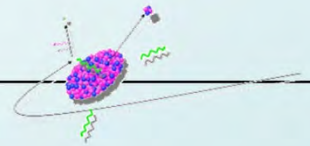
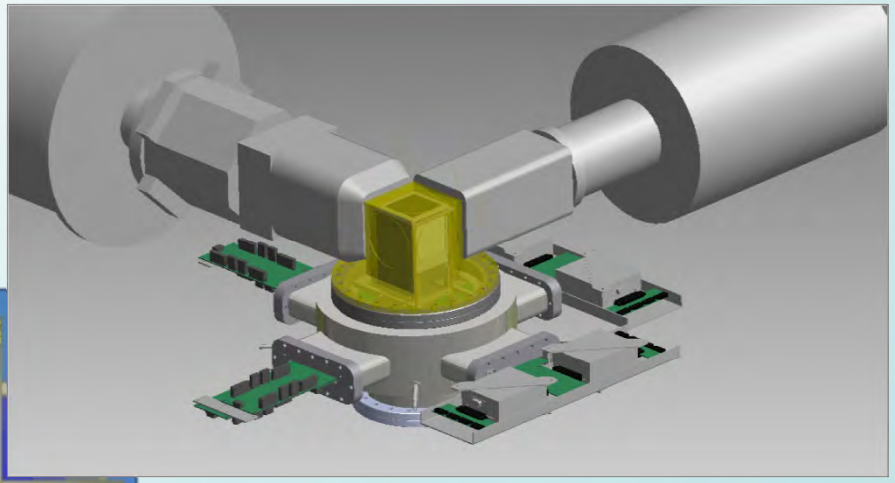
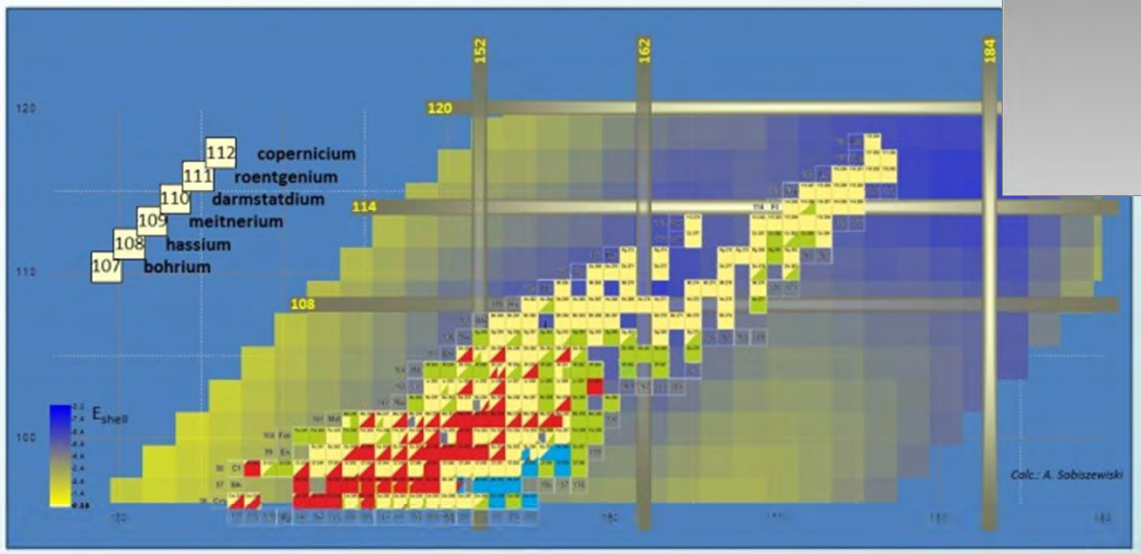
TASCA 14

13th Workshop on
Recoil Separator for Superheavy Element Chemistry
October 21, 2014, GSI, Darmstadt, Germany



