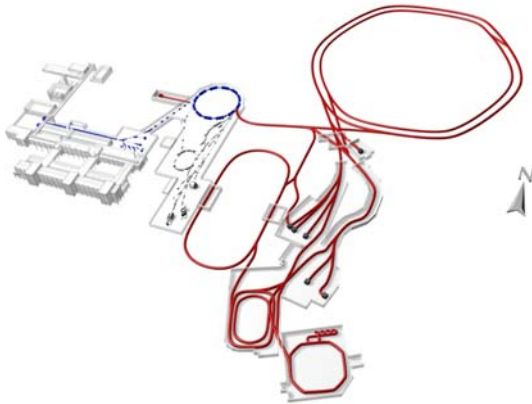


APD - and related – activities at

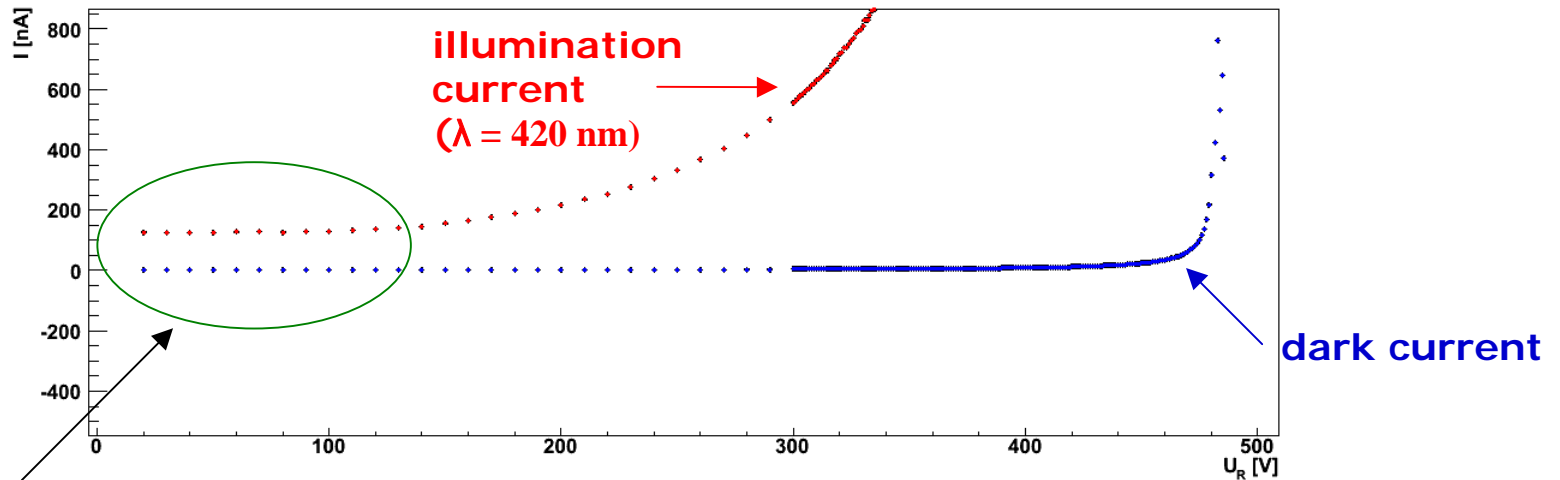


Andrea Wilms
GSI Darmstadt

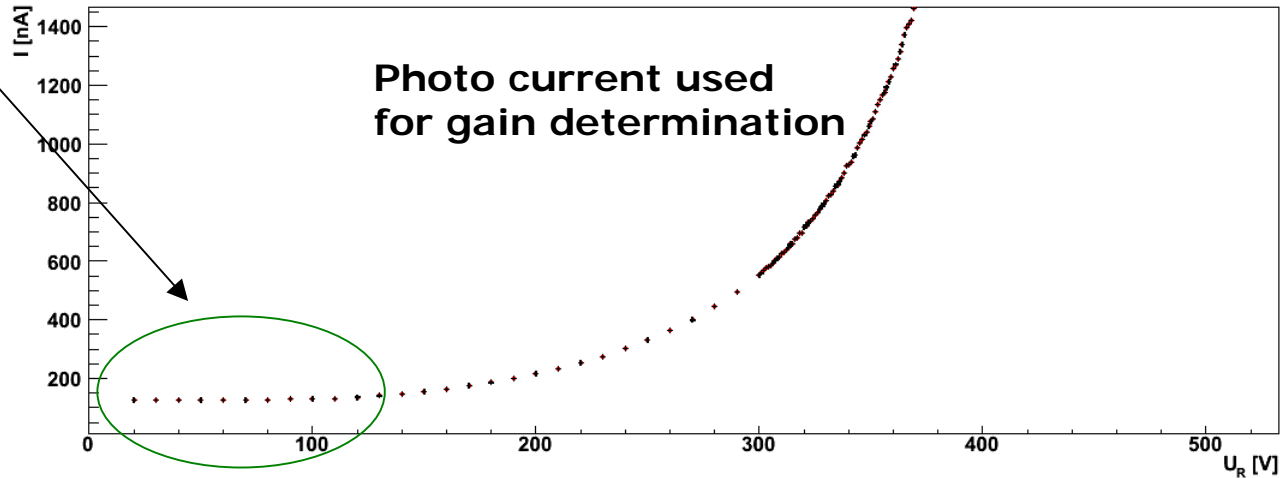
- Status of rectangular APD development
 - Gain problem
 - Increased dark current
 - New resin needed

