

Plastic Scintillators for low energy ToF measurements

Proton-recoil detectors for time-of-flight measurements of neutrons with kinetic energies from some tens of keV to a few MeV

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Neutron Detectors for nELBE

Time of flight experiments at ELBE:

- Neutron time of flight experiment:
 electron beam repetition rate/bunch length 100 kHz / 5 ps
 neutron kinetic energy range ca. 20 keV – 5 MeV

- flight path = 6.5 m
 → $\Delta t < 1$ ns required for $\Delta E/E = 1\%$

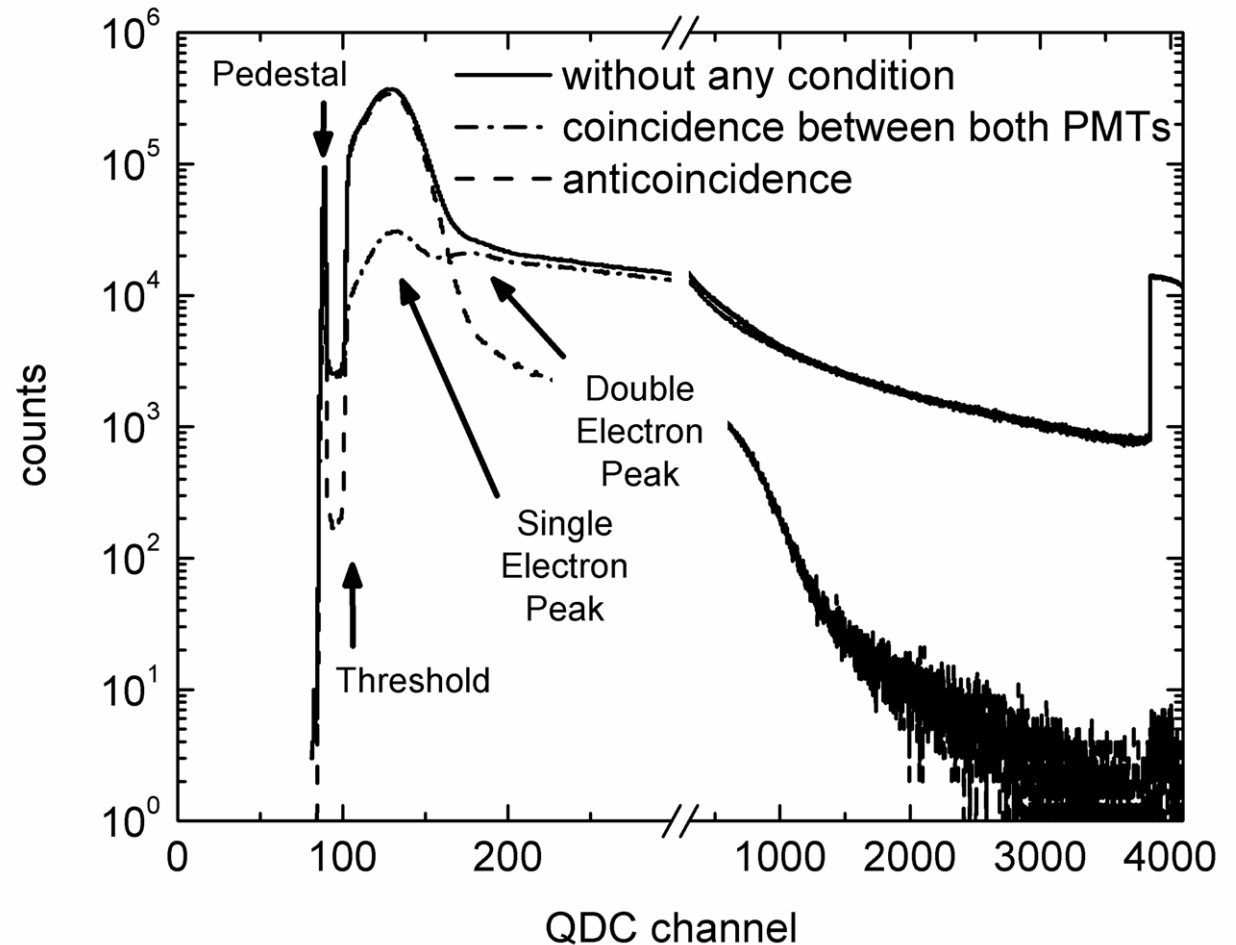
- Neutron scattering ($n, n'\gamma$)
 → high efficiency for neutron detection in the whole energy range