# A compact decay spectroscopy set-up for SHN research






Dieter Ackermann

GSI

*Helmholtzzentrum*
*für Schwerionenforschung GmbH*

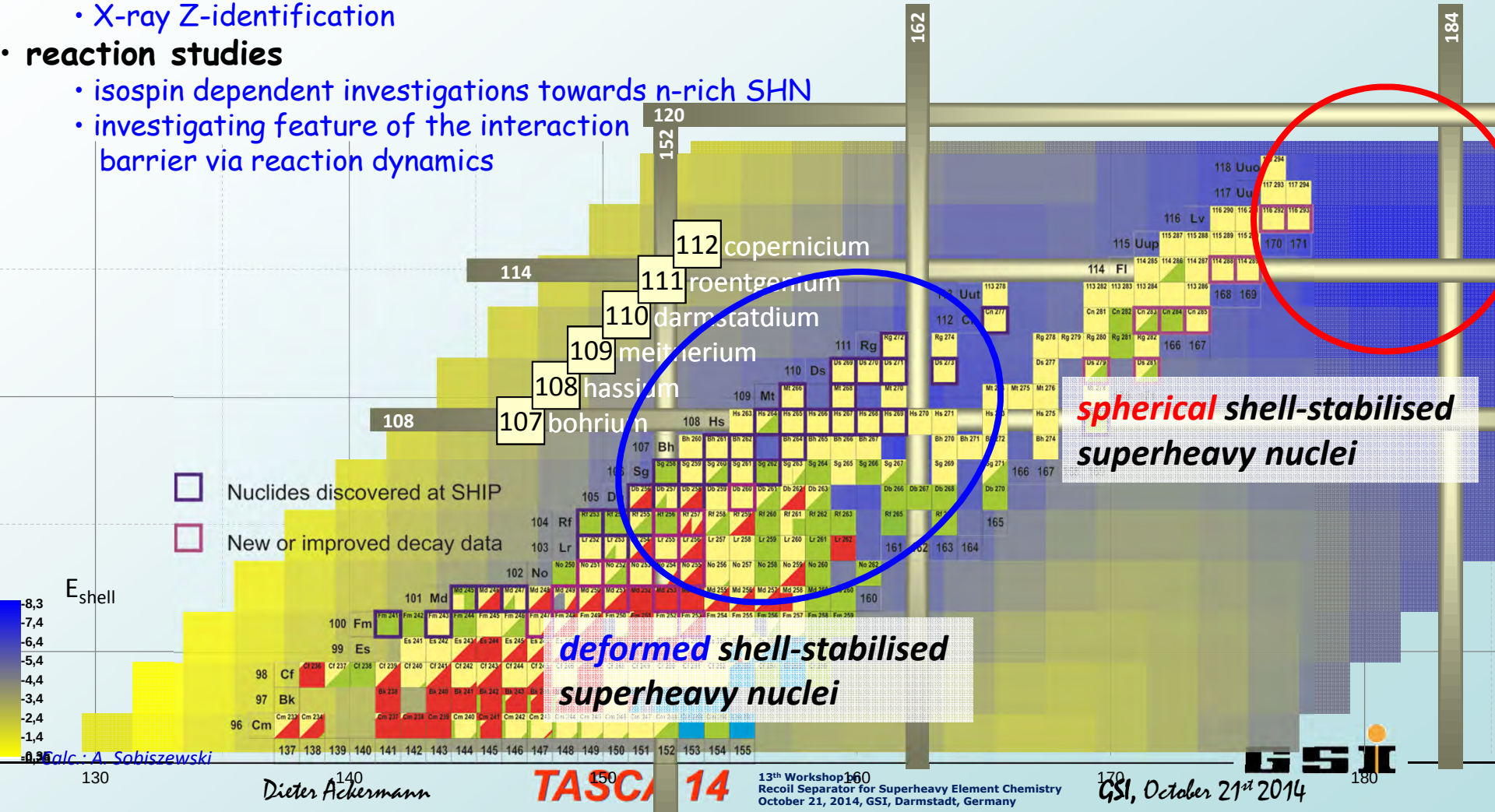
**GSI**, Oktober 21st 2014

# Si Detectors for SHE Research

## - decay spectroscopy for SHN

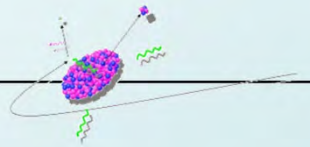
**detection**
- DSSD/SSSD array
- combined with large volume Ge's
- APFEL ASIC & FEBEX digital ADC's
- mobile set-up

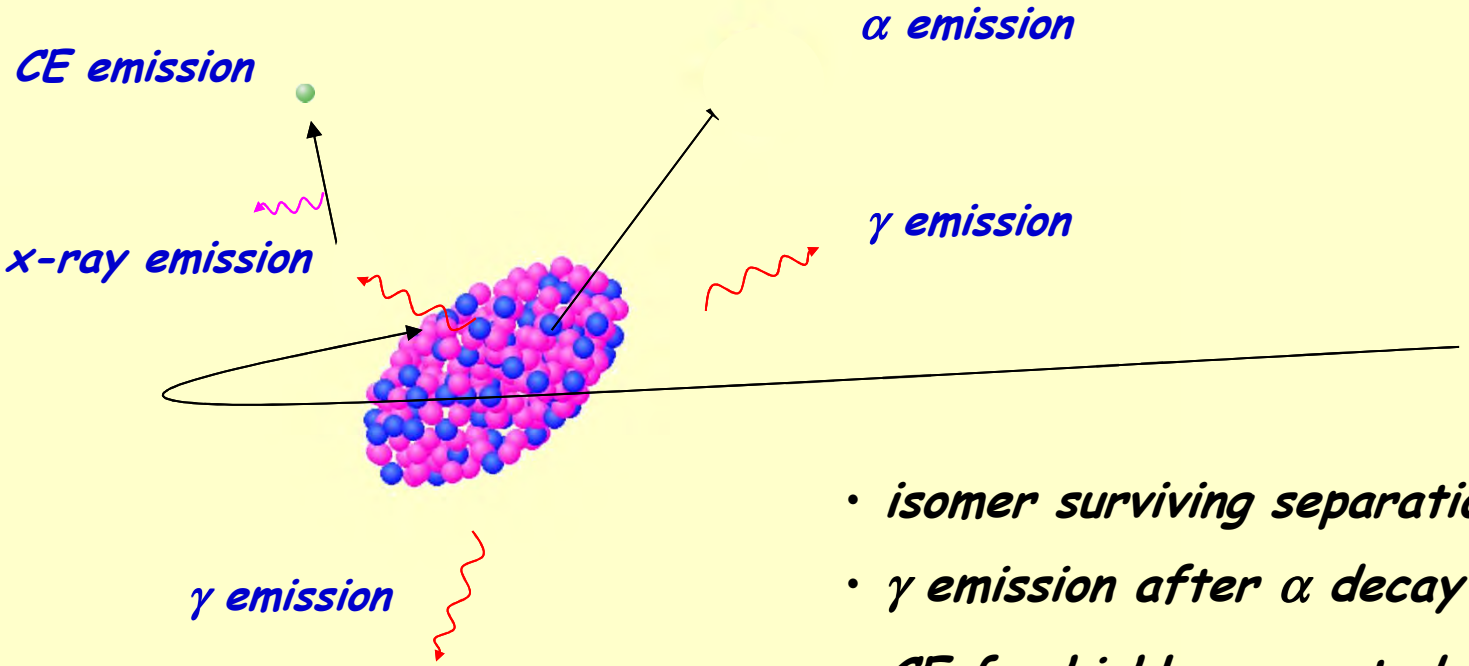
- **nuclear structure features of superheavy nuclei (decay spectroscopy after separation)**
  - quasi-particle excitations → deformation/K-isomers
  - single particle levels – trends towards the next closed p- and n-shell
  - X-ray Z-identification
- **reaction studies**
  - isospin dependent investigations towards n-rich SHN
  - investigating feature of the interaction barrier via reaction dynamics



