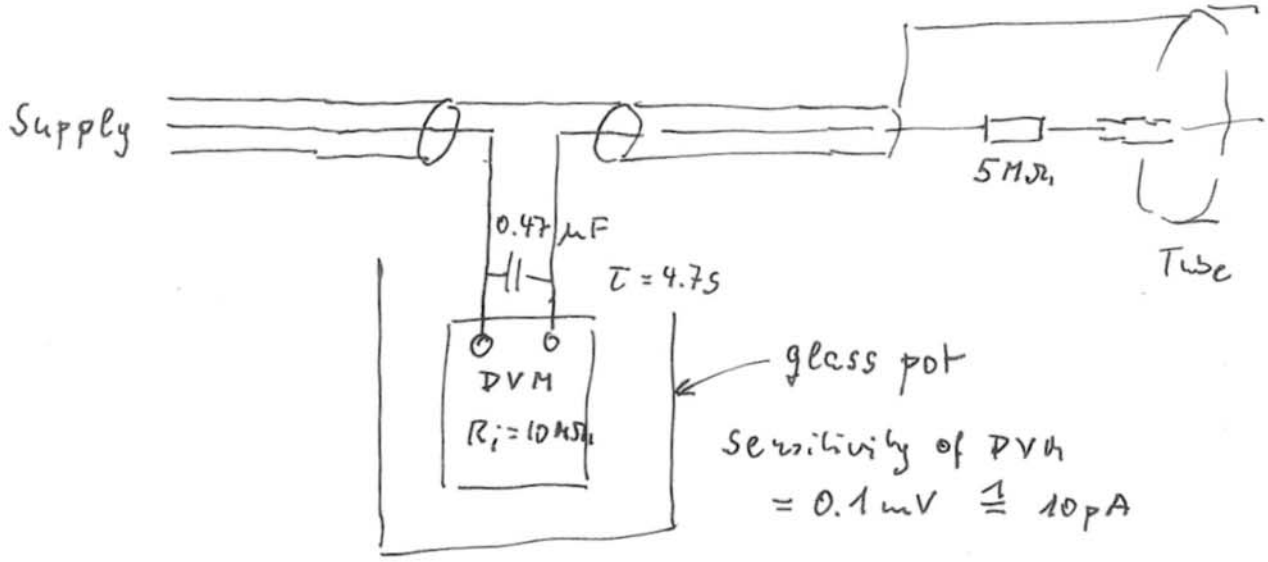
Discussion on electrical QC of tubes 13/4/99

1.) Experience with current measurement on 1.7m long tubes produced by Protvino

- gas: Ar/CO_2 93:7, 300 kPa
- Filling: Tubes were evacuated, filled to 300 kPa, pressure released, filled again.
- Current measurement:



- Measurement cycle

HV : 3080V, 3190V, 3400V, 3080V
gain : $2\,10^4$ $4\,10^4$ $\approx 16\,10^4$ $2\,10^4$

the whole cycle took $\approx 10'$

– Results

HV	current (mean for 49 tubes)	gain
3080V	120 pA	$2\,10^4$
3190V	205 pA	$4\,10^4$
3400V	880 pA	$16\,10^4$
3080V	110 pA	$2\,10^4$

– Interpretation

- The change of the current follows the change of gain
- The back part of the current can be explained by signals from cosmic ray particles

$$I(3080V) = 7\cdot10^2 \times 2\cdot10^4 \times 1.6\cdot10^{-19}\,C \times \frac{1.7m}{4.0m} \times 85\,\frac{1}{s} = 80\,pA$$

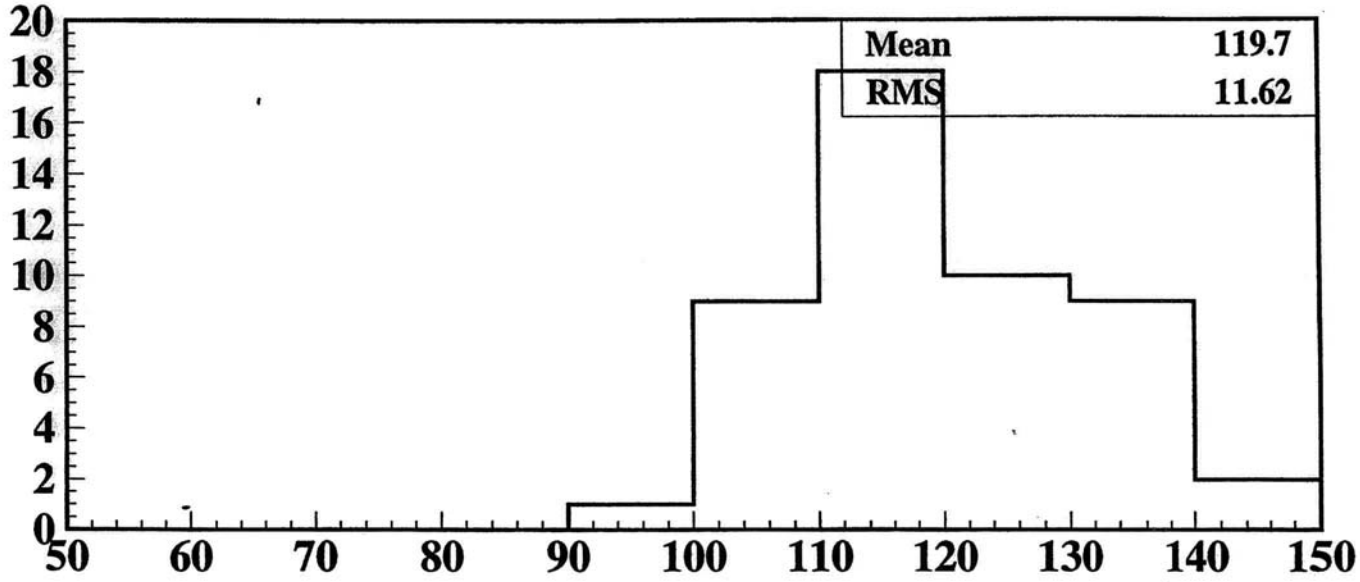
- $7\cdot10^2$: nr. of primarye per track
- $2\cdot10^4$: gain
- $\frac{1.7m}{4.0m}$: ratio of tube lengths Probing tube / BOS tube
- $85\,\frac{1}{s}$: cosmic rate in BOS tube

