CFT/CTT Midterm Outlook

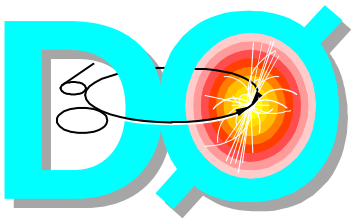
CFT

Larger issues:

- Frozen VLPC channels
- High Rate Effects and Rebiasing:
  - L1 dead time reduction
  - discr. occ.effects
  - VLPC rebiasing
- Offline ADC cut
- Monitoring for Radiation Damage

Smaller issues:

- Working Examine browser
- Added Examine functionality



FT_EXAMINE

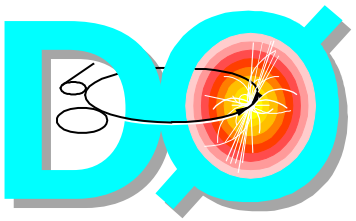
David Lam, ND, combined sub-detector online examines into a single examine.

Program runs well and is a great improvement

- ROOT browser is needed to view the histograms. Browser (patterned after the GM browser) crashes. From Fred: "Its half life between crashes is completely random and can be from hours to seconds. It does not crash benignly but does nasty things to the whole node. As a result it is unusable. This should be a simple fix, but we have exhausted our expertise and need help."

Need to add features:

- Automatic fiber occupancy checker: algorithm exists; need somebody to implement it
- SES alarm integration



Frozen Channels

- About 1.7% of all VLPC channels unresponsive/disconnected
- Kills 6.5% of CPS clusters !
- Most likely issue with water ice lifting the cold end cin::apse connectors (studies by George Ginther)
- Have outline of a battle plan for the Fall 2004 shutdown:
  - Warm up one cryostat, pump out, recool, extensive checks
  - Needs 2 weeks at beginning of shutdown, working DAQ for checks
  - If it works: repeat with 2nd cryostat; if not: warmup, inspect cassette
- Still debating on this, but doing nothing seems bad option for longterm operability prospects

L1 Readout Deadtime Reduction

From Fred Borcherding:
"Reduction of L1 Dead Time - This is a problem shared by SMT and FT with a common cause. Both the SMT and FT lead the detectors in the amount of L1 dead time. At the present L1 rate all other sub-detectors have less than 1/2 the dead time we do. Our dead time is set by the readout of the SVX chips. A group has already been formed with members from SMT, FT, and engineering experts for all the hardware involved. We have a weekly standing meeting that I chair. Active work is ongoing for both the SMT and FT groups that is being coordinated so that it is as complementary and non-overlapping as possible. Improvements in the range of 20% seem very possible and will take month long time scales to test and implement. Improvements of over 50% to a factor of 2 have been proposed but will take a lot of work and possibly hardware changes. This group has goals for both before the fall shutdown and for coming out of the shutdown."

Current Strategy

- Streamline some setup etc. times
- Remove VSVX addresses: 7% (Fred has detailed plan for this)
- Read out at 53 MHz: split clock for VSVX and SVX ? Some risk even if tests go well (cf. last year)

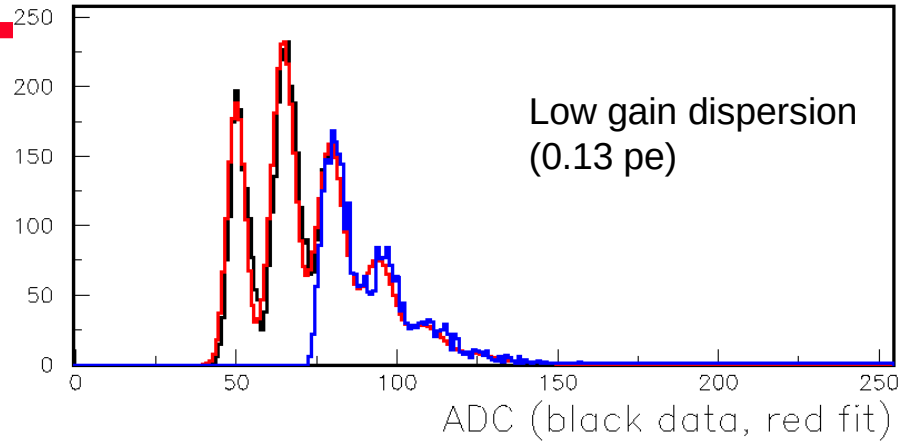
VLPC rate, rebiasing

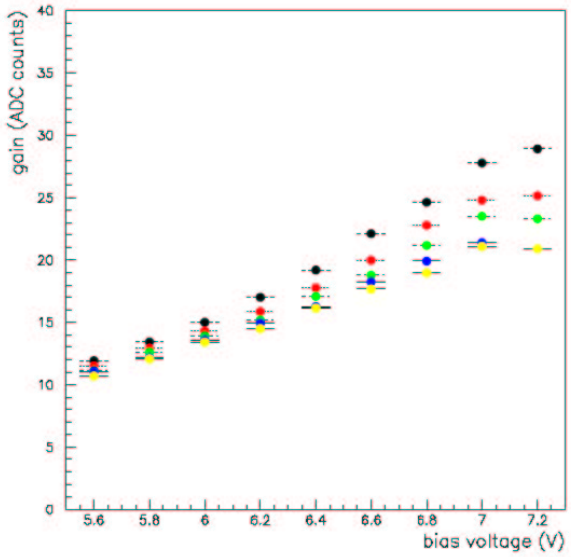
- Next slides directly taken from Juan Cruz Estrada

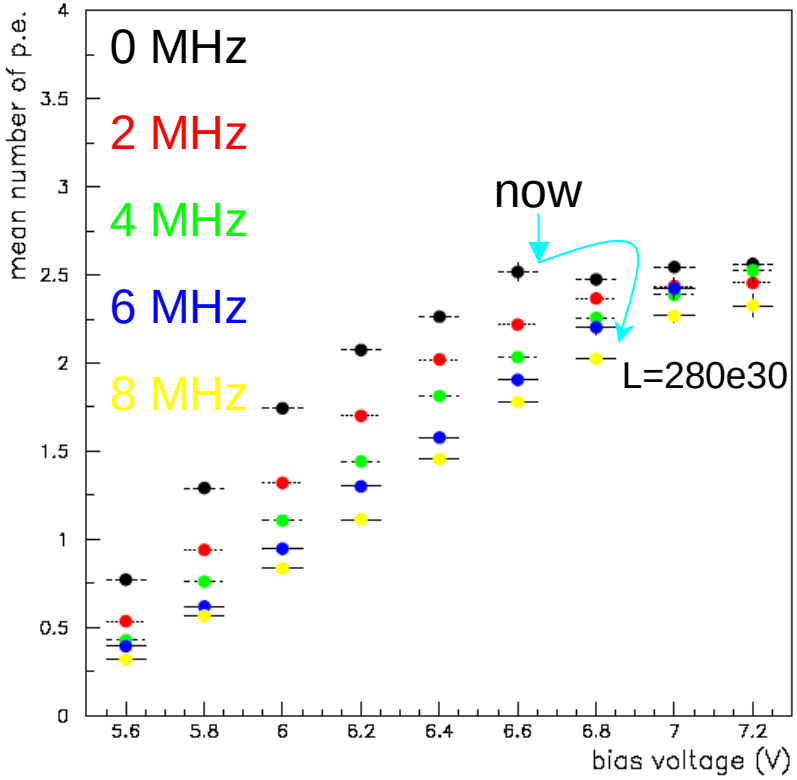
VLPC operation at high rates

Photopeak spectrum (using LED) gives relative Quantum Efficiency (Q.E.) and gain.

gain and Q.E. drop as the rate into the VLPC increases (calibration data from LAB3)







The model for this effect did not match our observations.

