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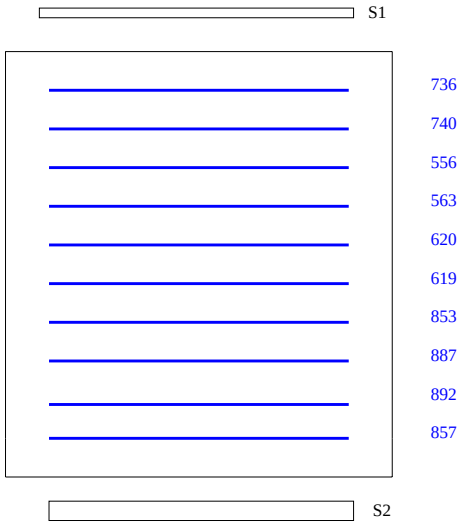
University of Oregon

Oregon RPC status report

- Test setup
- Status of chambers
- Efficiency and charge measurements
- Results of heating with low voltage
- Results of heating with high voltage
- Conclusion and Plans

Undergraduate student: P. Csonka

Test Setup



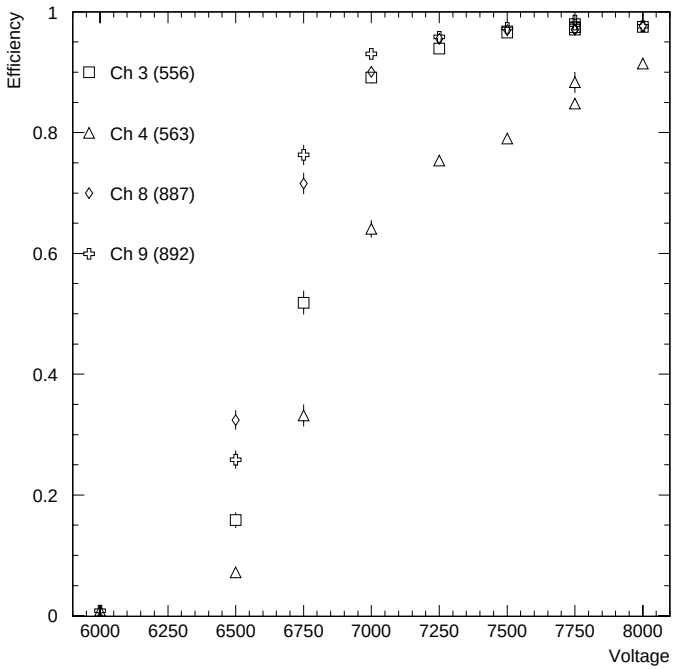
- Trigger is from scintillators. Top scintillator is ~ 20 cm deep, bottom scintillator is 90 cm deep.
- Gas is 40% Freon 134A, 4.2% isobutane and the balance Ar.
- For most measurements reported here 736, 556, 563, 887 and 857 are recorded using a TDC attached to the minicrate fast-or outputs.
- ADC's can be attached to any of the chambers. For most of these measurements all 32 channels of chamber 892 are attached to ADCs.
- HV uses old CAEN system. HV distribution boxes have 21MΩ of series resistance.n

Chamber Status

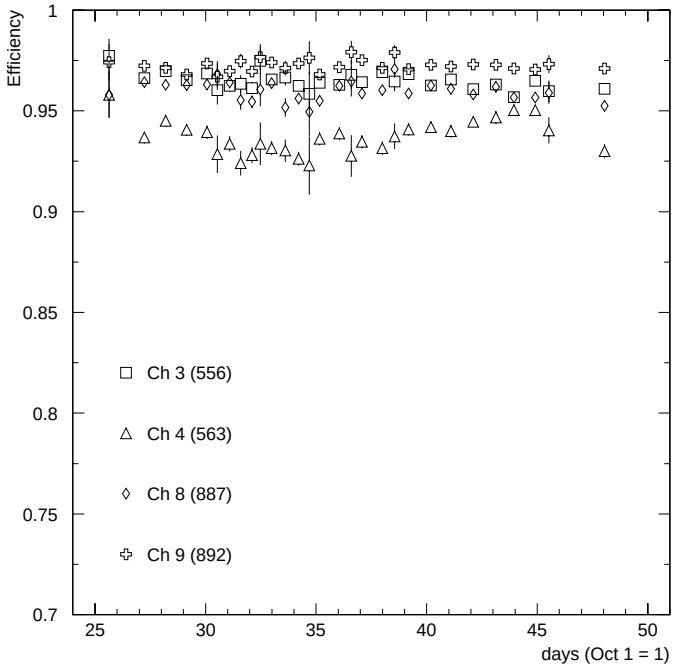
- 736 – good
- 740 – leaky (not tried on voltage)
- 556 – good
- 563 – some inefficient regions
- 620 – sparks, may have popped buttons
- 619 – may have popped buttons
- 853 – no strips, used for mechanical tests
- 887 – good **(presently being heated)**
- 892 – good
- 857 – efficient with high enough voltage (8500V), very uneven gain.

Typical Plateau Curves

For scintillators placed in center of detectors. ADC hits required in top chamber (736).



