# Precision experiments of exotic nuclei at the storage rings

Taka Yamaguchi (Saitama Univ/TCHoU)

for Rare-RI Ring RIBF collaboration
for ILIMA GSI/FAIR collaboration
for IMP collaboration

Overview of storage-ring mass spectrometry

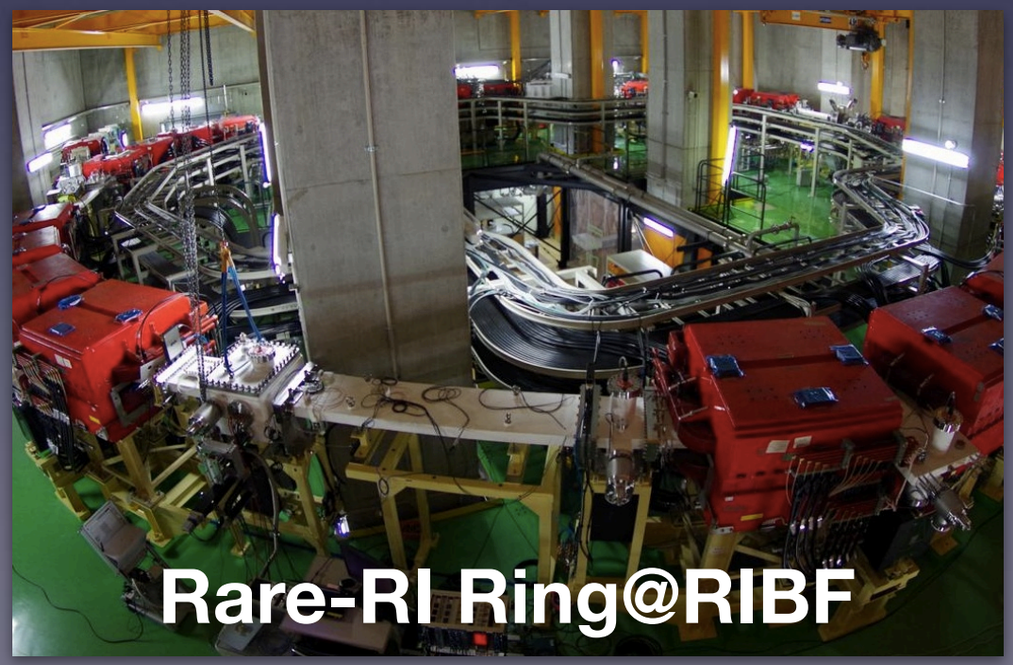
**Tsukuba Global Science Week**
**11 Sep. 2021, Online**