VLPC operation principles

When a bias voltage is applied, the electrons populate the inpurity levels (D*) in the gain region, leaving a fixed charge density in that area.

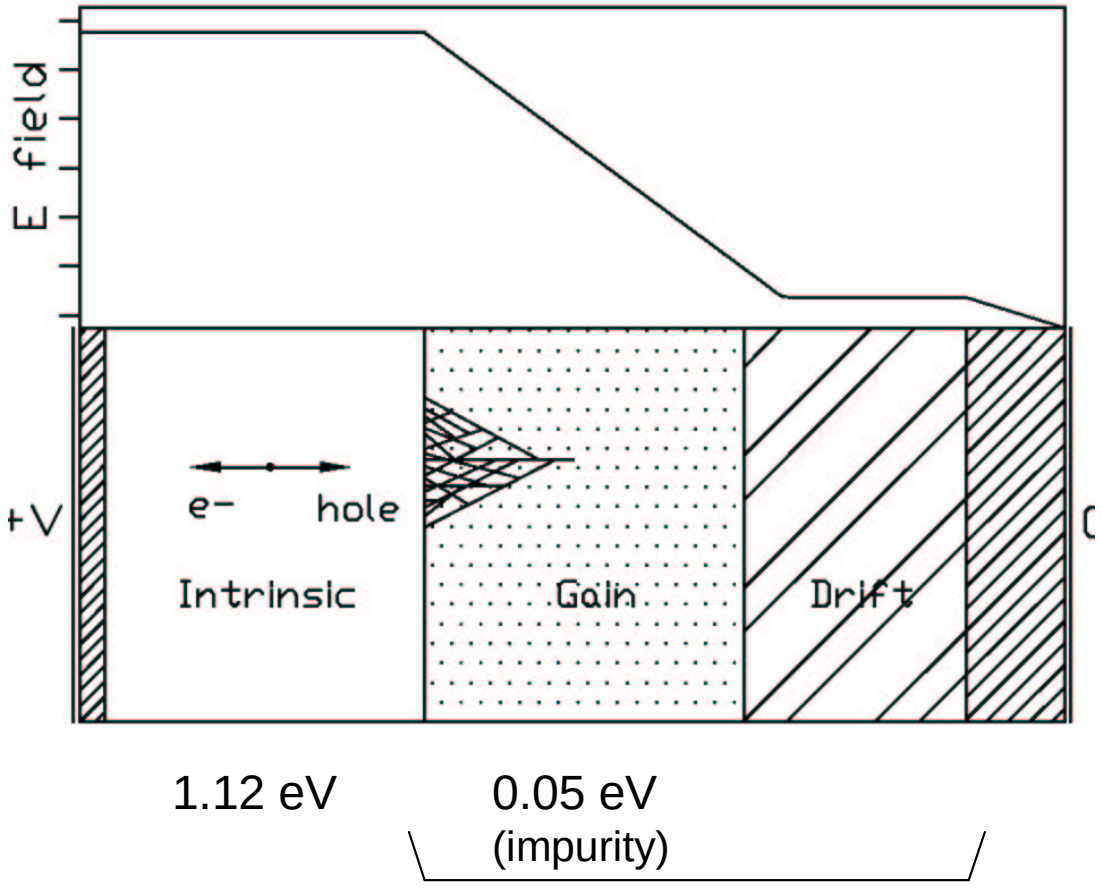
Operation:

- **photon is absorbed in the intrinsic or gain region creating an e-hole pair**.
- In the gain region the hole can separate an electron from a D* state starting the avalanche (also creating D^+ charges).

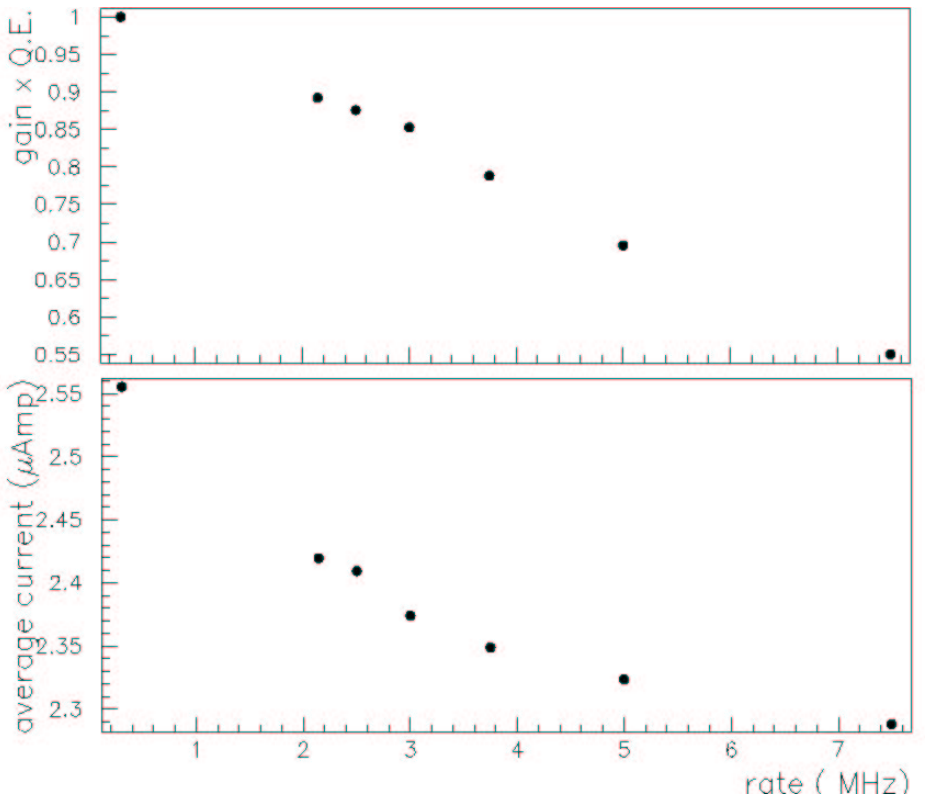
(old model: H.Hogue, Proceedings of SCIFI97)

