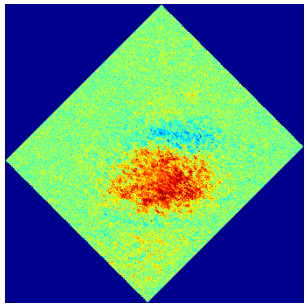
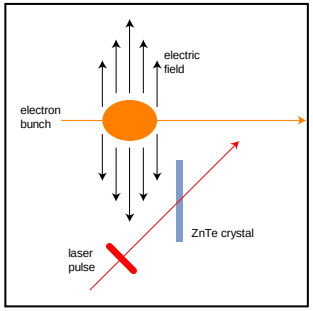


Electro-Optic Sampling of the Electron bunch in the Sub-Picosecond Pulse Source

Rasmus Ischebeck,
Holger Schlarb, Stefan Düsterer,
Adrian Cavalieri, David Reis, Soo, Juana Rudati

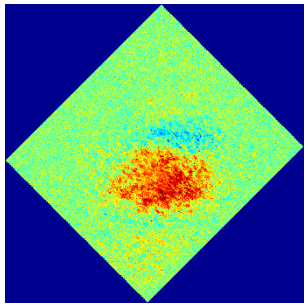
2004-01-30

Electro-Optic Sampling of the Electron bunch in the SPPS



- Principle of the Measurement

- Experimental Setup



- First results

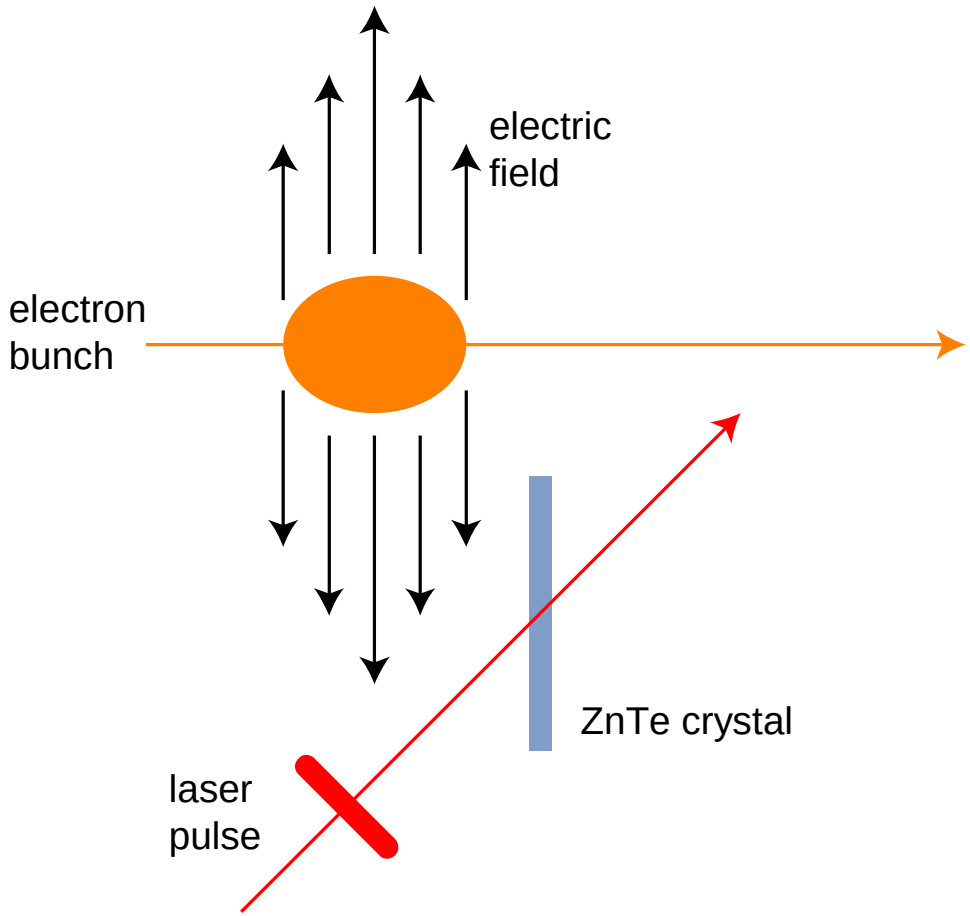
Principle of the Measurement

- Electro-optic materials:
  - Pockels effect:
  - birefringence induced by an electric field:
  - different refractive indices for the two polarizations
  - linearly polarized light acquires an elliptical polarization

Principle of the Measurement

Schematic view of the Setup

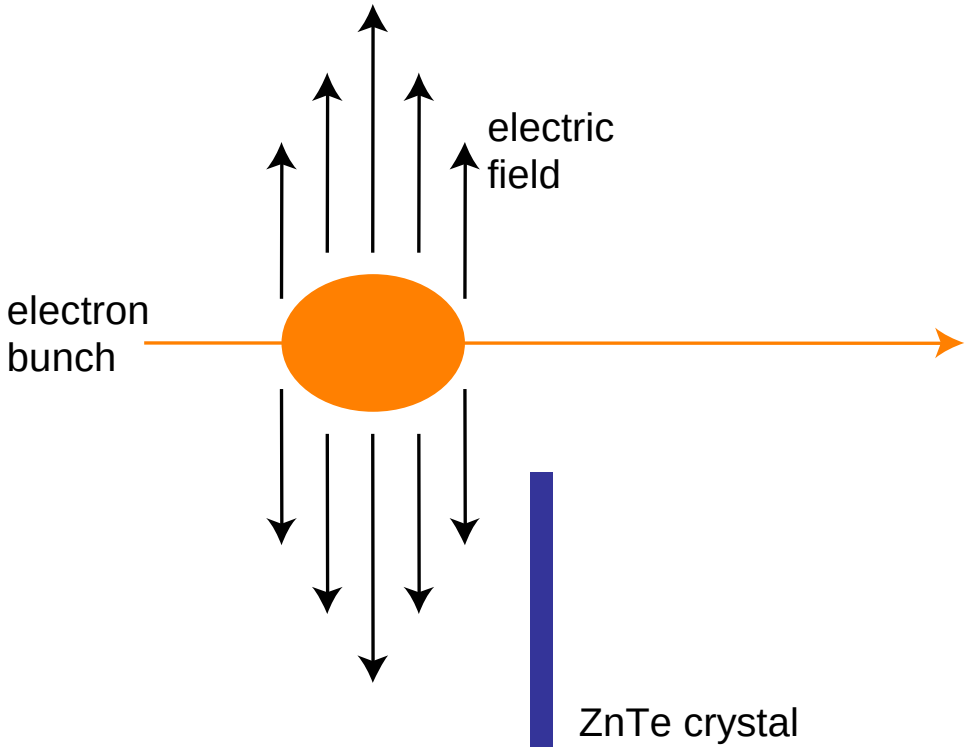
- The direction of the laser beam has an angle of 45° with respect to the electron beam



Principle of the Measurement

Influence of the e-Beam on the Crystal

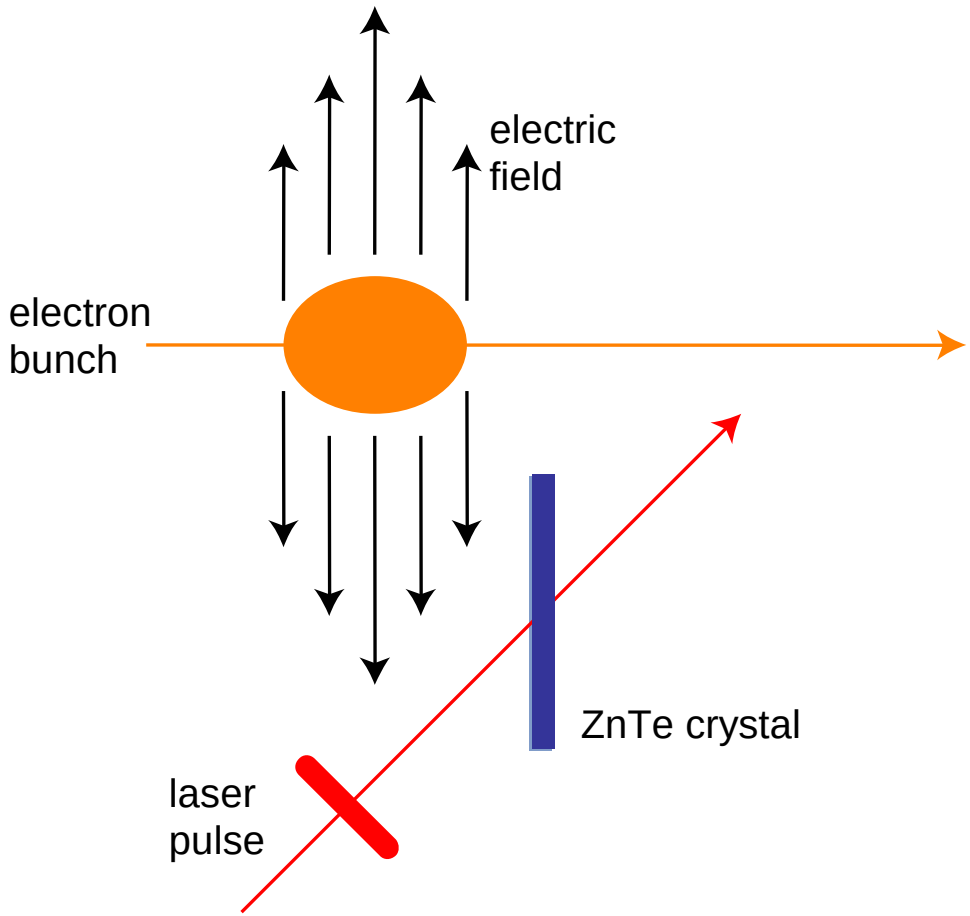
- The electron bunch at relativistic speed has a radial electric field
- This induces a birefringence in the zinc telluride crystal