# RI Beam Storage Rings
## Worldwide in Operation

ESR@GSI, Germany

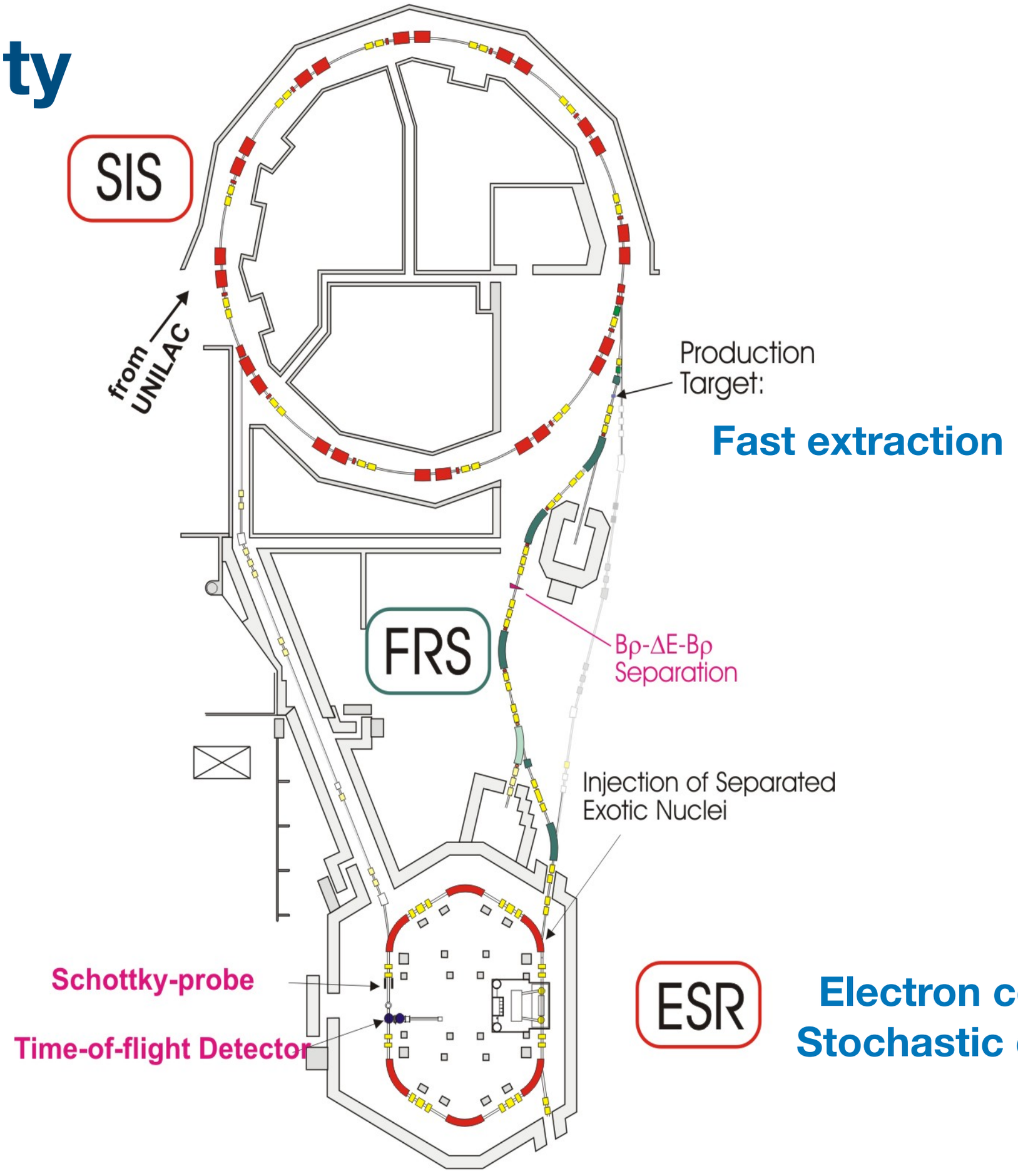
+CRYRING@ESR

CSRe@IMP, China



Rare-RI Ring@RIBF

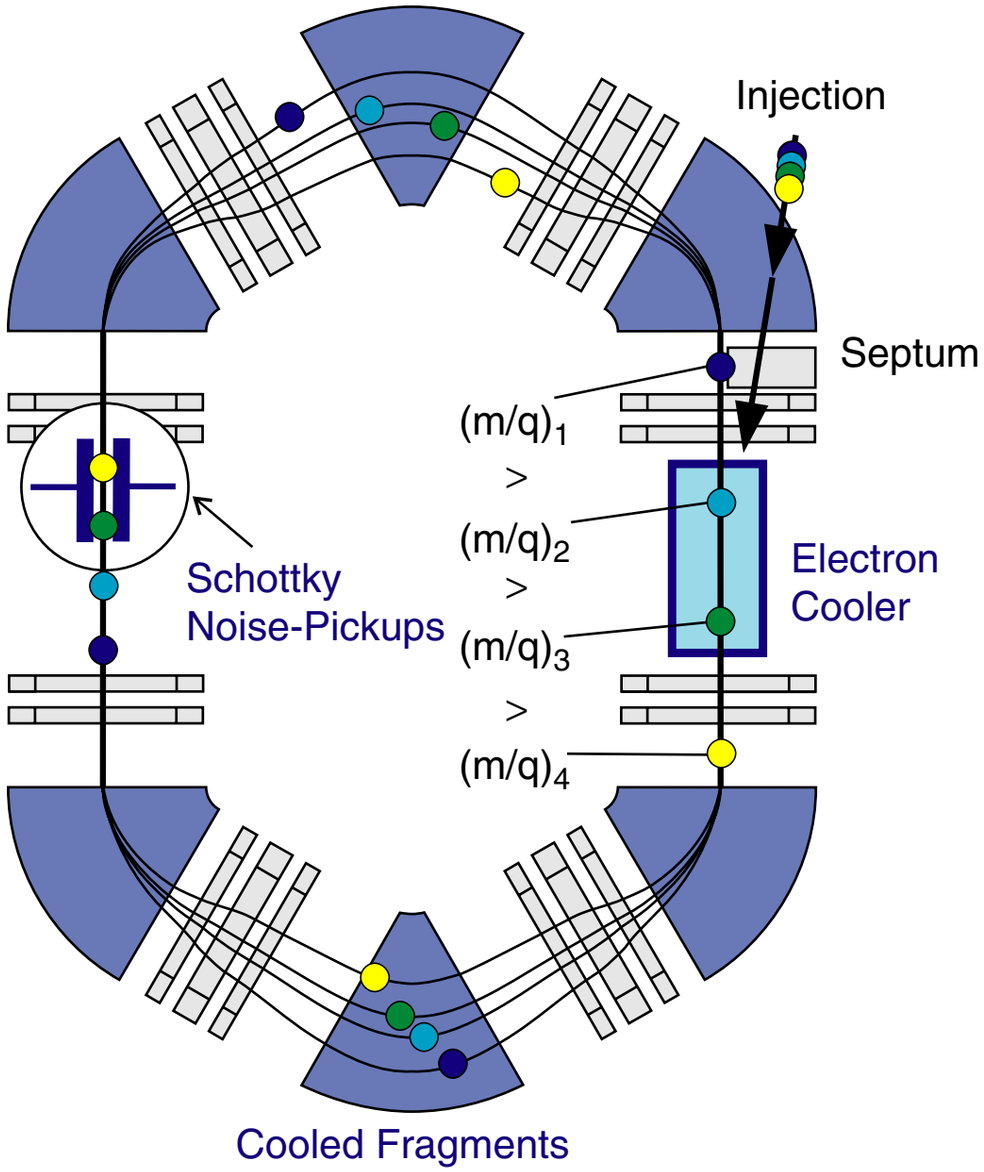
# GSI facility

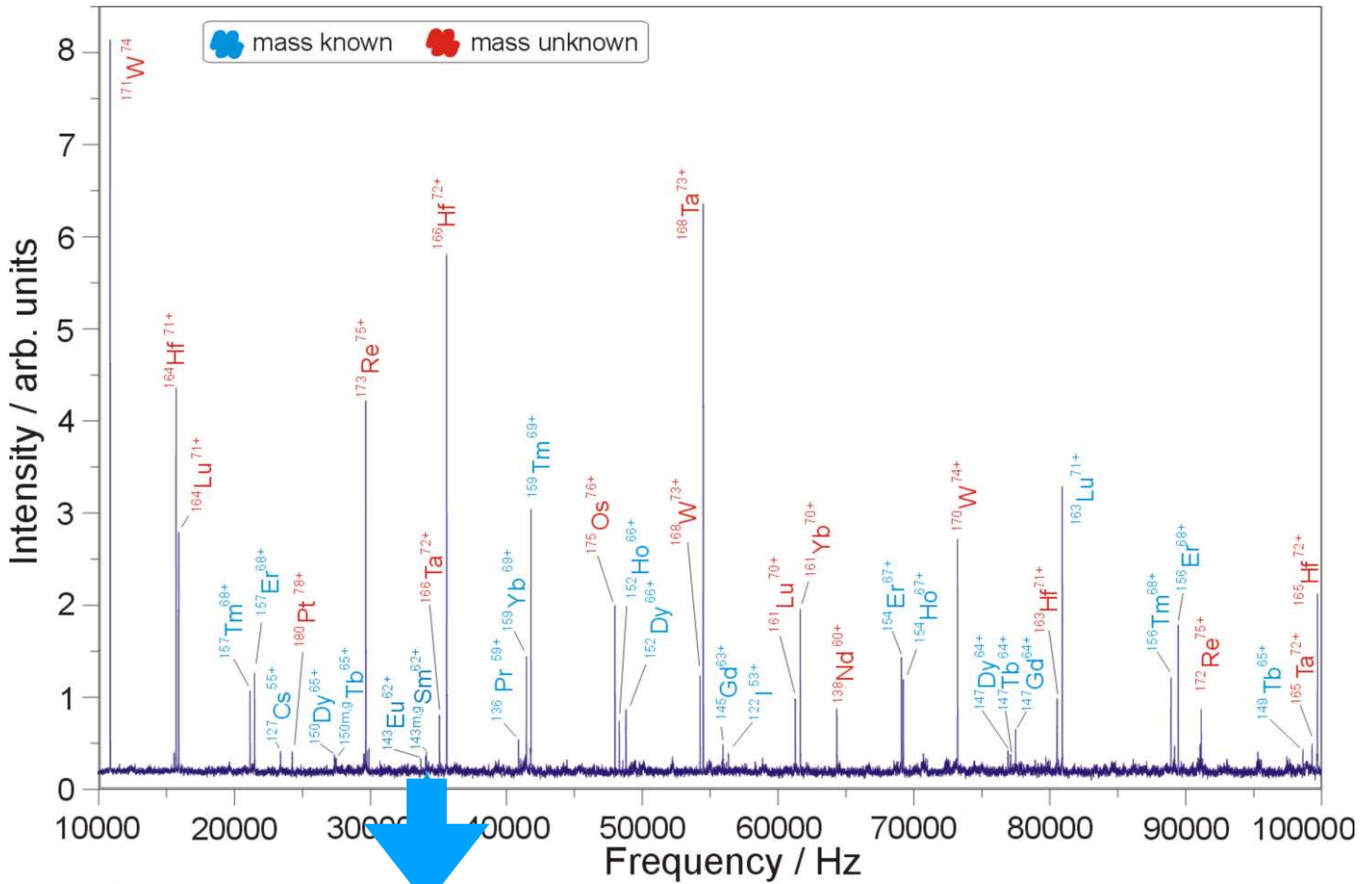