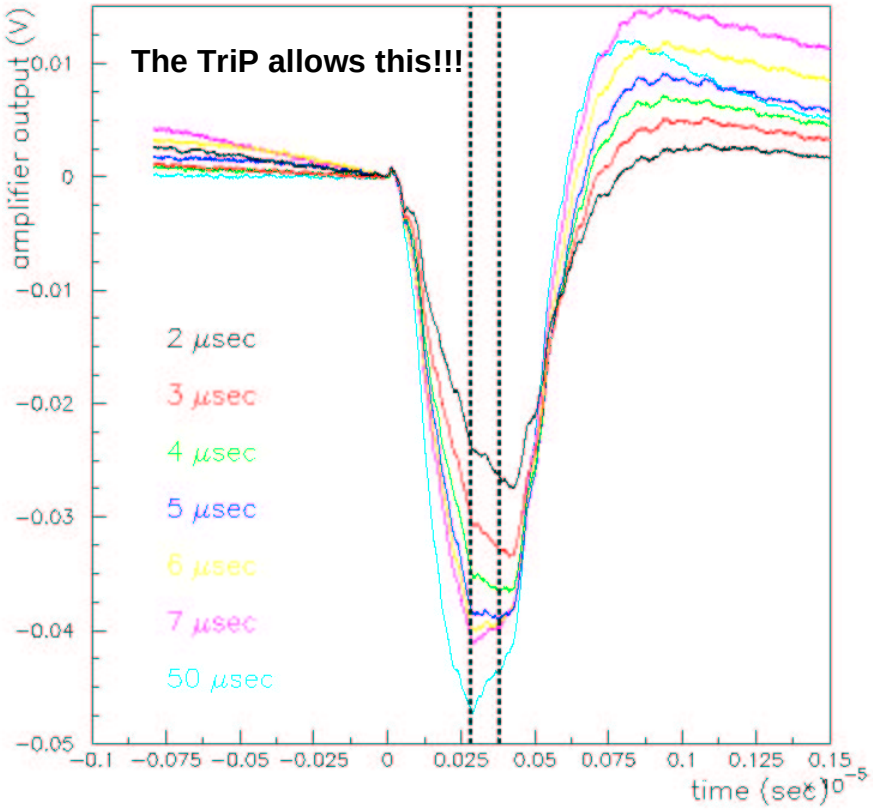
The current goes up with rate, and field in the gain region drops due to Ohm's law in Drift region.

donor(arsenic) : $N_D \sim 10^{18}/cm^3$
acceptor: $N_A \sim 10^{14}/cm^3$
highly doped weakly compensated



Verification in the test Cryostat



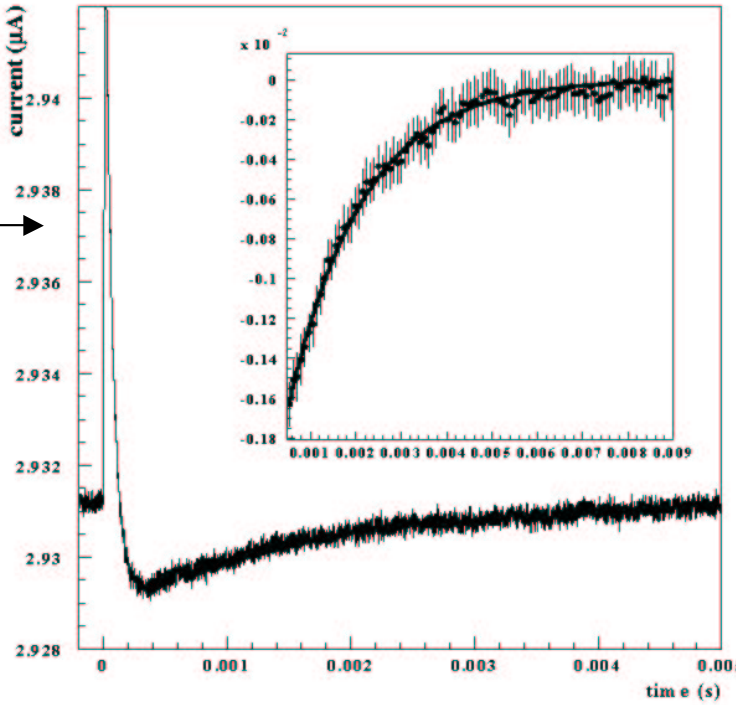


In order to verify what we saw in the detector, we did a rate experiment in the test cryostat and confirmed our observations. **We were able to see gain and Q.E. dropping with rate, and the bias current going up. The old de-biasing model is ruled out.**

VLPC operation at high rates (new model)

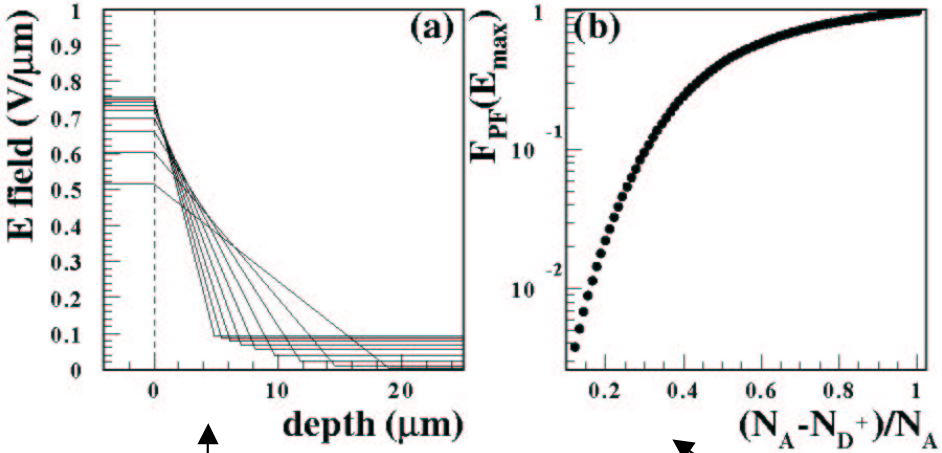
Effort to understand the effect.

We see a drop in dark current drop after a single pulse.



Measurements done with a digital scope in the test cryostat

Calculations using typical parameters for the VLPC

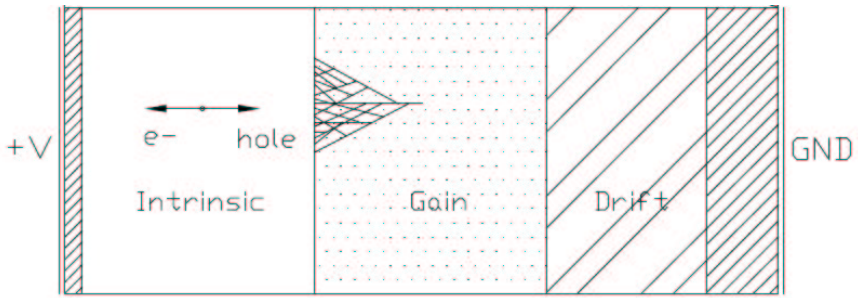


We conclude:

After an avalanche, a region of the VLPC has a concentration of D+ charges. The charge density in that regions drops, and this reduces the field.

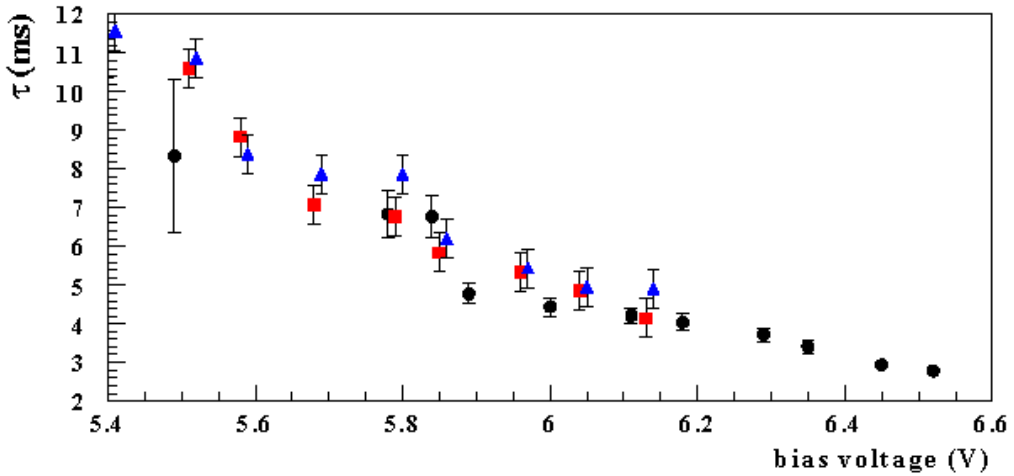
The dark current drops very fast with the field (Poole-Frenkel effect). QE and gain depend on the field.