# Nuclear Structure of SHE

## - Decay Spectroscopy at SHIP/TASCA



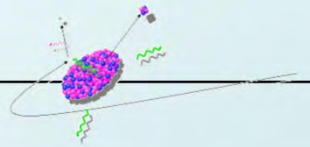


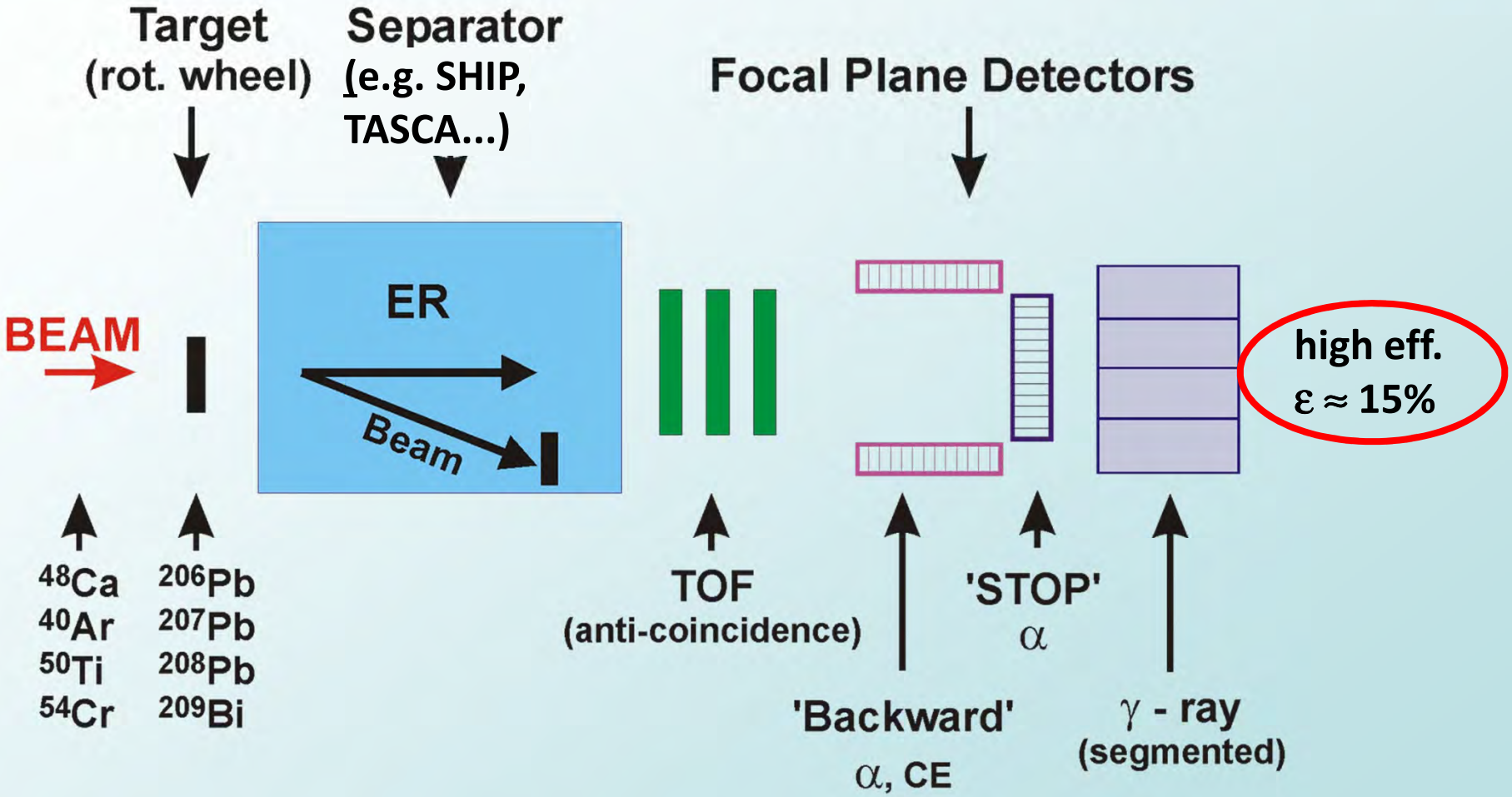

**evaporation residue after separation**

- isomer surviving separation
- γ emission after α decay
- CE for highly converted transitions + X-ray emission