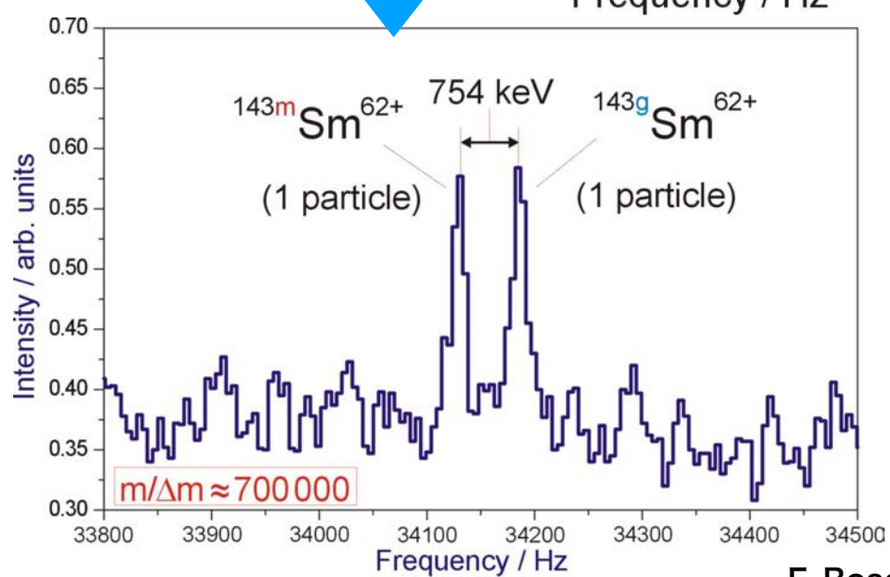
# SMS

## Schottky Mass Spectrometry

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



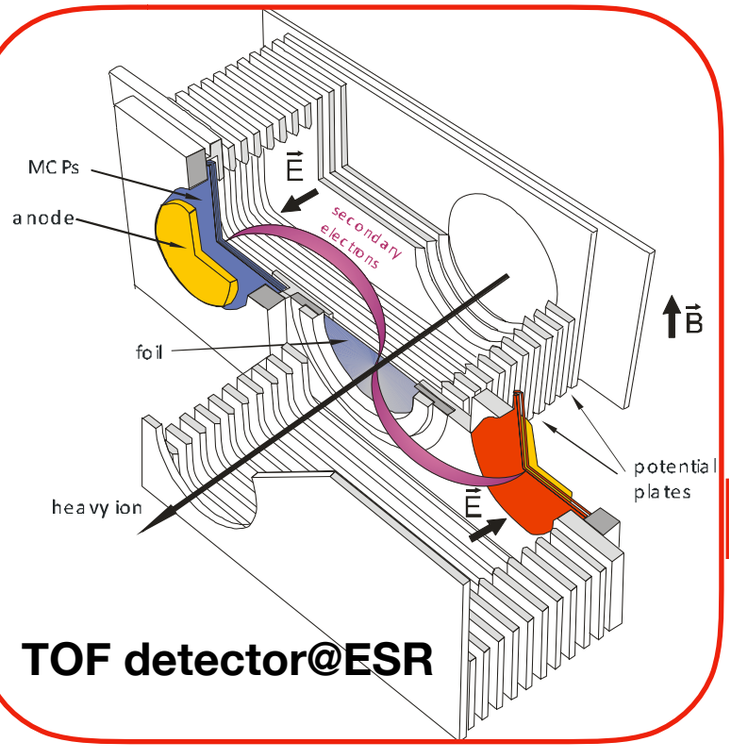

F. Bosch et al., PPNP 73 (2013) 84