Principle of the Measurement

Polarization change of the Laser

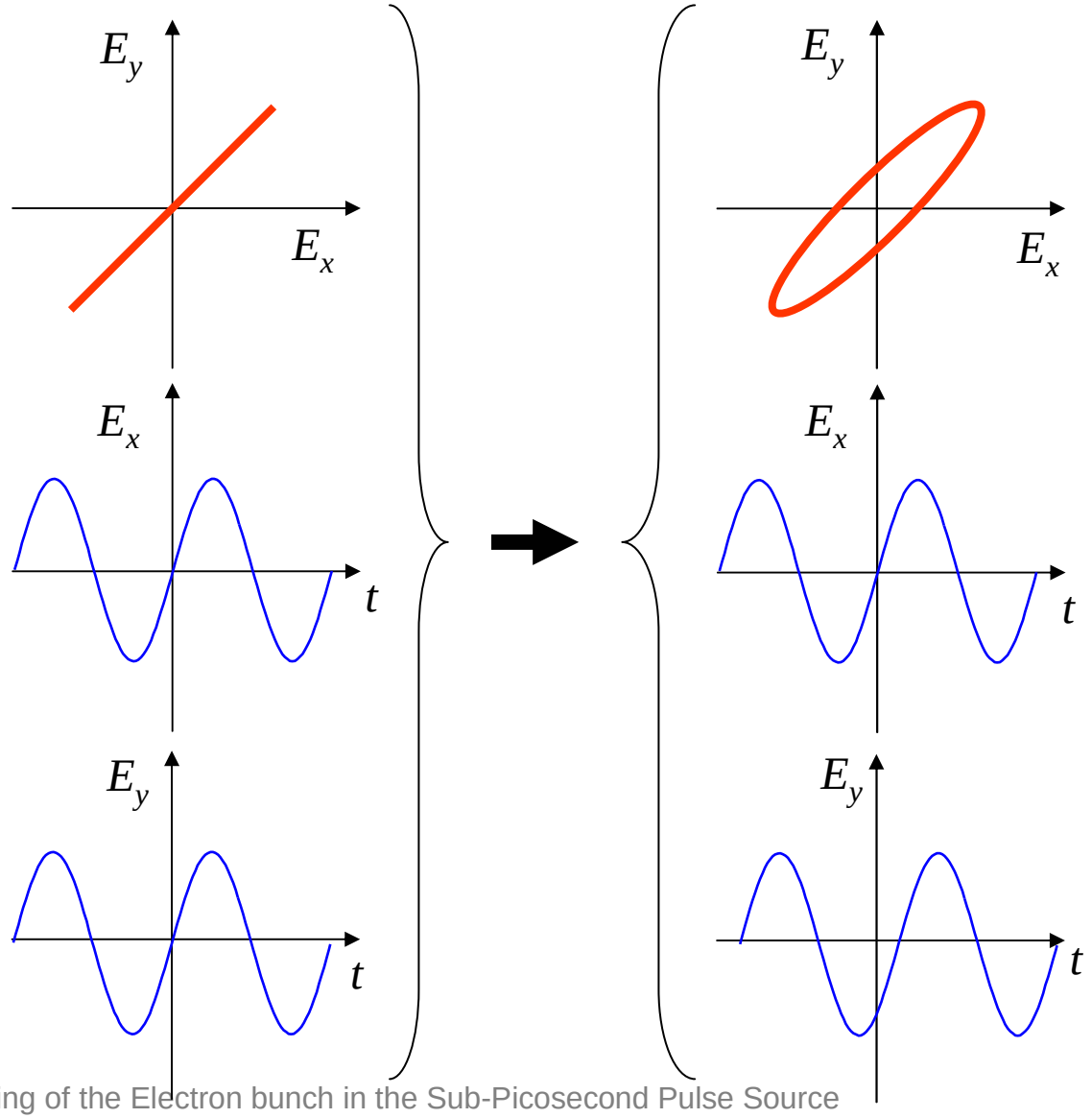
- The birefringence is measured with a polarized laser pulse
- Due to the 45° setup, the transverse position on the crystal corresponds to the longitudinal position in the electron bunch



Principle of the Measurement

Birefringence changes the Polarization

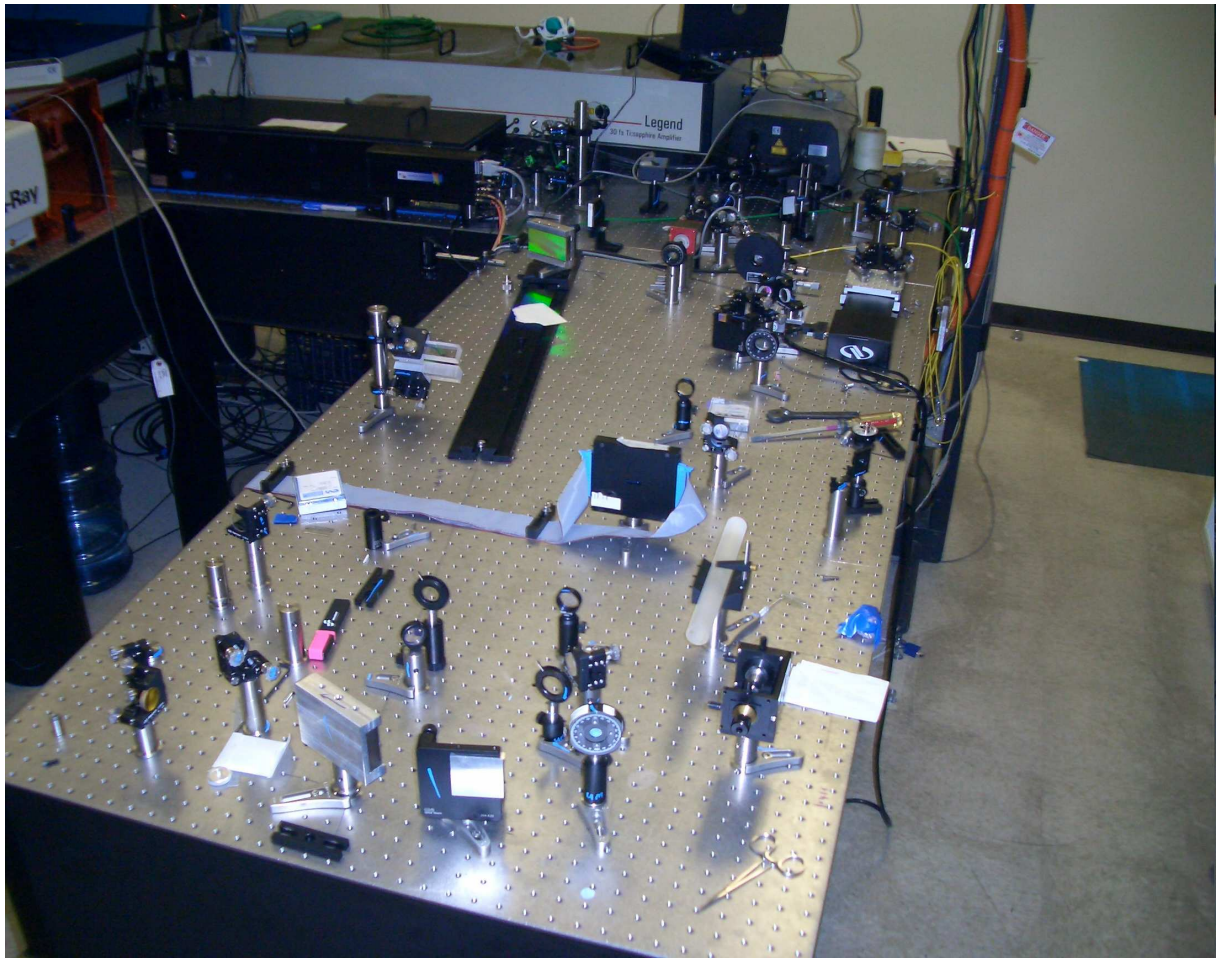
- Polarization diagram
- electric field of the horizontal polarization
- electric field of the vertical polarization



