CsK_2Sb PHOTOCATHODE DEVELOPMENT FOR bERLinPro

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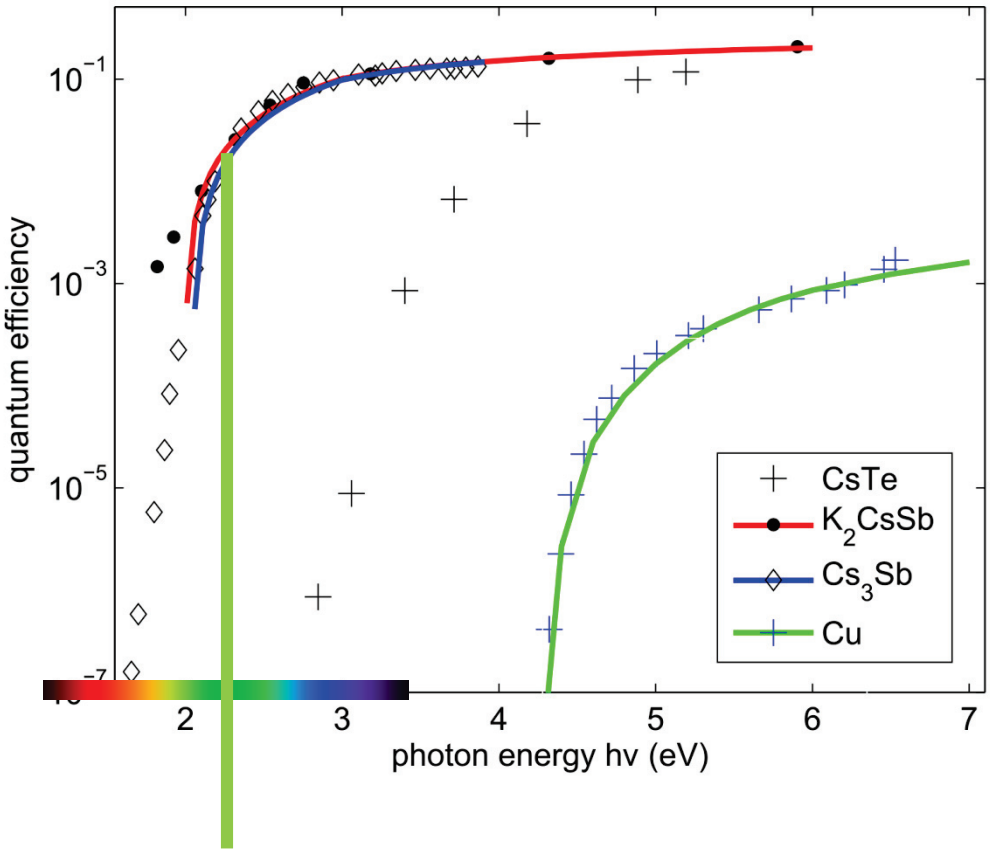


532nm available as 2. harmonic of Nd or Yb lasers

Photoinjector for bERLinPro

Aim:

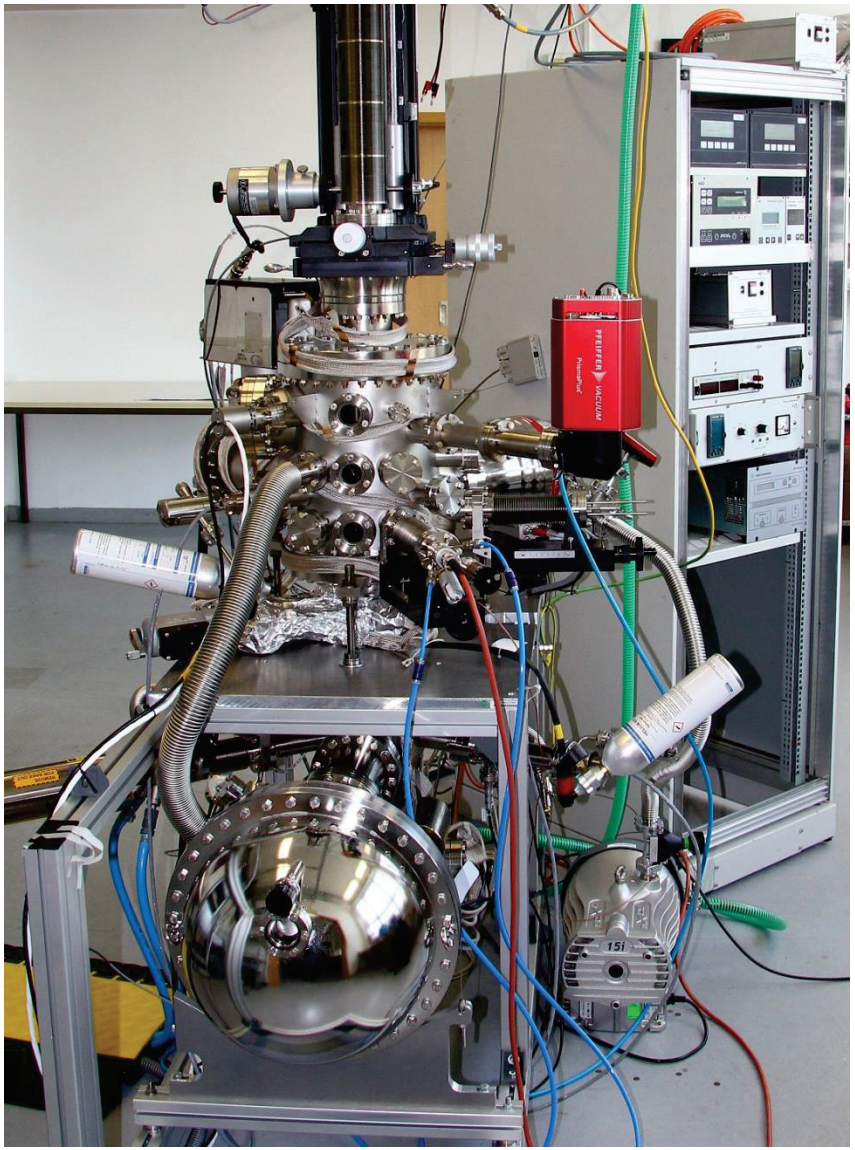
- 0.5 mm mrad emittance from gun
- 100mA in cw operation
- 2ps rms bunch length

Boundary conditions

- 1% QE at 532nm requires 23W average laser power on the cathode

$$P_{\text{laser}} = \frac{124\,\text{W nm}}{\lambda \cdot QE}$$

- High-QE semiconductors are highly reactive, survive only in 10^{-10} mbar vacuum



Preparation chamber:
- effusion cell for Sb, dispenser sources for K and Cs
- co-deposition of K and Cs or K and Sb

Quantum efficiency:
- Spectral response
- Spatial distribution

Intrinsic Emittance:
- Resolved in a drift-space spectrometer - Momentatron

See IPAC14 mopri019

Surface Analysis chamber:
- X-ray photoelectron spectroscopy (XPS)
- Low Energy Ion Scattering (LEIS)

Now commissioned and ready for experiments :
- First Sample in April ‘15
- XPS system calibrated
- Both chambers in 10^{-10} mbar UHV

