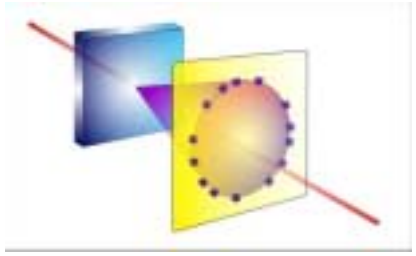
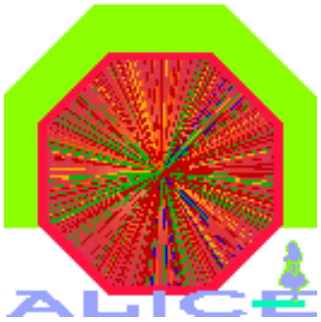


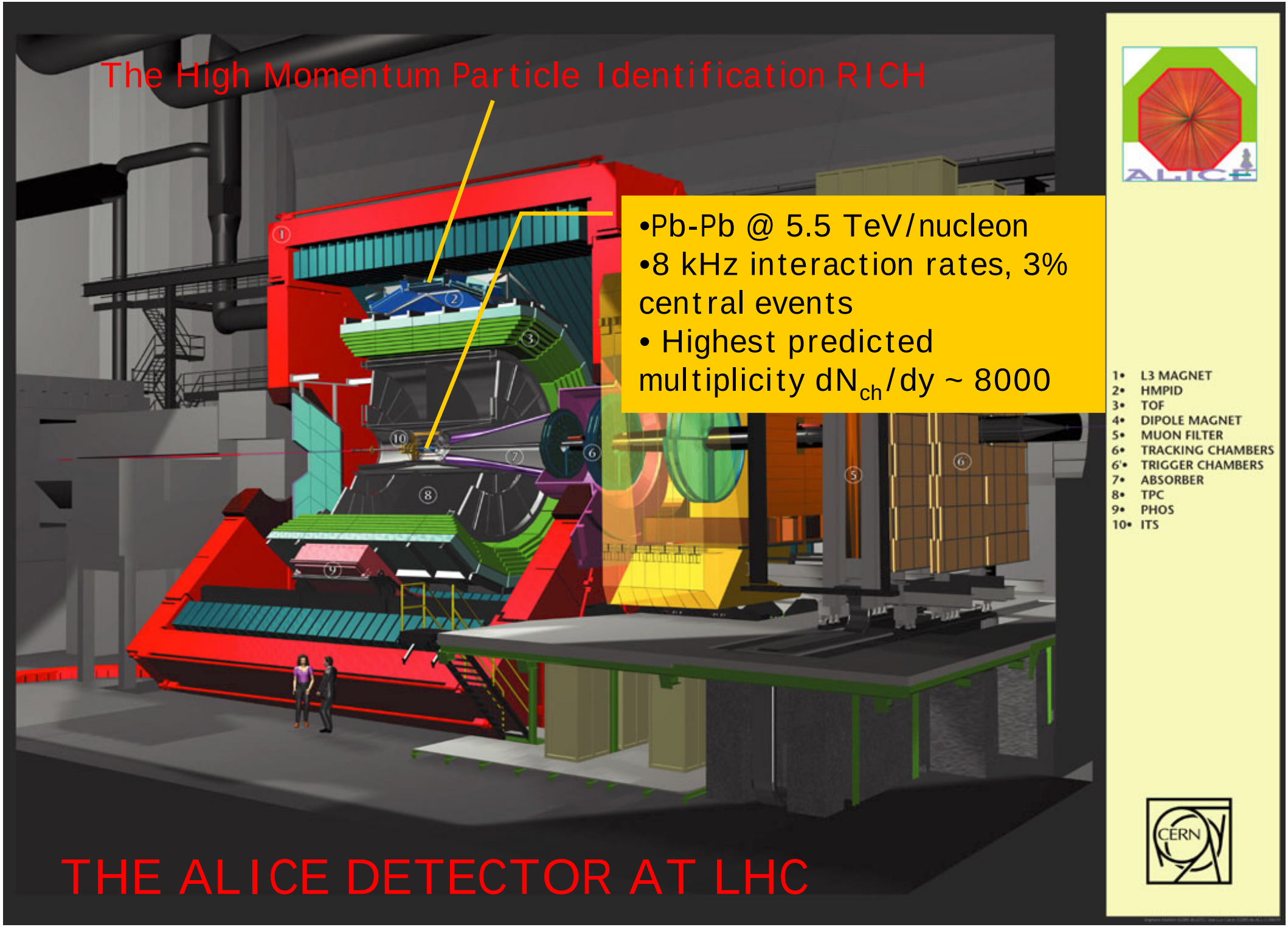
AGING OF LARGE AREA CsI PHOTOCATHODES FOR THE ALICE HMPID DETECTOR

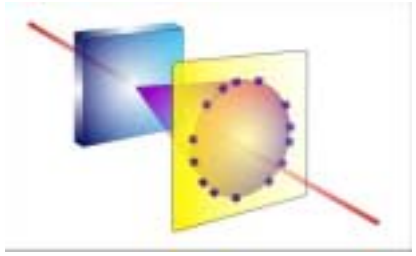


A. Di Mauro (CERN, Geneva)

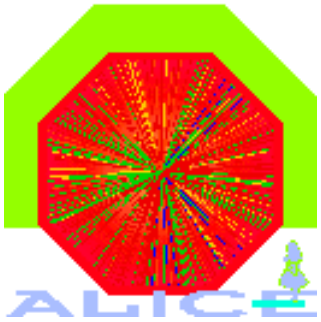
on behalf of the ALICE-HMPID group

Aging Phenomena in Gaseous Detectors – DESY, Hamburg, Oct 2-5, 2001


The High Momentum Particle Identification RICH
•Pb-Pb @ 5.5 TeV/nucleon
•8 kHz interaction rates, 3% central events
• Highest predicted multiplicity $dN_{ch}/dy \sim 8000$
1• L3 MAGNET
2• HMPID
3• TOF
4• DIPOLE MAGNET
5• MUON FILTER
6• TRACKING CHAMBERS
6'• TRIGGER CHAMBERS
7• ABSORBER
8• TPC
9• PHOS
10• ITS
ALICE
CERN
THE ALICE DETECTOR AT LHC



