

# Mass Measurements at Storage Rings

- Overview of mass measurement methods
- Mass measurements at storage rings
- Perspectives

Milan Matoš for:




# Mass Measurement Methods

indirect methods

direct methods

principle:


Q-value determination


 nuclear reactions


 decays

principle:

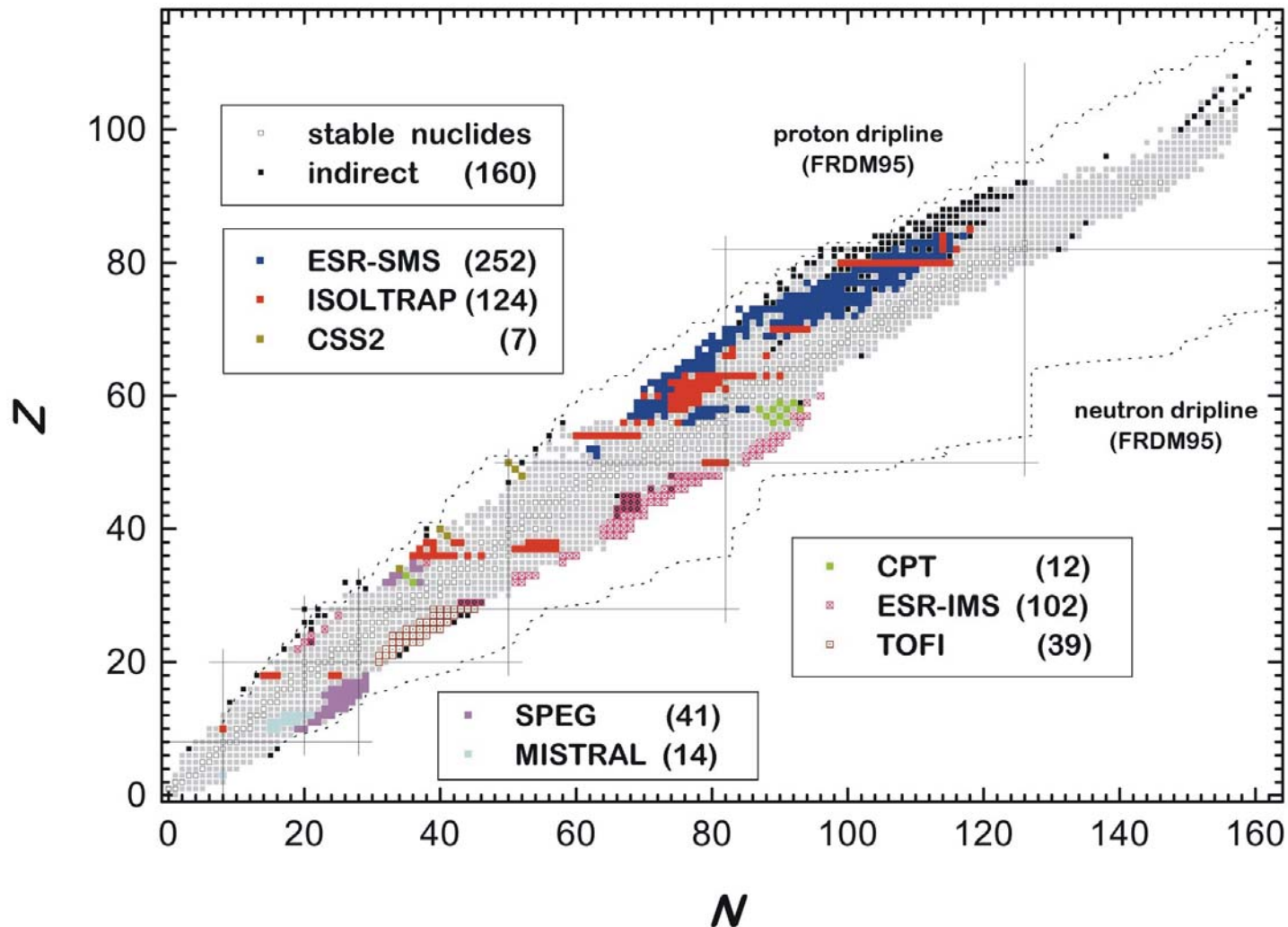
measurement of time or frequency

 time-of-flight

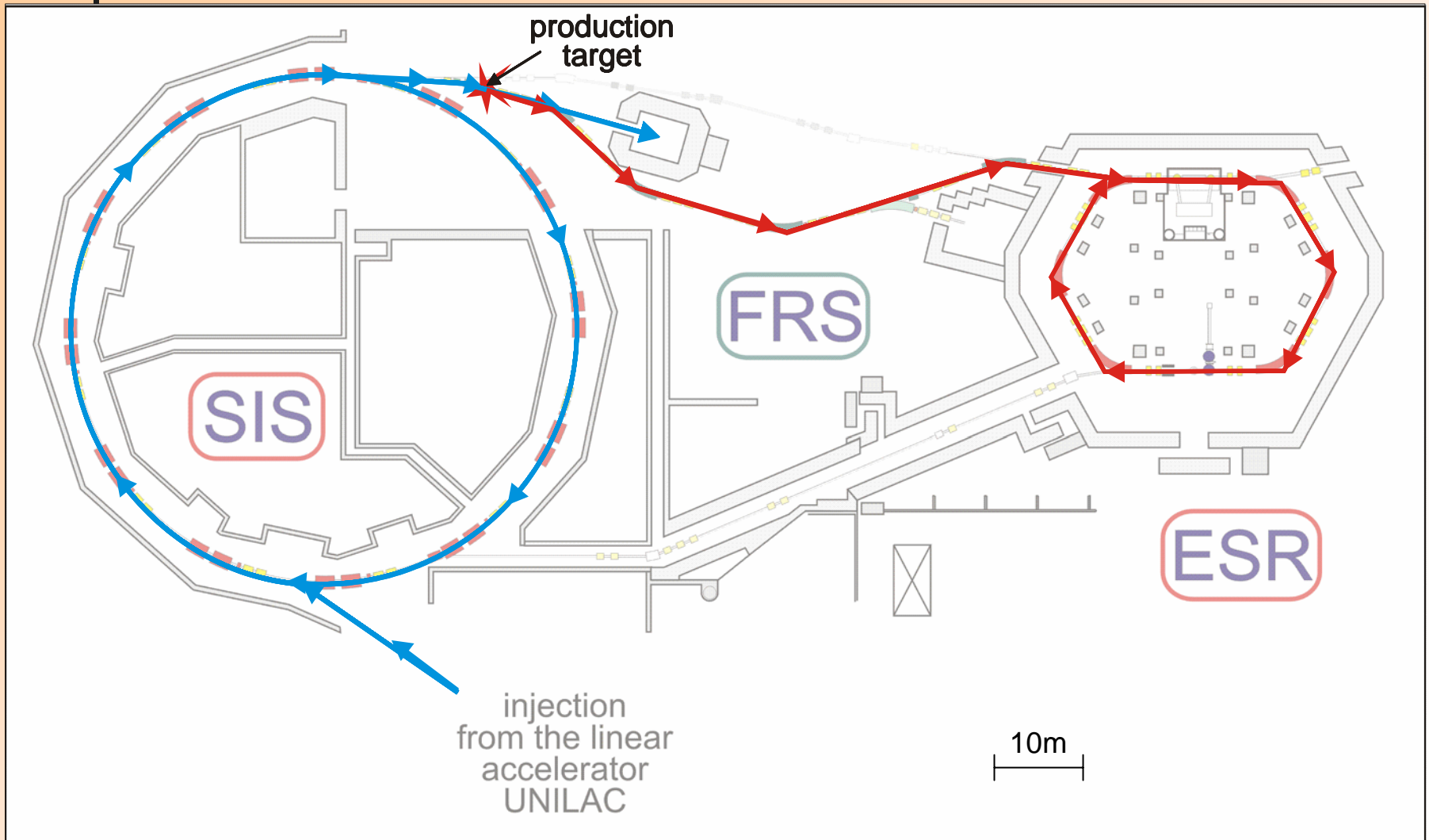
 cyclotrons and storage rings

 Penning traps

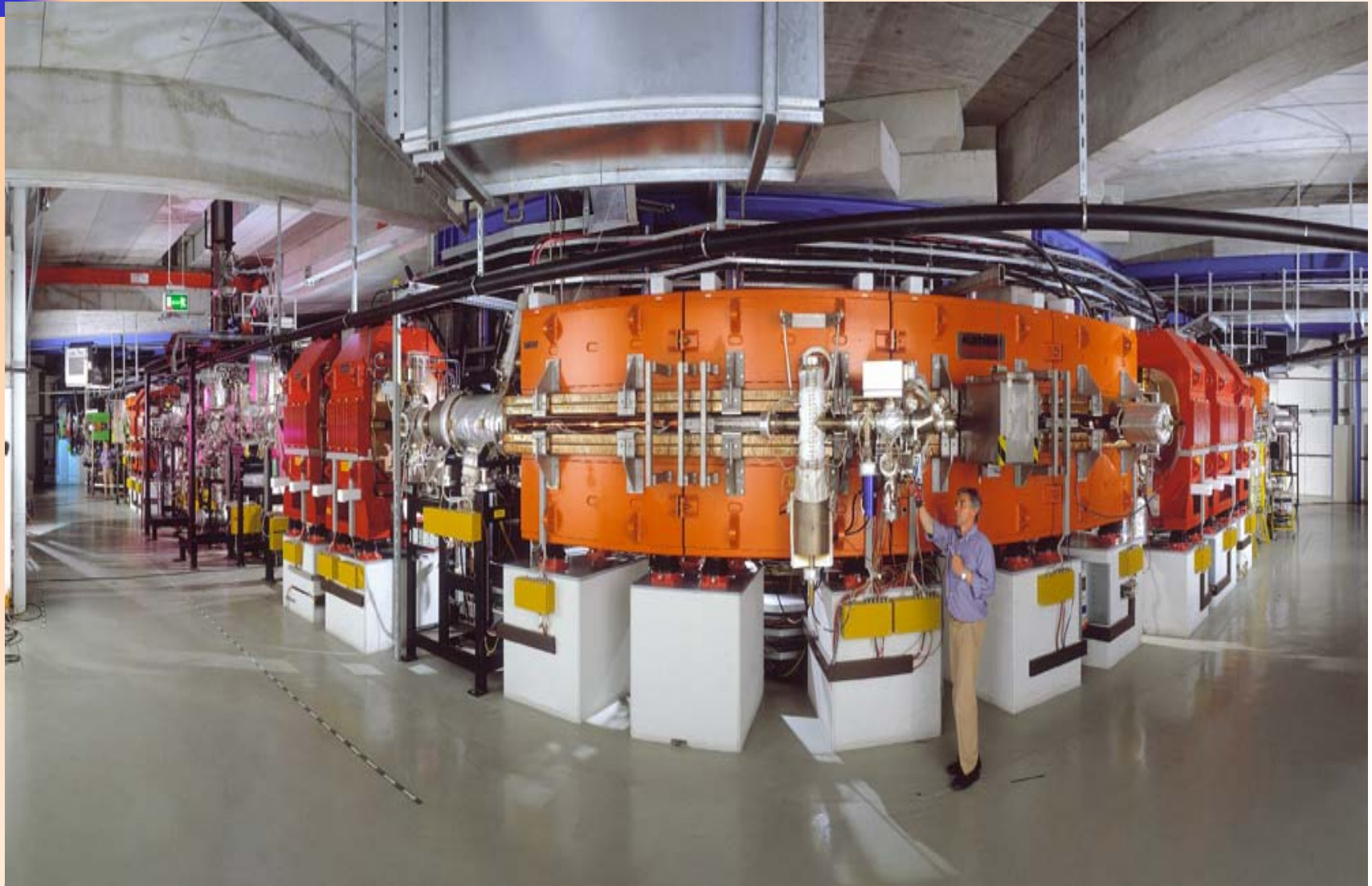
# Masses Determined by Various Methods Since 1994 (Lunney et al. Rev.Mod.Phys. 75-1021 (2003))



