications
  - Multipass time of flight
  - Pulsed gate for separator; ToF detector for spectrometer
  - RFQ buncher and cooler



Multipass Time of Flight Spectrometer
Tested stand alone – meets specs



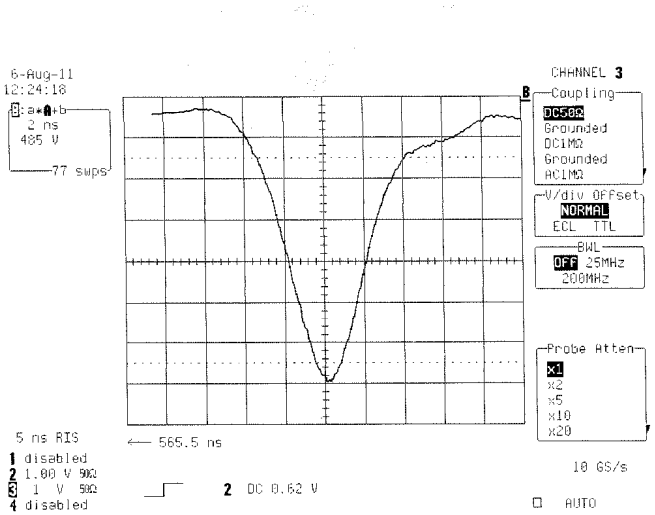
Pulsed Gate for Separator



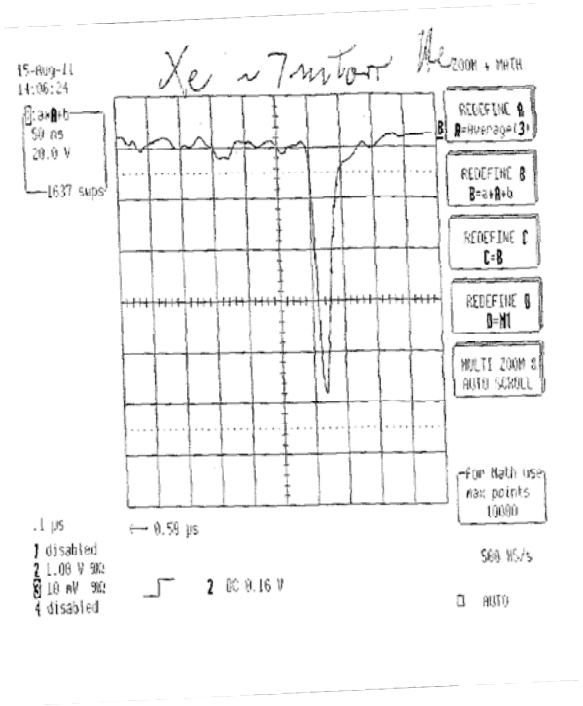
Design of a High-Voltage, Differential Drive Bradbury-Nielsen Gate Amplifier with Ultra-High Slew Rate and Input Isolation, Kevin C. Omoumi, Masters Thesis, University of Tennessee, May 2011.

