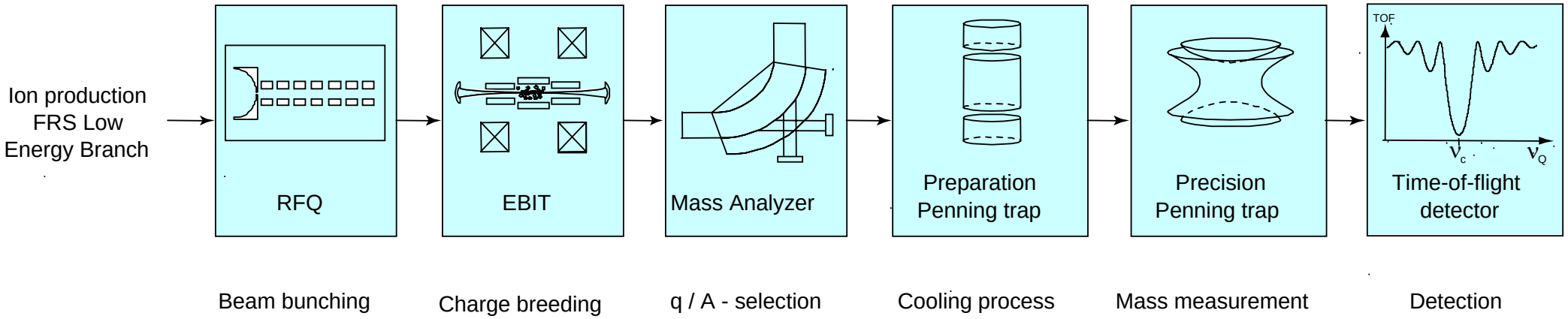
# MATS

## *Precision Measurements of Very-Short Lived Nuclei Using an Advances Trapping System for Highly-Charged Ions*

**Frank Herfurth, GSI-Darmstadt**
**for the MATS Collaboration**



# The MATS collaboration

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*Universität Greifswald*: A. Herlert, G. Marx, L. Schweikhard

*Universität Erlangen-Nürnberg*: P.-G. Reinhard

*GSI-Darmstadt*: D. Beck, M. Block, H. Geissel, F. Herfurth, Yu.A. Litvinov, Yu. N. Novikov, C. Scheidenberger, M. Winkler, C. Yazidjian

*CERN/GSI-Darmstadt*: A. Kellerbauer

*Universität Mainz*: K. Blaum, I.Bloch, S. Djekic, R. Ferrer, S. George, S. Kreim, W. Nörtershäuser, S. Stahl, J. Verdu, C. Weber

*Universität Gießen*: W. Plass

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*Michigan State University*: M. Bender, G. Bollen, M. Matos, S. Schwarz

*MPI KP Heidelberg*: J. Ullrich, J. R. Crespo López-Urrutia

*Universite Libre de Bruxelles*: P.-H. Heenen

*Stockholm University*: T. Fritioff, R. Schuch, N. Szilard

Kolkata India: A. Ray

**15 Institutes**
**52 Members**

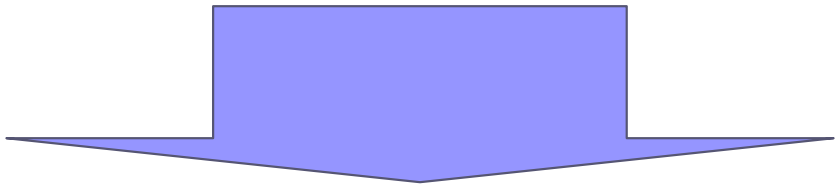
# Trapping

- effective use of rare species
- extended observation & interaction time
- high quality q/m selection
- manipulation of charged particles at low E
  - accumulation & bunching
  - charge breeding
  - polarization

