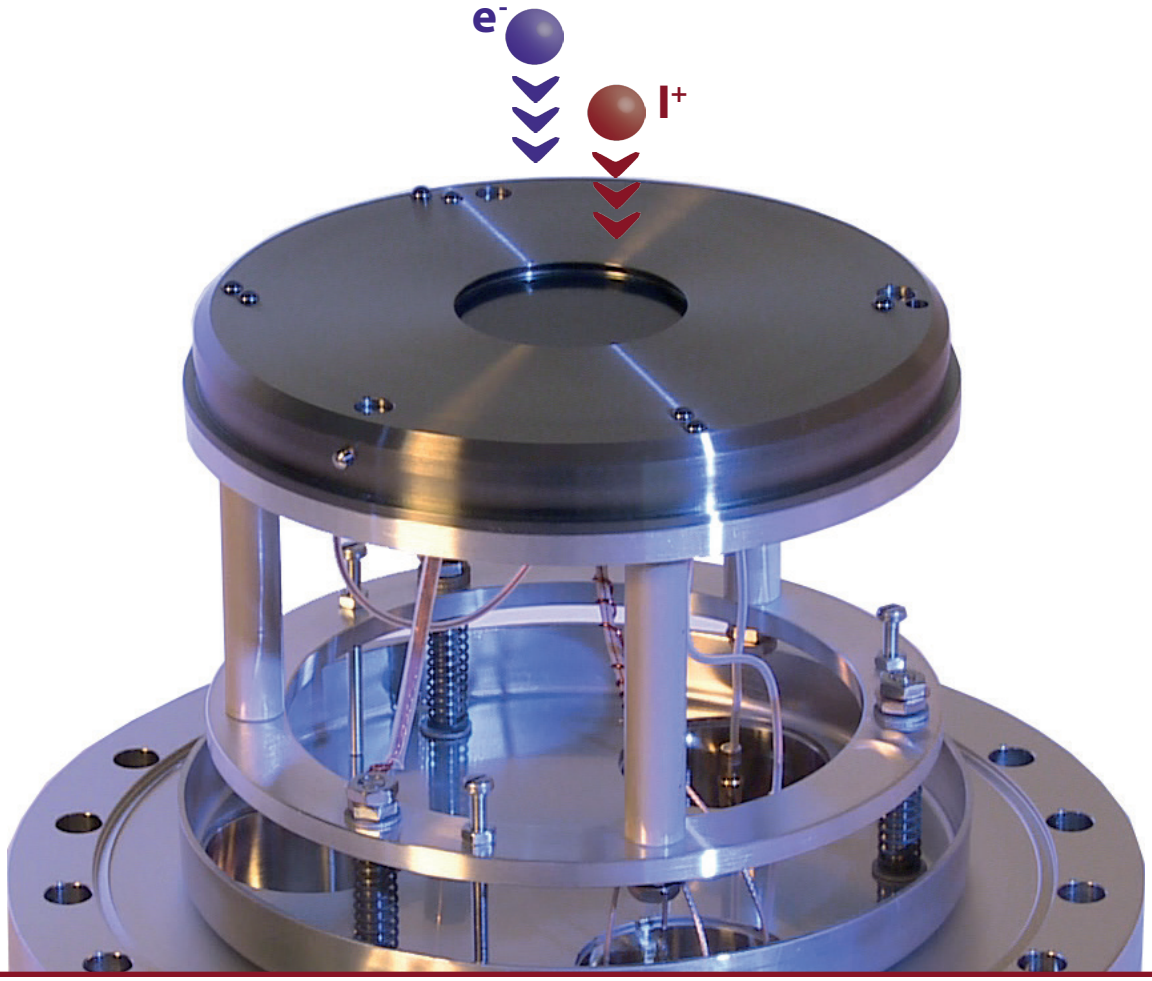
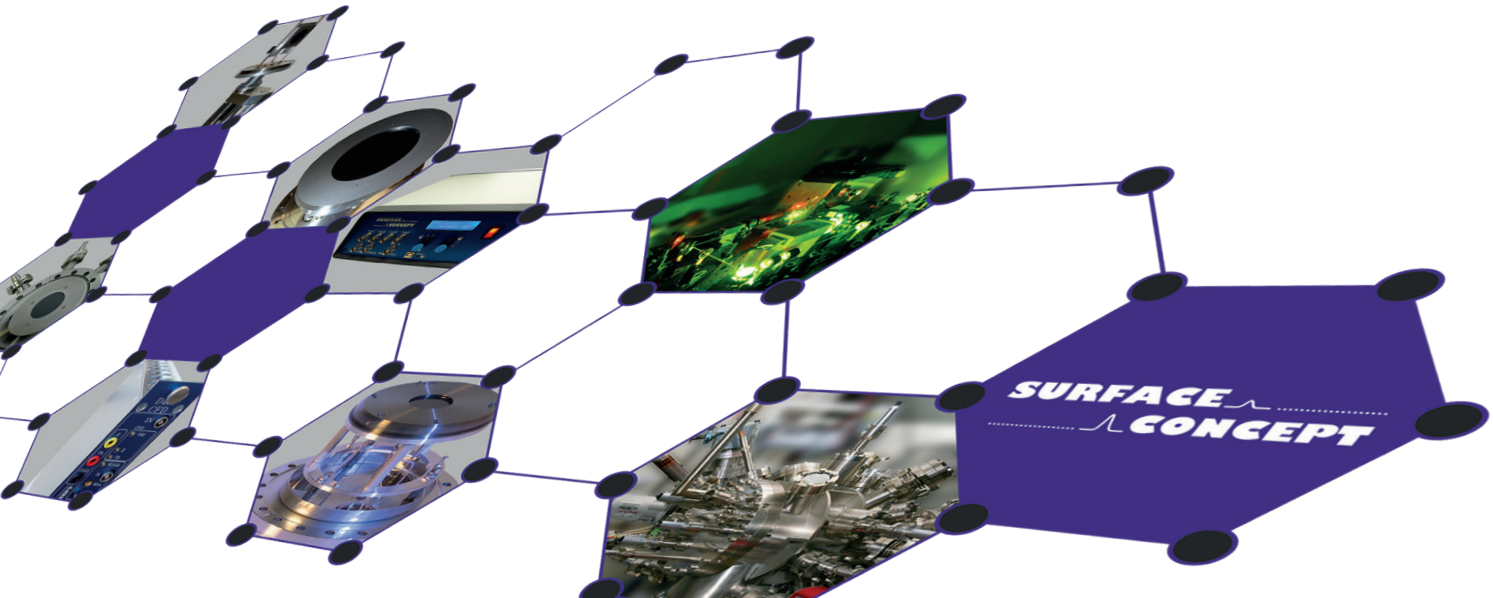
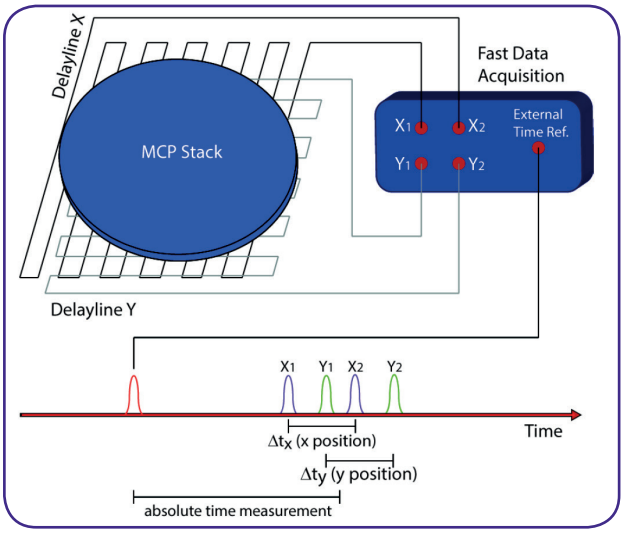
# Delayline Detectors