# Particle Identification and Discrimination

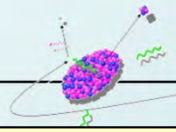
## - Spectroscopy of SHE at SHIP/TASCA





# Particle Identification and Discrimination

## - Spectroscopy of SHE at SHIP/TASCA

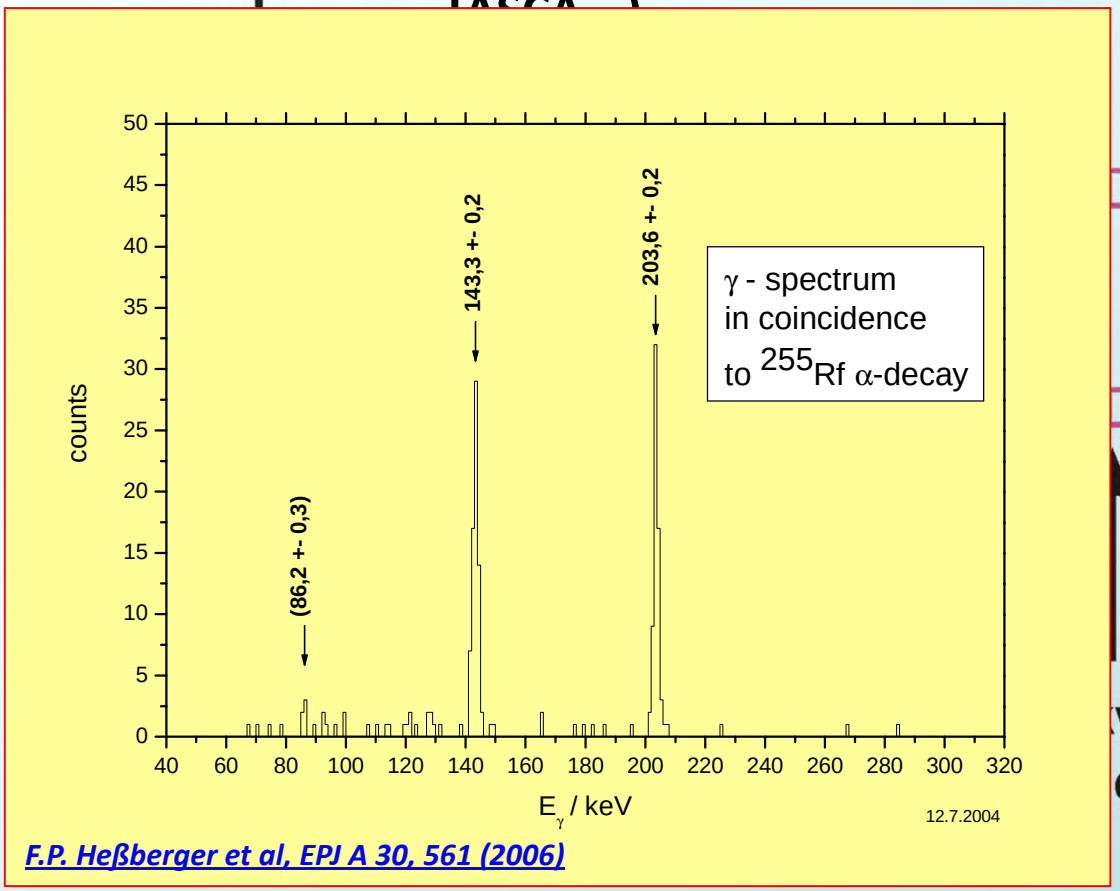


- inclusive measurement
  - ER, α's, γ's and e⁻
- clean
  - particle discrimination
  - ER-α-γ correlations
- higly efficient
  - close geometry
  - stopped source

Target (rot. wheel)

Separator (e.g. SHIP, TASCA, ...)

Focal Plane




F.P. Heßberger et al, EPJ A 30, 561 (2006)

high eff.
ε ≈ 15%

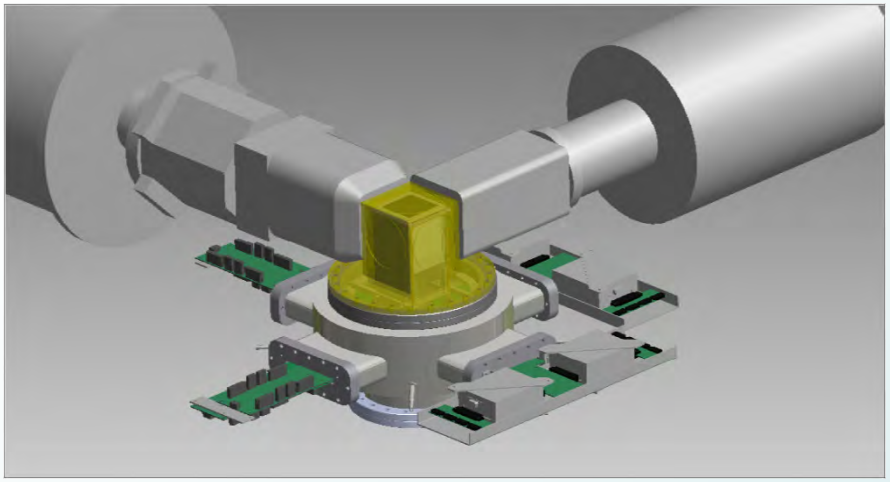
'STOP'
α

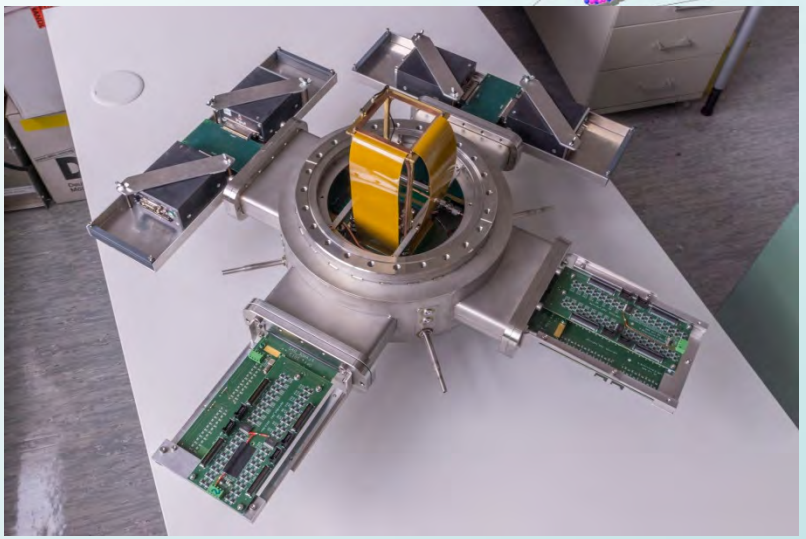
'ward'
CE

γ - ray
(segmented)

