



QUAD testbox

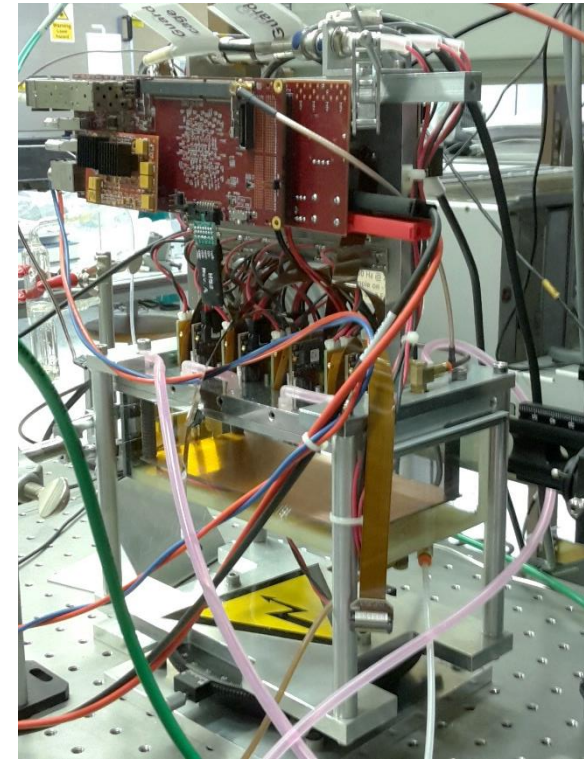
Fred Hartjes
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Nikhef/Bonn LepCol meeting
March 11, 2019

Status testbox

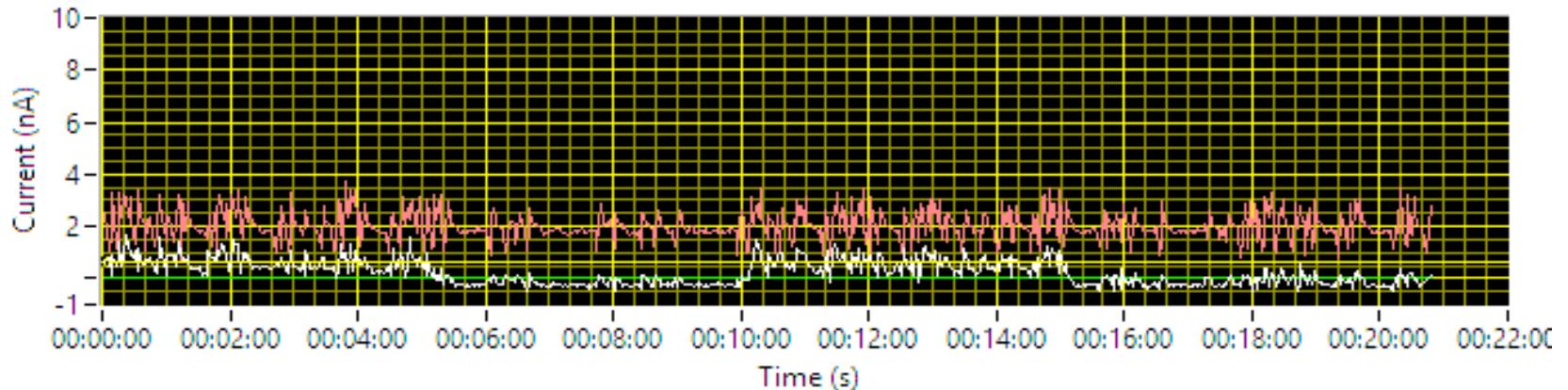
- ✓ **Done last 2 weeks**
- ✓ Check gas tightness, O₂ and water diffusion at **5 ml/min**
 - ✓ Leaks < 0.1 ml/min
 - ✓ O₂ level ~300 ppM
 - ✓ Humidity 2500 ppM
 - ✓ With higher flow (20 ppM) we can bring
 - ✓ O₂ level down to < 100 ppM
 - ✓ Further down with O₂ filter
 - ✓ Humidity < 1000 ppM after prolonged flushing
 - ✓ Note: chamber content ~ 780 ml
- ✓ All 8 quads tested simultaneously until 330 V
 - ✓ Initially no sparking seen
 - ✓ When testing (powering quad 13) minor discharges (< 20 nA)
- ✓ Install liquid cooling system
- ✓ Temporary DAQ with one or two SPIDR boards (lacking concentrator firmware)
- ✓ => **laser setup operational (quad 13) including DAQ, laser and stage control**

