RICH2013
Conference Summary

Jürgen Engelfried

Instituto de Física
Universidad Autónoma de San Luis Potosí
Mexico

8th International Workshop on
Ring Imaging Cherenkov detectors
Dec 2-6, 2013, Shonan Village Center
Hayama, Japan


RICH 2013
8th International Workshop on Ring Imaging Cherenkov Detectors
Shonan, Kanagawa, Japan,
December 2nd - 6th 2013
Topics
Cherenkov light imaging in particle and nuclear physics experiments
Cherenkov detectors in astroparticle physics
Novel Cherenkov imaging techniques for future experiments
Photon detection techniques for Cherenkov counters
Technological aspects of Cherenkov detectors
Pattern recognition and data analysis
Alternative PID techniques
International Advisory Committee
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RICH 201
RICH2013
KAMAKURA
WELCOME
GUIDES

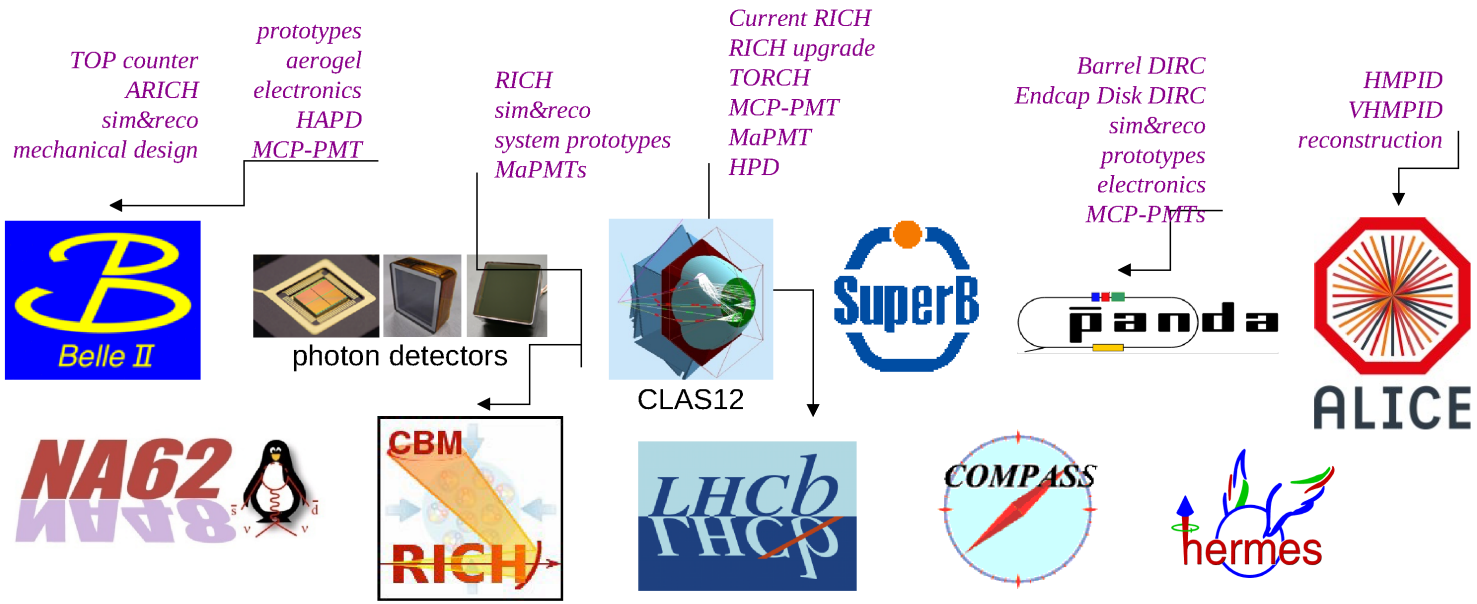

危険
車路を歩かないで下さい
Jürgen Engelfried
はろうきてぃ


Fermilab

SCOPE OF REVIEW

List of contributions:

- 54 abstracts within scope of this review,
- 28 talks on RICH systems, photon detectors, technical advances, prototyping.
- Leaderboard: Belle II (13), LHCb (7), PANDA (6), CBM (4), ALICE (3).