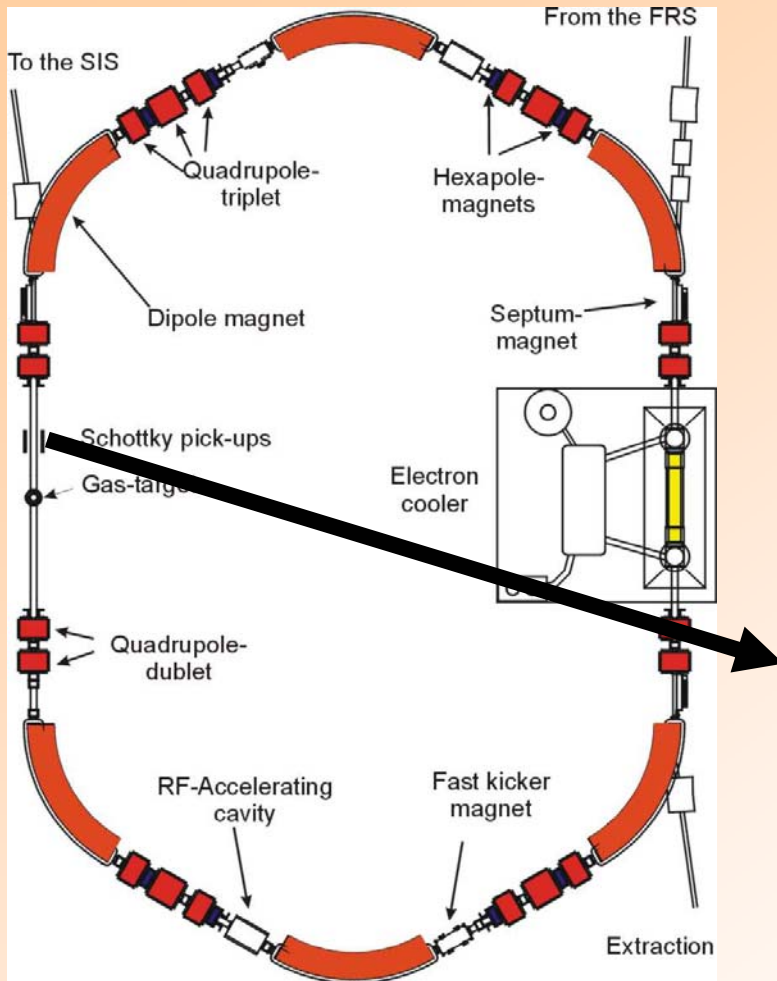
# Mass Measurements at the FRS-ESR Facilities



# The Experimental Storage Ring (ESR) at GSI

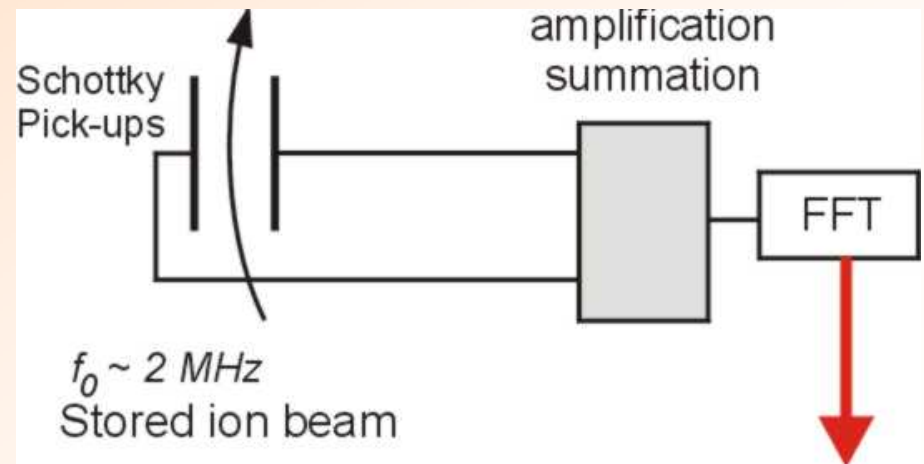


# Schottky Mass Spectrometry (SMS)



$$\frac{\Delta f}{f} = -\frac{1}{\gamma_t^2} \frac{\Delta(m/q)}{m/q} + \frac{\Delta v}{v} \left(1 - \frac{\gamma^2}{\gamma_t^2}\right)$$

