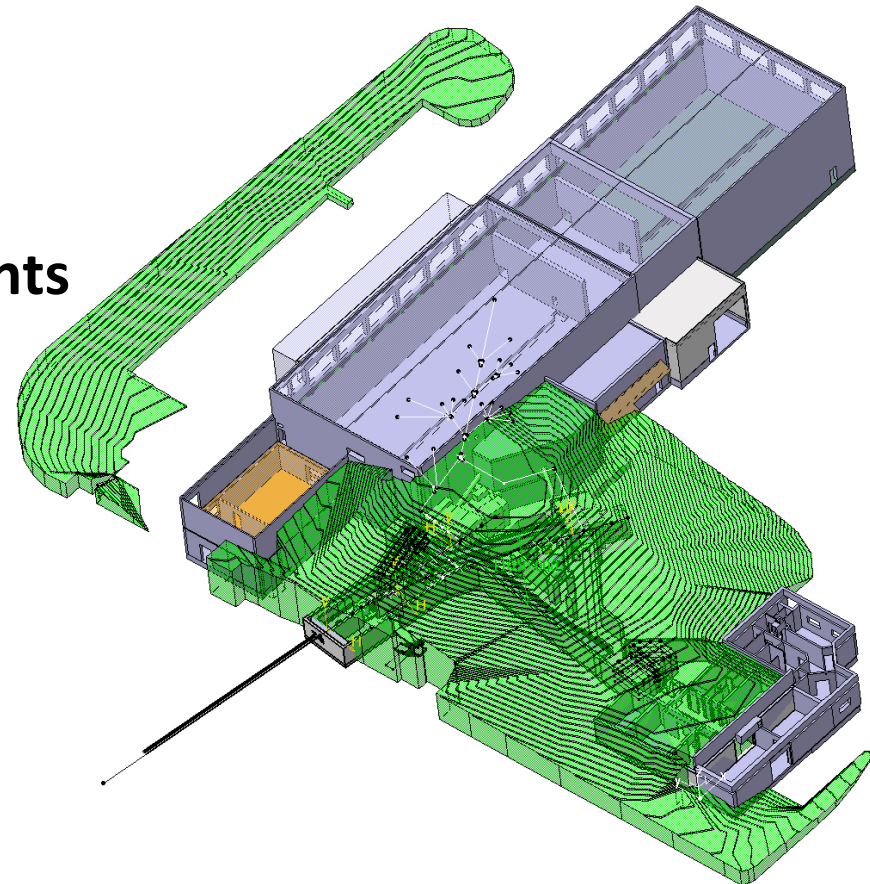


# Status of ISOLDE

**ISOLDE upgrades 2010**  
**Low-energy experiments**  
**High-energy REX-ISOLDE experiments**  
**HIE-ISOLDE project**



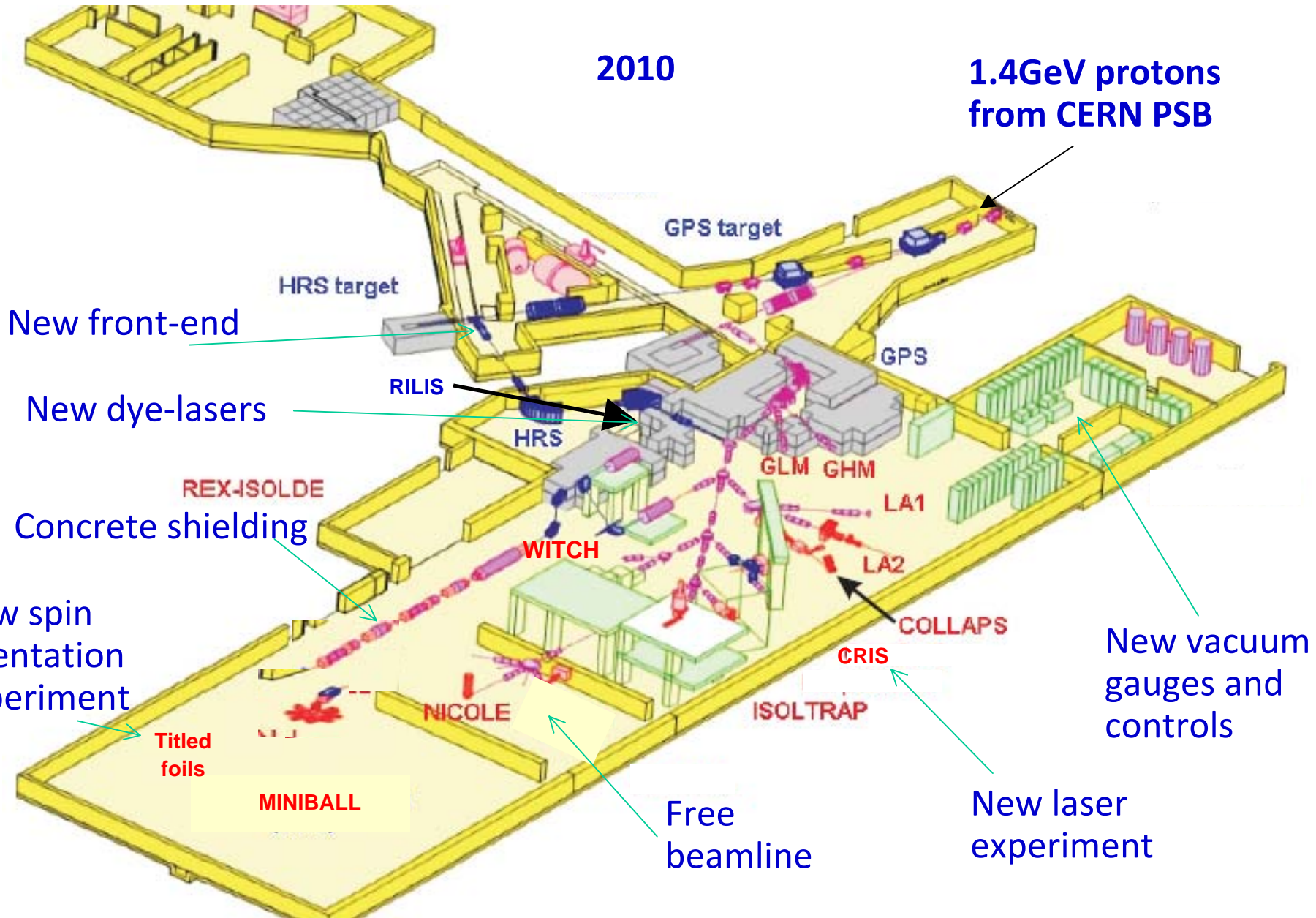
**Magdalena Kowalska**  
CERN, PH-Dept.

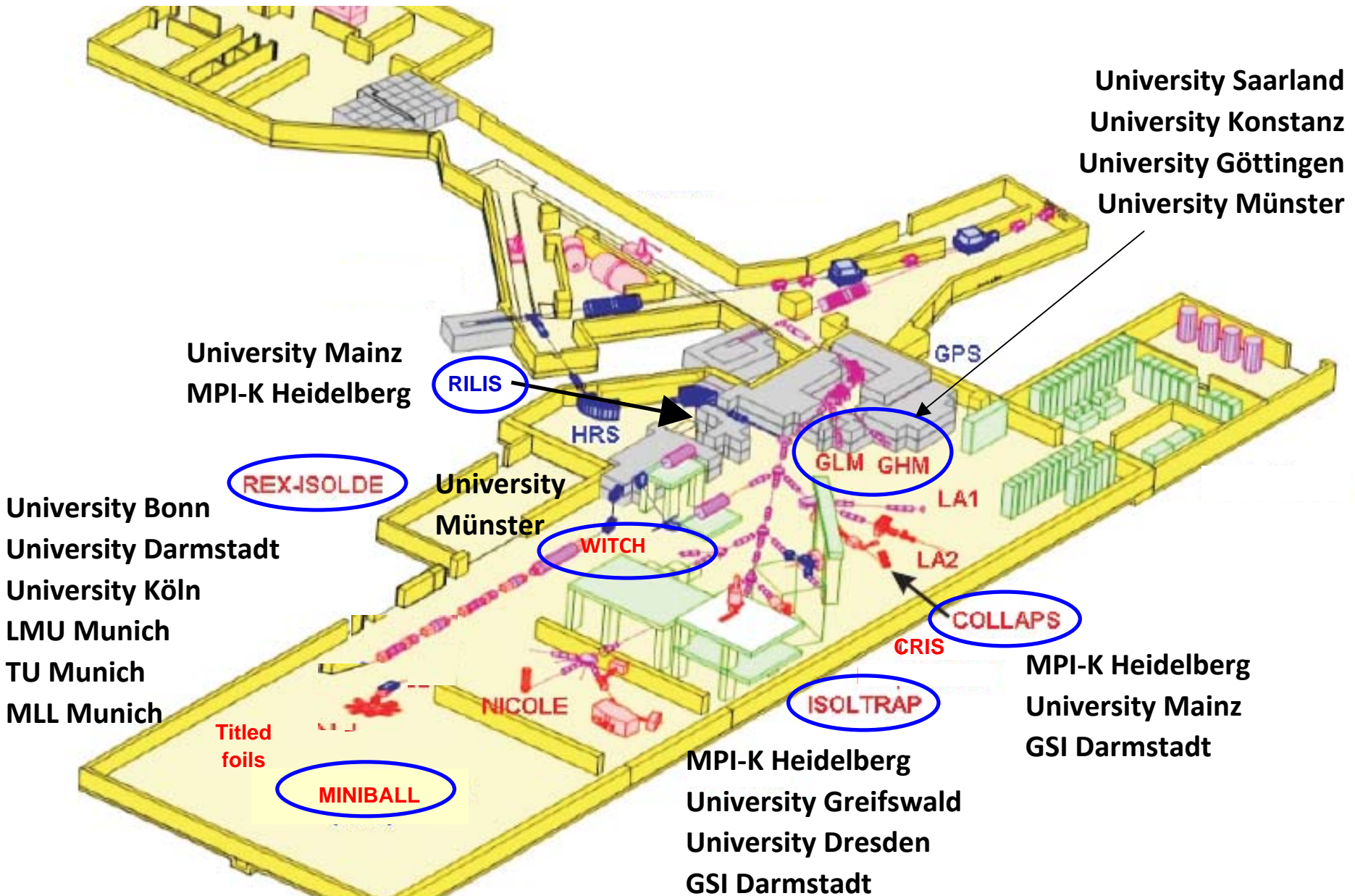
[www.cern.ch/isolde](http://www.cern.ch/isolde)