- Preparations for mass screening
 - Gain/Id measurement setup
 - QE setup
 - Annealing procedure after γ irradiation
 - Assembly of mass screening facility at GSI

Photocurrent quadratic shape: Example

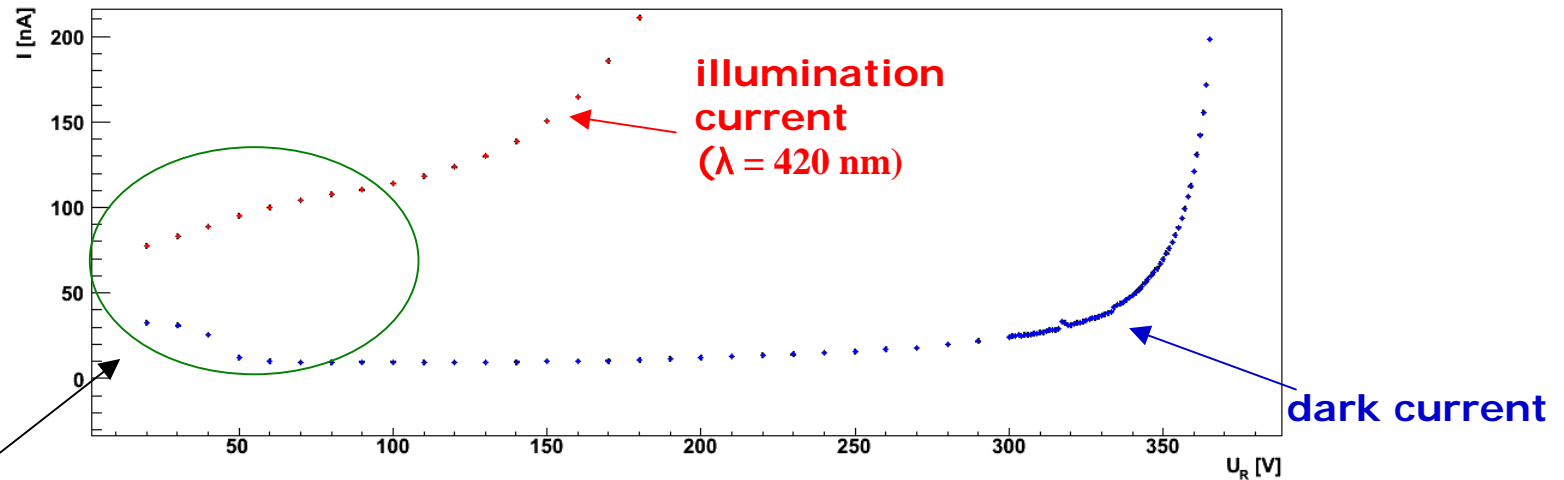


Always constant values
at low HV

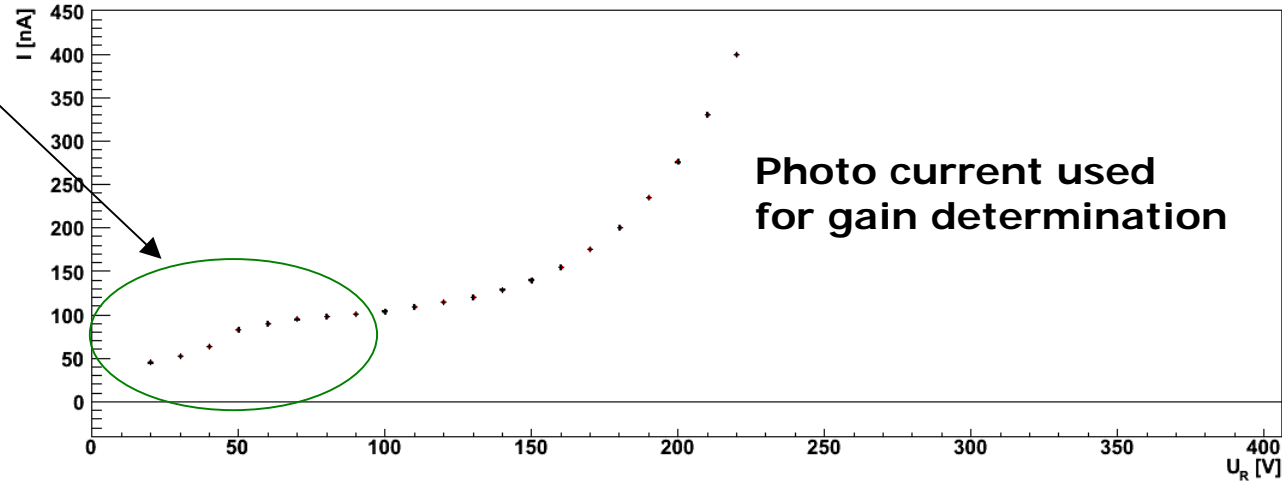


Photocurrent rectangular shape: Example

APD AA2932



No constant values
at low HV

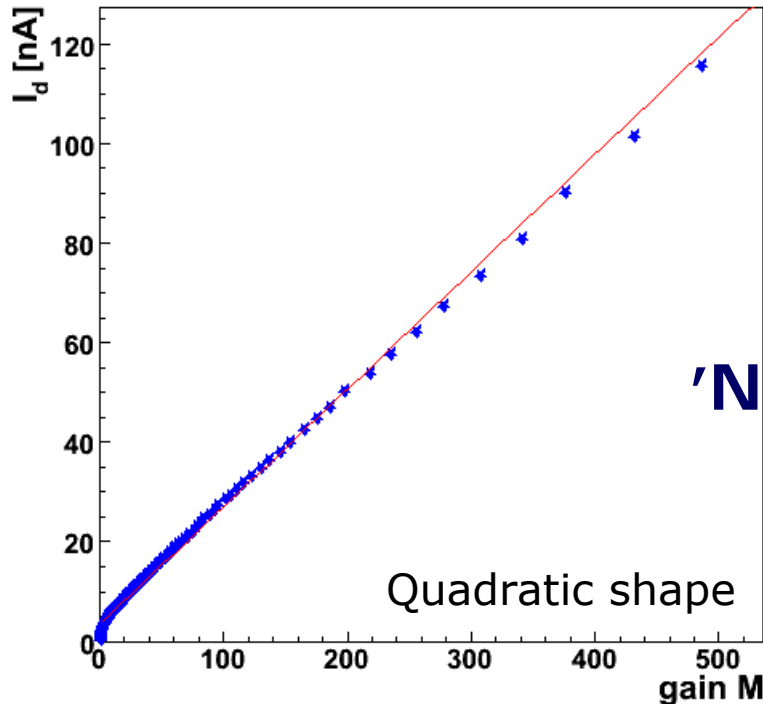


- Half of the ordered rectangular APDs have 'low gain problem'