SCOPE OF REVIEW

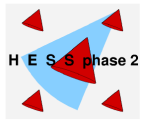
Many exciting RICH systems are outside the scope of this review:

- Neutrino detectors underground or in natural water/ice;
- Imaging air Cherenkov telescopes.

Will be reviewed by Razmik Mirzoyan Wednesday afternoon

"Cherenkov light imaging in Astroparticle Physics"

PIERRE AUGER OBSERVATORY



Tunka-133

SNO

KM3NeT

FACT
First G-APD Cherenkov Telescope

ICECUBE
SOUTH POLE NEUTRINO OBSERVATORY


RICH 201
December 2n
Topics

Special Talks

- **Masatoshi Koshiba – Memories of Kamioka Experiment**
- Yuji Yoshizawa – Latest Trend of Photon Detectors from Hamamatsu
- Youchira Suzuki – Present and Future of Ring Imaging Water Cherenkov Experiments

Review talks

- Jochen Schwiening – Cherenkov light imaging in High Energy and Nuclear Physics
- Razmik Mirzoyan – Cherenkov light imaging in Astroparticle Physics
- Antonello Di Mauro – Status and perspective of gaseous photon detectors
- Gianmaria Collazuol – Status and perspective of solid state photon detectors
- Jerry Va'vra – Optical components for Cherenkov light imaging devices
- Neville Harnew – Other PID techniques
- Sheldon Stone – Use of RICH detectors for Physics

Talks and Posters

- Special talks
- Review talks
- 45 talks on systems and details
- 28 posters

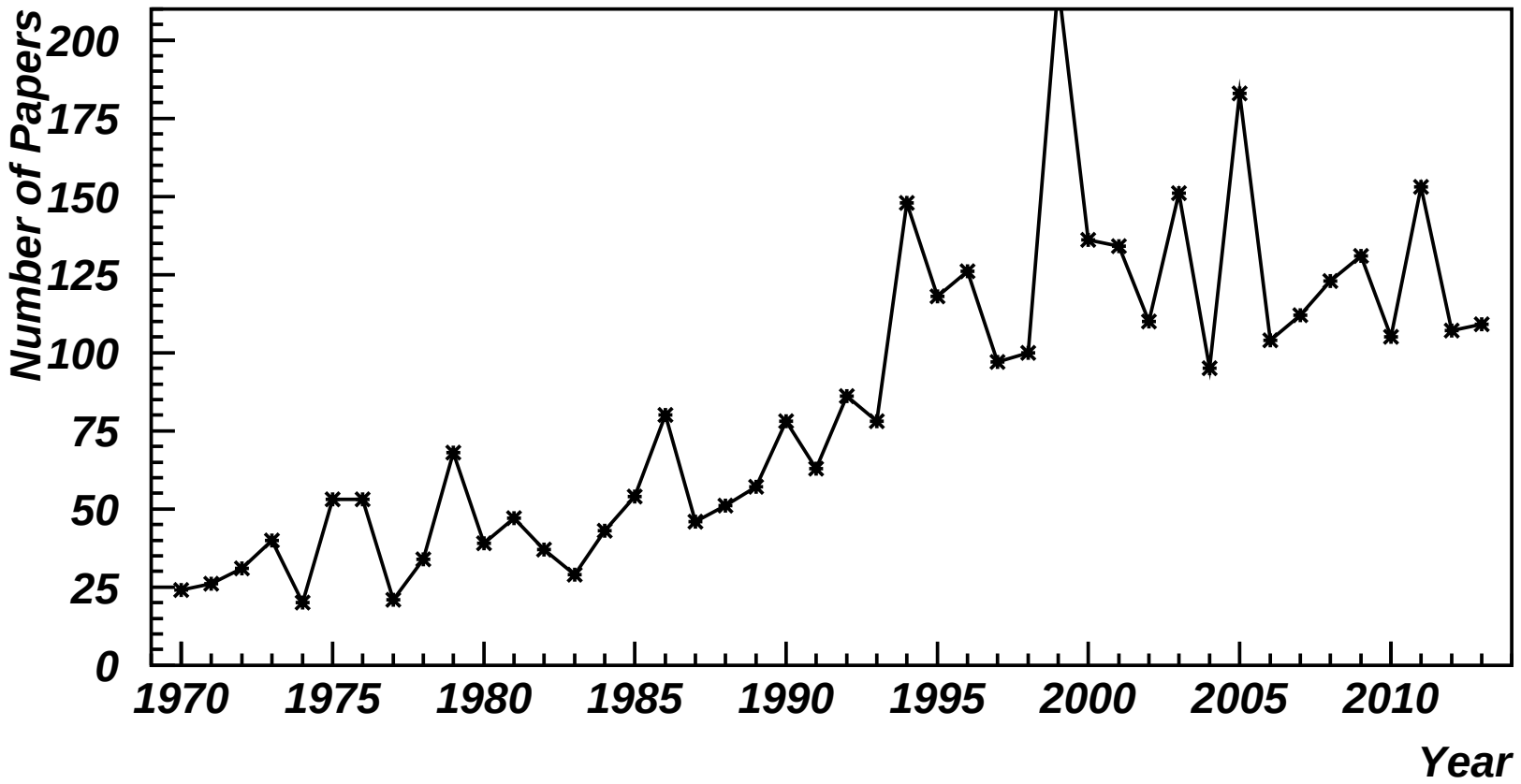
- Review talks already reviewed all the topics
  No need to review the review talks. . .
- Will just mention a few topics I personally found interesting

