

Demands from experiments for a spectrometer at HIE-ISOLDE

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 **LOEWE** – Landes-Offensive zur
Entwicklung **Wissenschaftlich-**
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Request from Lols



35 Lols for HIE-ISOLDE have been submitted so far

15 claim that they will profit from spectrometer or separator

- **Mostly to identify beam-like particles**
- **Only 1 explicitly mentions the use as spectrometer (reactions with light particles)**

12 of these Lols request the MINIBALL + CD or T-REX set-up

Other set-ups:

- **1 Lol with GASPARD**
- **1 Lol with ACTAR**
- **1 Lol for identification of fission fragments**
- **HELIOS / PARIS ... no spectrometer mentioned**
- **... impact on mechanical design?**

Reaction types:

- Coulomb excitation
- Direct reactions with light targets (up to ^{16}O)
- Transfer induced fission

Not proposed so far:

- Transfer reactions with heavy targets
- Deep inelastic reactions
- Fusion-evaporation compound reactions
- ...

Beams:

Full range of isotopes available at HIE-ISOLDE (Li to Ra)

- Energy: about 4 - 5.5 MeV/u
- Intensities: $> 10^2/s \dots 10^8/s$
- Large range of scattering angles
... event-by-event identification not possible
(if not a small acceptance of a spectrometer may be sufficient)
- 3 Lols mention A and Z determination for scattered particles
→ large area Bragg detector
- Spectrometer/separator used to determine
 - Beam composition for normalisation
 - Integral measurement sufficient

Transfer reactions with light targets

- Energy: 5.5 - 10 MeV/u
- Intensities: $> 10^5/s$
- Small scattering angles around 0°
- Event-by-event PID
 - Identification of heavy transfer product
 - Reactions of beam contaminants
 - Fusion-evaporation reactions with target / carrier
(CH_2 , CD_2 , $\text{Ti}+^3\text{H}$, $^9,^{10}\text{Be}$, $\text{X}+^3\text{He}$, $\text{X}+^4\text{He}$, $\text{X}+^{16}\text{O}$, ...)

Also needed for analysis:

- Beam composition for normalisation
- Integral measurement sufficient

Beam identification so far

- Integral values ... no event-by-event
- No identification of reactions (except by isomer catcher)

Devices / methods

- ΔE -E: Si-IC telescope, small Bragg chamber in beam dump
- Laser ON/OFF
- Decay spectroscopy at target position / beam dump
- Release curve gating (hardware / analysis)
- Isomer catcher (Ni transfer run)
- ... ???

New devices / methods under development

- Fusion veto (preliminary test performed)
- Large area Bragg detector ... status???
- RDT with CD detector

Specs for a spectrometer/separator

A device at 0° is sufficient for most Lols so far

- **A/Z-Resolution (covering also heavy beams)**
 - $A/\Delta A > 240$
 - $Z/\Delta Z > 90$... nuclear charges!
 - \pm a few mass and nuclear charge units should pass
 - atomic charge states?
- **Energy / momentum; $p/\Delta p$ or $E/\Delta E$???**
- **Intensities:**
 $10^5/s$ for heavy beams means $10^9/s$ instantaneous rate!!!
- **Timing:**
Usually slow extraction from EBIS required
→ useful timing signals from HIE-ISOLDE for TOF ???

... future ideas

Transfer with heavy targets / deep inelastic reactions

- angular distributions
- spectrometer needed at angles off 0°
... are the intensities at HIE-ISOLDE sufficient

Fusion-evaporation reactions → measurement at 0°

Future upgrade of MINIBALL set-up:

- Coupling to other particle detectors instead of T-REX ... e.g. MUST
- Plunger (under construction)
- e-spectrometer (... SAGE-type)
- Recoil decay tagging (RDT) ... for sure, we will do!!
(isomers, α - or β -tagging, $E0$ decays,)
- Large area Bragg detector (???)
- Neutron detector (mentioned by 1 Lol)
- ...

Conclusion (I) ... some kind of ...

Most need comes from transfer reactions on light targets

→ Device capable to be operated at 0° required

Flexibility coupling to MINIBALL / HELIOS / ...

Ray-tracing spectrometer (VAMOS,(PRISMA)...) or mass spectrometer (EMMA, MARA, RITU ...)?

One design can meet all experiments (all beam masses)?

Major challenges:

- High instantaneous count rates
- Beam spot size / entrance angle
- Z resolution for high Zs
- ...

Working groups to be formed:

- **Physics cases**
Reaction types, beams, targets, ...
- **Detectors: focal plane (incl. RDT), tracking for ray-tracing, ...**
- **Ion optics simulations**
... for relevant physics cases
- ...