 - problem was not confirmed by Hamamatsu
 - for clearance: measurement of device capacitance!?
 - occurring problem: Bias voltages up to 600 V & measurement of C in the pF regime
 - usual C-V-analyzer: voltages up to max. 400 V possible (fits for quadratic shape APDs)
 - worldwide only one system available for this needed measurement of the rectangular APDs (not on the market yet!)

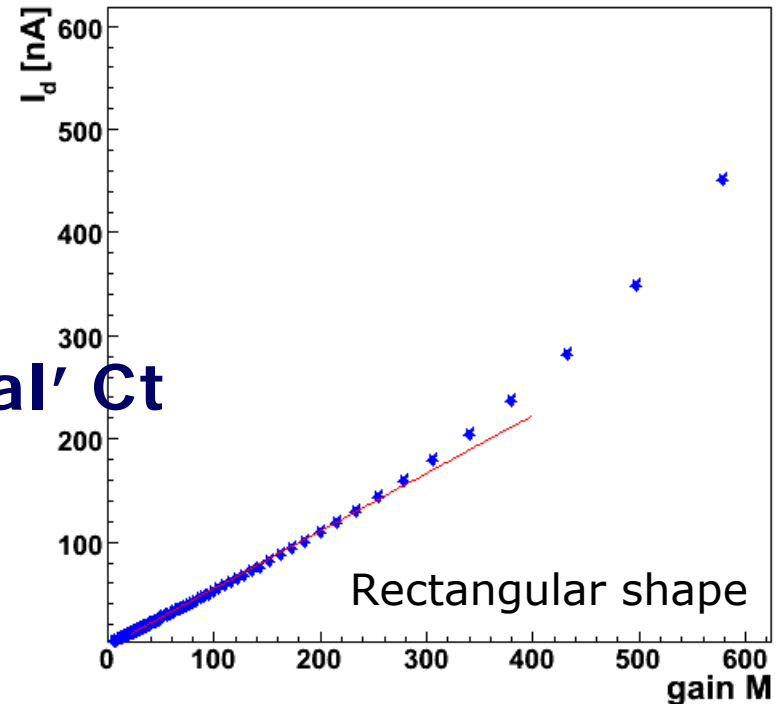
Main APD parameters: Gain & I_d examples