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

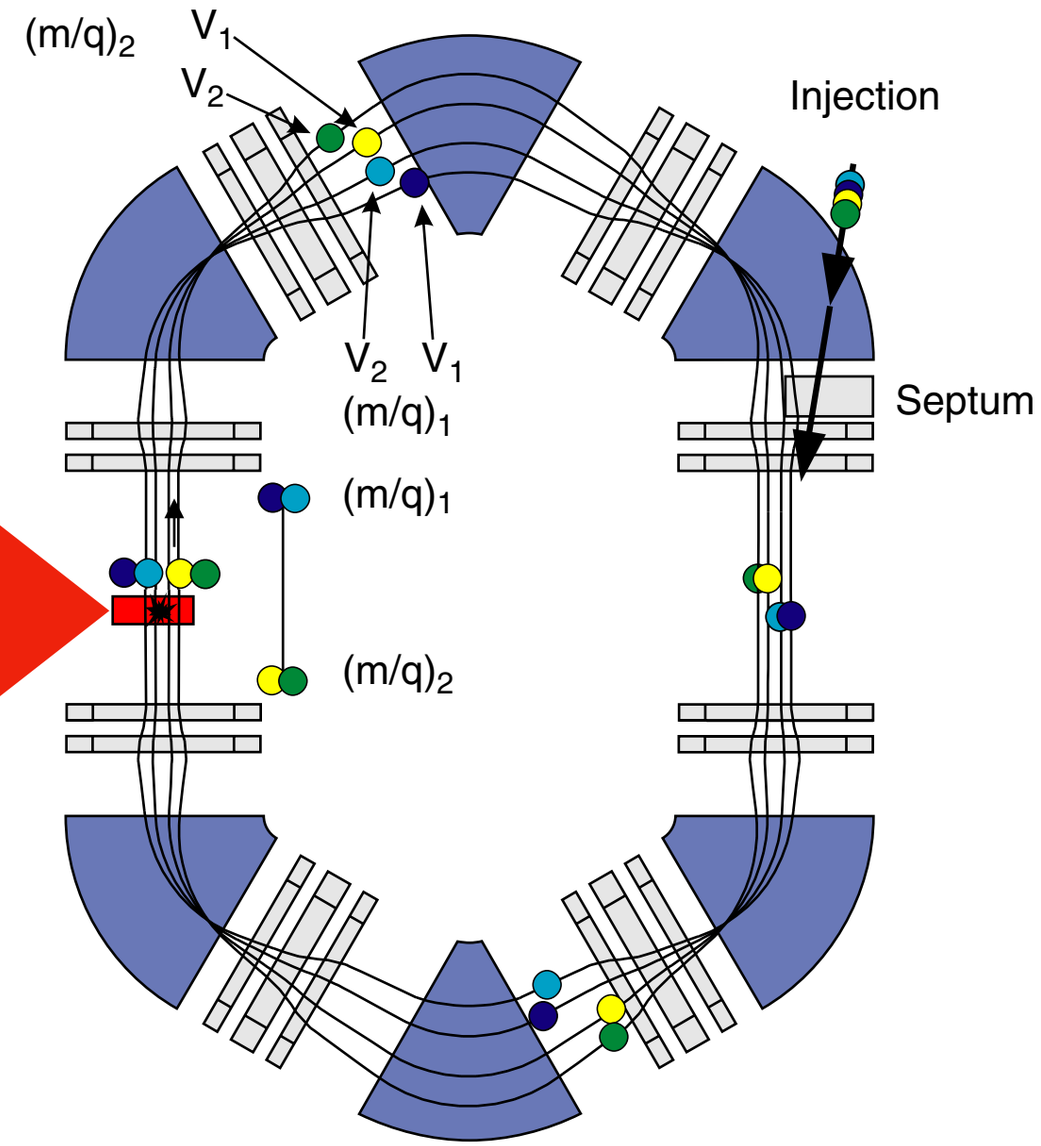
# IMS

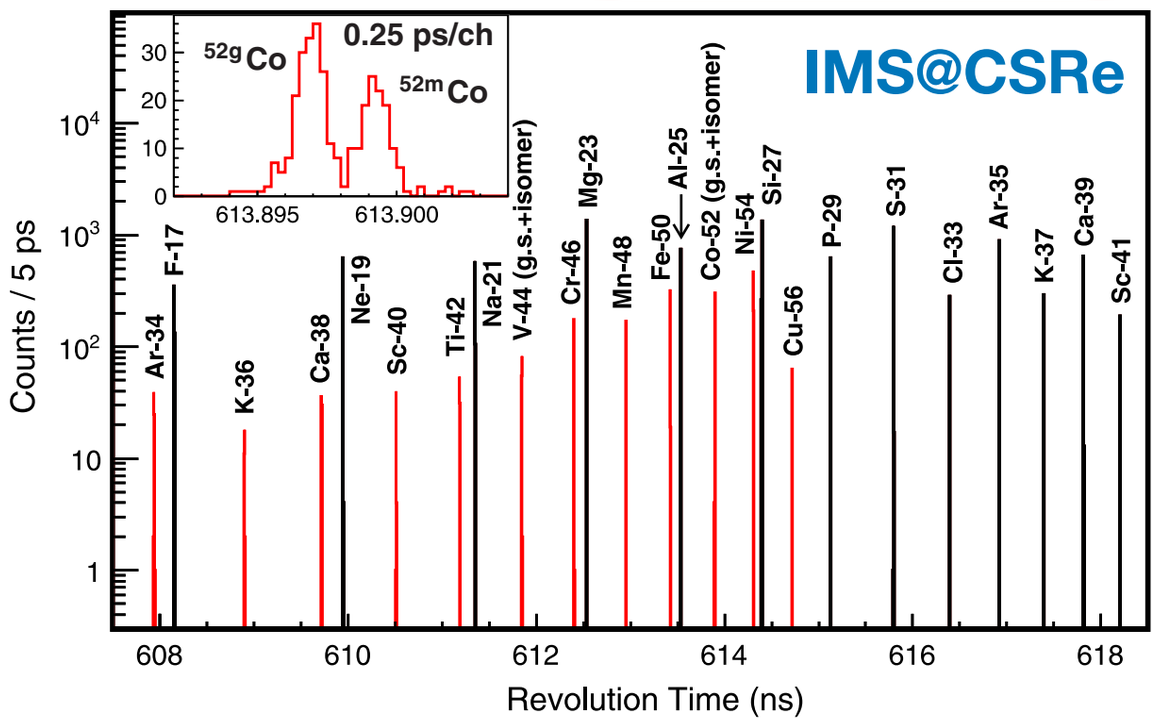
## Isochronous Mass Spectrometry

**In-ring TOF detector (C foil + MCP)**




TOF detector@ESR

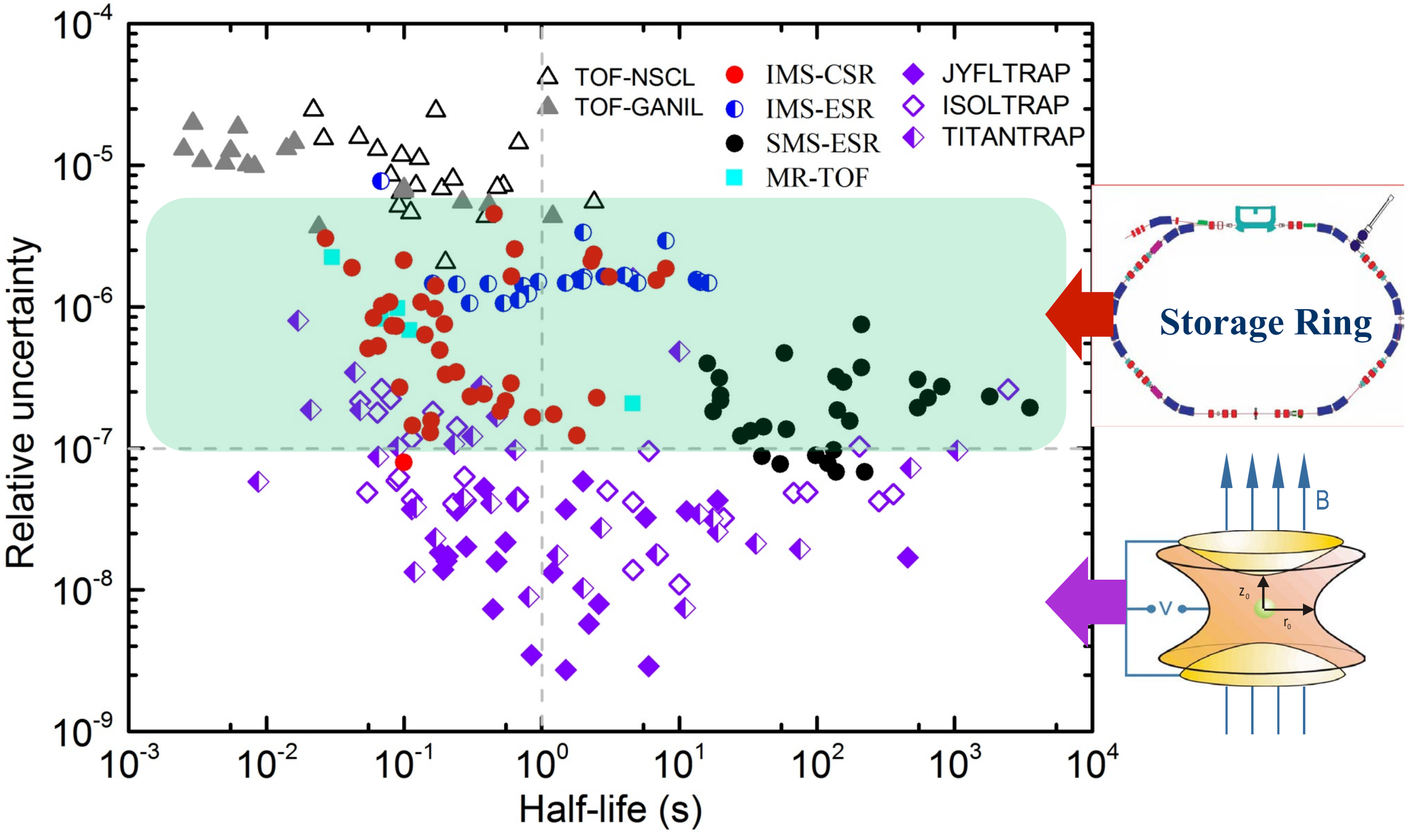