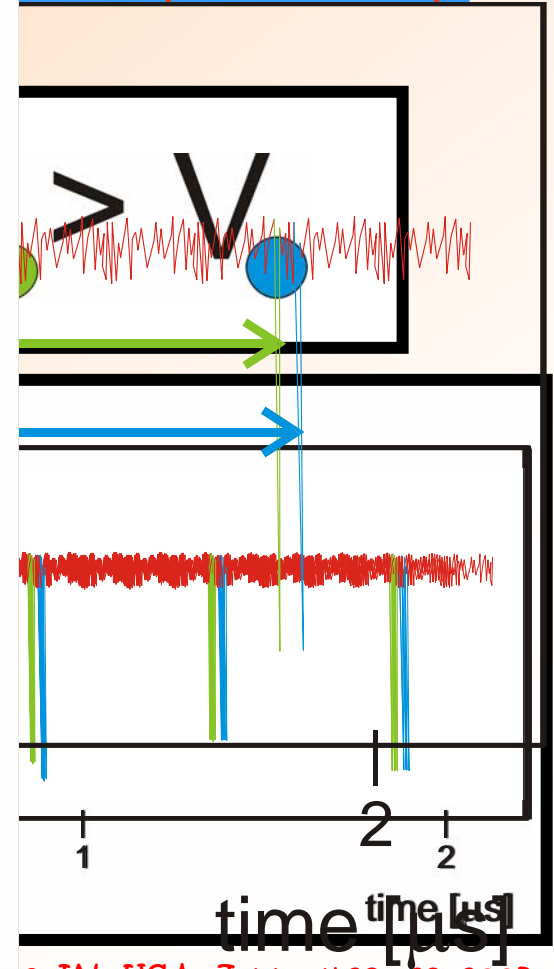
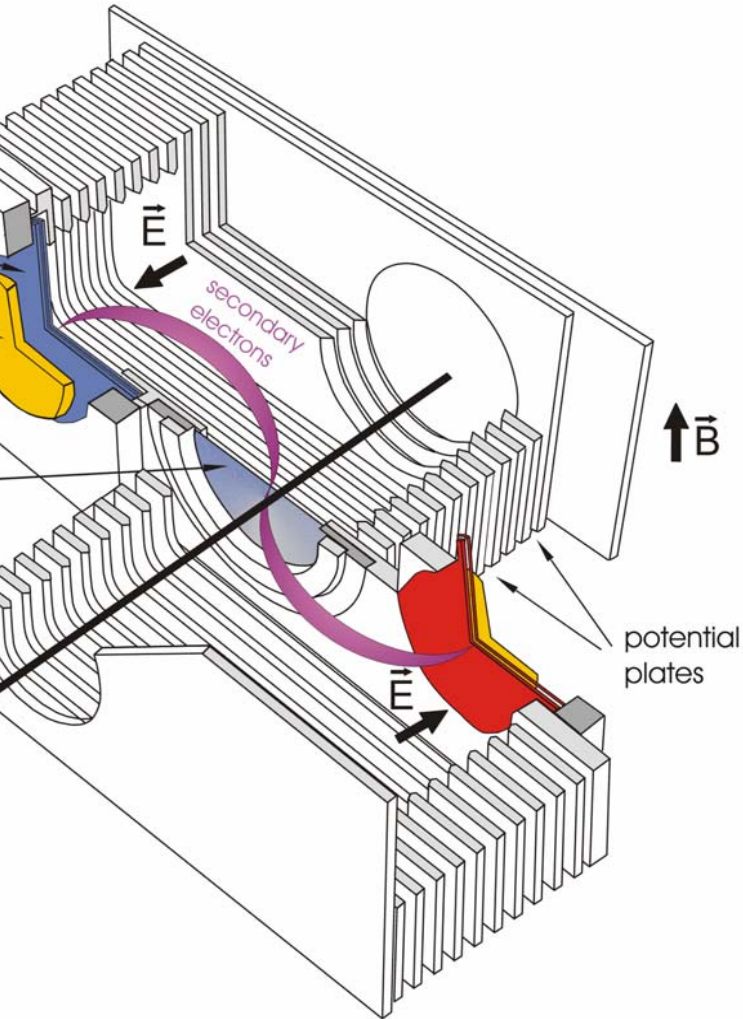
$$\frac{\Delta v}{v} \rightarrow 0$$



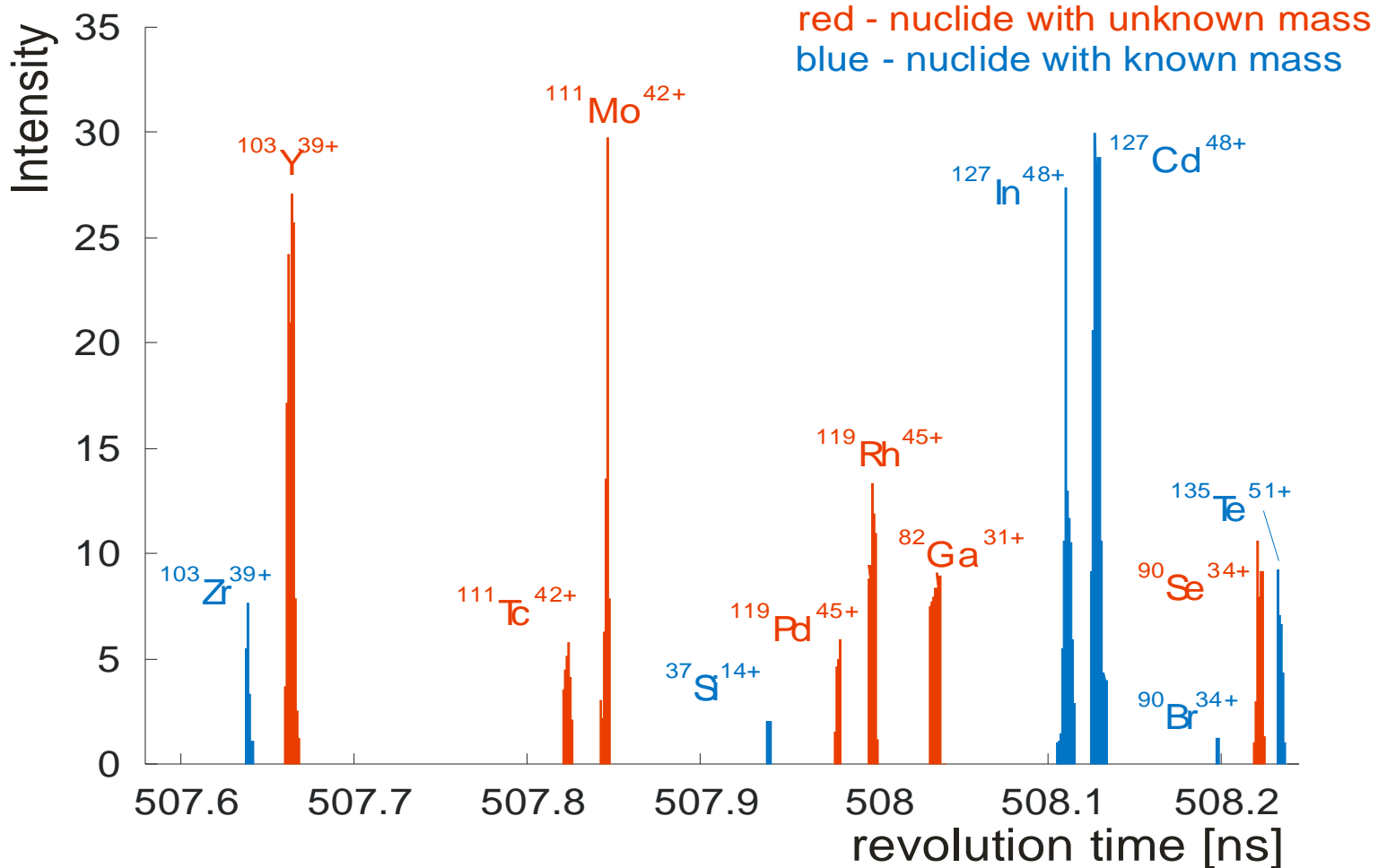
# Time-of-Flight Measurement with the Storage Ring in the Isochronous Mode

$\gamma \rightarrow \gamma$

$$\Delta f = 1 - \Delta(m/q) + \frac{\Delta v}{v} \left(1 - \frac{\gamma^2}{\gamma_t^2}\right)$$