Experimental Setup

Laser

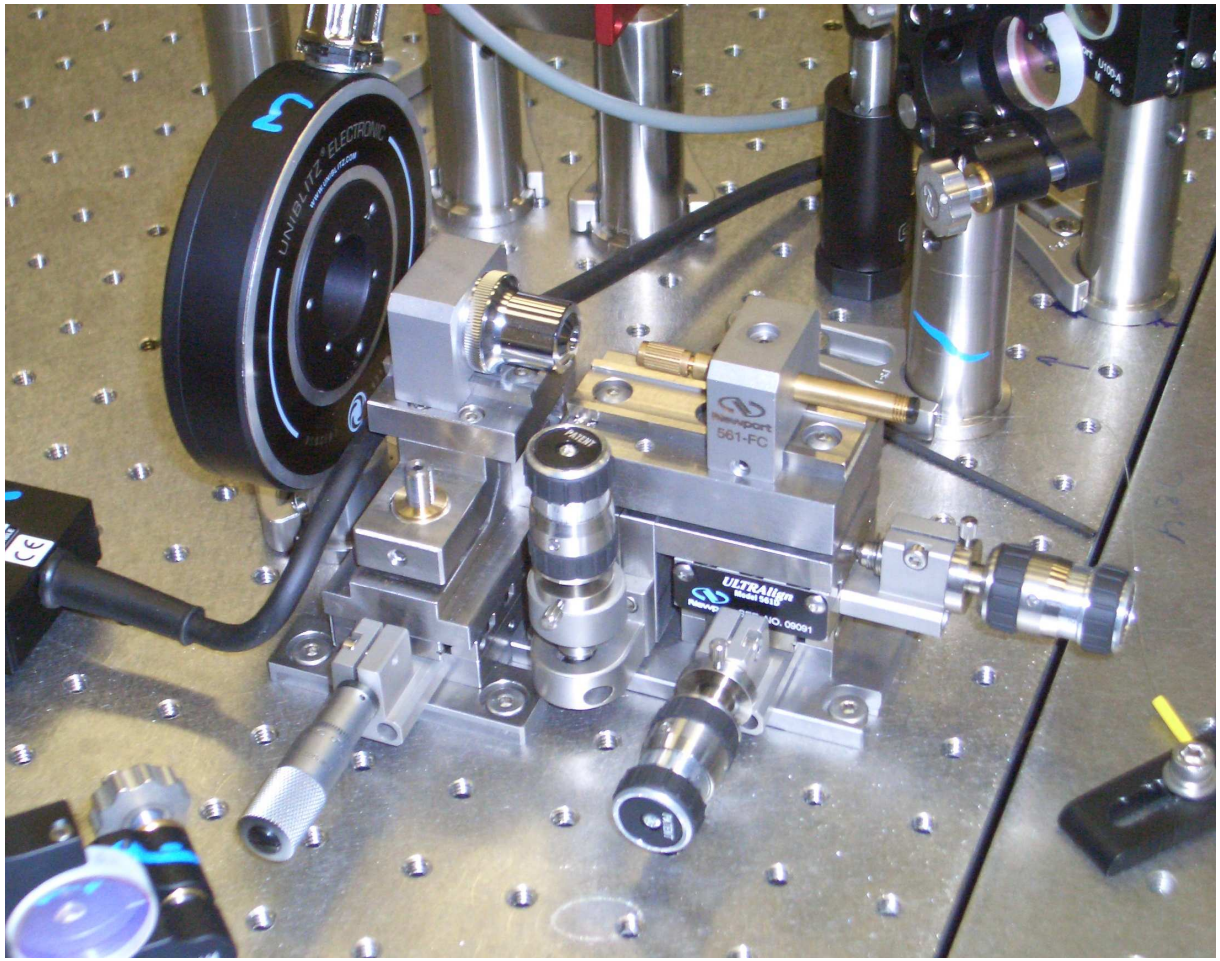
- pulse length 100 fs
- installed outside of the accelerator tunnel



Experimental Setup

Fiber-optic Transfer

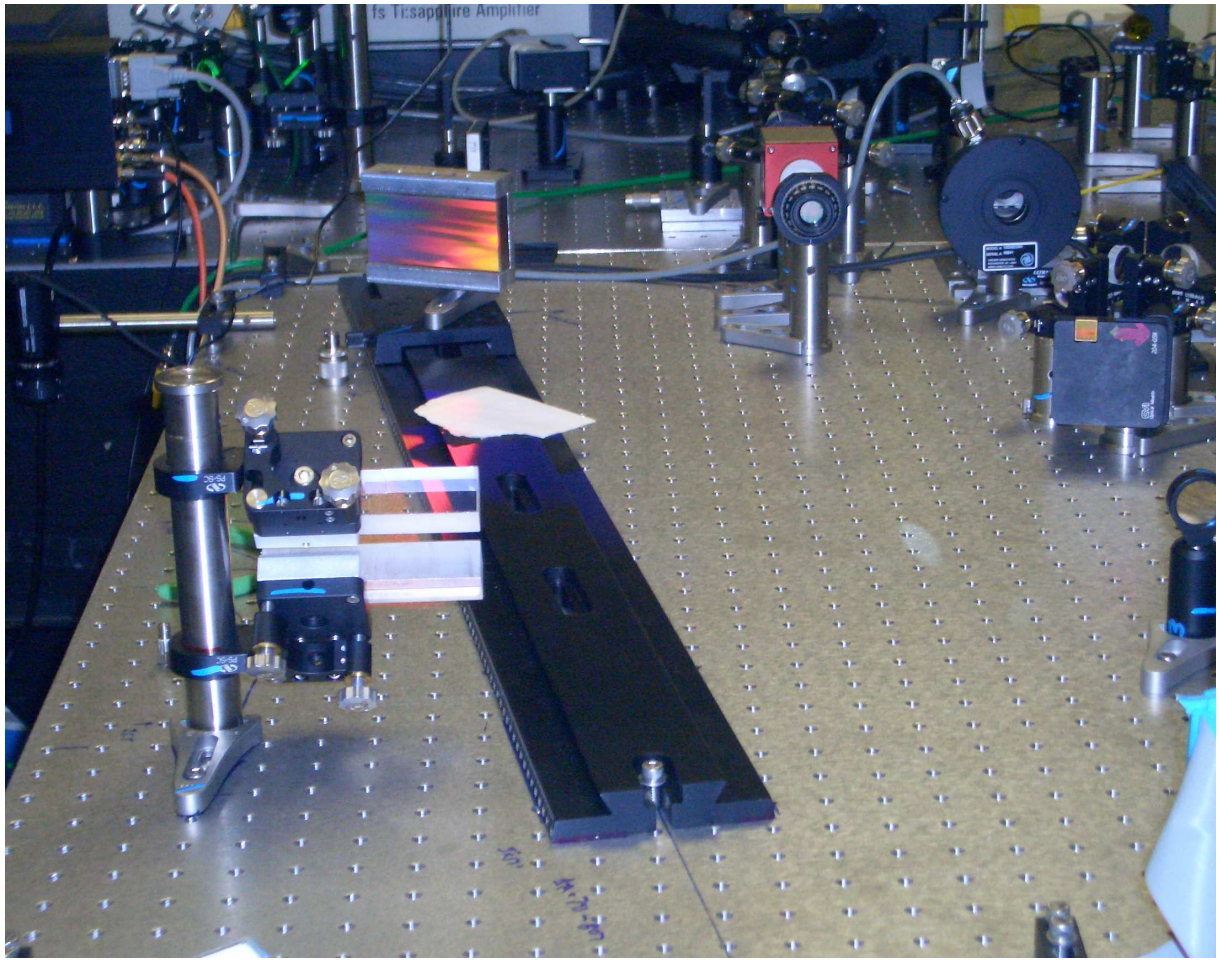
- To transport the laser to the experimental setup, it is coupled into a monomode fiber



Experimental Setup

Pre-Chirping of the Laser

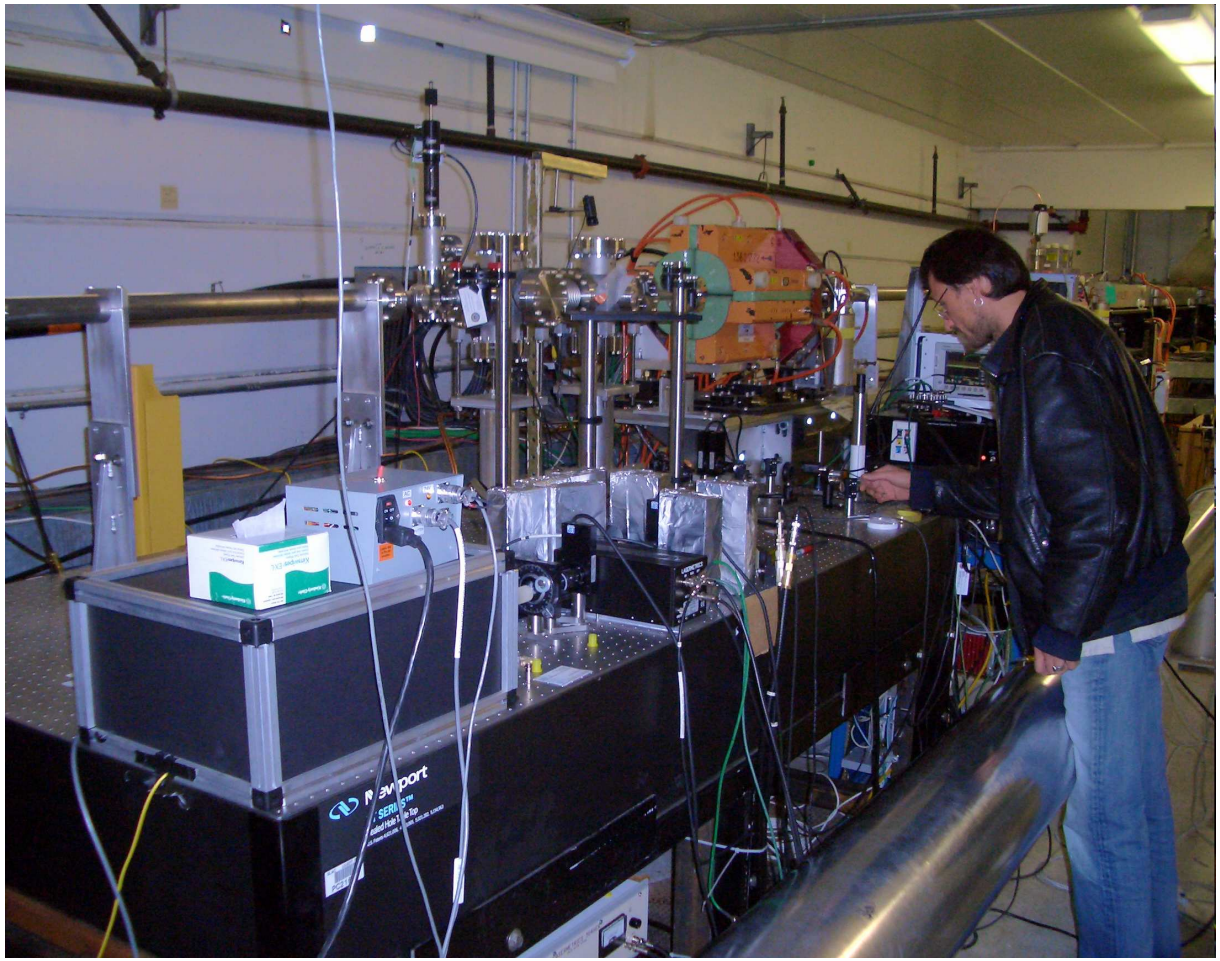
- To compensate for the chirp of the fiber, the pulse is chirped prior to the transport