Measurement at room temperature $I_d = I_{dB} \cdot M + I_{dS}$

I_{dB} measurement needed for noise characteristic (e.g. S/N) after preamp



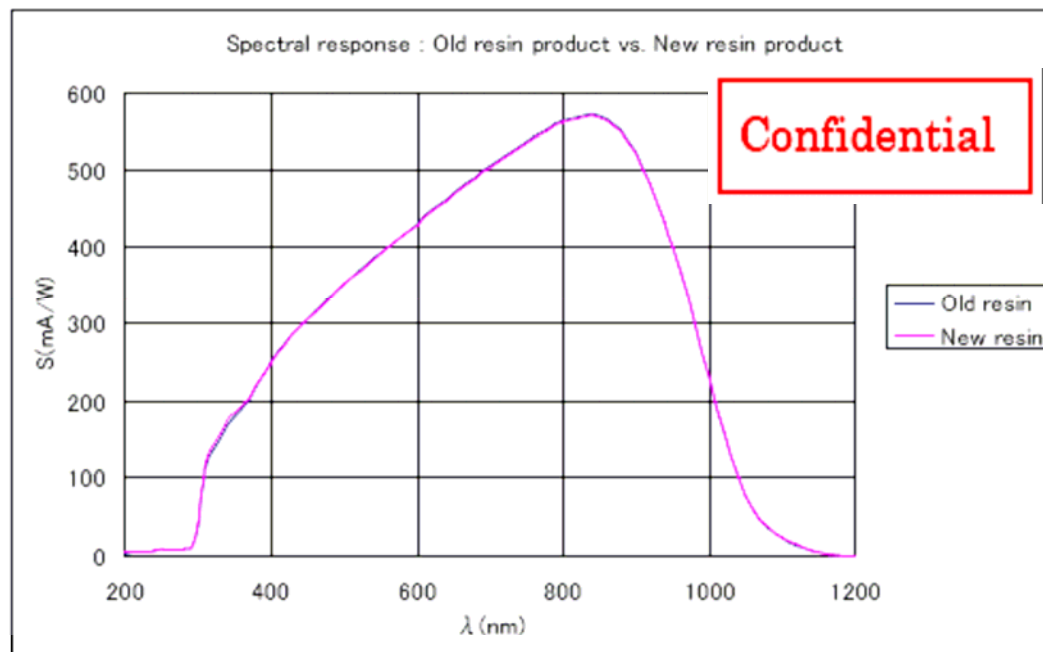
- Gain- I_d linearity ensured up to $M \approx 320$
- $I_{dB} = (0.236 \pm 1.223 \cdot 10^{-4})$ nA
 - I_d @ $M=50$: 15.27 nA



- Gain- I_d linearity ensured up to $M \approx 280$
- $I_{dB} = (0.559 \pm 3.356 \cdot 10^{-4})$ nA
 - I_d @ $M=50$: 27.05 nA

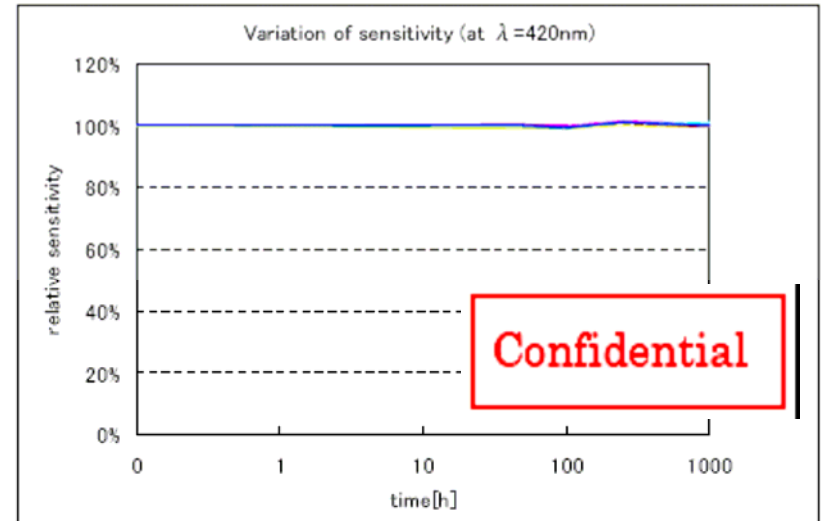
- resin producing company gets bankrupt
 - new producer found by Hamamatsu
 - no information concerning radiation hardness
 - irradiation tests needed
- optical properties of new resin type measured by Hamamatsu