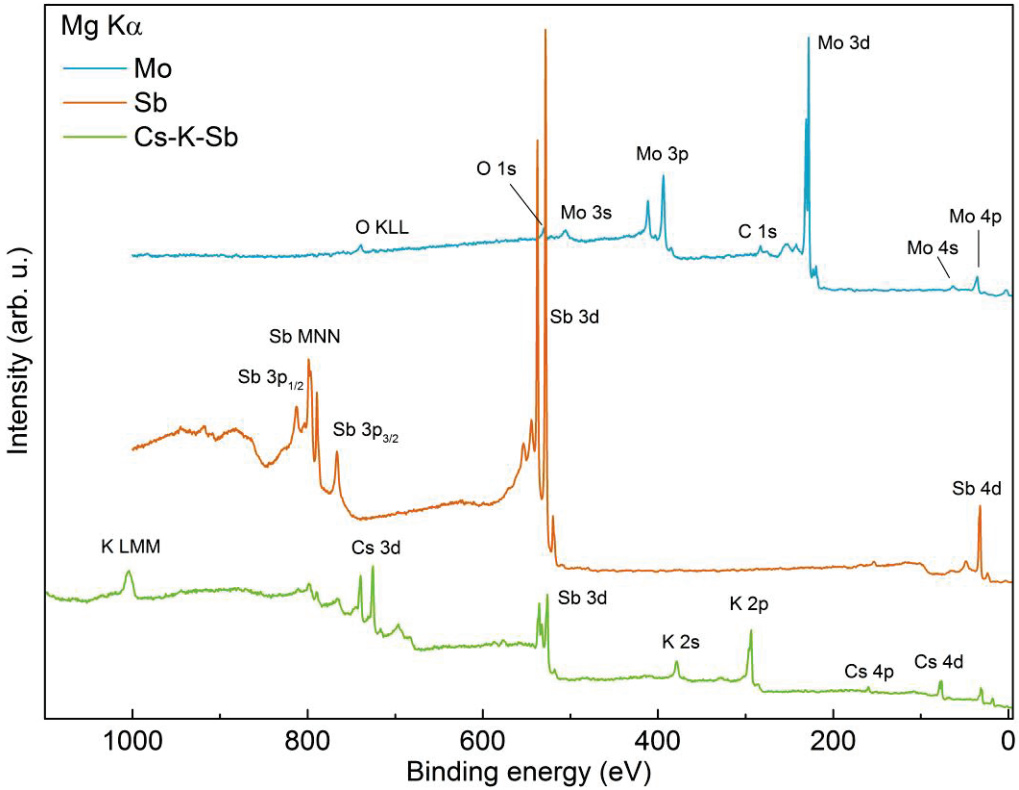
Sequential growth recipe

- Mo substrate, annealed at 450°C for 1h, sputter cleaned with Ar^+, 3kV for 30min
- Substrate is relatively clean, O and C impurities probably from the material (99.9%)

- Sb deposition at $1*10^{-7}$ vapour pressure, 0.5 A/s
- Very clean Sb film

- K and Cs deposition from SAES dispensers
- Alkalis are hardly resolved in the mass spectrometer
- During K deposition, partial pressures of H_20 $2*10^{-9}$ mbar, O_2 and CO < 10^{-10}
- Cs dispenser operated above its rated heating current to obtain a rate reading on quartz balance
- Cr and O impurities in the final Cs-K-Sb spectrum

- QE < 1%



Requirements

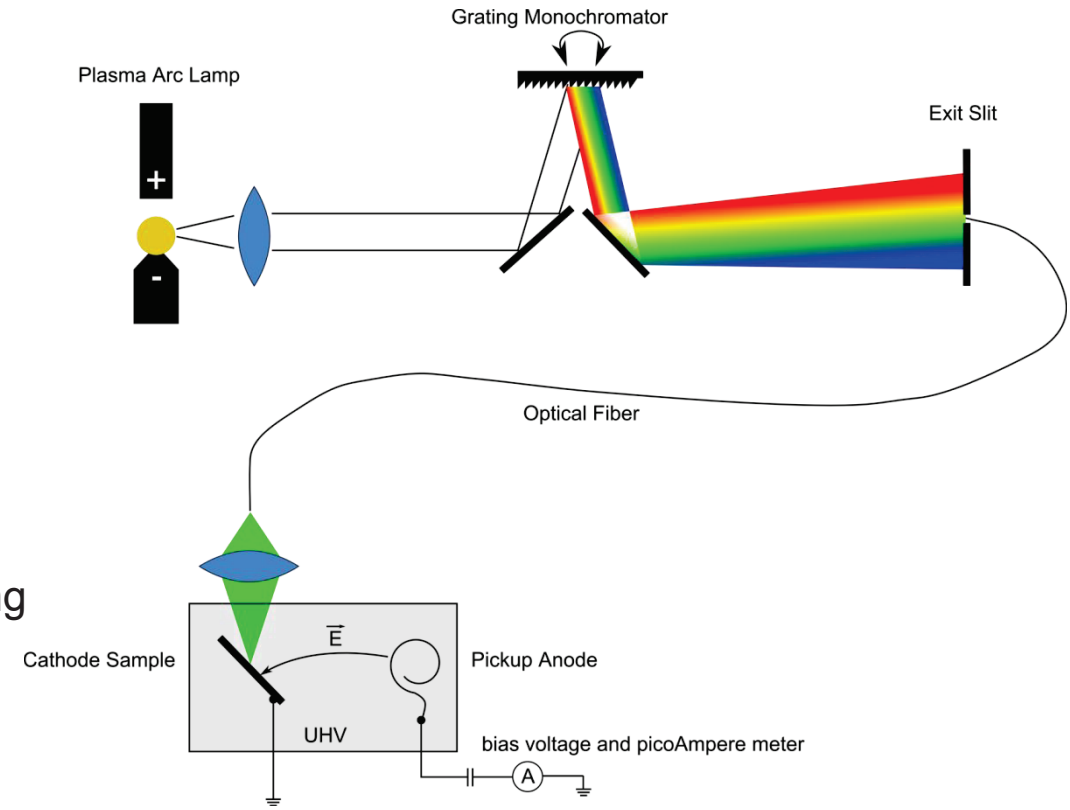
- Broad band light source 400-700nm
- Spectral Intensity ~ 1µW / nm
- High spectral resolution < 1nm

- Sensitive current measurement
- 10 pA resolution, low noise

All commercially available, need to be set up carefully.

