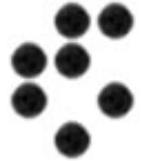




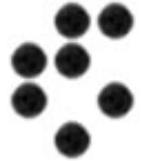
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Backup studies of photon detectors and read-out electronics

Peter Križan

University of Ljubljana and J. Stefan Institute



Contents

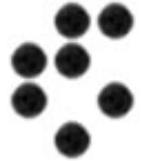
Motivation

Photodetector back-up candidate: Burle MCP

- Beam tests
- On-the-bench studies

Read-out electronics back-up: VA64TAP

Summary



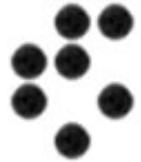
Motivation

Neither the photon detector for the ARICH (baseline: HAPD) nor the corresponding electronics are off-the-shelf products.

Check whether the available substitutes can be used as a back-up solutions.

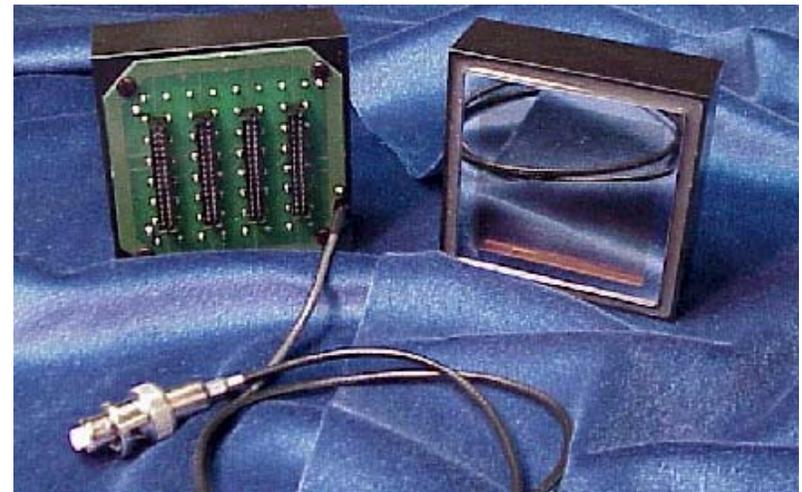


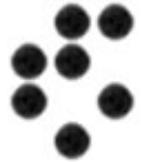
Photon detector back-up: Burle MCP PMT



BURLE MCP-PMT UPDATE

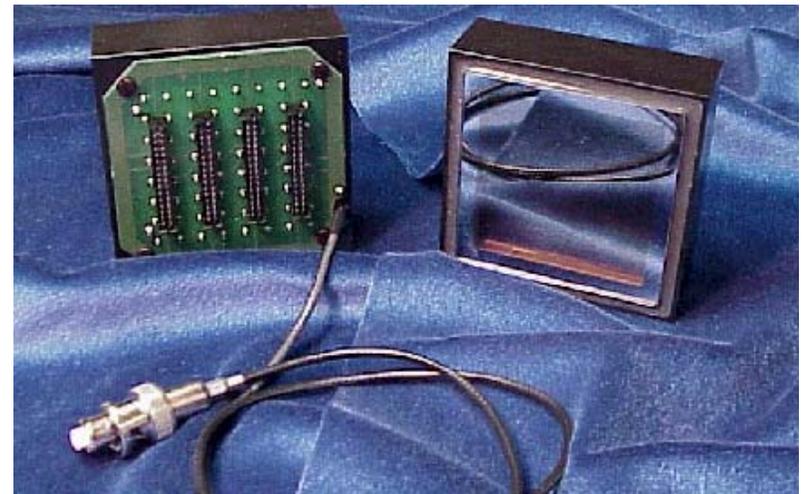
- beam test results
- new info from BURLE
- setup for relative channel response
- uniformity of response
- preparation for timing measurement

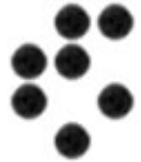




Data for the present version (85011)

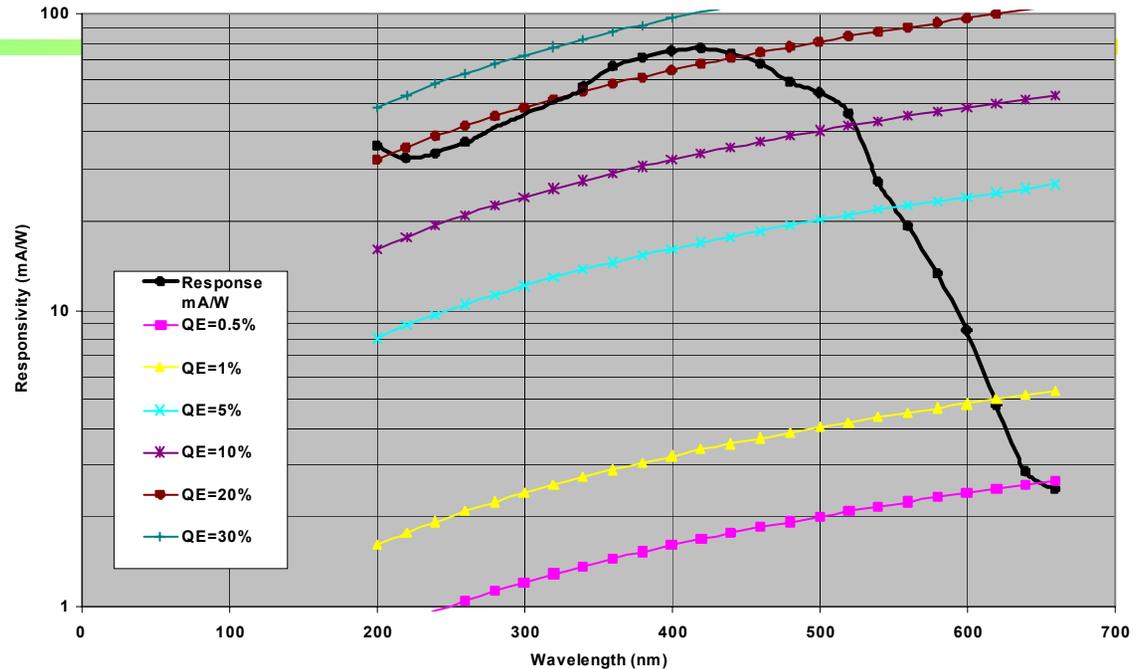
- PMT with three MCP steps
- box dimensions: 2.795" square
- active surface: 2" square (51%)
- 64 channels (8x8)
- pores 25 micron
- excellent timing properties





85011. Spectral Responsivity and QE

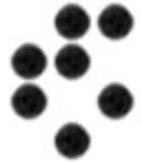
- typical Q.E. (figure)
- collection efficiency ~ 60-65%



Expected improvements using 10 μ m pore plates:

- better magnetic field immunity due to smaller pores and reduced gap between photocathode and MCP (successfully tested)
- collection efficiency ~ 70% (80% with additional improvements??)

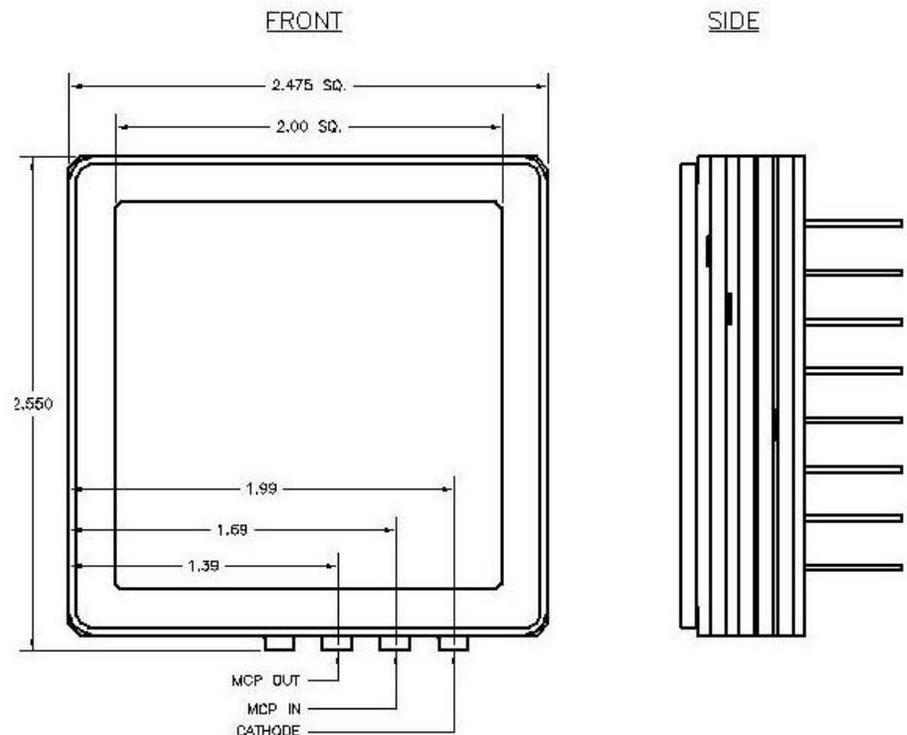
They hope that by the end of summer samples will be available for testing.



They can supply unpackaged PMTs with smaller outer dimensions of the product (active area 51% → 63%). We would have to make our own voltage-divider network – no problem.