X. Xu et al., PRL 117 (2016) 182503

# Brief results from CSRe mass measurements

## Precisions of new masses since 2010




Y.H. Zhang

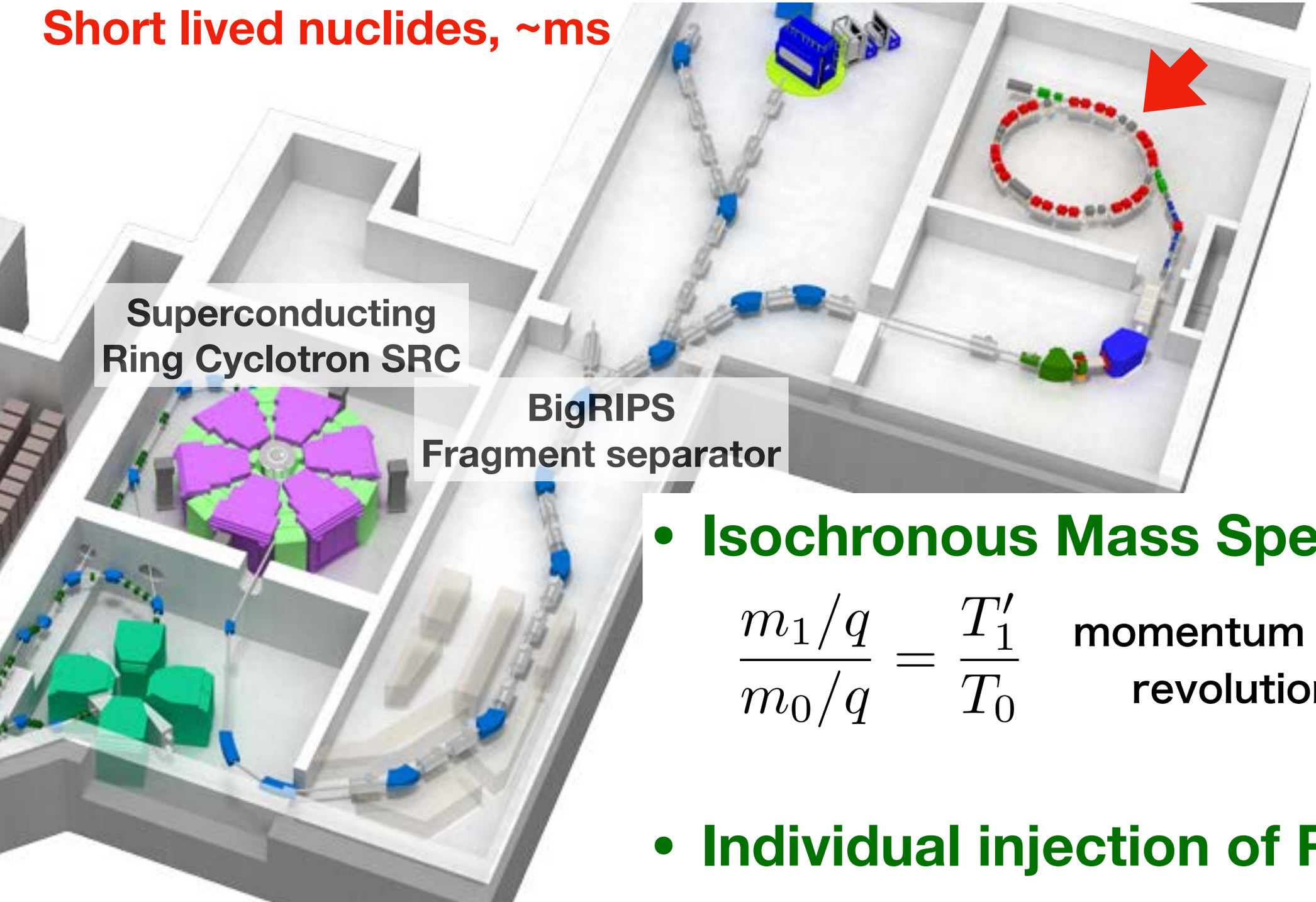
# Rare-RI Ring: R3

## A dedicated device for