- **To be done**
- Repair flex quad17
- Programming concentrator (started)



Laser ionization is present

- Laser beam **not attenuated**
- $V_{\text{grid}} = -330\text{V}$
- White curve is grid current
- 5 min on, 5 min blocked, 5 min on, 5 min blocked

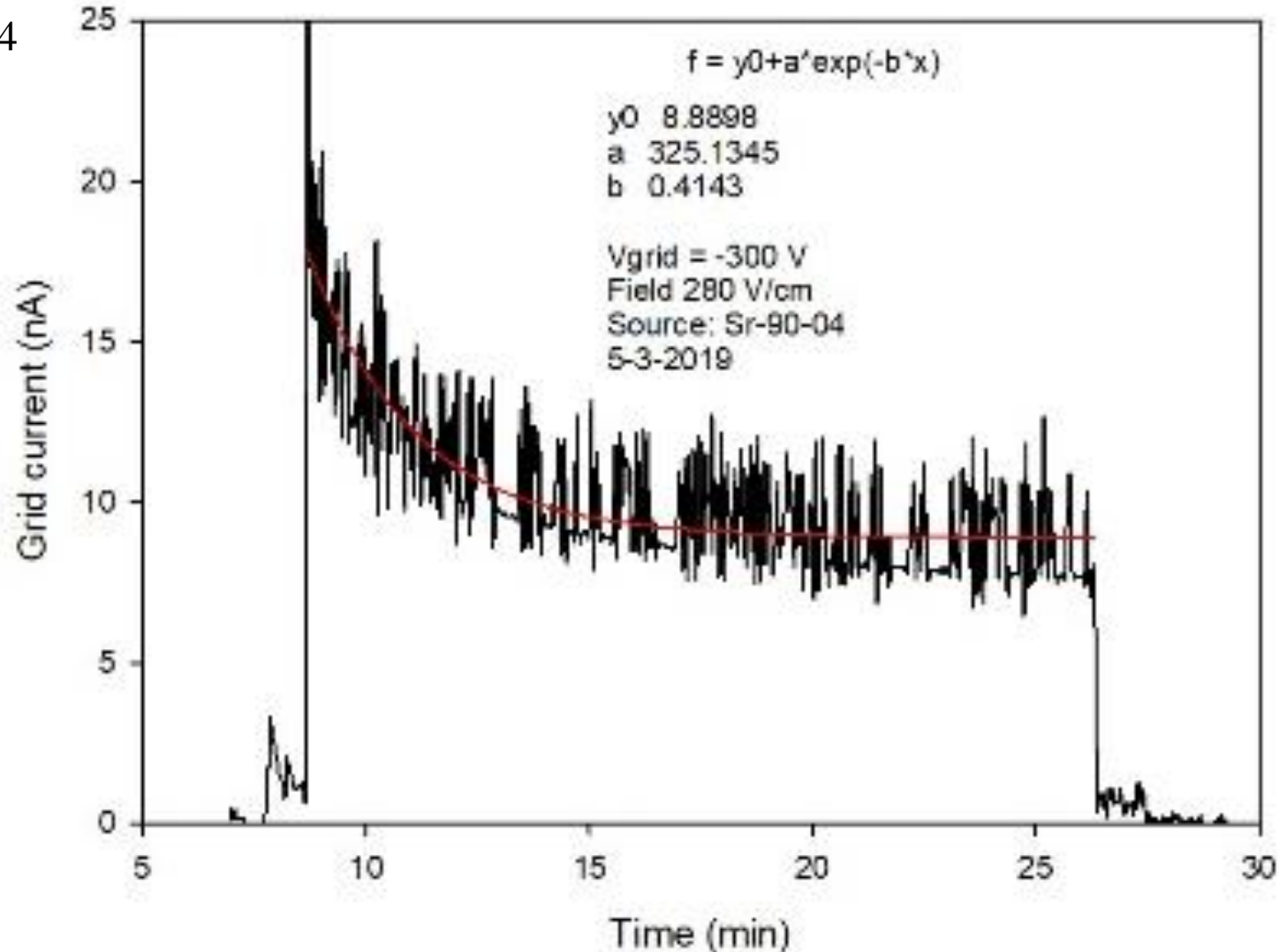


- Current with laser beam: 0.78 nA
- $\Rightarrow 1.6\text{M}$ electrons/s; 650k per shot
- Assume gain = 3000, 1500 e-/track
- \Rightarrow **corresponding track rate ~ 1 kHz**
 - **But all over ~ 1 mm wide band within ~ 20 ns**
- *We may need \sim factor 20 laser attenuation*