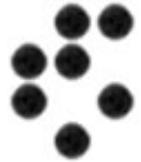
Burle also does some custom work and may be able to make a multiple PMT module for us – not very interesting for our tiling geometry.

Currently they are working on a new design that will increase the open-area-ratio of the unpackaged PMT, but maintain the same MCP active area. No specifics yet.

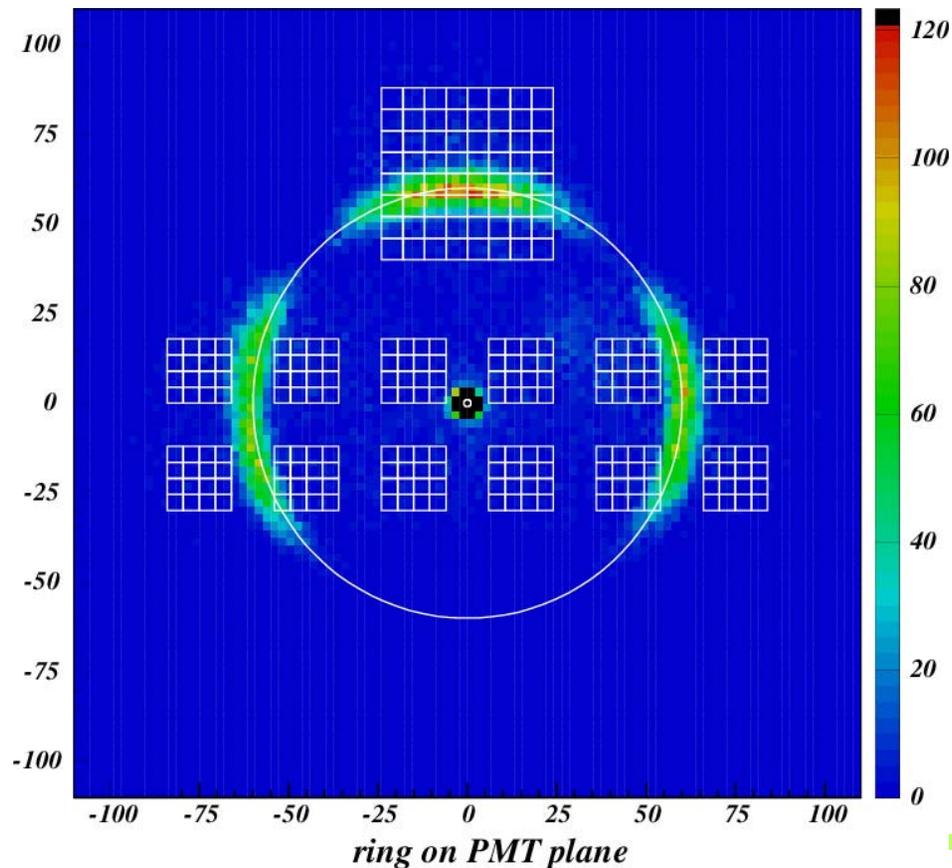
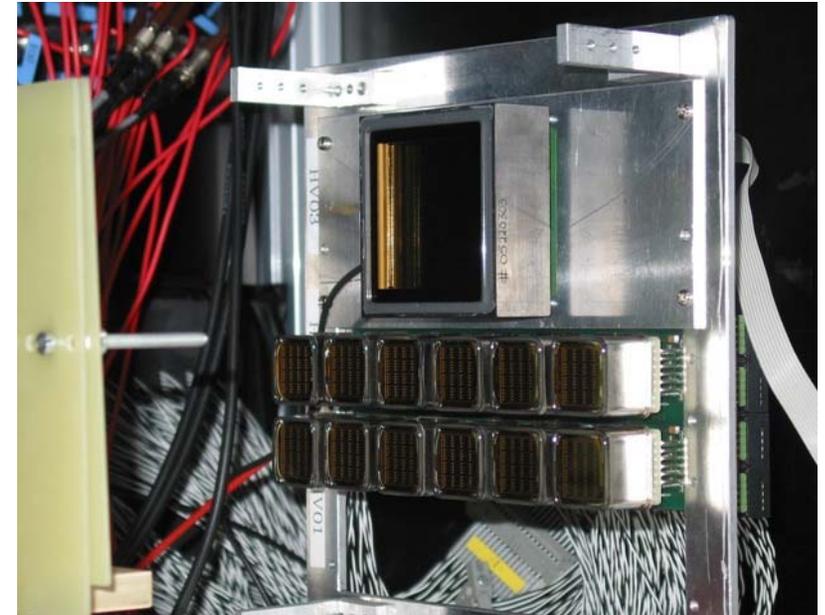




MCP-PMT: beam test setup



- MCP-PMT mounted together with RICH2



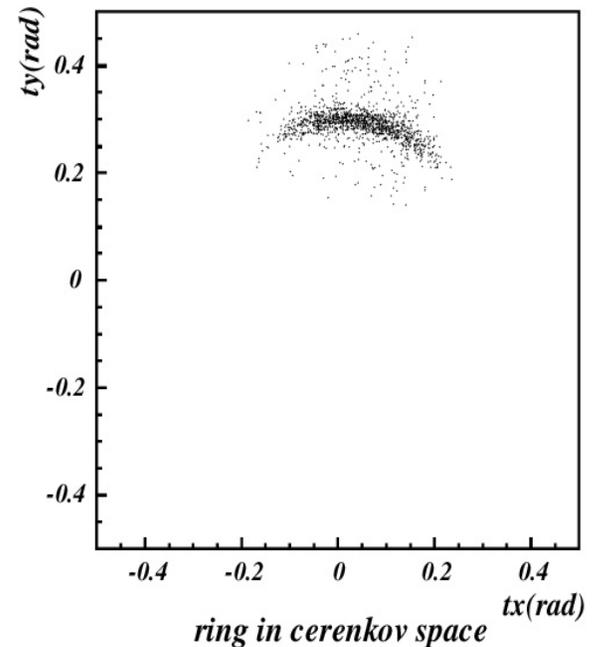
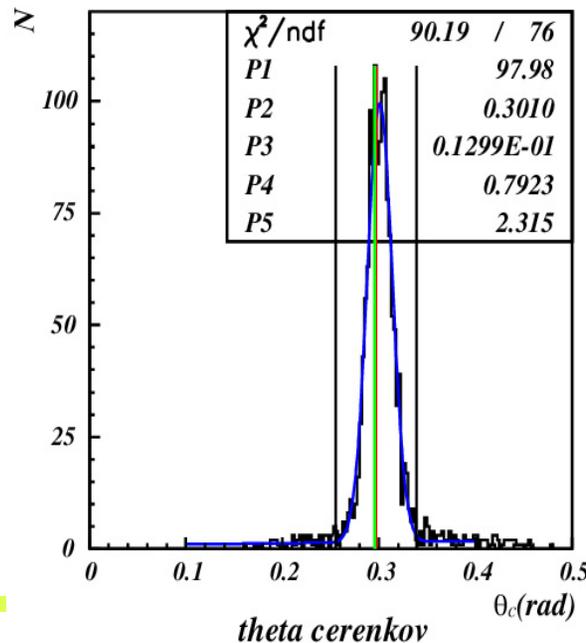
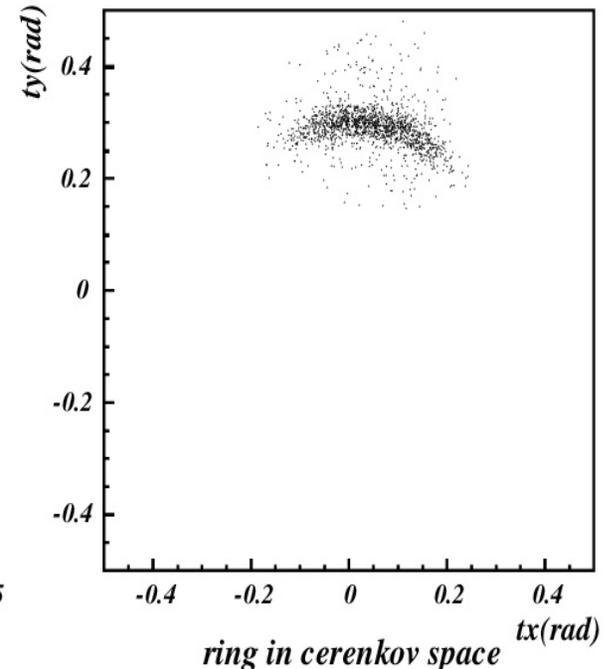
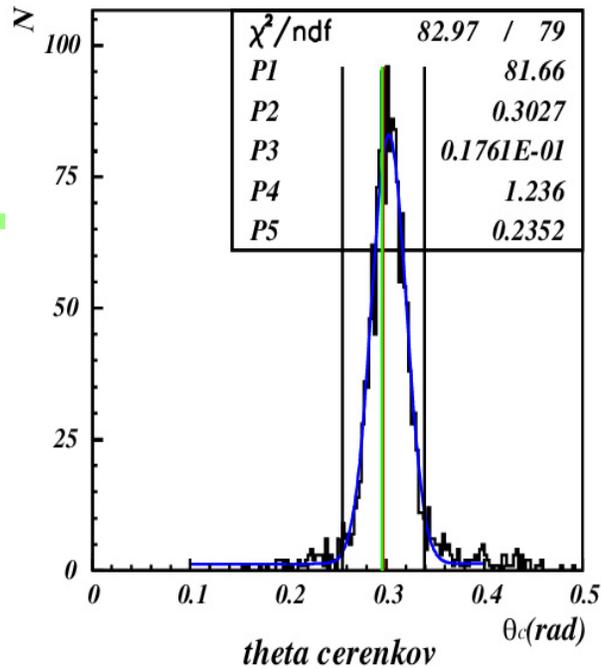
- ring on MCP-PMT and RICH2