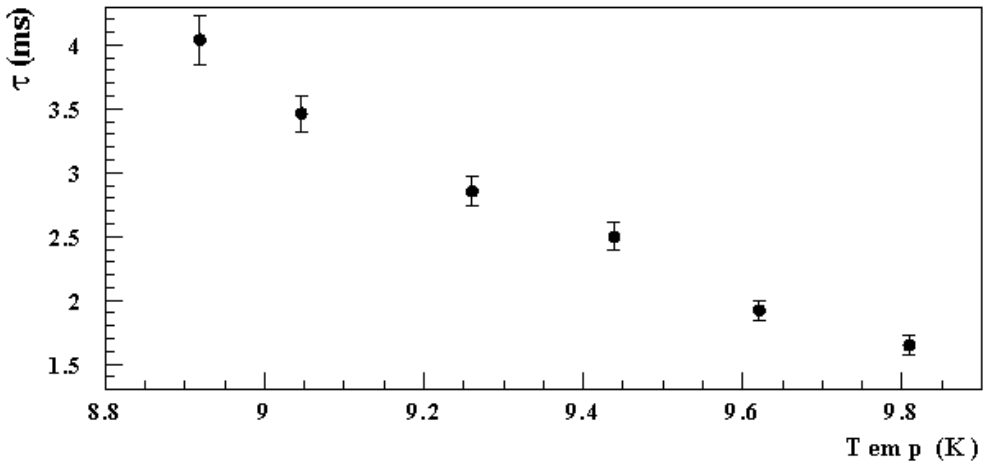
D^+ carriers are very slow.



Juan Estrada

Recovery time

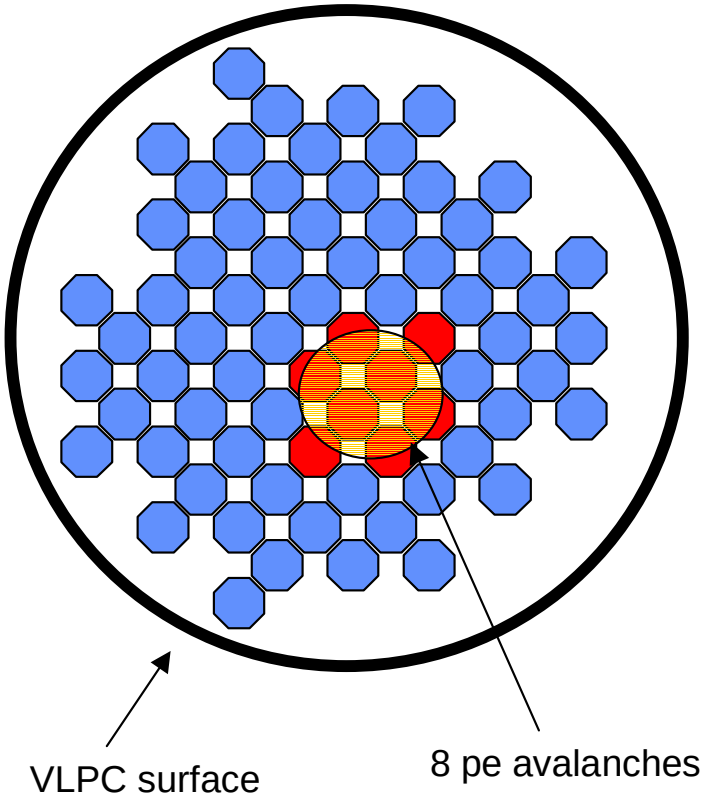




We measured the recovery time as a function of bias voltage and temperature.

This shows that the recovery is thermally activated.

VLPC numerical simulation



- the VLPC is made of cells (60K)
- the avalanche for a photon occurs inside one cell
- no communication between cells

The avalanche turns off the dark current for that cell, and has an exponential recovery with characteristic time on the order of 3.5 ms.

The gain recovers with the same characteristic time, the QE is a power of the gain.

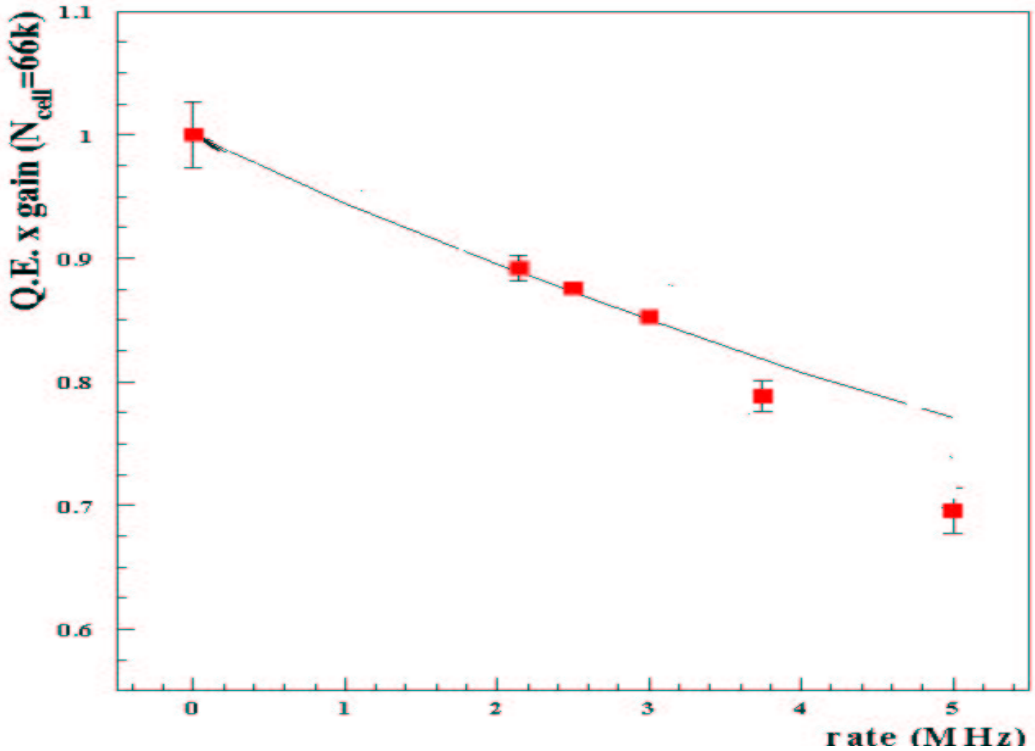
This VLPC can be simulated numerically

VLPC operation at high rates (new model)

Numerical simulations show that the observed characteristic time of 3.5 ms can explain performance decrease with rate for the VLPC.