**EFFICIENCY**

**ACCURACY**

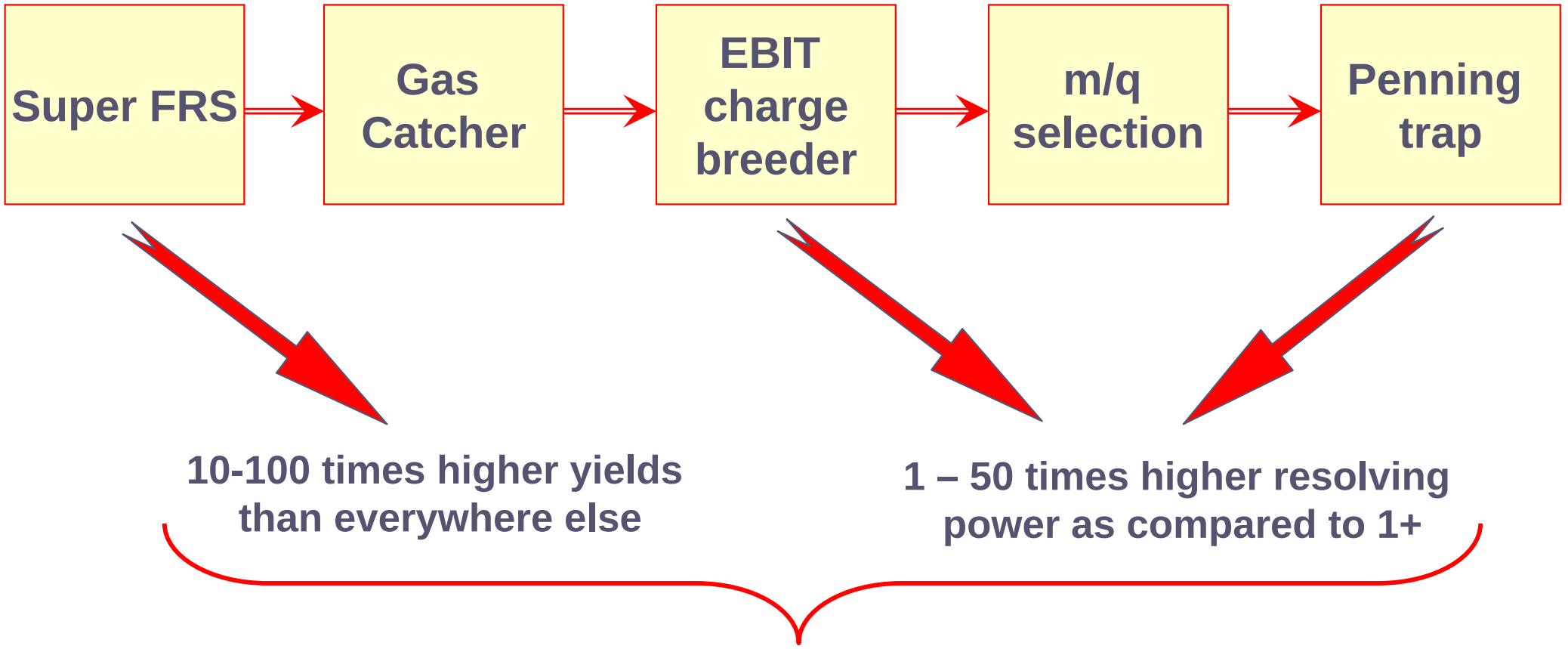
**SENSITIVITY**



**Mass measurements and**
**trap assisted nuclear spectroscopy**

# Production

**Precision measurements on short-lived nuclides.**




**factor of 10 - 5000**

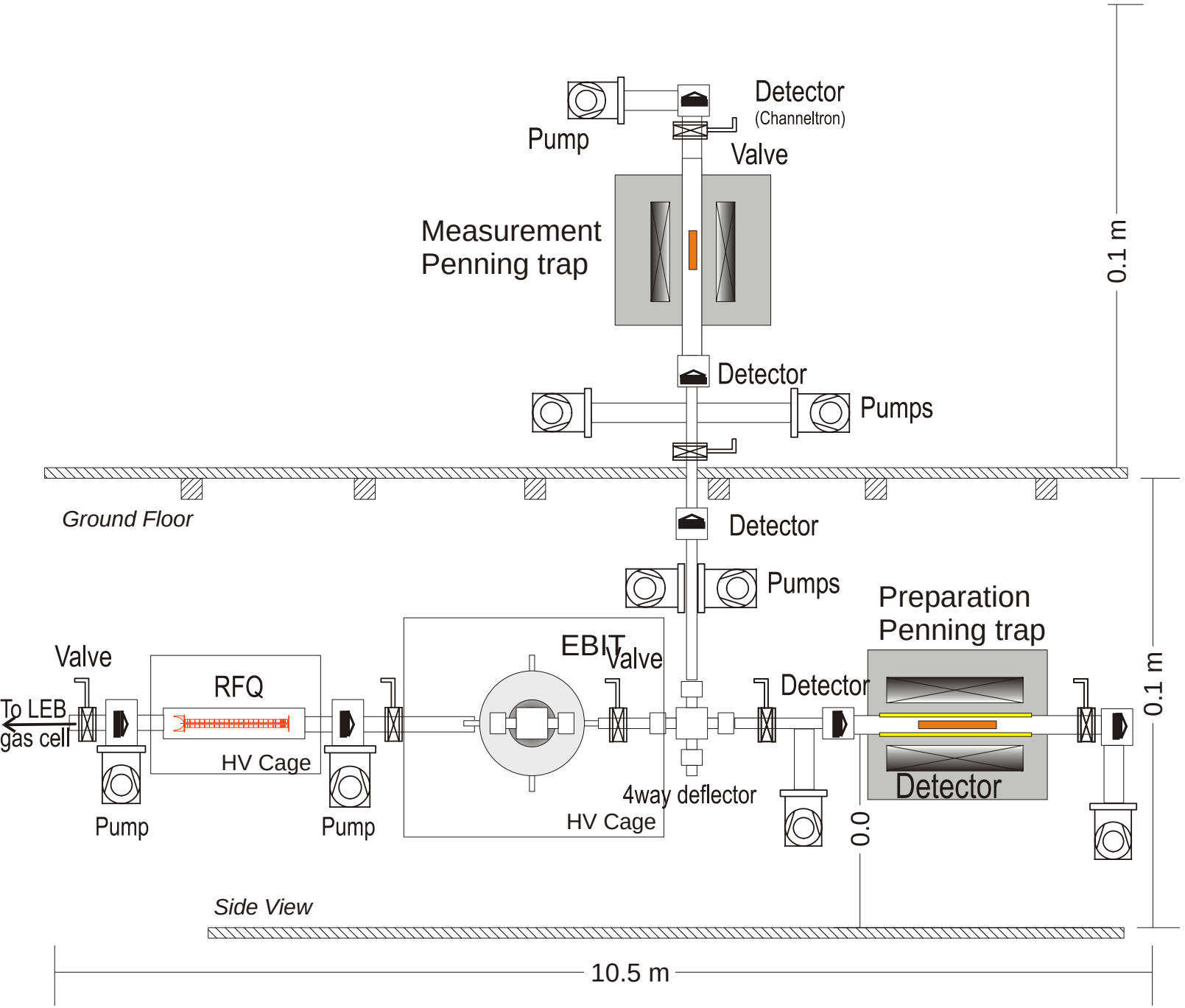
**shorter half-lives**

**higher resoving power and