- copying slides from the talks...

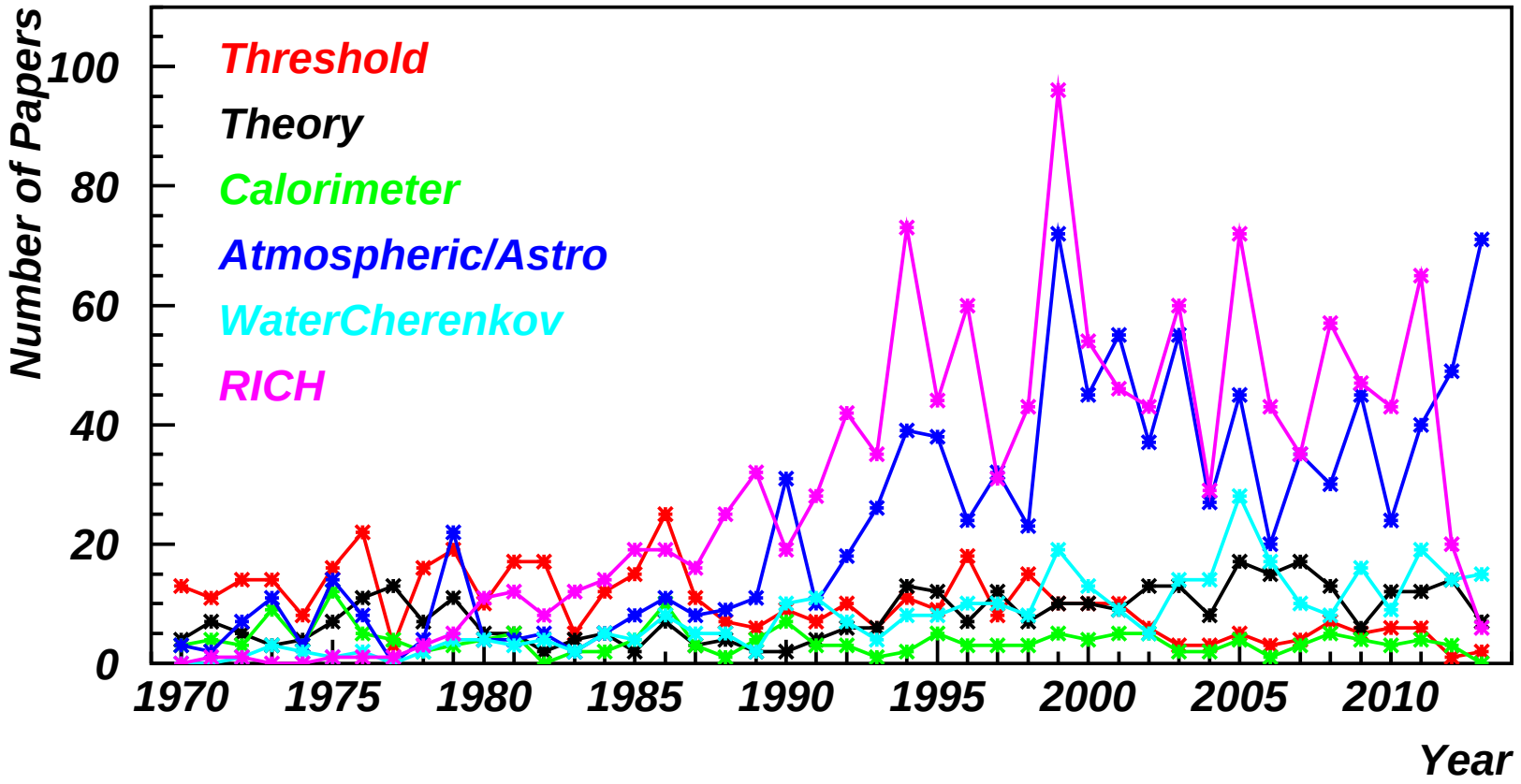
Are there new developments?