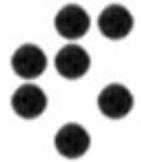


MCP-PMT beam test: ring sigma

- charge sharing at the edges of the pads
- better resolution using center of gravity of the cluster (right bottom)

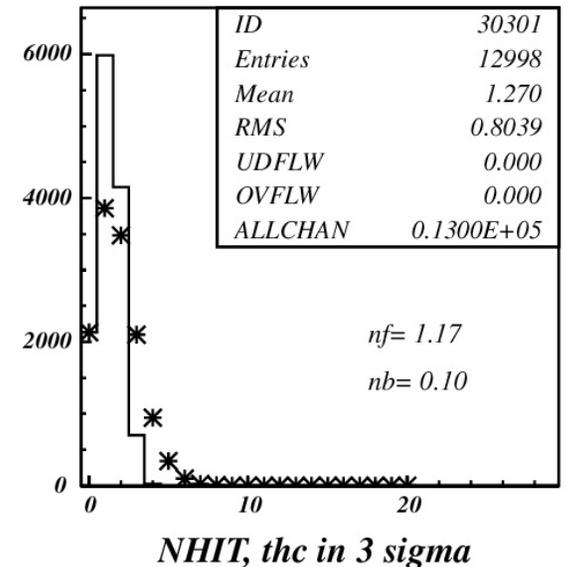
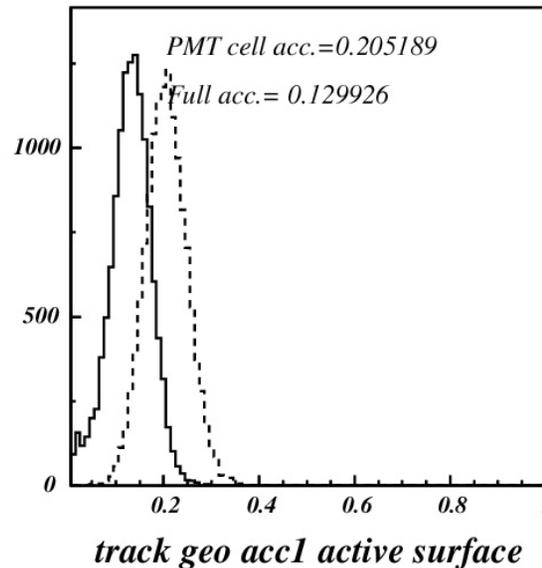
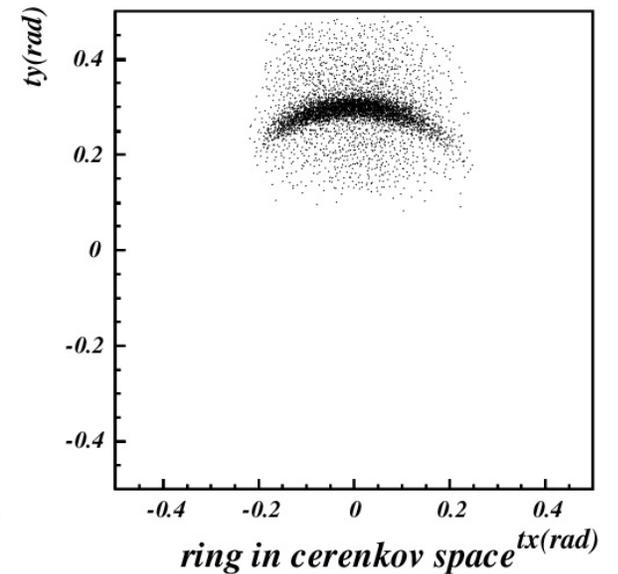
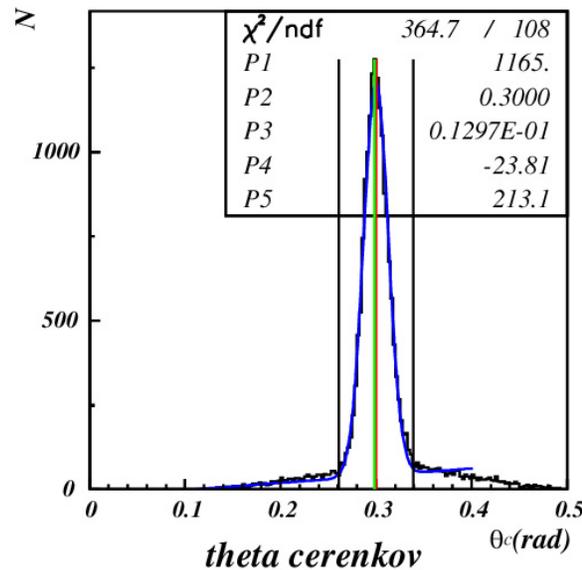
• 17mrad -> 13mrad





MCP-PMT beam test : number of hits

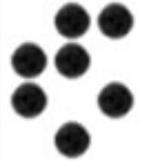
- $N = \sim 1.2$ (@ 13%)
- FULL RING ~ 9
- FULL COVERAGE ~ 4.5 (@ 50%)



RUN 139 (MD-6,9,4,5)

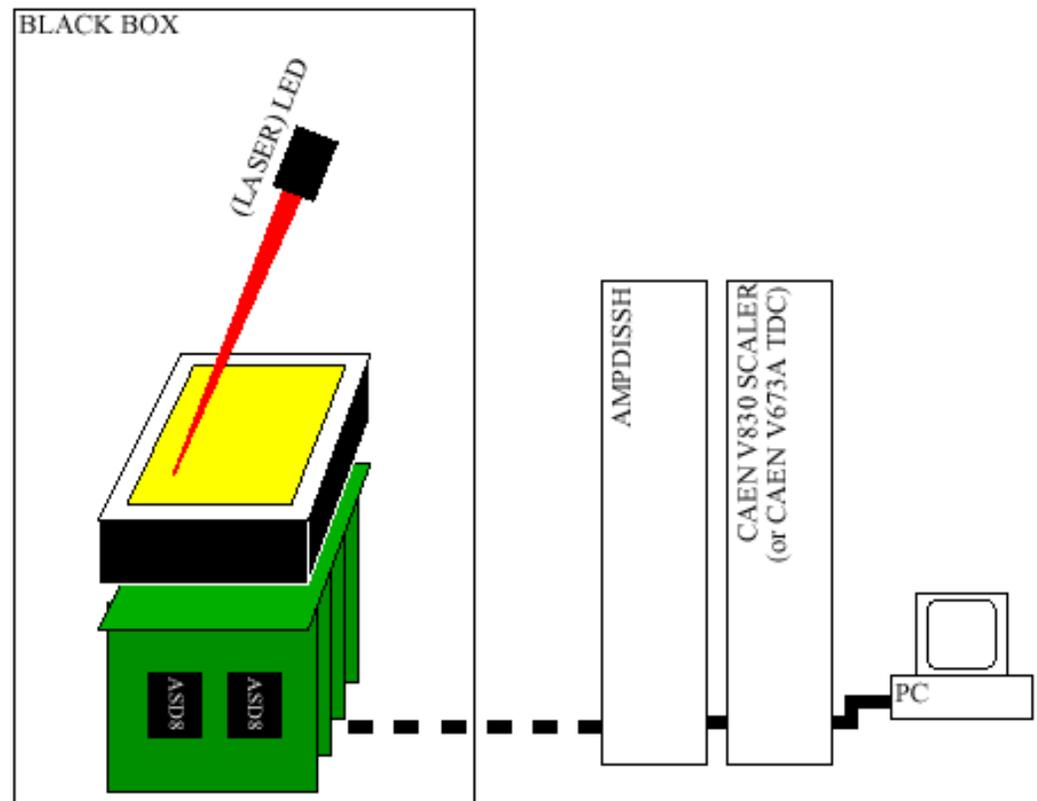


On-the-bench tests: measurement of the surface uniformity



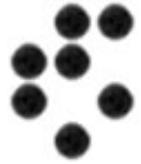
Readout is based on ASD8 chips. We use 16 channel boards (two chips) developed for HERA-B outer tracker and RICH.