precision**

**beam time saving**

**$\delta m/m < 1 \cdot 10^{-8}$ on isotopes with $T_{1/2} \approx 100$ ms $\Rightarrow$ perfect match with FRS LEB capabilities**

# Setup




Detectors:
- FT-ICR
- TOF-ICR
- Si(Li) electron

Precision trap:
mass measure-ments

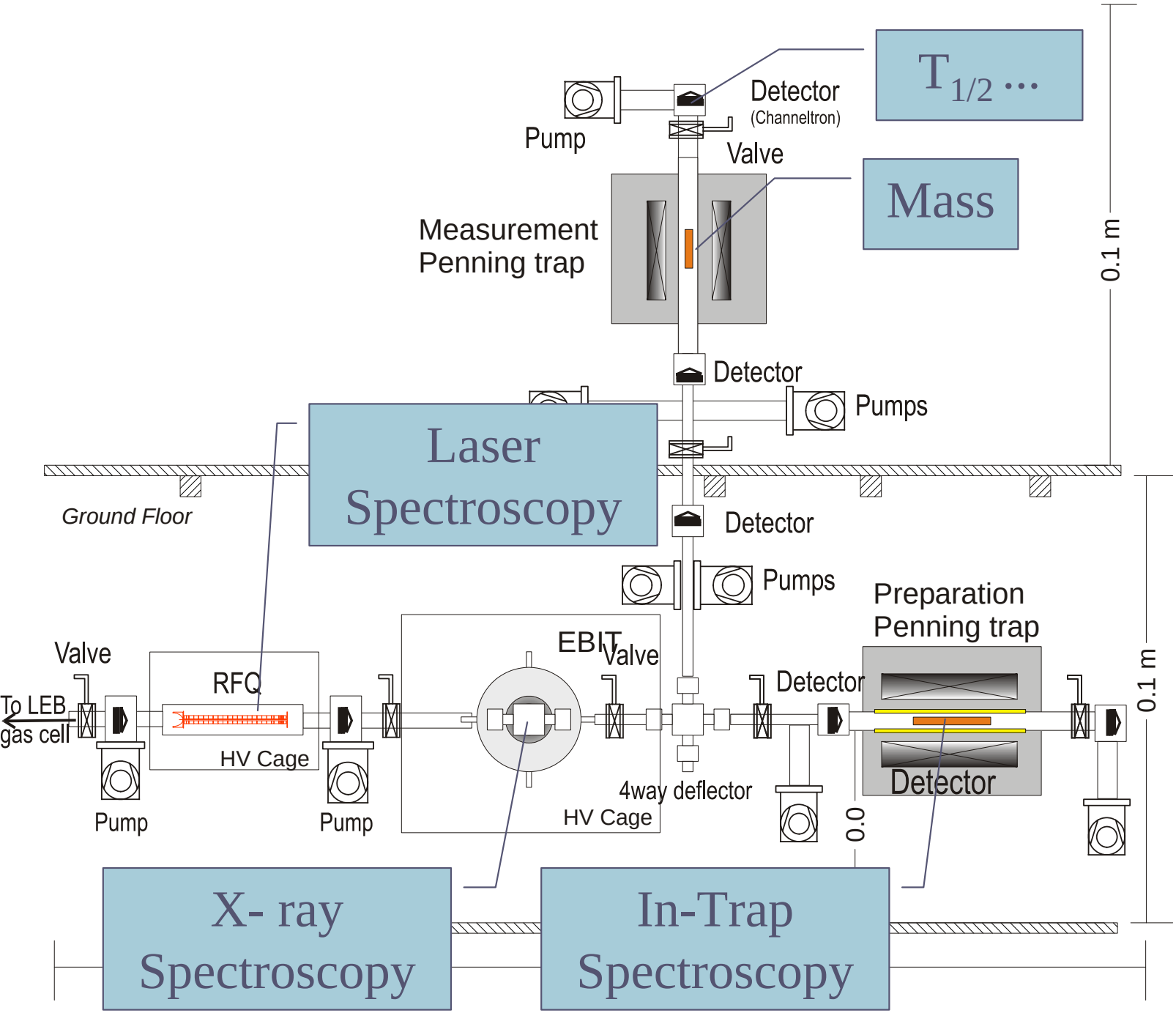
Cooler trap:
beam preparation
spectroscopy