The Detectors



The Trigger Level

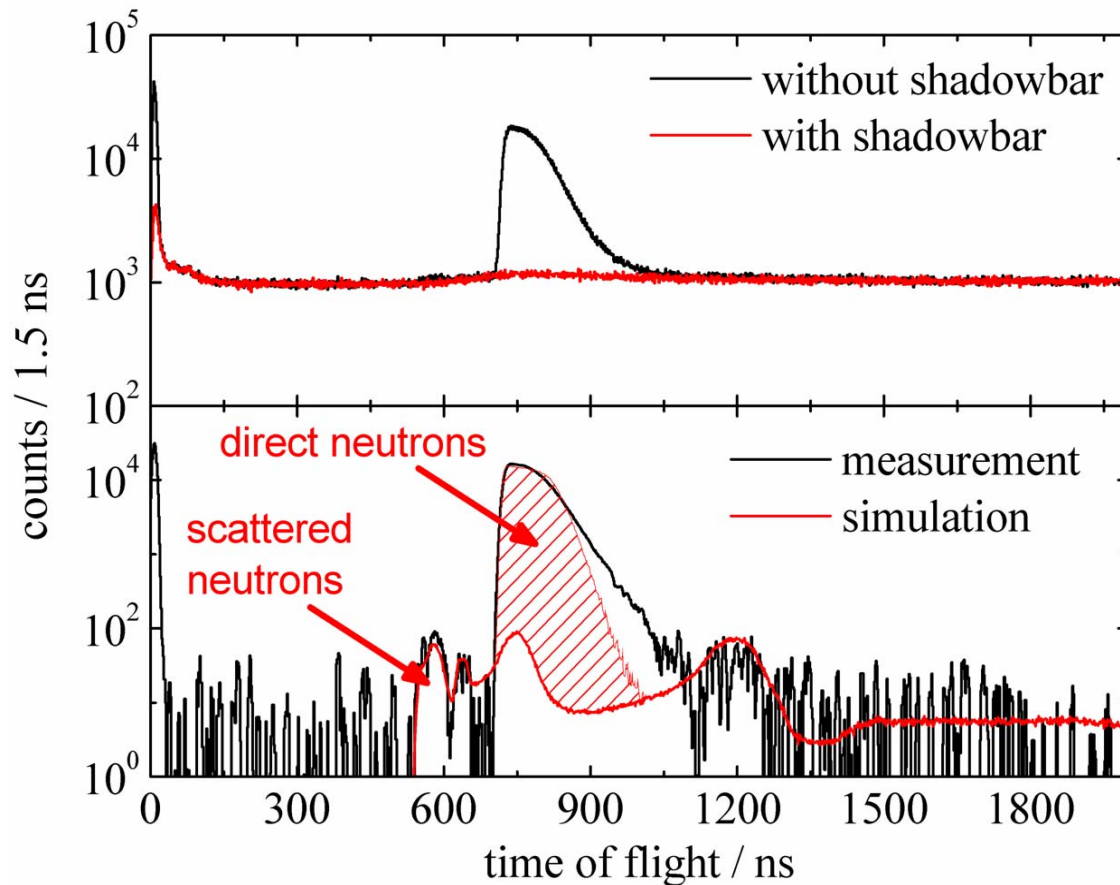
- PMTs are used in highest gain mode (approx. 2×10^7)
- CFD threshold of about 50 mV
- threshold just below the single electron peak
- maximum efficiency with minimum detection threshold
- stable and reproducible