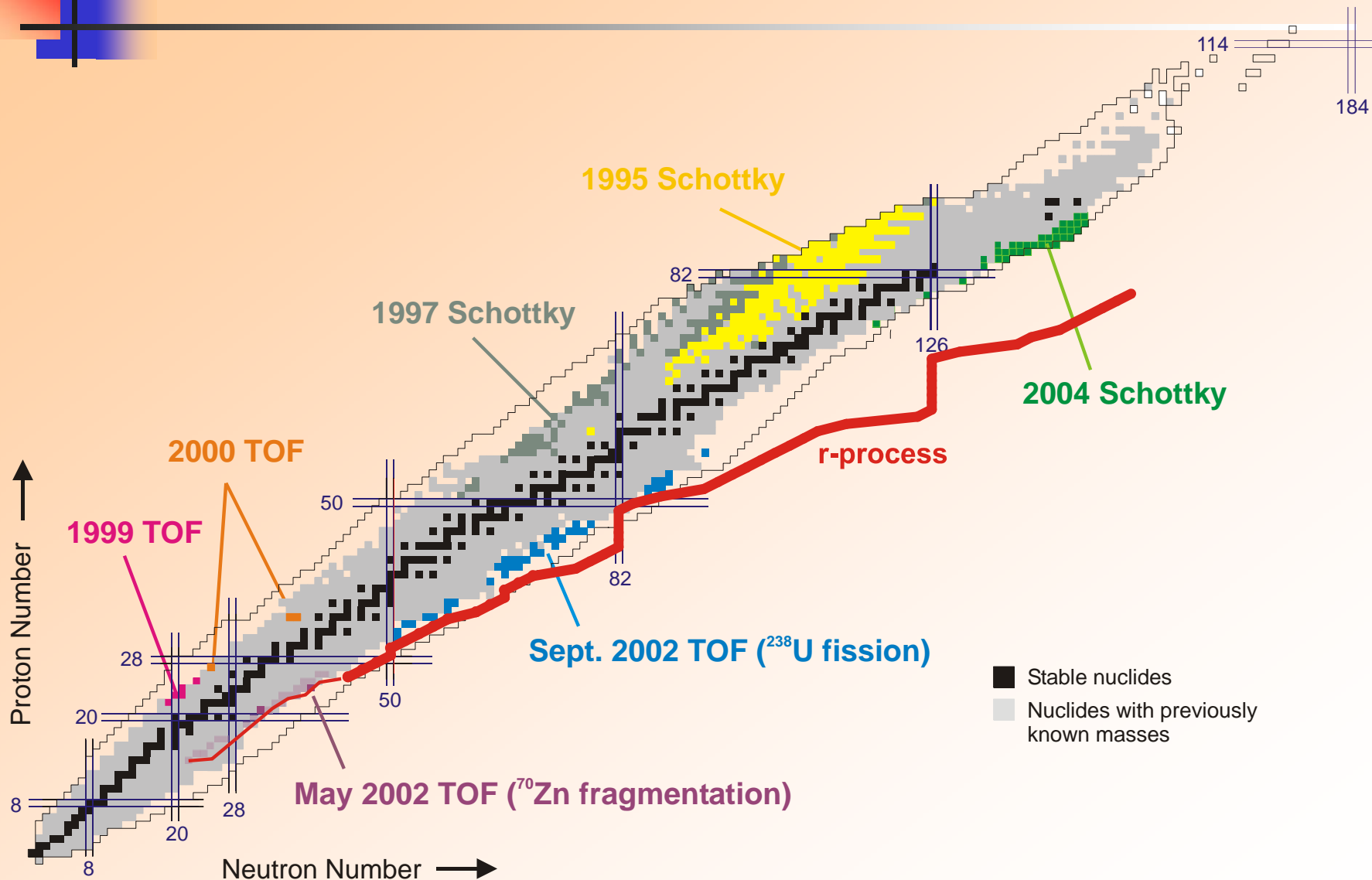


# Time-of-Flight Spectrum

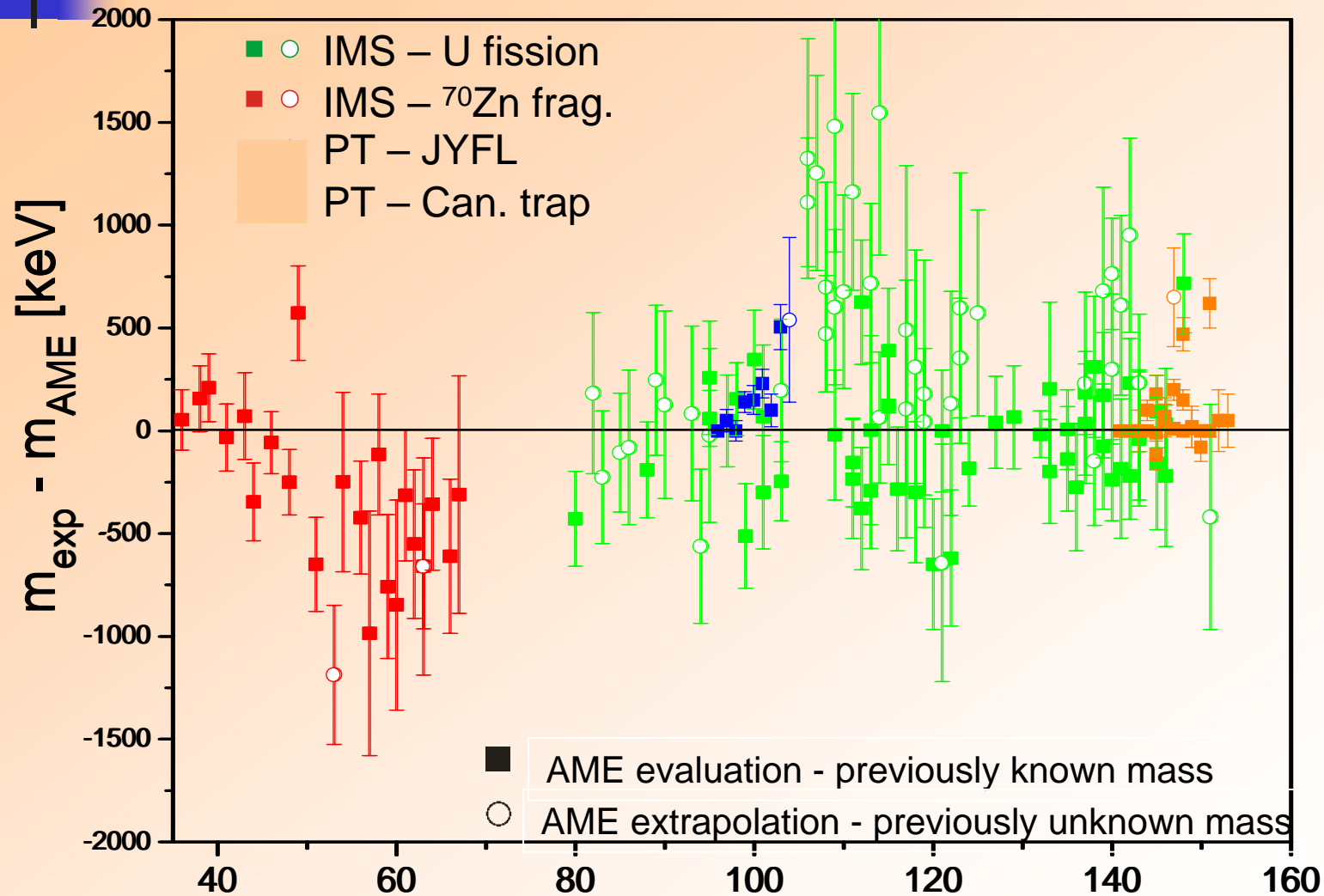




# New Masses Measured at the Storage Ring at GSI



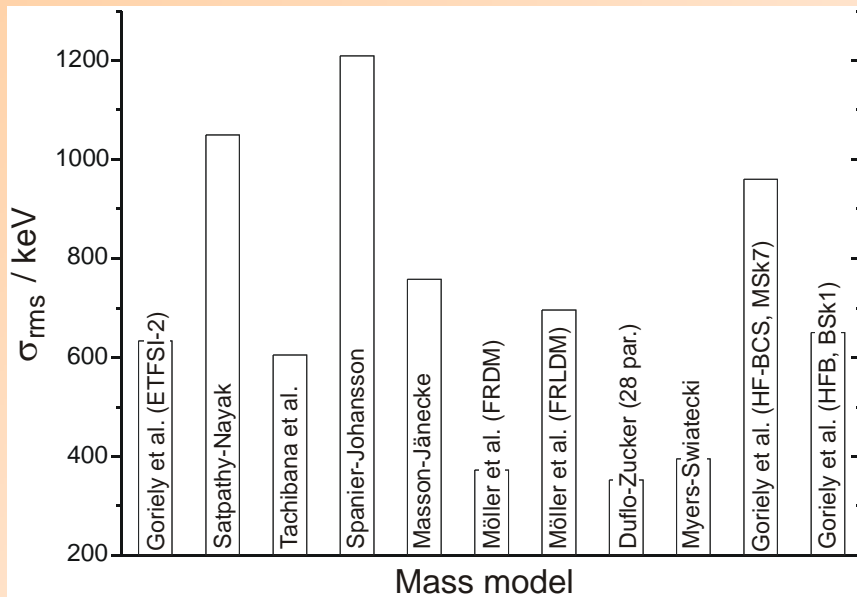