# **ISOLDE UPGRADES 2010**

2010

1.4GeV protons from CERN PSB

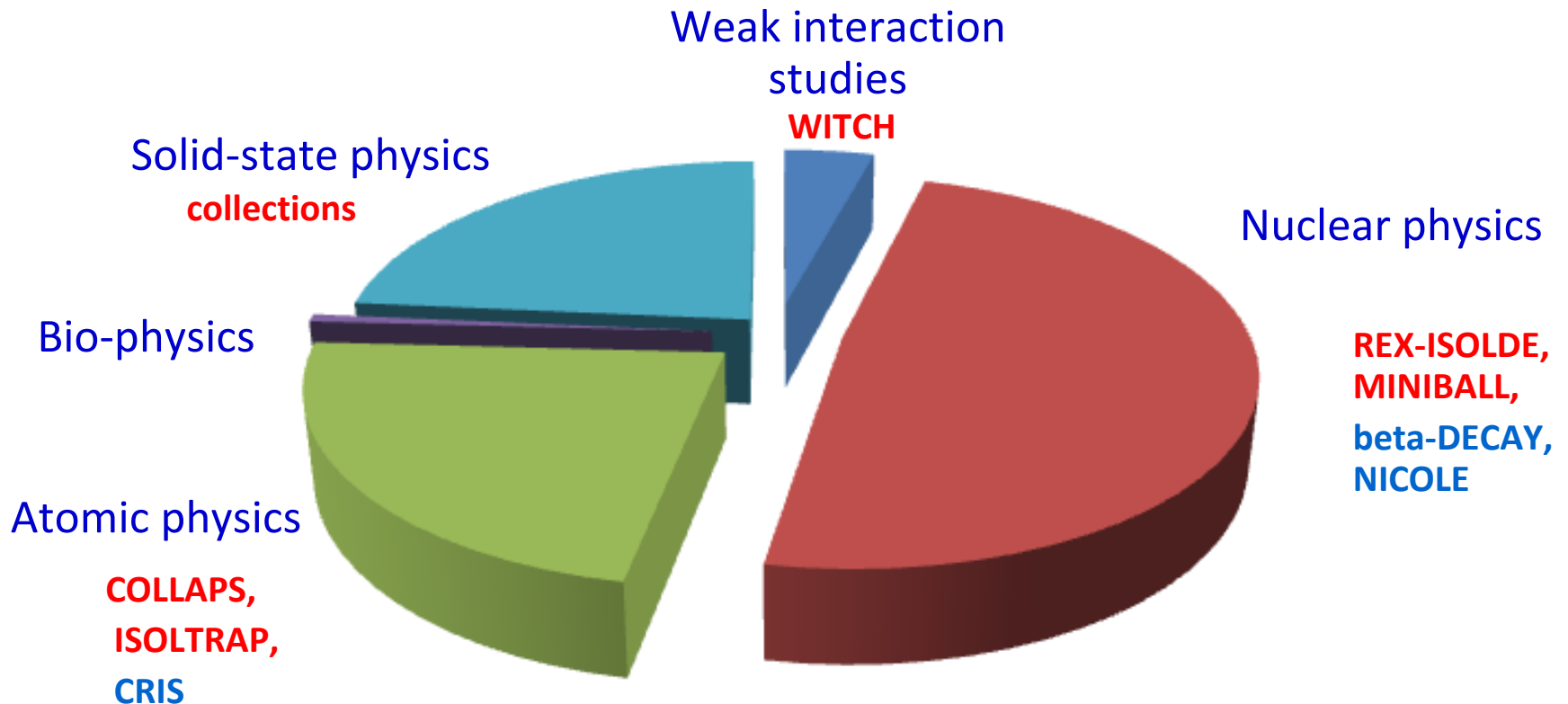




## Users:

450 users (7% total CERN): *potentially 1000 with HIE-ISOLDE*  
25 countries; 100 institutions  
175 projects (last 4 years)

## Experiments:



experiments with contributions from Germany

**Funding:** regular CERN budget and ISOLDE-Collaboration

**ISOLDE-Collaboration:** 13 member states (2 joined in 2010)+ CERN



BMBF-Funding (~10% contribution to the ISOLDE collaboration):

German contribution to ISOLDE (2010): 45 k€

to HIE-ISOLDE (2010): 45 k€

+ 2 Wolfgang-Gentner-Stipendium PhD students

**User support:** since Sep 2010 - FP7 support within ENSAR trans-national access

**Online shifts/year (2009,2010):**

running period - May-November

Requested shifts: 630 (210 days)

Scheduled: 420 (140 days)

## Upgrades:

- 2009: new solid-state pump lasers
- 2010: new tunable dye lasers
- 2011: new tunable solid-state Ti:Sa (in collaboration with University Mainz)

## New laser schemes (2009-2010):

Sm, At, 2011: schemes for Ti:Sa lasers

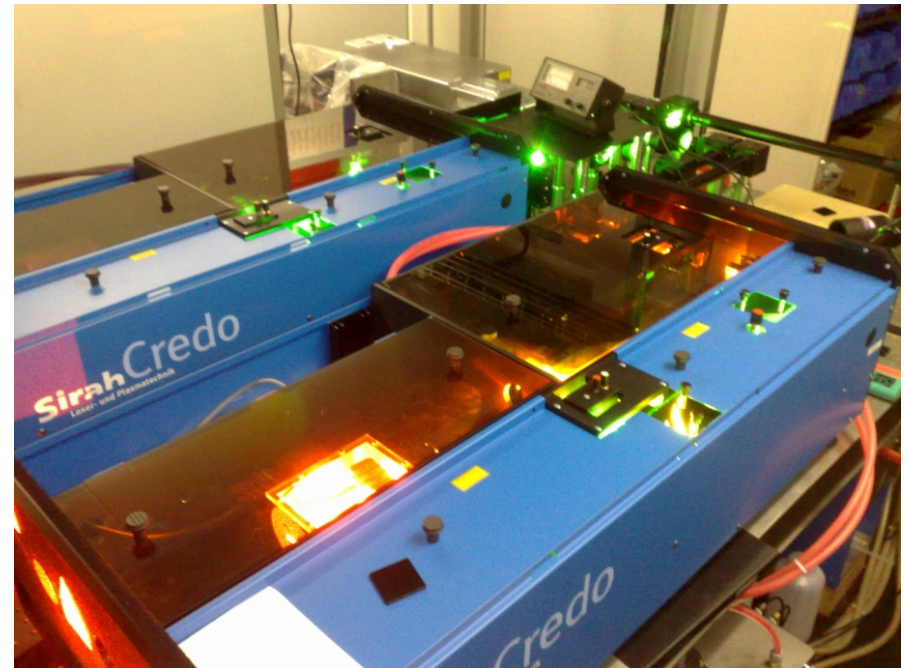
## New radioactive beams (2010):