# Mobile Decay Spectroscopy Set-up - MoDSS

## - Si stop+box (DSSD+SSSD) combined with large volume Ge-detectors





**configuration**

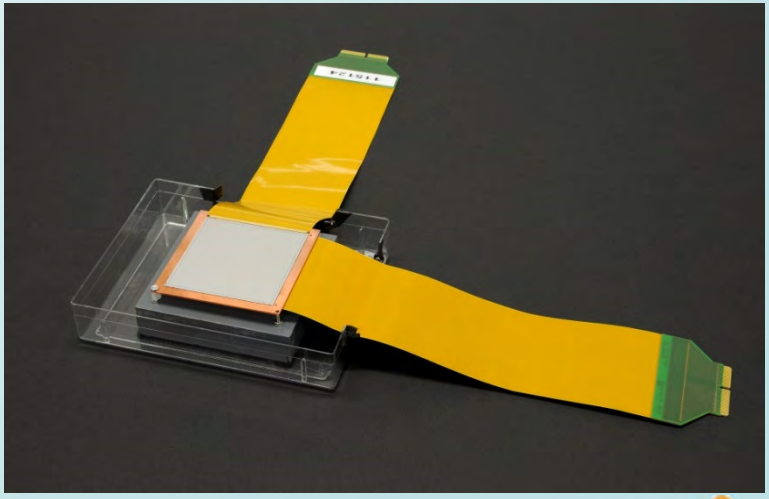
- *stop detector: 1 × DSSD (60×60 strips)*
- *box detectors: 4 × SSSD (32 strips, TASiSpec)*
- *overall efficiency similar to TASiSpec (40%)*

**chamber**

- *compact (overall length 35 cm)*
- *Al-cap with thin γ window (1,5 mm)*
- *compatible due to 150 mm standard flange*
- *electronics partly integrated (vacuum)*

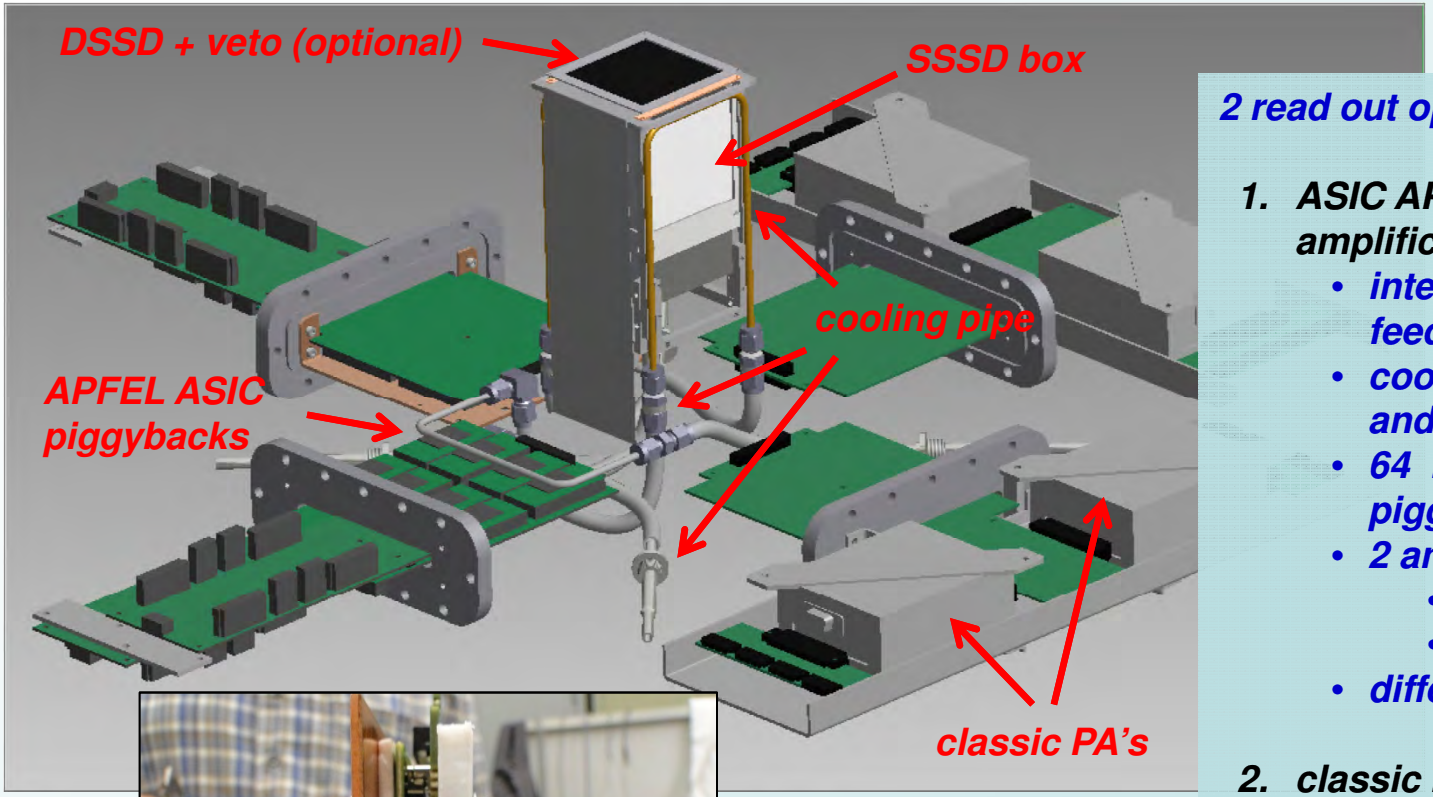
***DSSD***

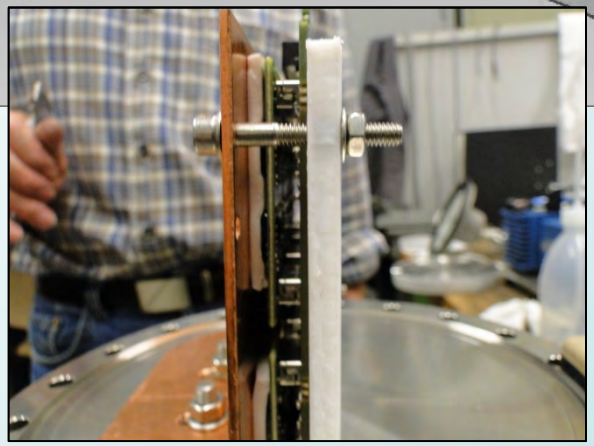
- *integrated cooling (Cu-frame) and connection (flex-PCB)*
- *60×60 strips/mm (pitch 1 mm)*
- *300 µm*