observed current 110 pA (i.e the esimate is 73% of it)

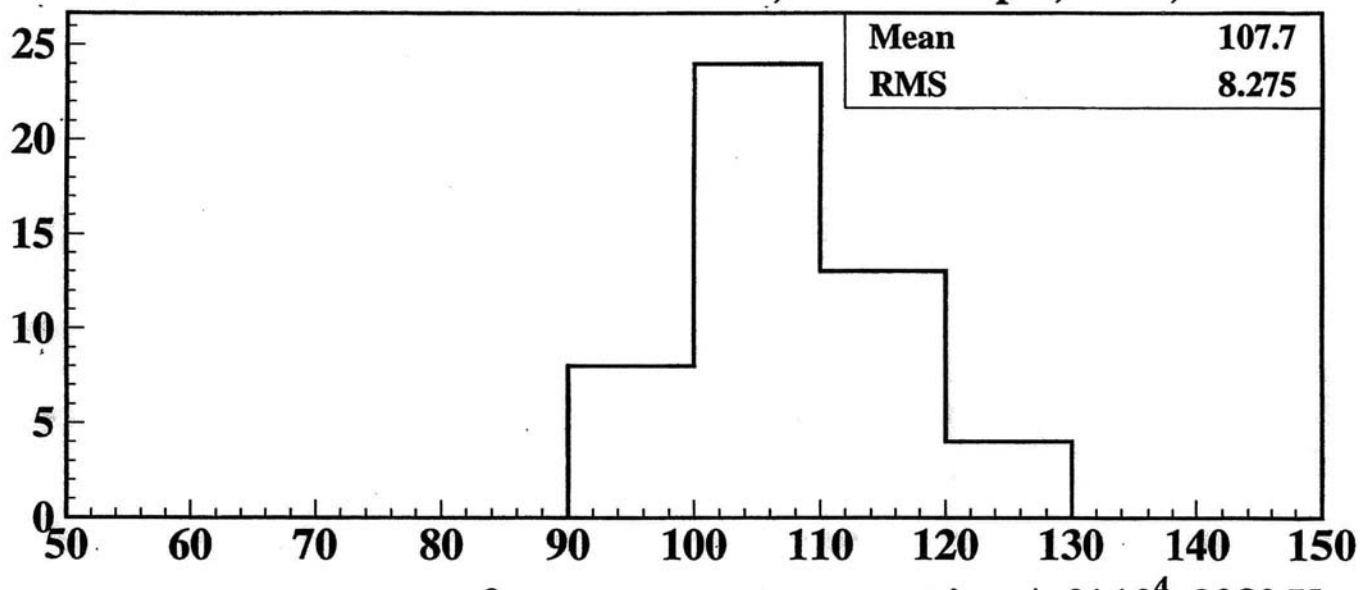
– Remarks

- Measurement on 1 tube 2 weeks later showed at 3080V $\approx$ 20 pA ($\hat{=}$ 18%) higher current.
- 1 tube was tested with 3400 V for a couple of hours. The current decreased very slightly ($\approx$ 10%).