Test with ^{90}Sr source

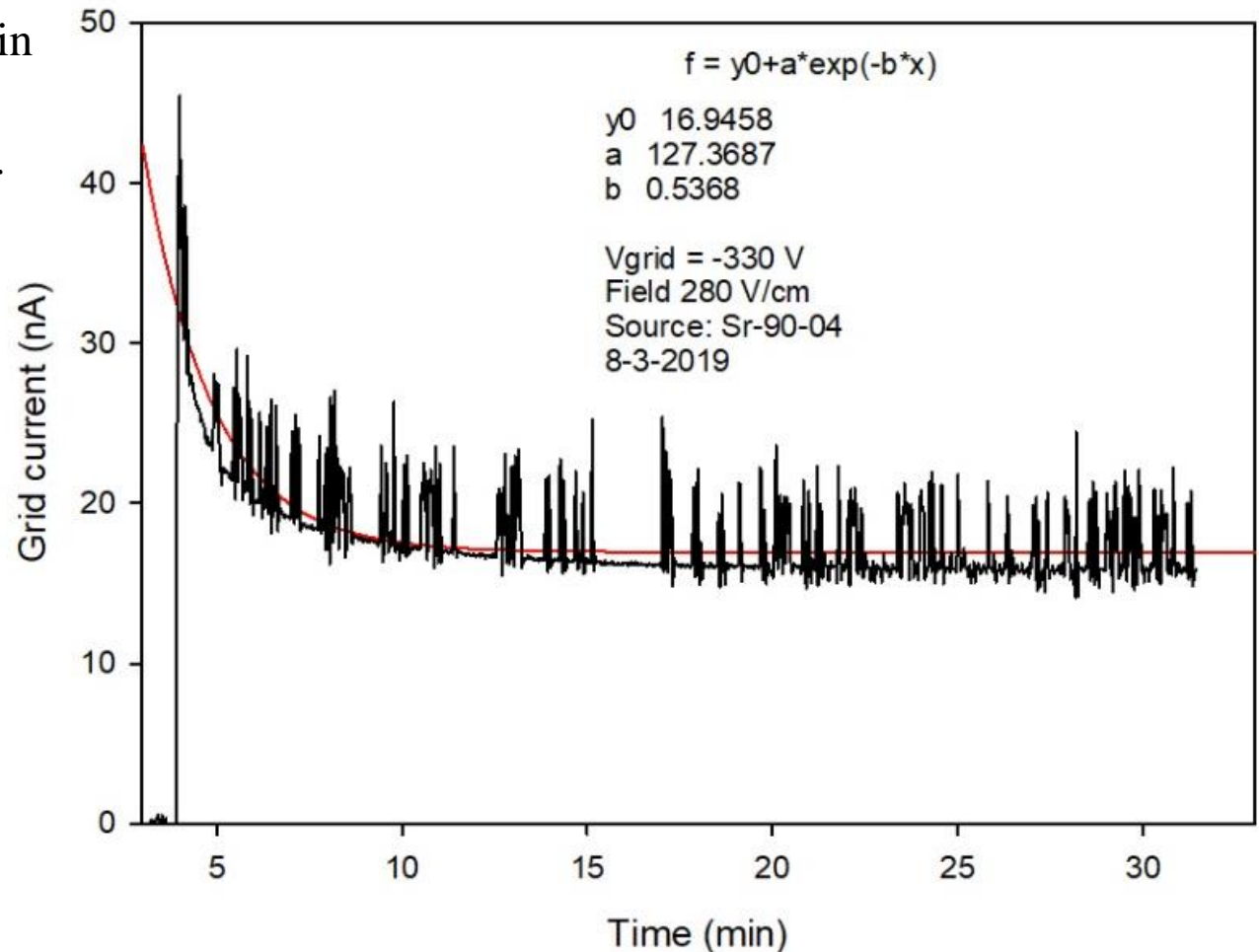
Grid current when irradiated with an ^{90}Sr source

