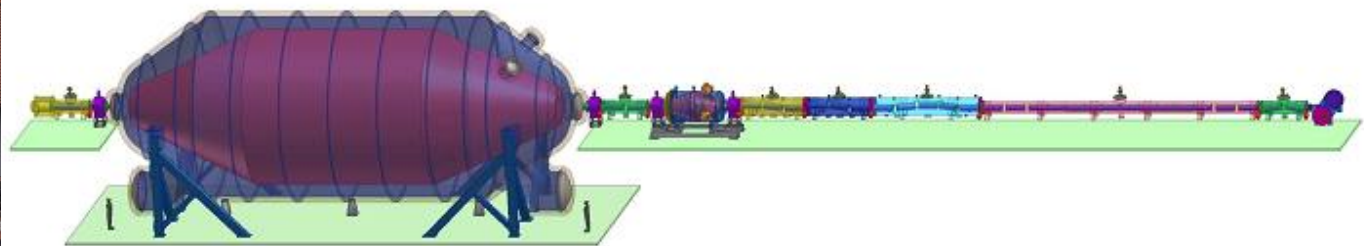


# KATRIN - Experiment

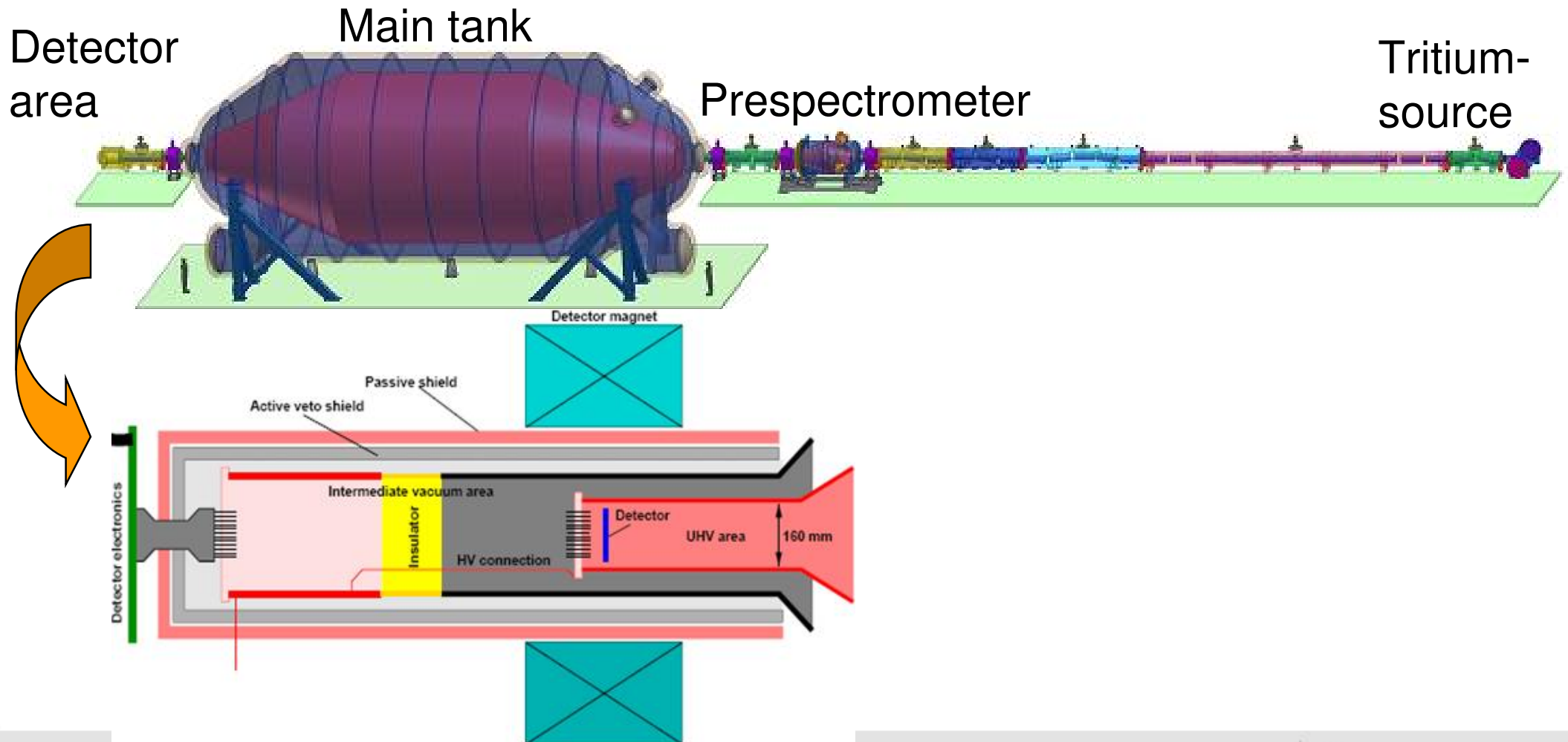
## Detector System of the Focal Plane Detector of KATRIN