Magn. deflector:
q/m separation

EBIT:
charge breeding

$$f_c = \frac{1}{2\pi} \cdot \frac{q}{m} \cdot B$$

# Experiments with Exotic Nuclei




Detectors:
- FT-ICR
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Precision trap:
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Cooler trap:
beam preparation & spectroscopy

Magn. deflector:
q/m separation

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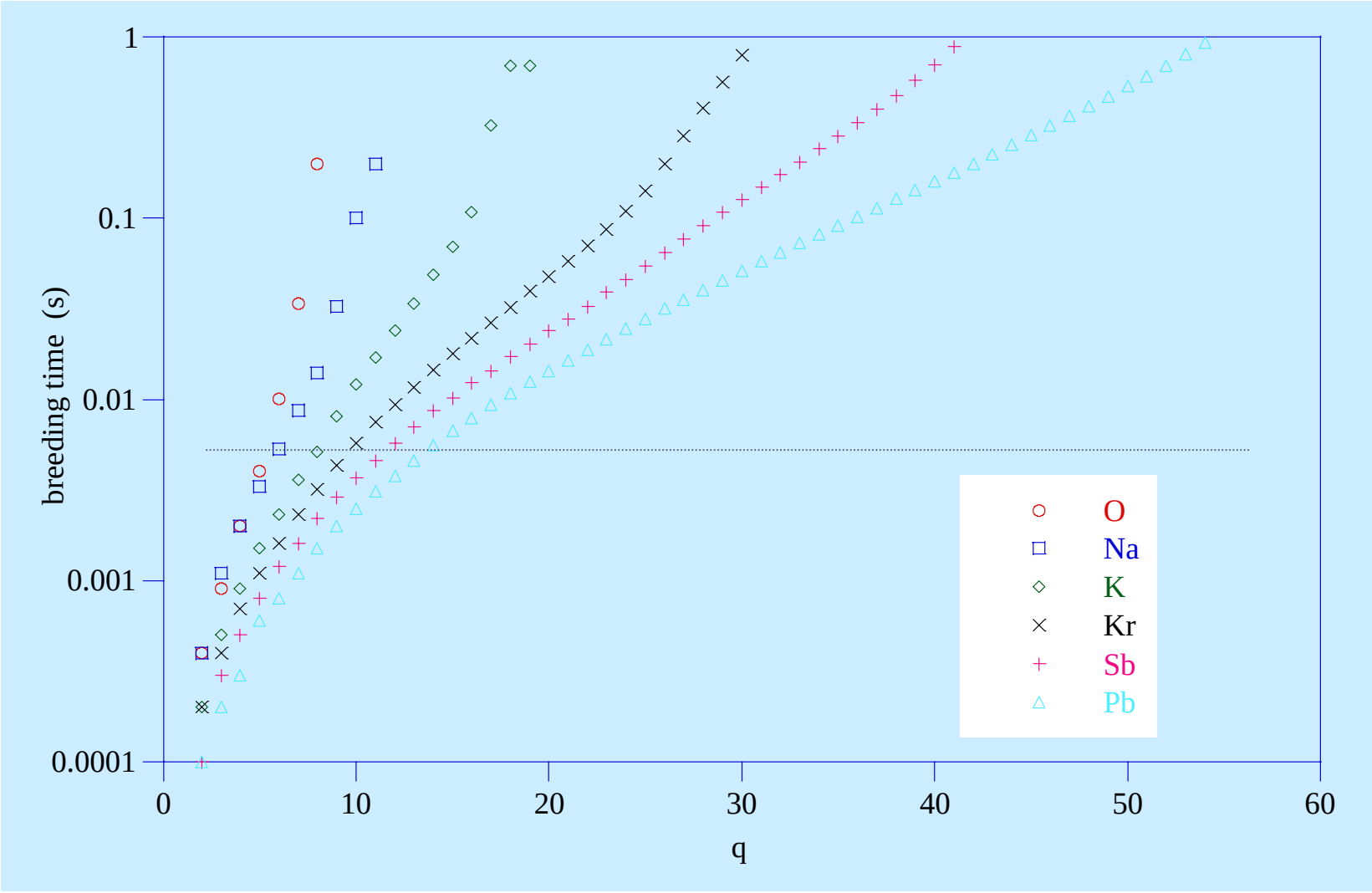
charge breeding