Experimental Setup

Setup in the SPPS

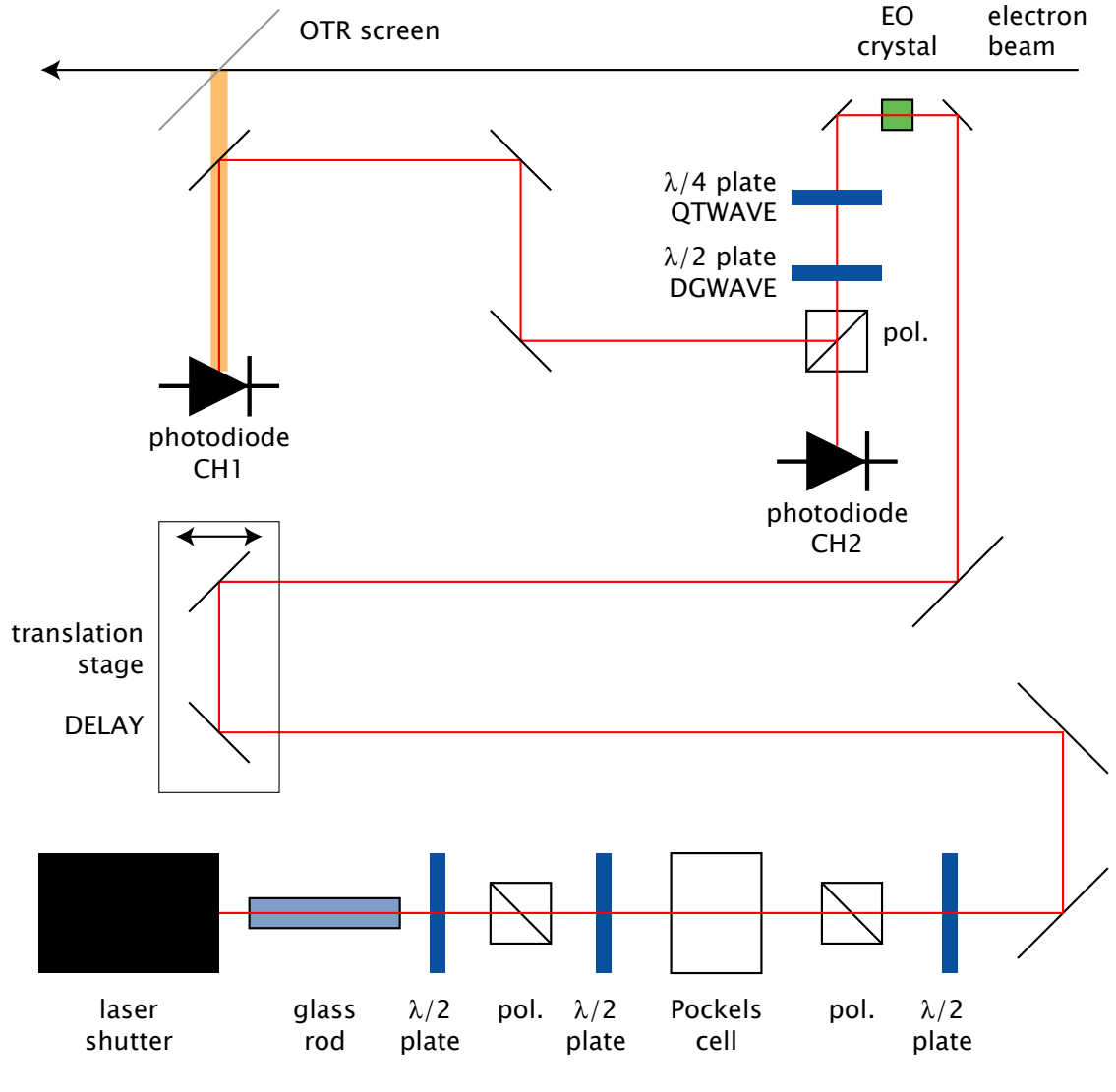
- Setup is installed on an optical table inside the accelerator tunnel



Experimental Setup

Setup in the SPPS

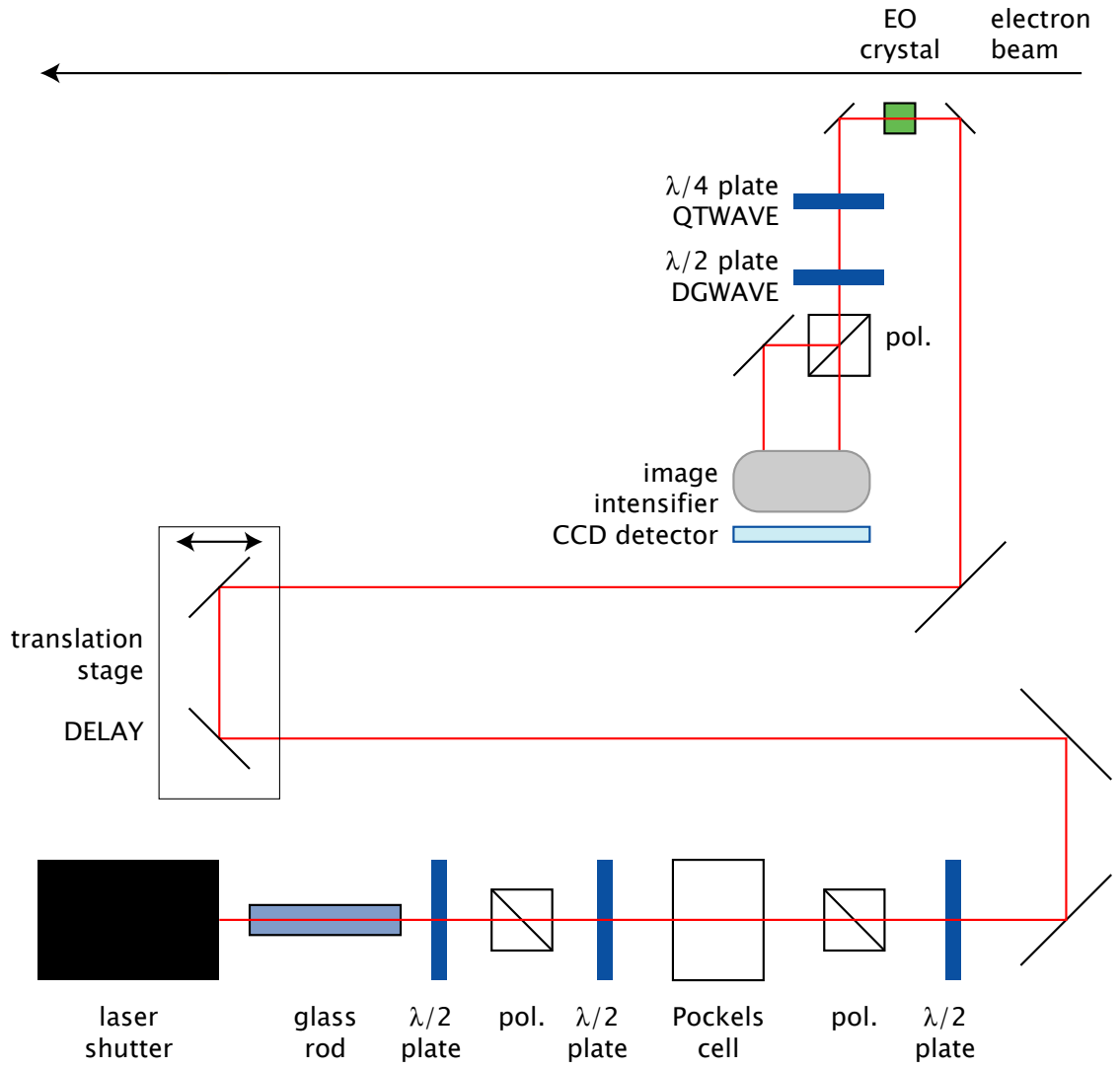
- Beam preparation
- translation stage
- crystal in vacuum
- detectors



