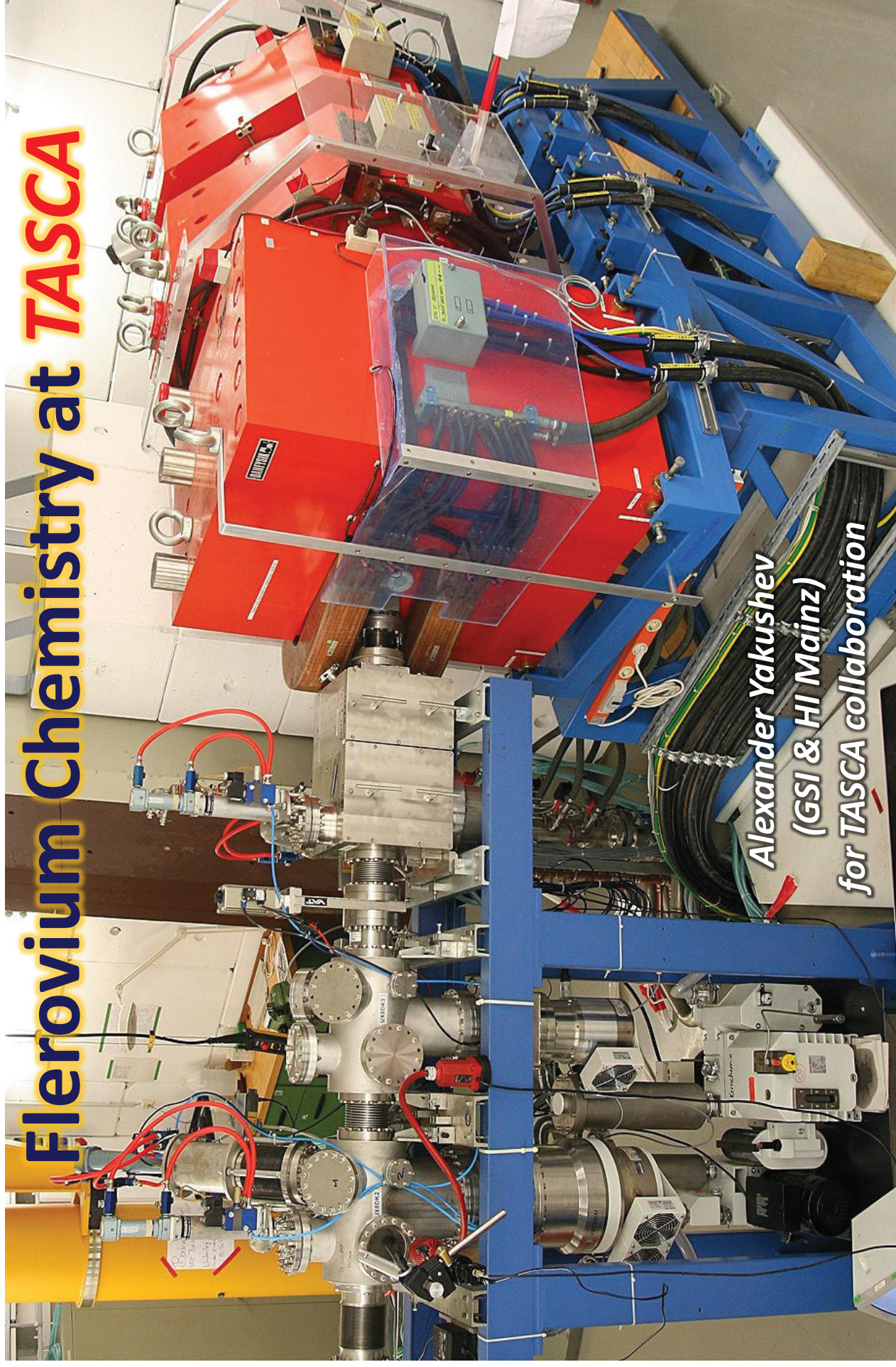


Flerovium Chemistry at TASCA



Alexander Yakushev
(GSI & HI Mainz)
for TASCA collaboration



HELMHOLTZ
Institut Mainz



JOHANNES GUTENBERG
UNIVERSITÄT MAINZ



UNIVERSITY OF JYVÄSKYLÄ



UNIVERSITY OF
LIVERPOOL



UNIVERSITÄT
BERN



UNIVERSITY
OF OSLO



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Outline

- ❑ Status of FI chemistry – theory vs. experiment
- ❑ Experiment challenges
- ❑ Recent FI chemistry experiments at TASCA
- ❑ Preliminary results
- ❑ Conclusions and outlook

Elements of interest

*Lanthanides

+Actinides

Status: Theory

1975

Are elements 112, 114, and 118 relatively inert gases?

Kenneth S. Pitzer

*Department of Chemistry and Inorganic Materials Research Division of the Lawrence Berkeley Laboratory,
University of California, Berkeley, California 94720
(Received 14 April 1975)*

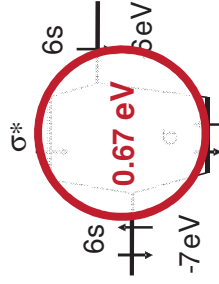
The Journal of Chemical Physics, Vol. 63, No. 2, 15 July 1975 1032

2001

M-Au Bonding (Dimer)

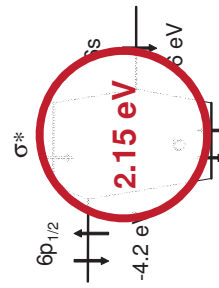
Group 12

Hg-Au

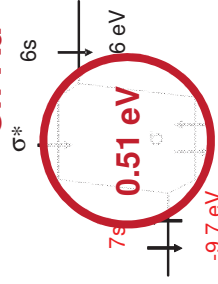


Group 14

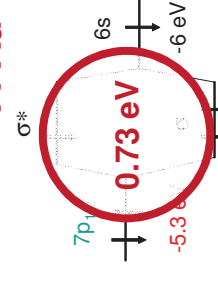
Pb-Au



Cn-Au

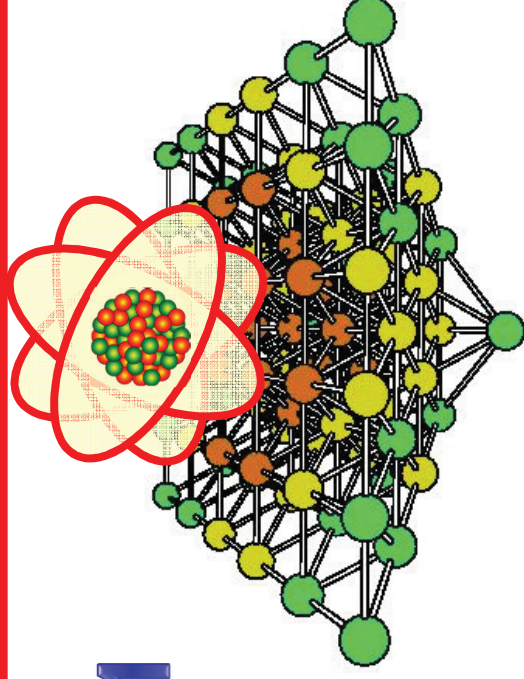


Fl-Au



[T. Jacob *et al.*, Surf. Sci. 486, 194 (2001)]

2011



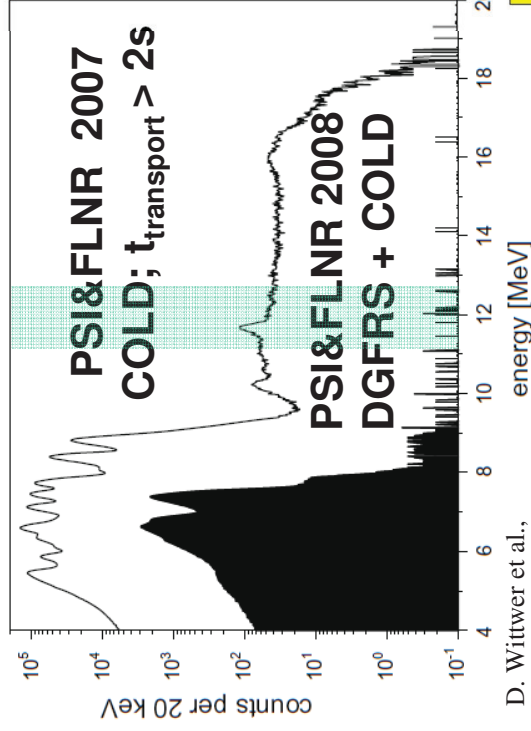
Cn-Au_n **Fl-Au_n**
0.30... 0.52 eV **0.47 ... 0.77 eV**