## Imaging Detection of Electrons, Ions & Photons with Picosecond Time Resolution



# Delayline Readout of MCPs
# - The Technical Approach -




Operation principle of a DLD based on local multiplication of electrons in an MCP stack triggered by an impacting particle. Coupling the resulting charge cloud into an anode structure of two perpendicular delaylines enables the measurement of impact position and time of the primary particle by determining the arrival times of the pulses at the four ends of the delaylines.

Microchannel-Plate (MCP) detectors provide highest perfomance in imaging of electrons, ions, neutrons and photons.

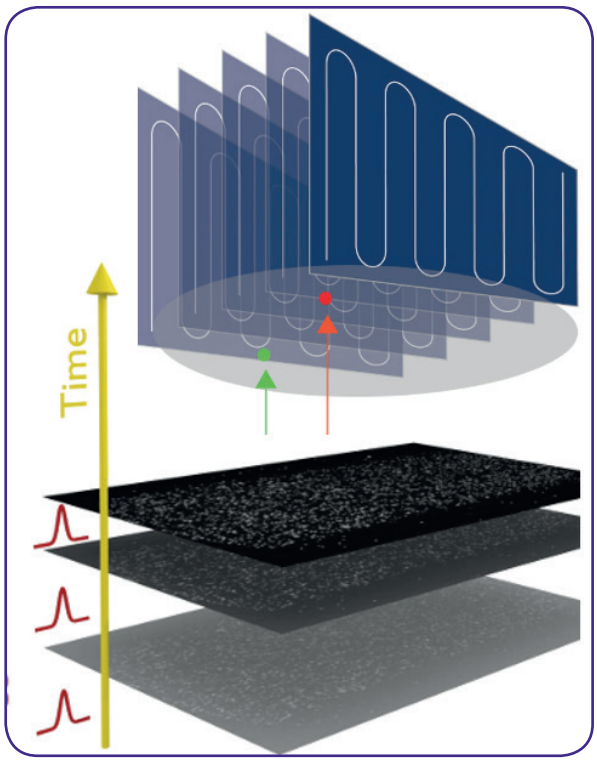
In case the application requires single event analysis, the Delayline readout of MCPs is by far the best choice as the Delayline Detector (DLD) enables **true counting with brillant signal to background ratio**. Moreover it is THE imaging particle detector with the highest time resolution.

Delayline readouts are superior among all time resolving MCP readout systems because they deliver time slice images with time windowing down to below 100 ps with highest intensity linearity.

Further new concepts with massively **increased Multi-Hit capability** are available. (See figure below)

## Key Features

| | |
|---|---|
| Active Diameters | 10mm - 150mm |
| Lateral Resolution | down to 30µm |
| Max. Imaging Countrate | > 8 million counts/s |
| Max. Burst Rate | 100 million counts/s |
| Multi-Hit Designs | > 10 hits |
| Time Bin Resolution | 6.8ps |
| Typical Time Resolution (Position Integrated) | < 200ps |
| Start Repetition Rate | max. 9MHz |
| Standard Coms | USB 2.0, USB 3.0 |



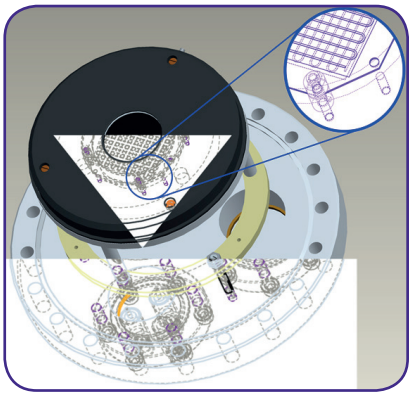

Design concepts of the Multi-Line Delayline Detector based on massive delayline parallalization.

# Speed up your application!

## Boost your detection tasks!

Whether in spectroscopy systems like XPS, microscopy like Atom Probe or in Time-of-Flight Analysis.

We offer **plug-and-play** Delayline Detector systems.

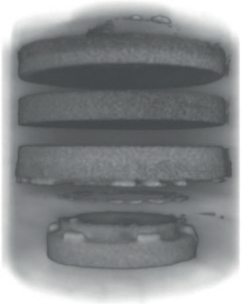


## Novel Applications of 2016

### Neutron Detection with Time Resolution

Noise free neutron cameras based on neutron sensitive MCPs and Delayline readout reach up to 60% QE for thermal neutrons with an extremly fast and robust imaging readout.

Imaging neutron detector with 40mm diameter.