System is also stable over time:



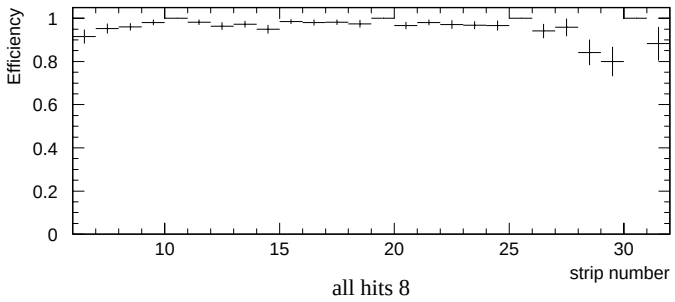
These data were taken in October with smaller scintillators

Currently Heating Chamber 8*

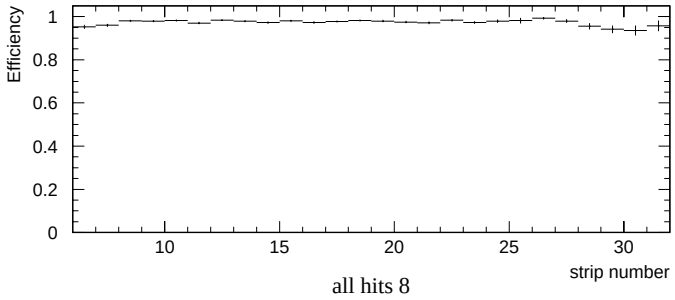
Efficiency of chamber 8 (887) as scintillators are moved to "front", "middle" and "back" positions:

Nominal Voltage is 7500V (actual 7350V) and position is that measured in chamber 9 (892). Strip not shown are outside of the geometric acceptance of the scintillators.