201, 203, 205Au, 12Be

**Offline tests of LIST** (Laser Ion Source and Trap, University Mainz, MPIK)

**Beams in 2010** (50% of ISOLDE shifts):

Mg, Cu, Ga, Tl, Be, Pb, Mn, Au, Be, Zn, Ag



## New beams:

n-rich Au  $^{201,203,205}\text{Au}$  delivered from UC-W + RILIS

new plasma-ion source (VADIS) ionises for 1<sup>st</sup> time Cr and Fe isotopes

2010

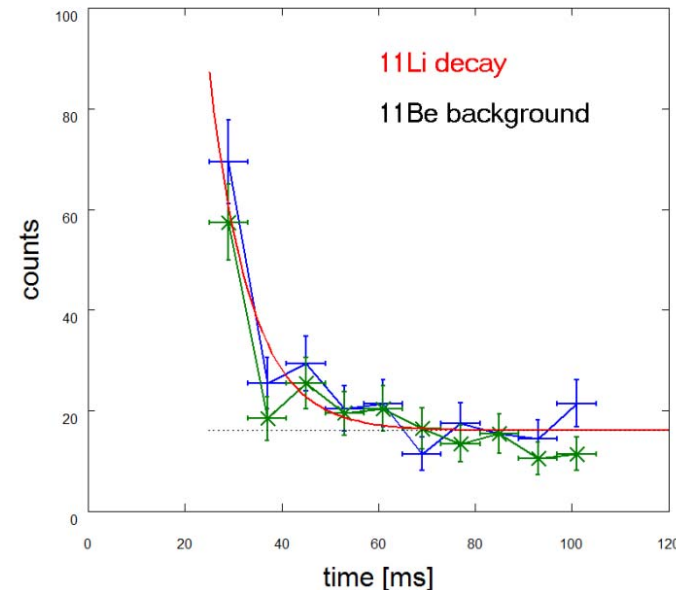
JRA2 – ActiLab starts within FP7 (development of UCx targets)



High density UC target UC440-W (alkalis+Ag) investigated (collaboration with IPNO, GANIL, INFN, PNPI, TRIUMF, ORNL)

Further exploitation of the Fast Tape Station (to be used as the default TS in 2011)

SiC nano-material for n-deficient species gets patented



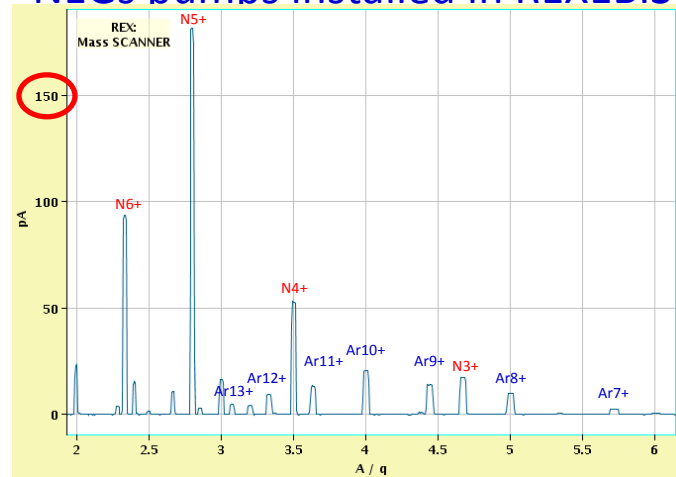
## REX scalability and reproducibility good (in most cases)

Beams to Miniball from target #433.

15/8	A/q=4	stable EBIS
16/8	208Pb49+	stable Isolde
	192Pb45+	radioactive
18/8	87Rb21+	stable Isolde
	95Rb23+	radioactive
19/8	93Rb22+	radioactive
20/8	30Na7+	radioactive
	99Rb23+	radioactive
23/8	A/q=4	stable EBIS
REX in standby, WITCH uses REXTRAP		
30/8	A/q=4	stable EBIS
	224Ra52+	radioactive
1/9	97Rb23+	radioactive
2/9	99Rb23+	radioactive
3/9	A/q=4	stable EBIS
	224Ra52+	radioactive
4/9	A/q=4	stable EBIS

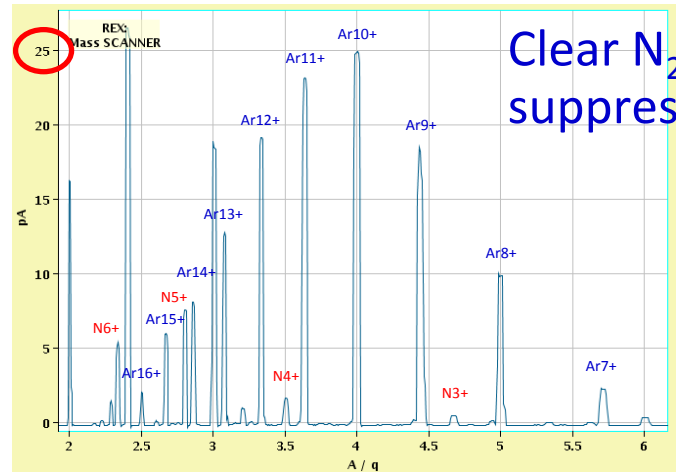
At least 16 beams in 15 days!

To improve the beam purity new  
NEG pumps installed in REXEBIS



July 2008  $I_{\text{coll}}=179 \text{ mA}$ ,  $T_{\text{period}}=20 \text{ ms}$ ,  $T_{\text{breed}}=18 \text{ ms}$

NB! Change of scale.



Clear  $\text{N}_2$   
suppression

July 2010  $I_{\text{coll}}=202 \text{ mA}$ ,  $T_{\text{period}}=26 \text{ ms}$ ,  $T_{\text{breed}}=24.4 \text{ ms}$

## 1. Consolidation of REXTRAP

- \* New
  - PLC
  - Control system
  - RF system
  - Beam diagnostics
  - Application
- \* Improved Voltage sampling
- \* Some new power supplies

Ready by beginning of May 2011

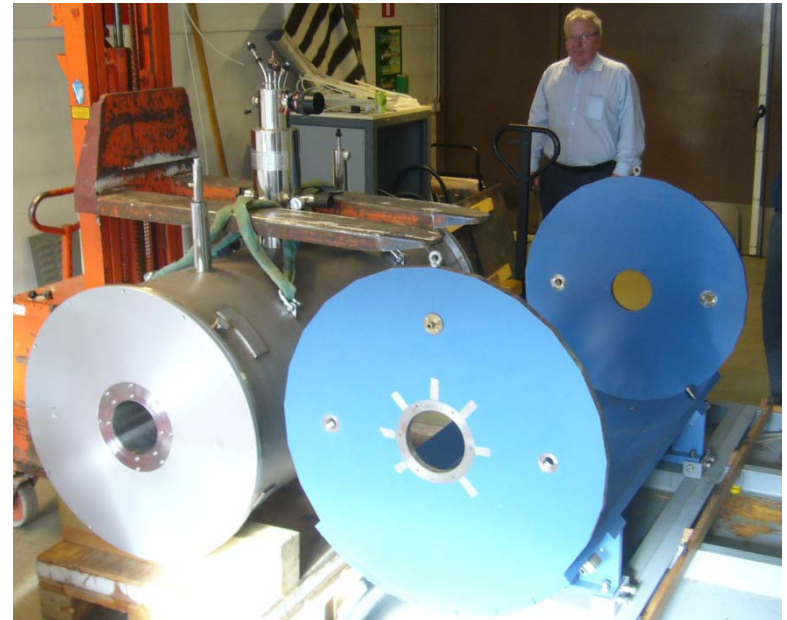
## 2. Consolidation of REX vacuum system

- PVSS (remote) control of complete system
  - Some new gauges and pumps
- Ready by beginning of May 2011

