J. Gerl
GSI

presented at

AGATA week

March 30 – April 1, 2009, Köln
In-beam Spectroscopy employing RIBs at GSI

**Nuclear Shell structure**
- \( N \approx Z \)
- \( N \gg Z \)

**Nuclear shapes**
- Quadrupole, Octupole, Triaxiality
- Shape transitions
- High K-isomers

**Collective modes**
- \( N \gg Z : \) GDR soft mode

**Nuclear Symmetries**
- mirror-isospin, pn-pair correlation

**Nuclear astrophysics**
- \( r, \) \( rp \) process

Coulomb excitation, Knock-out and Fragmentation studies using Rare Isotope Beams and high-resolution \( \gamma \) Spectroscopy
Fragment Identification, Reaction and Spectroscopy

production

selection

identification

reaction

spectroscopy

identification

γ detectors

Calorimeter
Relativistic Coulomb excitation / fragmentation

\[ ^{112}\text{Sn} \rightarrow ^{Au} \]

Coulomb interaction

excited nucleus

Prefragment

Equilibrated nucleus

Graph showing the relationship between kinetic energy and cross-section for different excitations.

Equation: $\sigma (\text{mb})$ vs. $\text{Kinetic energy (MeV/nucleon)}$ for $^{112}\text{Sn}$ to $^{Au}$.
Doppler Effect

Doppler shift

Doppler broadening

Position sensitivity
Prompt Flash

- X-rays from target atoms
- Radiative electron capture (REC)
- Primary Bremsstrahlung (PB)
- Secondary Bremsstrahlung (SB)

High granularity
105 Ge crystals
Energy resolution (FWHM): 1.24%
Total efficiency: 2.9%
[for $E_\gamma = 1.3$ MeV at 100 MeV/u]
Coulomb Excitation of n-rich Cr Isotopes

A new sub-shell closure exists at N=32

Evidence for reduced B(E2) value at N=32
RISING: Fast beam - physics focus

Coulex in nuclei towards $^{100}\text{Sn}$

Spectroscopy of mirror nuclei (A~50) via two-step fragmentation

Spectroscopy of $^{36}\text{Ca}$ via two-step fragmentation

Pigmy resonance in n-rich nuclei

Coulex in n-rich Cr isotopes

Coulex in triaxial nuclei $^{136}\text{Nd}$

Convener: P. Reiter, University of Cologne
From RISING to HISPEC/DESPEC

- RISING stops in August 2009
- HISPEC/DESPEC starts in 2014

Want to continue successful spectroscopy programme
Need to commission and implement new instrumentation

PRESPEC

- Decay and In-beam spectroscopy programme at the FRS until HISPEC/DESPEC starts
- Employing new instrumentation as it becomes available
- Platform for coordinated test and commissioning of HISPEC/DESPEC components
- Organisational framework of the spectroscopy community at GSI/FAIR
RISING to PRESPEC to HISPEC/DESPEC

Constraints:

- reduced beam time $\rightarrow$ duration of campaigns
- availability of AGATA $\rightarrow$ sequence of campaigns
- reduced planning reliability $\rightarrow$ more flexibility...

RISING Decay
passive stopper

RISING Decay
active stopper

PRESPEC
LYCCA-0 Commis.

PRESPEC In beam
AGATA Demonstr.

PRESPEC Decay
neutrons, 
g-factor, ...

HISPEC/DESPEC instrumentation commissioning
PRESPEC - AGATA Fast Beam Campaign

great perspectives....

LYCCA-0 provides mass resolution up to $A \approx 100$

SIS/FRS intensities increase up to $\approx 10x$

AGATA increases $\gamma$-sensitivity $\approx 10x$

Tracking det. and EDAQ upgrade increase max. rate and throughput 10x

PRESPEC Fast Beam Campaign
Physics Case
convener: M. Bentley

Very attractive and competitive spectroscopy themes

Unique combination of beams, set-up and people
PRESPEC – AGATA Fast Beam Campaign

how to complicate things....

History:

10.2008: Workshop in Daresbury defines physics scope and set-up
(Cluster Ge + LYCCA-0 + 100 kHz beam at S4)

1.2009: 16 proposals submitted to G-PAC (merged from 20)

1.2009: GANIL not available for AGATA in 2011/12

2.2009: G-PAC announces independent meeting for PRESPEC proposals

2.2009: Development of set-up starts
(≈10x sensitivity, EDAQ scenarios; 2 y for dev., constr. and install. )

3.2009: GSI management provisionally agrees to host AGATA in 2011/12
(resources and beam time planning starts)

3.2009: Principle PRESPEC set-up including AGATA discussed at
NUSTAR Annual Meeting and AGATA week

Reduced GSI funds

Reduced GSI personnel

Less beam time

More buerocracy
PRESPEC - AGATA Fast Beam Campaign

how to dissolve complexity....

Conclusions so far:

- LYCCA-0 commissioning and some up-front experiments needed before AGATA can be successfully implemented
- Previous proposals need to be checked/adopted
- Call for additional proposals from the wider community is mandatory
- Concentrating on outstanding and well focused physics themes is adequate
- Balancing the needs for beam time and resources within PRESPEC, NUSTAR and all other GSI/FAIR communities on a mid-term basis is essential

Time plan:

- 4.2009: GSI, AGATA and PRESPEC agree on a PRESPEC Campaign with AGATA
- 6.2009: PRESPEC workshop to agree on up-front experiments
- 10.2009: G-PAC on PRESPEC up-front experiments
- 1010: Perform PRESPEC up-front experiments without AGATA; AGATA Physics workshop, proposal submission and G-PAC evaluation
- 1011/12: Installation and operation of PRESPEC AGATA in-beam Campaign
Conclusions

- RISING was successful
- FAIR (unavoidably) causes more chaos
- AGATA at FRS offers a strongly improved set-up but limited beam time
- The future will be tough, but the perspectives are great
- Let us go for it...
### Accelerator Planning

**Beamtime and Shutdown from 2009 until 2015 (Estimate)**

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<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
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- **Beamtime UNILAC**
- **Beamtime SIS**
- **Shut-Down UNILAC**
- **Shut-Down SIS**
- **HSI**
- **HLI**
- **Commissioning**
- **HEST FAIR**
- **HITRAP available**
- **PRELIx available**
- **M-branch available**

**Remarks:**

For the given experiment beam times a reduction of about 15% for machine experiments/commissioning is to be considered. It is assumed that no accelerator sections (e.g., ESR) will be dismantled within the given period.

<table>
<thead>
<tr>
<th>Availability</th>
<th>2010</th>
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<th>2012</th>
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E_{\gamma,0} = 1 \text{ MeV}

Emission source @ $\beta = 0.50$

AGATA@GSI
Efficiency = 10 %
Resolution = 7 keV (FWHM)

RISING
Efficiency = 3 %
Resolution = 20 keV (FWHM)

About one order of magnitude improvement in sensitivity!