Efficiency Calibration

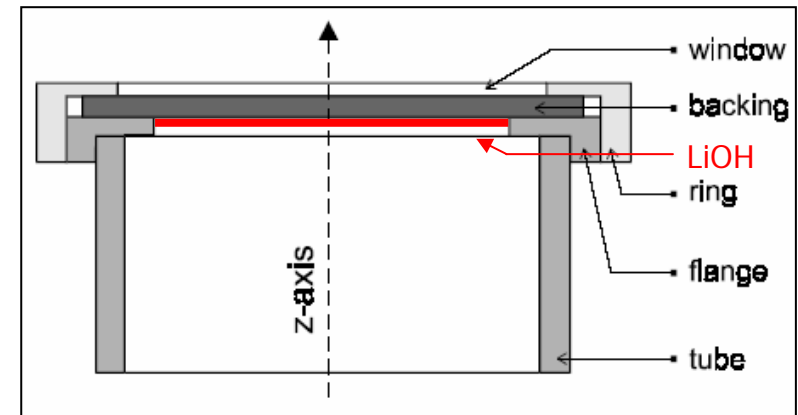
- done at Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig
- neutron production via ${}^3\text{H}(p,n){}^3\text{He}$ and ${}^7\text{Li}(p,n){}^7\text{Be}$
- pulsed proton beam for time of flight measurement
- quasi-mono-energetic neutron fields at 5 different energies:
 - 1200 keV at 0° from ${}^3\text{H}(p,n){}^3\text{He}$, $E_p = 2050$ keV
 - 560 keV at 0° from ${}^7\text{Li}(p,n){}^7\text{Be}$, $E_p = 2303$ keV
 - 150 keV at 0° from ${}^7\text{Li}(p,n){}^7\text{Be}$, $E_p = 1952$ keV
 - 73 keV at 50.5° -“-
 - 24 keV at 76.5° -“-
- well calibrated neutron monitors determine the neutron fluence

Measured ToF-Spectrum at 74 keV



400 ns → 294 keV
 800 ns → 74 keV
 1200 ns → 33 keV
 1600 ns → 18 keV

- Simulations of the neutron spectra done with TARGET (Dietrich Schlegel, PTB)
- neutron creation and transport inside the target → distribution of direct and scattered neutrons
- includes geometry of the target, proton beam, detector position, neutron cross sections