- $V_{\text{grid}} = -300 \text{ V}$
- Time constant 2.4 min



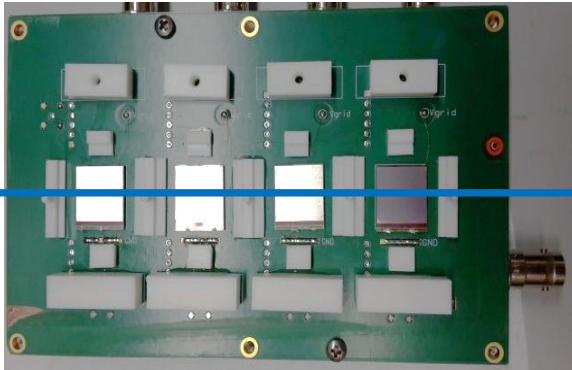
Test with ^{90}Sr source

Grid current when irradiated with an ^{90}Sr source

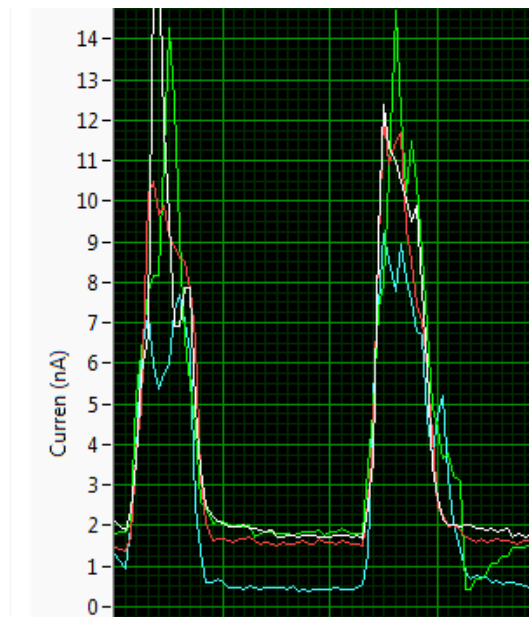
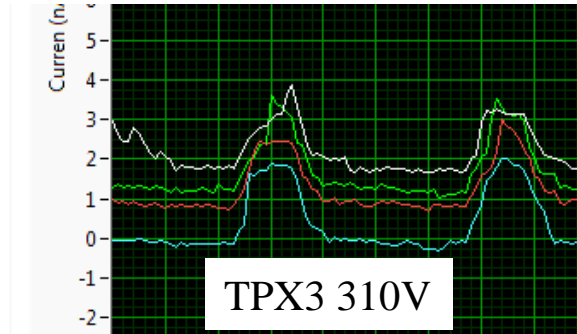


- $V_{\text{grid}} = -330\text{V}$
- Saturation value almost doubled (1.91x)
- Time constant $\sim 1.9 \text{ min}$
- Potential build up over protection layer
 - Lower field in amplification gap
 - \Rightarrow lower gain

Referring to spark testbeam November 2016 at SPS



- All detectors equipped with grid and SixNy layer by Yevgen
- 200 GeV pions
- Time structure 5s on, 13 s off
- Beam rate averaged: ~ 80 kHz
- ITK gas
- Dummy detectors (solid metal plate), TPX1 and TPX3
- Beam currents during spill (all converted to 300 V)
 - **Dummy ~ 10 nA**
 - **TPX1 ~ 6 nA**
 - **TPX3 ~ 1.6 nA**



Dummy 300V (white and red)
TPX1 325 V (green and blue)