■ Comparison of spectral response between new resin and old resin

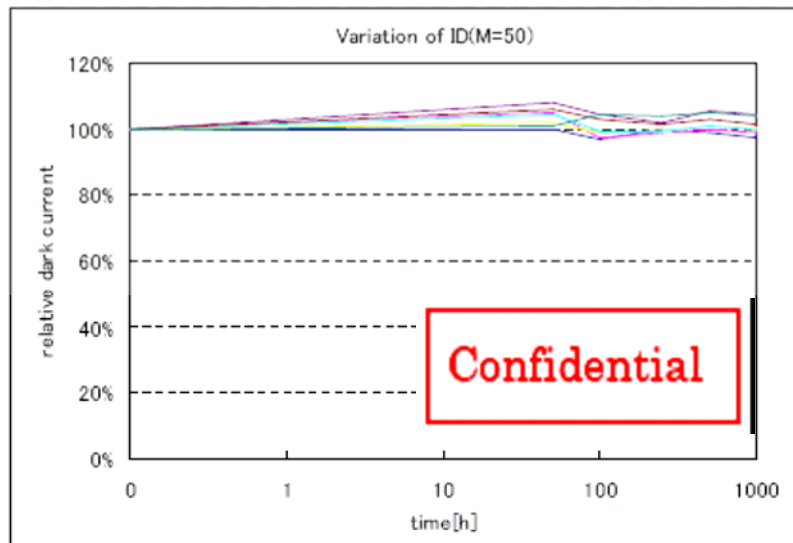


Reliability tests of 7 pcs

- Variation of sensitivity



- Variation of dark current (at M=50)



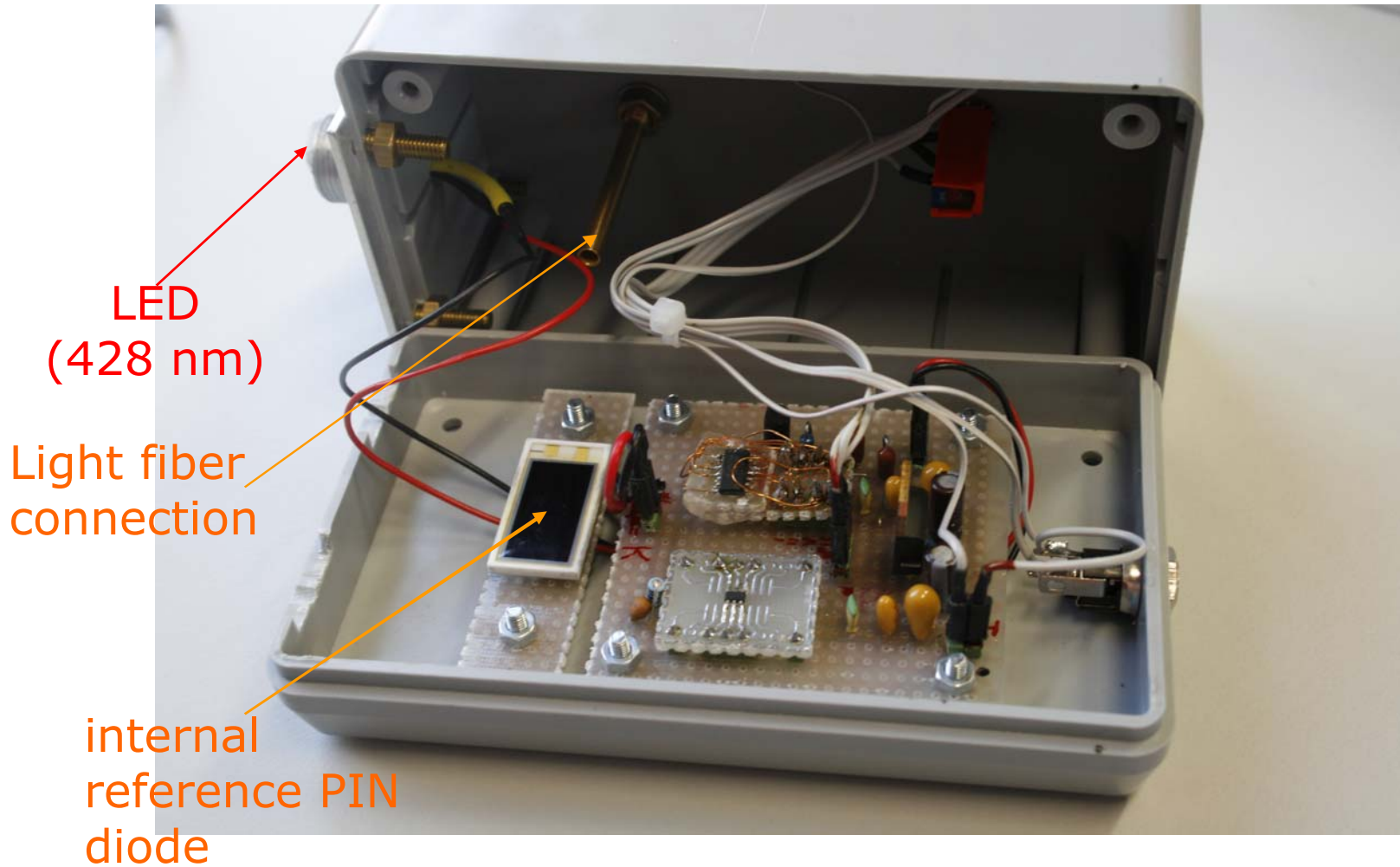
- No comparison to old resin available
- Radiation hardness assurance: highest priority
- KVI beam time begin of september