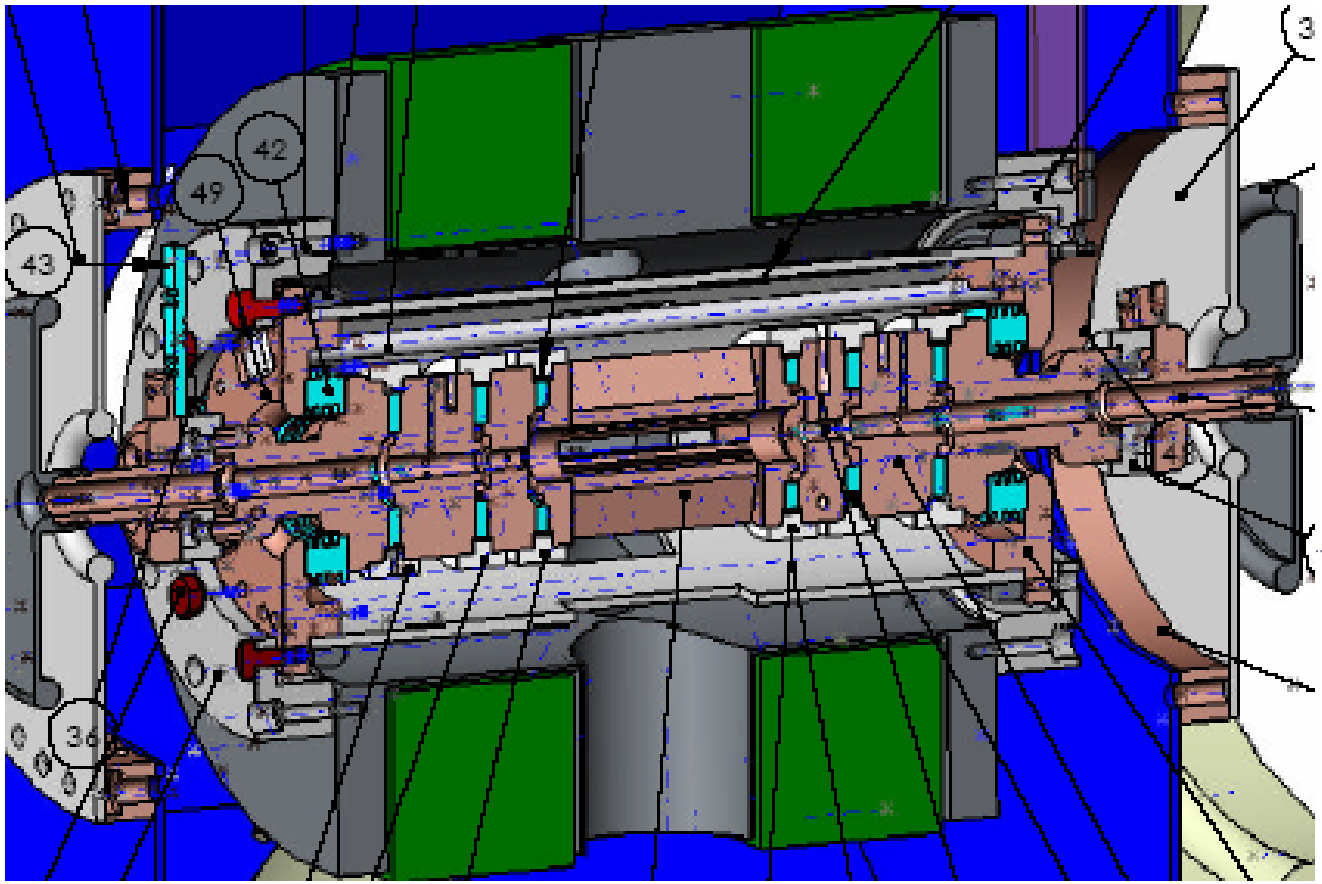
$$f_c = \frac{1}{2\pi} \cdot \frac{q}{m} \cdot B$$