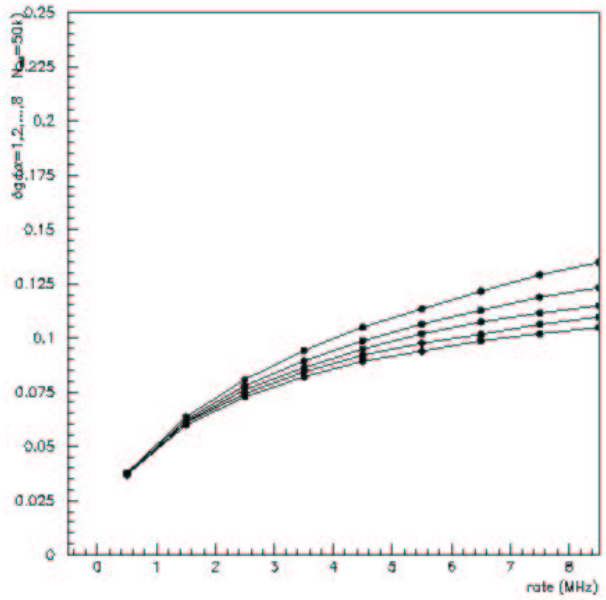
Using the model we estimate:

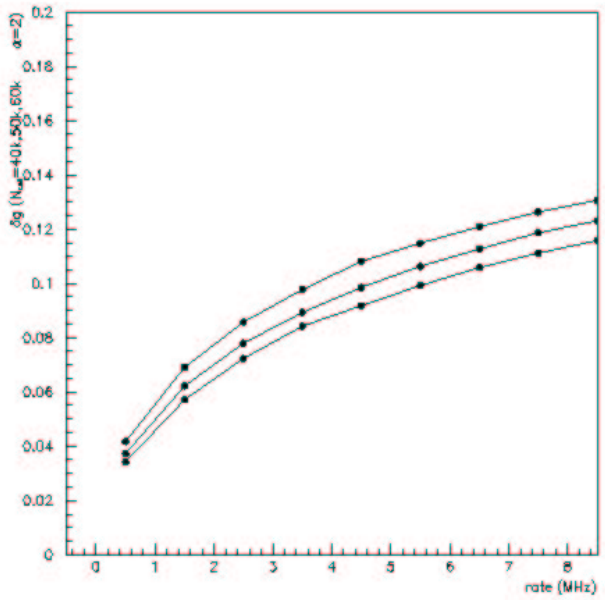
area for the avalanches: 12μm
drift velocity for the slow carriers: 0.3 cm/s

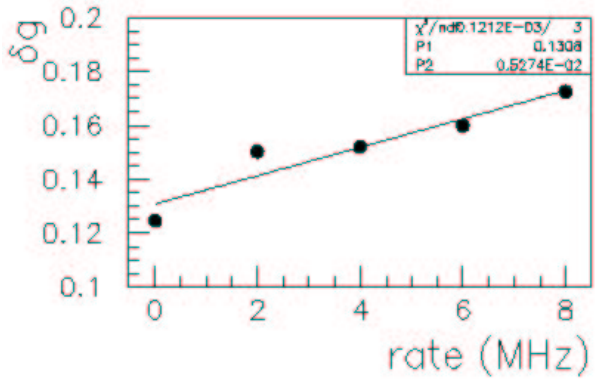


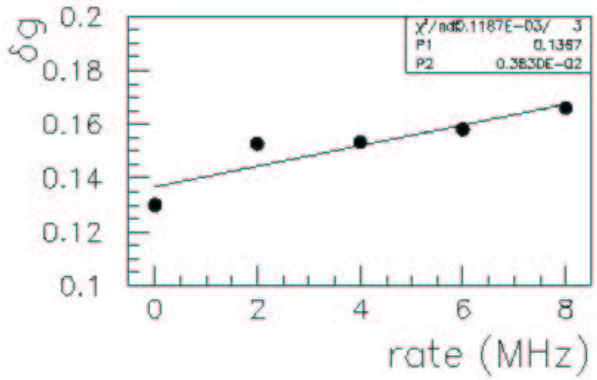
(measurements and model submitted to Applied Physics Letters)

Gain dispersion



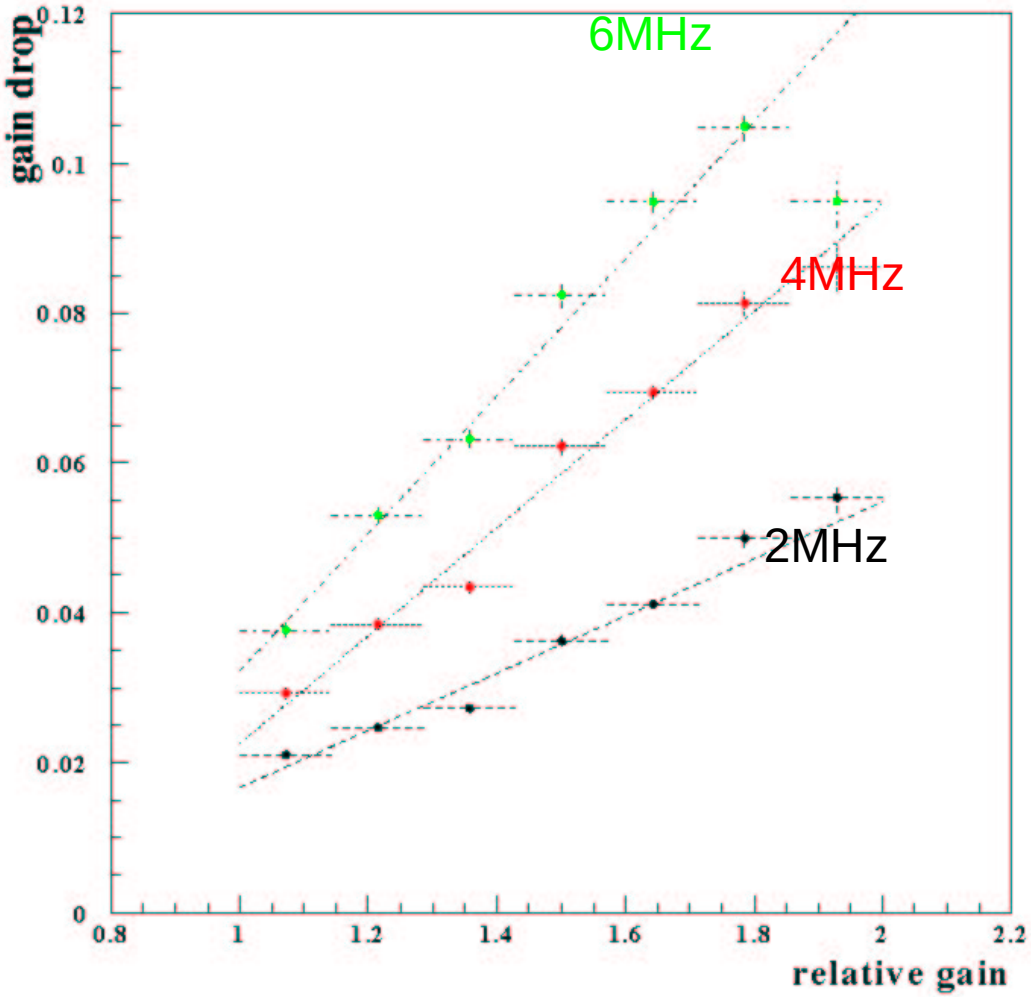






Another nice aspect of this model is that it predicts the increase in gain dispersion as a function of rate. This effect is seen in the LAB3 data. If our paper with the new model gets published, this is something that I will like to submit in the next VLPC paper.