Experimental Setup

Setup with Intensified Camera

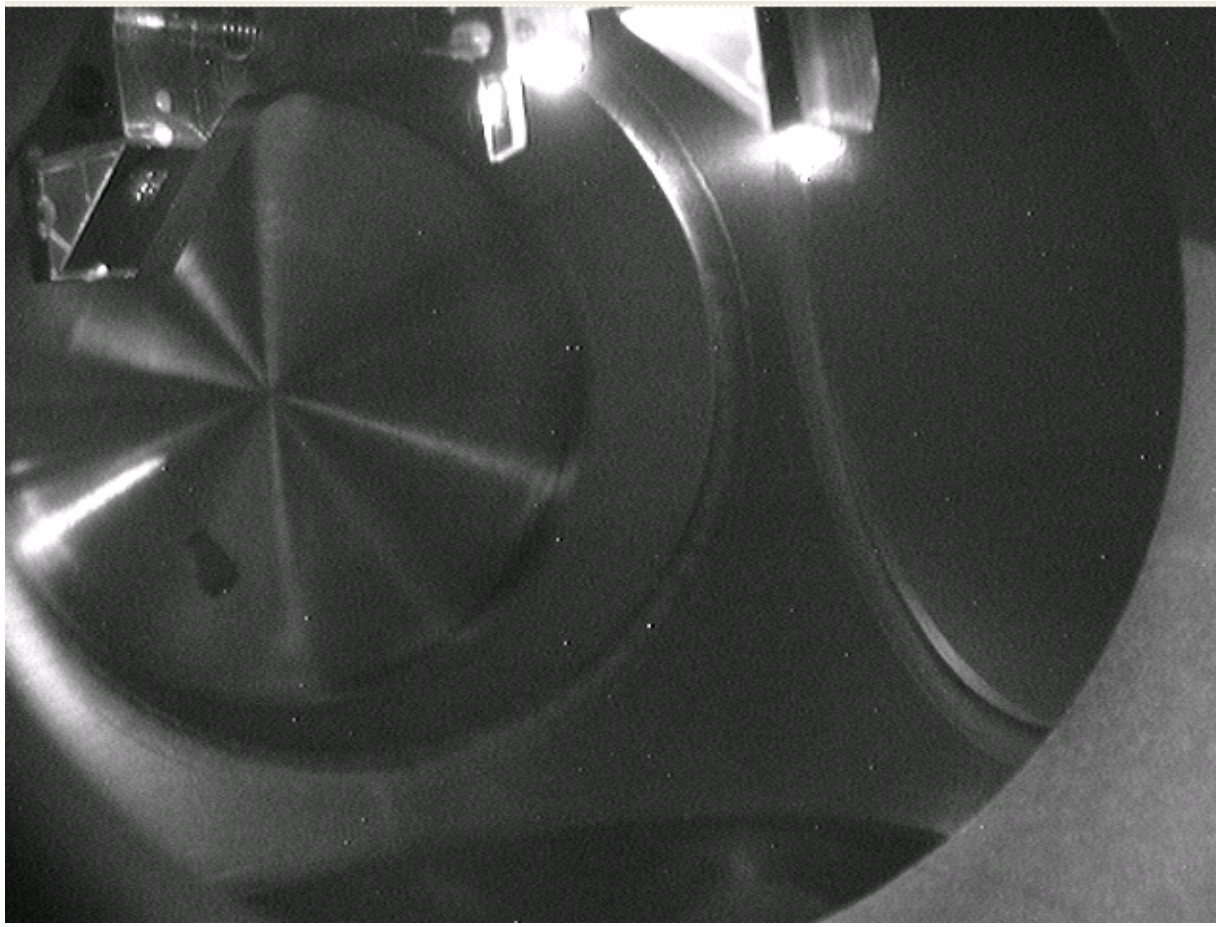
- Both polarizations are detected on the same CCD chip



Experimental Setup

Crystal

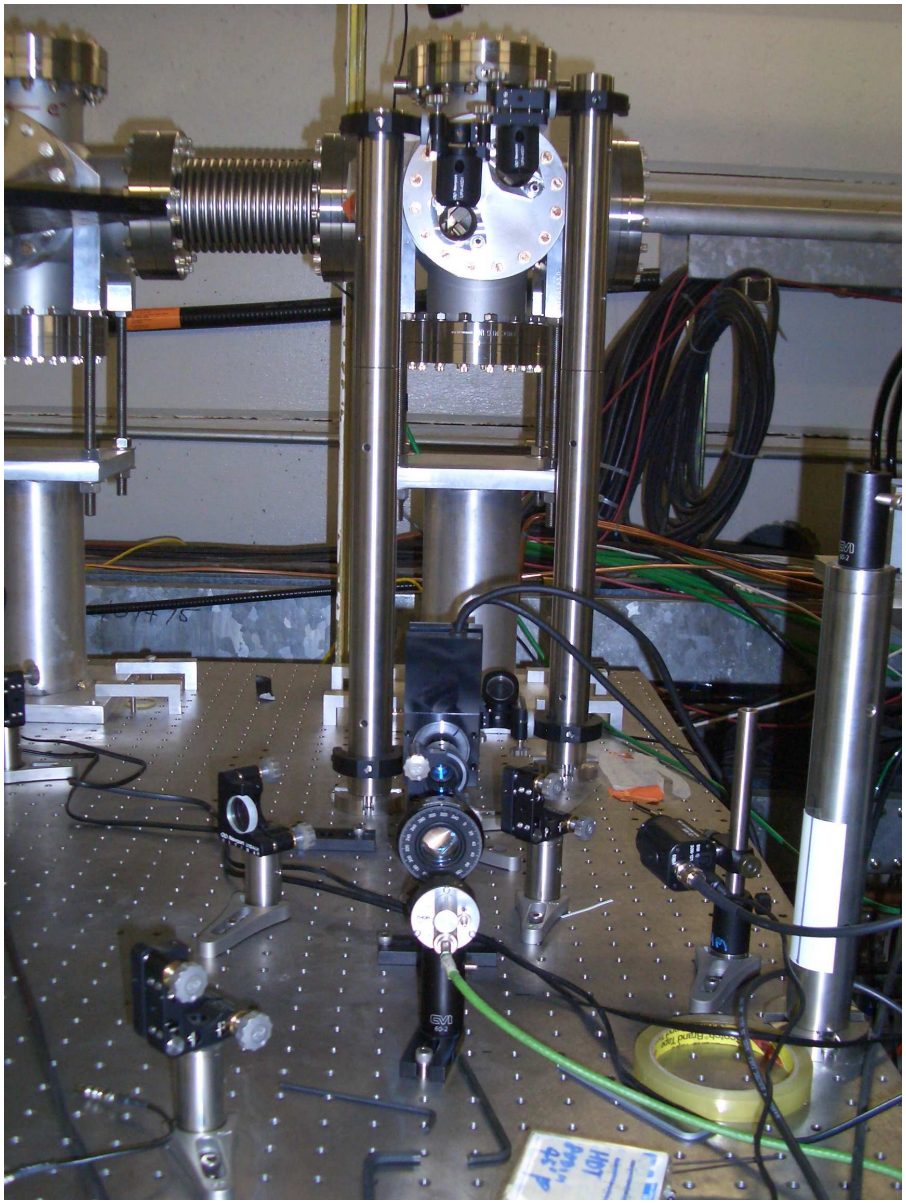
- Zinc telluride (ZnTe), 1mm thickness
- The laser passes the crystal at an angle of 45°



Experimental Setup

Crystal

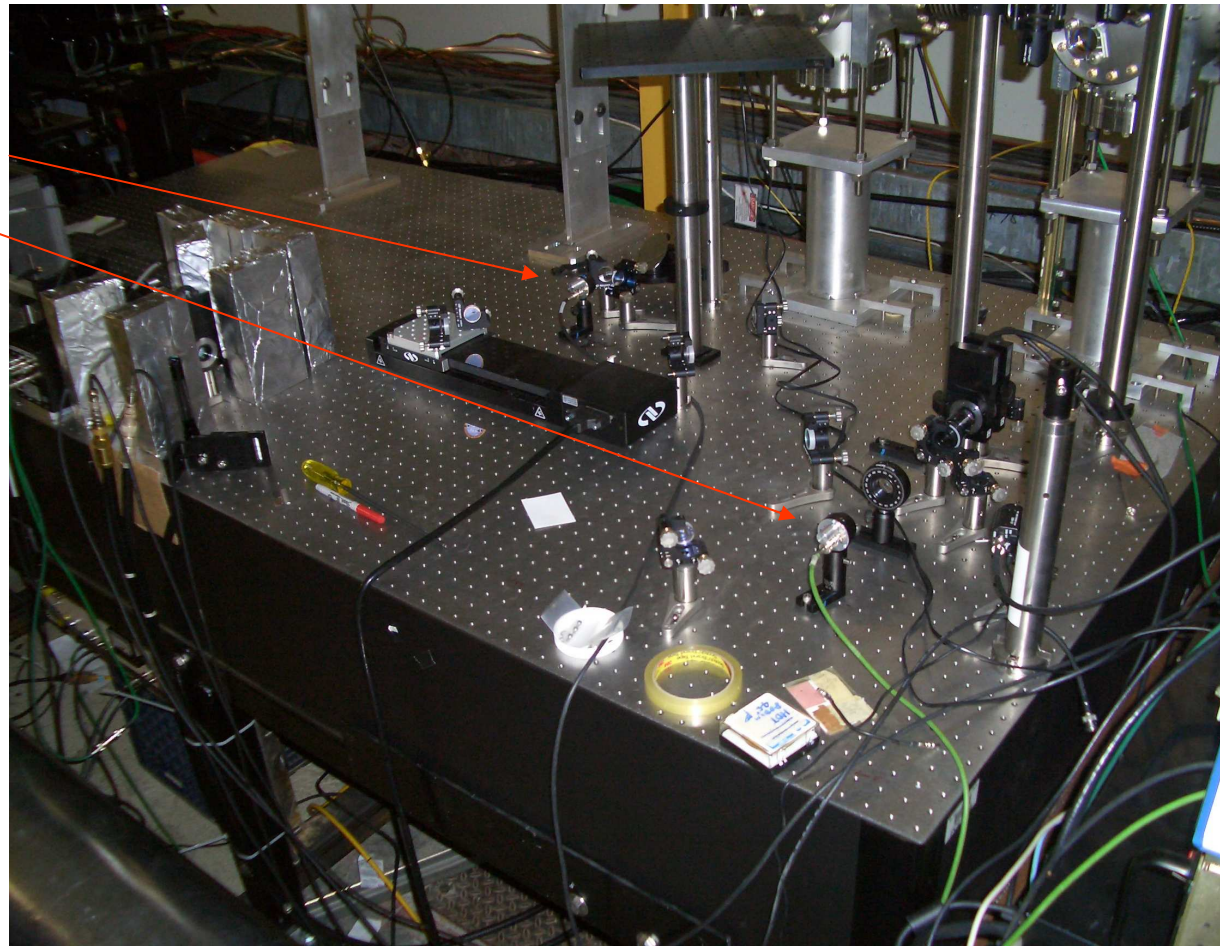
- Periscope to raise the laser to the height of the beam tube