precision mass measurements

**Rare RI:**

**Very low production rates, ~1/day**

**Short lived nuclides, ~ms**




- **Isochronous Mass Spectrometry**

$$\frac{m_1/q}{m_0/q} = \frac{T_1'}{T_0}$$

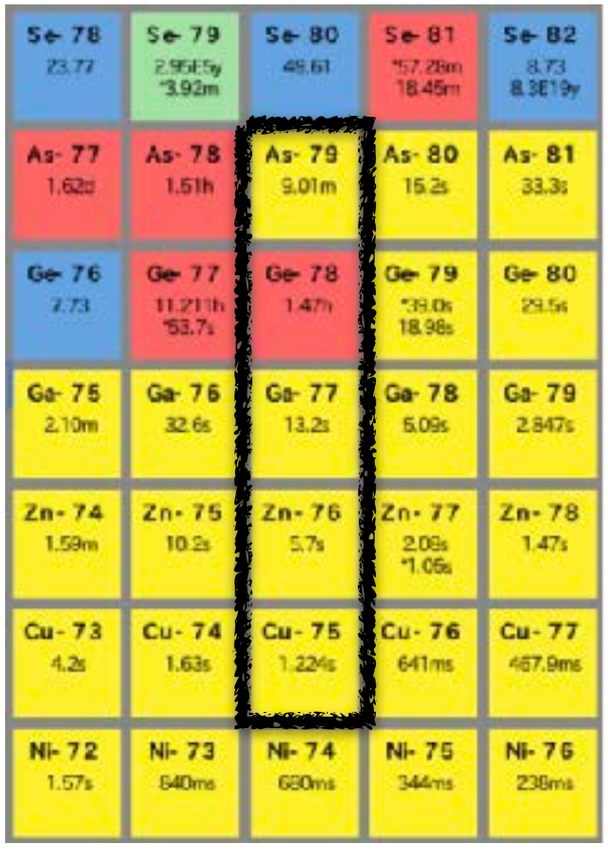