Lars Petzold, IPE, Forschungszentrum Karlsruhe



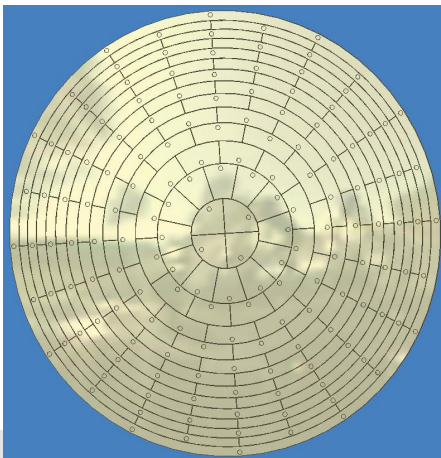
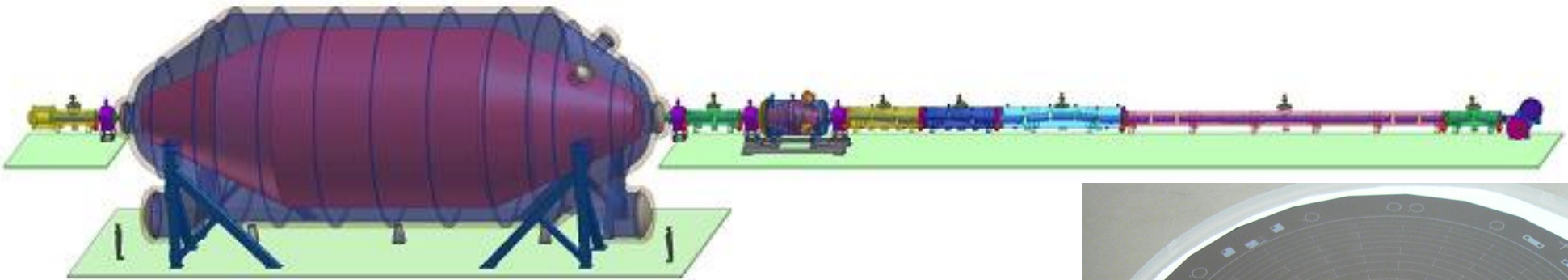
# Tritium source and main tank

Determine mass of electron-antineutrino with an error of 0.2 eV



# PIN-diode array as FPD

- Detection of electrons, resolution of approx. 600 eV
- Detector counts the electrons
- Resolution necessary for background suppression



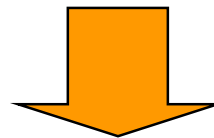
- 9 pF per pixel
- 148 pixel with same area
- charge at 18.6 keV: approx. 0.8 fC



# Mechanics

Specs:

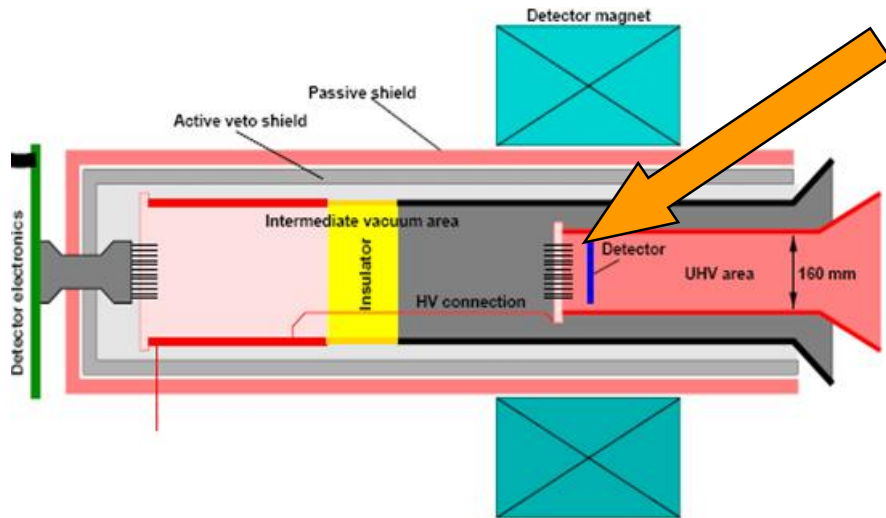
- High vacuum HV ( $10^{-9}$  mbar)
- Low temperatures (approx. 210 K)
- Low ( $\alpha$ ,  $\beta$ ,  $\gamma$ ) activities within  $\mu\text{Hz}$
- High magnetic field strength (6 T)