[V. Pershina, TAN2011, Sochi, Sept. 5-11 (2011)]

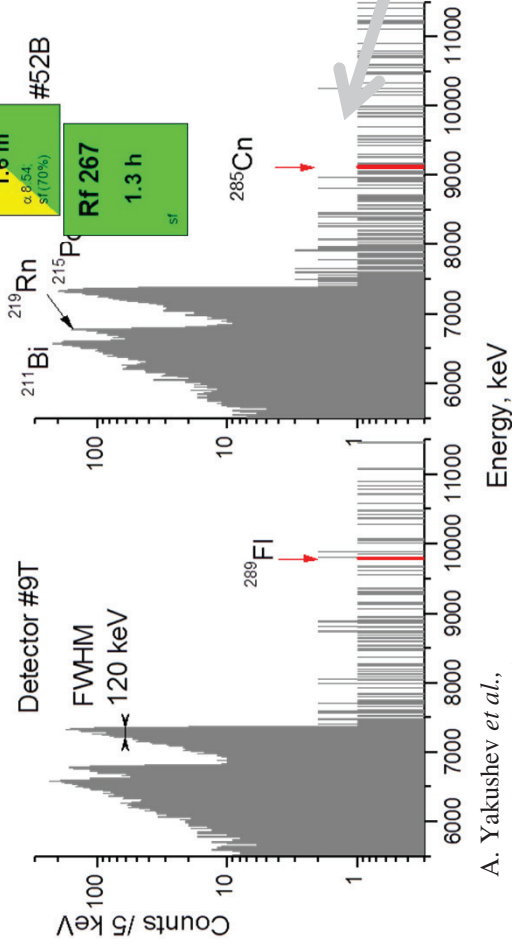


Experimental challenges:

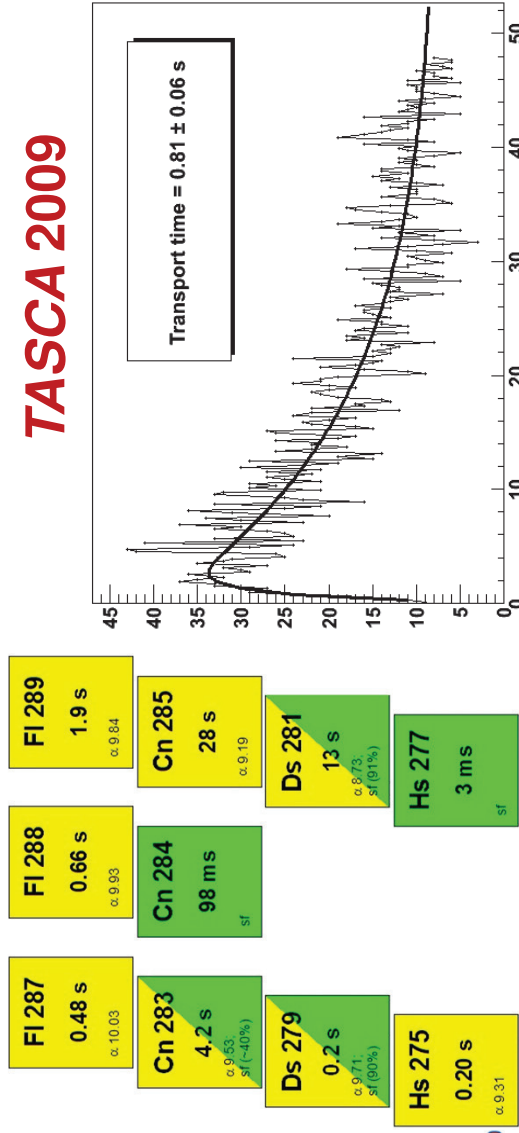
short half-life, background and efficiency (1)



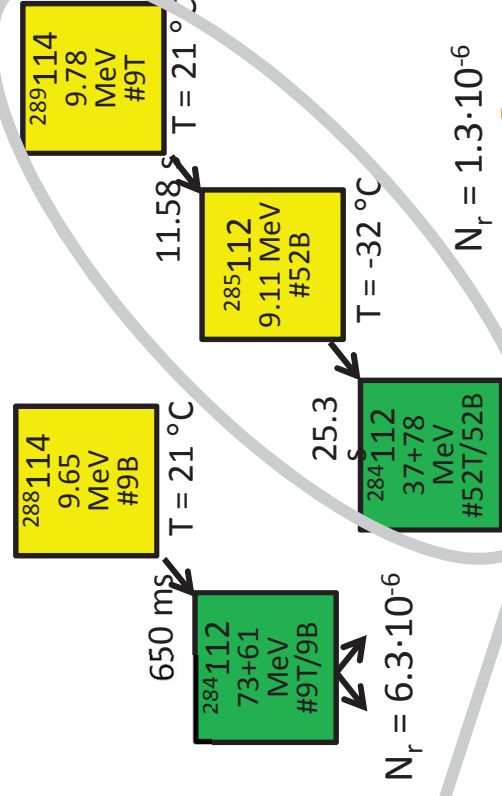
D. Wittwer et al.,
NIM B 268 (2010) 28–35



A. Yakushev *et al.*,
Inorg. Chem. 53, 1624 (2014)



TASCA 2009



$$N_r = 1.3 \cdot 10^{-6}$$

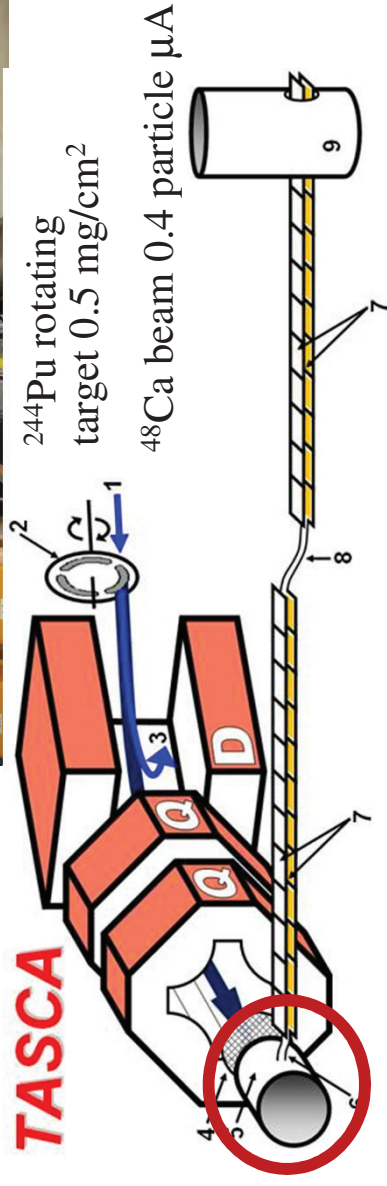
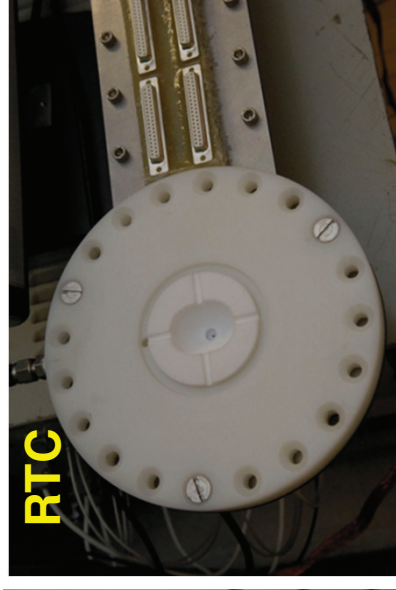
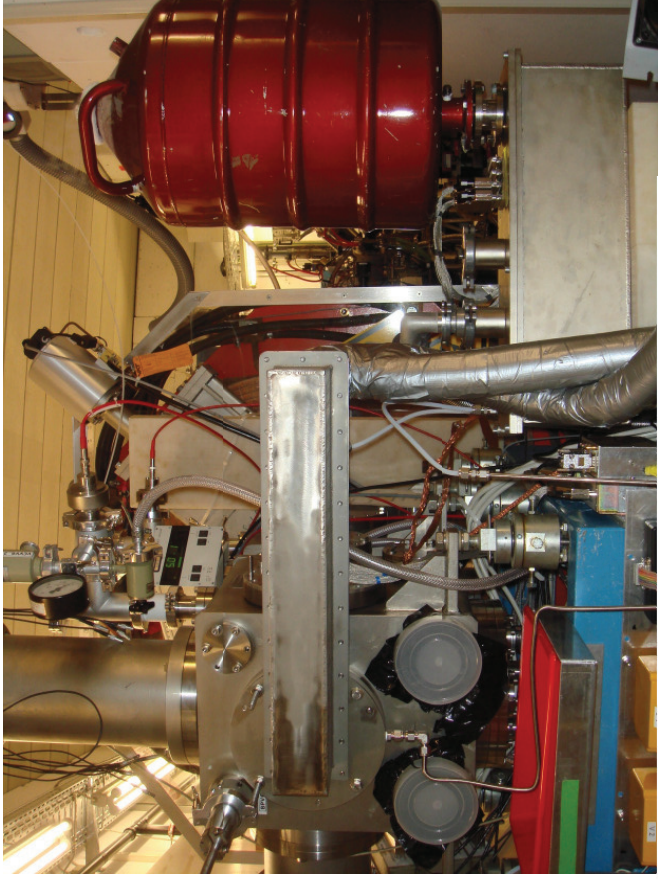
$$N_r = 6.3 \cdot 10^{-6}$$