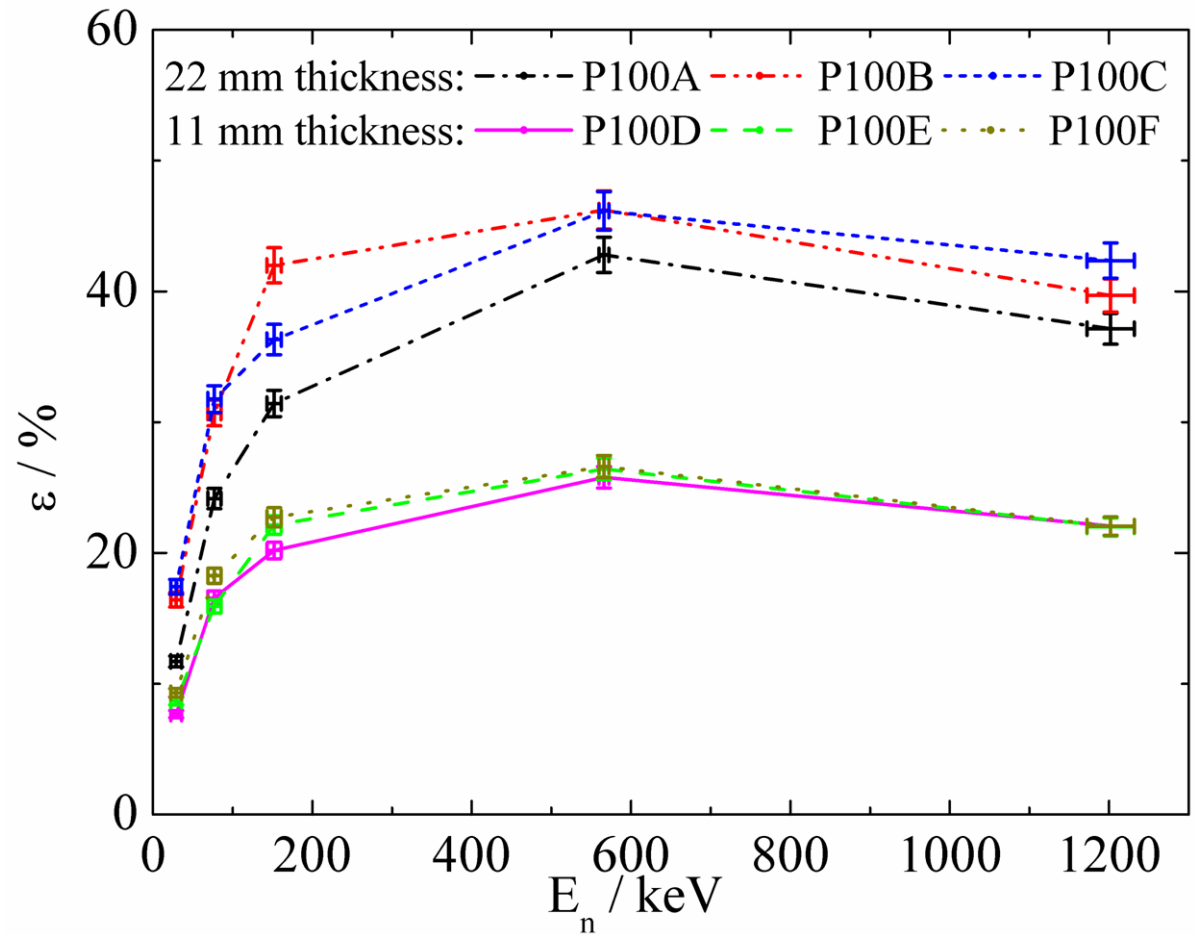


Results

E_n / keV	$\varepsilon / \%$
1202 ± 30	21.8 ± 0.7
566 ± 6	26.2 ± 0.8
152 ± 9	22.0 ± 0.7
77 ± 8	15.7 ± 0.5
29 ± 7	8.6 ± 0.3

$\Delta\varepsilon/\varepsilon \sim 3.2 \%$

→ mainly caused by uncertainties of the neutron fluence

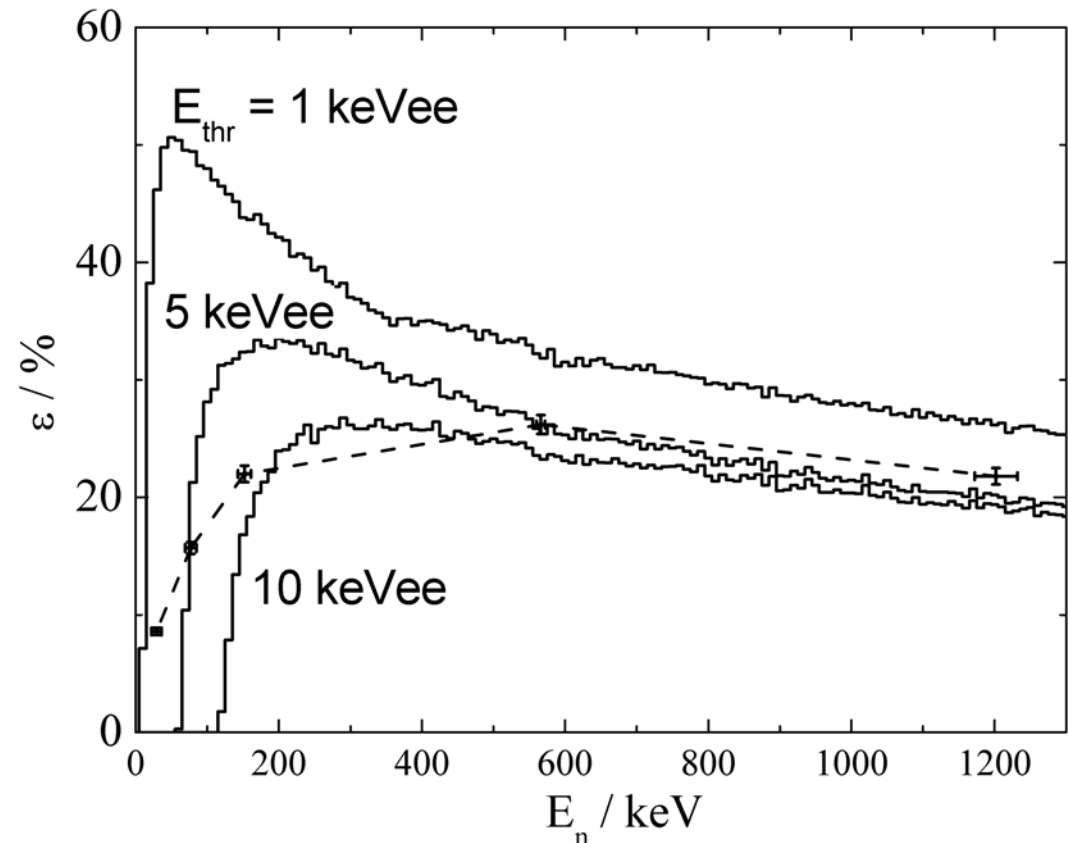


- high efficiency down to a region of some tens of keV
- quite constant above 150 keV
- good time resolution of 670 ps (FWHM)