Probable solution :

300W Xe arc lamp
1/4m monochromator with 1200l/mm grating
Picoamperemeter, might need a lock in amplifier + chopper wheel



Next steps for cathode characterization :

- Polished Mo substrates : characterize surface quality
- Influence of annealing and sputtering on surface quality

- Optimize Alkali deposition
    - Closer working distance of dispensers
    - Characterize K and Cs films separately
    - Determine purity
    - Determine good working parameters

- CsK_2Sb growth
    - Characterize purity and composition
    - Determine growth parameters for stoichiometric deposition
    - Learn more on influence of deposition parameters and composition on electronic structure and emission properties

- Evaluate alkali deposition from alkali chromates in a large crucible
    - Electron beam evaporators available
    - Co-deposition and sensitive rate control should be possible

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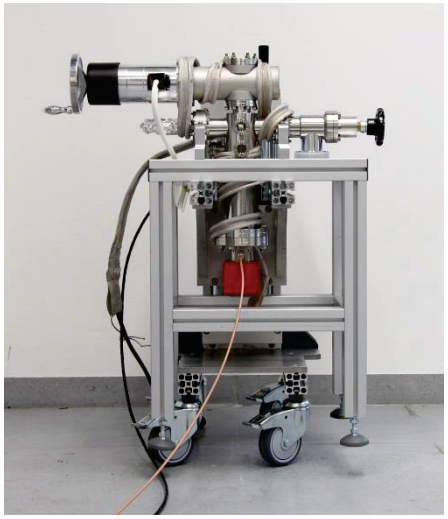
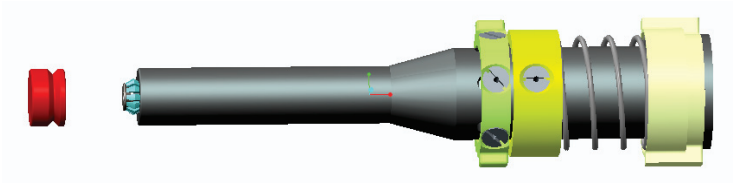
Cathodes must be stored and handled in 10^{-11} mbar UHV!