## 3. TwinEBIS arrival from Manne Siegbahn Laboratory

- Act as spare solenoid
- test bench for cathodes and guns

Plan Installation during 2010 Q1-Q3



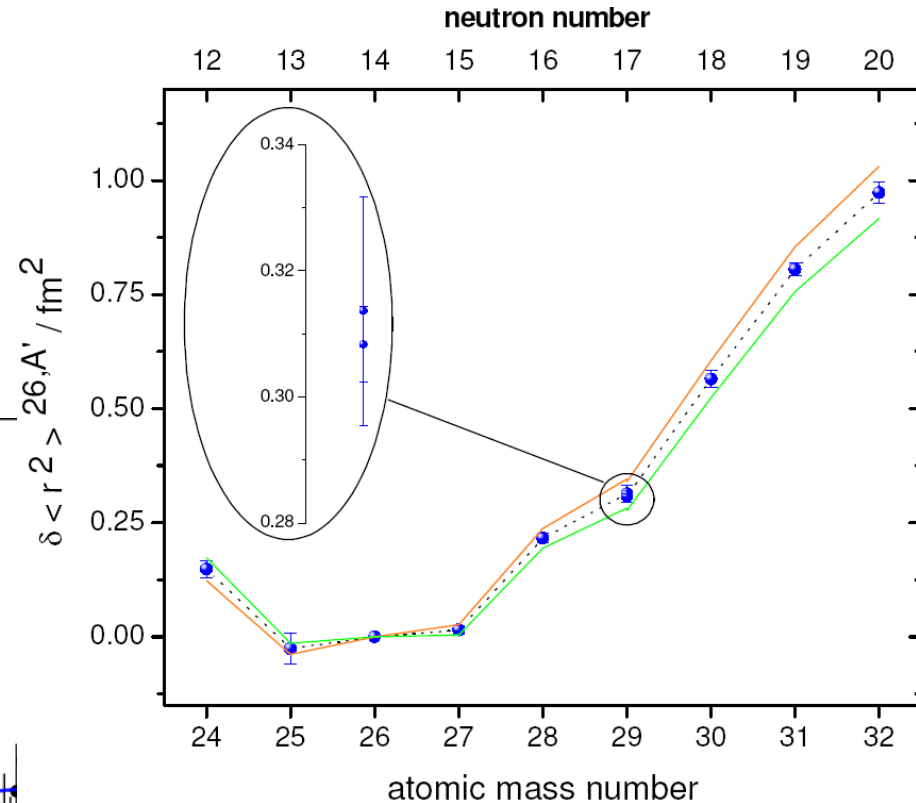
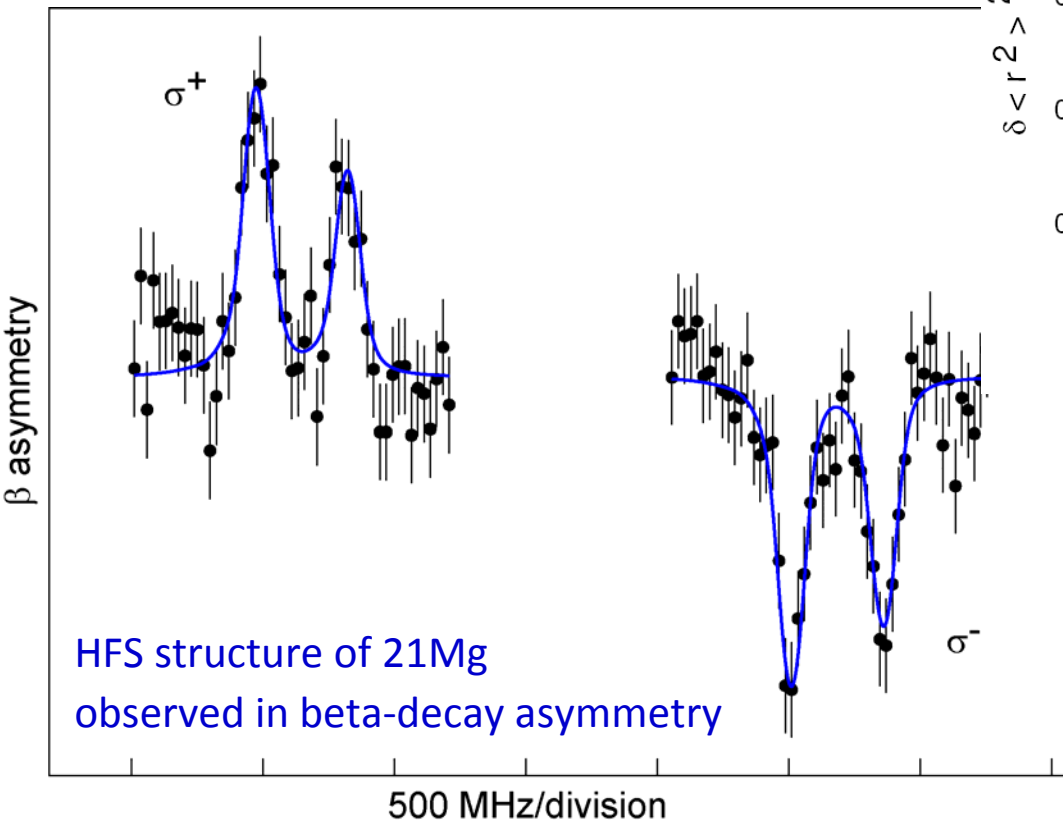
# **LOW-ENERGY HIGHLIGHTS 2010**

# Charge radii of Mg isotopes

COLLAPS setup: MPIK, Uni Mainz

Laser spectroscopy and beta-NMR

Differences in Mg charge radii known between N=8 and N=20 closes neutron shells for 21-32Mg:



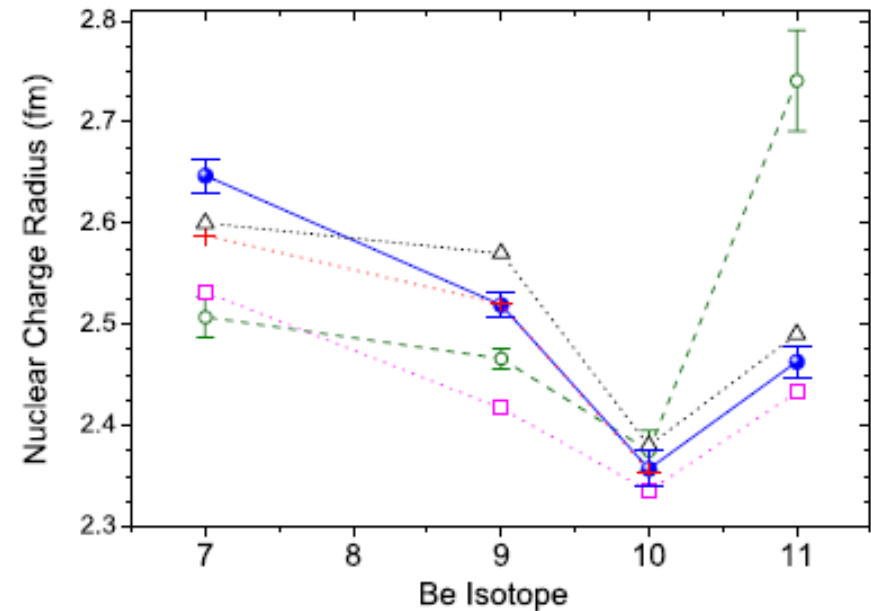
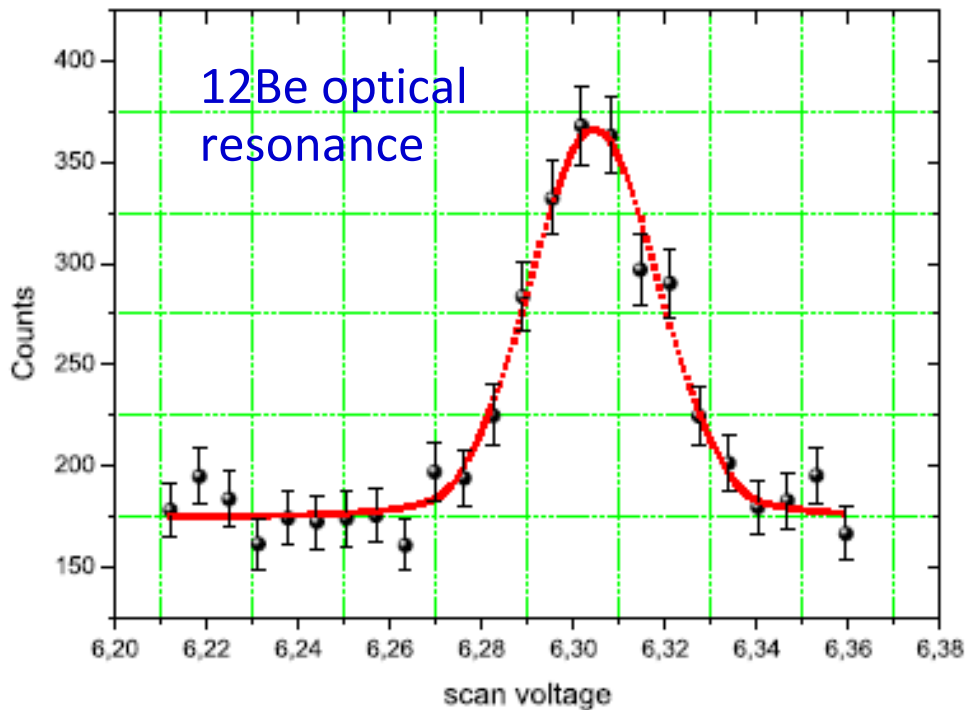
From cluster structures to "island of inversion"

# Laser spectroscopy of $^{12}\text{Be}$

COLLAPS setup: Uni Mainz, MPIK

**Charge radius of  $^{12}\text{Be}$ : 11Be halo + 1 neutron**

to be compared with theory and with 7-11Be radii, measured also at COLLAPS

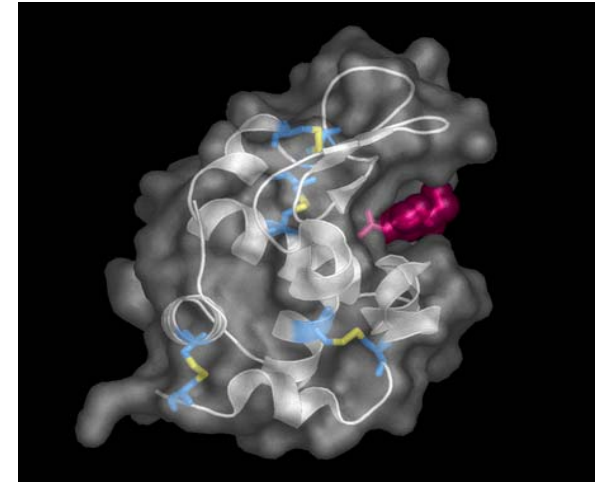


World record yield of  $^{12}\text{Be}$  ( $1e4$  ions/ proton pulse)