Experimental Setup

Detectors: photodiodes

- 1 GHz bandwidth
- Two detectors for horizontal (P) and vertical (S) polarization
- The coarse timing is adjusted with the P photodiode

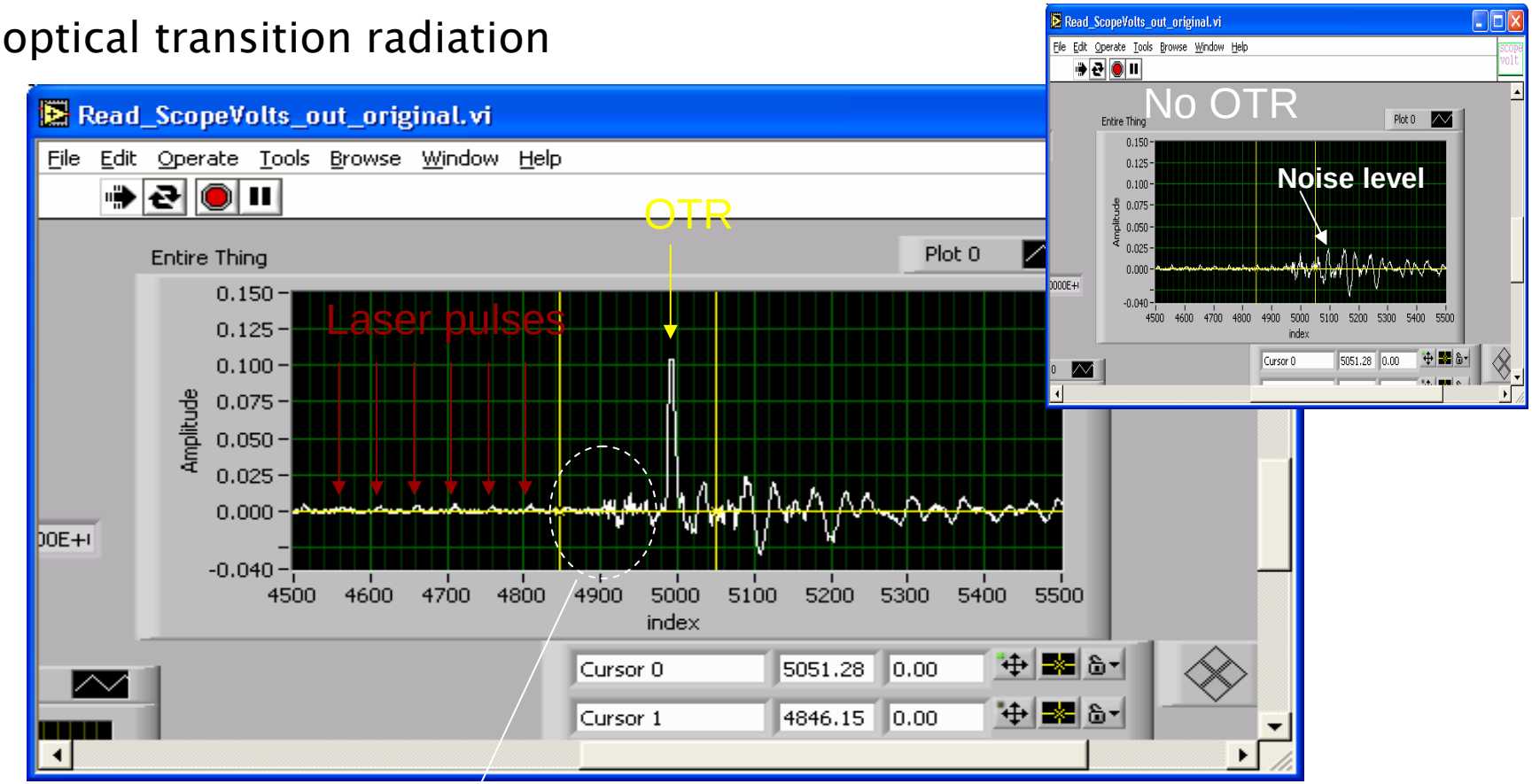


Experimental Setup

Adjustment with Transition Radiation

compare timing of laser with optical transition radiation

Signal vanishes when screen is removed

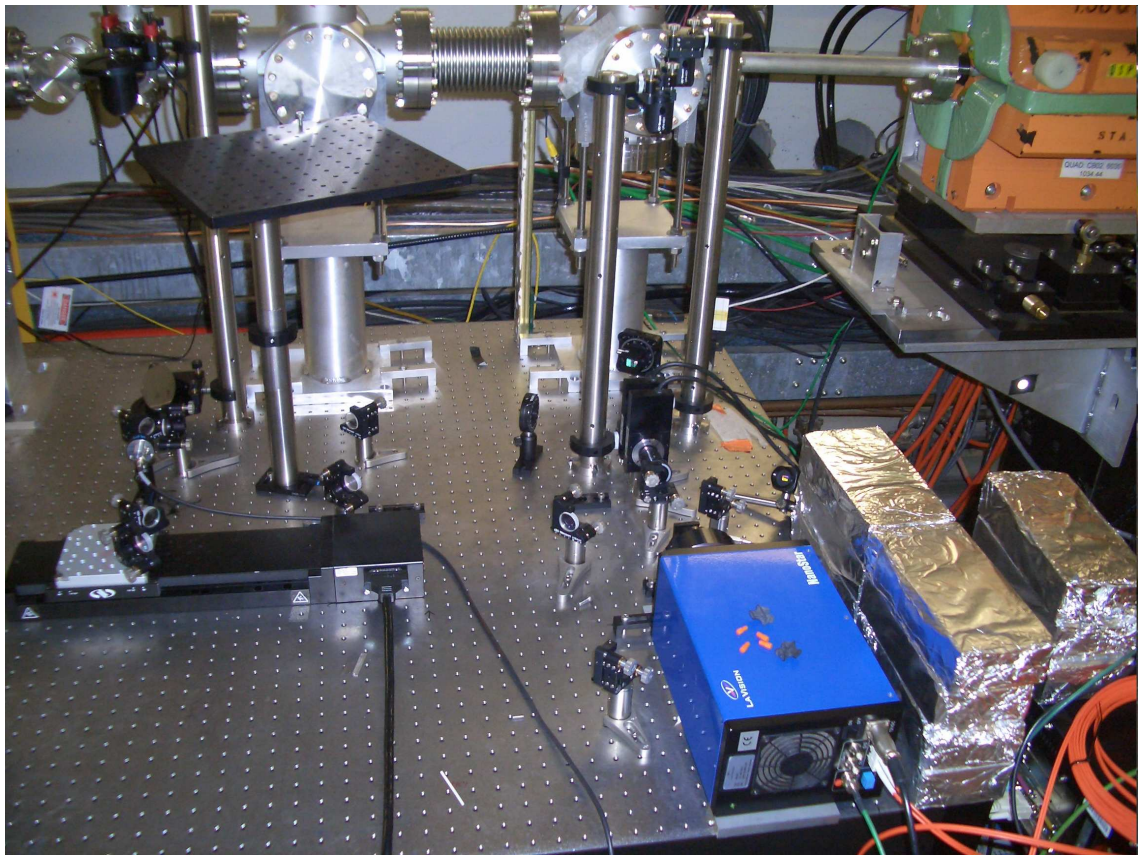


Where is this noise prior to the electrons beam coming from ???