# Charge Breeding


*Results from ISOLDE (Courtesy of F. Wenander)*

# Charge Breeding

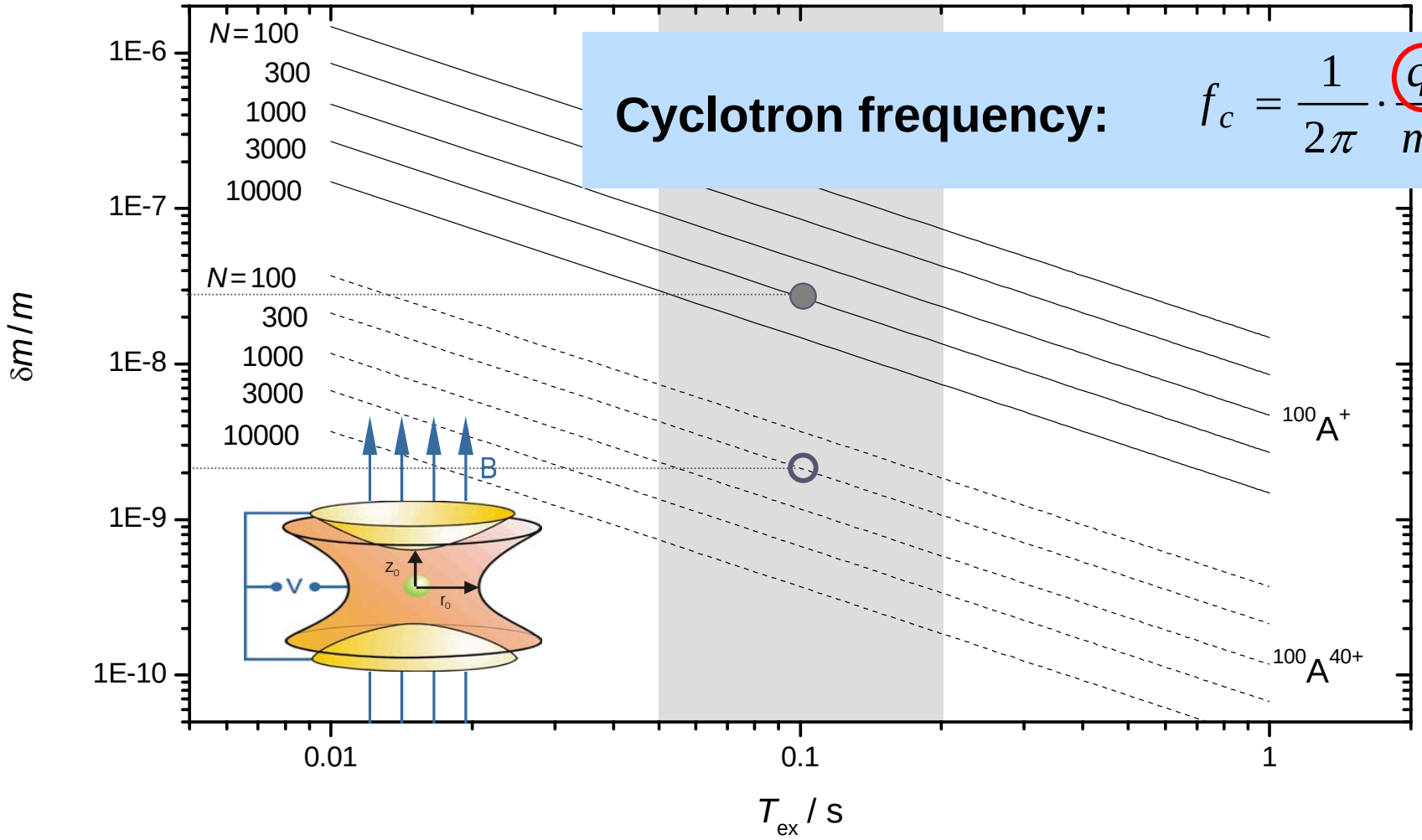




- cryogenic – XHV
- Helmholtz coils – open access

*TITAN EBIT (J. Crespo et al.)*

# The Advantage of Highly Charged Ions

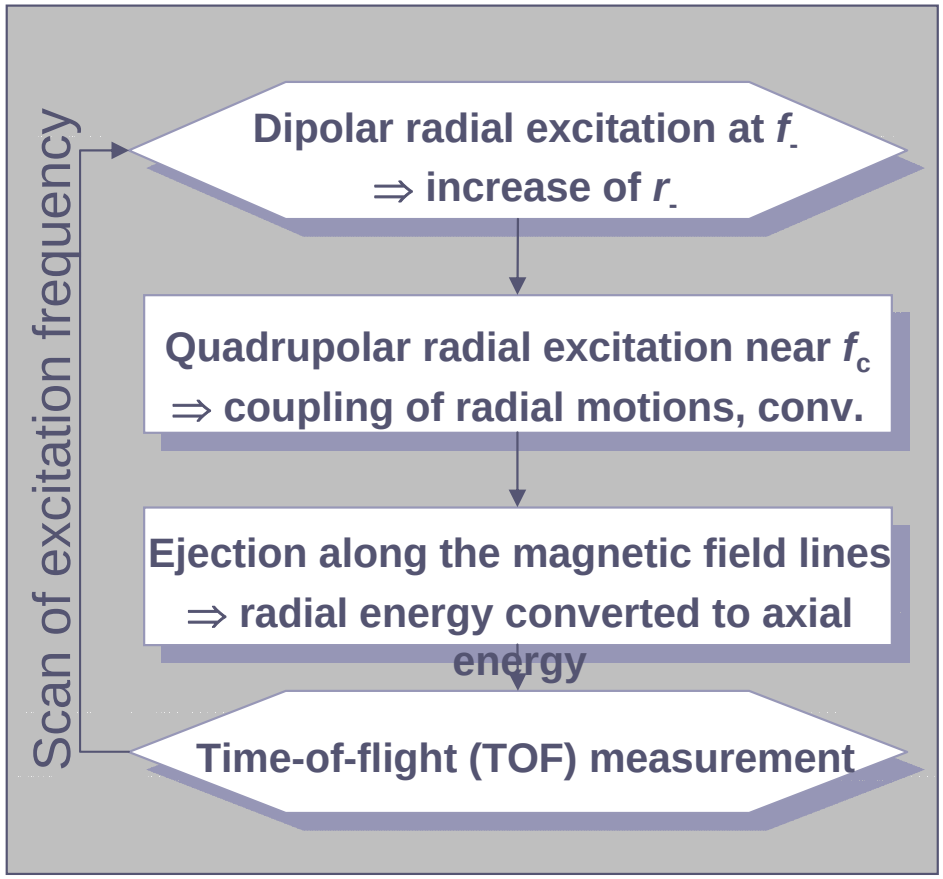

**Cyclotron frequency:** $f_c = \frac{1}{2\pi} \cdot \frac{q}{m} \cdot B$

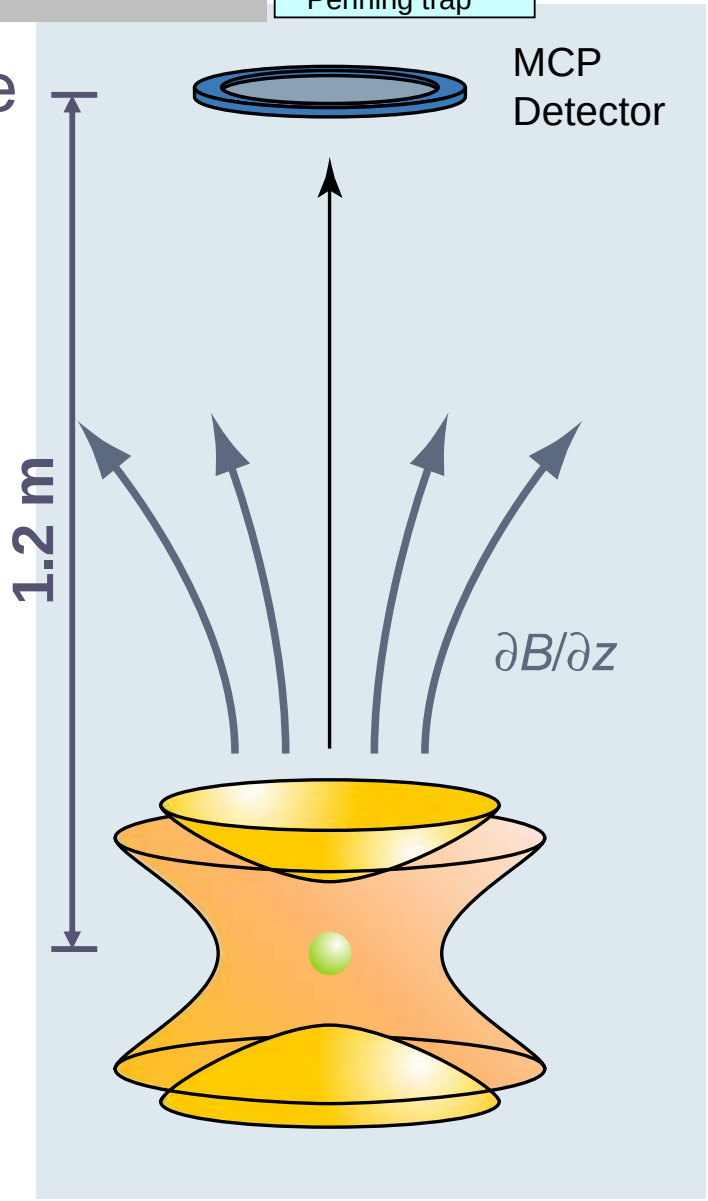



- much higher resoving power and precision
- reduced beam time requirement