momentum corrected revolution times

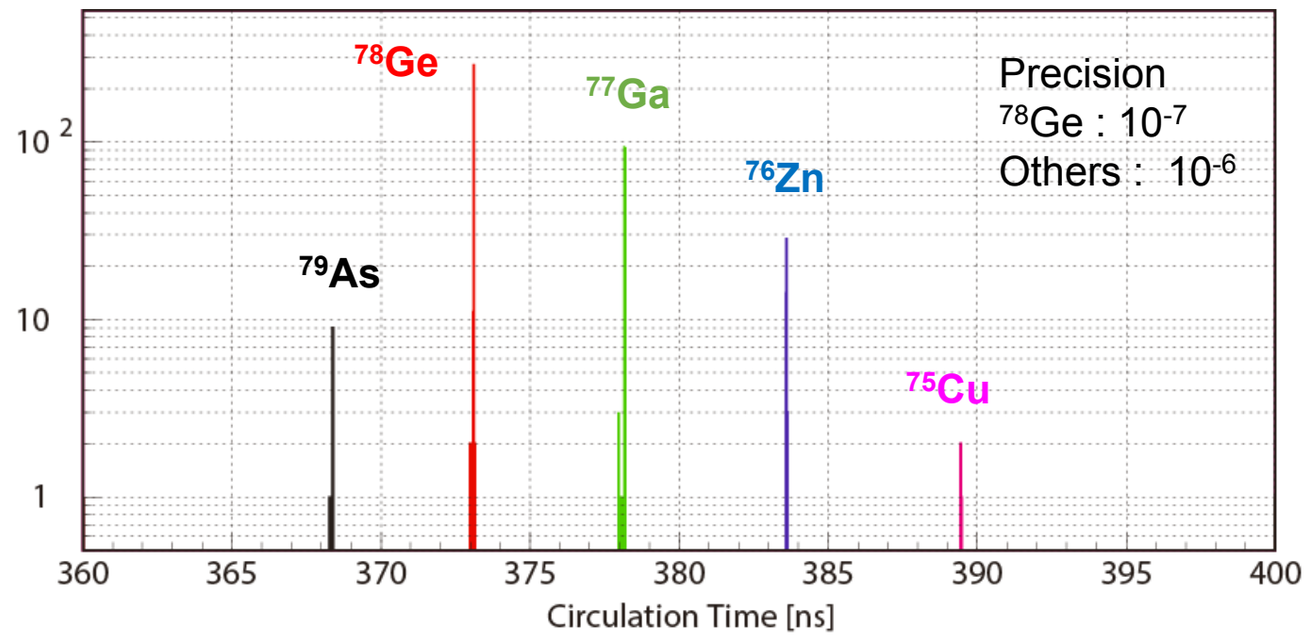
- **Individual injection of RI beam**

# First Mass Measurement

## With known masses

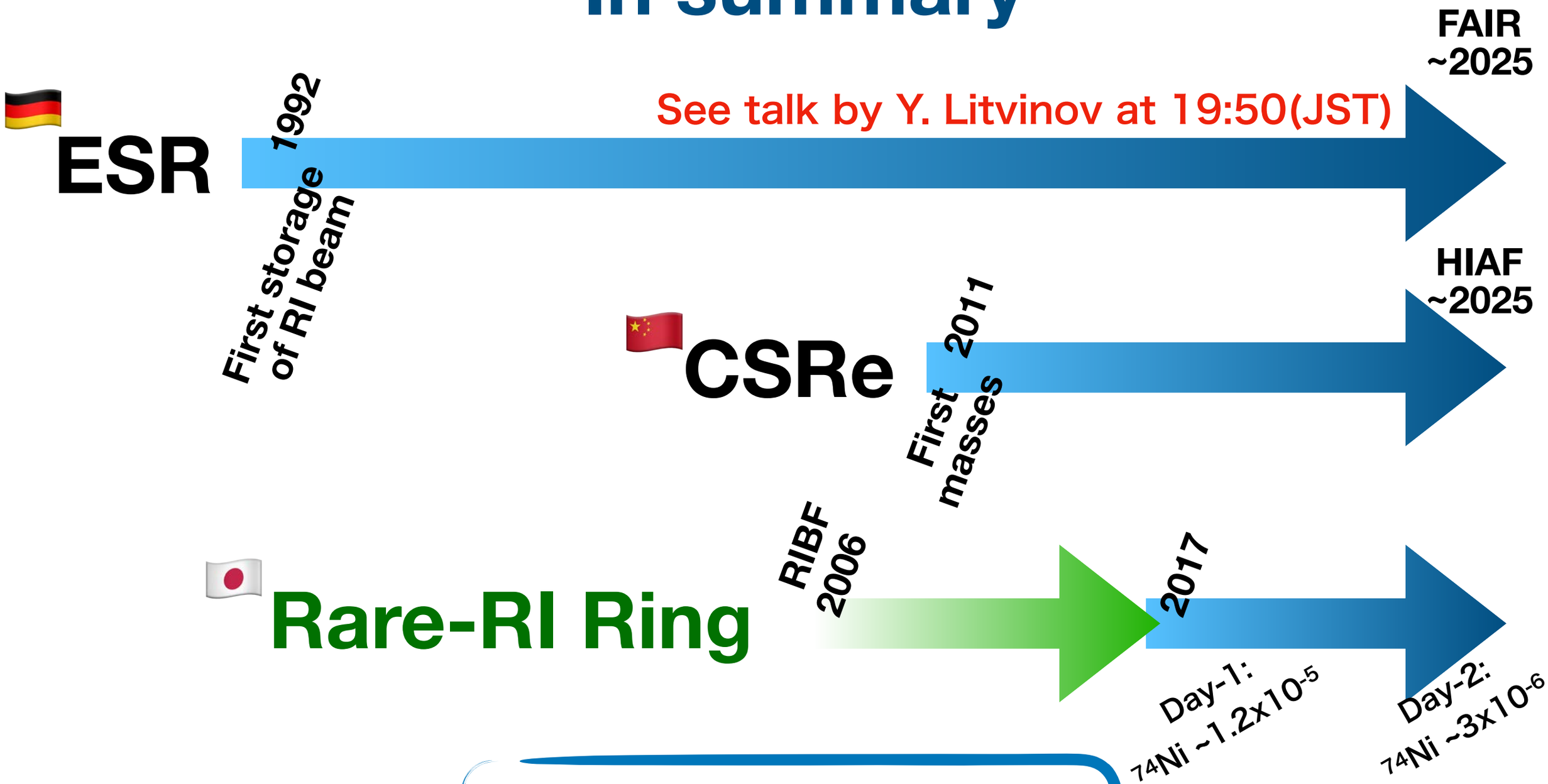
## $^{238}$U 345 MeV/u → $^{78}$Ge 168 MeV/u fission fragments




**Y. Yamaguchi & D. Nagae**

# In summary




**Isochronous cond.:** ~$10^{-6}$
**Total transmission:** ~$10^{-2}$
**Mass accuracy:** $10^{-6}$ -$10^{-7}$

**We are ready to delve into unexplored territories of masses**

# Thank you