Experimentel setup at TASCA(2009)



RTC



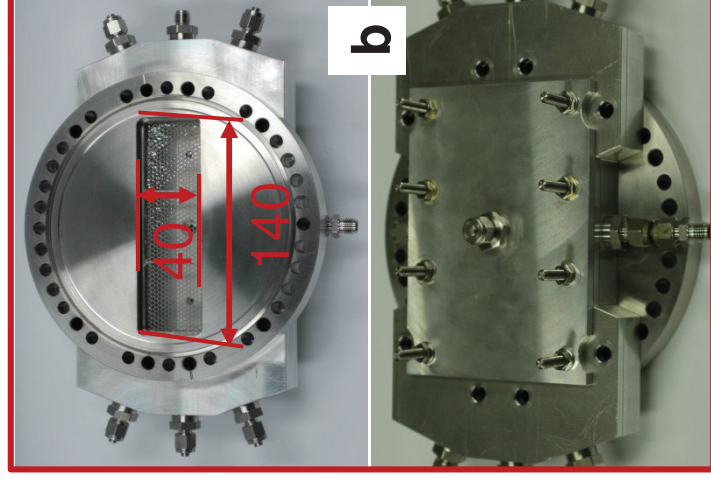
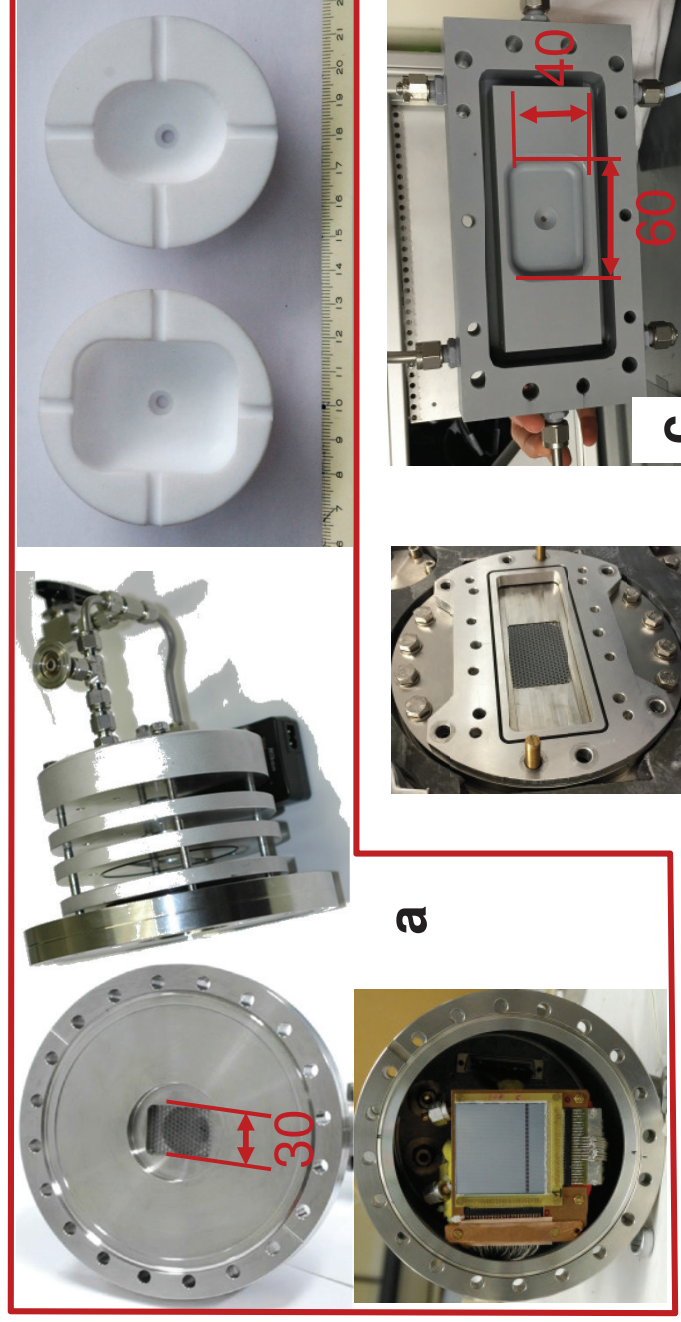
TASCA $\varepsilon \leq 30\%$

COMPACT I (IC)

COMPACT II (TC)



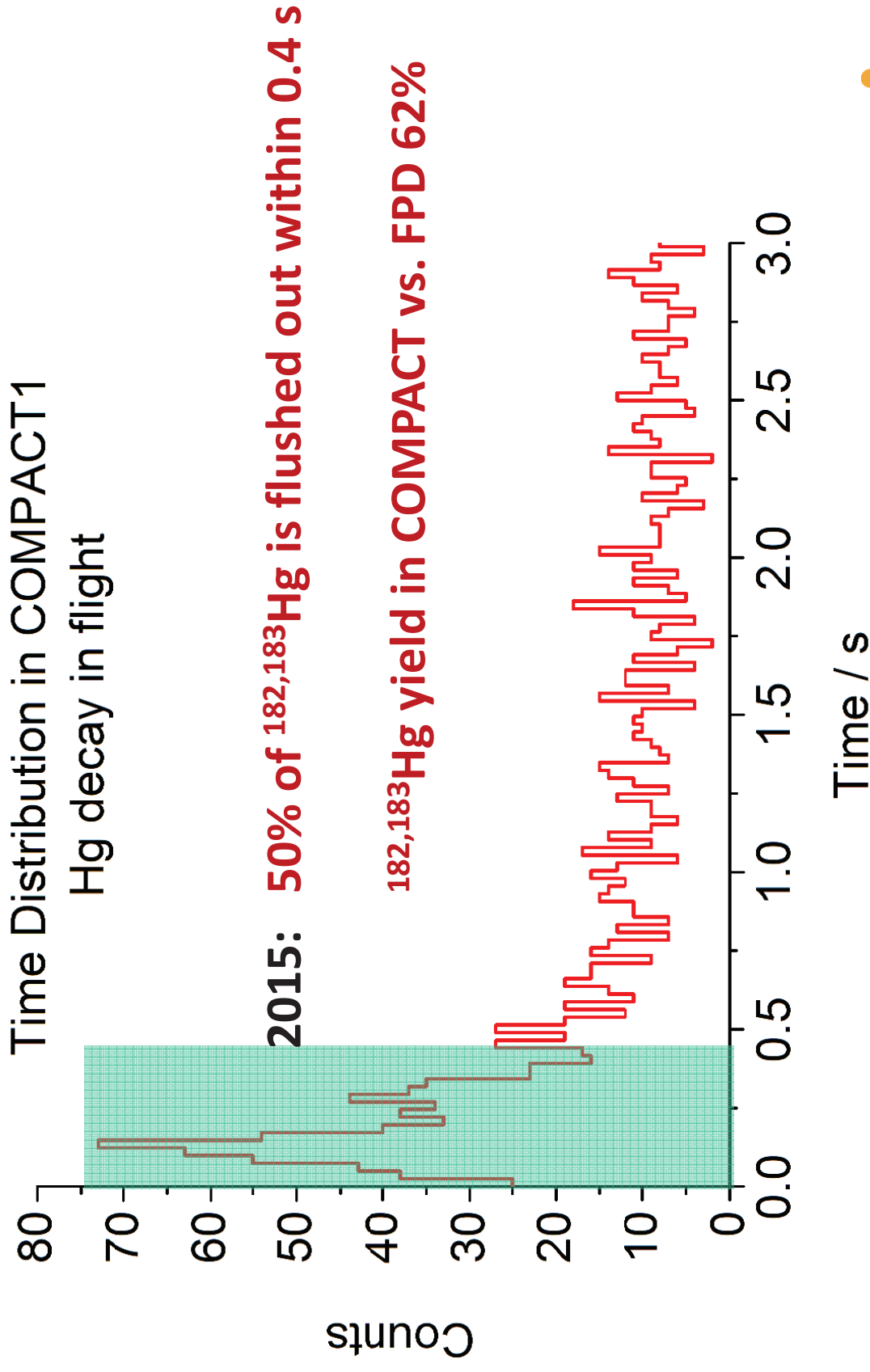
Recoil Transfer Chamber (RTC) and a „100% yield“ detector developments