# Comparison of several recent measurements with AME-2003



# Predictive Powers of Mass Models

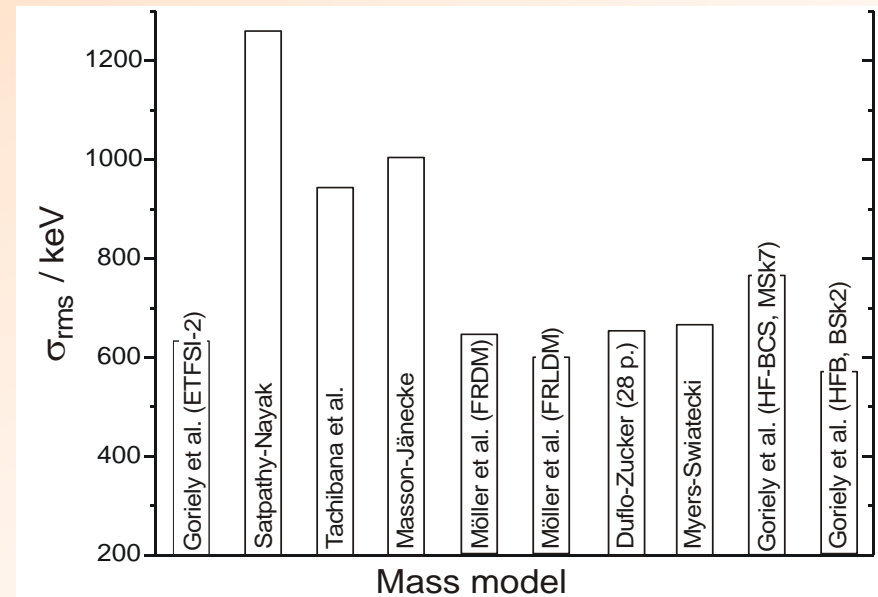
$$\sigma_{\text{rms}}^2 = \frac{1}{n} \sum_{i=1}^n (m_{\text{experiment}} - m_{\text{model}})^2$$

neutron-deficient nuclides (SMS)