Ar:CO2, 93:7

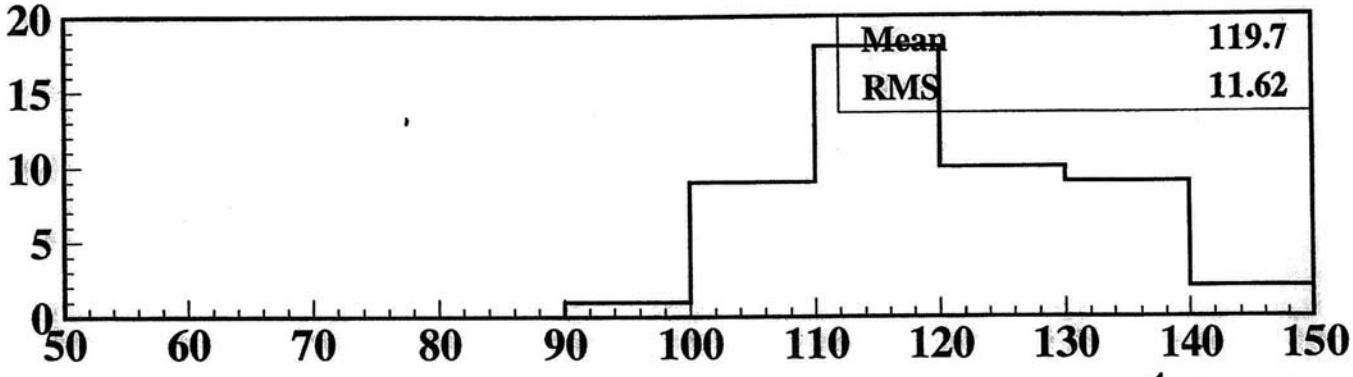


1.measurement, current in pA,$2*10^4$, 3080 V

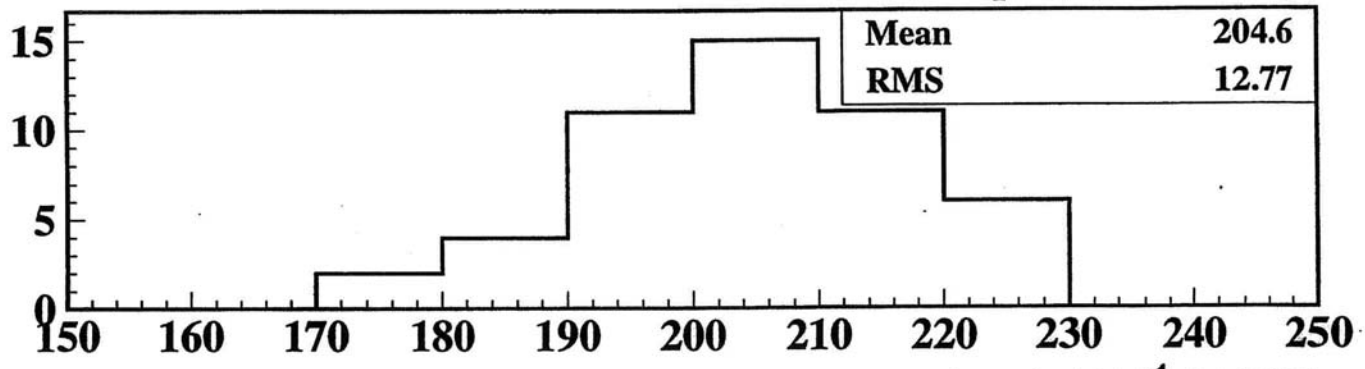


2.measurement, current in pA,$2*10^4$, 3080 V

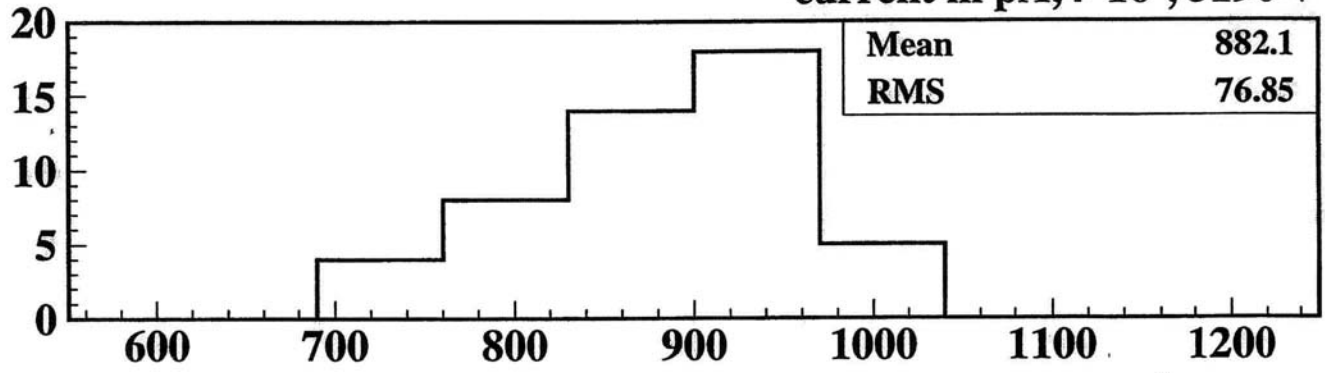
Ar:CO2, 93:7



current in pA,$2*10^4$, 3080 V



current in pA,$4*10^4$, 3190 V



current in pA,$16*10^4$, 3400 V

2. Measurement of current and counting rate for a few (11) BOS tubes

- gas: Ar/CO_2 93:7 at 300 kPa
- Current measurement: as for Proturino tubes
- counting rate measurement:

BNL amplifier and shaper
LeCroy discriminator, threshold 30 mV
} threshold for counting ≃ 25th primary e