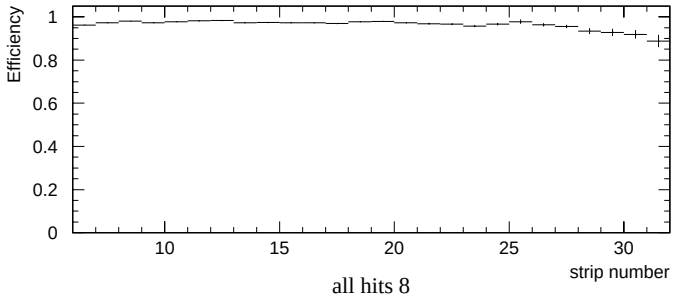
Front



Middle

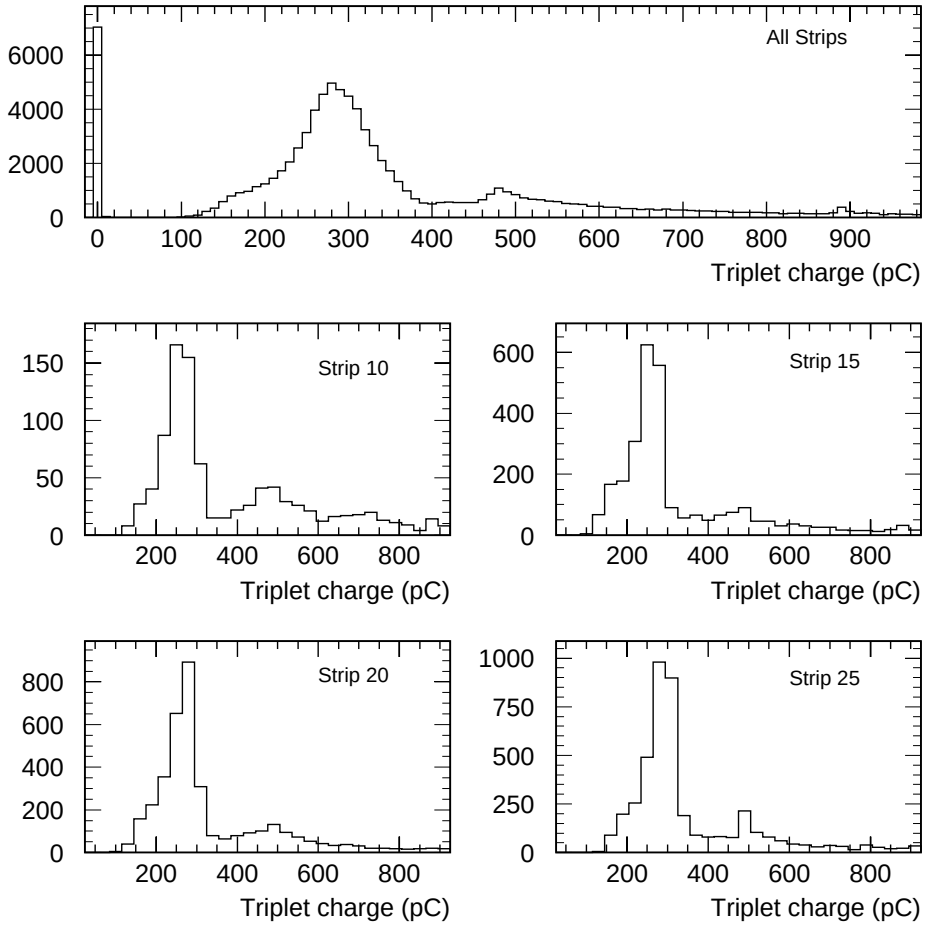


Back

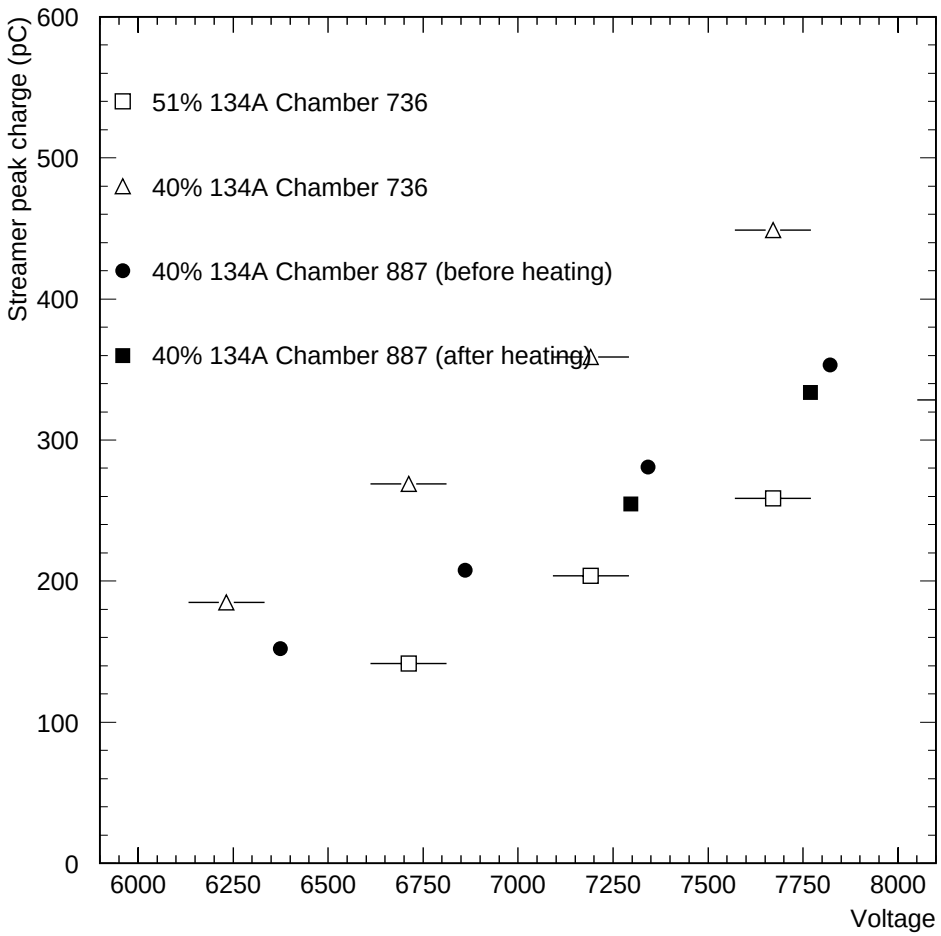


* From "good" part of production.

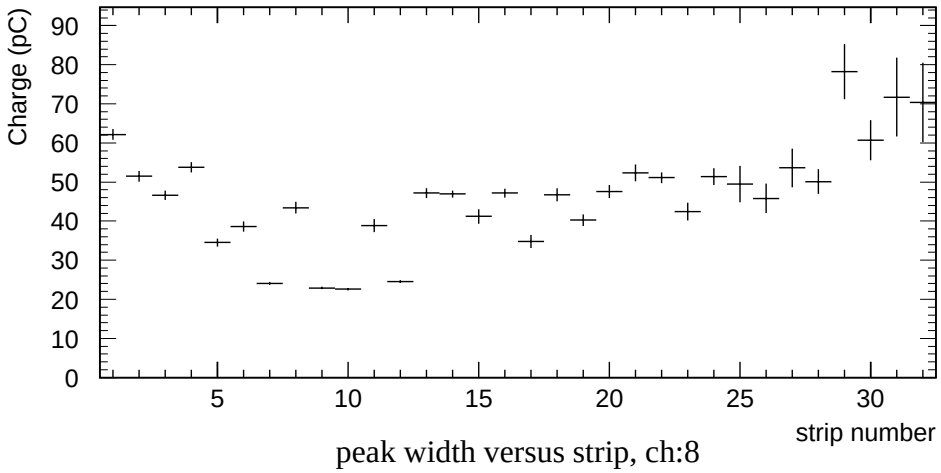
Streamer peak (all channels) chamber 8 (887). Somewhat broader than for other chambers.



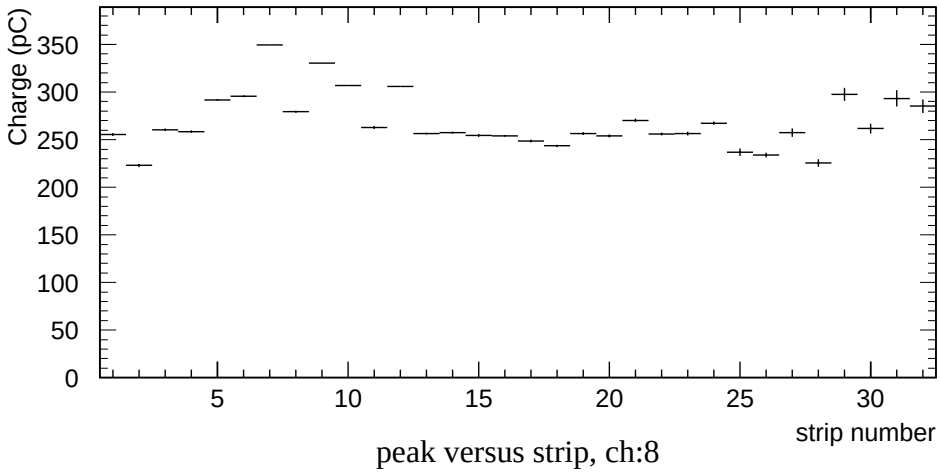
Streamer peak pulse height versus voltage for chamber 8 (887). Chamber produces somewhat smaller charges than were in seen chamber 1 with the same gas mixture.



Streamer peak versus strip position in chamber 8 (before heating).