TASCA RTC:

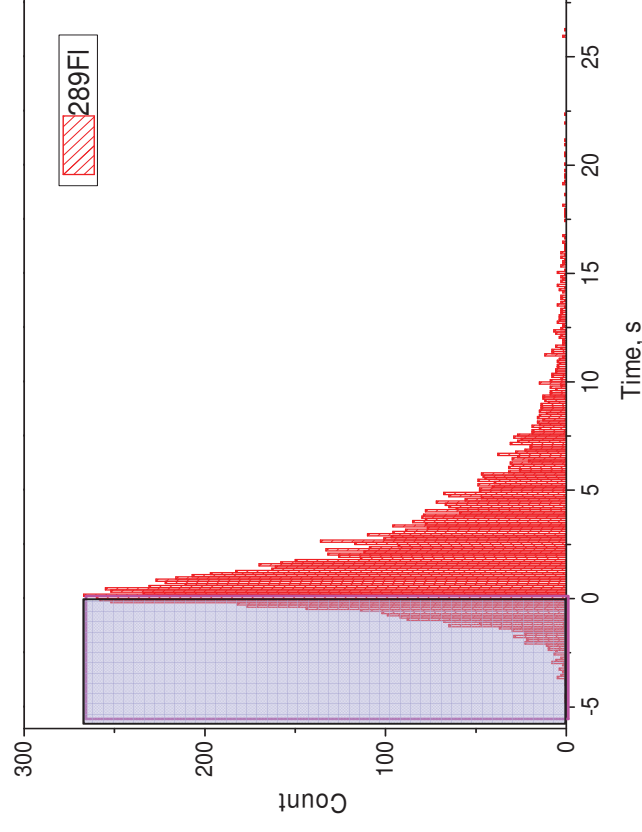
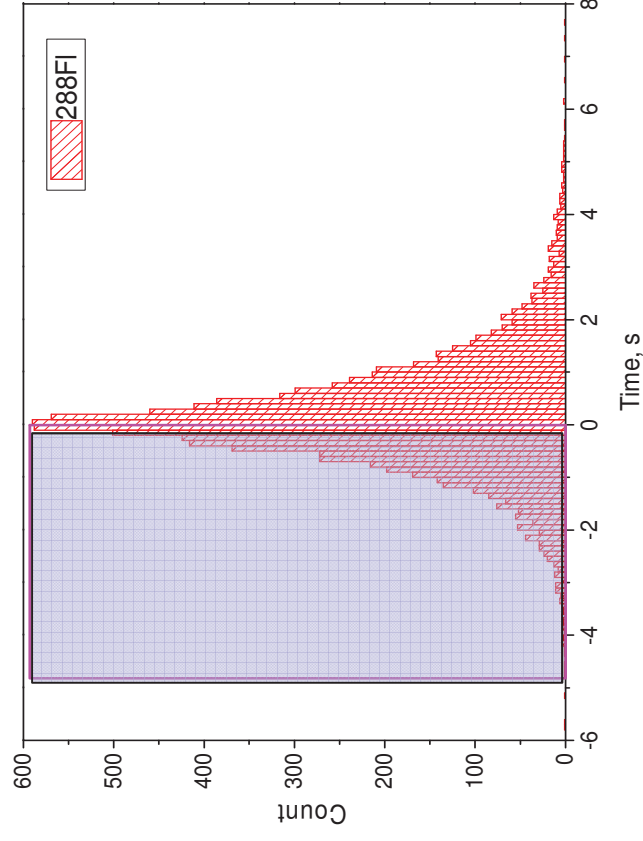
- a - Small Image Mode (SIM)
- b- High Transition Mode (HTM)
- c – A „small“ RTC for HTM

Flush out time and Hg yield (2015)



How much FI we are loosing inside RTC

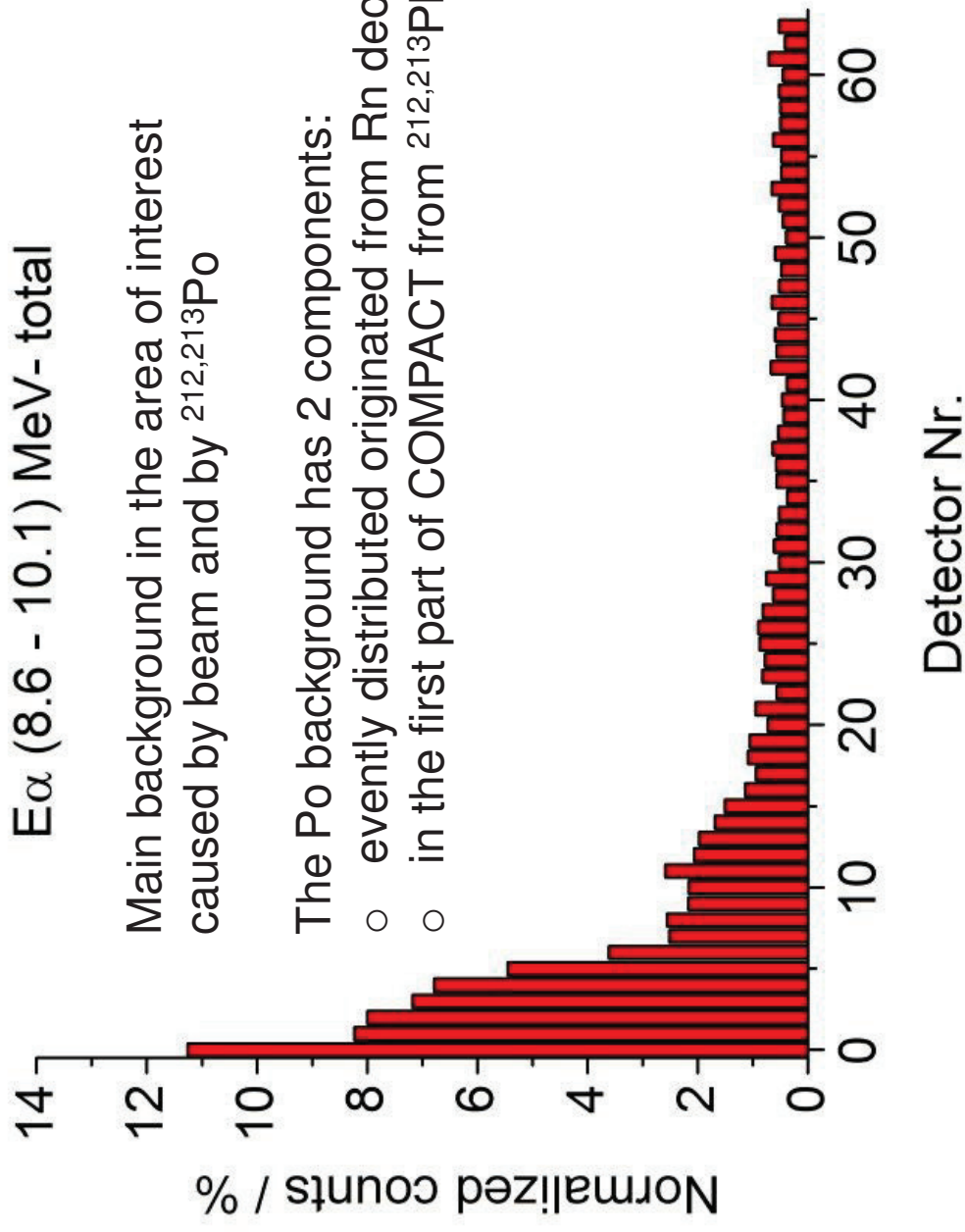
Distributions of the simulated time difference between random lifetime of $^{288,289}\text{Fl}$ and random staying time in RTC