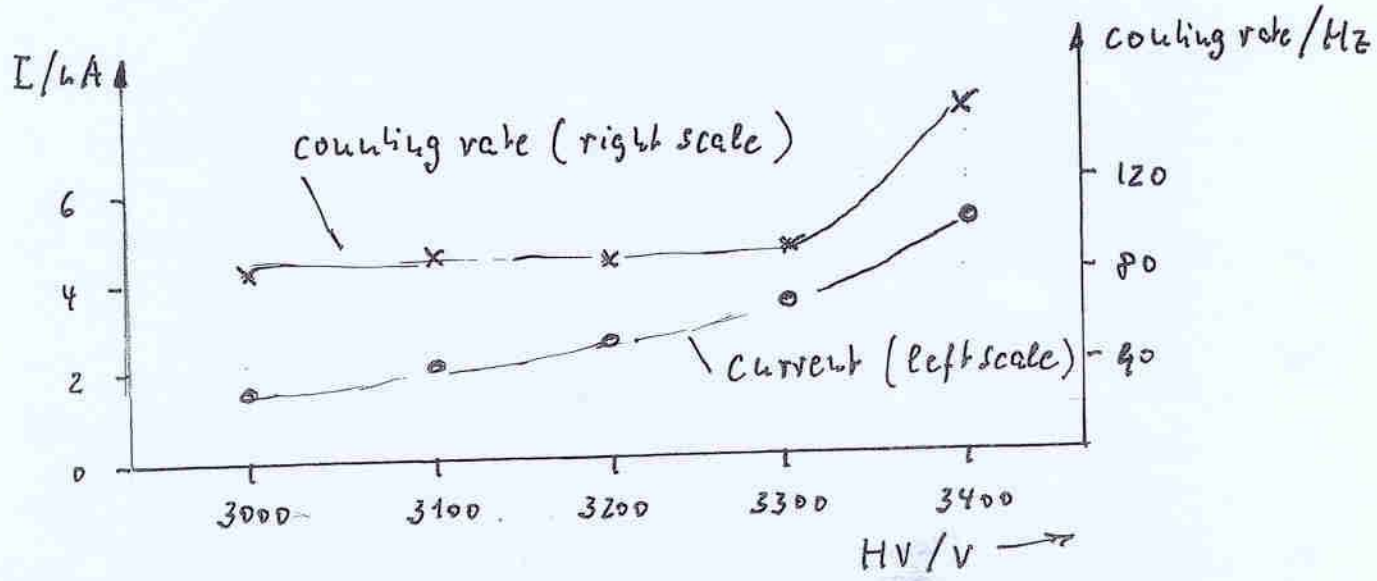
deadtime for counting: 1.5 μs

From the results of the Aug '98 testrun were selected

good tubes (no accidental hit for 200 triggers in a 3.1 μs window)
noisy tubes (up to 5 accidental hits ")
bad tubes (very noisy, good hits are swamped by accidentals)

a) Good tubes

Current and counting rate for a typical good tube



Remarks:

- Currents (scaled with the lengths BOS/Protvino) are higher than for Protvino tubes (Caveat: the measurement was done in the cold and rather moist EHN1 hall)
- Counting rate measurement was difficult (sometimes pick-up from electrical machines used for construction work in the hall)
- Increase of the counting rate at 3400 V is mainly due to doublecounting
- Except 1 tube, which showed some discharges at 3350 V, all good tubes behaved well for HV up to 3400 V.

b) Noisy tubes

1 tube: no difference to good tube seen (noise seen in testrun probably due to electronics)

1 tube: 3400 V could not be reached (current > 100 µA)

c) Bad tubes

no tube reached 3400 V (current > 100 µA)

Conclusion:

- Measuring the current for HV up to 3400 V allowed to spot all weak or bad tubes.
- The measurement of the counting rate gave no additional information

3 Criteria for acceptance of tubes which Hubert Kroha will propose (if there are no strong objections)

- Use Ar/CO_2 93:7 at 300 kPa

  Why? This gas is our baseline. It is a delicate gas and tube faults are not covered up by effective quenching

- Measure current at 3400 V (i.e. 300 V above our normal operating voltage)

  Why? Good tubes can stand this voltage. Weak or bad tubes show up.

  Currents are big enough that a meaningful measurement can be done with 1 nA sensitivity

- The current for accepted tubes should be below 2 nA / m of tube length

  Why? In good tubes the current is mainly given by signals from cosmic particles and hence should scale with the length of the tube.

  Prototype tubes had ≈ 0.5 nA/m. The proposed limit 4 × higher. It can be monitored with instruments having 1 nA sensitivity

- The measurement of the counting rate is very well come but not mandatory.