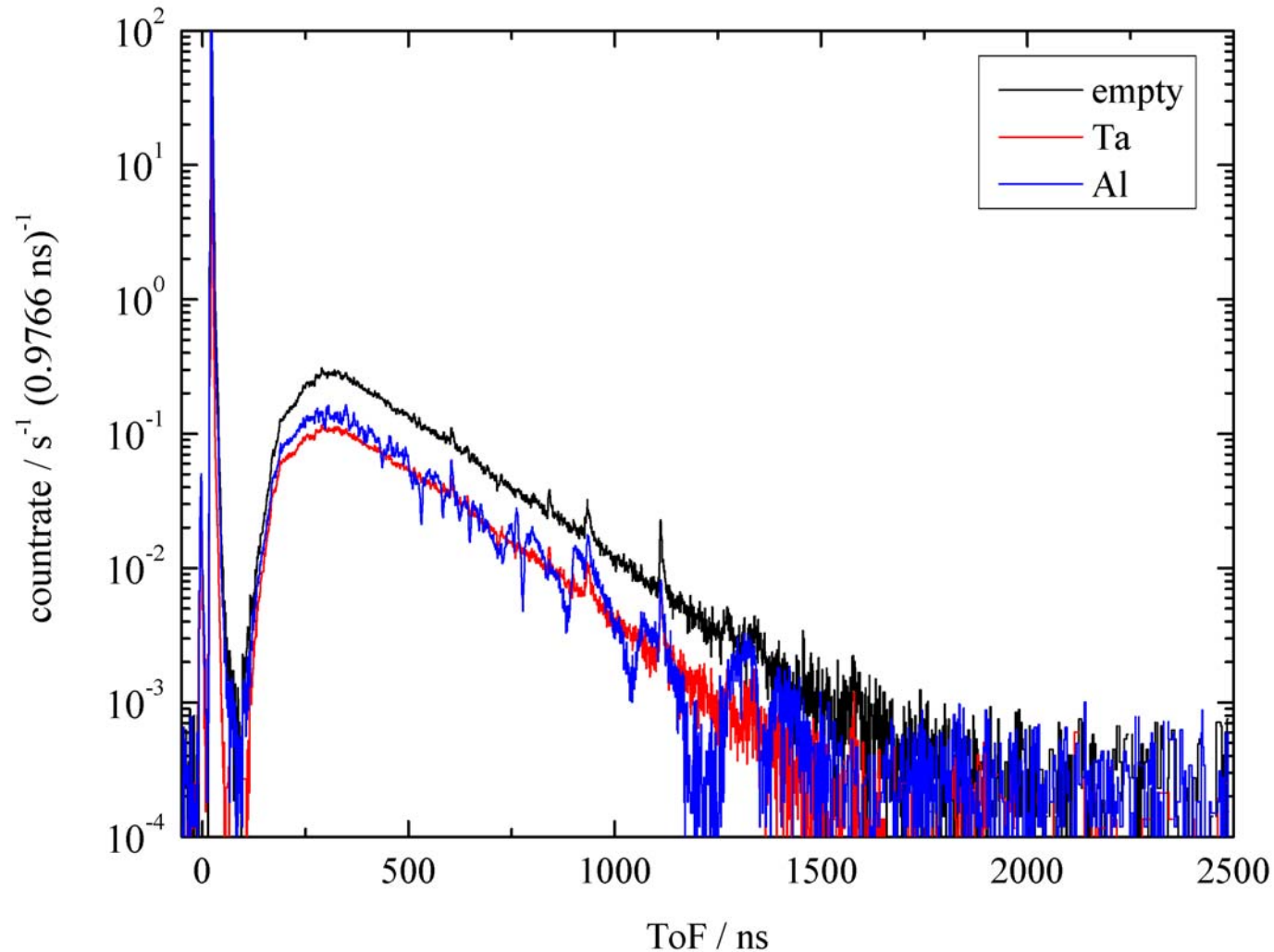
R. Beyer et al., Nucl. Instr. Meth. A 575 (2007) 449