**Even with the fast transport time we are loosing
 $\approx 50\%$ of ^{288}Fl inside the RTC**

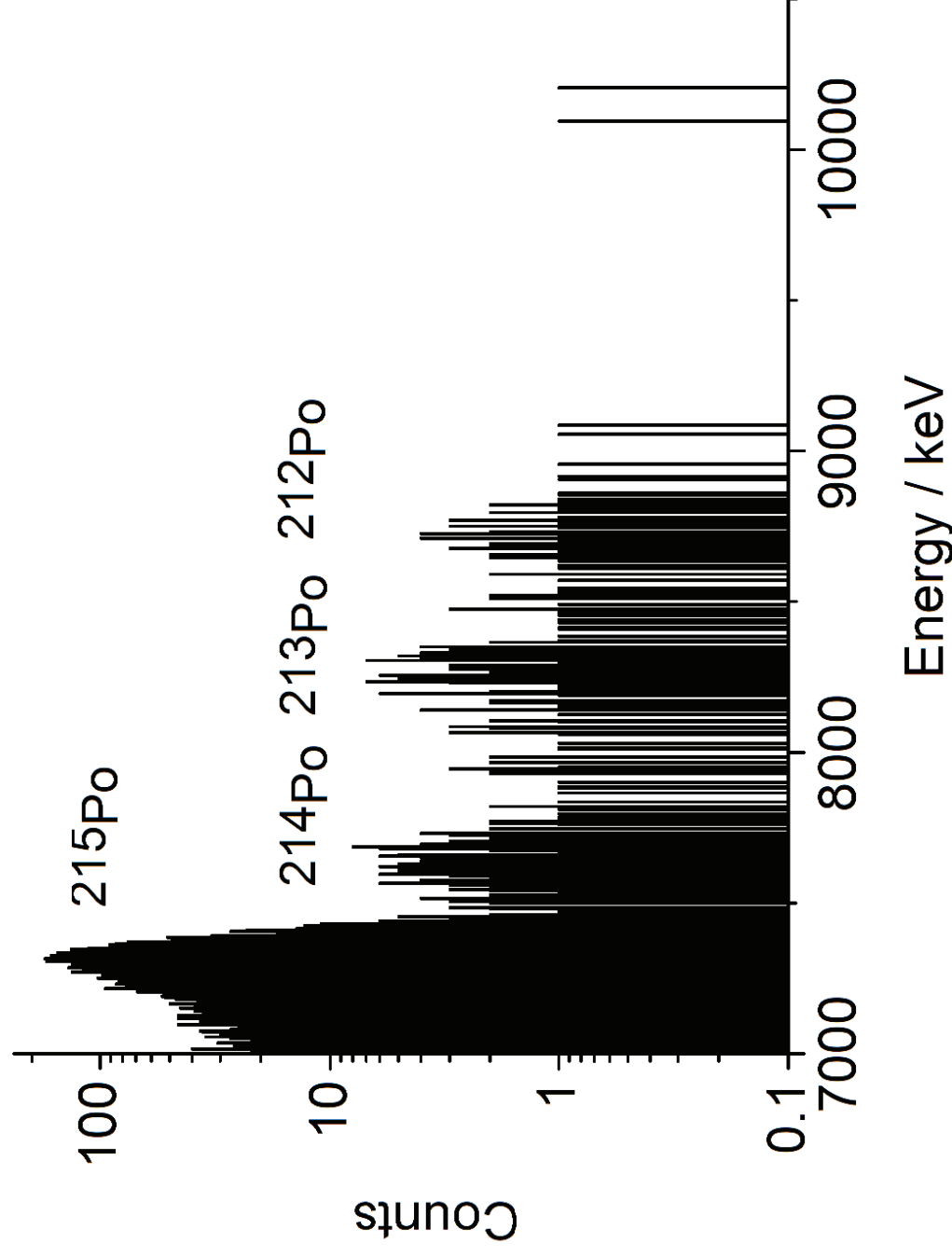
Carrier gas He:Ar =50:50; 2.0 L/min

Background distributions



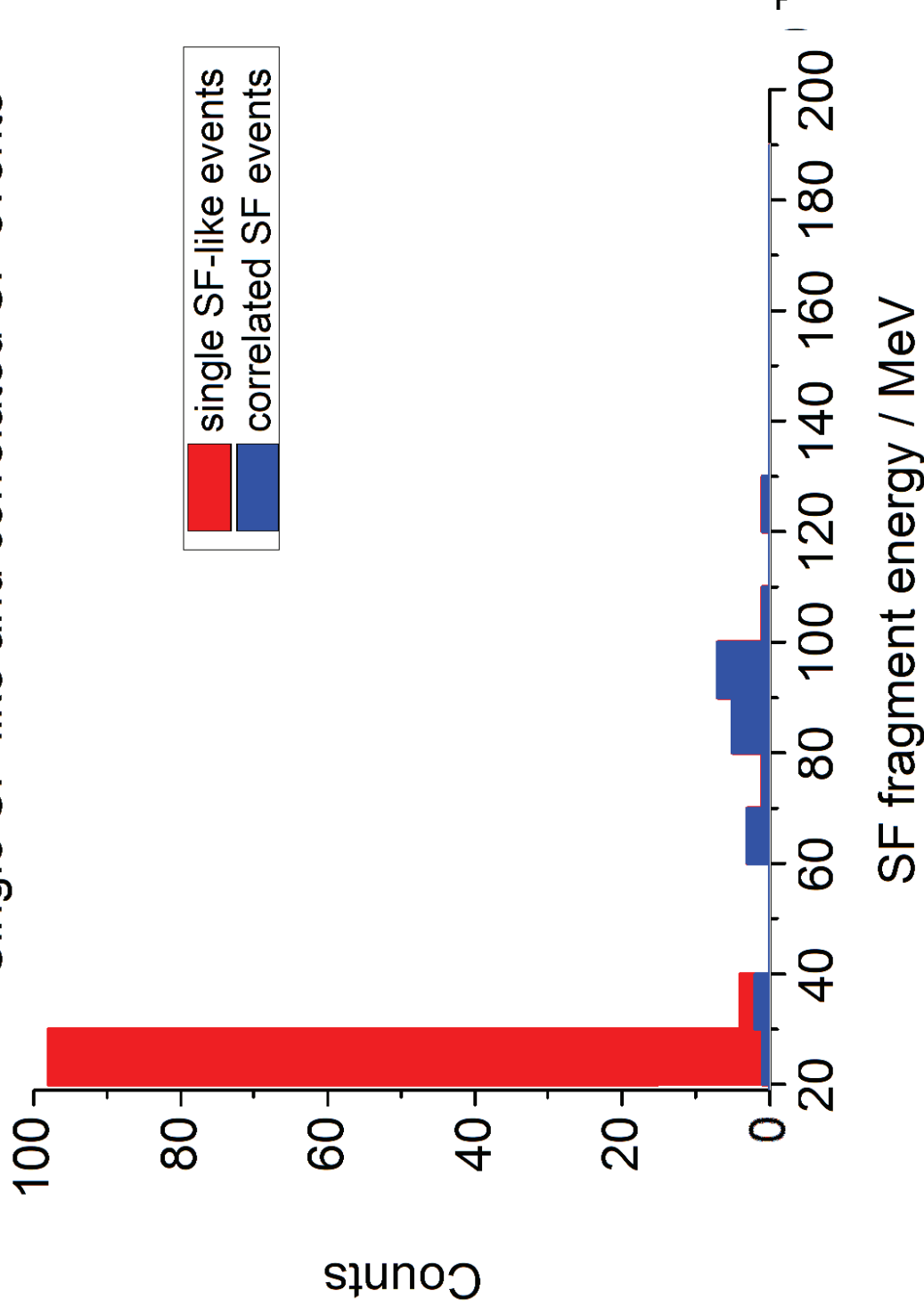
Background distributions

COMPACT1_00_beam off



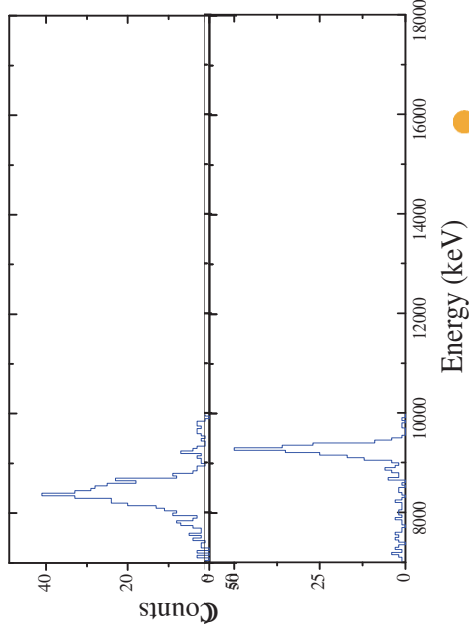