Summary of meeting

Ar/CO_2 93:7 was accepted

300 kPa : current upper limit of 2nA/m @ 3400V was accepted

however charge should be limited
ie 20nA not longer than 1' (1.2 μC)

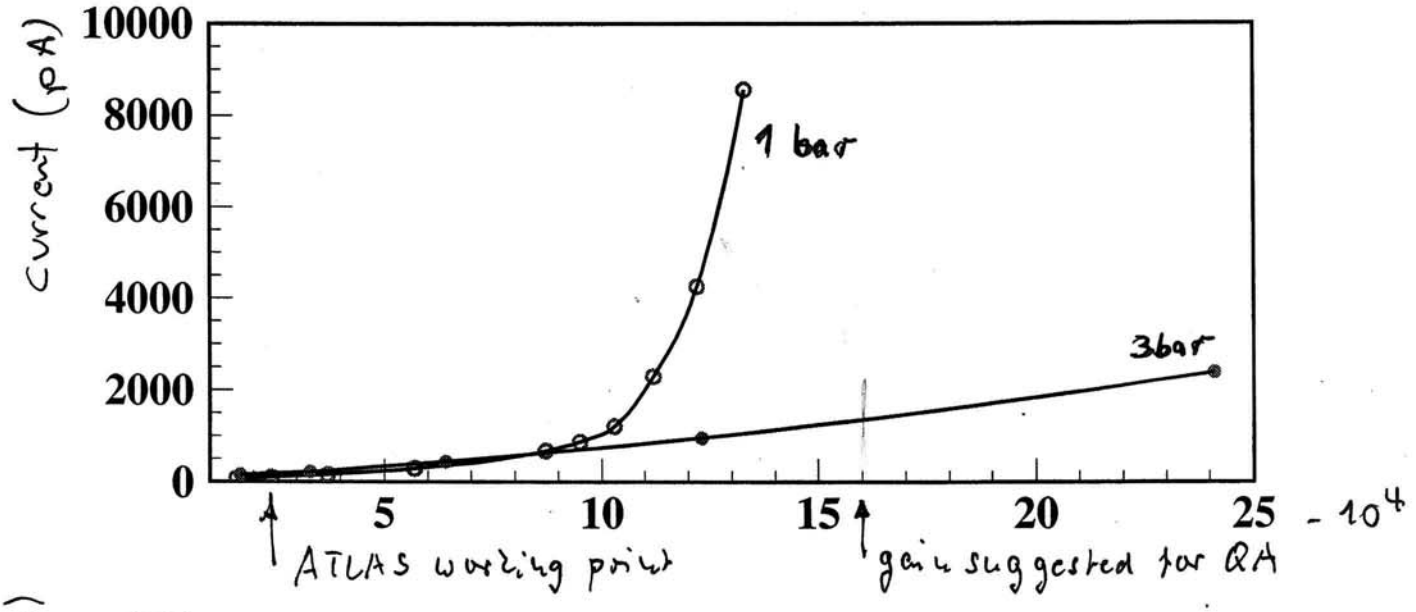
100 kPa : the voltage corresponding to gain $16\,10^4$ should be be determined (I accepted this job)
Test at this pressure should be allowed.

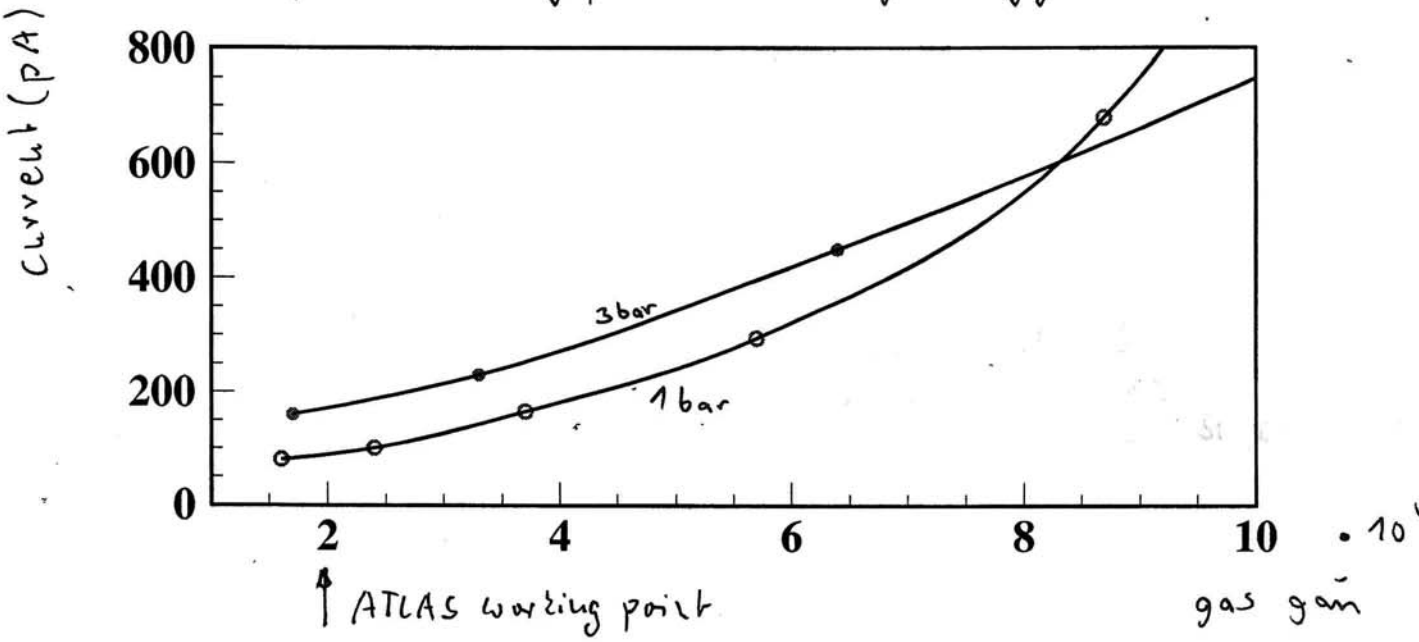
No procedure for conditioning was proposed (this should be free for the sites). However ramping up of HV not faster than 100 V/s.