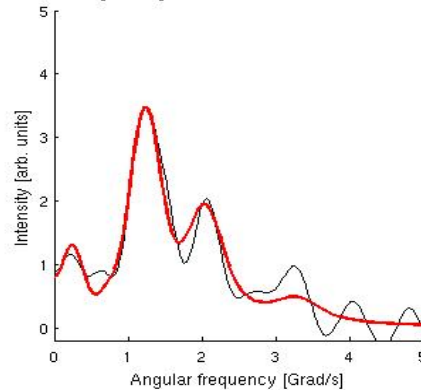
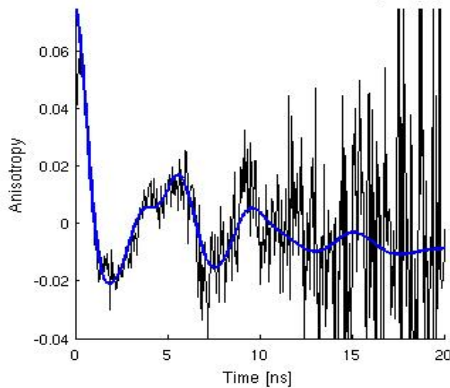
$t_{1/2} = 22$  ms

Enzyme which destroys bacterial cell wall

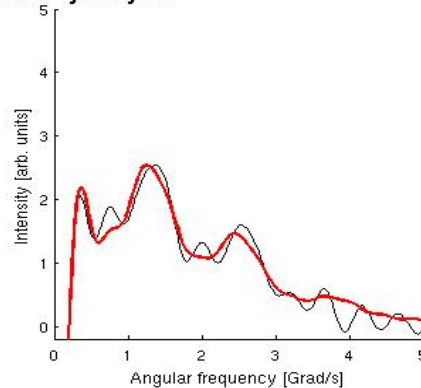
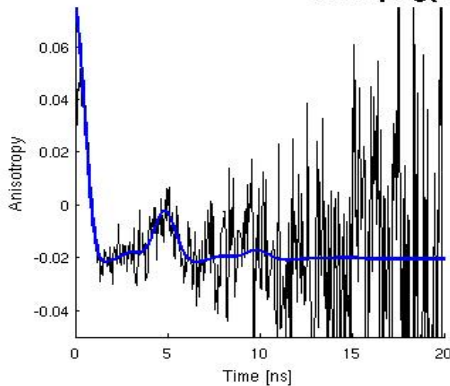
No experiments ever with heavy metals and this protein



0.1 eq Hg(II) - reduced lysozyme



0.1 eq Hg(II) - native lysozyme



## Results:

It can bind Hg(II), however, this changes its structure dramatically

Does protein preserves its functionality?

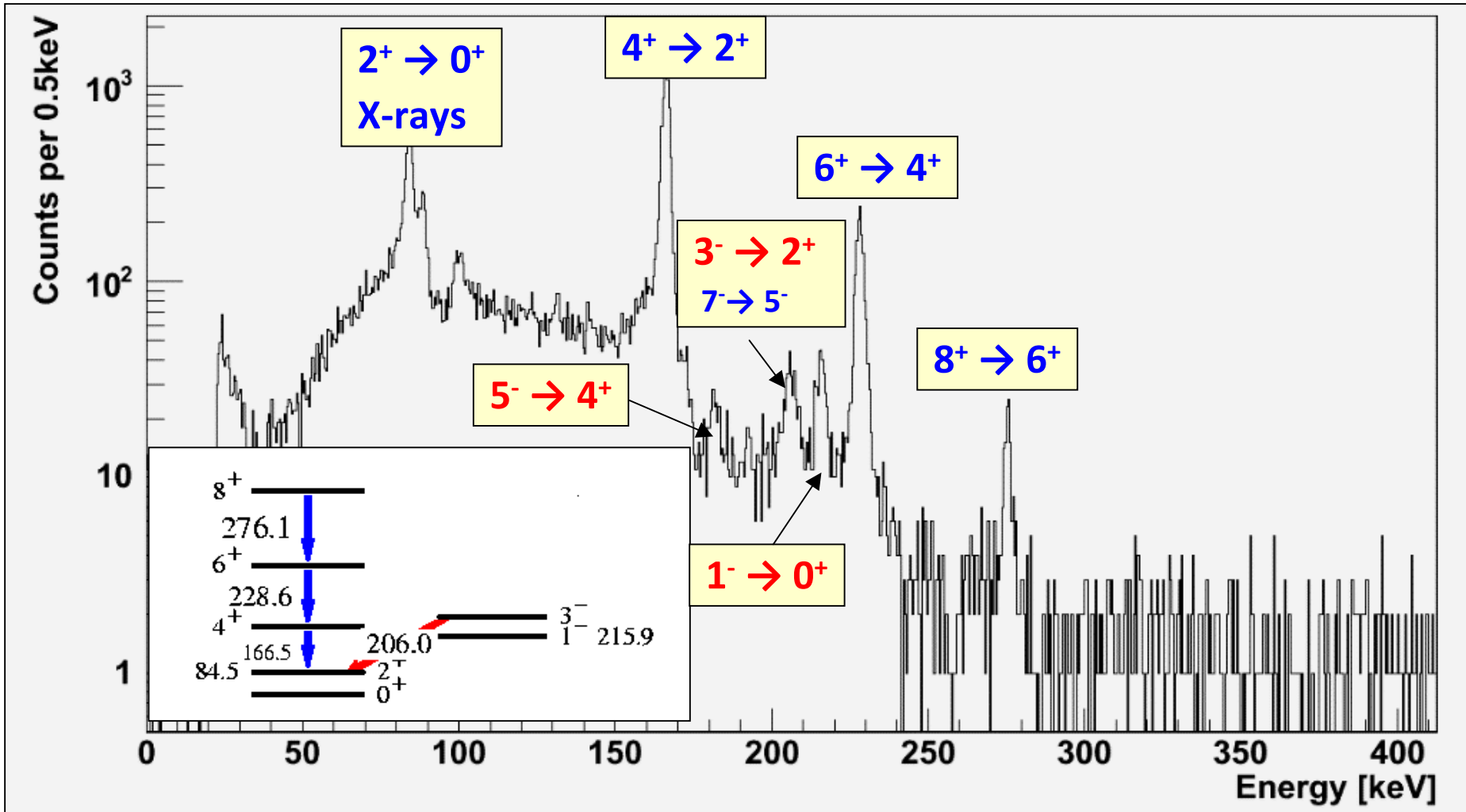
Binding of Hg(II) most likely speeds up the protein folding

Catalytic function of Hg(II)