- signal are amplified and discriminated by ASD8 boards
- AMPDISSH modules are used as level adapters
- digital signals are fed to VME counters
- computer control by LabWindows CVI
- light source is LED focused by microscope

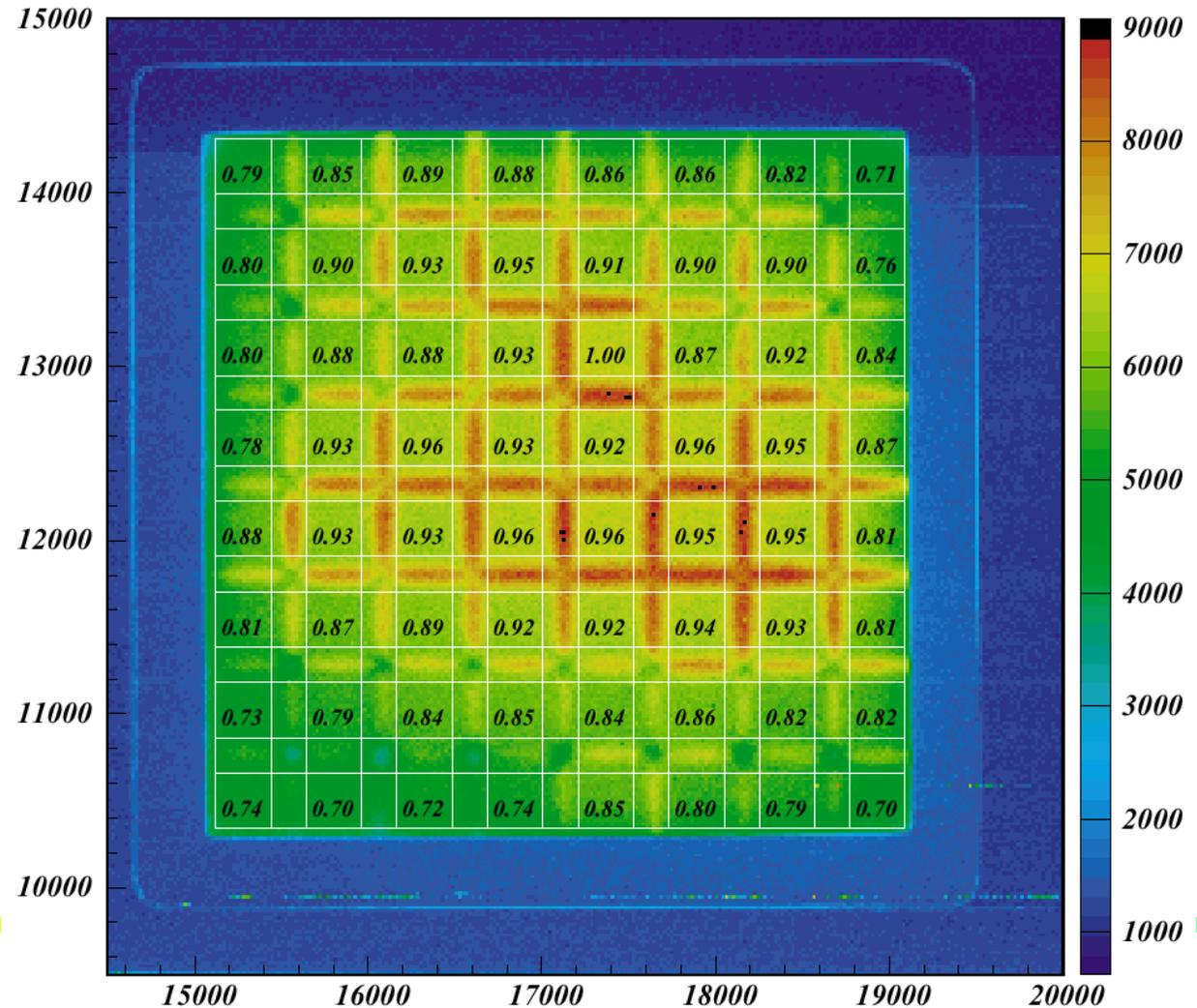




UNIFORMITY OF THE CHANNEL RESPONSE



- number of counts in the middle of the channels varies for 30%

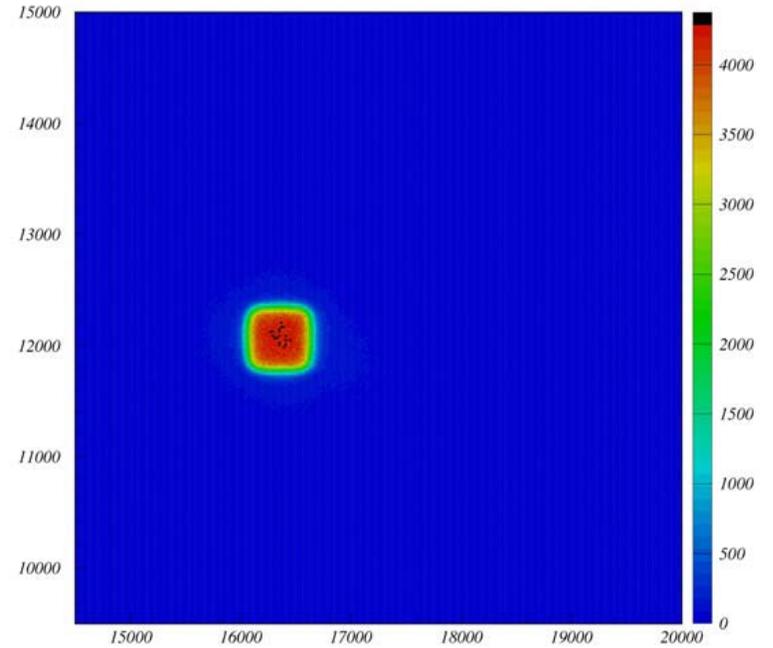


Aug. 9, 2004

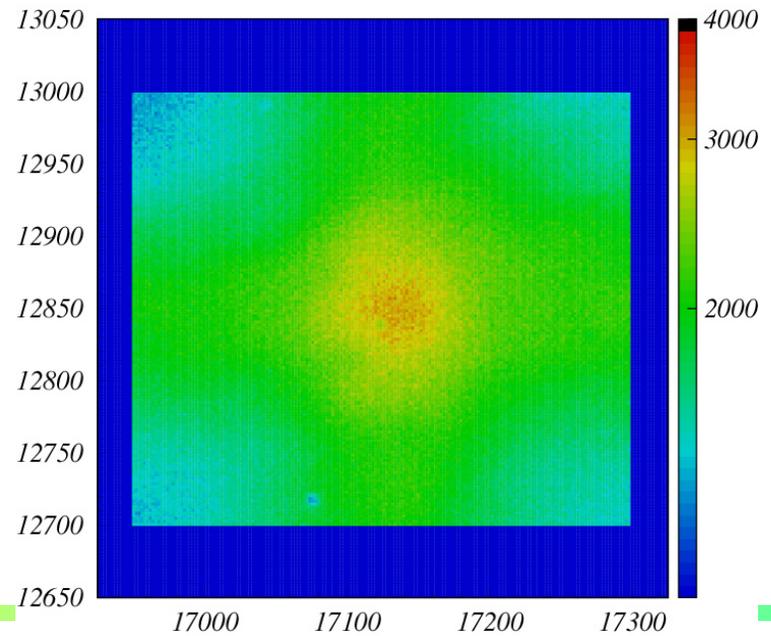
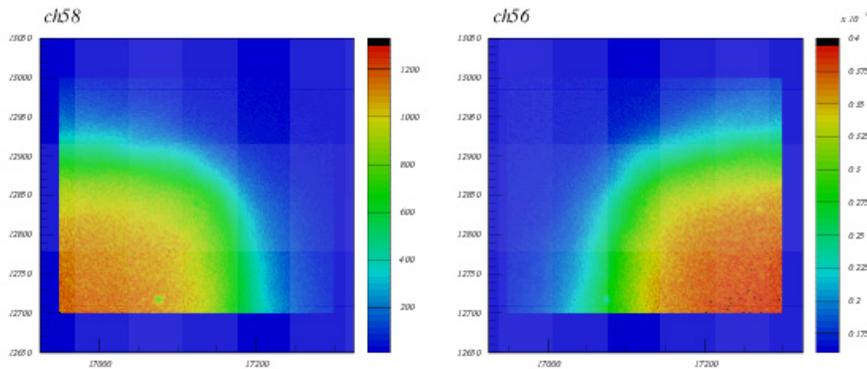
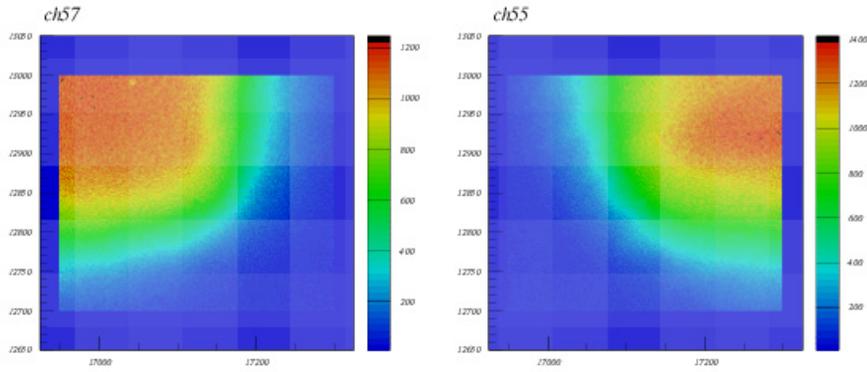


SOME DETAILS

- uniform single channel response (right)
- fine scan over the boundary of 4 pads (bottom)

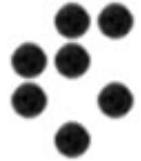


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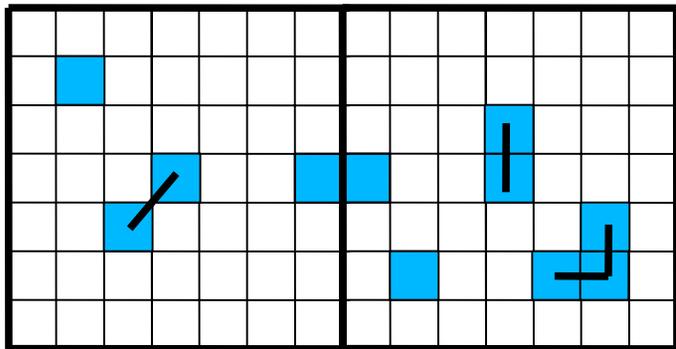