Current vs gain, 1 and 3 bar

gain calculated from Diethorns formula
(parameters from ATLAS Note Alessa + Riegler, Dec. 98)

Ar/CO_2 93/7. tubes Protvino, 1.65 m long



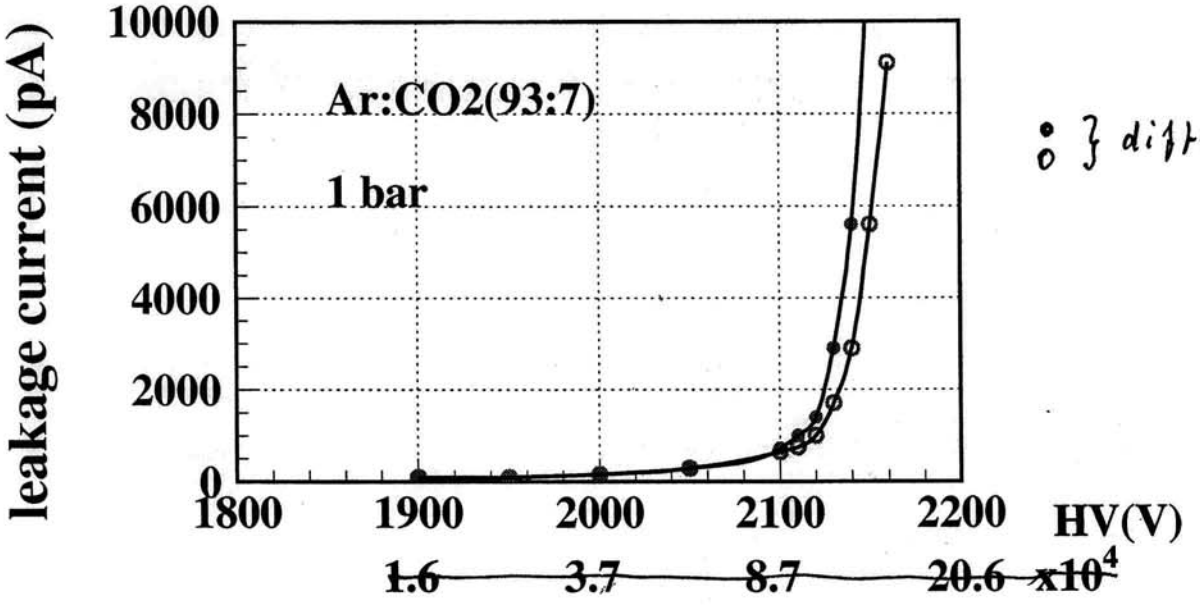


Observations:

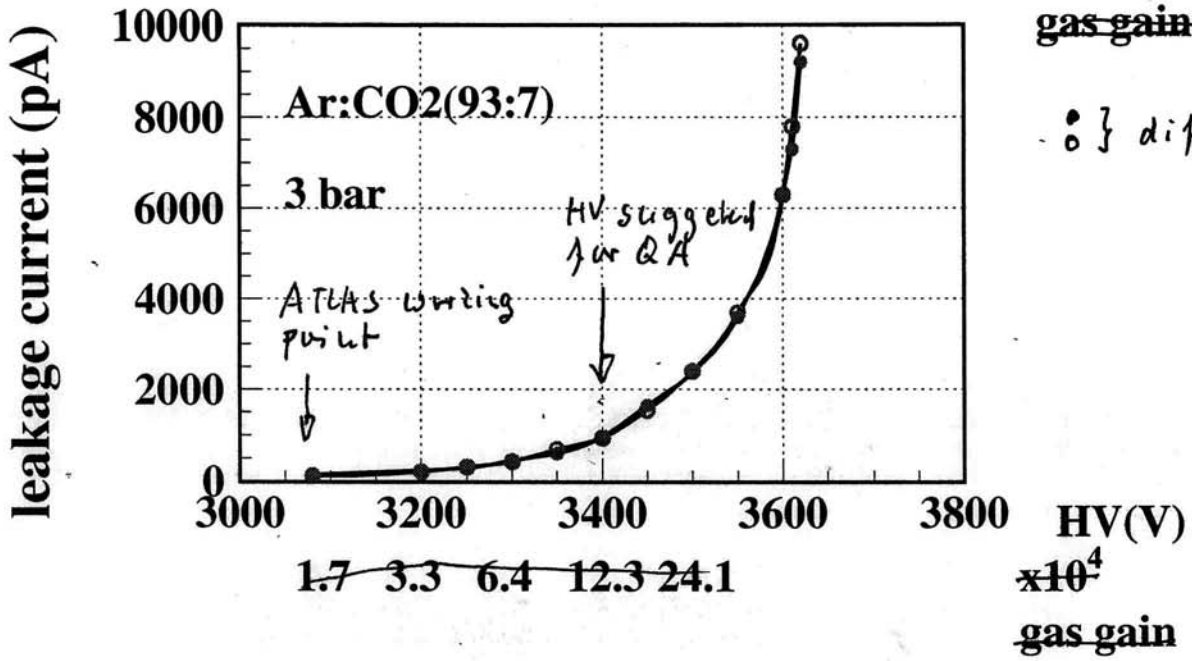
- @ gain 2×10^4, the current with 3 bar is only 2x higher than with 1 bar (streamers at 1 bar?, parameters in Diethorns formula not very precise?)
- @ 3 bar, current increases almost linearly with gain
- @ 1 bar, current increases steeply with gain. Scope inspection shows the onset of strong multiple pulsing