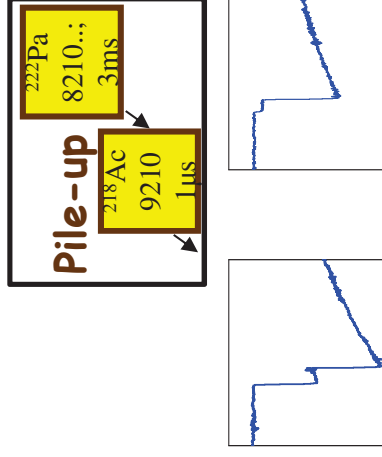
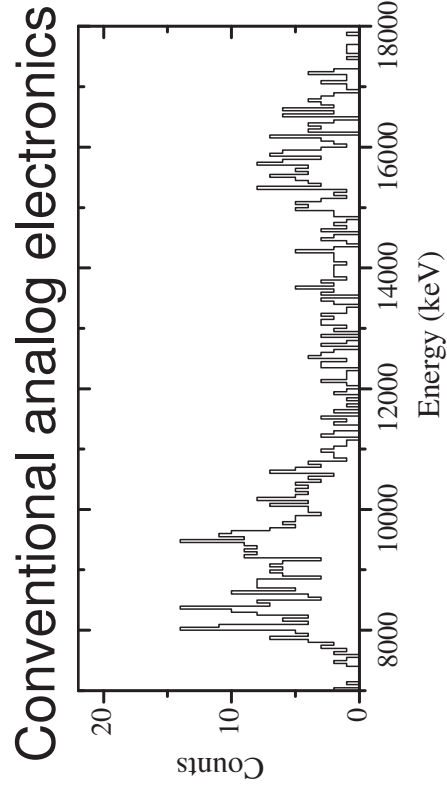
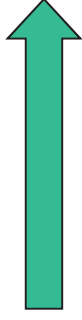
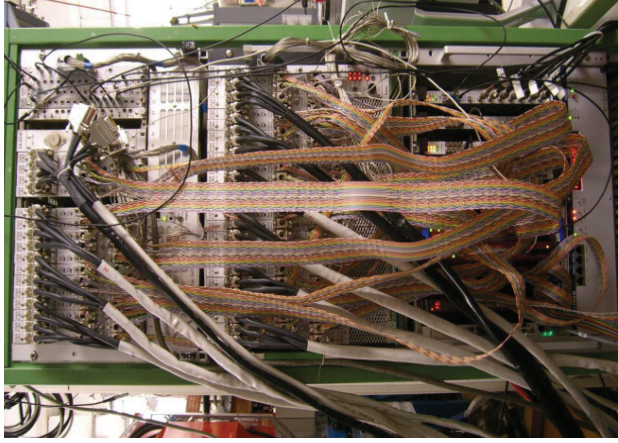
Background distributions

Single SF-like and correlated SF events

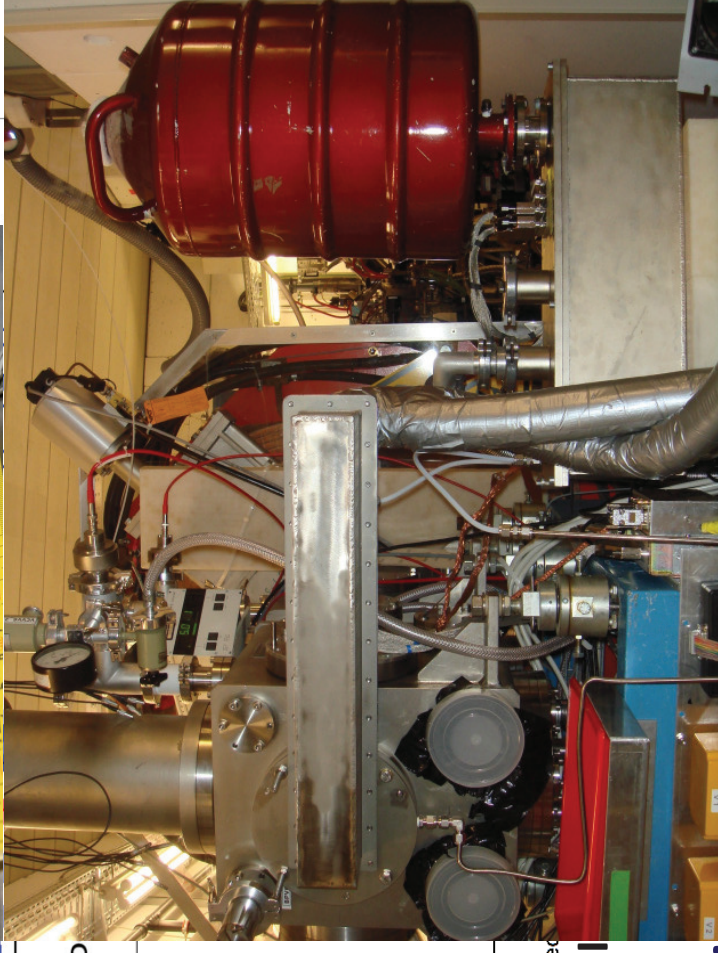
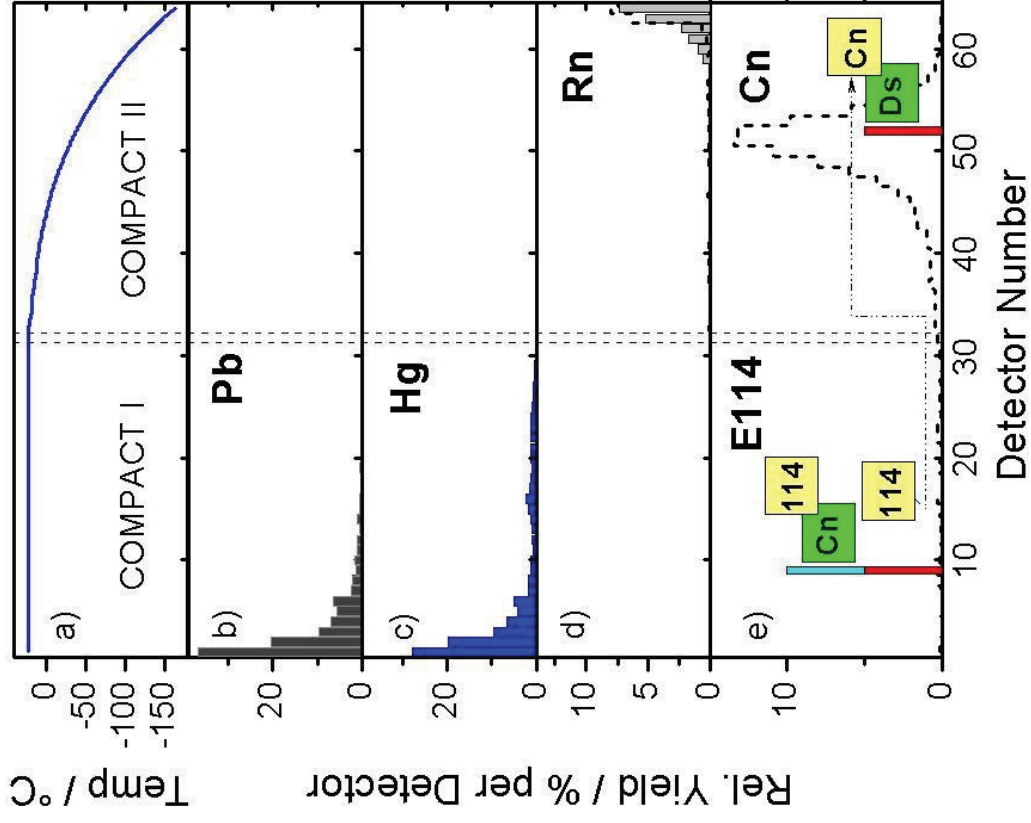