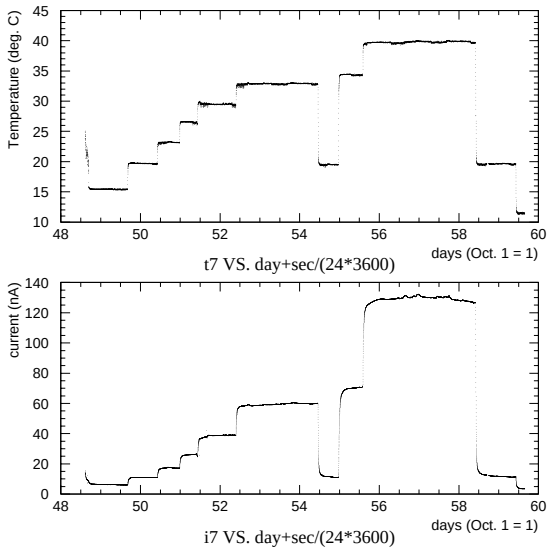
peak width versus strip, ch:8

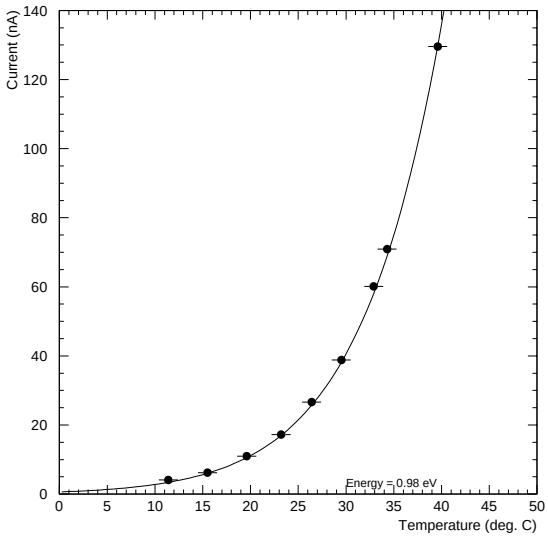


peak versus strip, ch:8

(7375 Volts)

Test of heating/cooling system using chamber 7 (853). Voltage applied to chamber is -10V. Chamber is open to the air. No permanent change in current seen after heating.



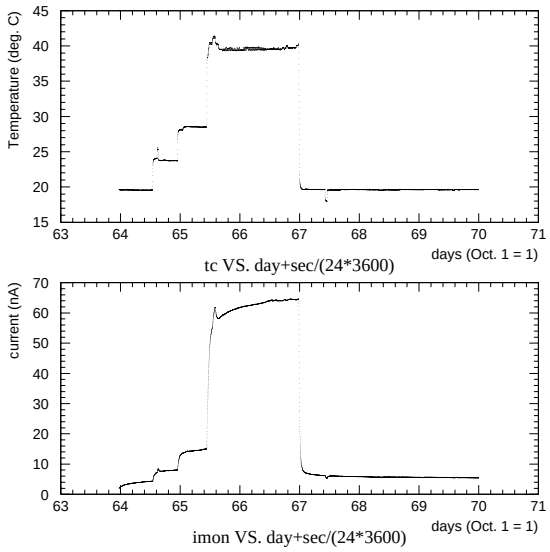


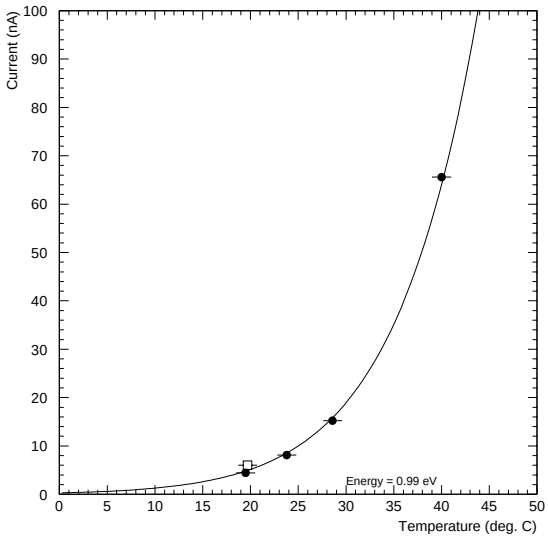
Current versus temperature follows an exponential:

$$I = I_0 e^{-E/kT}$$

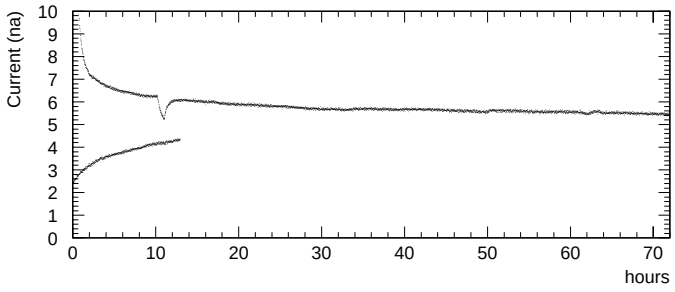
where T is the absolute temperature and E is of order 1 eV:

Similar results are observed with chamber 8 (887):





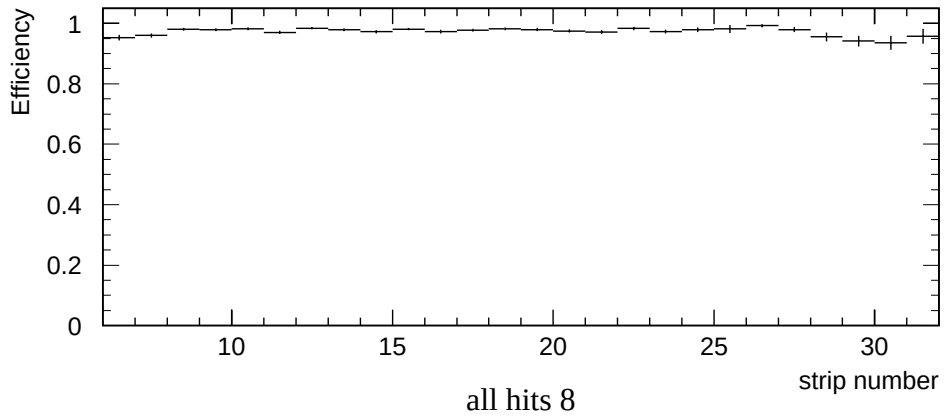
Possible small permanent increase in current seen, but more likely just an effect with a very long time constant. Could be due to chemistry of impurities in gas (e.g. O_2).