Radiograph of a pneumatic cylinder (N. Kardjilov et al.)

| | |
|---|---|
| Active Detector Area | up to 150mm |
| Spatial Resolution | < 50 µm |
| Temporal Resolution | < 100 ns |
| Cold and Thermal Neutron Sensitivity (5 meV-25 meV) | ~ 60 % (5 meV) to ~ 45 % (25meV) |
| Background | < 1 ct/s/cm2 |

### Transmission Electron Microscopy goes ultra-fast scanning

There is no other TEM detector with comparable **low noise** levels. The typical noise event rates are 5-10 events per second for the entire detector area. The detector is well suited for all applications which require **low dose** due to sensitive samples and very fast time correlated imaging like in STEM diffraction setups (e.g. strain measurements).

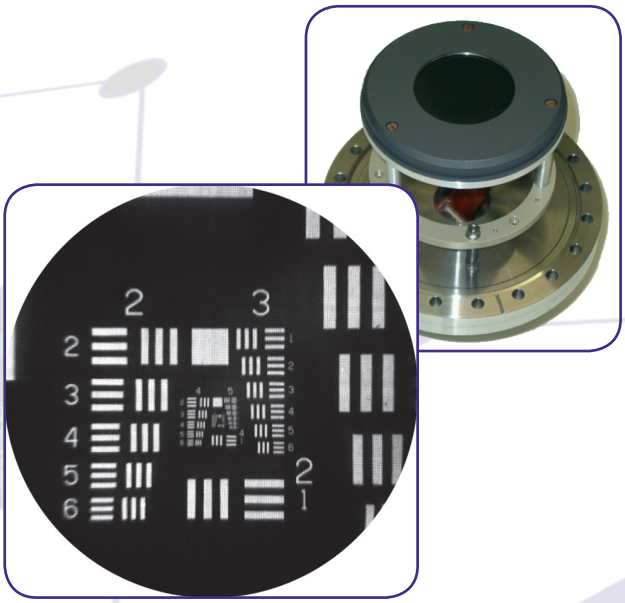
Up to millions of raster positions with diffraction imaging are feasible **without any dead time** and step times down below 1 ms. Delayline Detectors can be used to acquire ultrafast 4D data sets in STEM.

Setup of a STEM Delayline Detector.

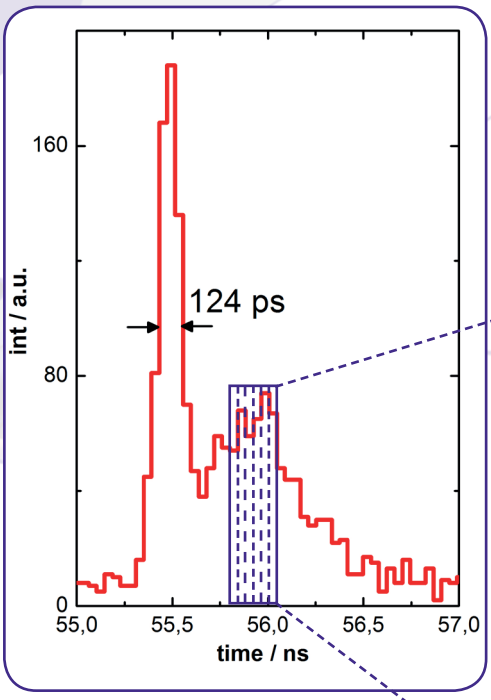
# 3D Detector Systems
# - Imaging Detectors with Time Resolution -

**Boost your particle analysis** to a new level of high speed measurement. Delayline Detectors are superior particle imagers with excellent temporal resolution, very fast sampling (up to several 10MHz), and 1D/2D/3D histogramming on the fly.

Anyone who aims for **dead time free data streaming** will largely benefit of the use of our multidimensional detector layouts.



Imaging of a UV-irradiated USAF 1951 type mask with a 40mm DLD.