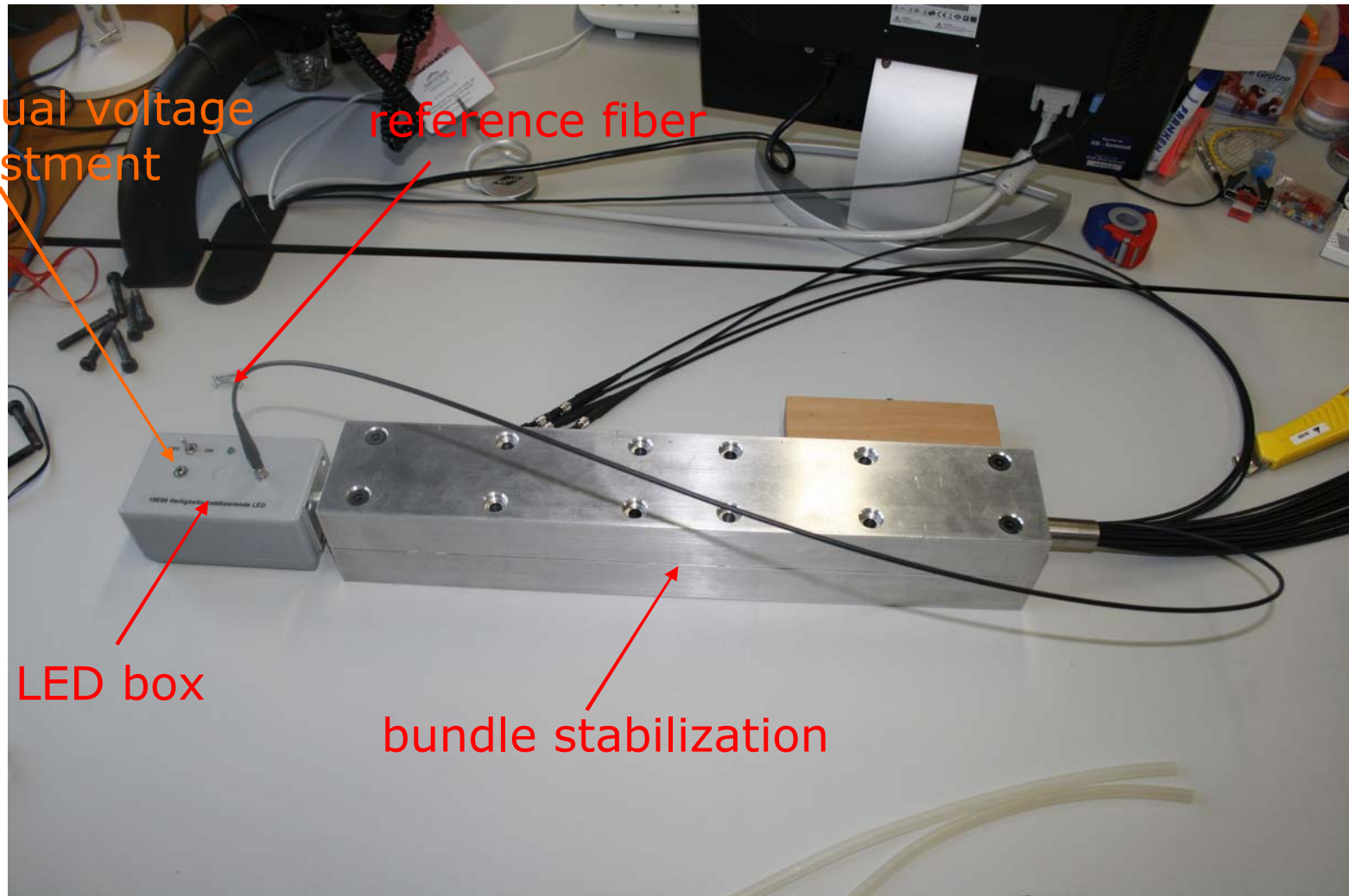
Goals:

- avoidance of occurring failure sources during screening of approx. 1000 APDs/month
- Manageability has to be ensured

Gain measurement:

- LED intensity varies with temperature
 - LED current has to be monitored and/or adjusted
- gain of 20 APDs have to be measured simultaneously
 - they have to be optically decoupled
 - temperature have to be kept constant ($\Delta T = \pm 0.1^\circ \text{C}$) for all of them