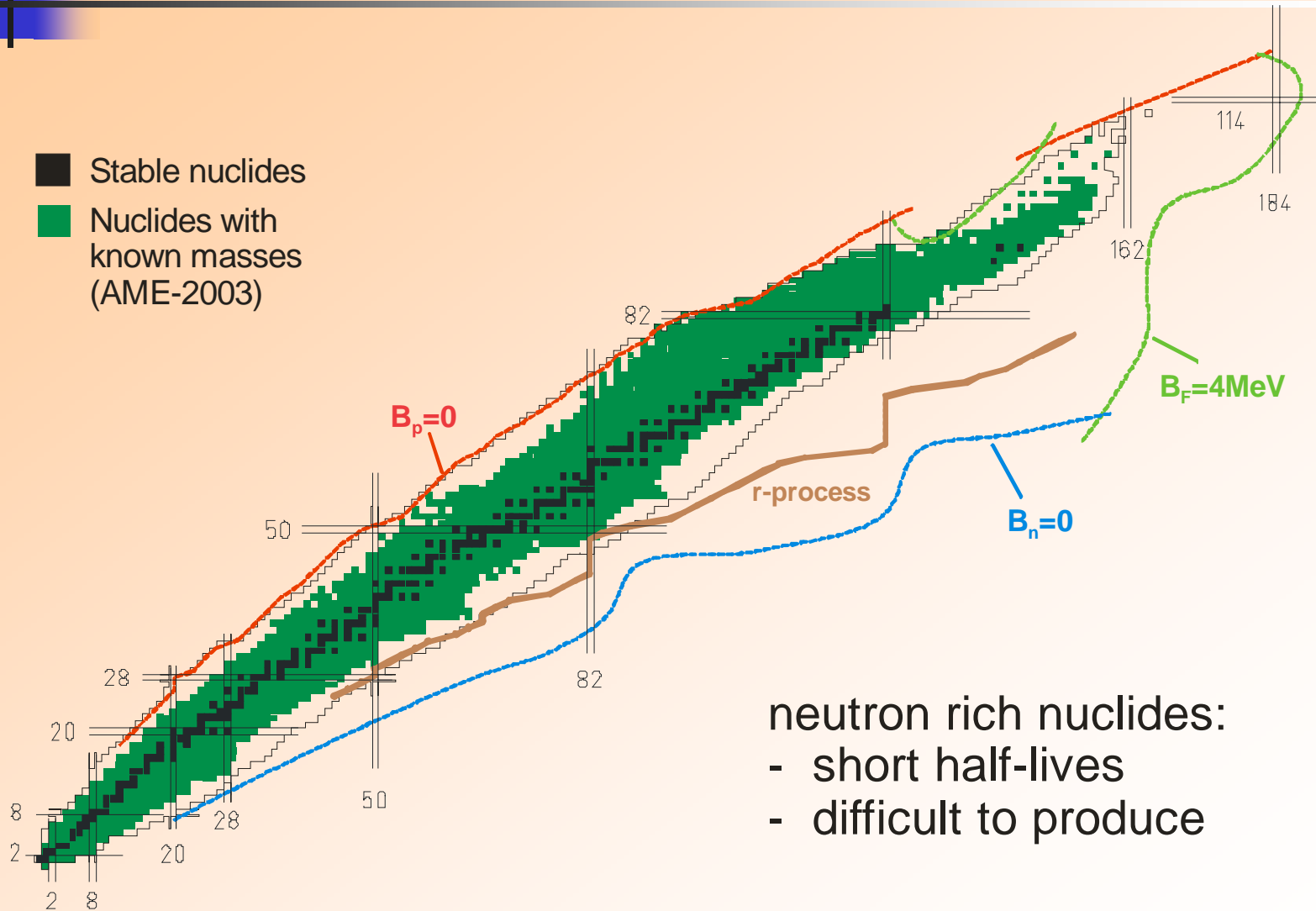
Litvinov, PhD thesis

neutron-rich nuclides (IMS)