THE HMPID DETECTOR



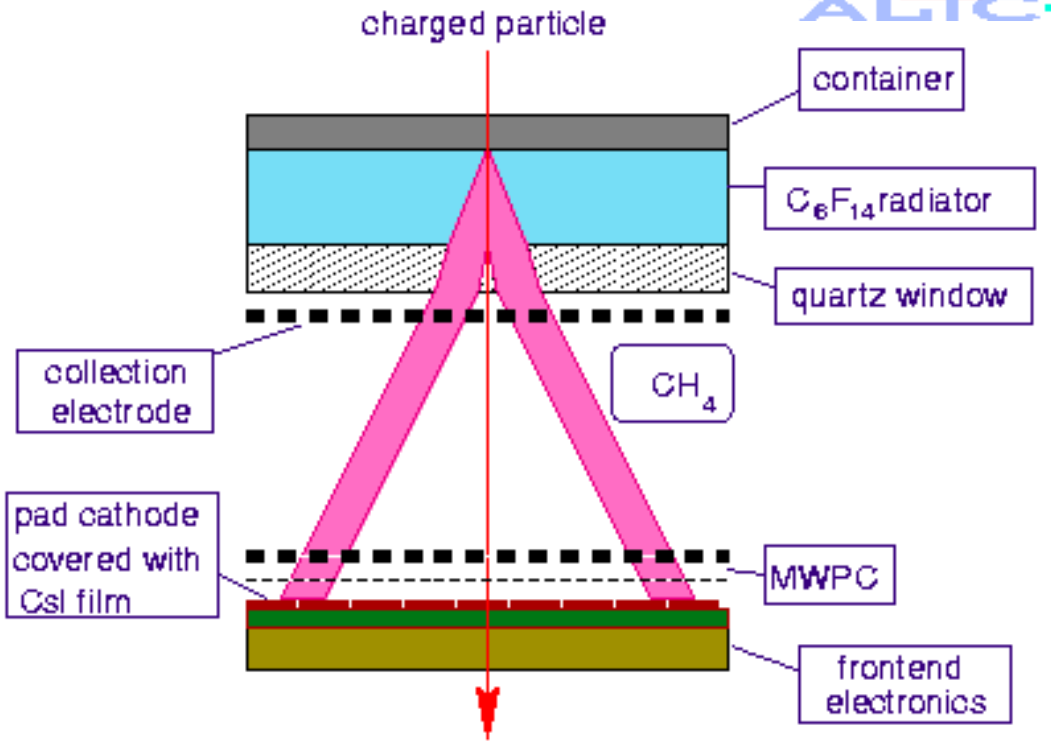
Operating principle

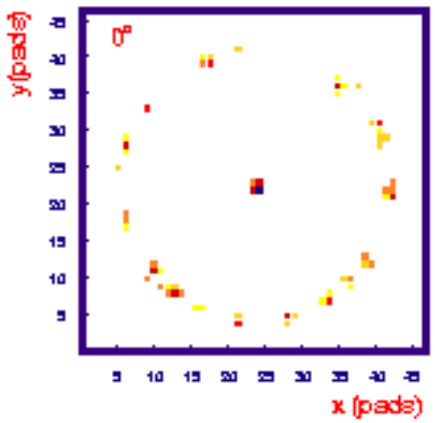
Radiator:
15 mm C_6F_{14} – n=1.3 @ 170 nm

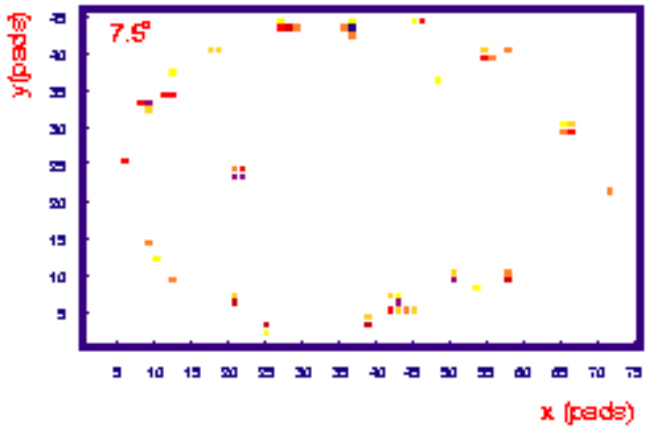
Photon detector:
- MWPC with CH_4 at atmospheric pressure (4 mm sensitive gap)
- analogue pad readout

Photon converter:
Reflective layer of CsI (QE= 23% @ 170 nm)

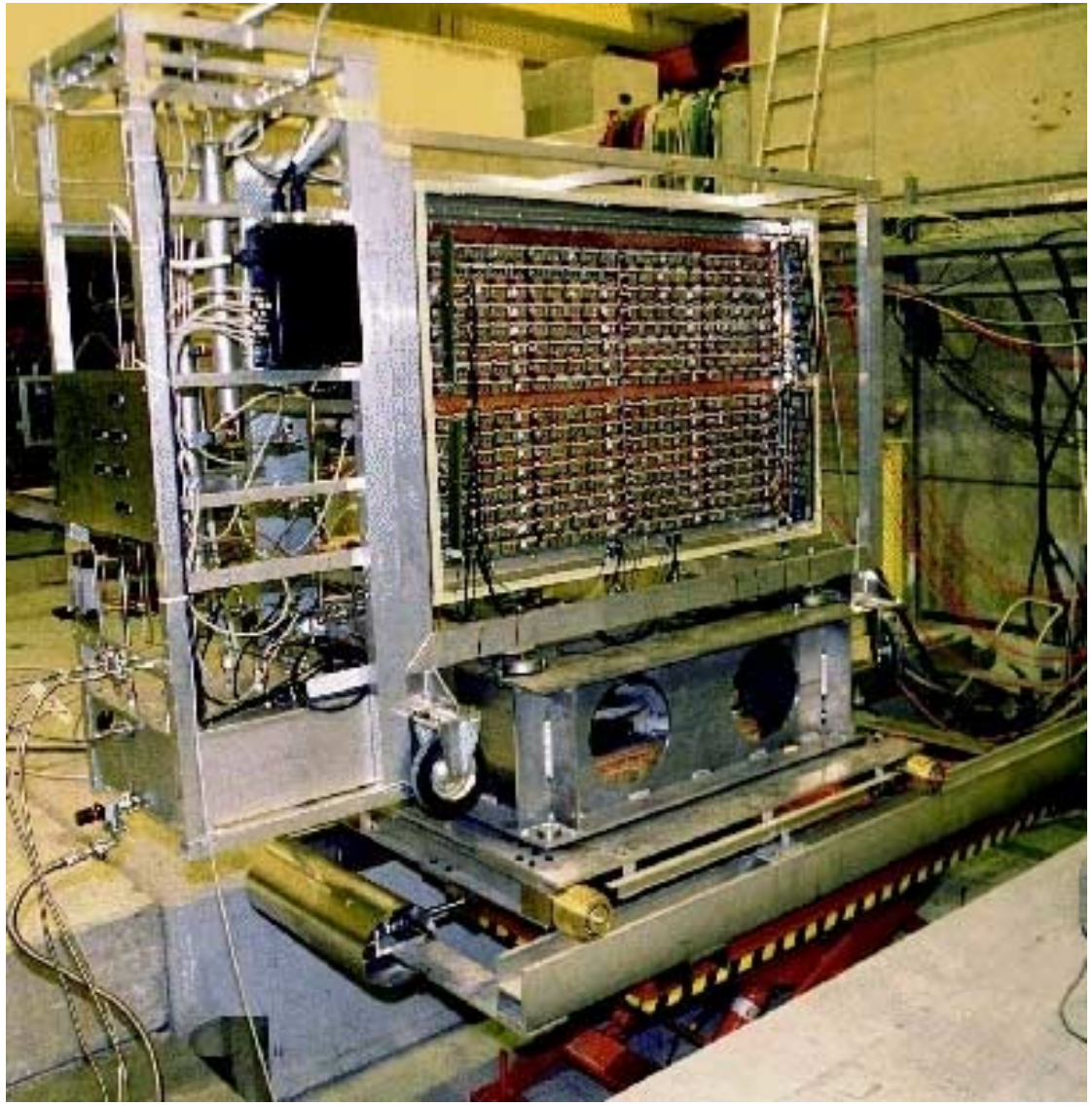
PID range:
- 1 < p < 3 GeV/c π K
- 2 < p < 5 GeV/c p