HITS & CLUSTERS

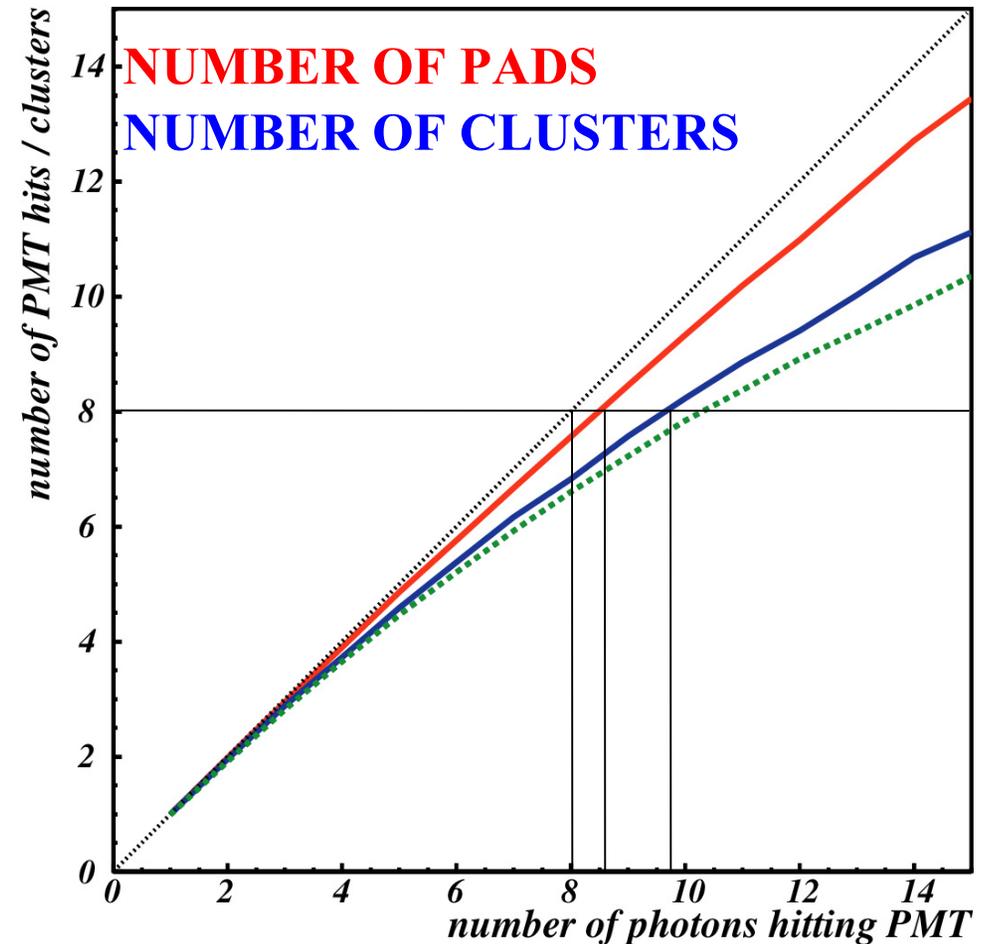


simple simulation:

- generating Cherenkov photons
- counting number of hit pads
- counting number of clusters within the 8x8 channel areas

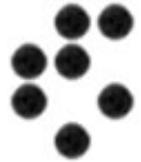


- 11 pads
- 7 clusters

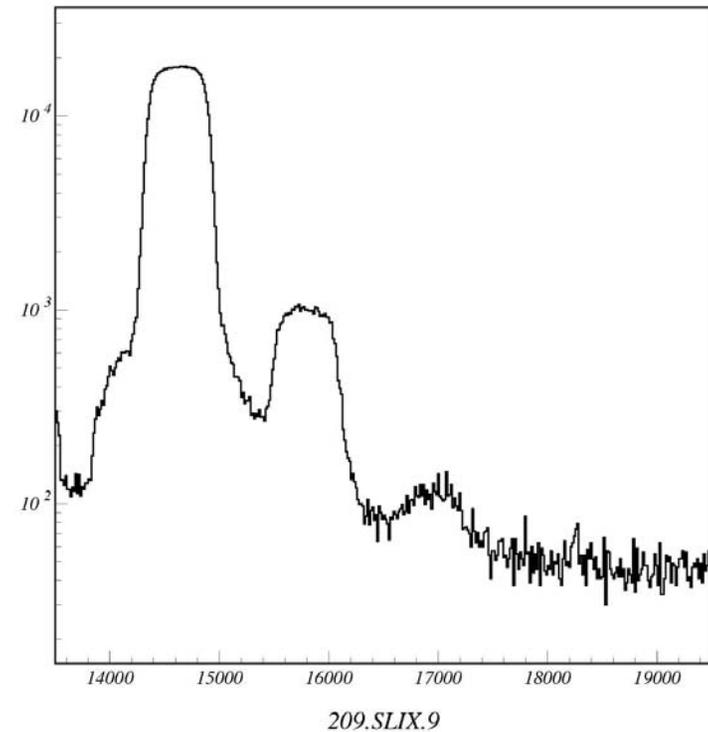
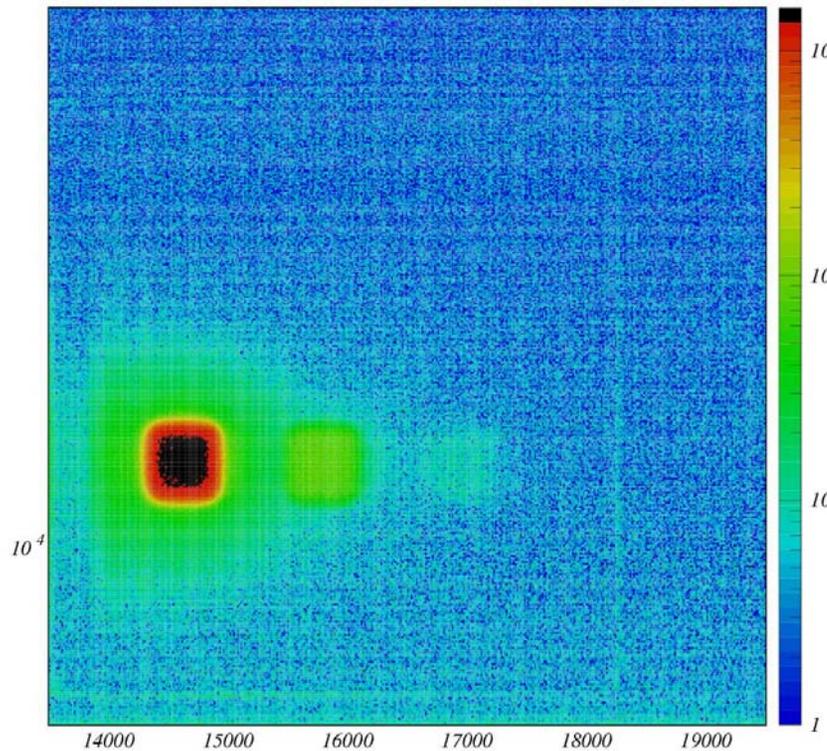




Bench tests: vary angle of incidence

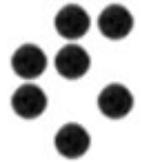


- Photon direction 45 deg.
- Observe response of a single channel
- In addition to the single channel: displaced images

