The BGO-OD Setup at ELSA

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For the BGO-OD Collaboration

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Motivation

- Investigate nucleon structure
- ELSA energy range up to 3.5 GeV
  - Baryon spectroscopy
  - Meson photoproduction
- Strangeness production

\[ \gamma + p \rightarrow K^+_0 + \Sigma^+ \]
\[ \downarrow \quad \downarrow \]
\[ \pi^+ \pi^- (69\%) \quad p\pi^0 \]
\[ \pi^0 \pi^0 (31\%) \]

- \( \omega \): decays mainly to \( \pi^+ \pi^- \pi^0 \) (90\%), \( \pi^0 \gamma \) (9\%)
- \( \Lambda \): \( p\pi^- \) (64\%), \( n\pi^0 \) (36\%)

Already existing detector Crystal Barrel (Talk D. Elsner HK4.1) very successful, but:
- mainly sensitive on neutrals
- no magnetic field → no charge sensitivity, no momentum information

Hence: New BGO-OpenDipole setup with dipole magnet
**Electron Stretcher Accelerator (ELSA)**

- **Energy range:** 0.5–3.5 GeV
- **Typ. extracted intensity:** 1 nA
- **Electron polarisation:** typ. 55–65%
- **Talks:** HK26.4 and HK26.5
ELSA: Experimental Areas

Crystal Barrel

BGO-OD

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DPG Frühjahrstagung, Münster 2011
Tagged photon facility

- Bremsstrahlung off thin radiator
- Hodoscope new construction
  - thin plastics, adjacent pieces overlapping
  - → low neutron efficiency
  - coincidence between adjacent scintillators
  - → background suppression
- Prototype: (Diploma project G. Siebke) successfully tested
  - 9 channels, efficiency 99%
- Readout electronics
  (PhD project F. Messi)

Talks: G. Siebke (HK28.6) and F. Messi (HK28.7)
Experimental Setup

BGO (Rugby Ball)

- 480 BGO modules in 2 hemispheres
- Length 24 cm (≅ 21 radiation lengths)
- Scintillator barrel: 32 segments (5 mm thick) → Particle ID
- 90% solid angular coverage
  - polar $25^\circ - 155^\circ$; full azimuth coverage
- $\delta E_\gamma/E_\gamma \approx 3\%$ (@1 GeV)
- 2 concentric cylindrical MWPCs around target
- Si strip detectors
- Test beamtime scheduled April 2011
Target

- Horizontal cryostat for liquid hydrogen/deuterium
Experimental Setup

Open Dipole Magnet

Objective

Momentum analysis and sign of charge

- Pole gap 84 cm
  Angular coverage
  $\pm 8^\circ$ (vert.), $\pm 13.5^\circ$ (hor.)
  $B_{\text{max}} \approx 0.5 \text{T@1340 A}$
- Field measurement courtesy of GSI (FAIR-Magnet Technology)
- Magnet precisely aligned with respect to photon beam line
- Influence of detectors on magnetic field (and vice versa) under investigation

Needed

Trajectories before and behind magnet
Experimental Setup

Tracking Detectors

- Silicon strip detectors

SFB/TR16 sub-project B8 (K. Brinkmann)
- Spin analysis of recoil protons by double scattering in carbon
- High precision tracking using silicon strip detectors → secondary vertex
Momo
- 3 layers of 224 fibers each
- layers turned by $60^\circ$
- readout by 16ch PMTs
- $\Delta x \approx 1.5 \text{ mm} (> 50k \text{ pixels})$

SciFi2
- 640 fibers; active area $66 \times 51 \text{ cm}^2$
- readout by 16ch PMTs
- fiber Ø 3mm

- Both mounted close to target
  → high particle flux density
  → scintillating fiber detectors
- time resolution $\Delta t \approx 2 \text{ ns}$
Drift chambers

- 8 chambers (16 layers)
  2 vertical wires, 2 horizontal wires, 2 pairs tilted by $\pm 9^{\circ}$ resp.
- hexagonal drift cells (8.5 mm radius)
- sensitive area $1.2 \times 2.4 \, \text{m}^2$
- insensitive spot for primary $\gamma$s
- all 8 chambers working & ready
- 5 chambers installed in place (one $x$, all $u$ and $v$)
- efficiency $> 97\%$ for single wire

→ Talk: J. Hannappel (HK7.4)
Time-of-flight Walls

- Neutron detection: Time of flight method
- Flight path: 5 m
- Time resolution: $\Delta t \approx 0.25 \text{ ns}$
- In total 4 walls with 14 bars each (2 vertical + 2 horizontal)
- Bars: 5 cm plastic scintillator
- 2 walls installed in area and tested in photon beam
Additional BGO-OD Talks/Posters

- DAQ (Talk D. Hammann HK20.2)
- Trigger-FPGA (Poster D. Hahne HK39.26)
- Slowcontrol (Poster J. Hannappel HK39.41)
- Simulation (Talk R. Johnstone HK46.5)
BGO-OD setup very well suited for detection of charged reaction products
Dipole field together with multiple tracking sections allows for momentum/charge analysis of reaction products
Test beamtime scheduled for April 2011
Commissioning of full setup to be finished in 1st half 2011
First data taking intended in 2011
Awaiting data...
Member Institutions

- Univ. of Bonn, Physikalisches Institut
- Univ. of Bonn, HISKP
- INFN-LNF Frascati, Inst. Sup. di Sanità & INFN Roma 1, Italy
- Univ. of Pavia, INFN Pavia, Univ. of Torino & INFN Torino, Italy
- Univ. Roma “Tor Vergata” and INFN Roma 2, Italy
- Univ. of Messina, Italy
- Univ. of Edinburgh, UK
- Nat. Sc. Center Kharkov Inst. of Phys. & Techn., Ukraine
- Univ. of Moscow, Russia
- Petersburgh Nucl. Phys. Inst. (PNPI), Gatchina, Russia
- Univ. of Basel, Switzerland