M.M., PhD thesis

# Present Knowledge of Nuclear Masses



neutron rich nuclides:  
- short half-lives  
- difficult to produce

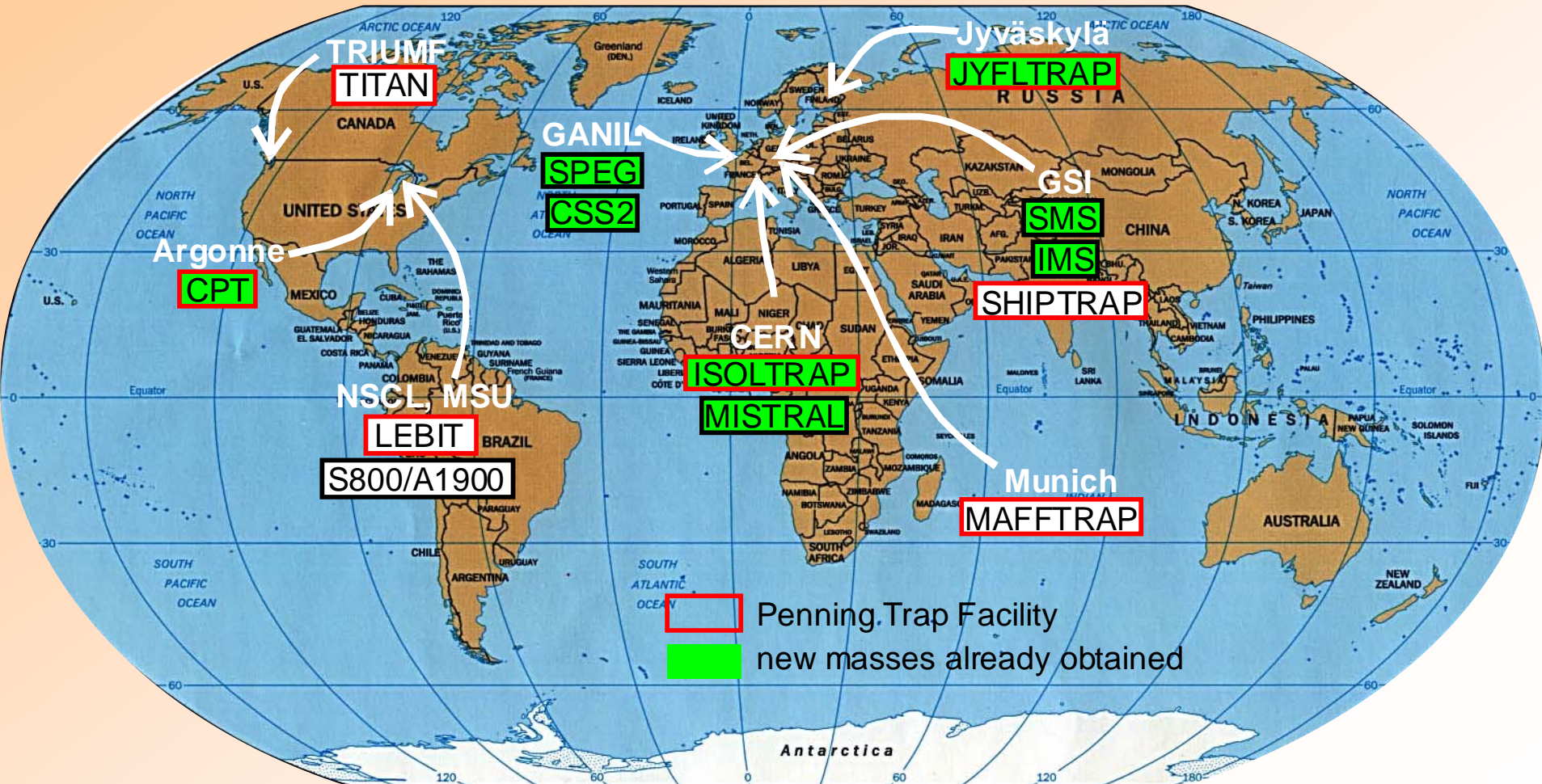


# What is needed?

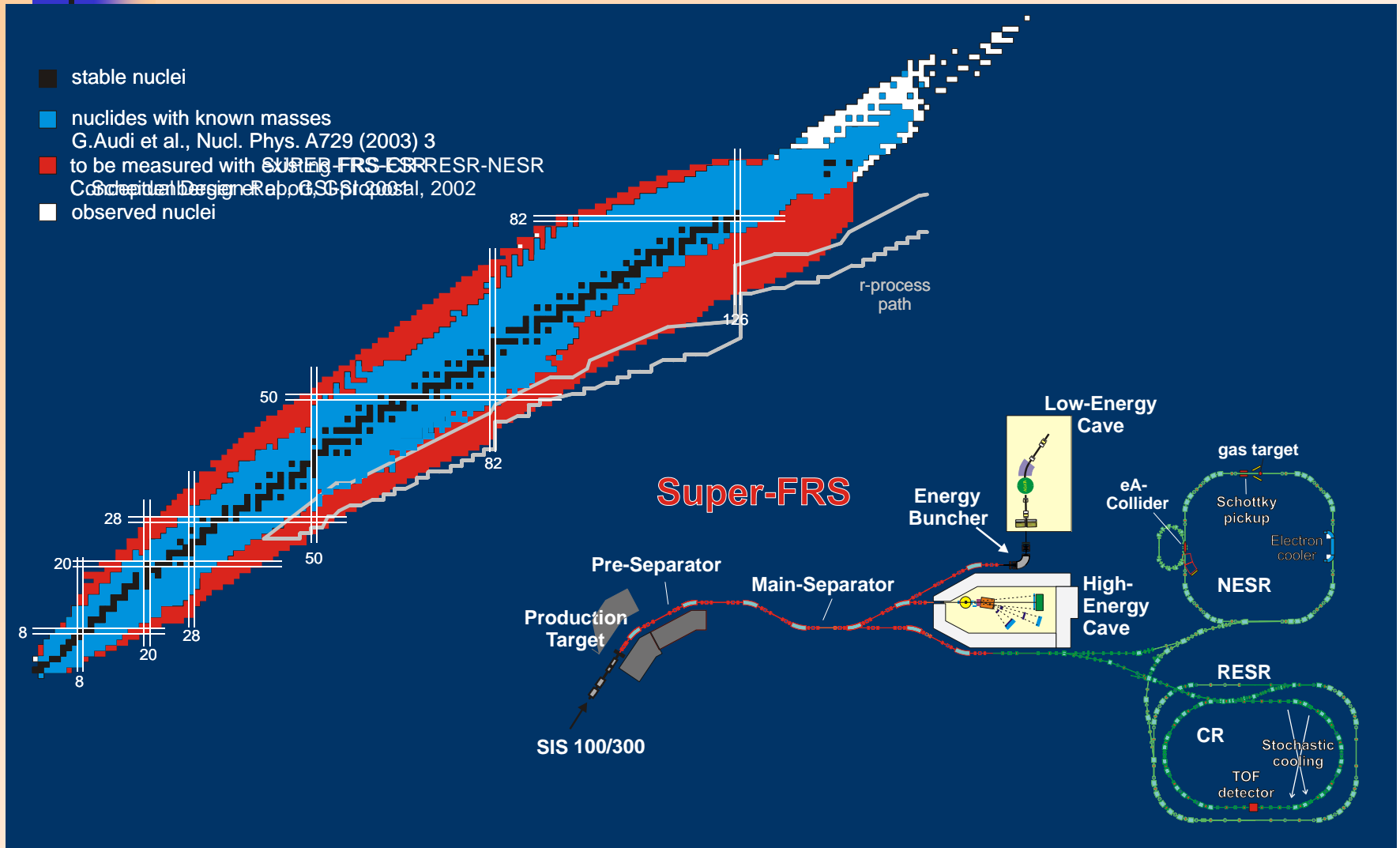
---

**MORE and MORE  
MASS  
MEASUREMENTS!**

# Mass Measurement Facilities



# FAIR at GSI - ILIMA Proposal





# Thanks:

---

F. Attallah, K. Beckert, P. Beller, F. Bosch, D. Boutin, T. Buervenich,  
H. Eickhoff, T. Faestermann, M. Falch, B. Franczak, B. Franzke,  
H. Geissel, M. Hausmann, M. Hellström, E. Kaza, Th. Kerscher,  
O. Klepper, H.-J. Kluge, R. Koyama, C. Kozhuharov,  
K.-L. Kratz, K.E.G. Löbner, S.A. Litvinov, Yu.A. Litvinov,  
L. Maier, F. Montes, G. Münzenberg, F. Nolden, Yu.N. Novikov,  
T. Ohtsubo, Ostrowski, A. Ozawa, Z. Patyk, B. Pfeiffer, M. Portillo,  
A. W. Quint, T. Radon, H. Schatz, C. Scheidenberger, V. Shishkin,  
B. J. Stadlmann, M. Steck, K. Sümmerer, T. Suzuki,  
M.B. Trzhakovskaya, S. Typel, D.J. Vieira, G. Vorobjev, S. Watanabe,  
P. Walker, H. Weick, M. Winkler, H. Wollnik, T. Yamaguchi