RFQ Buncher and Cooler

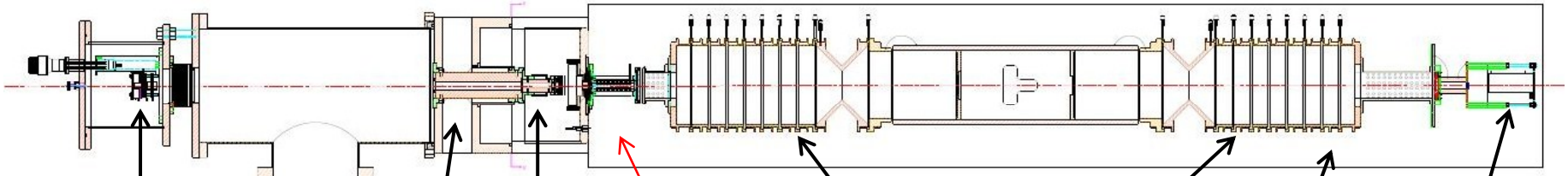
N_2
FWHM = 4 nsec



Xe
Multiple isotopes



Present Status
All components assembled, operational

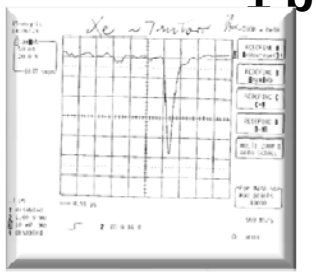


Electron Impact
Ion Source
for off line testing