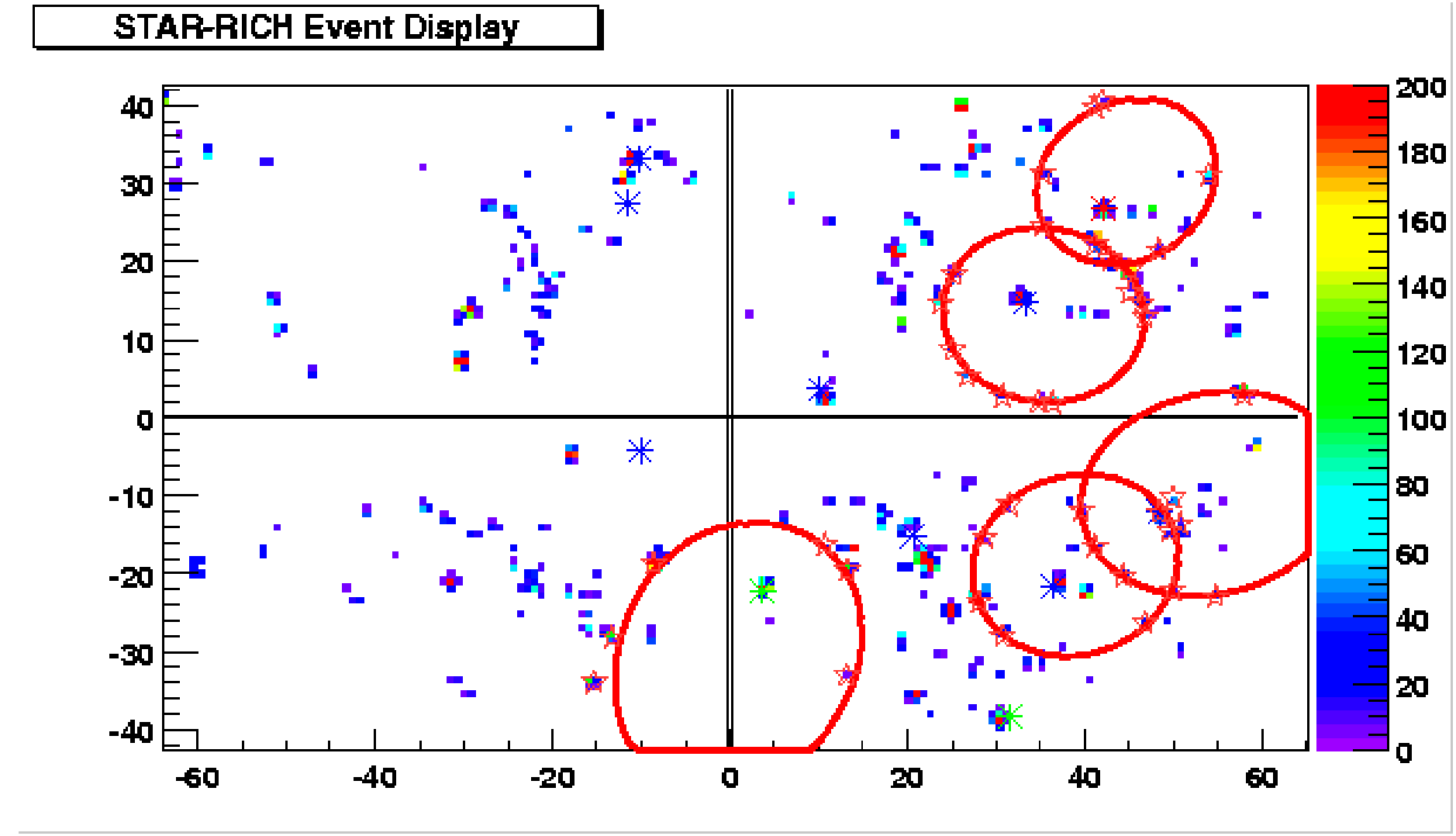


THE HMPID PROTO-2



CHERENKOV EVENTS AT SPS

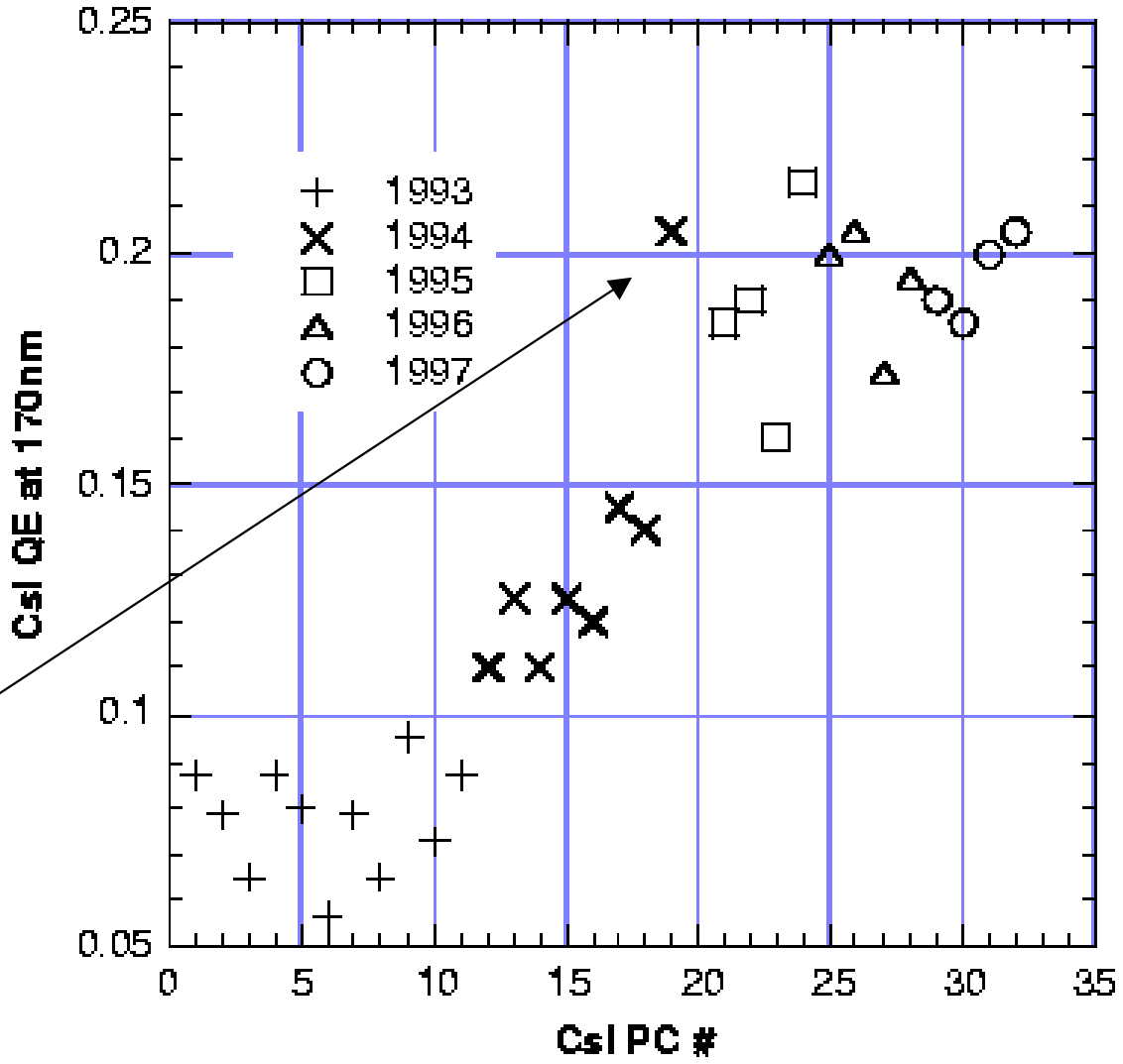
CHERENKOV EVENTS AT STAR

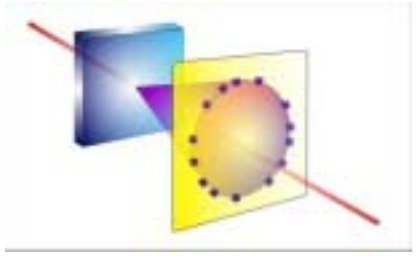


THE CERN/RD26 PROJECT

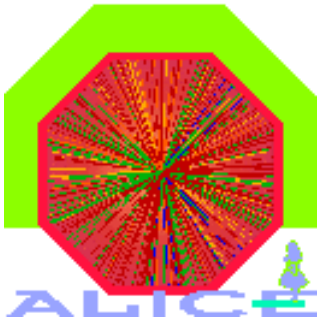
- In 1993-1997: 32 CsI PC's produced, area from 20x10 to 64x40 cm^2

- Definition of a procedure to prepare large area CsI PC's with reproducible high QE + handling under clean conditions

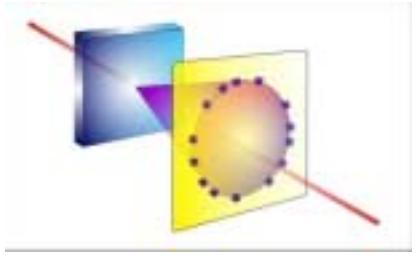




THE PC'S UNDER STUDY



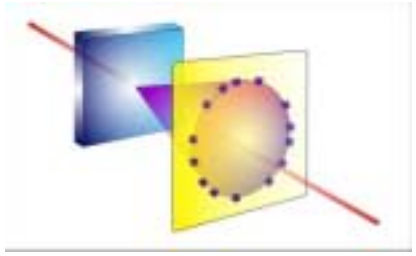
PC id #	Pad plane area	Date of evaporation
PC19	29x32 cm^2	29/11/1994
PC24	29x32 cm^2	6/12/1995
PC29	64x40 cm^2	2/6/1997
PC30	64x40 cm^2	24/6/1997
PC31	64x40 cm^2	16/7/1997
PC32	64x40 cm^2	30/7/1997



MAIN DEPOSITION PARAMETERS

Substrate type	copper-clad PCB + 7 μm Ni + 0.05-0.1 μm Au
Pressure before deposition	2×10^{-6} Torr
Temperature during deposition	50 °C