**HIGH-ENERGY REX-ISOLDE  
HIGHLIGHTS 2010**

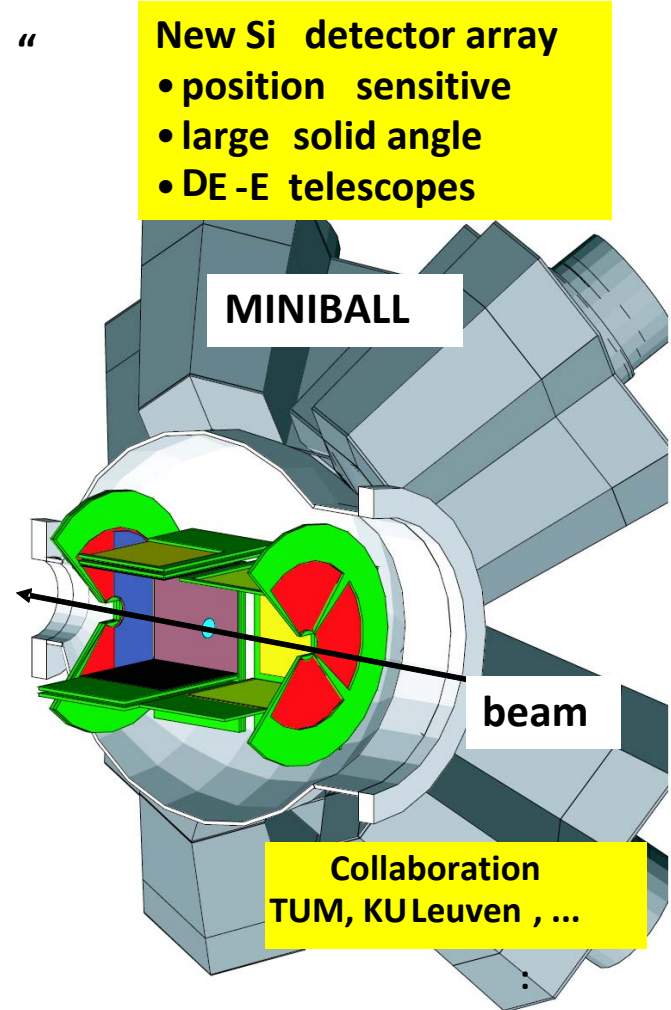
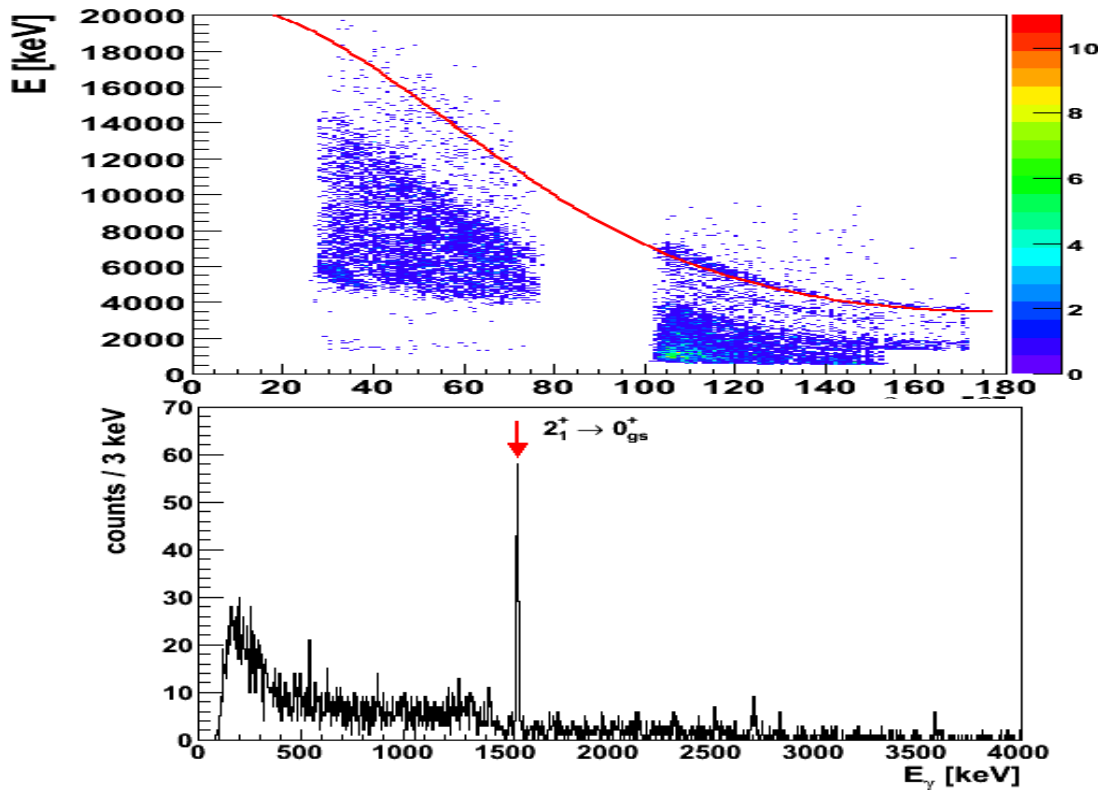
Octupole collectivity

MINIBALL Coulex system



Onset of deformation and shape coexistence in  $^{46}\text{Ar}$   
via inverse kinematics (t,p) reaction

T-REX setup  
(+ tritium target)



**$^{44}\text{Ar}$  at T-REX:**

CO<sub>2</sub> and Kr contamination cleaned

New states identified

Very good yield maintained for 10 days

**HIE-ISOLDE**



[www.cern.ch/hie-isolde](http://www.cern.ch/hie-isolde)



High Intensity and Energy ISOLDE

**Increase of REX-ISOLDE energy**

Coulex for all RIB

Transfer reactions

**Increase of primary beam intensity**

Higher RIB yields

**Improvement of secondary beam production efficiency**

for low energy and accelerated beams

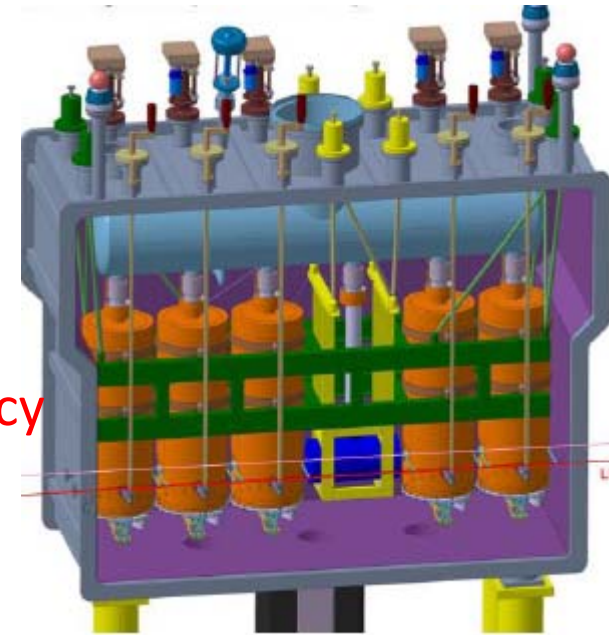
**Improvement of beam purity**

Selectivity

**Improvement of secondary beam optical quality**

Reduction of phase space

bunching



Nov 2009: approved as official CERN project

Mar 2010: tests of prototype cavity at TRIUMF

Jun 2010: project included in CERN Mid-Term Plan

Jun 2010: HIE-ISOLDE letters of intent

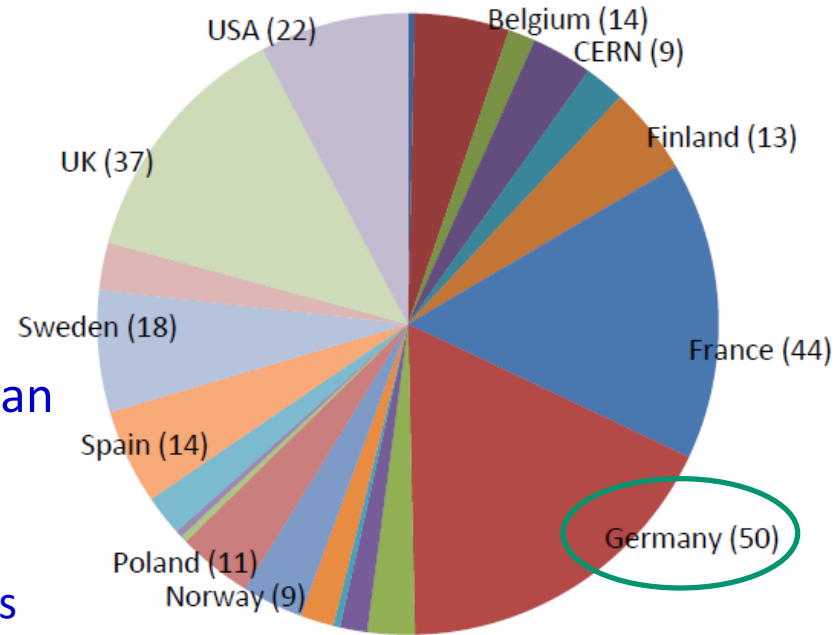
34 LOIs, 284 participants from 76 Labs in 22 Countries

Setups: MINIBALL/T-REX, ACTAR, PARIS, GASPARD, HELIOS

Oct 2010: 1<sup>st</sup> meeting of Physics Steering Committee (new layout accepted)

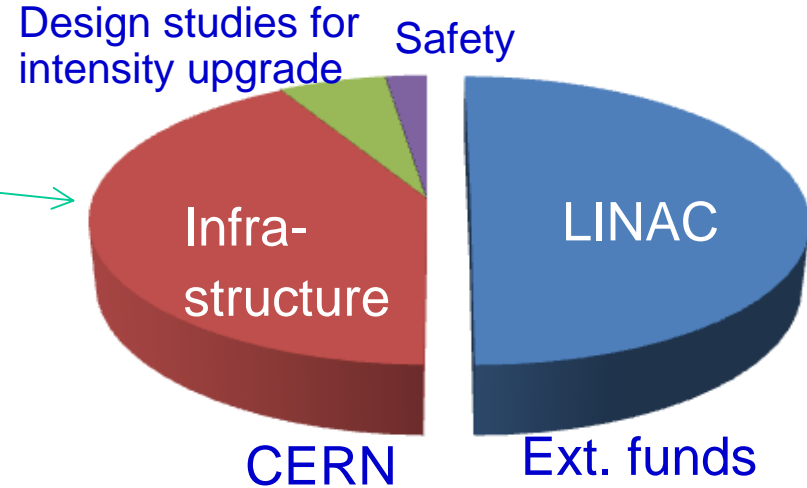
Nov 2010: start of CATHI FP7 Initial Training Network

Nov-Dec 2010: tests of 1<sup>st</sup> prototype cryomodule at CERN; 2<sup>nd</sup> module in fabrication



## Material cost (40 MCHF):

4.8 MCHF from Ext. Funding already spent  
 35.3 MCHF remaining budget (2010 -2016)



## Personnel budget:

CERN Staff

Resources defined by group leaders (105 FTE over 5 years)