# Electronics and read out

## - 2 integrated options



*2 read out options:*

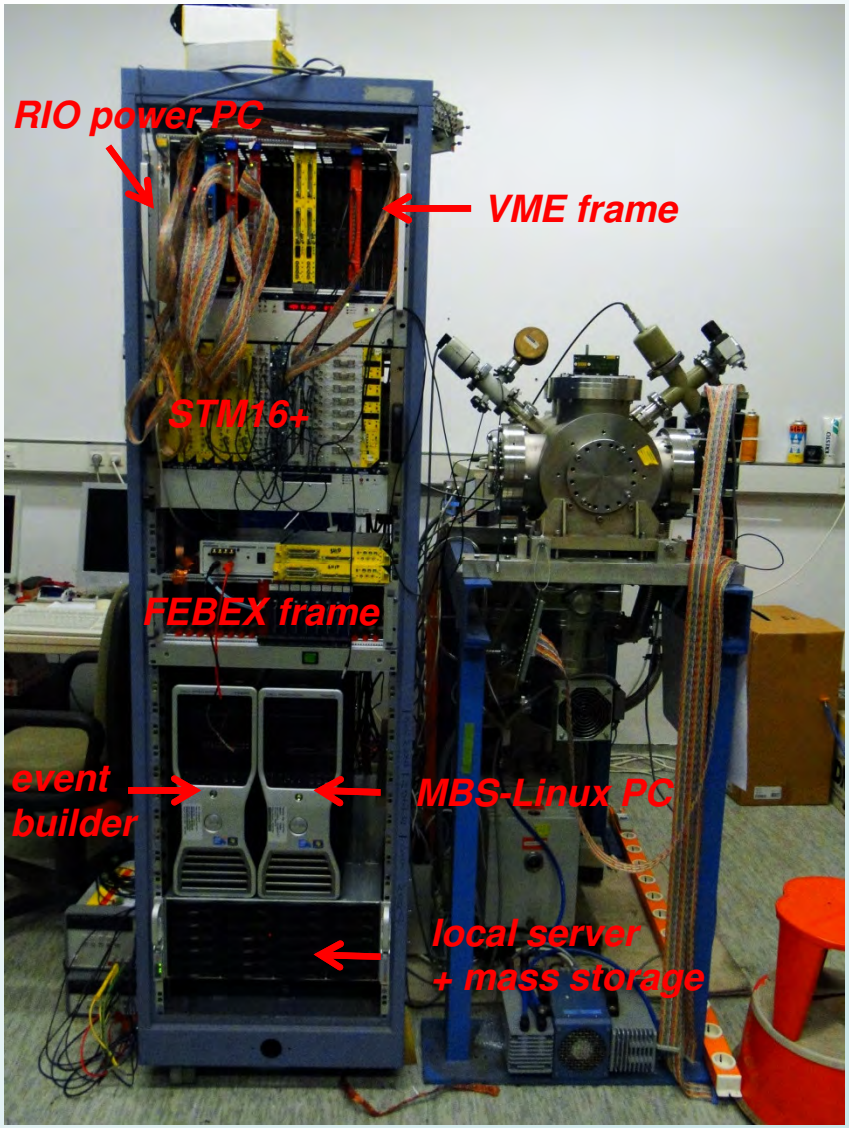
1. *ASIC APFEL (fast shaping and amplification)*
   - *integrated in PCB vacuum feed through*
   - *cooled (separate detector and ASIC cooling)*
   - *64 input channels (8 piggybacks)*
   - *2 amplification factors*
     - *1*
     - *16/32 switchable*
   - *differential output*

2. *classic PA*
   - *PCB vacuum feed through*
   - *2×32 channels*
   - *differential output*

*In total max. 256 channels*

# Electronics and DAQ

## - compact front end and MBS/NUSTAR DAQ




**MBS architecture**

- local server + mass storage (standalone)
- 2 MBS branches

1. RIO power PC/VME
   - analog shaping and amplification ( Mesytech STM16+)
   - 32-fold 12bit ADCS (Mesytec MADC, CAEN V785)
2. FEBEX + MBS-Linux PC
   - 1 FEBEX frame – 198 channels

- event builder
- 3 operation modes

1. classic PA + RIO power PC/VME
2. classic PA + FEBEX
3. ASIC APFEL + FEBEX

# Digital electronics

## - FEBEX: the GSI approach

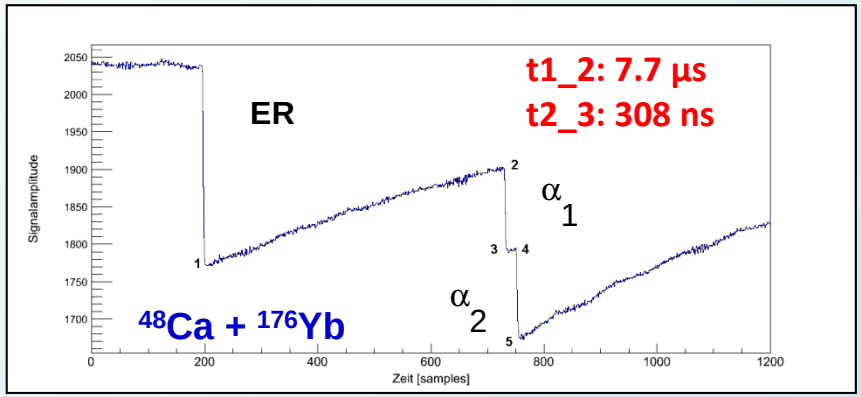
pipeline ADC **F**ront **E**nd **B**oard with optical link **Ex**tension
actual version: FEBEX 3a