Efficiency Simulation = Open Question

- done with NEFF7 code from PTB:
→ well-established for neutron energies above 500 keV
- discrepancies below 500 keV: simulation shows higher efficiency and sharp cut off at threshold
- may be due to unknown light output function, effects because of single electron triggering, or coincidence readout out



Measured time of flight spectra from transmission experiment on Ta and Al

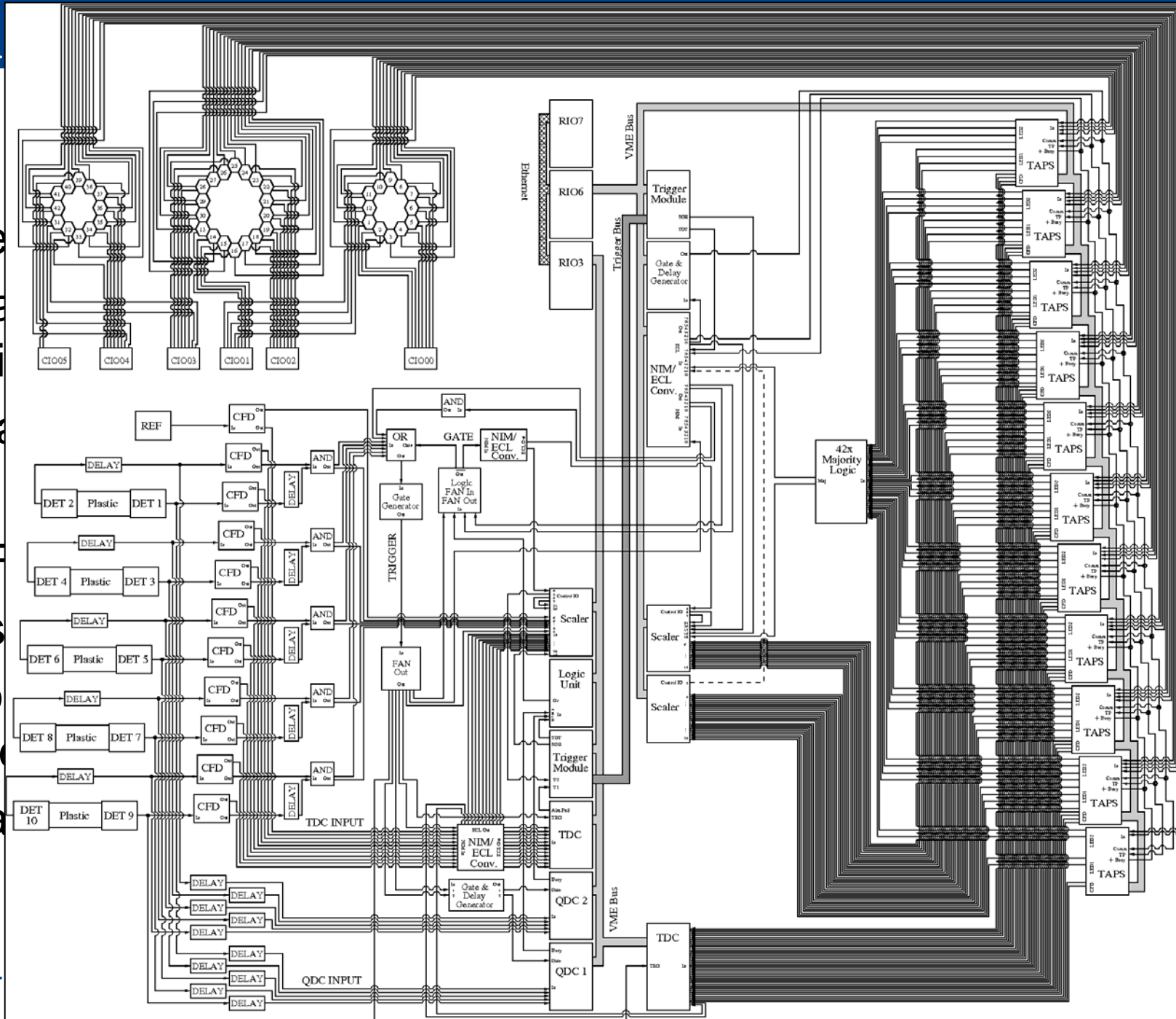


The End

Thanks for listening!

Setup

- one → a
- emi
- data →
- BaF
- bus
- two for
- dea



and

one

Setup for Efficiency Calibration