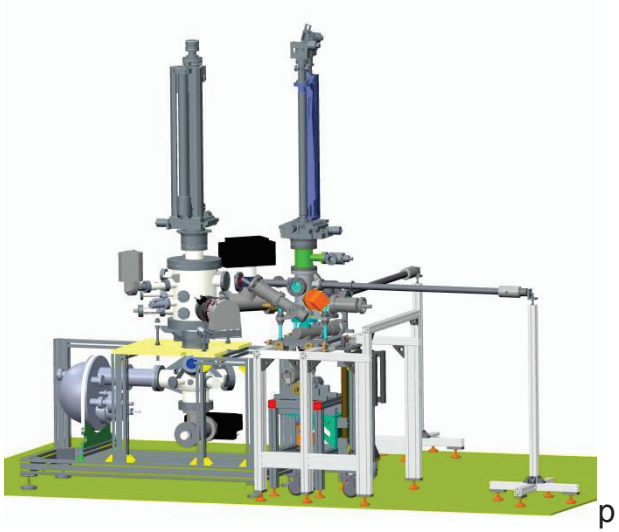


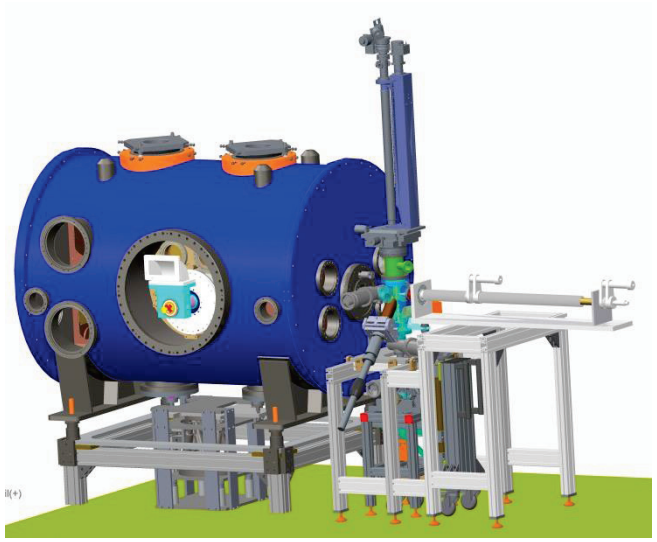
- Vacuum suitcase is available. Vacuum ~ $1*10^{-11}$ mbar
- Stability with and without getter pump will be tested

- Design of plug holder is converged
- Tests of thermal contact are ongoing
- Disc springs inside the holder rod are too stiff, will test with softer ones



- Transfer system 1 (at Prep chamber) is ordered, comissioning in fall `15
- Engineering Design : Petr Murcek, Kerstin Martin



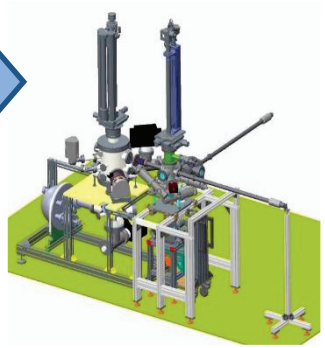


PHOTOCATHODE LAB - TIMELINE

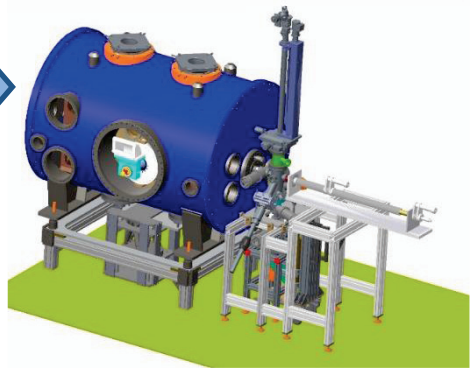
HZB Helmholtz Zentrum Berlin
bERLinPro

06.2015 — 12.2015 — 03.2016

Photocathode Preparation and assembly of Transfersystem #1



1st CsK_2Sb photocathode for Gun 1.0

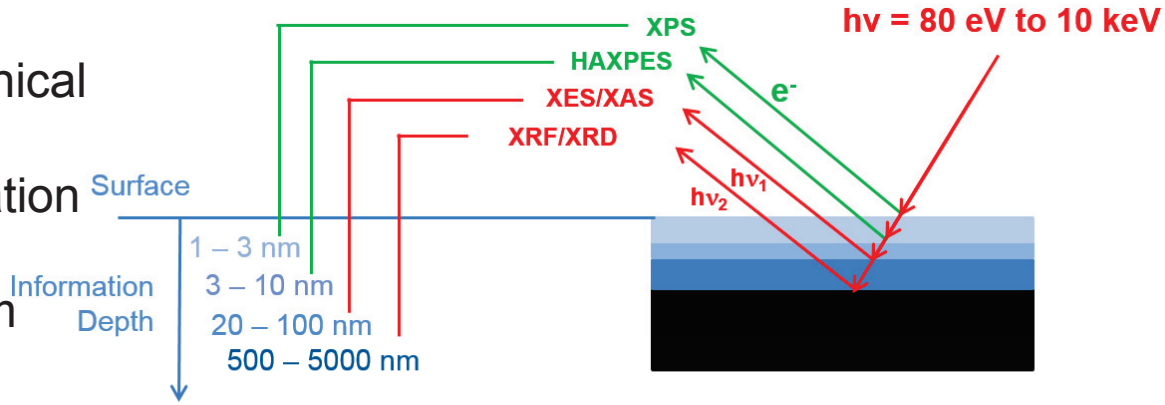


Fall 15
- Deposition studies
- Substrate preparation
- Set up transfer system 1

Spring 16
- Set up transfer system 2
- 1st CsK_2Sb photocathode for Gun 1.0

bERLinPro meets EMIL

- Access to EMIL and technical apects under discussion
- Unique methods combination
- Resolve chemistry and crystal structure in-system and for the same sample



THANK YOU FOR YOUR ATTENTION!

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- Julius Kühn, Thorsten Kamps
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- Zihao Ding, John Smedley
- Susanne Schubert, Howard Padmore

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