Deposition rate	2 nm/sec
CsI thickness	300 nm
Final treatment temperature/time	50 °C / 8 h

(since 2000, RGA before and after CsI deposition)

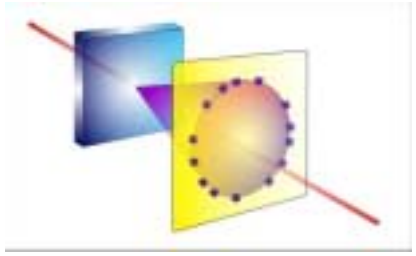


AGING SOURCES

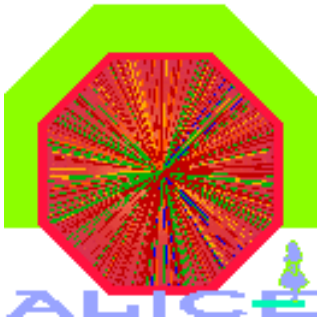
CsI PC's performance periodically evaluated in beam tests of RICH

QE degradation

- exposure to O_2 and H_20
- ion impact
- photon impact



EXPOSURE TO O_2 AND H_20

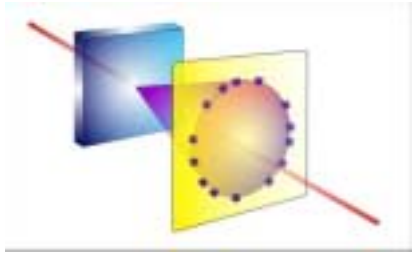


- PC storage under Ar flow: O_2 and H_20 at < 10 ppm

- At each test-beam:
  1. Mounting/dismounting in glove-box: ~1 h, O_2 at 400 ppm and H_20 at <100 ppm
  2. Measured at chamber gas exhaust: O_2 at 20 ppm and H_20 at 10 ppm

- Controlled exposures, with and without gas flow: 6-18 h, O_2 up to 100000 ppm and H_20 up to ~50 ppm (⇨ slide on shipment to BNL)

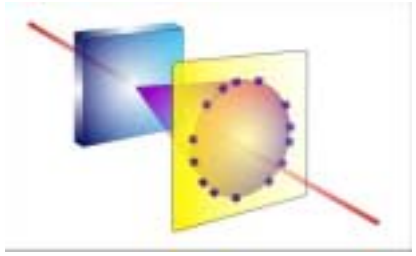
- Exposure to air: 10' at ~ 40% relative humidity