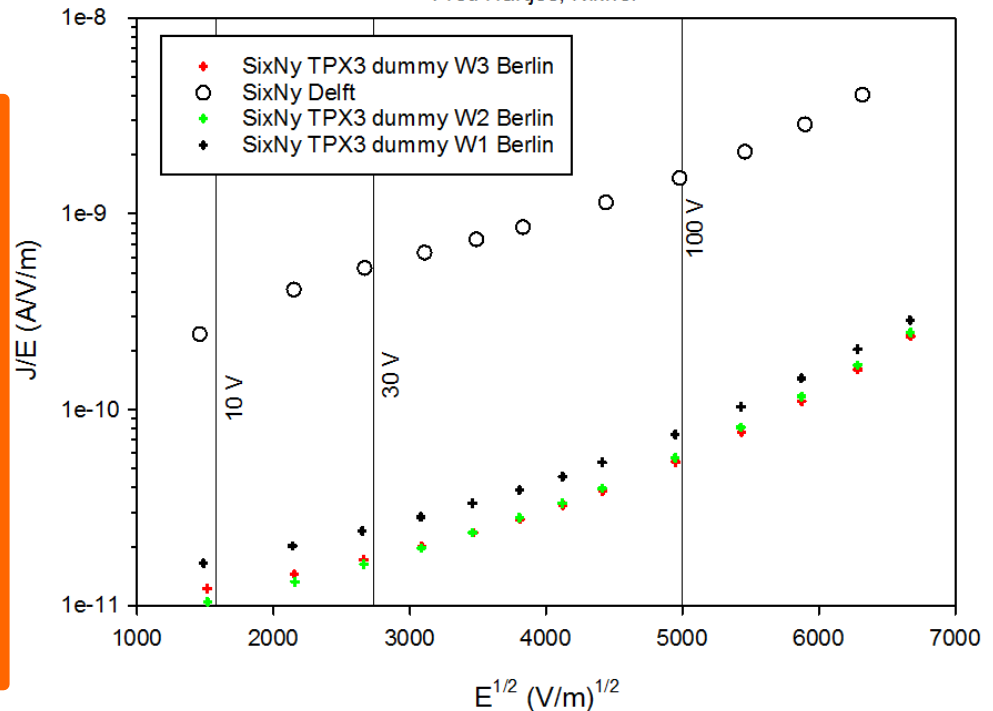
Potential buildup across protection layer

- Poole-Frenkel effect
- Conductivity higher at higher field
- Substrates Yevgen (2016?)
- Layers Delft (Violeta) ~ 20 x lower resistivity
- Latest production by Yevgen (IZM) unknown

- **We have to measure a chips from the last run with the Hg probe**
 - => only conductivity per mm² is relevant for us
 - (not surface resistivity)
- **We may have to enlarge the pads to reduce the charge up effect**

Conductivity (J/E) vs square root electric field ($E^{1/2}$)

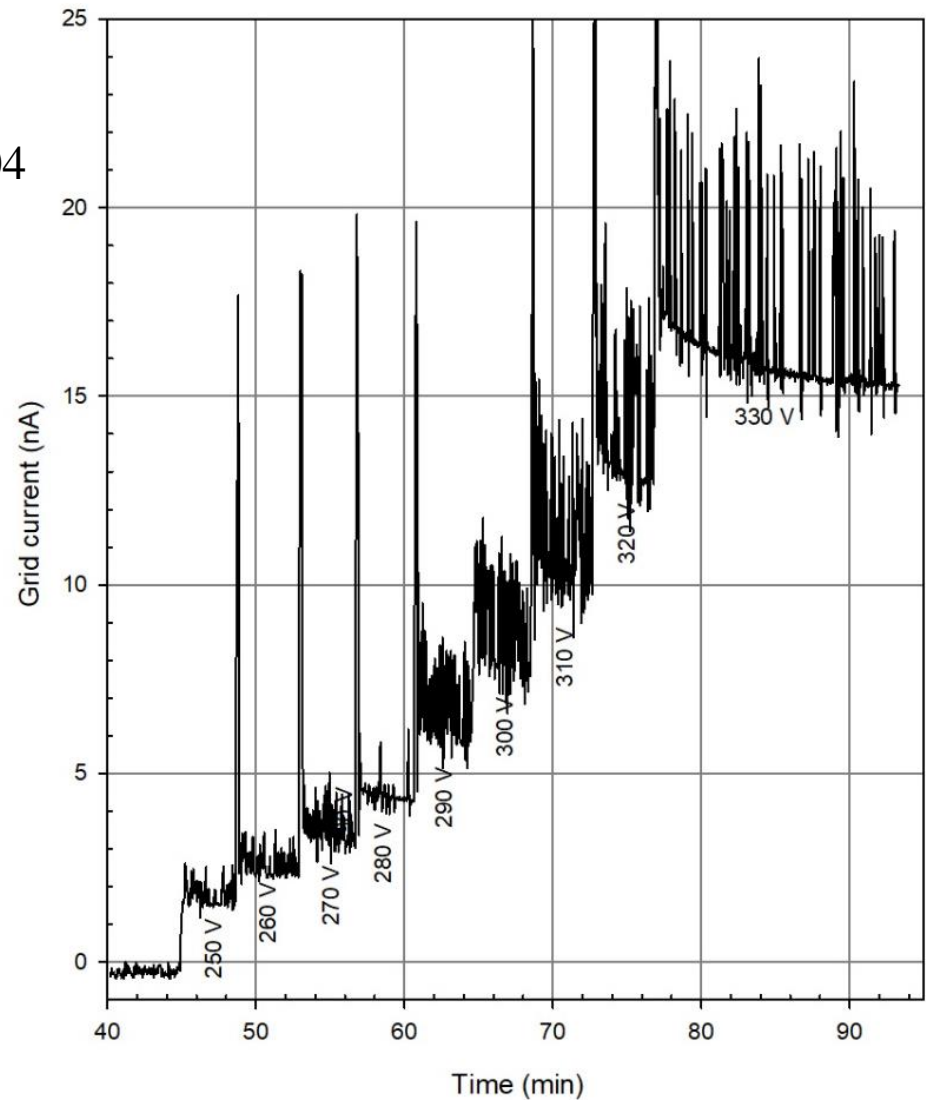
substrate: 4 μm SixNy on TPX3 dummy W3; W2; W1 (Berlin)
substrate: 4 μm SixN on 1 μm Al (049.1, Delft)
negative potential on layer surface
measured on August 15, 2016 and Feb 7-16, 2017
Fred Hartjes, Nikhef