# TOF Resonance technique

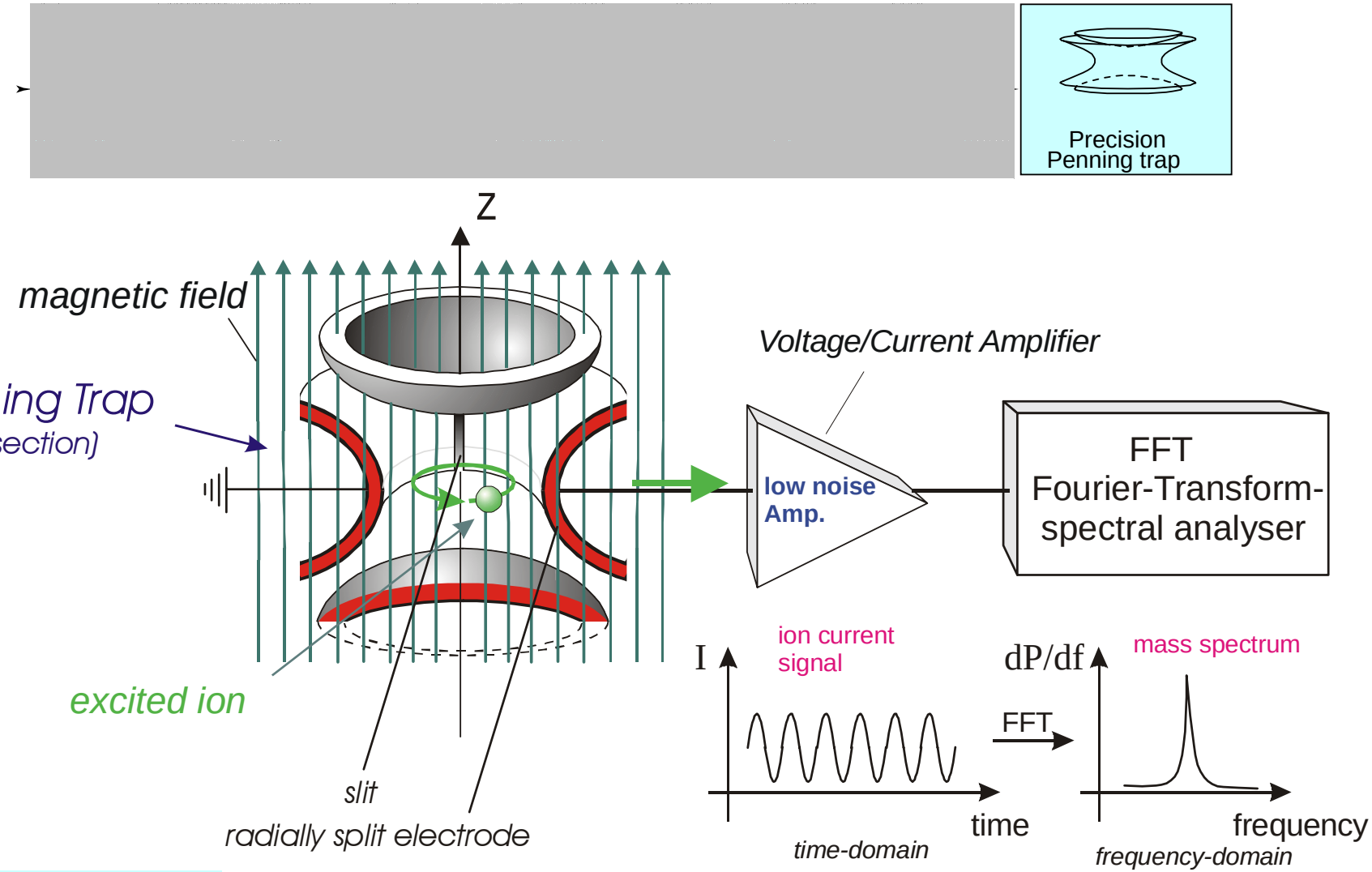

## Time-of-flight resonance technique




Resolving power: $R = f_{exc}\, T_{exc}$

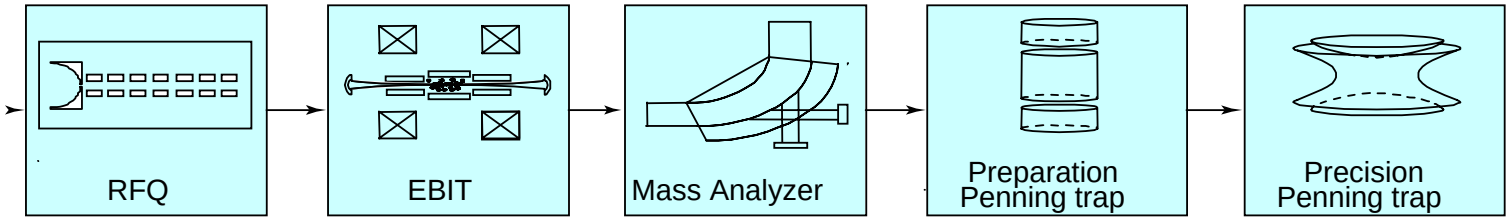
# Single Ion FT-ICR




## Applications

- Mass measurements on very rare nuclides
- High-precision mass measurements on more abundant nuclides

# Summary




## Design parameters:

| | |
|---|---|
| Overall efficiency | 1-5% |
| Maximum resolving power | $10^{8}$ |
| Accessable half-life | 10 ms |
| Relative mass uncertainty | $10^{-9}$ |

## Organisation and responsibilities

| | |
|---|---|
| Mainz, Greifswald, Jyväskylä, Stockholm: | Penning trap system |
| GSI, Munich: | RFQ cooler and buncher |
| Heidelberg, GSI, Livermore, Seattle: | EBIT |
| Giessen, Mainz, Orsay: | Detection system and electronics |
| Mainz, Munich: | Trap assisted spectroscopy |

**MATS will be an advances trapping system for mass spectrometry, laser spectroscopy, and in-trap decay spectroscopy with highly-charged, short-lived ions.**