- 16 channels
- 50 Ms/s (optional/future 100+ Ms/s)
- 14 bit flash ADC

***J. Hofmann GSI/EE***

FEBEX + conventional PA

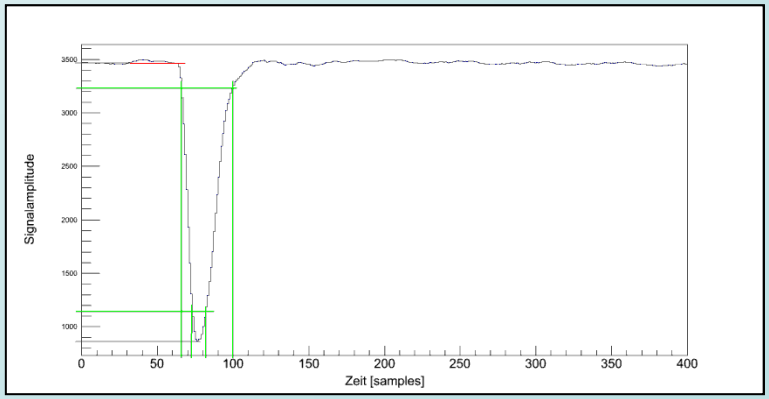
- fast timing
- deadtime free
- pulse shape analysis options




*J. Khuyagbaatar*
*R. Mändl*

FEBEX + ASICS "APFEL"

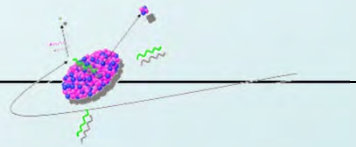
- fast shaping (<250 ns)
- 2 amplification ranges (1x and 16x/32x)
- PANDA development – P. Wieczorek




*R. Mändl*
*bachelor thesis*

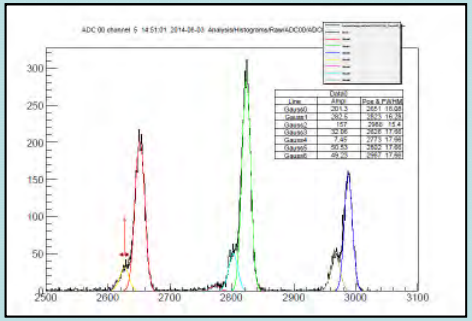
# Test and first application

## - spectroscopy at the LISE velocity filter @ GANIL



### Tests with sources — summer 2014

- all solutions have been tested singly with α-source
- resolution for classic PA + analog ADC
  - ✓ ΔE(6MeV) <30 keV
- APFEL/classic PA + FEBEX needs some more effort
  - ➢ ΔE(6MeV) >50 keV

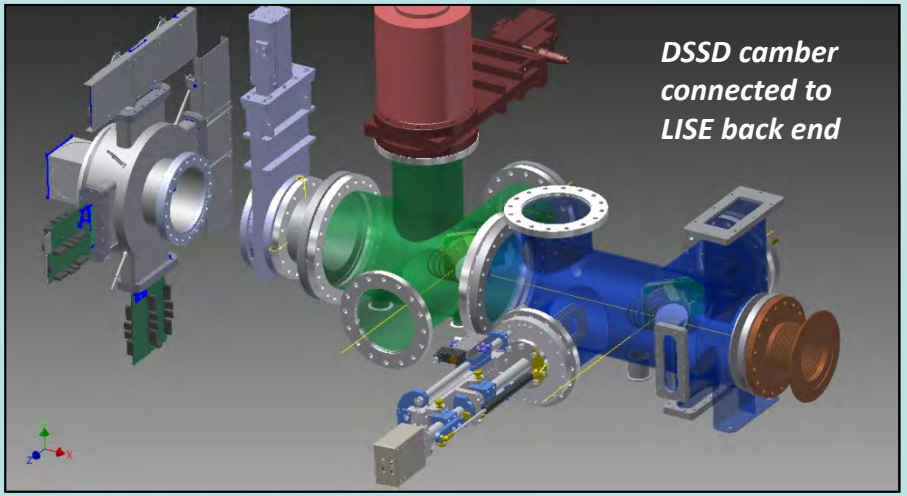


### First in beam test — november 2014

- $^{40}Ar + ^{174}Yb \rightarrow ^{214}Ra^*$
- test of all options (analogue and digital)
- integration in the LISE focal plane set-up
- α and α-γ correlations

### First experiment — spring/summer 2015*)

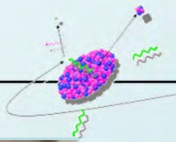
- $^{50}Ti + ^{209}Bi \rightarrow ^{257}Db + 2n$
- α and α-γ spectroscopy for $^{257}Db$, $^{253}Lr$ and $^{249}Md$




