Dear Colleagues,

A brief summary of the working group session No 5 (electron and electron-positron spectrometer) is given.

Subject of discussion were two separate projects, the extended reaction microscope (coordinated by S. Hagmann) and the high resolution electron spectrometer (coordinated by R. Mann). Besides the participants present at the meeting there were several more colleagues interested in active participation in projects but who were not able to attend the meeting.

Different details can be found in the protocol attached. From temporary 12 participants during the session a closer number of presently 4 members have announced their collaboration in the two projects.

For the Extended Reaction Microscope these were J. Tanis, Western Michigan State Univ., X. Ma from Inst of Modern Physics, Lanzhou, B. Sulik from Atomki Devbrecen, and G. Garcia from CSIC Madrid. Besides these four participants there are currently seven more colleagues who have communicated a serious interest in the project.

The high resolution spectrometer system will start with trajectory calculations (electron optical properties of two analysing magnets as separately and in combination). This may imply also a reconsideration of a possibly alternative spectrometer for the HRES (high resolution electron spectrometer) part. Theo J.M. Zouros from Atomic and Molecular Division Dept. of physics University of Crete will contribute in this direction and in doable calculations concerning spectrometer design with inclusion of the experimental kinematics. Likewise G. Garcia from Instituto de Mathemáticas y Física Fundamental (CSIC) in Madrid having extended experience in calculations and designing of electrostatical electron optical systems will be engaged in this direction. From B. Sulik (Atomki) in Debrecen we have support from extended knowledge on design and construction of electron spectrometers and detectors. He could activate a doctoral student or a postdoc for doing studies, tests and built up procedures at GSI. From Xinwen Ma, Institute of Modern Physics, Lanzhou (China) we have support in constructional work and specifying technical parts, the next important step for the project. Following these lines we may precise the requested technical proposal in next weeks. Of course, for the concretisation of collaboration we have to find proper financial supporters.

We will keep (increasingly) close contact for further proceedings.

Cheers, Rido Mann, S.Hagmann.
See subsequent protocol.

PROTOCOL

SPARC Workshop – 29-30 Oct. 04
Working Group Session V
Contact persons: S. Hagmann and R. Mann

29.10.04:


Hagmann:

A Reaction microscope with improved detection capabilities - particularly concerning the accessible dynamic range for cross sections will be designed for experiments in the future LSR storage ring of FLAIR as well as in the NESR.
Low energy electron detection with reaction microscope: Standard configuration of reaction microscopes currently in use (worldwide) can mostly detect low energy target electrons (up to ~100 eV and with strongly reduced solid angle up to 1000 eV) and in longitudinal configuration - simultaneously electrons of moderately high energy emitted by the projectile ion of $E_{\text{Proj}} \leq 4\text{AMeV}$ (i.e. up to $E_e \sim 3\text{ keV}$). Concerns arise for measurement of cross sections small compared to the ionization cross section of He. Search needs to focus on configurations which are able to handle a large dynamic range of cross sections.

**Physics studies** with kinematically complete measurements using the extended reaction microscope:

- atomic fragmentation - multiple ionization
- dynamics of SI, MI - ionization processes near threshold
- $(e,2e)$ processes with ions in arbitrary charge states, i.e. accessibility of isoelectronic sequences
- short wavelength limit of $e^-$ nuclear Bremsstrahlung (radiative electron capture to continuum close to threshold)
- molecular targets? (Sulik suggestion)

**Apparatus:** Part 1: reaction microscope + gas jet; Part 2: imaging forward electron spectrometer

**PART 1:**
need beam/electron optics calculations + electron/recoil trajectory calculations
OPERA code is available at GSI for calculations at GSI, procedures to have code be used by collaborations are discussed

target zone: focus on how to increase overall detection efficiency - geometry of extraction electrodes

need for nanosecond-fast-pulse deflection voltages to reduce background events (e.g., suppression of collision products not associated with projectile ionization in $\text{Ar}^{17+} + \text{He}$ collision system), i.e., detect fast electron in forward direction around $0^\circ$ and then turn on spectrometer voltages for slow ions

need to encapsulate entire detector, recoil- and electron-, and in-chamber signal leads to shield from high-frequencies during ns-HV pulses

**Stoehlker:**
Discussion of properties of new internal supersonic jet target:
the community would like to have He target (there is a strong request for this) – $10^{12}$ part/cm$^2$ for a 1 mm length (presently ~ 5 mm).

**Notes:** beam diameter ~ 1-4 mm; immediately after injection into the ring beam must be on correct trajectory.

- need to consider space requirements for support structure
- need to have space for high-resolution electron spectrometer (HRES) (Mann)
- there will be a large preparation area to right of jet target region

**Hagmann:** for the reaction microscope it is highly desirable to increase the distance from the last skimmer to the interaction region to ~ 10 cm
(in current ESR configuration this distance is 50 mm)

**PART 2:**
**Forward electron spectrometer** (see future website)
- need imaging feature in order to reconstruct collision plane (and target recoil momentum) for kinematically complete experiments; use magnetic analysis with 2 $60^\circ$ dipoles and magnetic quadrupole triplet (instead of electrostatic)
- electron optics: need telescopic mode in operation
- will use 3-channel plate configuration for efficient electron detection
- need to further investigate channel plate configuration properties for efficient 2D-position sensitive detectors for H.E. electron detection for $E_e \geq 100$ keV
- Sulik: why not use optical conversion? Hagmann: need more than 30 keV for efficient conversion
- spectrometer will be run in stepping mode using ESR software
- would like to have prototype in next two years
- for calibration: use radioactive sources, but these cannot be put into NESR
- Physics case: instrument is unique because of imaging properties and range of energies that can be detected

**Tasks and manpower:** (see future website)
- Need to do optics calculations first – who will do? Who will pay for software?
- Who will pay for travel to GSI?
- Need to approach funding agencies in individual countries for support of collaborative efforts: DAAD, NATO, European community grants for PhD students and postdocs.
- MONEY IS A BIG PROBLEM!!!!!

**Continuation on 30.10.04:**


Mann:
- $e^+ +$ RIMS spectrometer (an imaging detector) – used mainly for projectile electrons, but can also use for target electrons

- Physics studies: combined atomic and nuclear effects

- Electron Spectrometer Schematic (see attachment?):
  - 270° transport magnet: can detect electrons from a few ~ keV to > 1 MeV
  - similar to spectrometer used in ELISE project (nuclear physics)

- Technical proposal: need a spokesperson (local contact: R. Mann)
- Project duration: ~ 5 years
- Tasks: see attached list (get from Rido)

- Subproject 1:
  - Electron transport calculations; geometrical design
  - target chamber: design and construction
  - 2D detector development

- Subproject 2:
  - High-resolution electron spectrometer (HRES)
  - Mounting and testing of HRES

**Tasks and manpower:**
- Need technical report by Jan. 15
-Optics calculations: can optics from BILL be used? 
  **Zouros:** will do some simple calculations

-Need for external support: DAAD, NATO, Marie Curie grants for students???

-OPERA code – **Hagmann:** will see if code can be made available externally
  (also check on availability at HMI and BESSY II – **Tanis**)

- tentative task schedules for reaction microscope discussed (see attached table)

**General plan:**

- Reaction microscope and forward imaging spectrometer: Tanis will work with Hagmann
- High-resolution spectrometer: Zouros will work with Mann
- Conceptual design of instrumentation: generally seems ok

**Sulik:** 2D position sensitive detectors: need to consider different designs

**Zouros:** Should set up a website for our working group. Hagmann will check into this

Submitted by:
J. Tanis/S.Hagmann/R.Mann