SF fragment energy / MeV

Background reduction with a digital DAQ

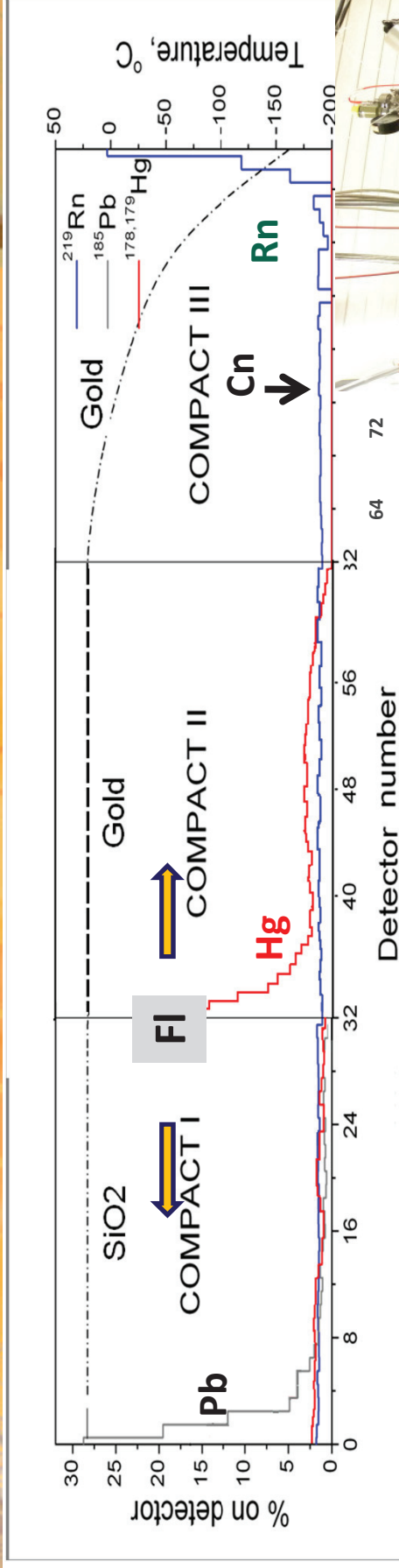


Fl chemistry run at TASCA (2009)

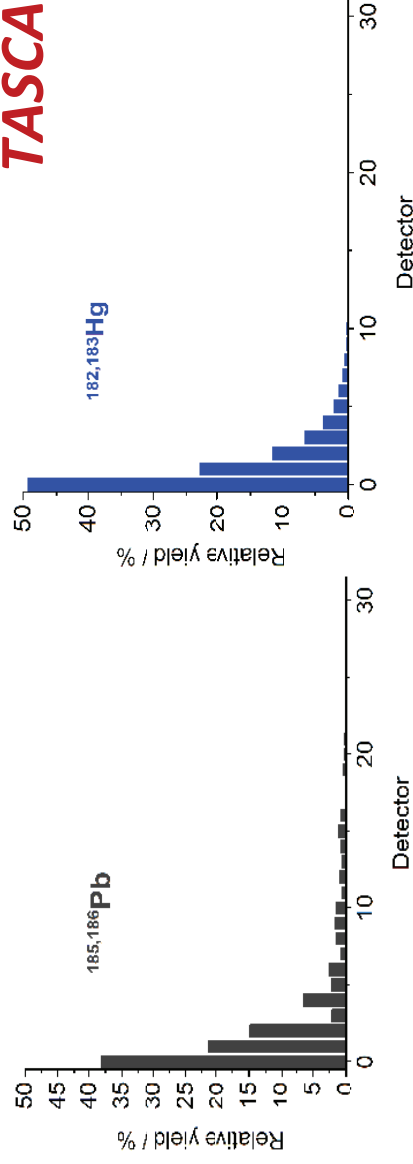


Carrier gas He:Ar = 30:70; 1.5 L/min

FI chemistry run at TASCA (2014)



TASCA in HTM



COMPACT I

COMPACT II

COMPACT III

Carrier gas He:Ar = 30:70; 1.5 L/min

The Flerovium Experiment 2015

Experiment duration 10 days (5 Hz), 30 days (45 Hz))

$^{48}\text{Ca}^{10+}$ Beam

- ❖ Energy 260 MeV (E^* in target center: 43 MeV)
- ❖ Average intensity $4 \cdot 10^{12}$ particles/ s
- ❖ Projectile dose DT3 $\sim 6 \cdot 10^{18}$

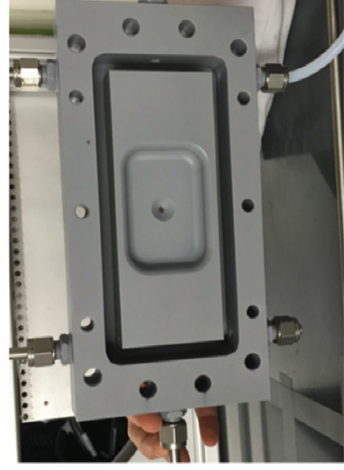
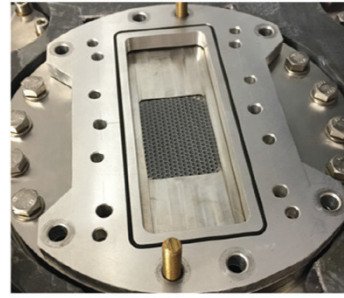
^{244}Pu Target