*) not scheduled yet

# Test and first application

## - spectroscopy at the LISE velocity filter @ GANIL



**Tests with sources** summer 2014

- all
- res
- AF

**First in be**

- $^{40}$A
- tes
- int
- α a

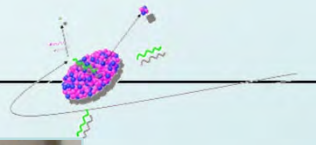
**First expe**

- $^{50}$T
- α a

*) not scheduled yet

# Test and first application

## - spectroscopy at the LISE velocity filter @ GANIL



**Tests with sources** summer 2014

- all
- res
- AF

**First in be**

- $^{40}$A
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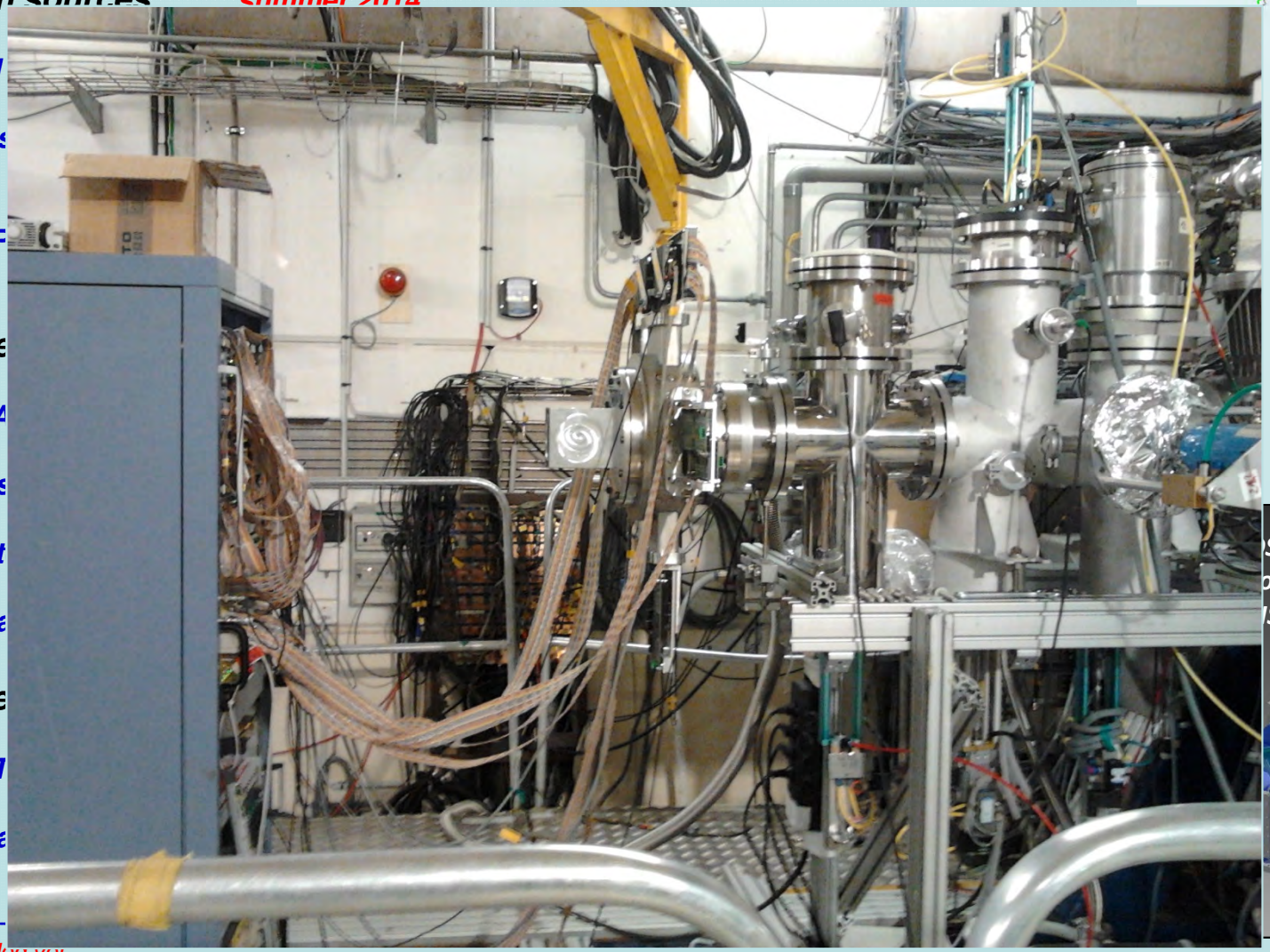
- α a

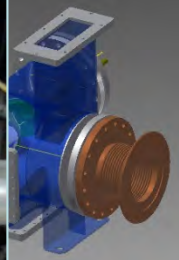
**First expe**

- $^{50}$T
- α a

*) not scheduled yet

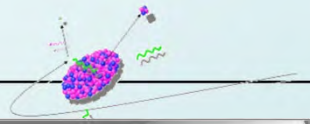


SSD camber
onnected to
ISE back end



# Acknowledgement

## - set-up working group and experiment collaboration



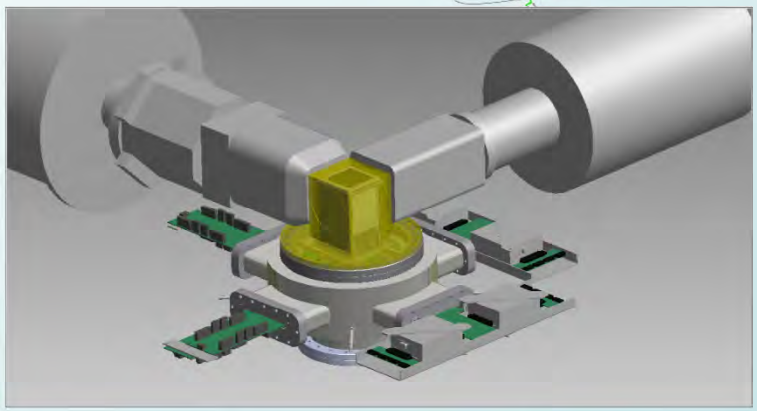
***Preparation of the set-up***

***GSI:***

***J. Hoffmann (electronics design)***
***N. Kurz (MBS)***
***J. Maurer (chamber design)***
***S. Voltz (PCB lay-out)***
***P. Wieczorek (APFEL ASIC)***
***D. A.***

***GANIL:***

***M. Vostinar***
***J. Piot***



GANIL spiral2 laboratoire commun CEA/DSM CNRS/IN2P3

| PAC Date: | EXP # (Do not fill in): |
|---|---|
| **April 2014** | **E** |

**PROPOSAL FOR AN EXPERIMENT**

**Title: Decay spectroscopy of $^{257}$Db**


**Collaboration:** Participant names, institutions, and indicate students (S), and post-doctoral fellows (PD): M. Vostinar,1 H. Savajols.1 E. Clément,1 C. Stodel,1 B. Gall,2 D. Ackermann,4 S. Antalic,5 B. Bastin,1 L. Caceres,1 F. Dechéry (PD),2 O. Dorvaux,2 A. Drouart,6 H. Faure (S),2 J. Gibelin,7 K. Hauschild,8 G. Henning (PD),8 R.-D. Herzberg,9 F.P. Heßberger,4 J. Konki,3 W. Korten,6 J. Ljungvall,8 A. Lopez-Martens,8 T. Roger,1 M. Sandzelius,3 J. Sorri,3 B. Sulignano,6 C. Theisen,6 and J.C. Thomas1, J. Uusitalo3

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