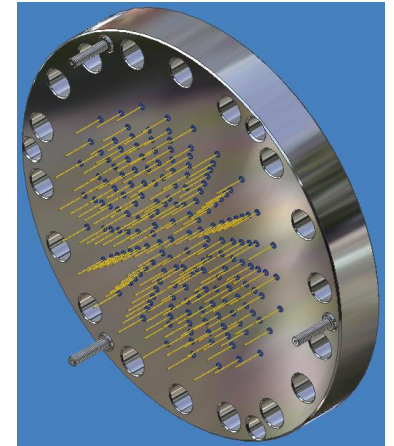
Stringent environmental and spatial restriction



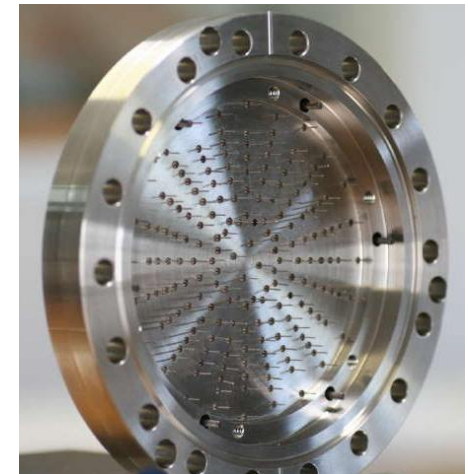
# Feed-through



Electronics side



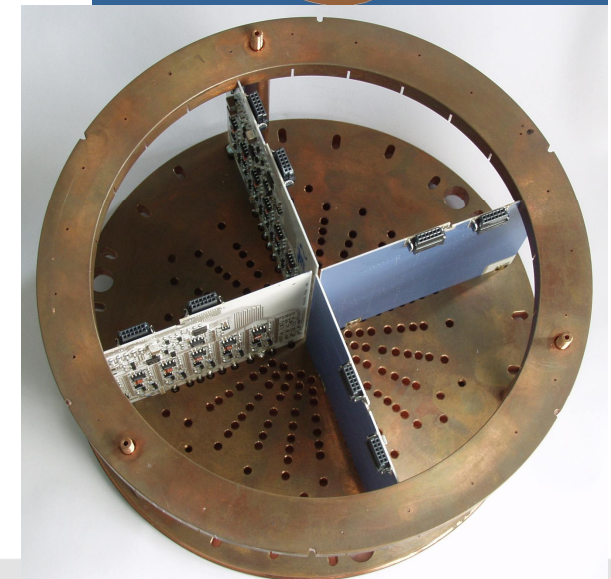
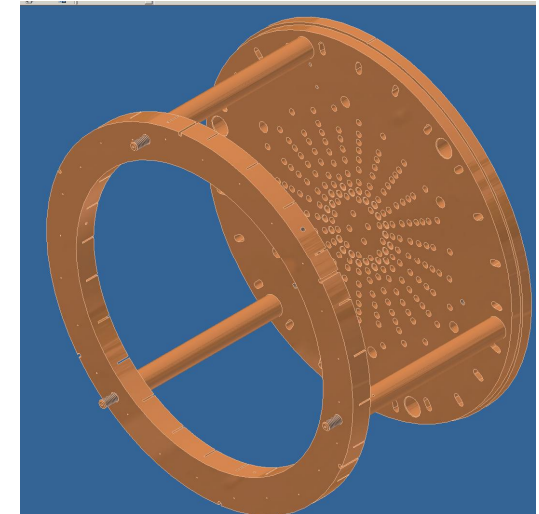
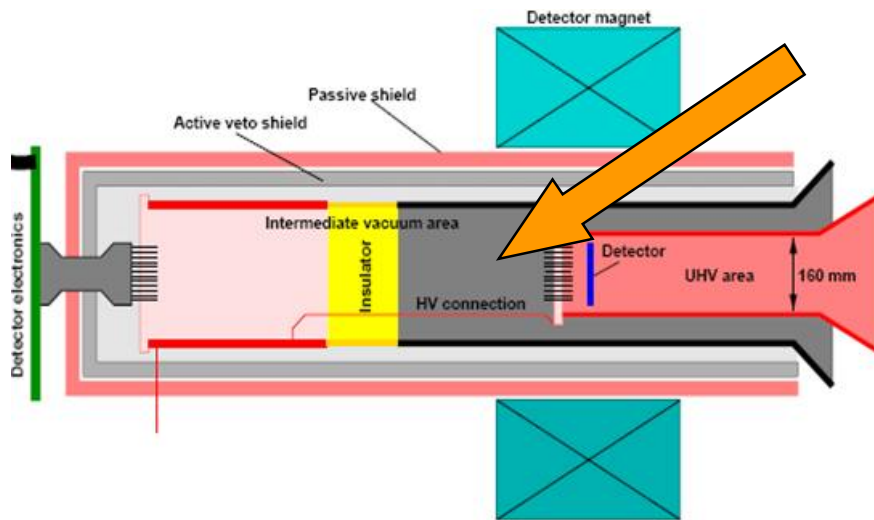
Detector side