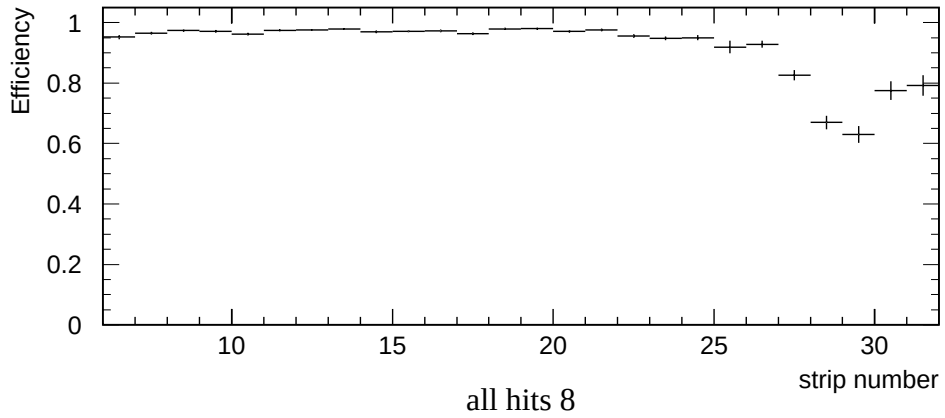
(Note these results are for -10V applied. At low voltage this chamber acts like a diode, current for +10V is larger by a factor of 2 or more.)

Efficiency in central region before and after heating with only low voltage.

Before (7350V)

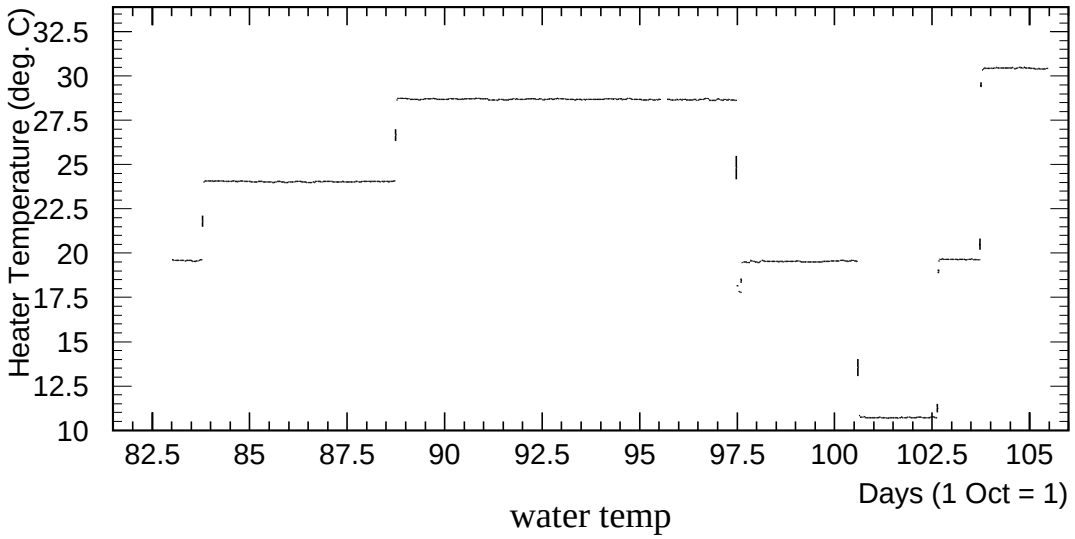


After (7350V)

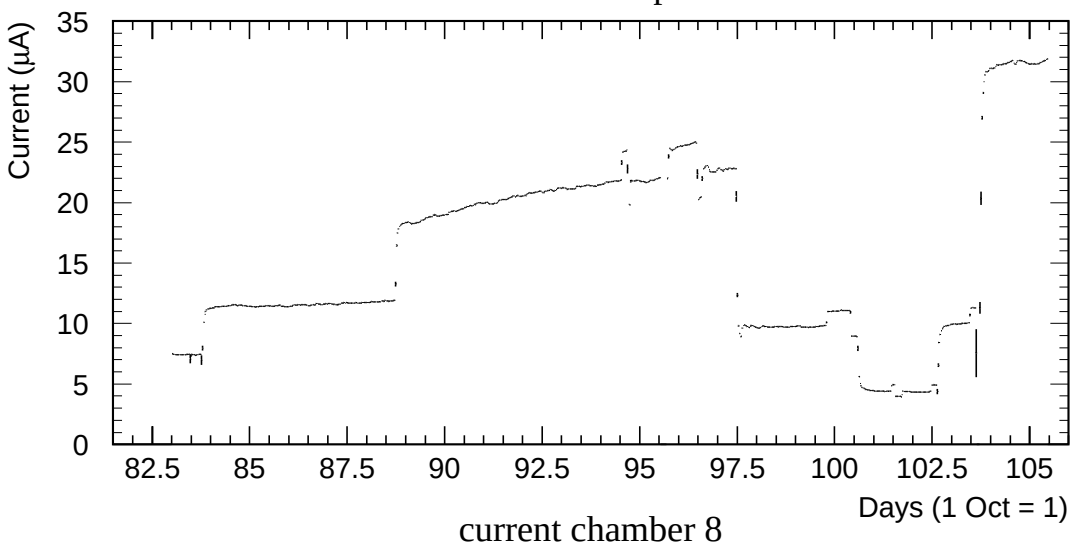


Slight decline in efficiency noted at high strip number. Measurements made at nominal voltage of 7500V (actual 7350 V). Can be recovered by increasing V.