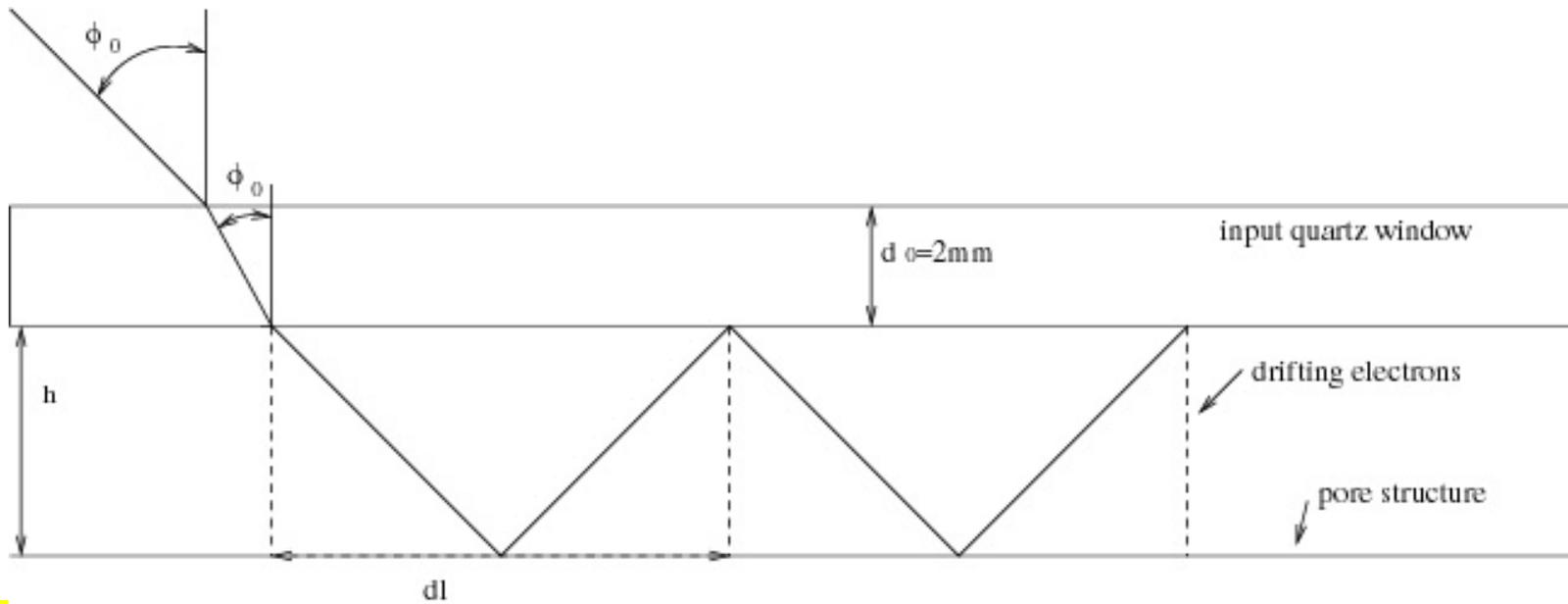




Bench tests: vary angle of incidence 2

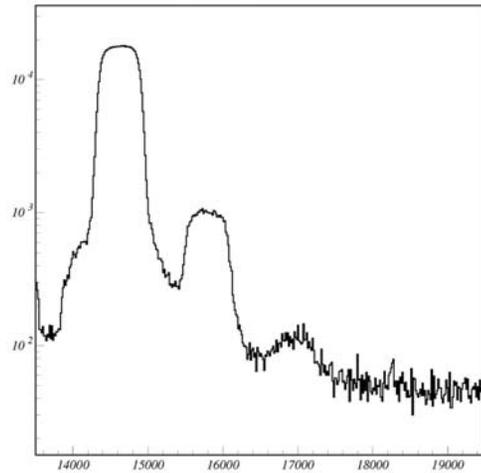
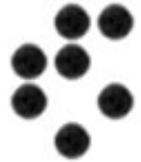


- What is the origin of displaced images?
- Reflection on the MCP entry plane?
- In this case: spurious image should be displaced by $dl=2h \tan\phi=2h$ at 45deg: **YES**

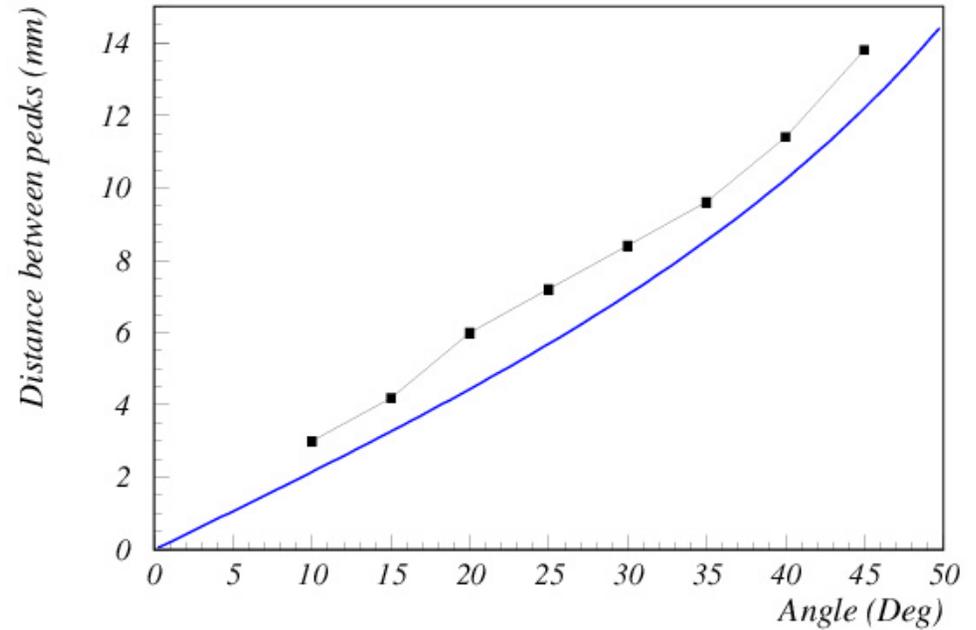
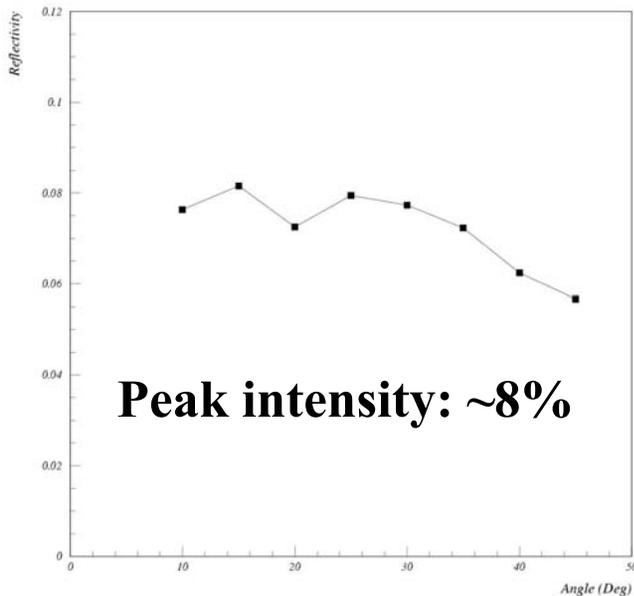




Bench tests: vary angle of incidence 3



2004/08/06 13.12

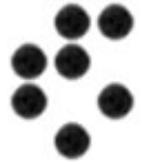


Shift of the second peak:

- Points: measured shift
- Curve: $dl=2h \tan\phi$



Bench tests: vary angle of incidence 4

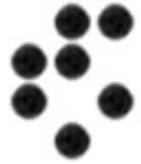


Why could this be important?

- **Our typical angles of incidence are quite big**
- **The additional 8% signal probability on the neighbour (or next-to-neighbour) pads smears the Cherenkov ring (actually it did not cause trouble in the test beam data)**
- **It could have impact on the timing for accurate timing applications like TOP (perpendicular incidence: 2x6mm longer photon flight = 40ps delay for reflected photons)**

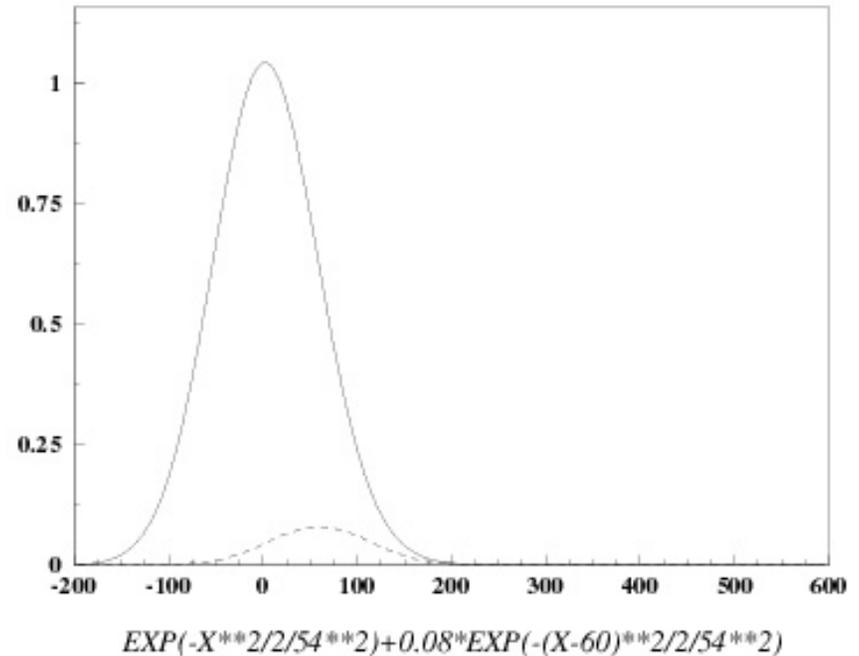
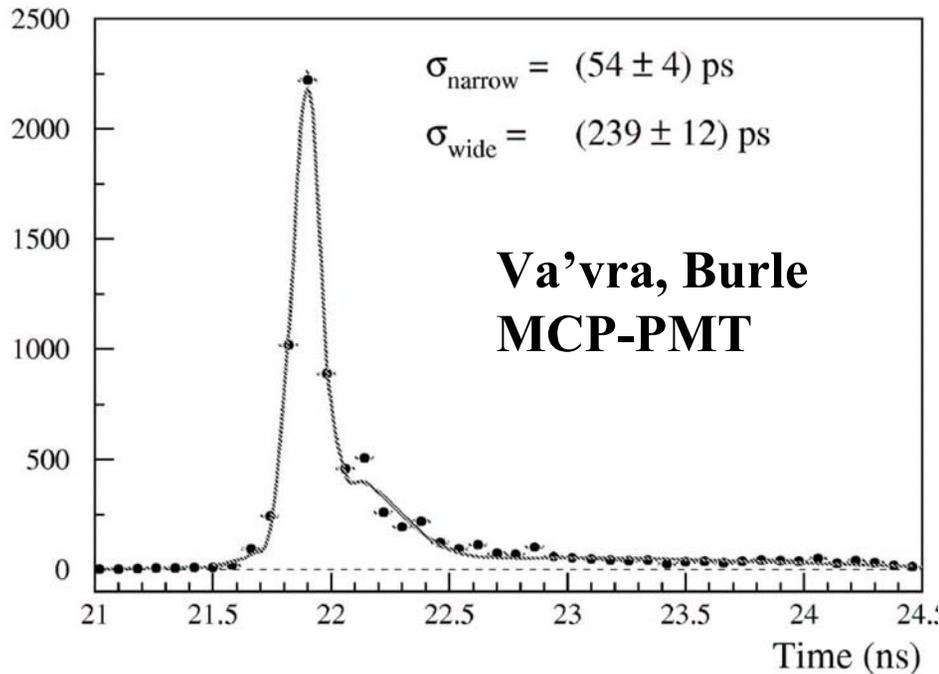


Bench tests: time delay of the reflected photon



Can this explain the time structure observed by Jerry Va'vra?