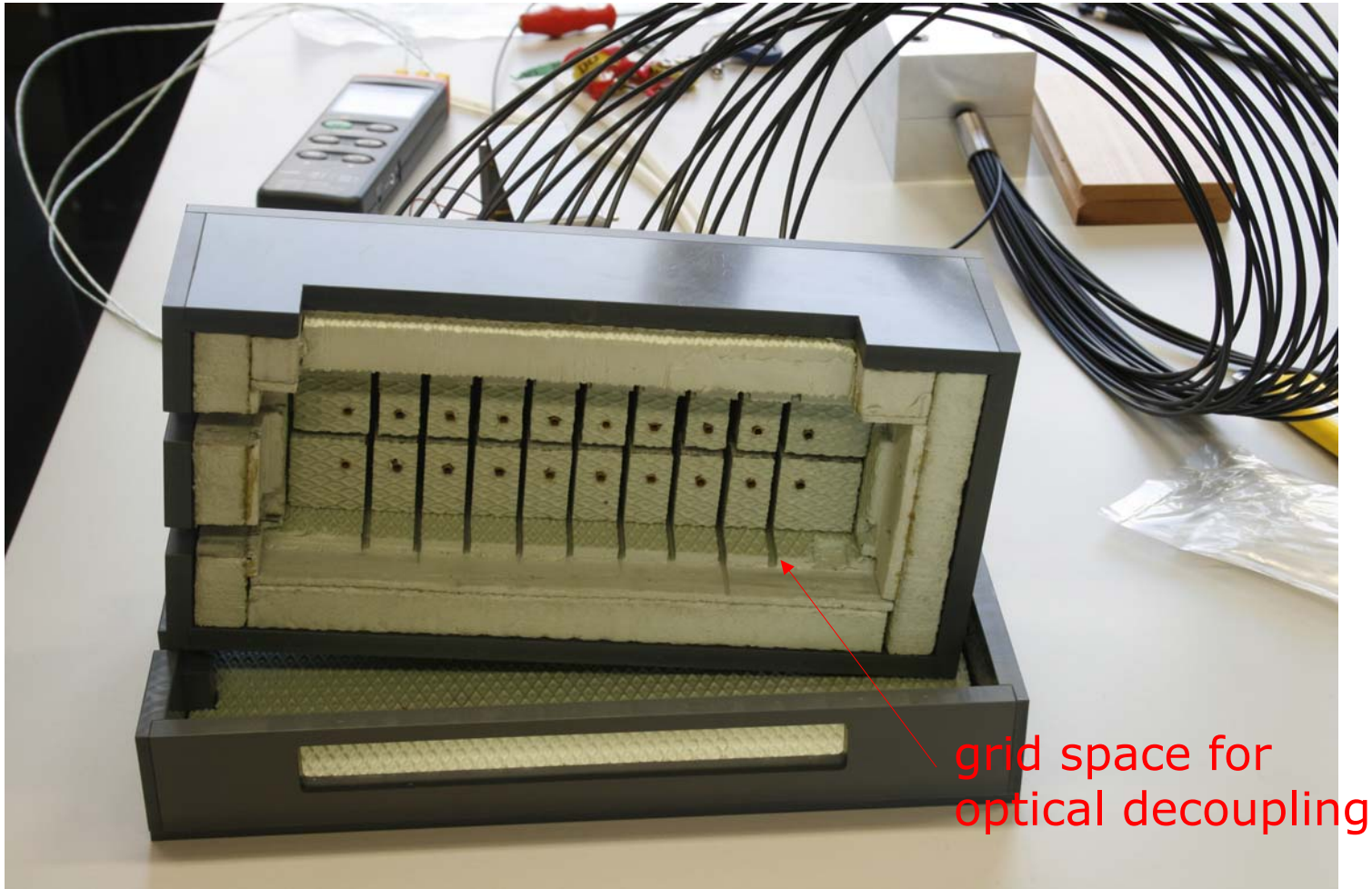




20 APDs (quadratic) insulated setup



Thermal insulation box (prototype)



Gain measurement

- First light tight and insulated cooling box for rectangular APDs including PCB is ready
- Measurement at different temperatures necessary
 - approx. five boxes are needed
 - ✓ PCBs including LEMO-adapters are in stock
 - ✓ 5 light tight boxes for external reference PIN diodes are on the shelf
 - PCBs will be build soon
 - ✓ fiber bundles are at hand
 - other insulation boxes will be build soon

Ongoing work:

- homogeneous coupling of the LED light into a bundle of 20+1 fibers (+4 spares)
 - needed lens system is in preparation

QE

(will be randomly checked)

- insulation boxes similar to gain measurement are needed (APD + calibrated PIN diode)
- need of additional fiber bundles

At the moment:

- ✓ 2 insulated boxes including PCBs are at hand
- ✓ fiber bundles with 3 fibers (2 + 1 spare) are on the shelf

Ongoing work:

- homogeneous coupling of monochromator-light into the bundle has to be fine tuned