Fellows (70 FTE)

5 FTE on dept. budget,  
 9 FTE paid by ISOLDE Collaboration  
 56 FTE paid by ITN3 Marie Curie Contract  
 (20 fellows, CATHI proposal ranked 3rd/863)

<https://hr-recruit.web.cern.ch/hr-recruit/special/CATHI.asp>

German contribution: 60kCHF/year

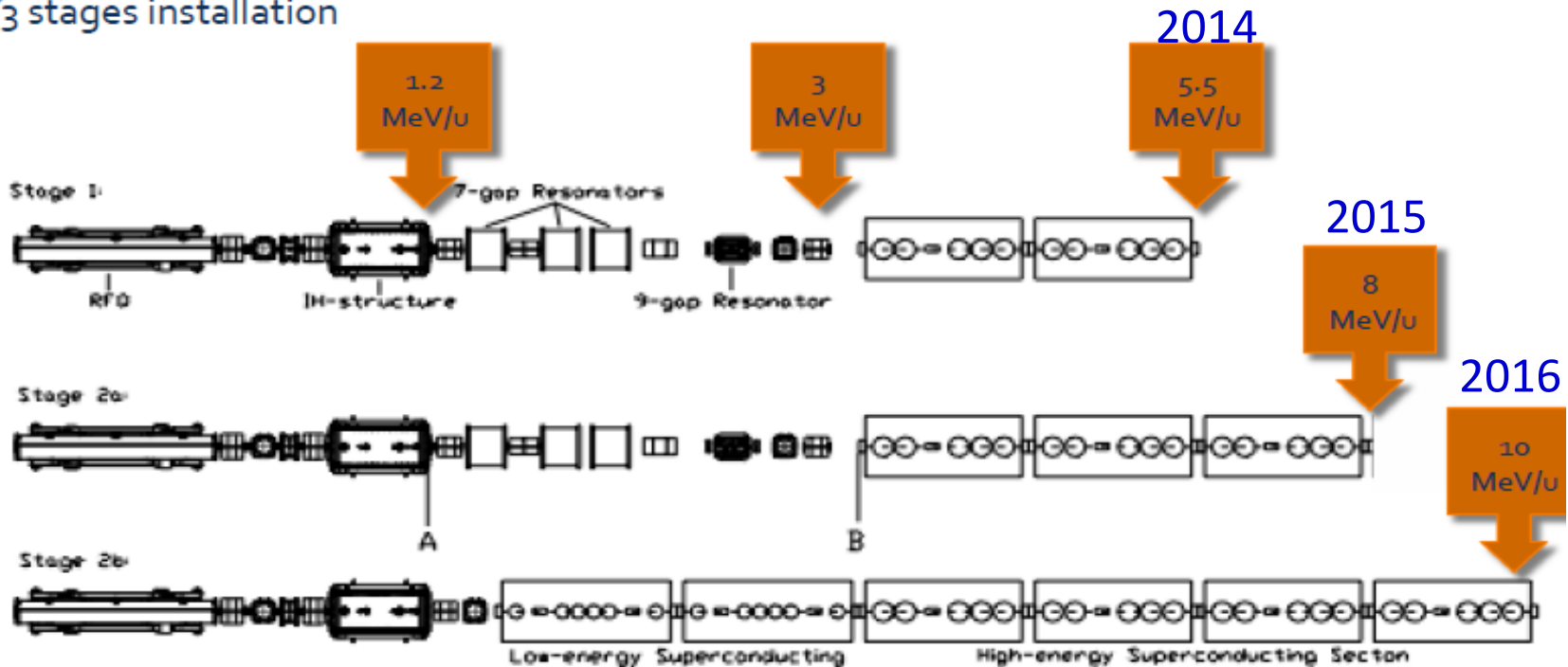
HIE-ISOLDE Subsystem	Research Training Theme
I. SC Linac	1. Super-Conducting Cavity Development an tests 2. Beam Instrumentation Development 3. New Magnets 4. Linac Integration and Innovative Alignment Method 5. Linac Commissioning
II. Design Study for intensity upgrade	6. New Target and Front-End Design 7. ISOLDE target area and Class-A Laboratory Upgrade 8. Beam Quality Improvements
III. Safety	9. General Safety and Radiation Protection Implications Studies

# Outlook of HIE-ISOLDE

## 2011 outlook:

- 1<sup>st</sup> meeting of International Advisory Committee
- First CATHI INT3 fellows employed
- Funds available from newly accepted Spanish Grant
- Tests of second prototype cavity
- Tendering: Civil Engineering and Cryogenics

## 3 stages installation



# Summary and outlook

**ISOLDE saw many upgrades and new beams in 2010:**

e.g. new frontend, RILIS elements and schemes, plasma-elements

**Involvement of German institutes** in the ISOLDE physics is very strong  
(also in the future HIE-ISOLDE)

2010 was a **very good year** with many highlights (involving German groups) :

Atomic- and solid-state physics

REX-based MINIBALL experiments (both Coulex and transfer)

**HIE-ISOLDE project** is well **under way**:

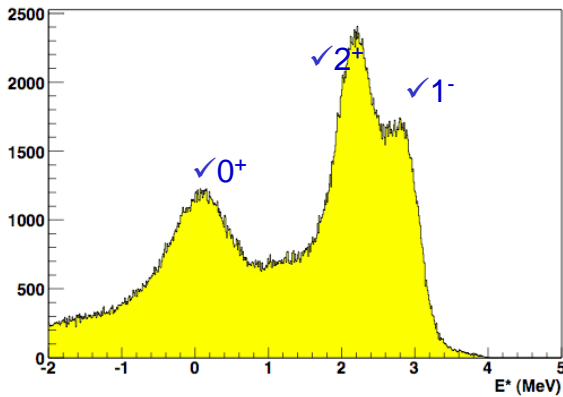
Included in CERN MTP, large part of funds guaranteed, experiments with higher energy planned for 2014-2015-2016



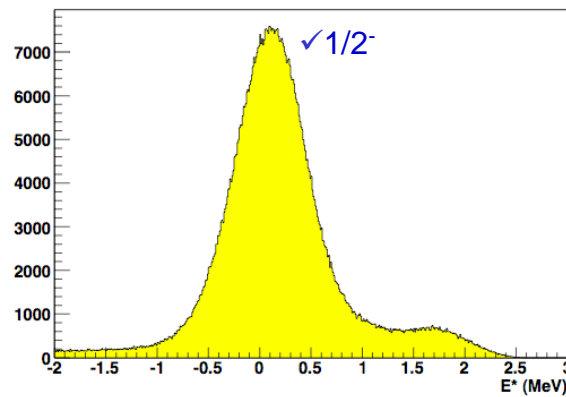
Most intense  $^{11}\text{Be}$  beam (for 10 days) behind REX used with T-REX setup

## Excitation spectra from particles

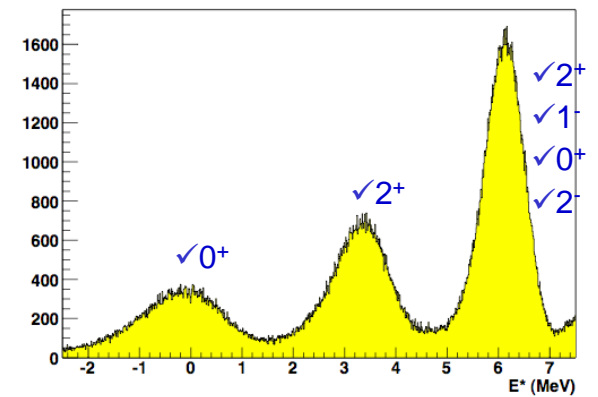
$d(^{11}\text{Be},p)^{12}\text{Be}$



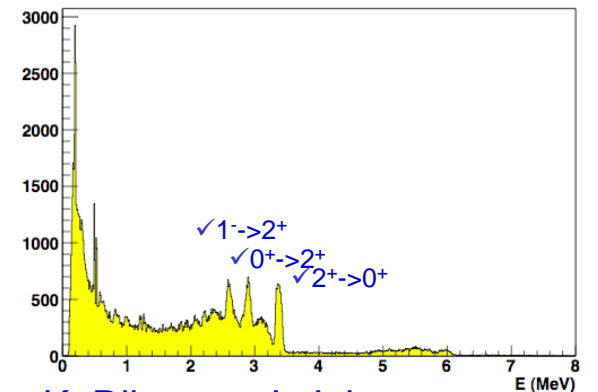
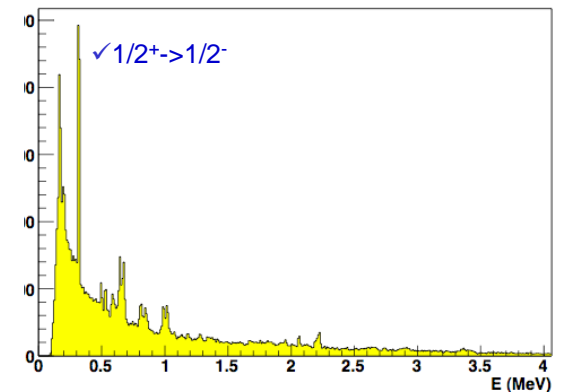
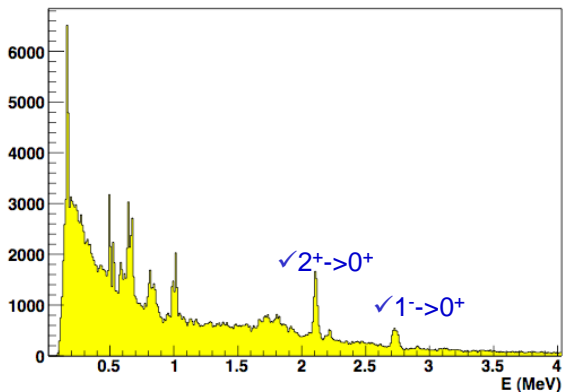
$d(^{11}\text{Be},d)^{11}\text{Be}$