After heating at High Voltage, a permanent increase in current from 7.5μA to 9.9μA is seen:



water temp

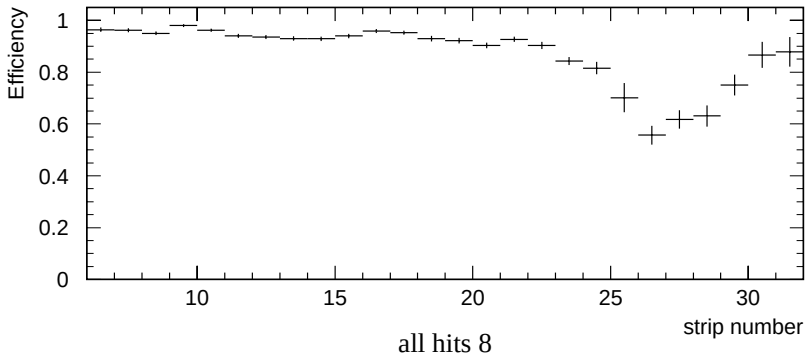


current chamber 8

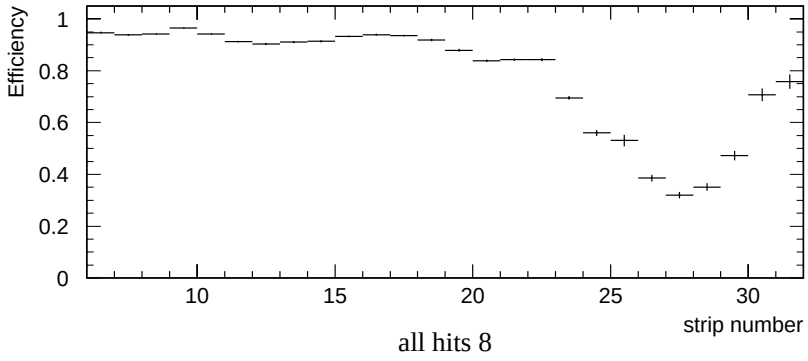
(Nominal voltage is 7500 V. Some data were taken at nominal voltages of 8000 and 7000 V.
Note that rate of current increase is faster at higher voltages, e.g. 4%/day, versus > 0.2%/day.)

Efficiency in "bad" part of chamber rapidly declines as the current increased at the *high temperature* ($T = 28.5°C$), primarily due to drop across 21MΩ resister