- Separation of UHV ( $10^{-11}$  mbar) and HV ( $10^{-9}$  mbar)
- Thermal decoupling of cooled detector and electronics
- Connector: sapphire insulated niobium pins

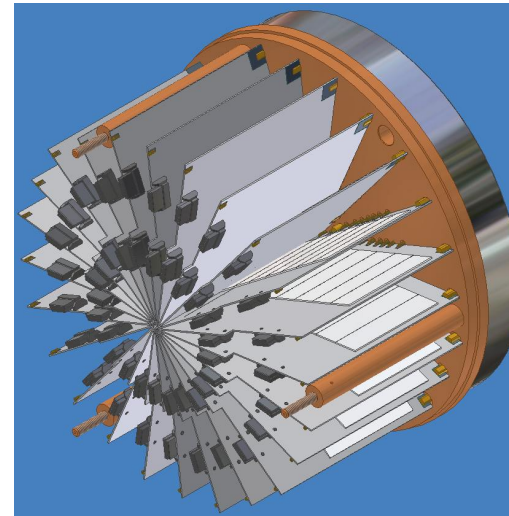
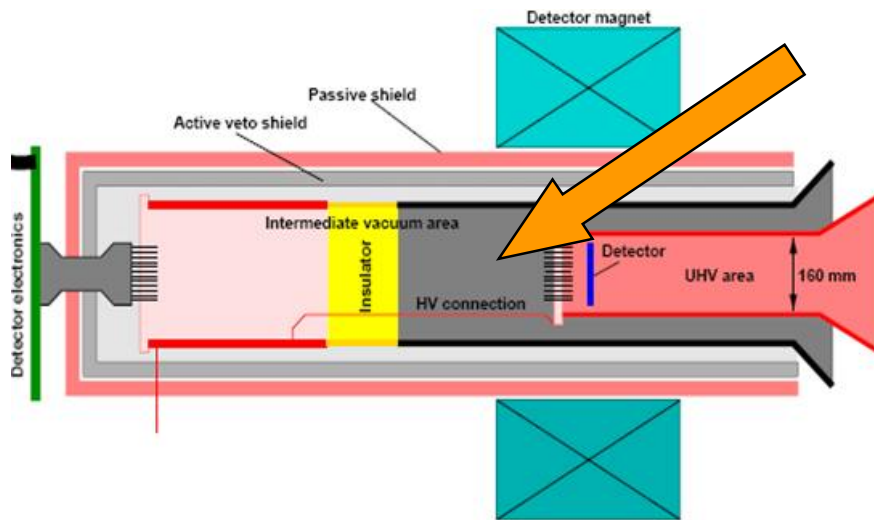
Low activity materials