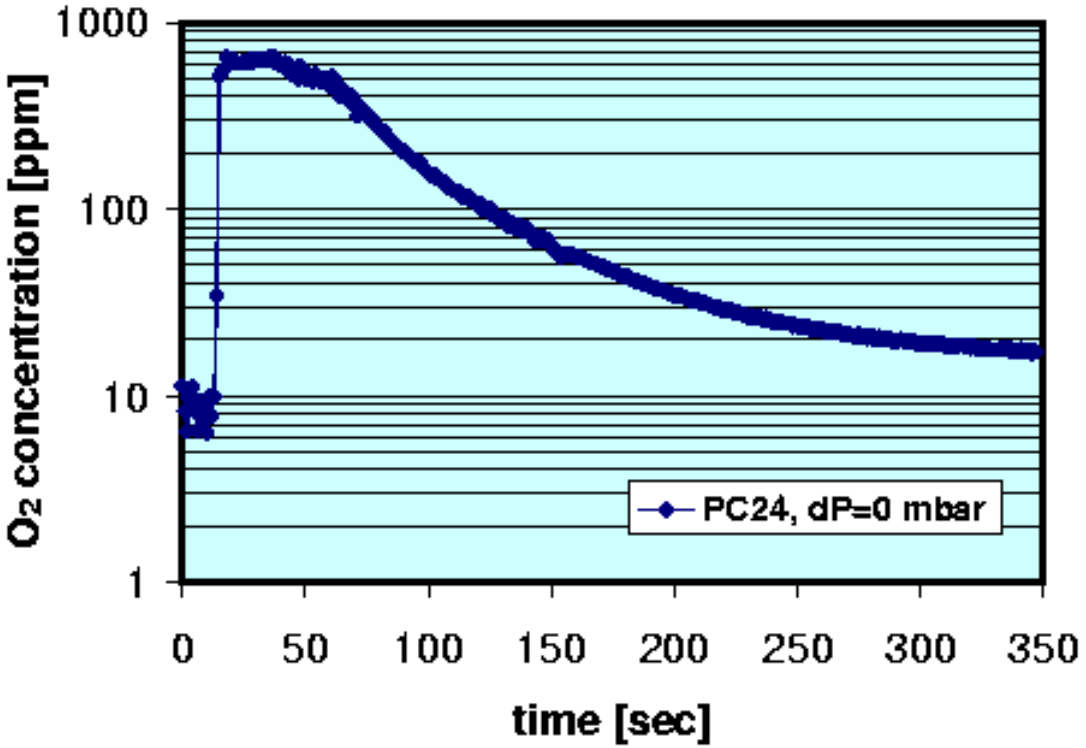
THE SHIPMENT TO BNL

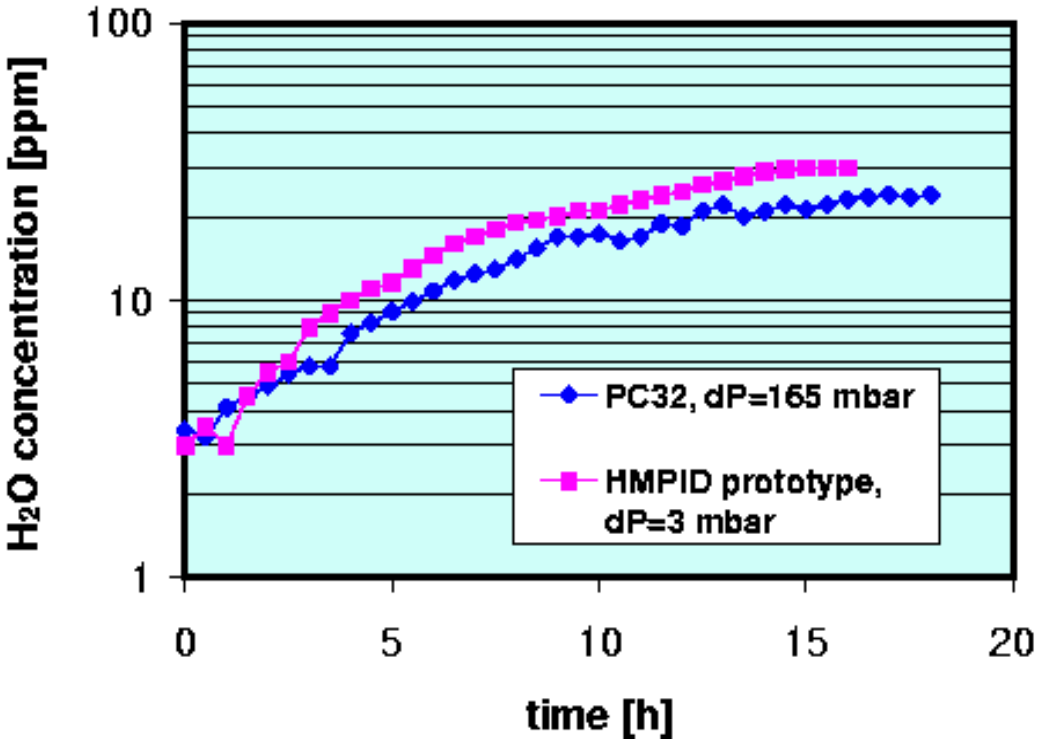
- In the summer of 1999 proto-2 was disassembled and shipped by plane to BNL to be installed in the STAR experiment. The 4 PC's have been put inside sealed vessels pressurized with Ar at 1.2 bar (18 h).

- The solution was adopted after exposure tests to O_2 and H_2O:
  a) produced by the outgassing inside a sealed detector or container;
  b) under gas flow (Ar/dry air mixture).
  (Nucl. Instr. & Meth. A 461(2001), 584-586)

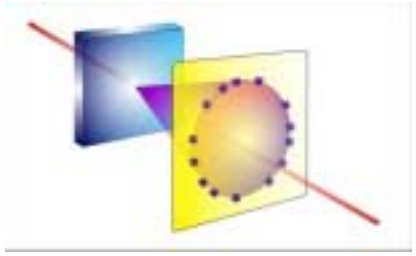


O_2 AND H_2O LEVELS IN SEALED VESSEL





No photoemission degradation has been observed after the test



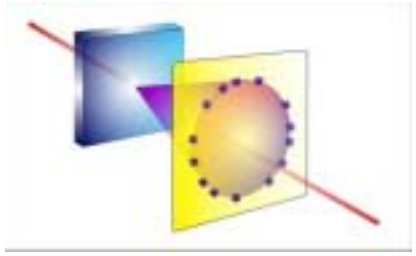
ION IMPACT

- Local beam irradiation up to $2x10^4$ cm^{-2} s^{-1}, stable behaviour @ gain of 10^5

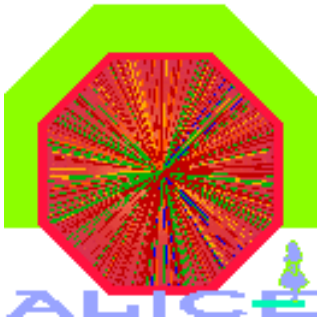
- PC19, PC24
  Beam in fixed positions: inside the Cherenkov fiducial area (~200 cm^2), accumulated charge (from single photoelectron avalanches) 2-10 $\mu C/cm^2$ at each TB period

- Proto-2 (PC29 to PC32)
  1. Beam in fixed positions
  2. π^- -Be events: 10-50 $\mu C/cm^2$
  3. STAR physics runs: 10 $\mu C/cm^2$

(EXPECTED IN ALICE: charge rate $5x10^{-11}$ C cm^{-2} s^{-1}, charge density integrated over a year Pb run 50 $\mu C/cm^2$)

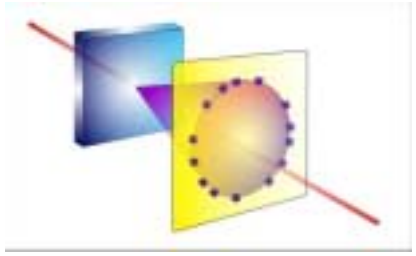


PHOTON IMPACT



- Largest rate with beam in fixed positions: inside Cherenkov fiducial area, ~ 2 x 10^{4} photons cm^{-2} s^{-1}