- Made a InSpires search on title containing:
  *"RICH" or "Ring Imaging" or "cherenkov" or "tscherenkov" or "cerenkov" or "DIRC"*for every year since 1970.
  compared to last time: Spires→ InSpires, include "DIRC"
- Divide (by hand) into the following Categories:
  - Water/Ice Cherenkov
  - Threshold (and similar) Counters
  - Atmospheric Cherenkov and Astronomy
  - Calorimeters (lead glass and similar)
  - Physics Results with Cherenkov detectors
  - Cherenkov Theory
  - RICH
- Not counting Accelerator techniques etc.

Total Number of Papers



Separated By Category



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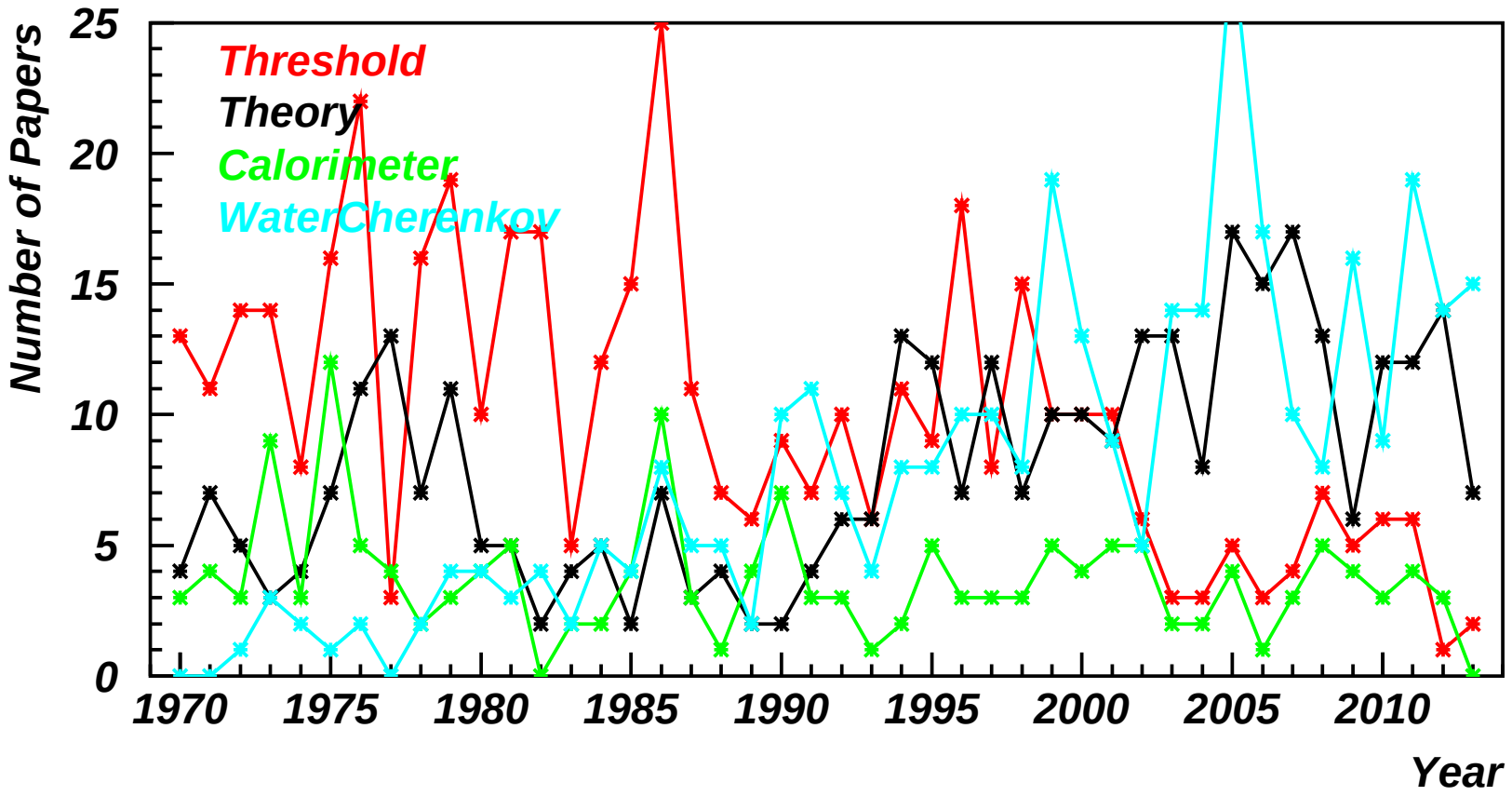