# oxygen free copper-Housing

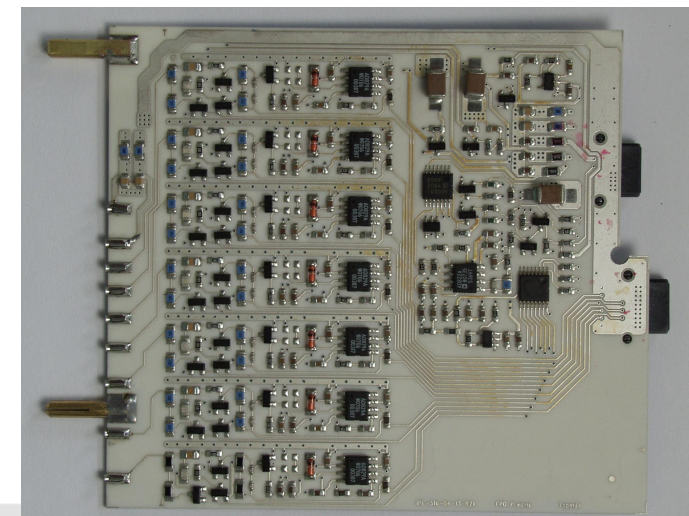


- Cooling of preamplifiers
- Additional radiation shielding of detector
- Positional fixation of preamplifier-modules
- Electrical shielding
- Low impedance reference potential

# Preamplifier modules



- 148 preamps in a carousel
- Modules with 6 ch. (resp. 7 ch.)
- Cooled and fixed with two pins
- Arranged on  $\text{Al}_2\text{O}_3$  ceramic



# Used materials

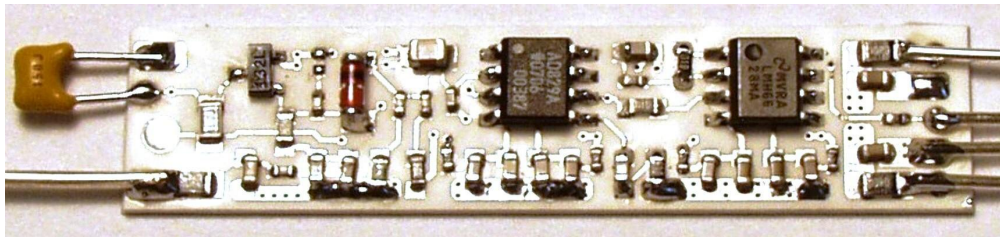
- Preamp boards (RUBALIT 710 S, Ceramtec)
  - Less pollution with Uranium, Thorium and Potassium
  - GEANT simulation estimates count-rate of 80  $\mu\text{Hz}$
- Feed through flange (stainless steel, sapphire windows)
- Detector pins (Niobium)
- Front-plate, rods, back-ring, shielding-tube (oxygen free copper)
  - Radiation shielding
- PCB-boards for less radioactive background
  - REXOLITE, Ensinger
  - ULTRALAM, Roger



# Preamp modules

Specs for KATRIN:

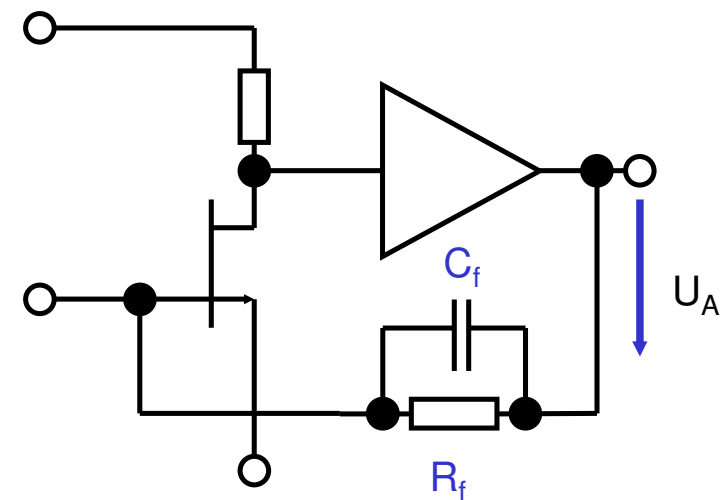
- Working within vacuum
- Temperature range: 370 K to 210 K
- Influence of magnetic fields
- Low noise: 600 eV
- Power consumption : < 100 mW / channel
- Bandwidth: 5 MHz