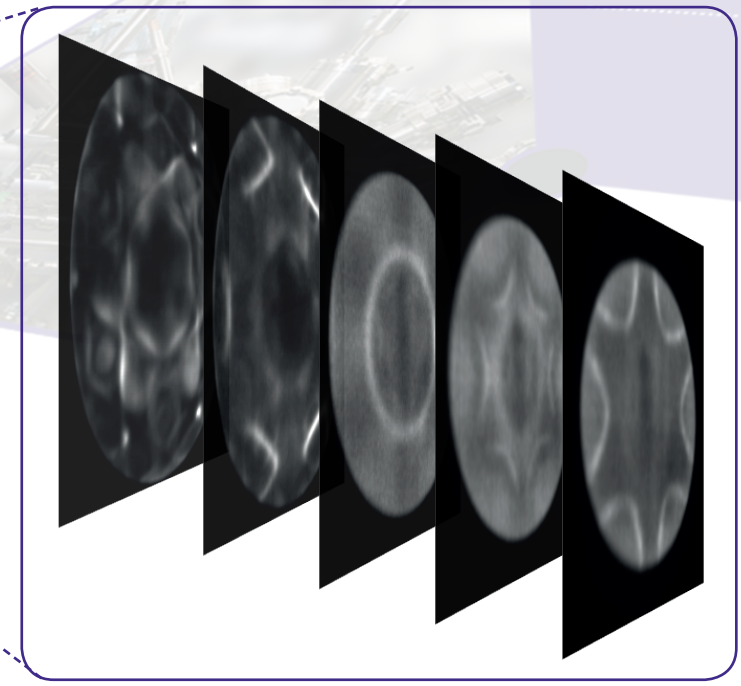
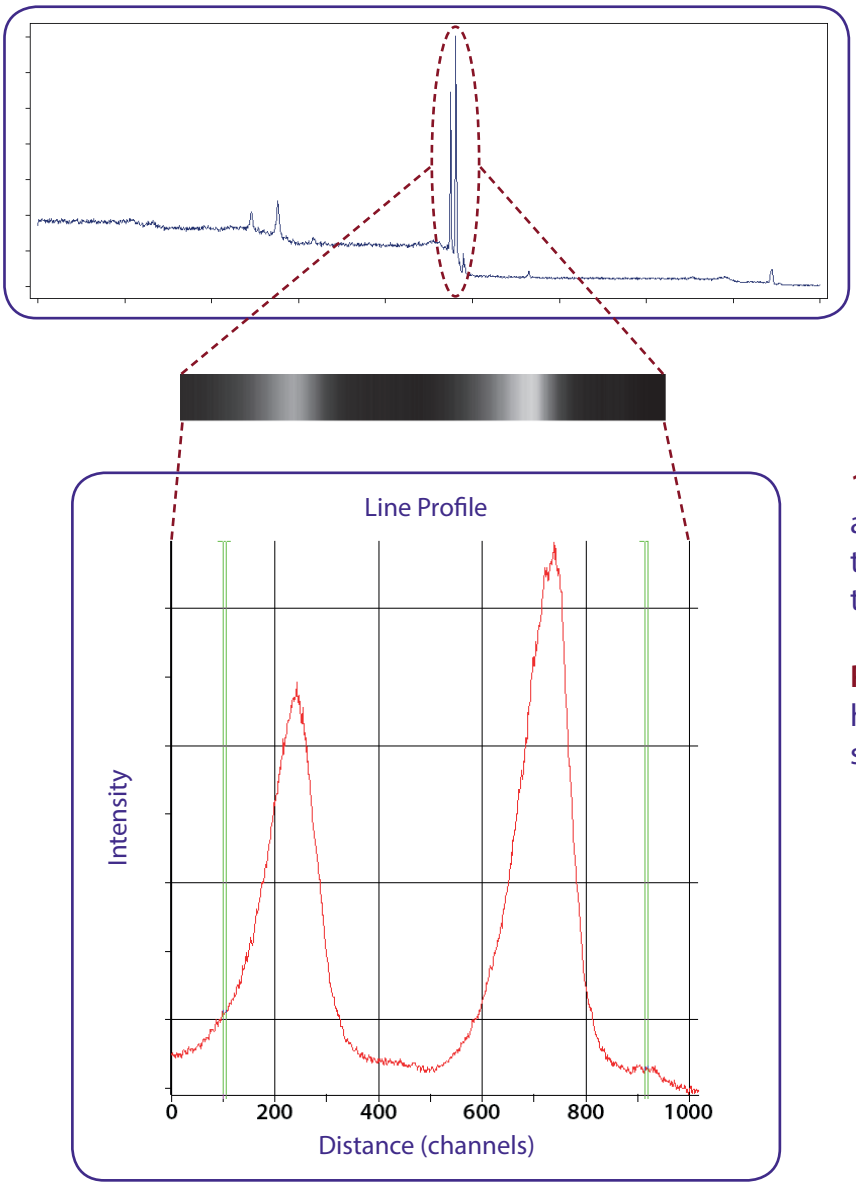



Image time slices measured with a DLD.