RFQ Buncher
and Cooler

Each mirror:
8 electrostatic
1 pulsed electrodes

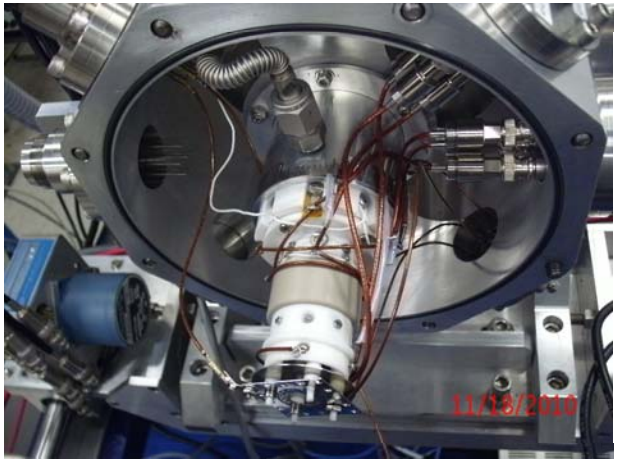
ToF Detector
Or
Gate

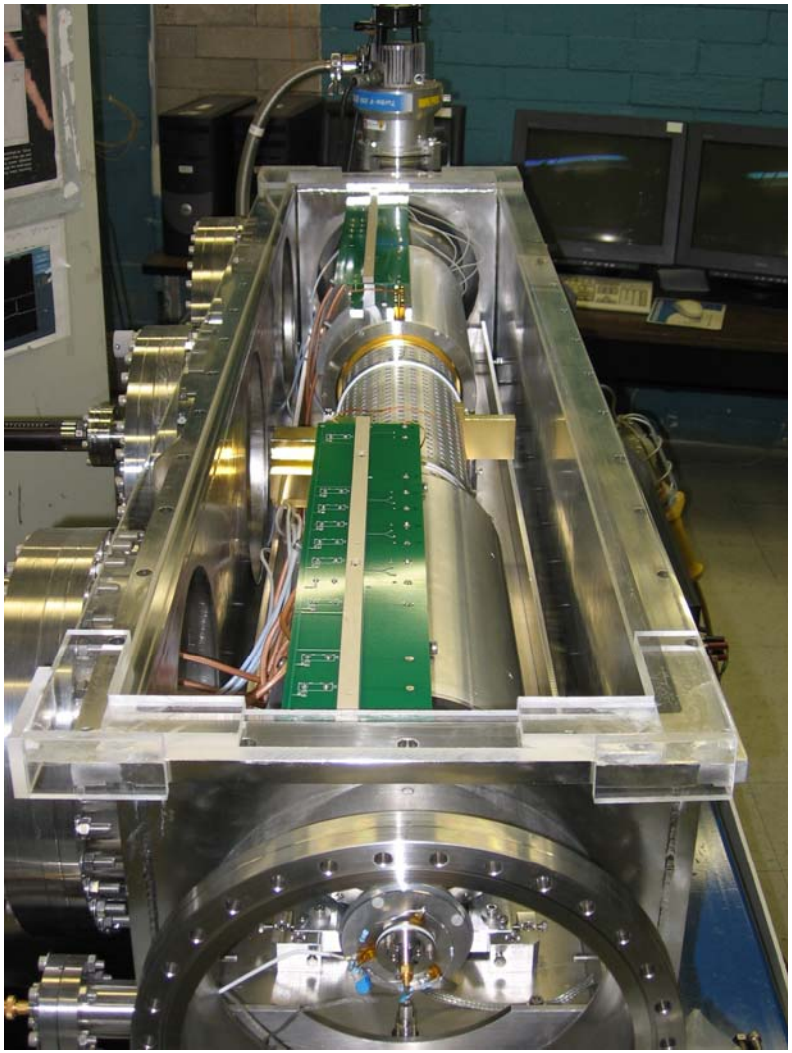


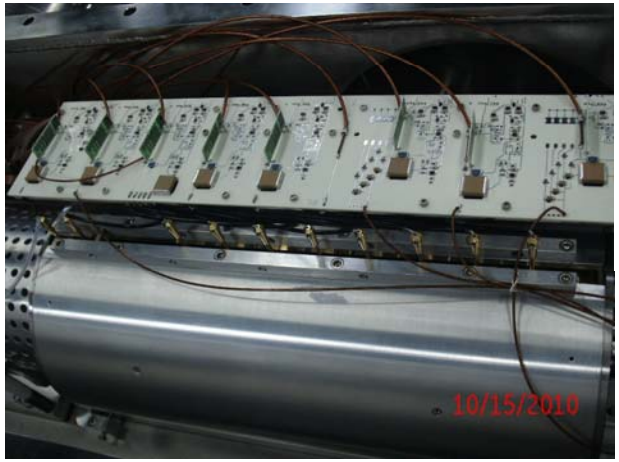
Pressure: RFQ 5 – 10 mTorr, He MTOF 1×10^{-8}