$d(^{11}\text{Be},t)^{10}\text{Be}$



## Gamma spectra



**Mn-doped GaAs:** most well understood dilute magnetic semiconductor (DMS)

Potential application in *spintronics* challenge: increase  $T_c$  above RT

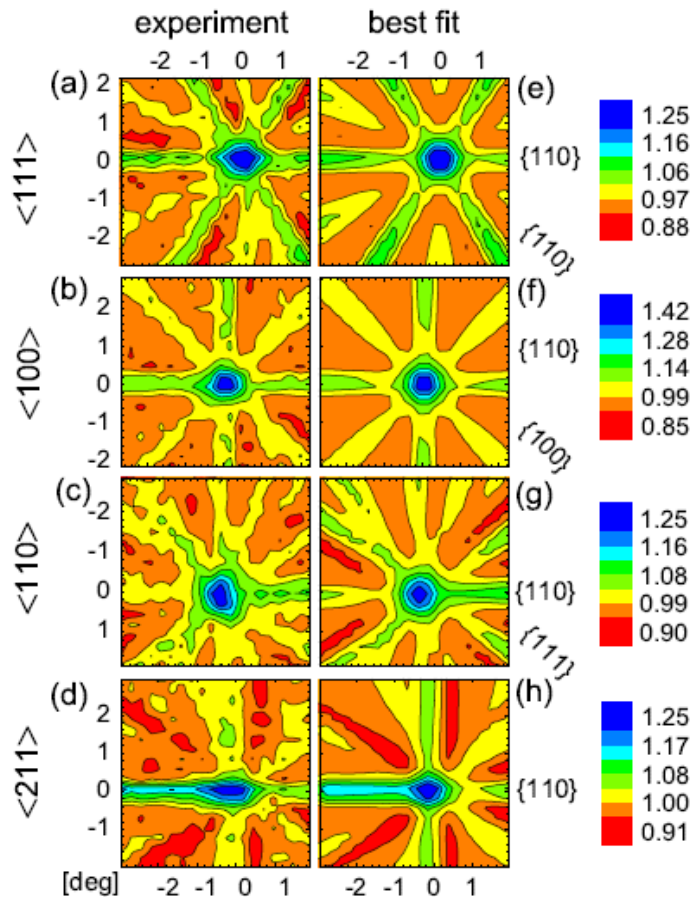
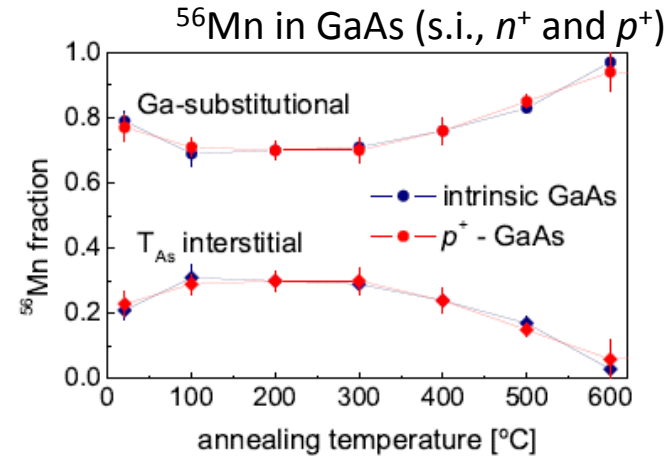
Known: Mn takes **substitutional** and **interstitial** lattice sites

Interstitial vs. substitutional fractions controls  $T_c$

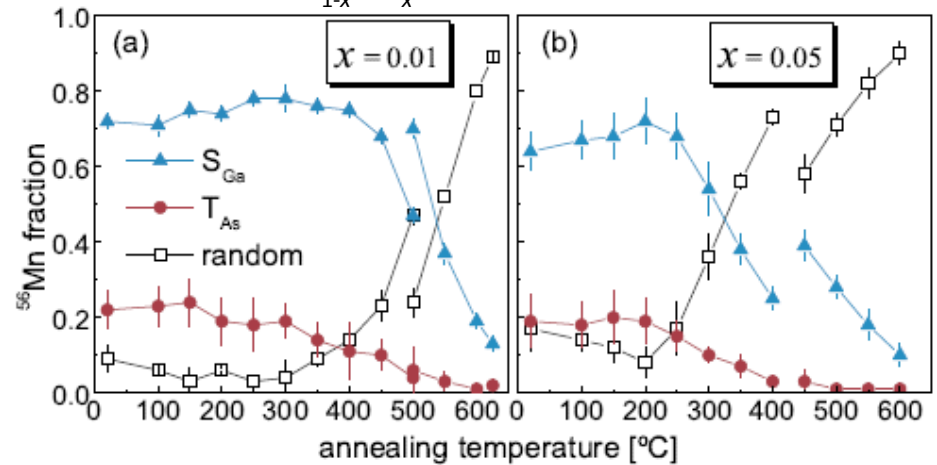
General belief: **Low thermal stability** of interstitial Mn

(~200 °C with activation energy of 0.7 eV)

L. Pereira,  
G. Correia



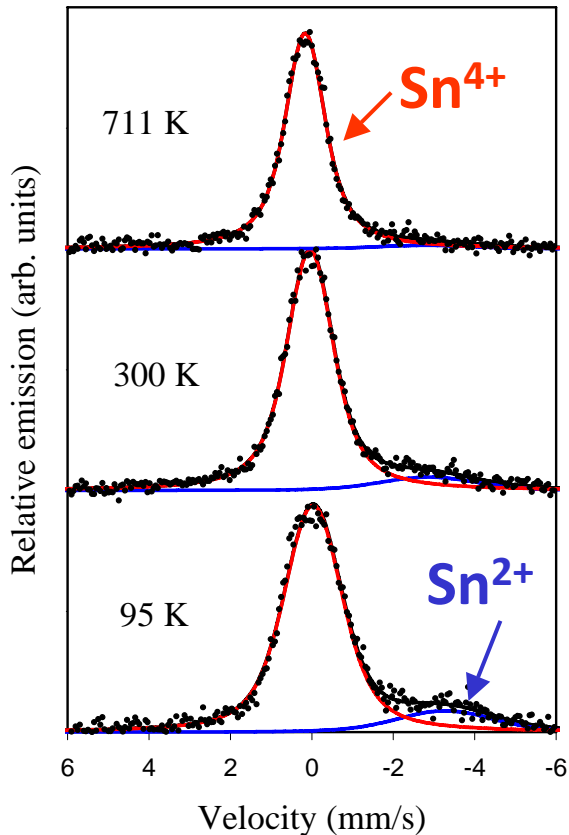
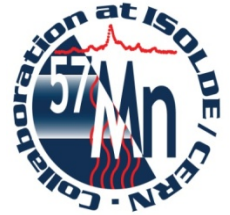
$^{56}\text{Mn}$  in  $\text{Ga}_{1-x}\text{Mn}_x\text{As}$  (MBE grown with stable  $^{55}\text{Mn}$ )



- ✓ Direct identification of the Mn interstitial site
- ✓ Evidence of **high thermal stability** of interstitial Mn
- ✓ Possible **implications on the strategies and prospects to increase  $T_c$**  in Mn-doped GaAs

## $^{57}\text{Mn}$ and $^{119}\text{In}$ at ISOLDE collection point

More than 2000 spectra taken (a record) and many surprises in the data, with ongoing analysis.



First time since early 1980s that  $^{119}\text{In}$  has been used as a Mossbauer probe at ISOLDE.

### *Results from $\text{Al}_2\text{O}_3$*

Initial (and surprising) main result:

- Spectra are dominated by  $\text{Sn}^{4+}$  ( $d = 0.07(1)$  mm/s)
- Also seems to be the case for all oxides measured: why? ( $\text{Sn}^{4+}$  is *not* the natural valence state...)

# HIE-ISOLDE beamline layout

agreed within HIE-ISOLDE Physics Steering Committee (Oct 2010):  
3 beamlines for MINIBALL + spectrometer and 2 other setups