Raw data gas gain curve

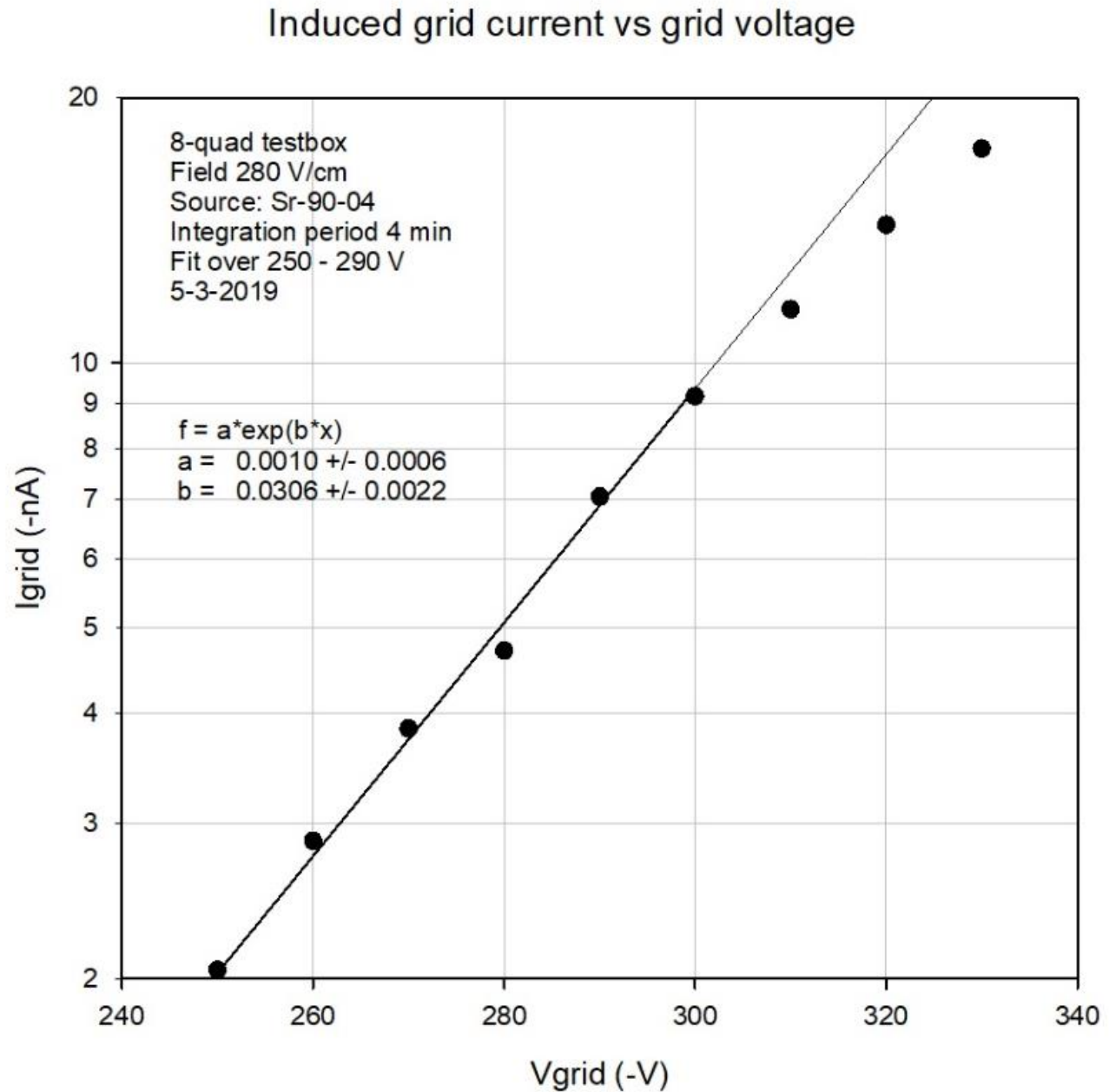
IV curve grid current with source

- Permanently irradiated with Sr-90-04
- Current averaged over ~ 4 min
- Noise on current
 - Proportional with averaged current



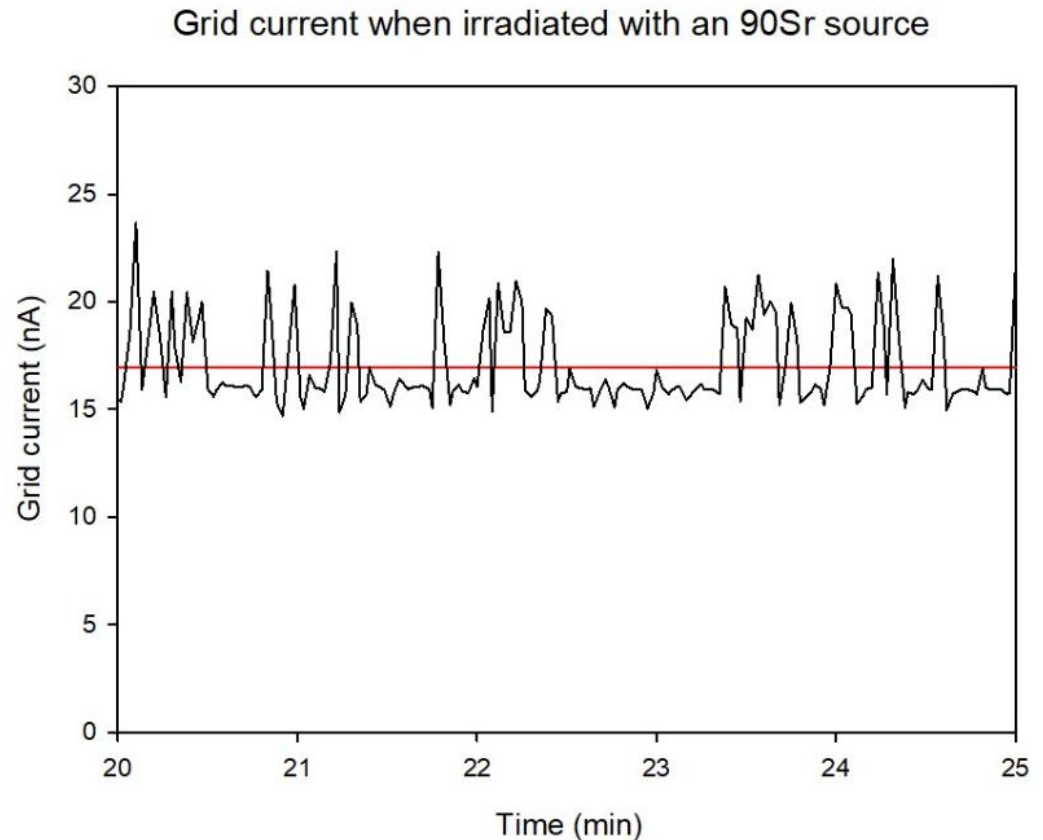
Gas gain curve

- Fit over 250 – 290 V
- Expected exponential rise
 - Slope 0.0306
 - => 23 V gives factor 2 in gain
- Lower slope for $V_{\text{grid}} > 300$ V



Grid current stability

- Nature of the current noise still unclear
- Amplitude proportional to the induced source current
- No extreme peaks
- Without source at 330V stable without any current during many hours
- Occasional minor peaks (10 – 20 nA) observed at powered quad
- Discharges??
- Regulation instability??
 - 7.5 => 15 nF capacitive load



HV circuit 8-quad testbox