Offline testing has begun – first TOF spectra momentarily

All Mechanical, Electronic Components and Controlling Software in place



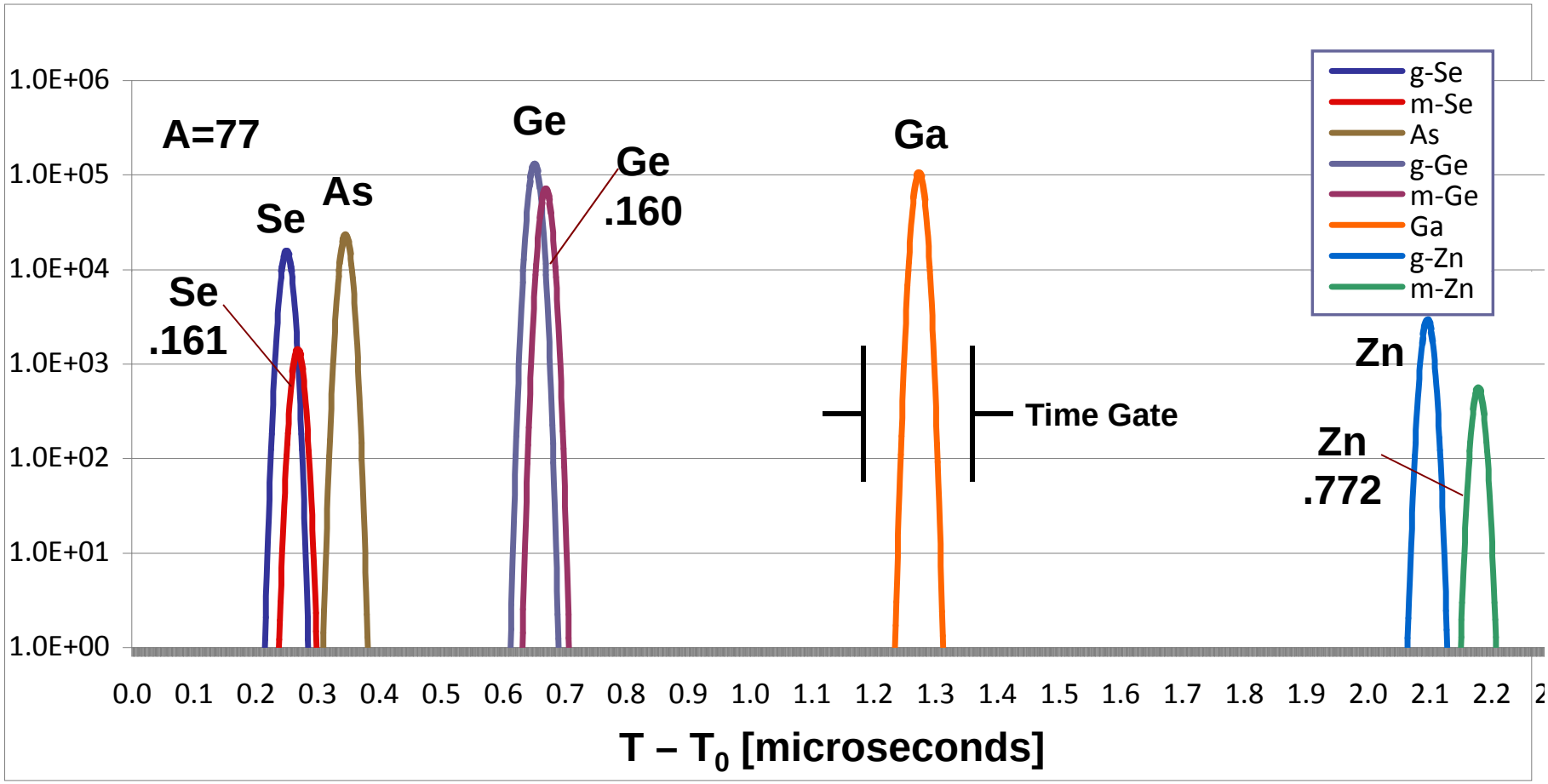




SIMULATION

What you can do with mass resolving power of 400,000:

- **resolve all isobars**
- **resolve many isomers**

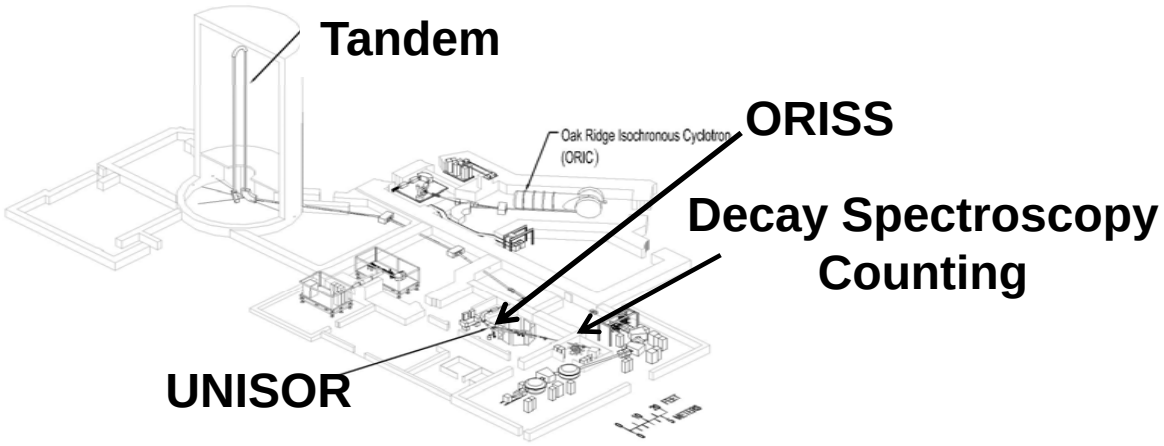


Budget and Schedule

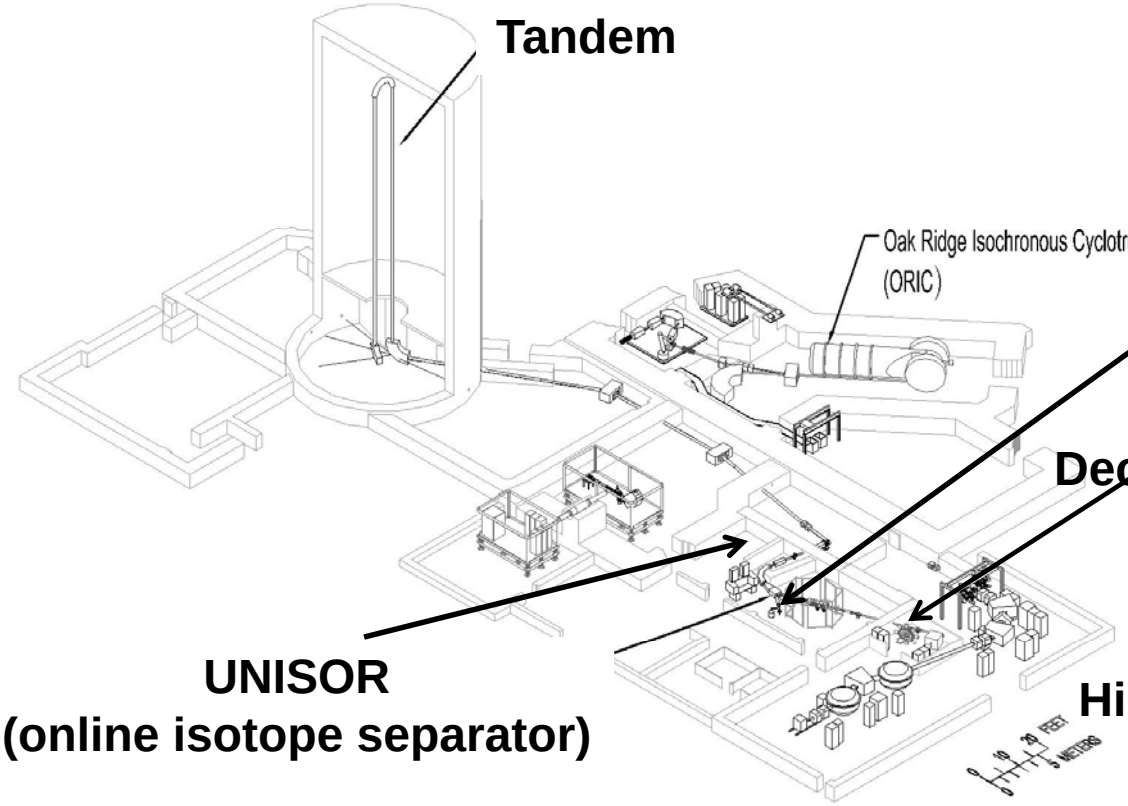
- In budget
- Will demonstrate online system performance
  - M/dM = 400,000
  - Transmission ~ 50 %

Applications

- Basic Nuclear Physics (Discovery Science)
  - Provide pure beams at resolving power 400,000
    - Selectivity enables experiments long sought after (^{100}Sn region)
    - Isomer Scope
    - Study Decay of Isomeric states



