Begin of user operation at MePS in Rossendorf

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EPOS (ELBE Positron Source)

**MePS**
Monoenergetic Positron Spectroscopy
- monoenergetic (slow) positrons
- pulsed system
- LT, CDBS, AMOC

**CoPS**
Conventional Positron Spectroscopy
- LT, CDBS, AMOC
- using $^{22}$Na foil sources
- He-cryostat
- automated system
- digital detector system (in future)

**GiPS**
Gamma-induced Positron Spectroscopy
- Positron generation by Bremsstrahlung
- Investigation of bulky samples (up to 10 cm$^3$)
- all relevant positron techniques (LT, CDBS, AMOC)

Information Depth:
- MePS: 0…5 µm
- CoPS: 10…200 µm
- GiPS: 0.1 mm …2 cm
ELBE labs
Upgrade of the Dresden ELBE labs

- Extension of ELBE hall started 2011
- Electrons back in positron cave in December 2012
ELBE -> superconducting electron LINAC (40 MeV and up to 40 kW) in HZDR Dresden-Rossendorf

- Repetition time: 38 ns, 77 ns, ... , 615 ns, ...

- User-dedicated facility

- main features of MePS:
  - high-intensity bunched positron beam ($E_+ = 0.5...30$ keV)
  - Coincidence Lifetime & Coincidence Doppler Spectroscopy & AMOC
Relative yield of positrons as a function of the incident electron energy. The yield of total positrons increases virtually continuously (closed squares) while the number of thermalized positrons appears to approach saturation at about 60 MeV both for reflected moderation (filled circles) or transmitted moderation (open circles). If one is going to design an electron-linac-based positron source the optimal electron energy for positron generation will be in the 40-60 MeV range.

SLOPOS-12 Monday Afternoon talk of Sergey Chemerisov, Chemistry Division, Argonne National Laboratory
MePS scheme

- converter, moderator and electron beam dump
- 3.20 m concrete wall between cave and lab

ELBE.

- electron beam with 30 MeV energy
- up to 1.6 mA average beam current
- repetition rate $26/2^n$ MHz
  - flexible in materials choice by covering a wide range of positron lifetimes
  - adjustment of repetition rate keeping a high average current
- electron bunch with ~ 5 ps temporal width
  - well suited as start signal for positron lifetime measurement

Please see our poster P-39 in session B
Positron Converter in Cave 111b
Signal to noise ratio \( \sim 10^4 \)
- Positron energies up to 30 keV
- Timing resolution \( \sim 400 \text{ ps (08.2013)} \)

**Count rate**

![Count rate graph](image)

**Low-K sample**

![Low-K sample graph](image)
Chopper

- Plate capacitor ≈ 1 pF
- 2 stages → delay of $e^+$ bunch ≈ 5 ns
- bias voltage of ≈ 100V keeps the beam deflected → chopper pulse kicks it in
IXZ4DF18N50
- CMOS FET switch
- 95A peak current
- 500V, 500W
- 40 MHz
- IXYS RF, $50
chopper stage

wiring of all 4 chopper plates
4 chopper pulser

terminating resistors and 60 dB attenuators

water cooling of pulser
- single chopper pulser; water-cooled
- dissipates 200W @ 13 MHz; only 25W @ 1.6 MHz
- constructed by Dr. G. Staats (HZDR)
Simulation of Chopper Performance

- simulation done by SIMION-8
- BaF$_2$-PMT included
150 V

3.8 ns
Delay Control for Chopper and Buncher

- control done by LabView
- allows \( t_{\text{rep}} = 77 \text{ns} \ldots 615 \text{ ns} \)
- driven by ELBE 26 MHz mother generator
- constructed by A. Müller (MLU)
26 MHz double-slit buncher

\[ U \approx 500 \text{ V} \]

- 8 Wdg, 1.5 Cuf
- 16 mm lang
- ca. 550 nH
- Anzapfung bei 0.5 Wdg

Voltronics Trimmer
AT55HV (1.5-55pF)
600V DC max. 1200V DC

\[ U_\approx = 500 \text{ V} \]
Action of Chopper and Buncher

- buncher on, chopper on
- buncher on, chopper off
- buncher off, chopper on
- buncher off, chopper off

bunch repetition time = 615 ns
Problem: large fraction of positrons will be backscattered from high-z sample

\[
\text{Backscattering probability vs. Incident positron energy [keV]}
\]

Mäkinen et al., 1992

- in many systems: E×B filter in beam line prevents backscattered positrons from being re-accelerated
- in spite of this ⇒ often side peaks in spectrum
- our solution: a bent beamline ⇒ steering coils guide positrons to sample but backscattered to the wall in some distance
- Bent beam line: no disturbance due to backscattered positrons
  - straight beamline
  - accelerator is on
  - strong side peak due to re-acceleration of backscattered positron
- bent beamline: 45°
  - accelerator is on
  - no side peaks
  - less background $\approx 1 : 10^4$
  - no chopper in use for test
Positron lifetime spectra of a 400 nm low-k layer on Si measured at different positron implantation energies.

Please see the MELT analysis of these spectra on our poster P-39 in session B.
Up to now (Run 1 - 2 2013) we studied mainly porous materials

- low-K dielectrics (Fraunhofer ENAS Chemnitz)
- low-K dielectrics (Fraunhofer Dresden)
- gas separation membranes (FZ Jülich)

- ELBE time schedule for 2013 Run 3 and 4 (July - Dec)
- GiPS and MePS gain 11%
- interested in own beam time?
- applications twice a year - just contact one of us
- Next application deadline: 4th November
- http://www.hzdr.de/db/Cms?pNid=1732
## 1. Title of the project:

- **[Blank]**

## 2. Project leader

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- E-mail address: [Blank]
- Phone number: [Blank]

## 3. Spokes person for the proposal

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- If different form affiliation of project leader:
- Affiliation: [Blank]
- Address: [Blank]
- E-mail address: [Blank]
- Phone number: [Blank]
- Mobile number ² (“emergency number”): [Blank]

## 4. Collaborating partner from HZDR (if appropriate, please specify leading scientist of the collaborating group at HZDR):

- [Blank]
Conclusions

• MePS and GiPS now ready for external users

• Further developments of MePS:
  - improvement of time resolution
  - complete automation of measurement by LabView (handling by users should be possible)
  - digital lifetime and Doppler measurement
  - sample magazine in vacuum
  - temperature stage