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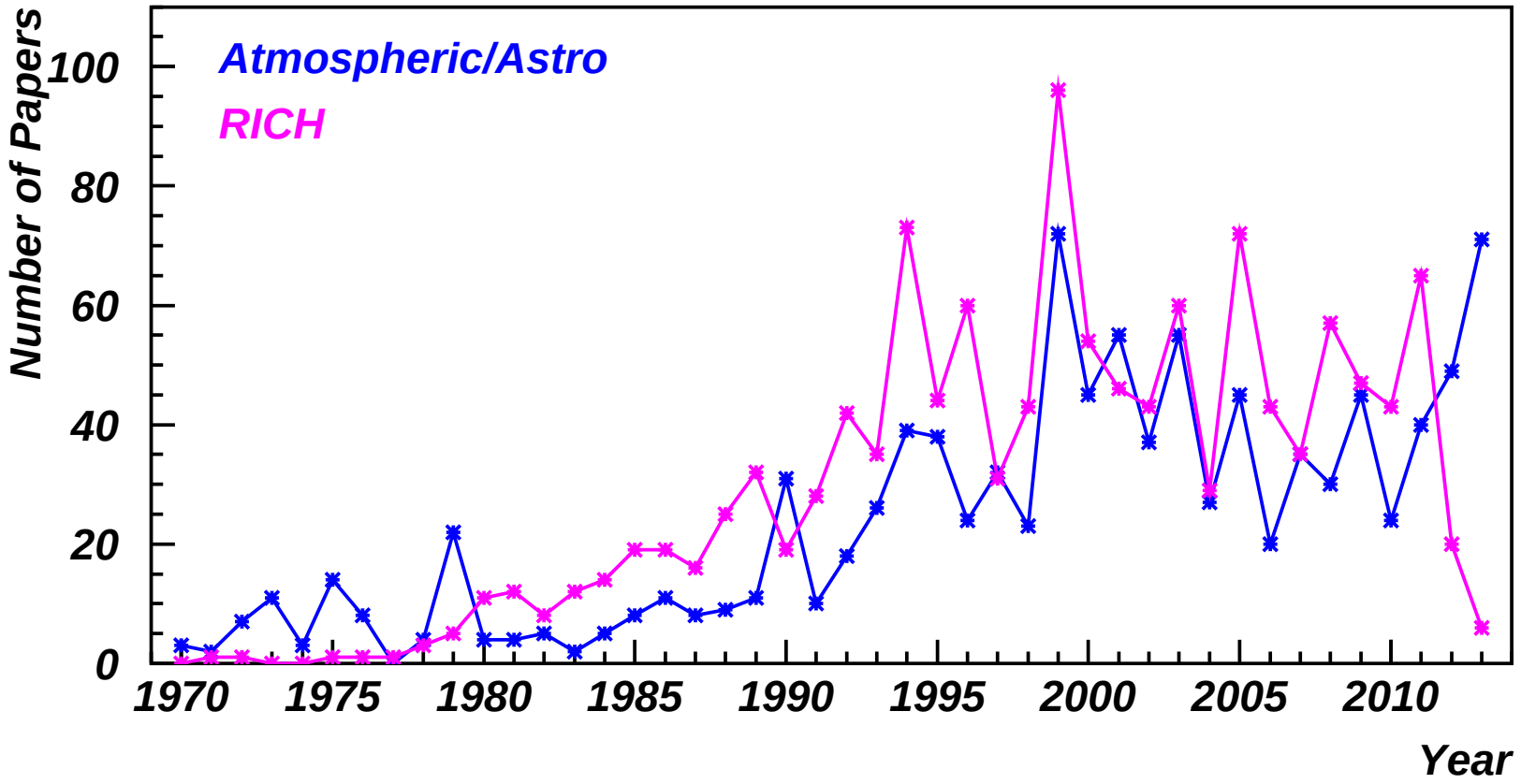