Gain drop vs gain

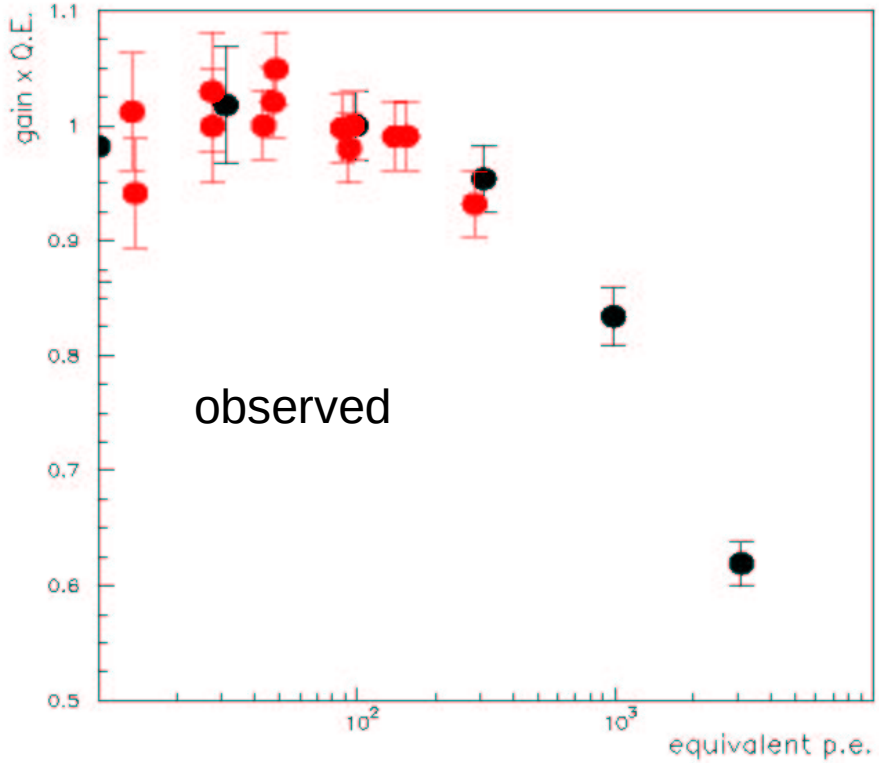


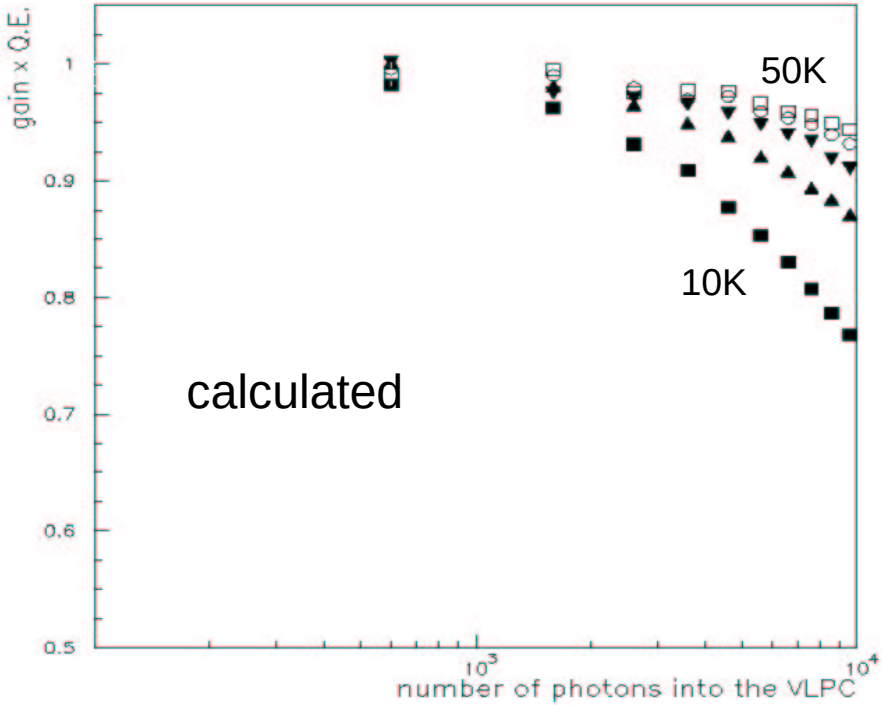
The fractional gain drop is larger for VLPCs that have a larger gain. The plot includes the calibration data for 10240 channels at a fixed bias voltage.

In our model this means that the **higher gain is achieved by increasing the size of the avalanches**.

If our model is published in APL, I will like to include this in a next VLPC paper.

Single pulse saturation





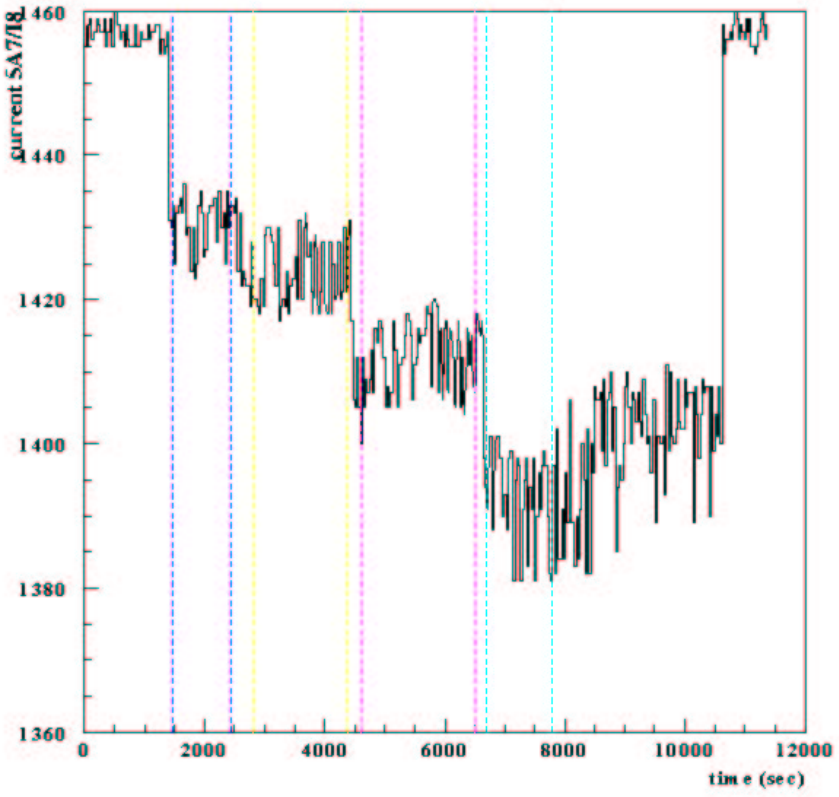
There has been observation of single pulse saturation in the VLPC, deviations from linearity for ~1000 photons (Marvin Johnson, Don Lincoln, Bruce Hoeneisen, Alan Bross, and others) .

We see this occurring much earlier than expected due to avalanche superposition.