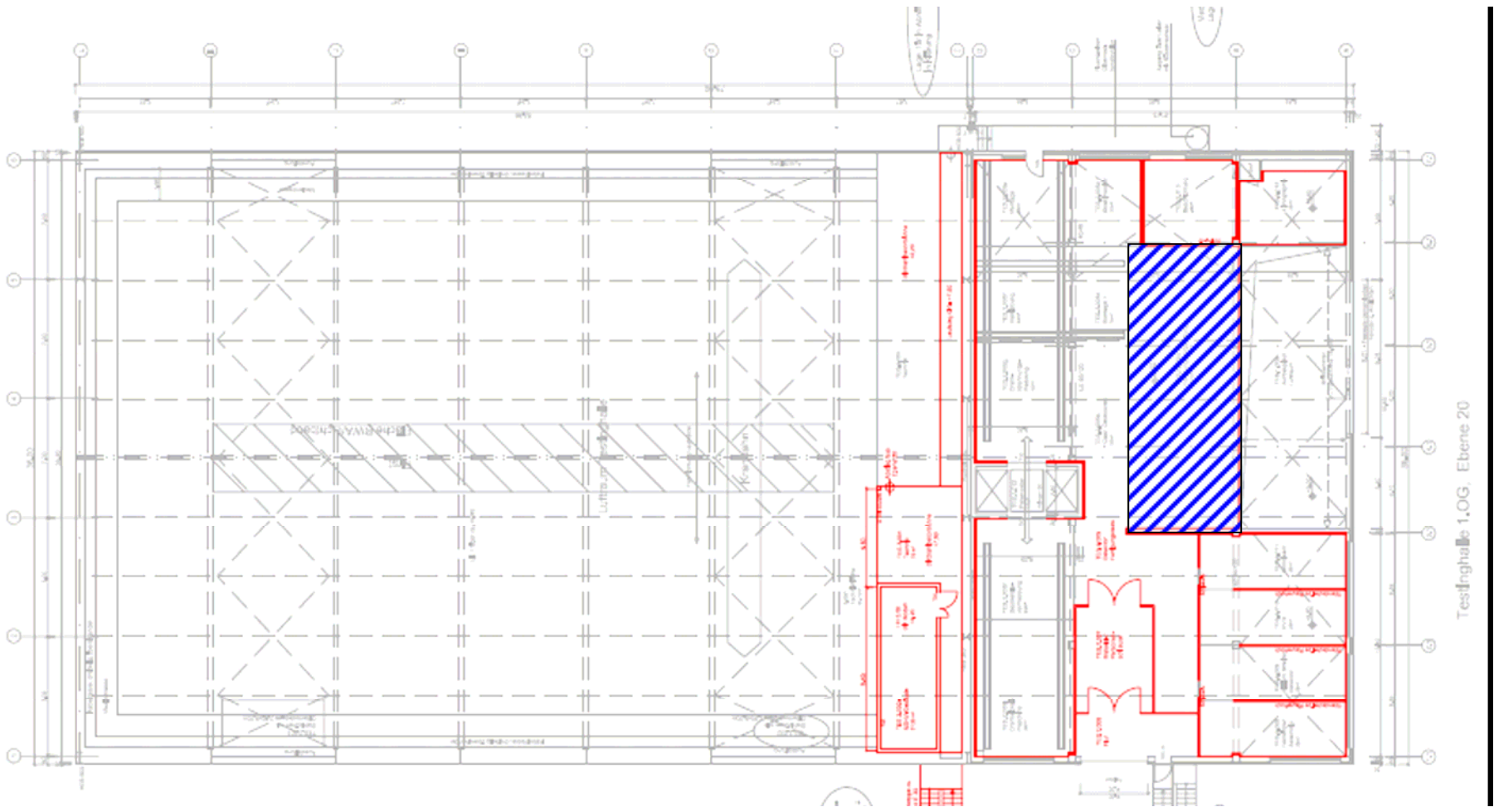
*Irradiation with photons at Strahlenzentrum Giessen
will be part of the screening procedure*

- Irradiation of nearly 1000 APDs /month
 - Coolable irradiation plates needed
 - HV should be mounted in Giessen
 - Annealing in oven has to be monitored in the lab

Status:

- ✓ 2 ovens are already mounted in Frankfurt
(each oven: 500 APDs)
- exhaust device of hot air (needed due to safety reasons)
is in preparation
- ✓ 'baking trails' will be ready this week
- ✓ electrical insulation is in preparation (workshop)
- large PCBs for I_d monitoring are build in the electronic workshop
- special cables needed due to large amount of HV channels

Space available at new detector lab @ GSI, 1st floor



- Available space for APD testing will be part of a clean room 10,000
- temperature stabilized ($\Delta T = \pm 1^\circ \text{C}$)
- major part of this area will be used for APD screening procedure:
 - gain/ I_d
 - QE
 - ENF
 - @ different temperatures
 - before and after irradiation