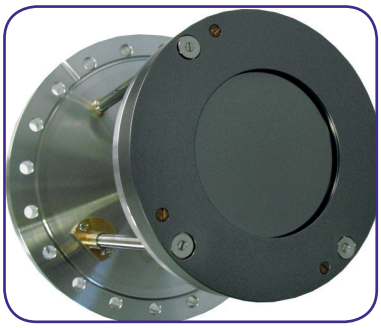
## Achieved Performance

- permanent random count rates > 5 *$10^6$ cps
- special layouts for > 20 * $10^6$ cps
- true spatial resolutions of below 40 µm for large DLDs and below 70 µm for small designs
- time slice steps of 13.7 ps with true time resolutions down to 100 ps

# 1D / 2D Detector Systems
# - Multichannel Line Detectors -



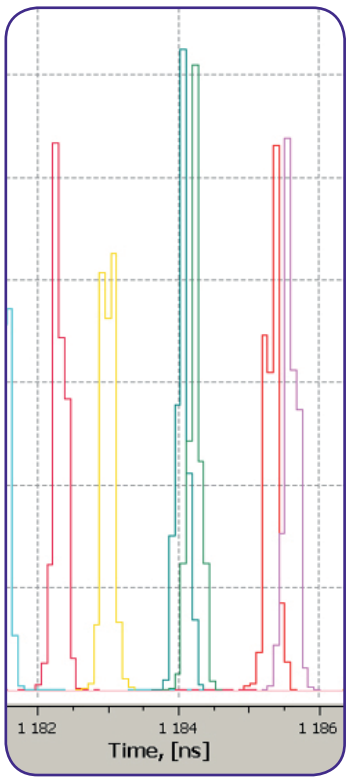

Silver 3d XPS-Spectrum measured with a 1D-DLD with 1024 channels on 64mm active area.



Imaging DLD with time resolution and 80mm active area.

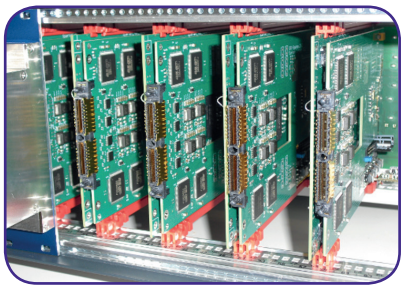
**1D** and **2D** imaging Delayline Detectors are well suited for a variety of applications like XPS that require superior signal to noise ratio and imaging dynamics.

**Permanent data streaming** allows for highspeed scanning of spectra with true single event counting.




Time resolution of the prototype is 126ps in all 128 channels.

Extensive Multi-Hit capability for novel applications like Free-Electron-Laser science is reached with the Multi-Line Delayline Detector by **massive parallel segmentation of anodes** perpendicular to the image plane.
The detector system can be easily scaled to cover all possible application requirements.



The system can be equipped with up to 16 TDC modules with 32 stop channels each.

# Applications

- Time-of-Flight Analysis of Electrons and Ions (**ToF**)
- Time Correlated or Coincidence Photon and Particle Imaging
- Gated Imaging for X-Ray and Electron Spectroscopy
- True Counting Imaging with large Areas up to 120mm Detection Size
- Electron Energy and Time-of-Flight Analyzers (**XPS**, UPS, EELS)
- Time-of-Flight Photoemission Electron Microscopy (ToF PEEM)
- Medium Energy Ion Scattering with Time-of-Flight Analysis (MEIS ToF)
- Atom Probe Tomography / Microscopy (**APT, 3D-AP**)
- X-Ray Absorption / Emission Spectroscopy (**XAS, XES**)
- X-Ray Picosecond Imaging by Means of Time Gating for Contrast Enhancement
- Fluorescence Lifetime Imaging (FLIM, FLIM-FRET)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