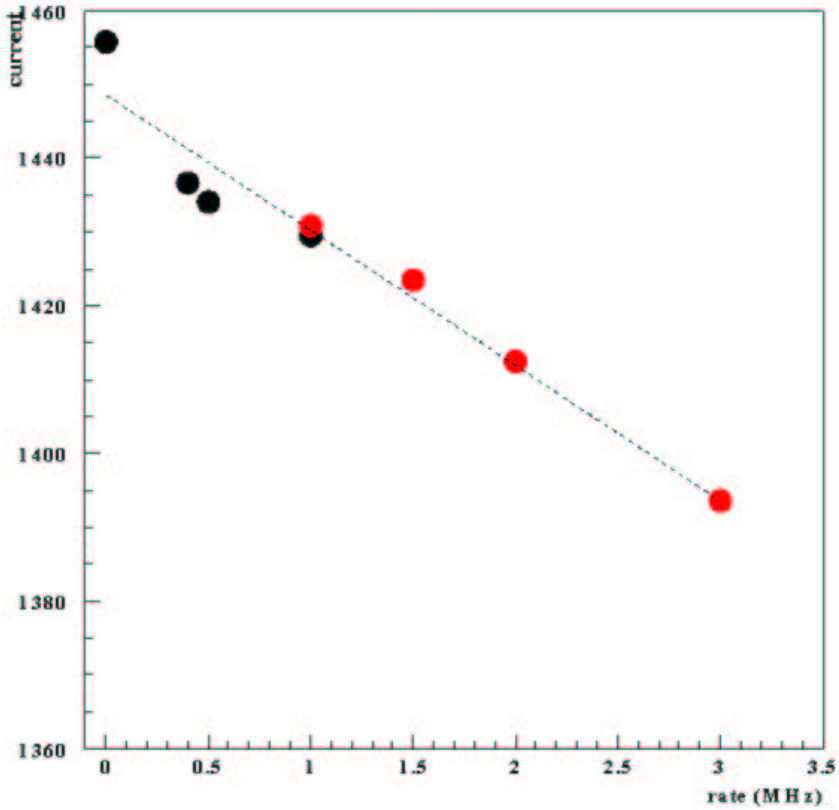
I think this is real debiasing, the bias current really goes up for a short time after the pulse and the effective voltage in the VLPC drops. I will also like to include this is a possible next VLPC paper.

How can we use this model at DØ?

We can determine the rate of pe avalanches in the VLPC by looking at the bias current, as measured by the AFE. Using the LED system we did a calibration of this measurement

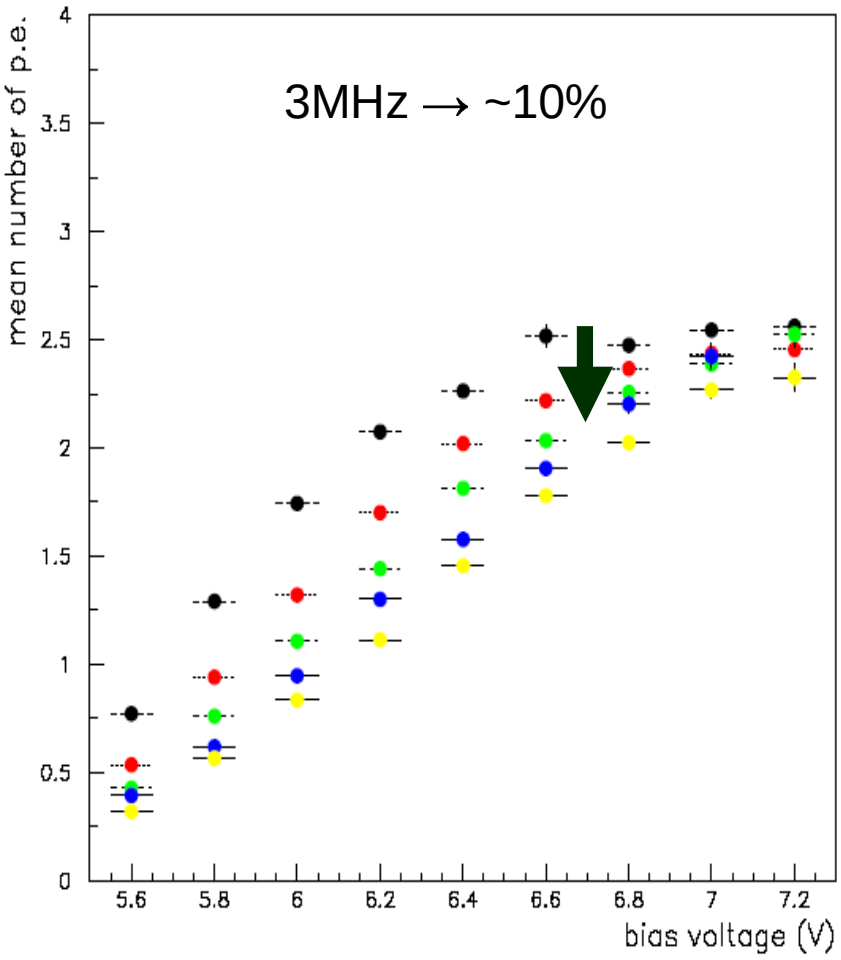


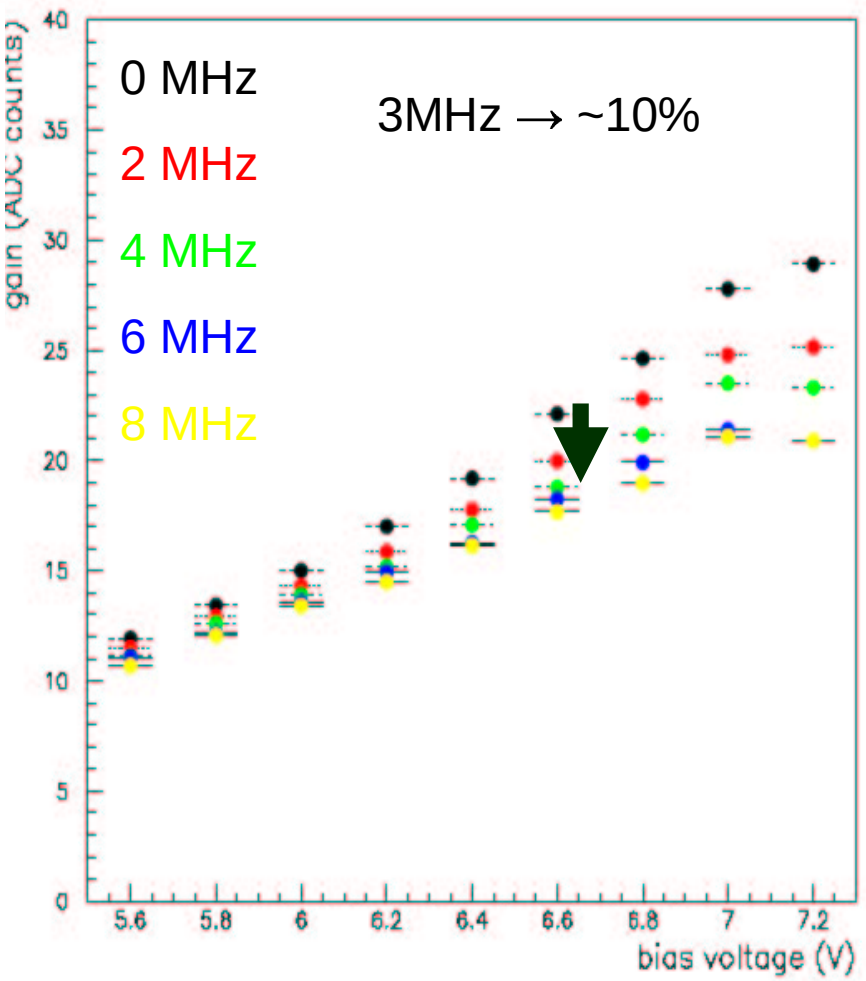
Channel archiver for different LED rates.