Applications
Applied Nuclear Physics: Decay Heat



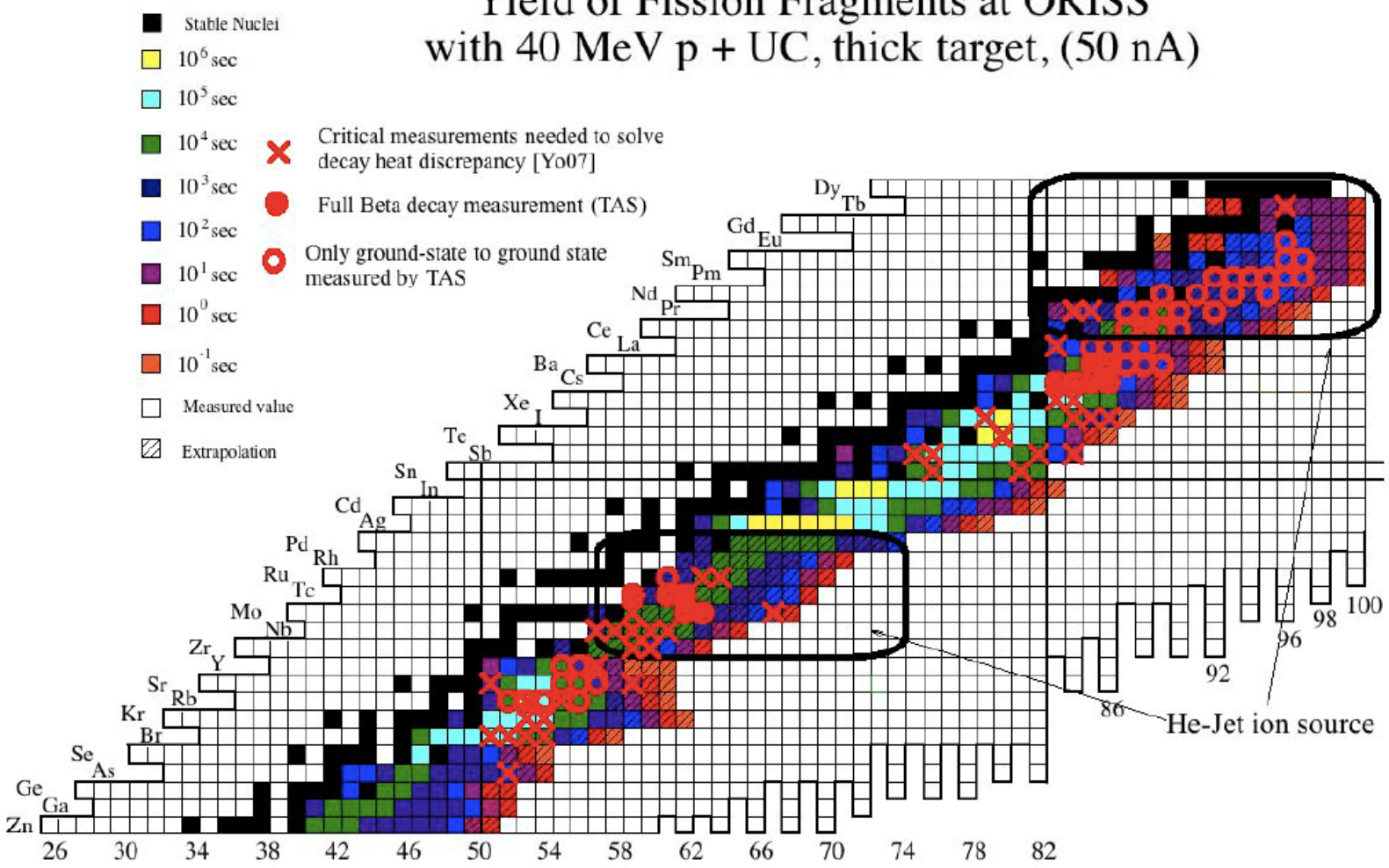
NEA/WPEC-25
International Evaluation Co-operation
VOLUME 25
ASSESSMENT OF FISSION PRODUCT
DECAY DATA FOR DECAY HEAT CALCULATIONS

" However, a dedicated facility should be established at a particle accelerator where sufficient beam time can be devoted to TAGS measurements in a systematic manner. Such a facility would consist of a suitable target/ ion-source, a mass separator of sufficient resolution, a sample transport system, and a total absorption spectrometer with associated equipment. Furthermore, high resolution -ray and internal conversion detectors should be made available for decay scheme studies. Sufficient collaborative manpower and resources would be required to exploit and realise the full potential of a dedicated facility and fulfil the desired aims of such a work programme (an additional benefit of this systematic approach would be the production of highly skilled manpower to undertake other types of nuclear data study).
Provide pure beams for Total Absorption and / or neutron measurements for over half of Critical Isotopes for Decay Heat "

ORNL Tandem + UNISOR separator + ORISS + MTAS and existing detectors

Exceeds these requirements.

Yield of Fission Fragments at ORISS with 40 MeV p + UC, thick target, (50 nA)



People

Direct Support from this project

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