⇒ IT CAN BE NEGLECTED FOR OUR APPLICATION

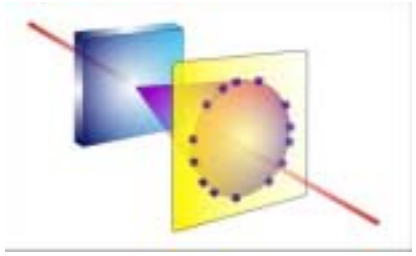


QE EXTRACTION FROM TB DATA

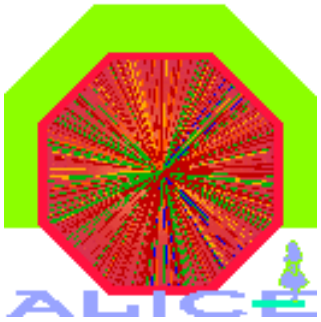
- Definition of a Cherenkov fiducial area, according to detector geometry and beam momentum
- Pad clusters analysis and deconvolution, needed because of large fraction of cluster overlap
- Distributions of main quantities: multiplicity and size of pad clusters, single electron pulse height, ….
- Monte Carlo simulation: "tuning" of QE curve in order to reproduce experimental results, all processes taken into account

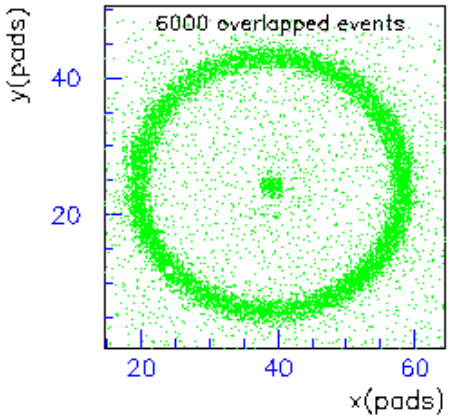
-ALICE HMPID Technical Design Report, CERN/LHCC 98-19

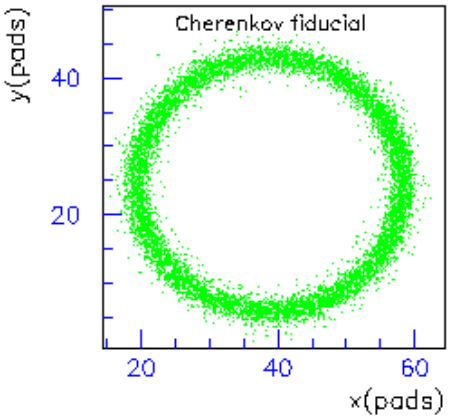
- Nucl. Instr. and Meth. A 433(1999), 190-200