Current vs HV, 1 and 3 bar

Ar/CO_2 93/7
Plotting tubes, 1.65 m long



: } different tubes



: } different tubes

Observations:

@ 1 bar, current for gain $16\ 10^4$ has already run away

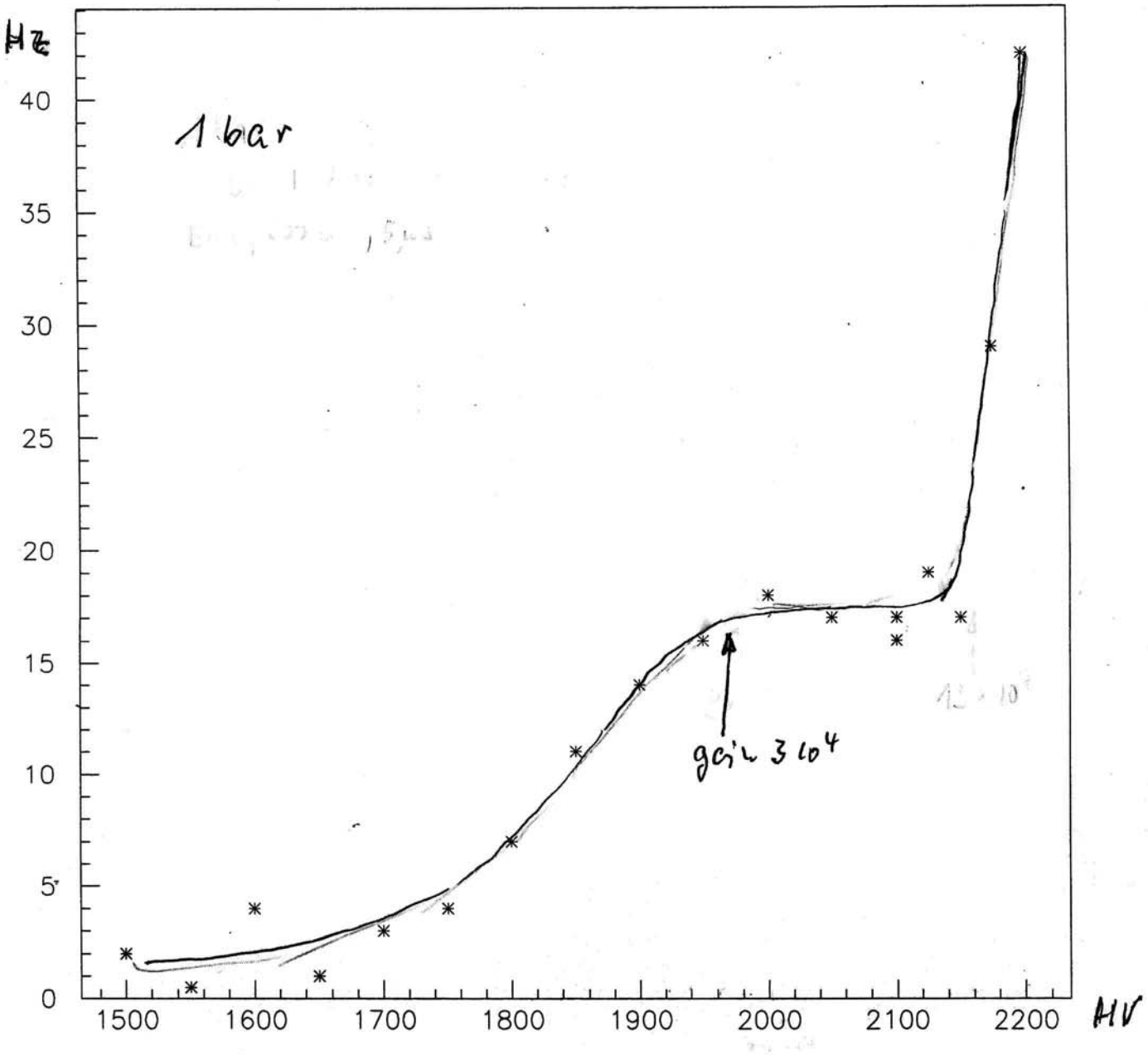
Conclusion:

QA at 1 bar has disadvantages

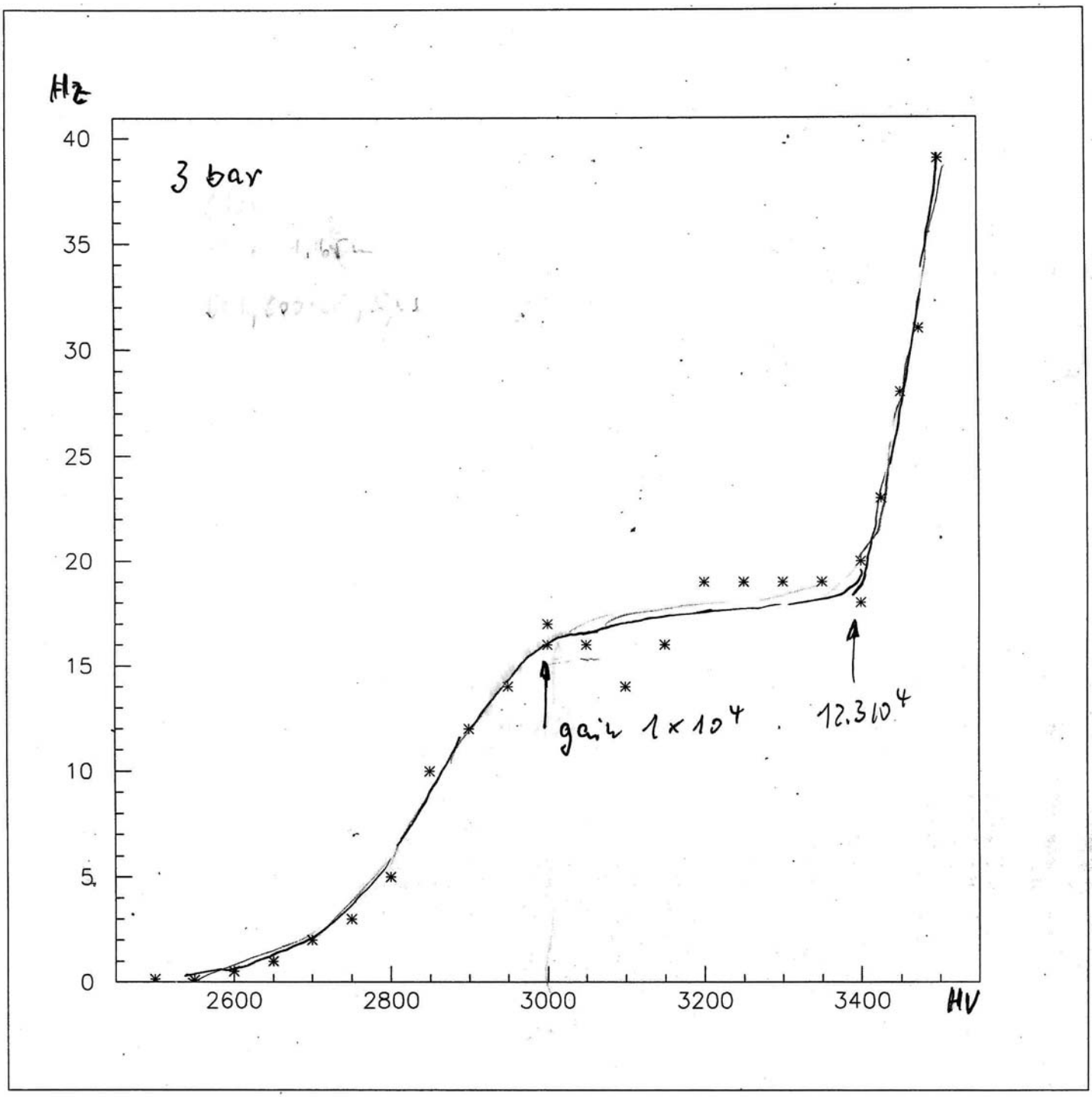
- test is performed at a low HV (lower than ATLAS operating point)
- QA cannot be performed at gains higher than 10×10^4 while at 3 bar one could go to $20\ 10^4$.

Counting rate vs HV

Ar/CO_2 93/7
Prototube 1.65 m long
BNL shaper + amplifier
Threshold 200 mV $\hat{=}$ 170 e^- (x 6.5 x higher than ATLAS plan)



note: The increase of the counting rate is strongly influenced by the electronics.
A timing-unit with 5 µs pulselength was used as deadtime generator. The unit is updating


Hz
40
35
30
25
20
15
10
5
0
3 bar
gain 1×10⁴
12.3 10⁴
2600
2800
3000
3200
3400
HV