Prototype Revision2

Attributes at 300 K

- Sensitivity: 1keV cause approx. 85  $\mu$ V
- Noise: 100  $\mu$ V



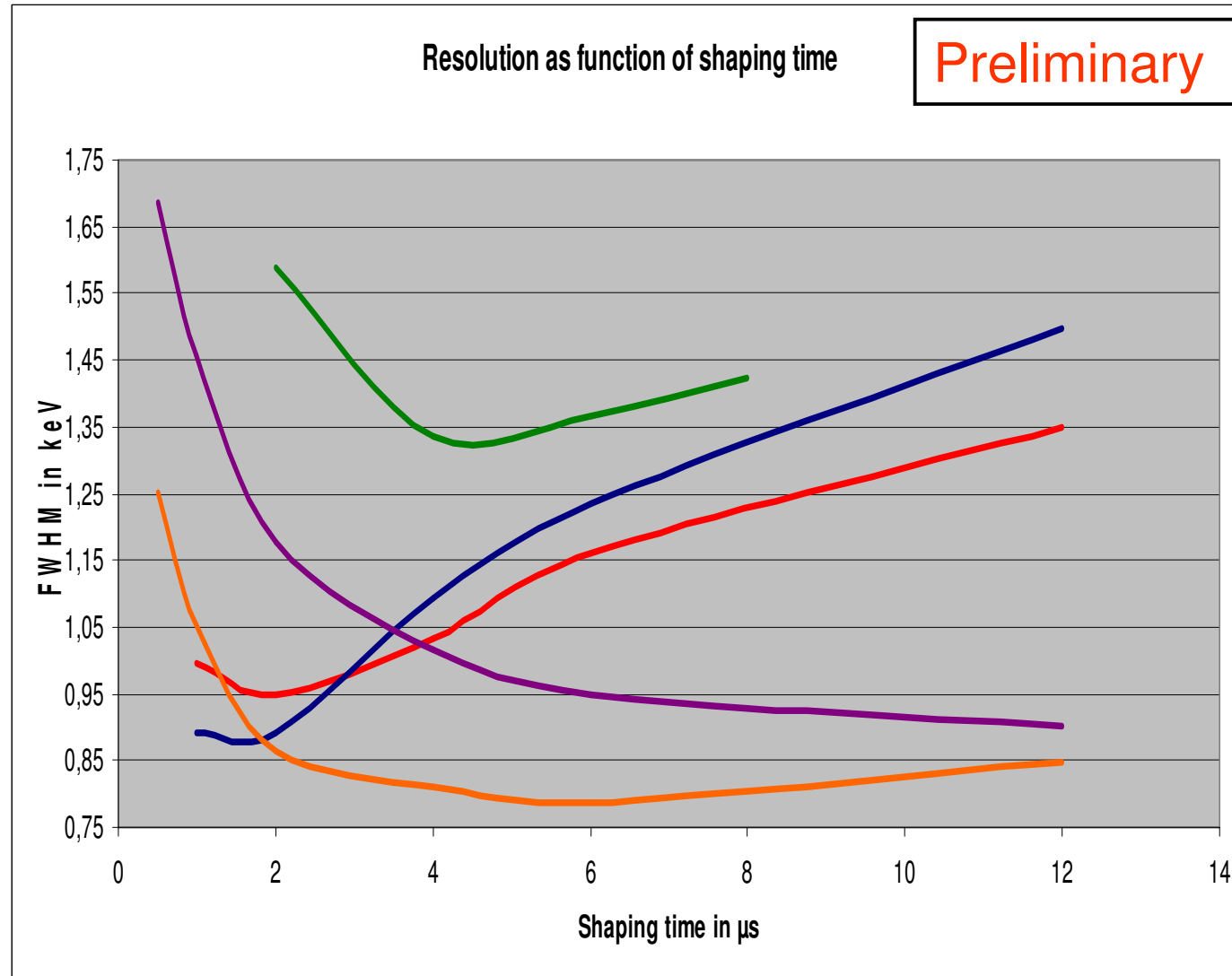
$$U_A = - \frac{Q_{IN}}{C_{FEEDB}} e^{-t/\tau}$$

# Resolution

Used input: Testinput

Temp.: 300 K

- Best results at 6  $\mu\text{s}$  (770 eV)
- domination of current noise changes to voltage noise



# Thanks for your attention

Thanks to

- Michelle Leber (UW, Seattle)
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- Peter Doe, (UW, Seattle)
- Hamish Robertson (UW, Seattle)
- John Wilkerson (UW, Seattle)
- Markus Steidl (FZK, Karlsruhe)
- Sascha Wüstling (FZK, Karlsruhe)