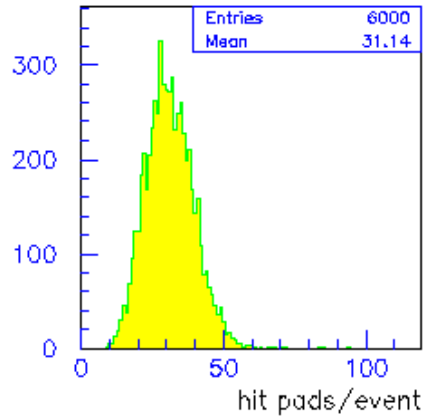


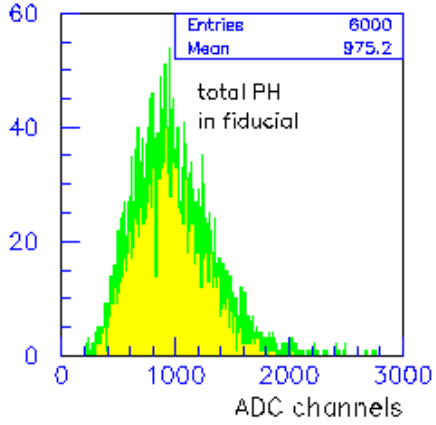
SOME TYPICAL DISTRIBUTIONS

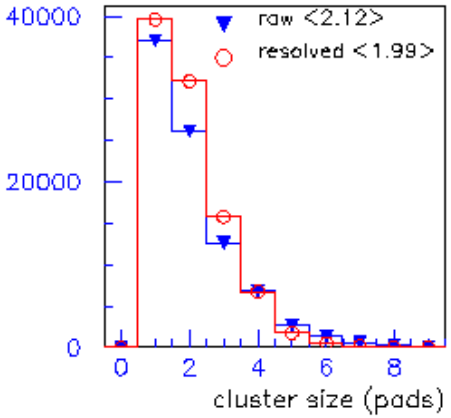


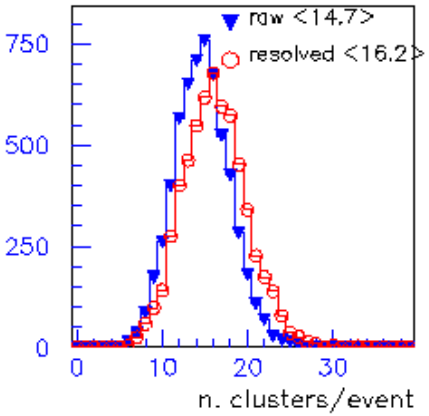


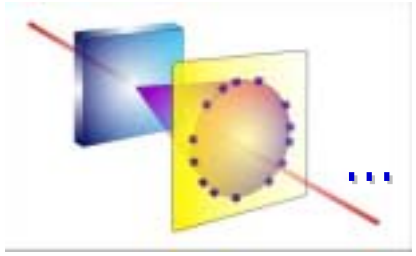




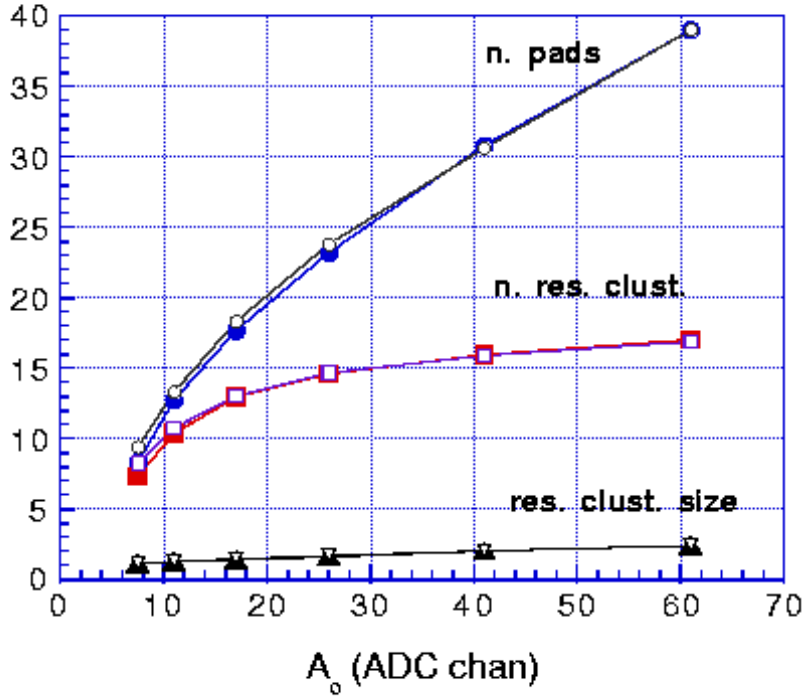


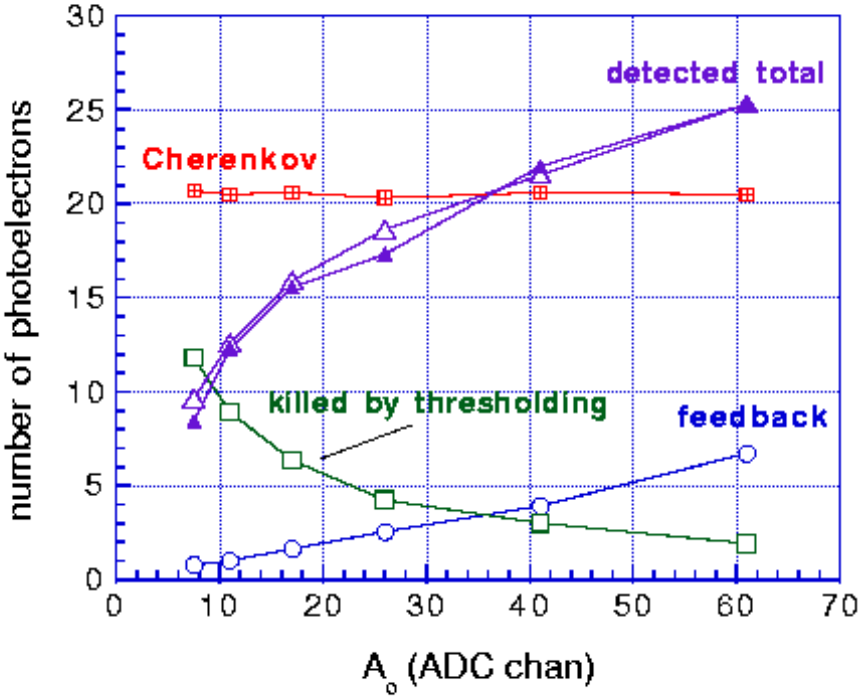






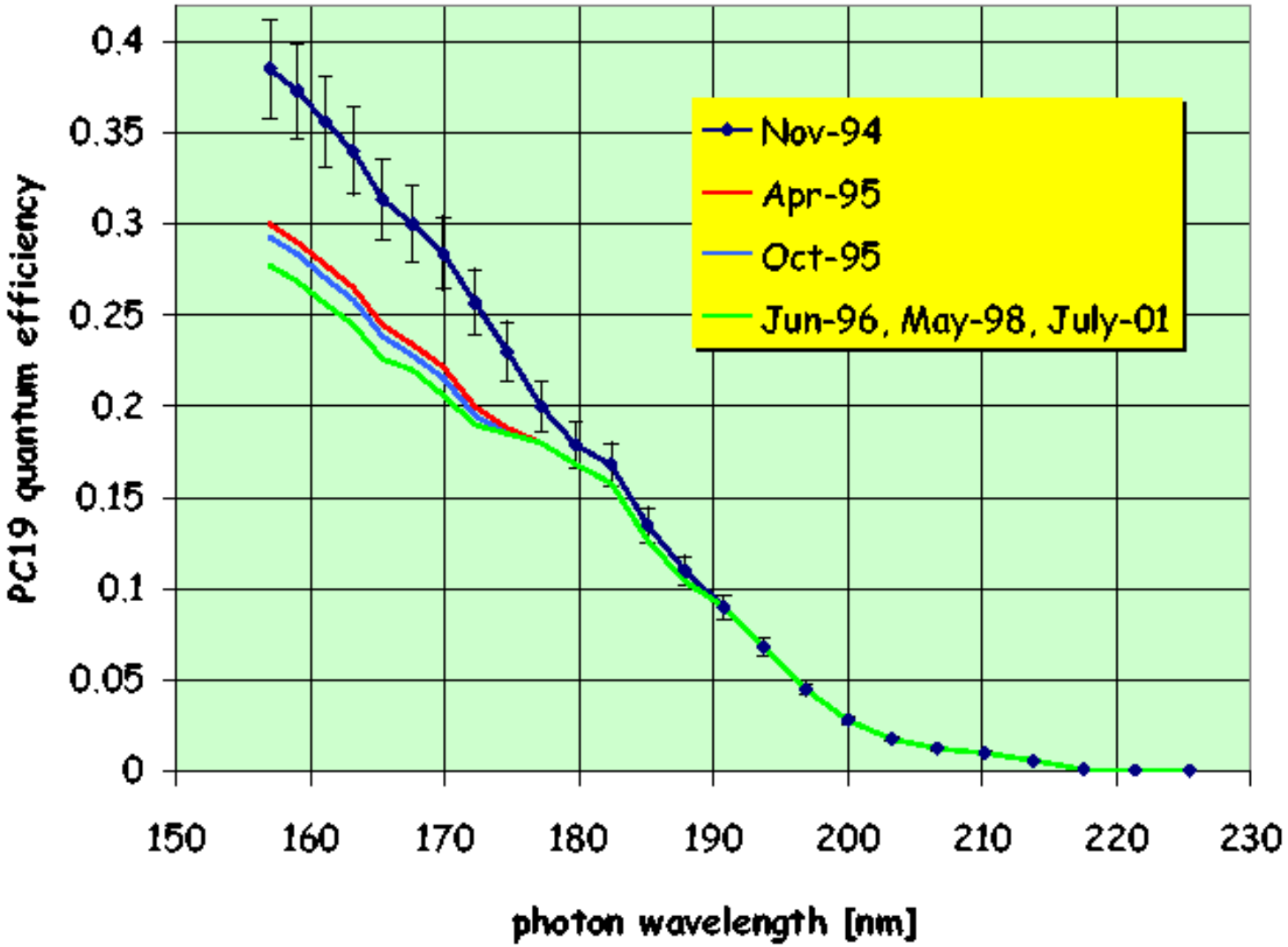
... AND THE SIMULATION RESULTS



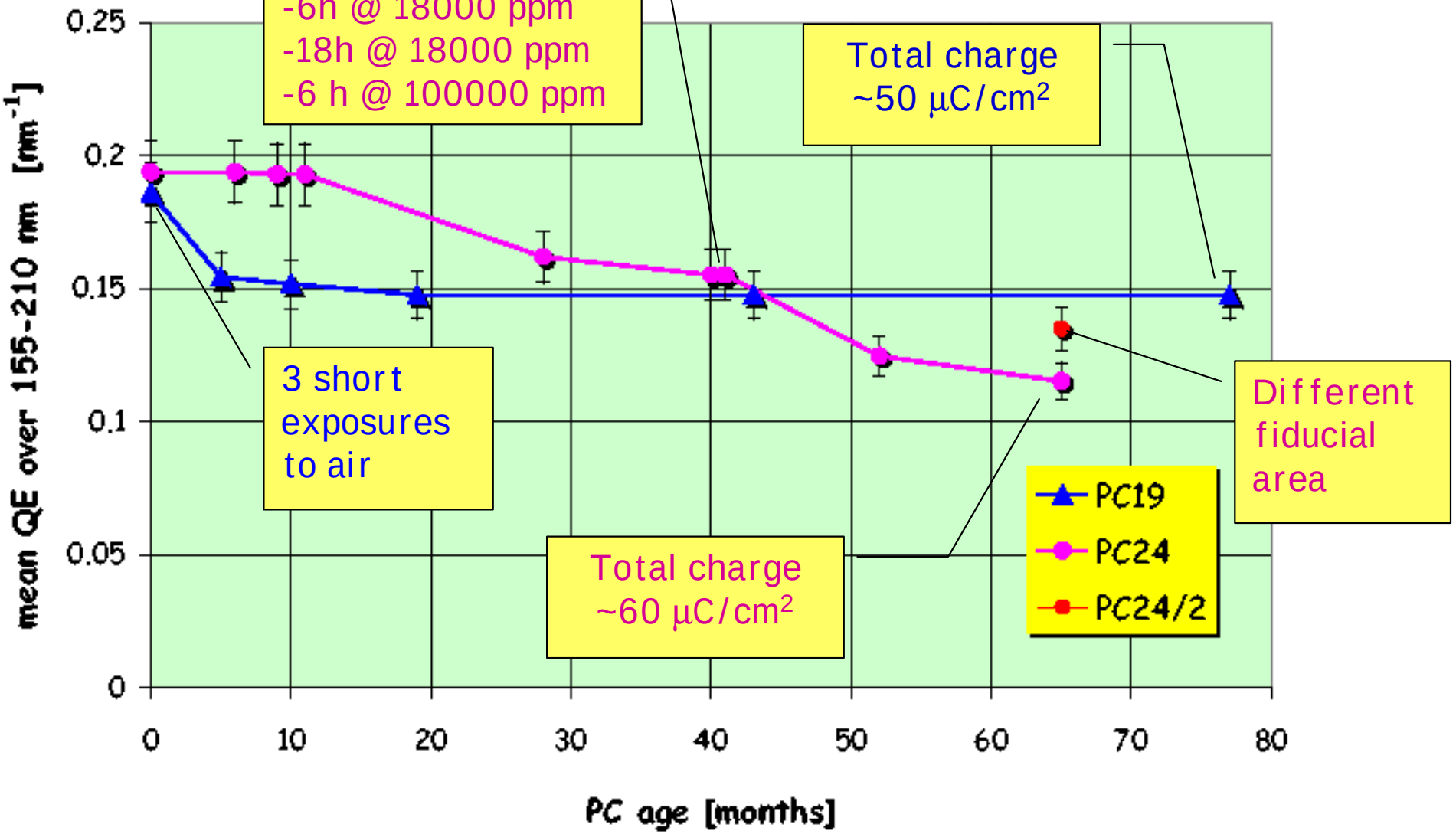


(full symbols: measurements; empty symbols: simulation)

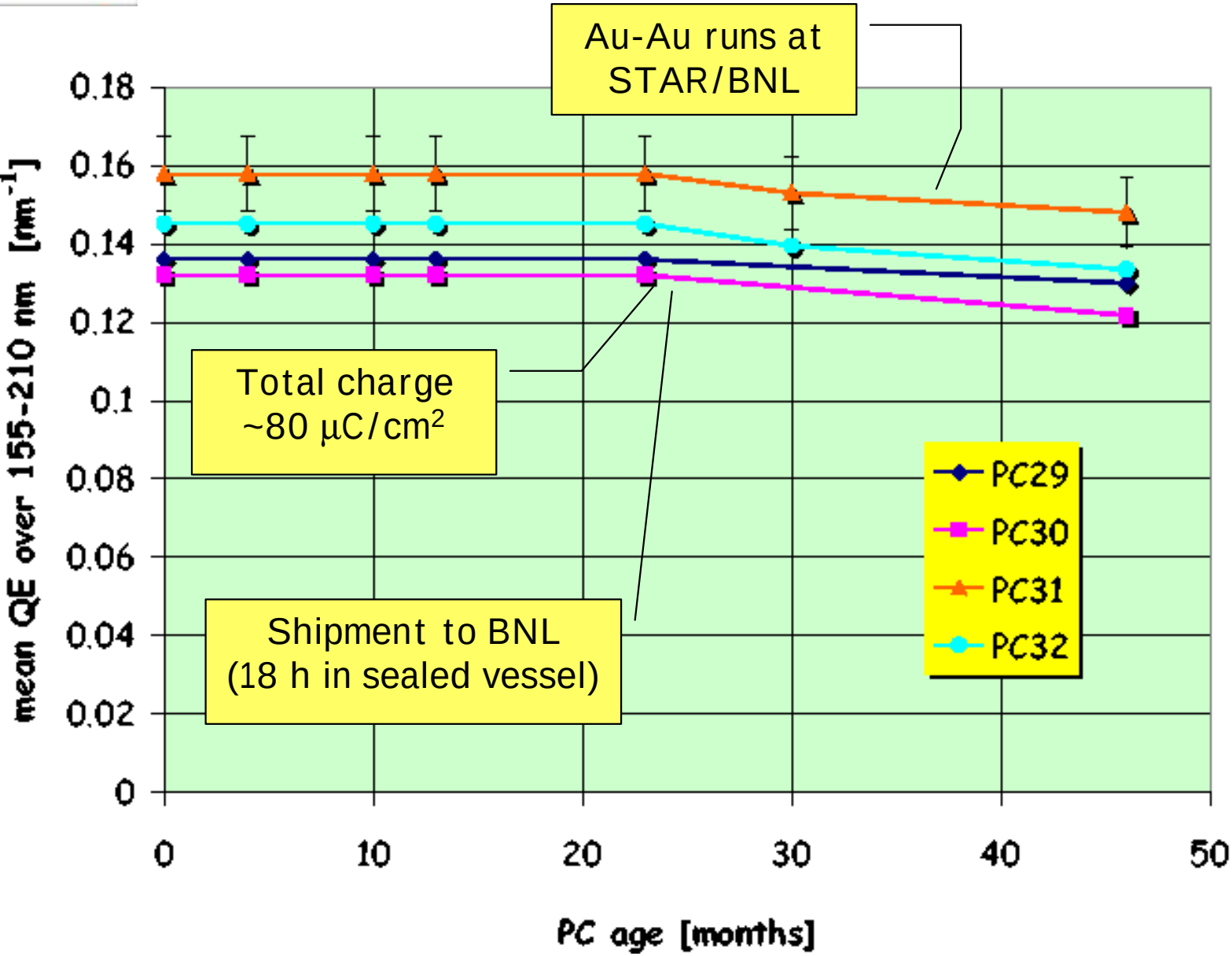
PC19 DIFFERENTIAL QE

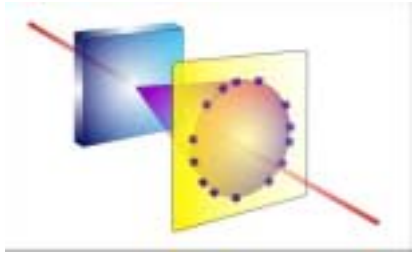


QE HISTORY OF PC19 AND PC24



QE HISTORY OF PC29-PC32





SUMMARY

- With the exception of PC24, the examined PC's have been found quite stable at the considered accumulated charge densities, when the exposure to O_2 and H_2O is limited to the ppm level.

- As expected, a QE degradation (20%) has been observed after short exposures to air (humidity).

- The effect of the exposure to O_2 amounts > 1000 ppm is not quite clear and is a subject for further investigations.