Using this calibration we measured about 3MHz for L=50E30, consistent with the zero bias occupancy (David Lam).

How can we use this model at DØ?





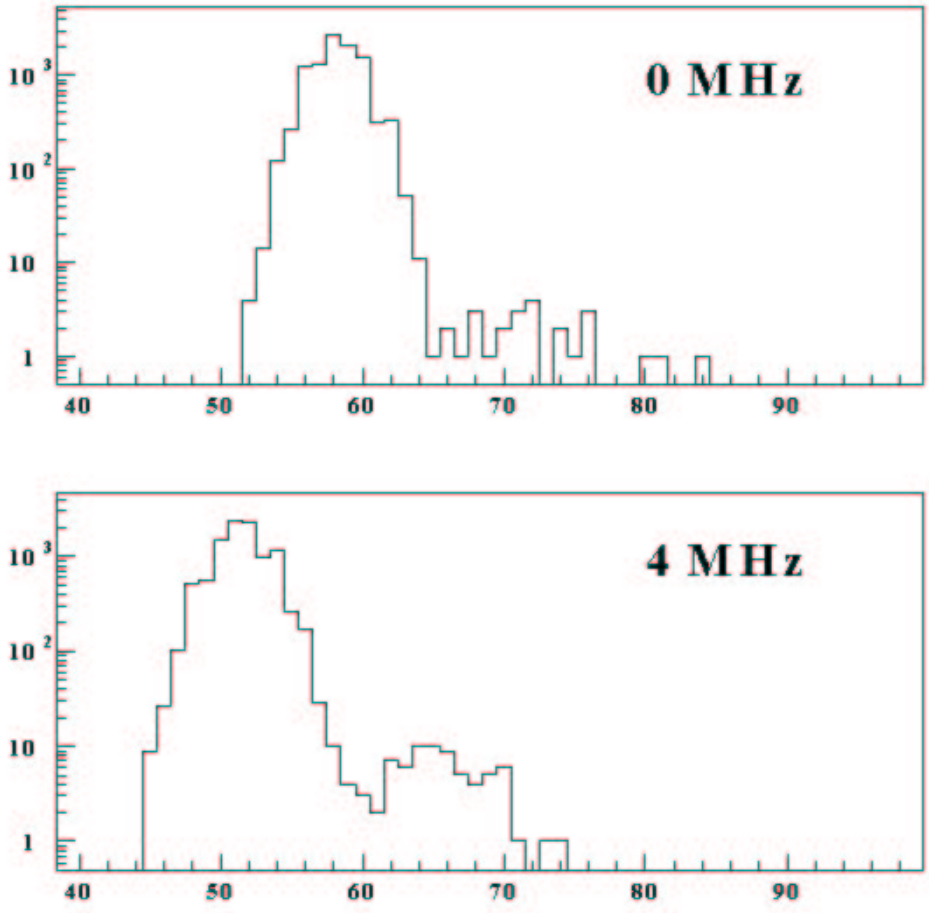
Using the LAB3 data we can determine by how much we need to change the voltage to obtain the "desire" performance (is not clear to me that we know what is the desired performance). We are probably getting a drop of 20% in performance in the inner most layer for L=50E30.

How can we check that we are doing this right?

As suggested by Jadzia last week, we need to check that we see the rate effect and that we are changing the bias correctly. This could be done looking at the pedestal for unsuppressed channels, also suggested by Jadzia.

This is the difference that we will see between 0 and 4 MHz (data taken at LAB3)

This is also incompatible with the de-biasing model.

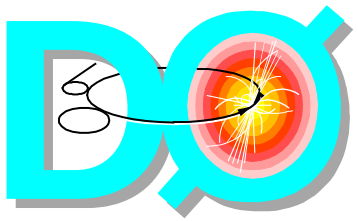


Rebiasing: Conclusion

- We know have a better understanding of the rate effect in the VLPC.
- We now have another tool to measure the rate in the VLPC, that could be of use for the operation of the detector.
- At 40E30, we get ~3MHz in the inner most layer of the CFT (this has been measured by David Lam and confirmed with bias current measurements). We should be able to see some inefficiency.

We need to:

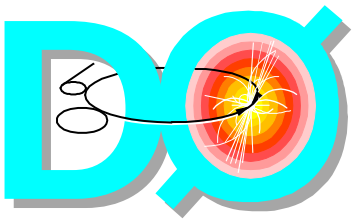
1. **Define what we want to optimize (Efficiency for a fixed occupancy? What occupancy? How often do we want to rebias?)**
2. **Implement the rebiasing, this will be a very large project, but is going to be needed to keep up with the luminosity.**



+20 ADC count offline cut

- Online: 1 cut value per SVX chip (= 64 channels) targeted at 1% occupancy
- Offline: we (Jadzia) supply them with channel-by-channel thresholds
- Because of tracking problems, offline chose to add a fixed offset of +20 counts to this channel-by-channel threshold => equivalent in photoelectrons (and MIPs) varies wildly (1-1.5 pe)
- Works now, will seriously cut into efficiency once detector ages

- Need to get rid of it, if necessary replace it with something that makes (more) sense; tick (crossing) dependent cut?

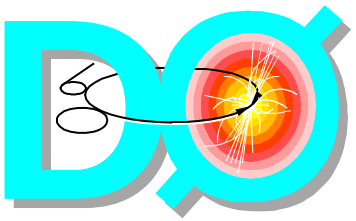


CTT upgrade

- (SG): plan presented at Trigger-3 and INSTPHYSCOM meetings (see agenda server)
- New system (2 DFEA crates from Boston) very similar to existing CTT
- Challenges: hardware not accessible in MCH; need to keep old system running
- Plan: establish parallel data path for prototype of new system on platform, and debug while still running the CTT with the old DFEA crates
- Fall 2004 shutdown: install and test splitter hardware and infrastructure (crate, backplane, cables, power supply, downstream modules) on platform
- Fall 2004 and later: multi-step bootstrapping of new system
  - Test new boards (Crate Controller, DFEB) (JTAG, 3rd floor test stand)
  - install tested prototypes in parallel system on platform (brief accesses)
  - Establish download and control; verify input handling; establish L3 readout; establish Trigger Framework connection; test trigger algorithms on platform
- Summer 2005: switch over to new system

CTT upgrade

- Worries:
  - Manpower for adaptation of infrastructure and verification software
- INSTPHYSCOM WG feedback:
  - Will hardware be ready? -> different committee… (seriously: it's on schedule)
  - Need to establish procedure to insure that new hardware will work for all existing CTT customers ('victims'), in particular STT (receives duplicate output)
  - Final replacement of DFEA crates, recabling and connection testing will still be challenging



CFT summary

- Quite a few changes planned to maintain performance and longterm efficiency of CFT
- Some trivial (except for manpower and communication/persuasion issues), some not
- Rebiasing: pick one possible performance metric, compute bias vs. rate, test
- Frozen VLPC channels: agree on and finalize plan for Fall 2004 shutdown