- ❖ Average thickness $811 \mu\text{g}/\text{cm}^2$
- ❖ Backing 2.3 mm titanium

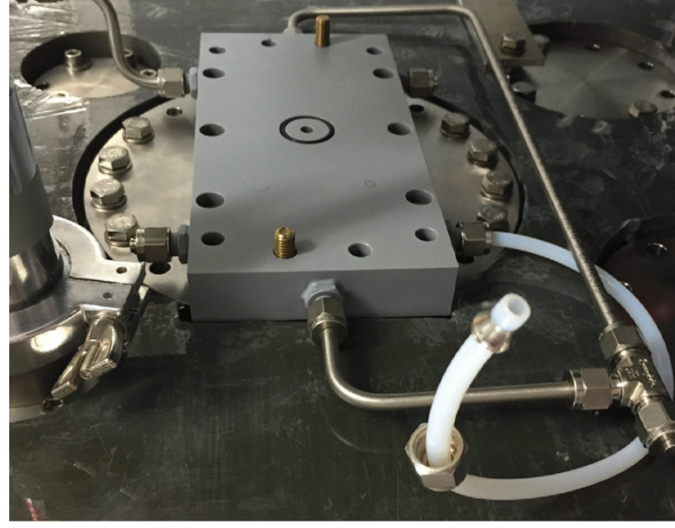
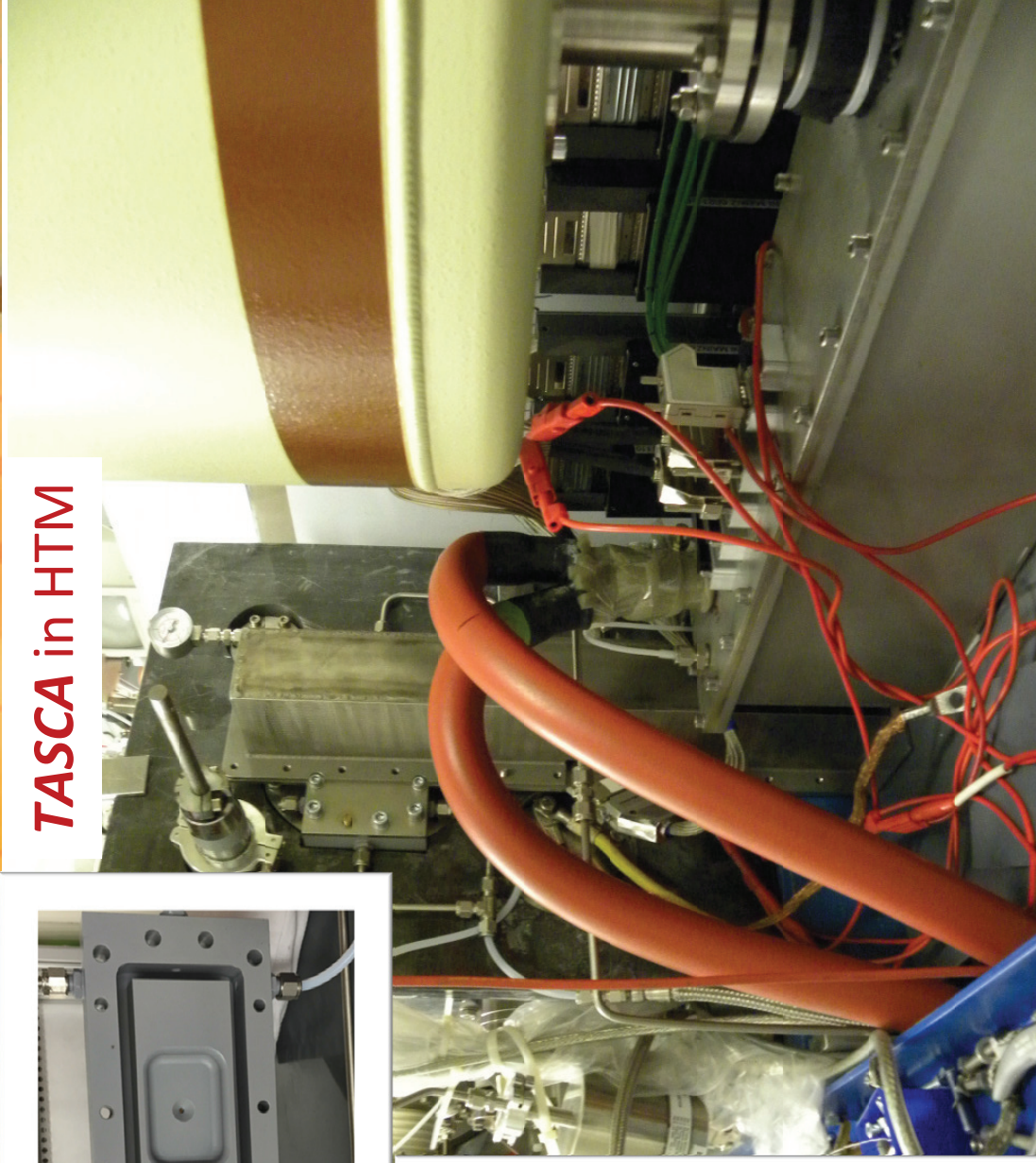
Evaporation residues

- ❖ $^{48}\text{Ca} + ^{244}\text{Pu}$ $^{289,288}\text{Fl}$

Experimental setup 2015



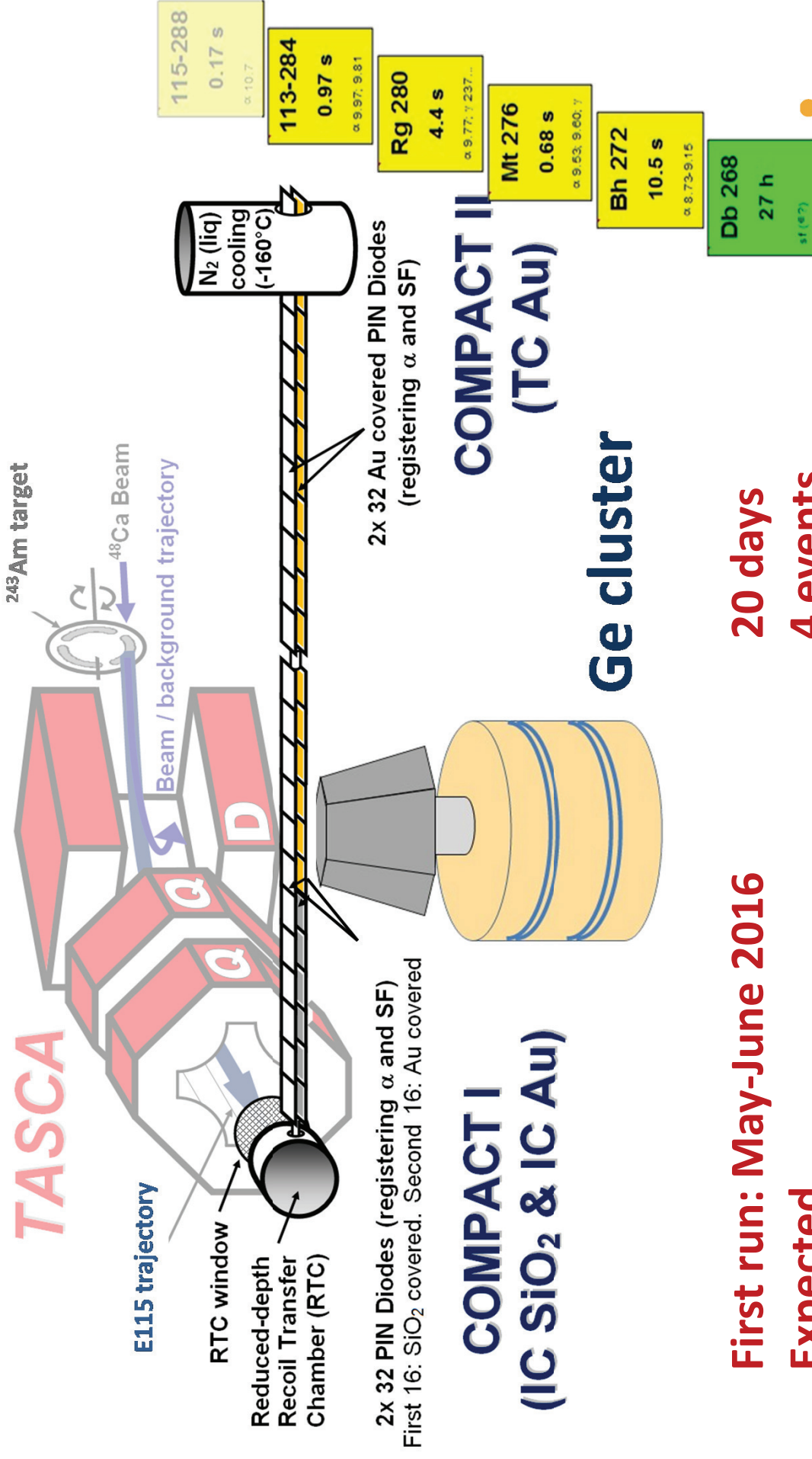
TASCA in HTM



Conclusions and Outlook

- ❑ 6 more FI events in 2014/2015 measured
- ❑ FI is distributed between Au and ice
- ❑ FI seems to be less reactive to Au compared to Cn
- ❑ Detailed analysis is ongoing
- ❑ Ready for E113 chemistry in 2016

2016: E113 chemistry at TASCA



First run: May-June 2016

20 days

Expected

4 events