- Probably not.

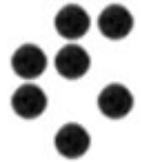


Need tests with precise timing

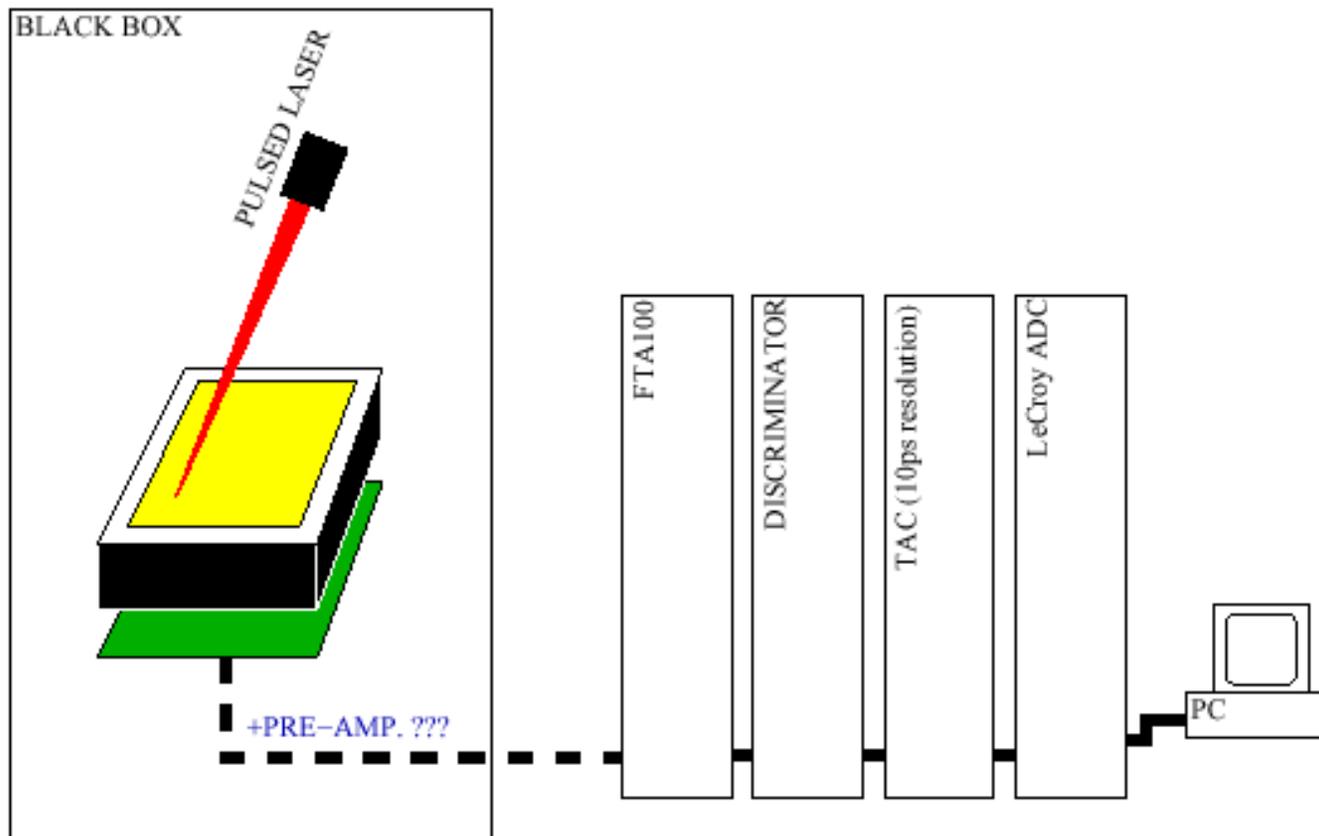




Next step: timing scan setup

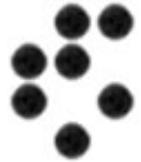


- LED will be replaced with pulsed laser
- fast amplifier and discriminator instead of ASD8 boards
- TAC and CAMAC ADC will be used for time measurement





Burle MCP PMT - summary



Excellent performance in beam tests

Good surface uniformity

Small number of photons

Improvements are underway: number of photons \rightarrow \sim 8-9

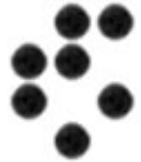
A very good candidate for the photon detector for both ARICH and TOP

More on-the-bench studies (timing performance) underway

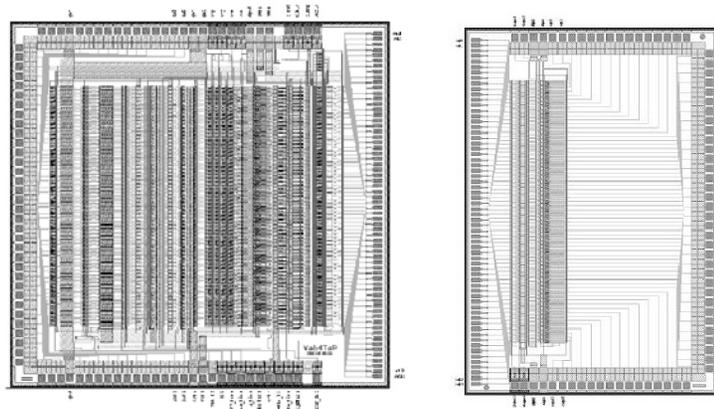
Waiting for the improved model



Read-out electronics back-up



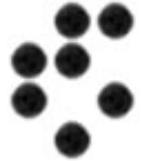
VA64TAP as readout candidate



- VA64TAP: low-power, low-noise ASIC from **ideas**
- LS64: level adapter



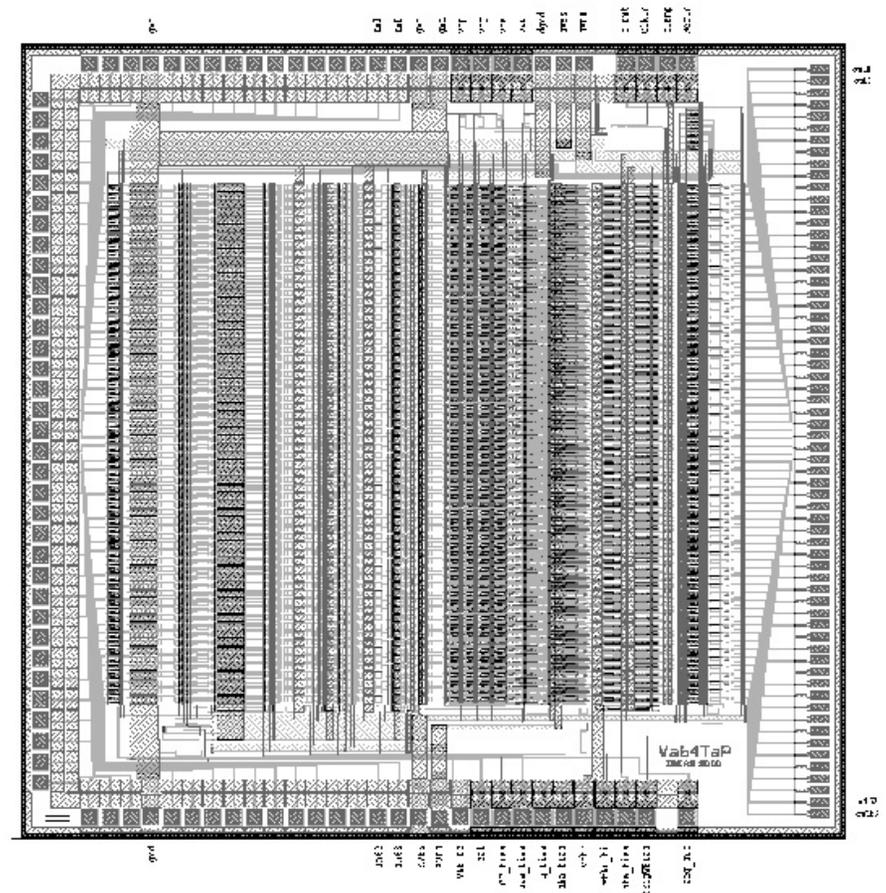
VA64TAP: characteristics



VA64TAP is low-power, low-noise ASIC with 64 channels, each with:

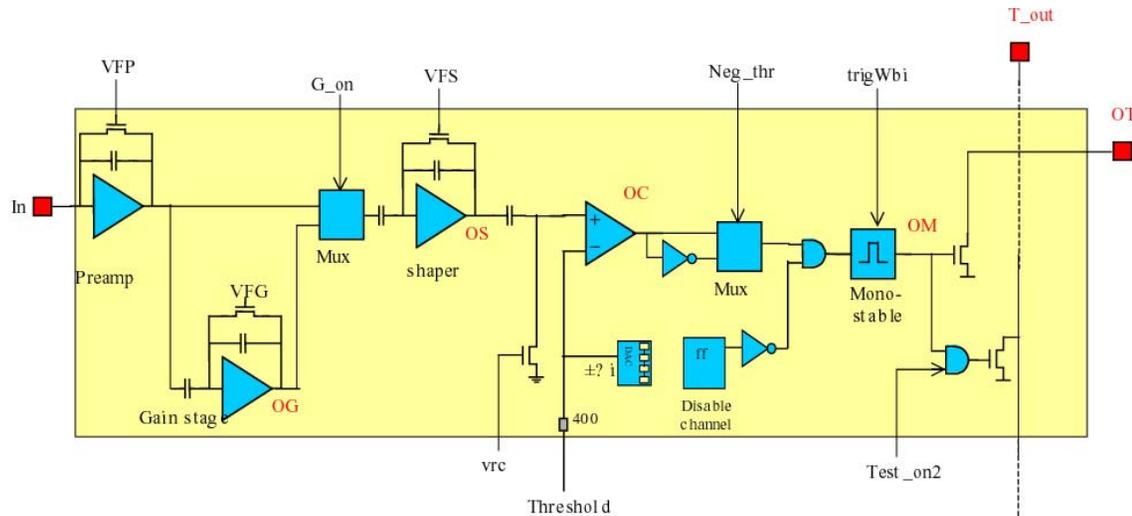
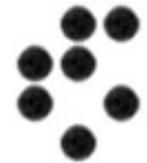
- preamplifier (ENC ~ 500 @ 10 pF)
- amplifier (can be switched off)
- fast CR-RC shaper (75 ns)
- discriminator with 4-bit trim-DAC
- threshold uniformity: $\pm 200e^-$
- threshold nominal value: $3000e^-$
- power: 2.3 mW/ch.
- parallel output

die size: 5.5mm x 5.4mm





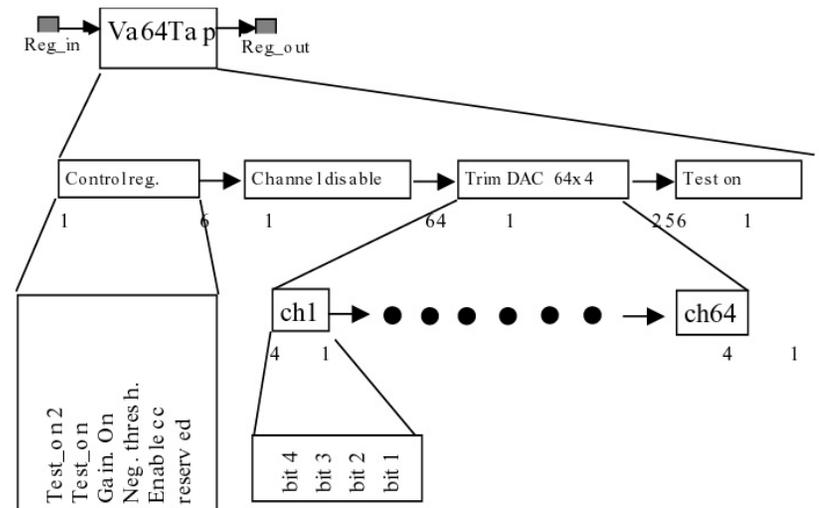
VA64TAP: schematics



- schematics of a single channel

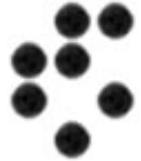
Control register:

- input polarity
- test signal enable
- threshold trim DACS
- channel disable ...



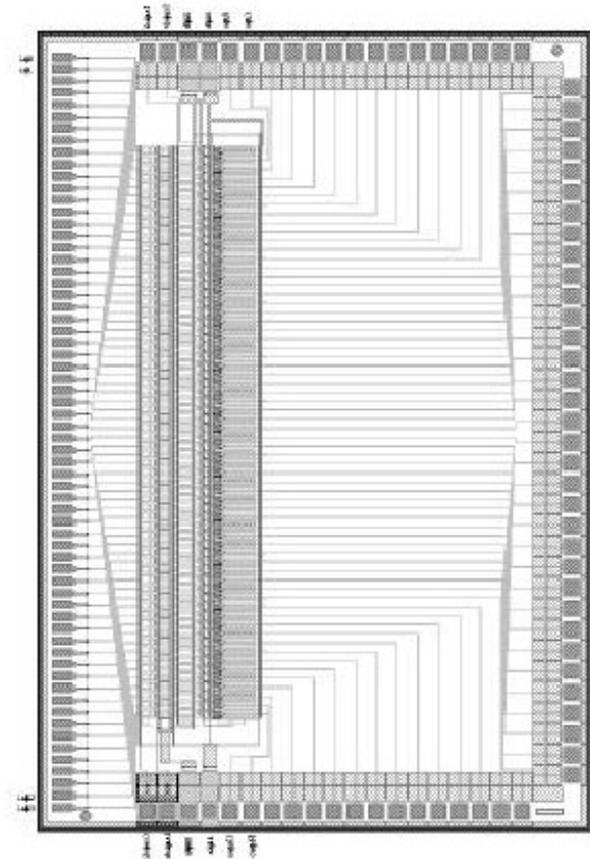


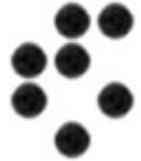
LS64: characteristics



Auxiliary chip: logic level adapter,
converts current logic (from VA64TAP)
into CMOS logic (0V, 2.5V - 5V)

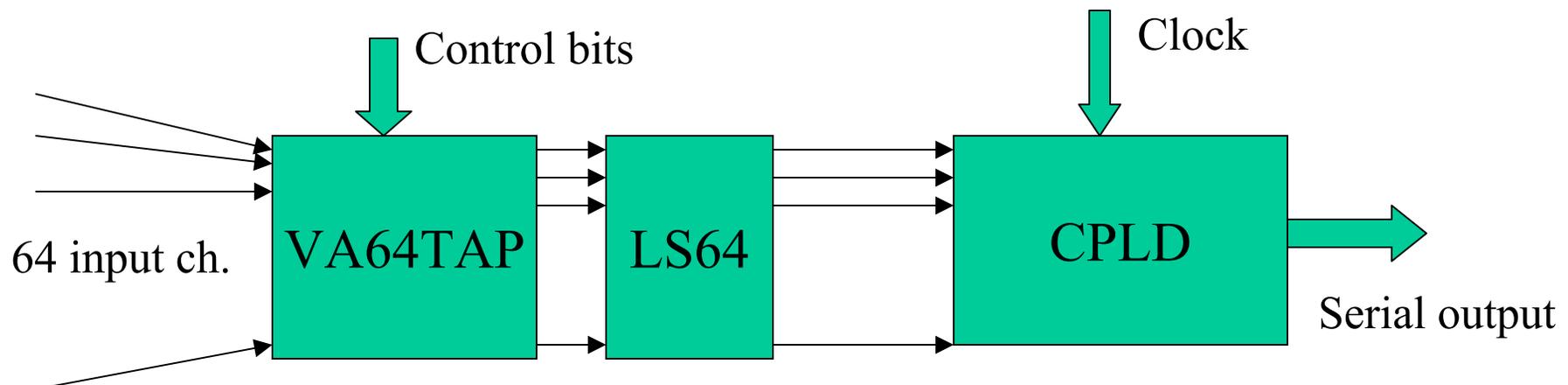
- die size: 5.5mm x 5.4mm
- same lateral dimensions, direct channel to channel bonding
- should be mounted next to VA64TAP

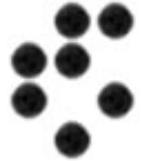




The test version should as simple as possible

- VA64TAP bonded to LS64
- line for control bits
- a CPLD with external clock for 64 parallel to 1 serial conversion
- steering through a VME I/O unit





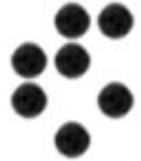
Since this is the back-up solution, the highest priority will be to make the board for the baseline electronics.

However, some activities can be done in parallel, so the plan is to

- design a hybrid for the two chips and a CPLD, with input/output lines
- design an interface (signal routing) board to the detector
- board production (2 weeks)
- mount components, bond VA64TAP to LS64
- goal: have a tested board by end of October



HAPD baseline read-out board: status, plans

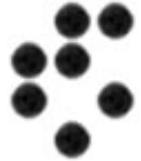


Board for the baseline electronics:

- with two read-out chips
- communication with the digital control board
- connection through an interface board (signal routing) to HAPD

Status+plan

- board being designed, finish this week
- production 2 weeks – ready end of August
- then test, next iteration could be ready by end of Sept.



Summary

- **Burle MCP PMT looks like a good back-up candidate**
- **Number of photons is at the moment too small, but with the improvements underway we can expect that the detector could be usefully applied**
- **VA64TAP will be tested as the read-out candidate in the next few months**



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Back-up slides