Experimental Setup

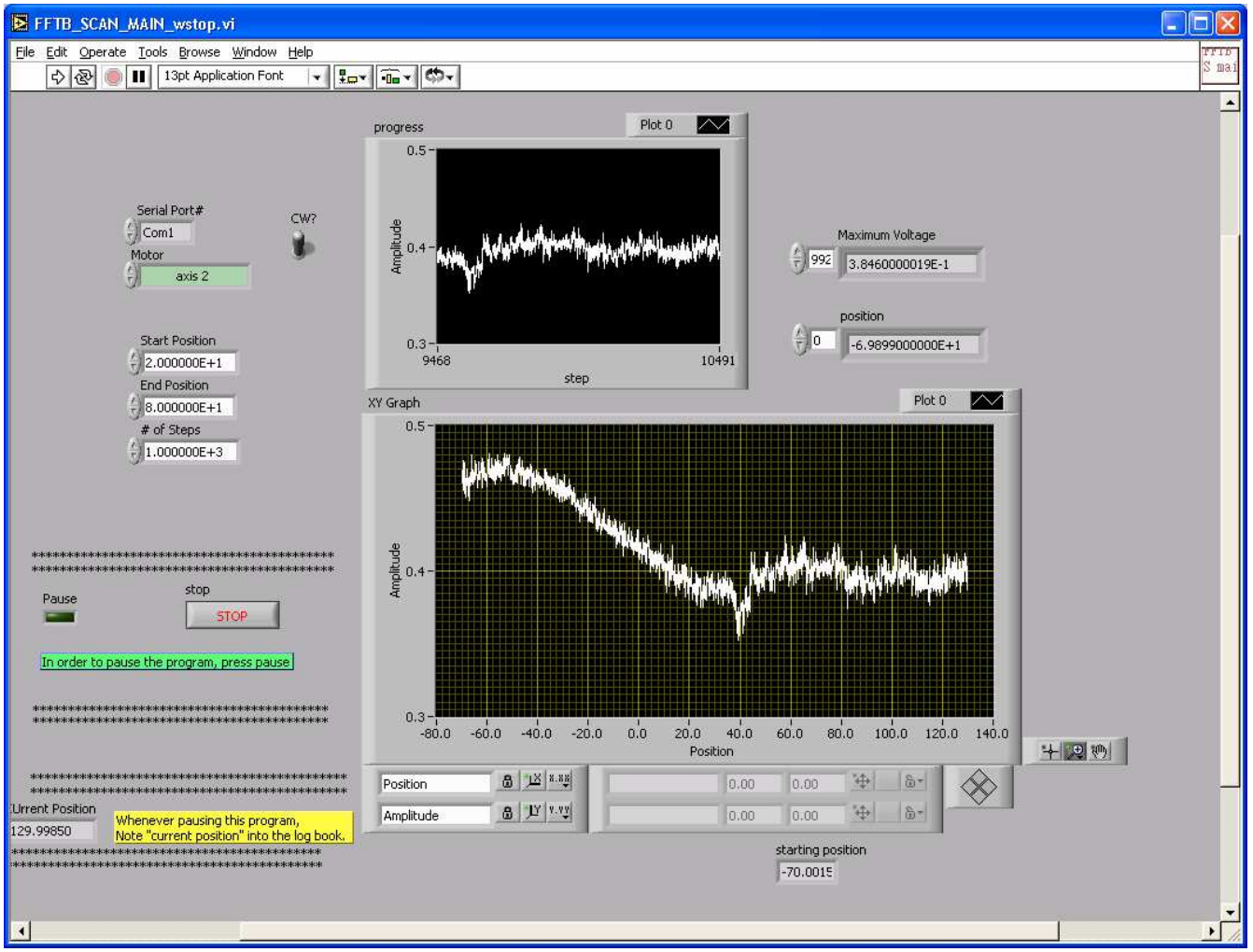
Imaging of the Crystal

- After the passage of the crystal, the beam is imaged onto an intensified CCD camera