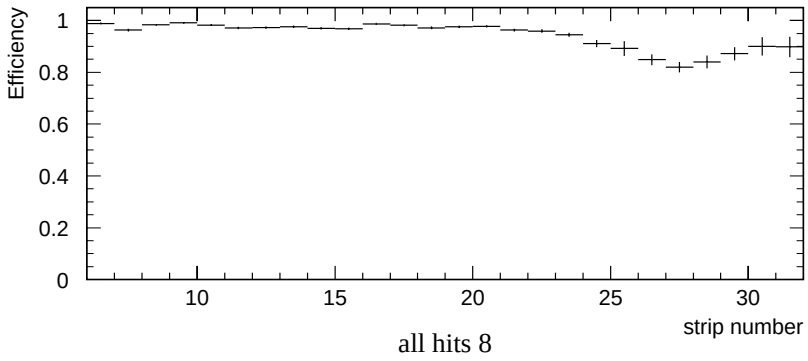
Start of heating 7100 Volts



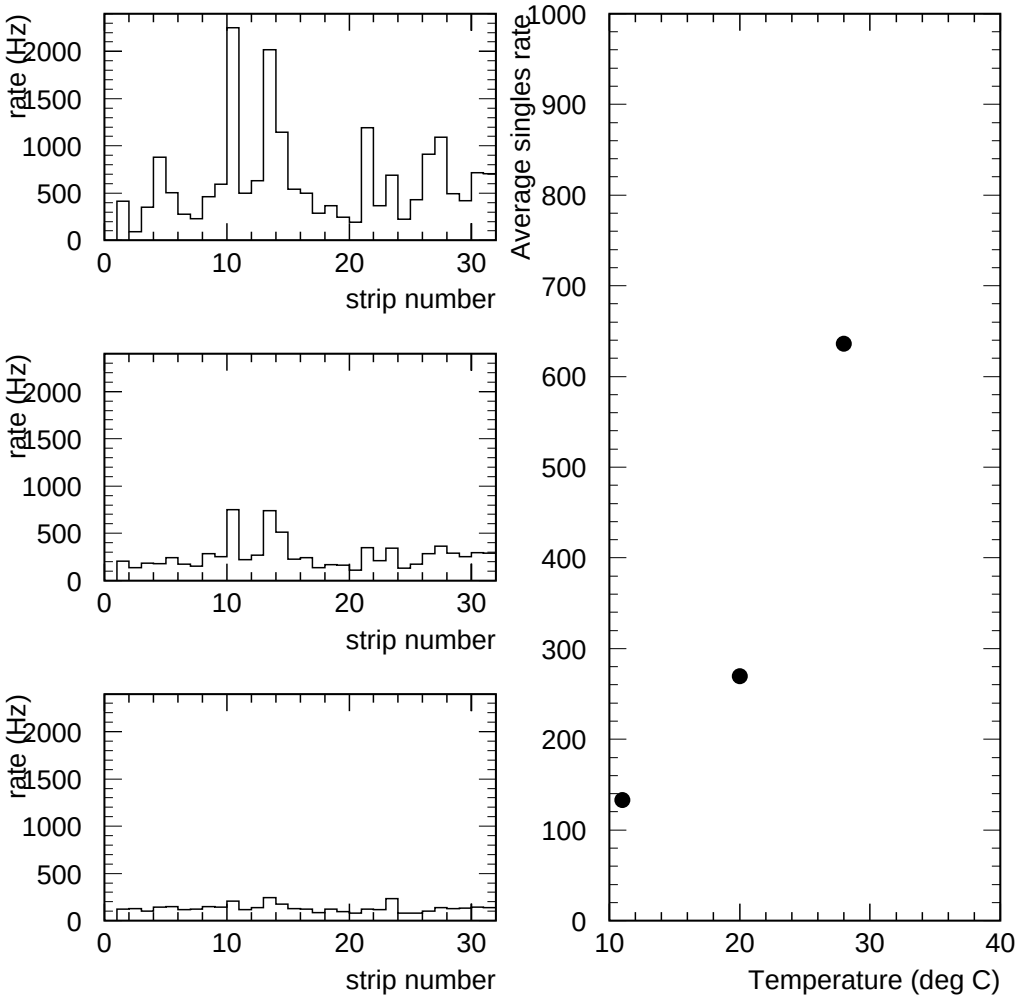
End of heating 7025 Volts



End of heating 7500 Volts

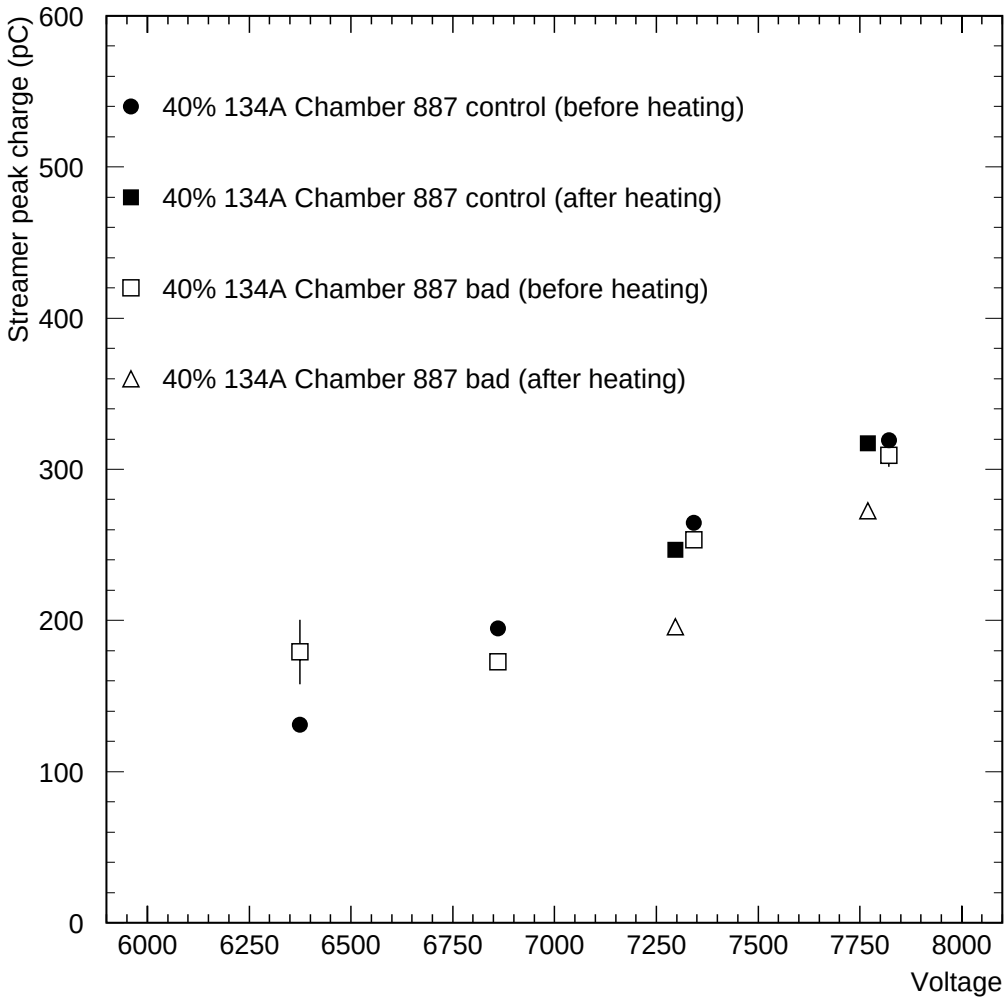


A high singles rate does not seem to be associated with the inefficient region of the chamber:



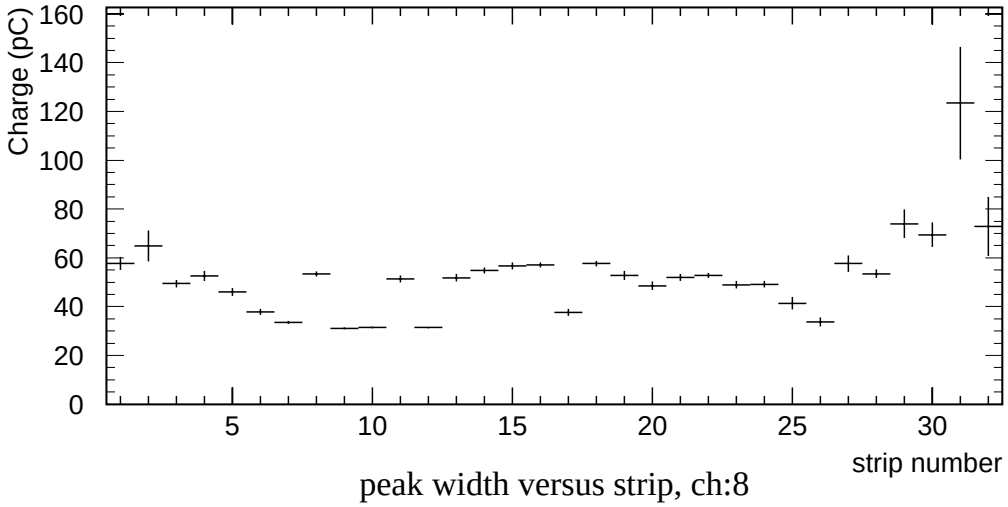
Plots on left show singles rates with 10mV threshold for the three temperatures, 28.5, 20 and 10.5 ° C

Even correcting for voltage drop in 21MΩ resistor, average size of streamer peak appears to decline after heating (both sets of data at 20° C).