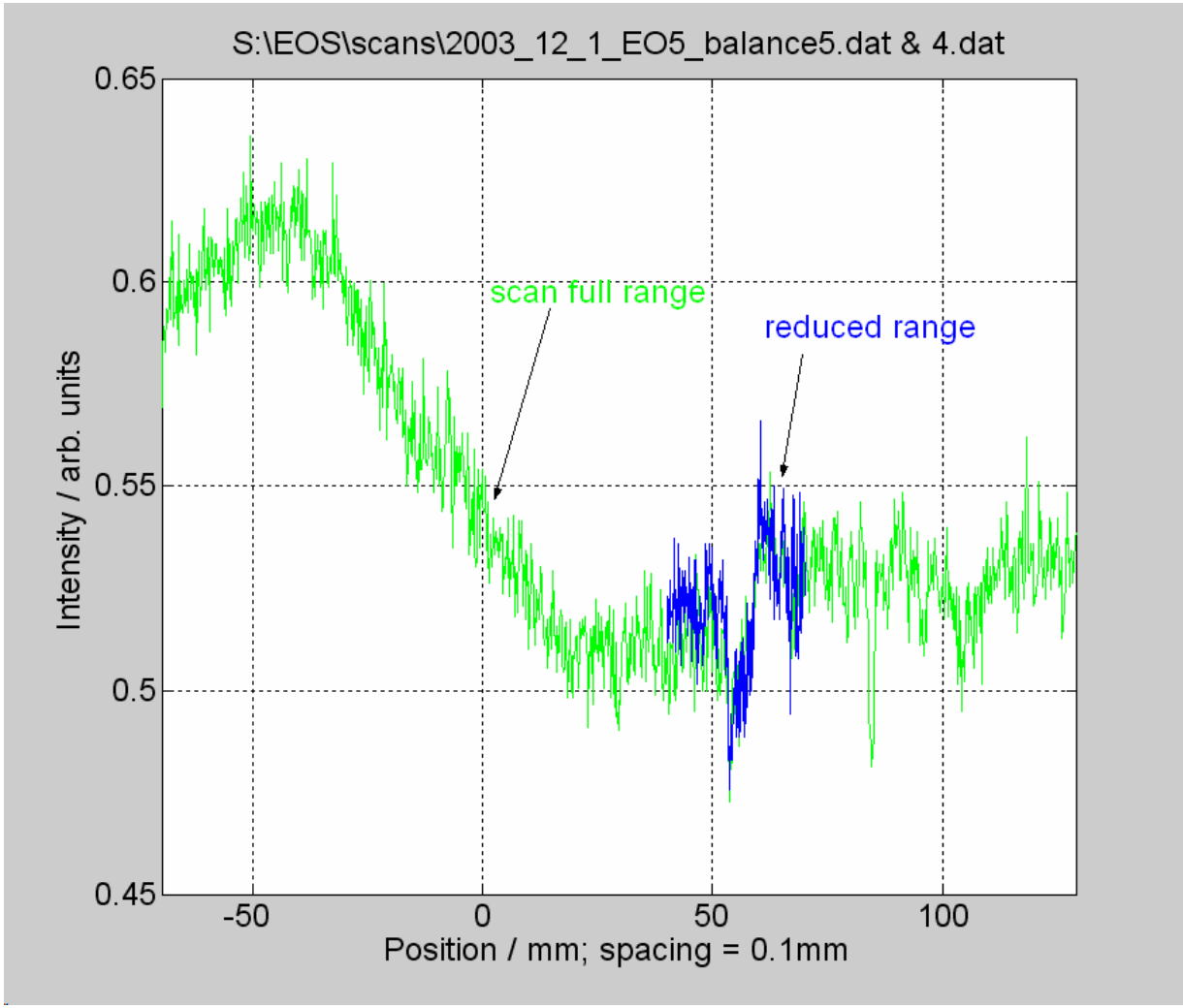
First results

First signals

- 

First results

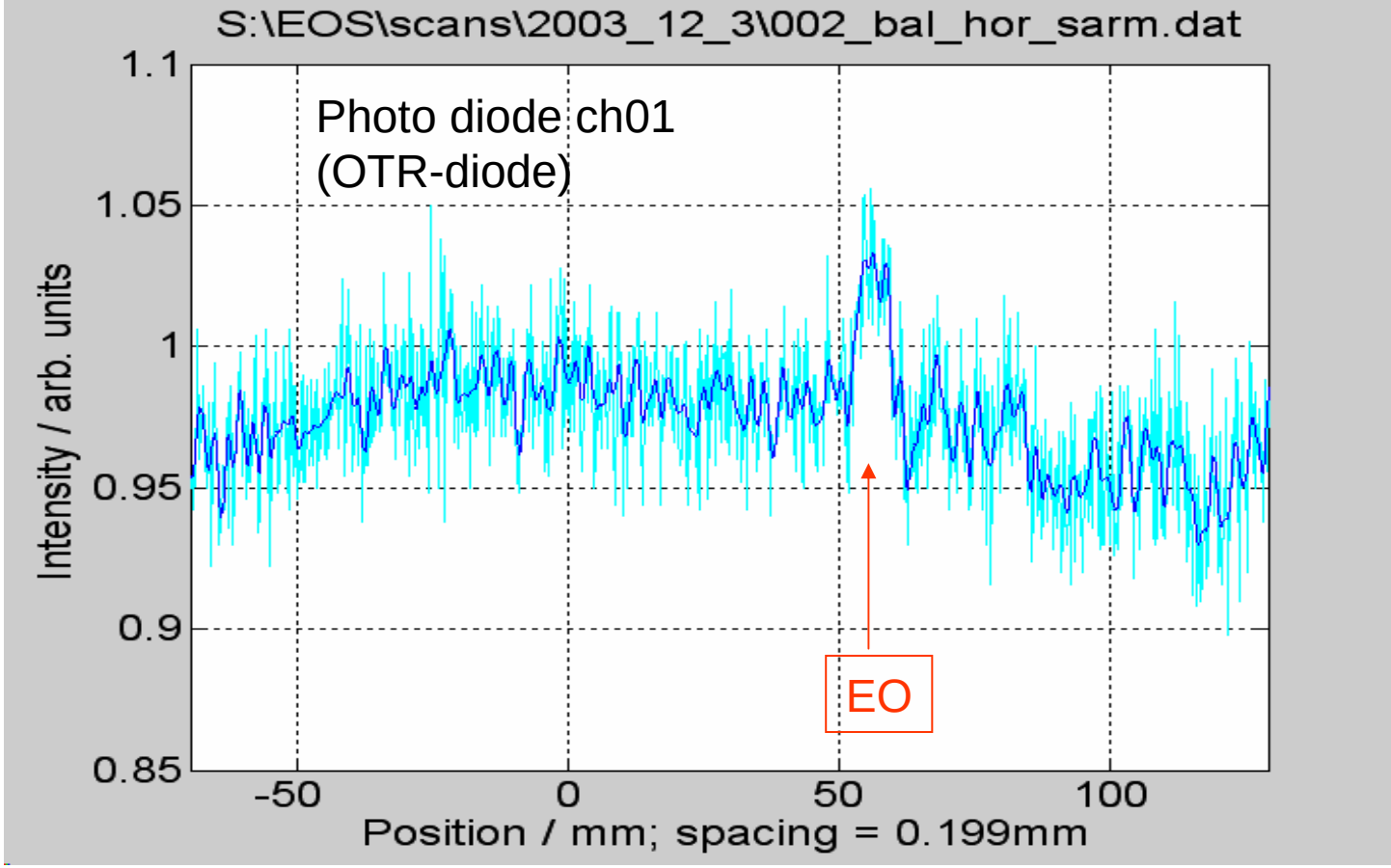
Confirmed by Second Measurement



First results

Signal on the Two Photodiodes

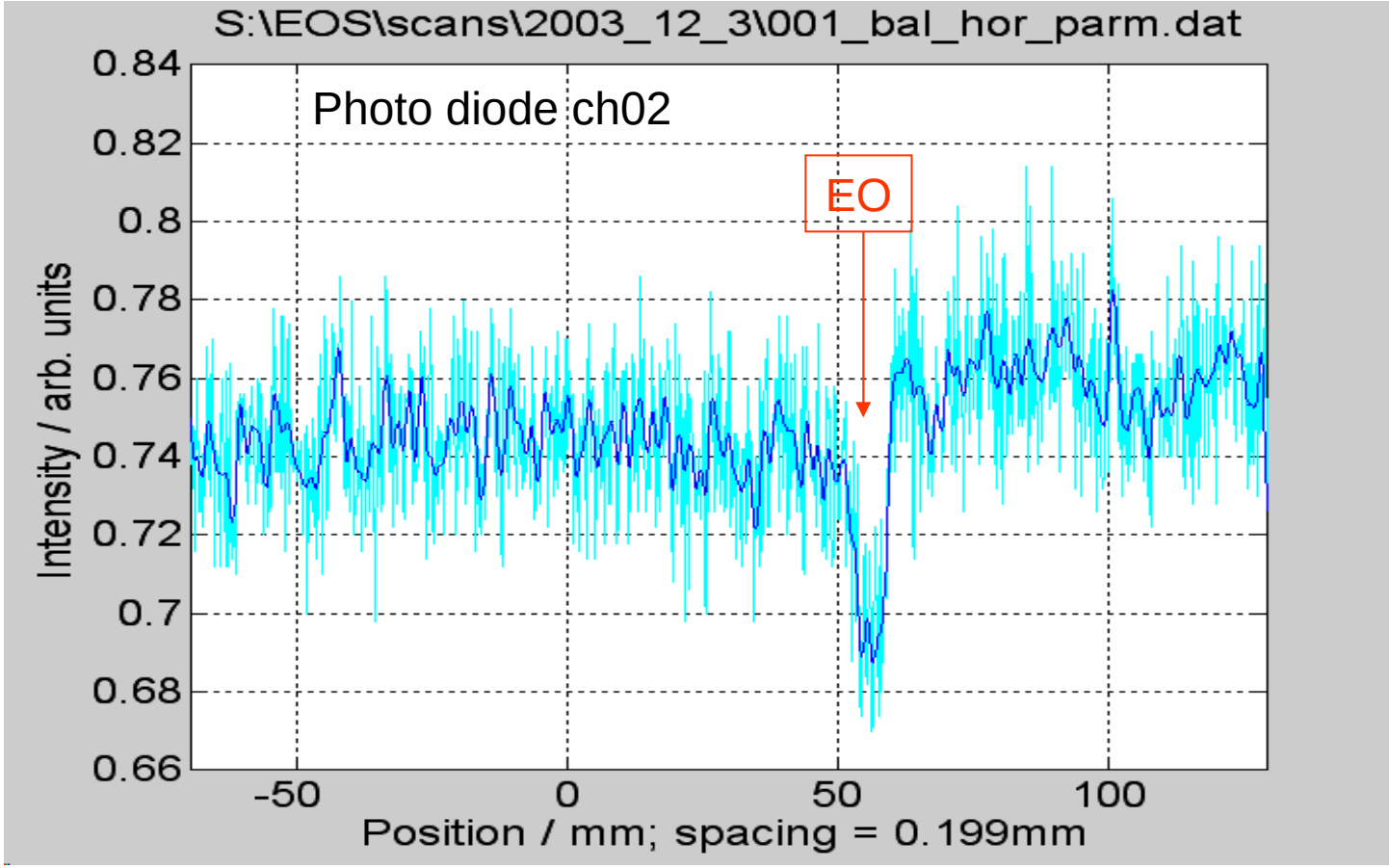
Observe an increase in the P polarization



First results

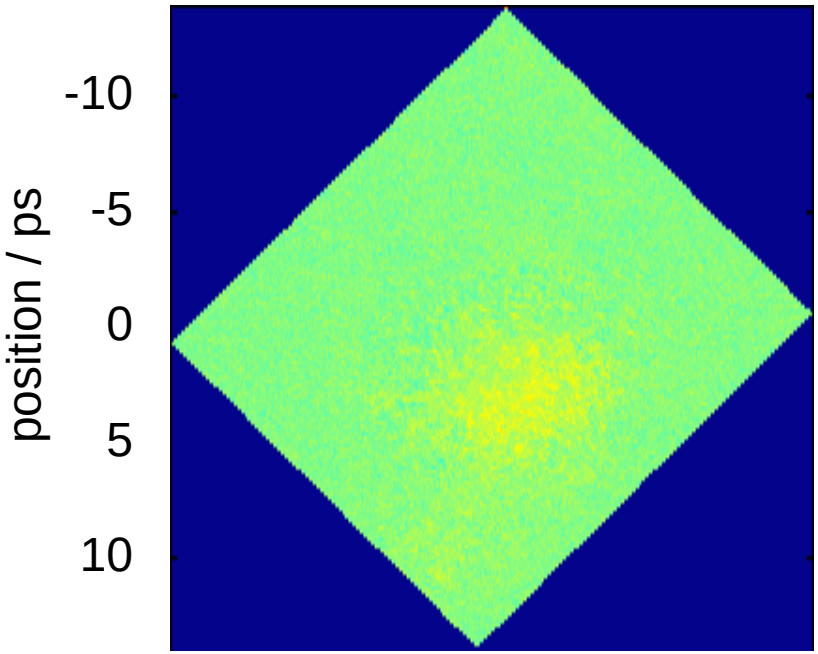
Signal on the Two Photodiodes

… and a decrease in the S polarization



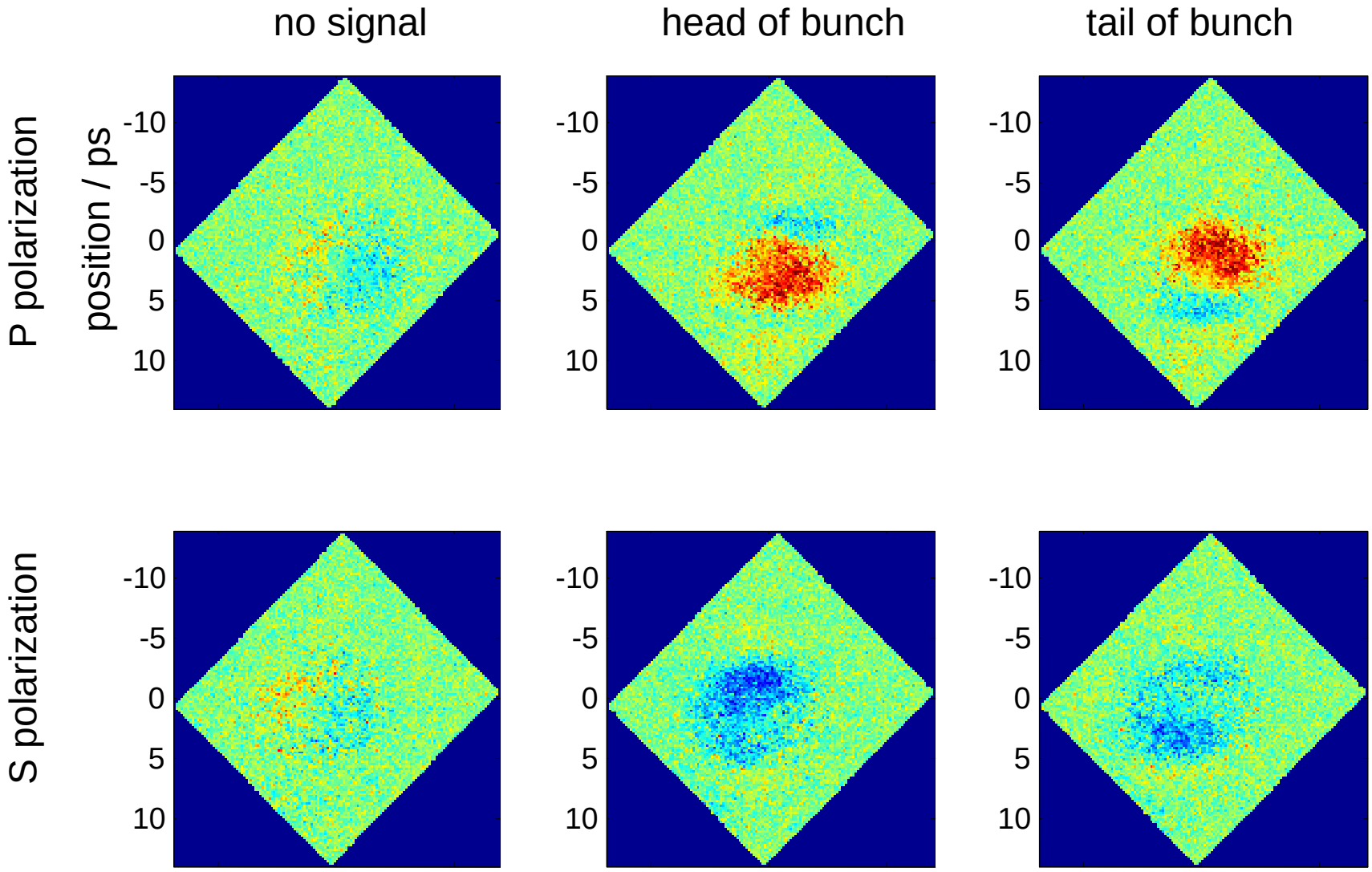
First results

Signal on the Camera



First results

Signal on the Camera



First results

Signal on the Camera