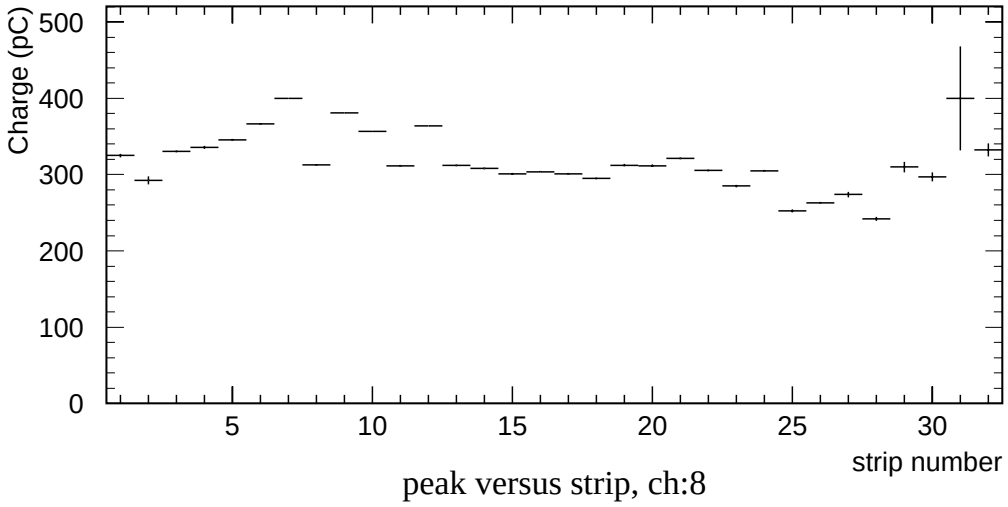


Bad region is strips 23-29
Control region is strips 10-20

Streamer peak position versus position, end of heating, 7750 Volts.



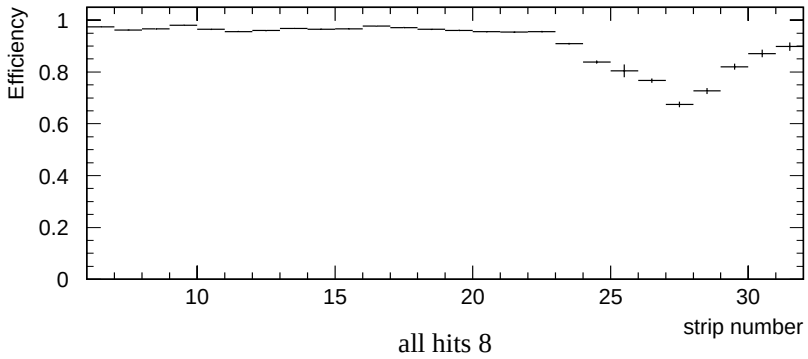
peak width versus strip, ch:8



peak versus strip, ch:8

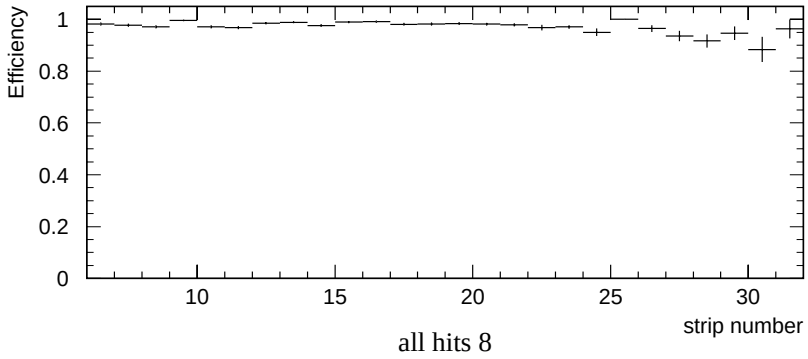
Does the chamber become efficient at high enough voltage?

7340 Volts



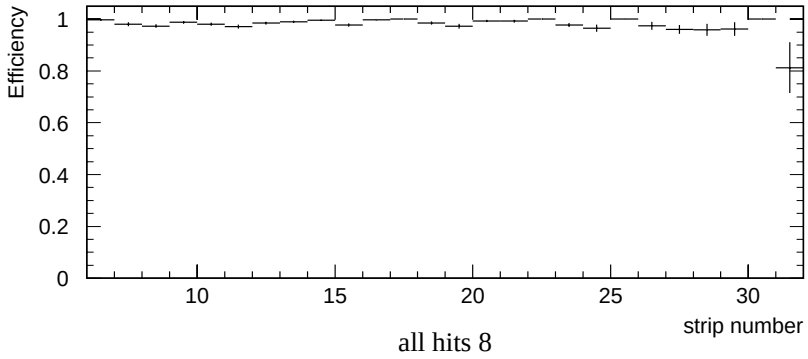
all hits 8

7750 Volts



all hits 8

8170 Volts



all hits 8

Conclusion

- Chamber current and singles rate are a very sensitive function of temperature.
  $\Rightarrow$ Keep chamber temperature below 25°C or even lower (not exactly news).

- No measurable permanent change in current seen when heating at low voltage only.

- Permanent change in current with heating and high voltage is seen for a chamber in the "good" part of the previous production at only 28.5°C.

- Rate of increase in chamber current at high temperatures is faster at higher voltage.
  $\Rightarrow$ Keep high voltage low.

Plans

- Continue to increase temperature of chamber 8 to 40°C. Perform autopsy if chamber fails.
- Repeat procedure on chamber 3 (556) (Should be likely to fail because it is from the bad part of the production.)
- Repeat procedure on a new Babar RPC (is it possible to get one?)
- Explore gas mixtures with still lower fractions of 134A – Does rate of current increase depend on steamer charge or on electric field?
- Try to understand loss in efficiency in chamber 10 (857) and chamber 4 (563)
- Attempt to use a radioactive source to do radiography