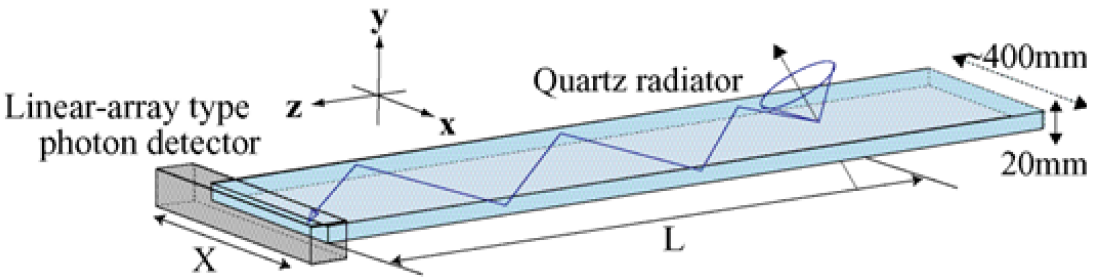
Paper Search Summary

- Number of papers increasing, so there are new interesting things!
- Number of papers treating “conventional” (old) detectors, like Threshold Counters is constant.
- Most (but not all!) are (highly sophisticated!) “optimizations” of the known Cherenkov basics.
- Some concern with the decreasing numbers of “RICH” papers...

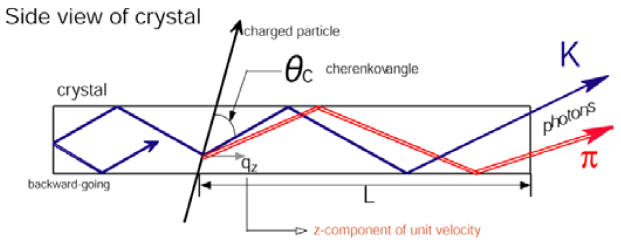
Where did the rings go?

Basic concept

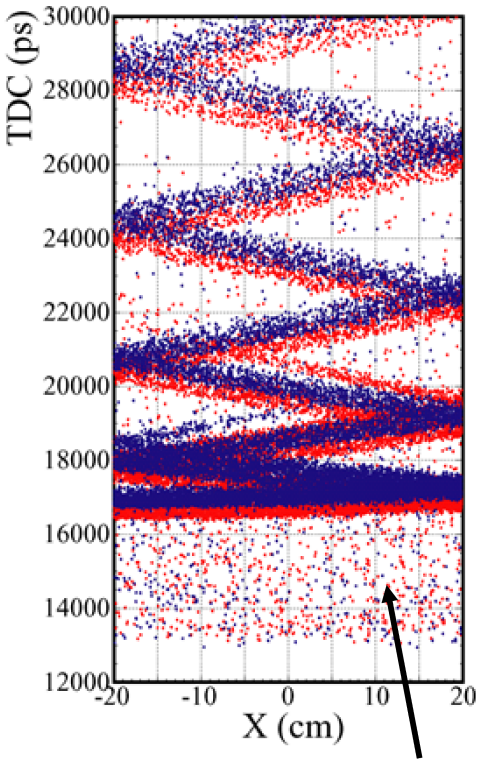
- Cherenkov ring imaging using timing information
- Very compact, suitable for collider geometry.
- Key technologies:
  - Single photo detection with precise timing
  - Accurately polished quartz bar



$$cos\theta_c = \frac{1}{n(\lambda)\beta}$$



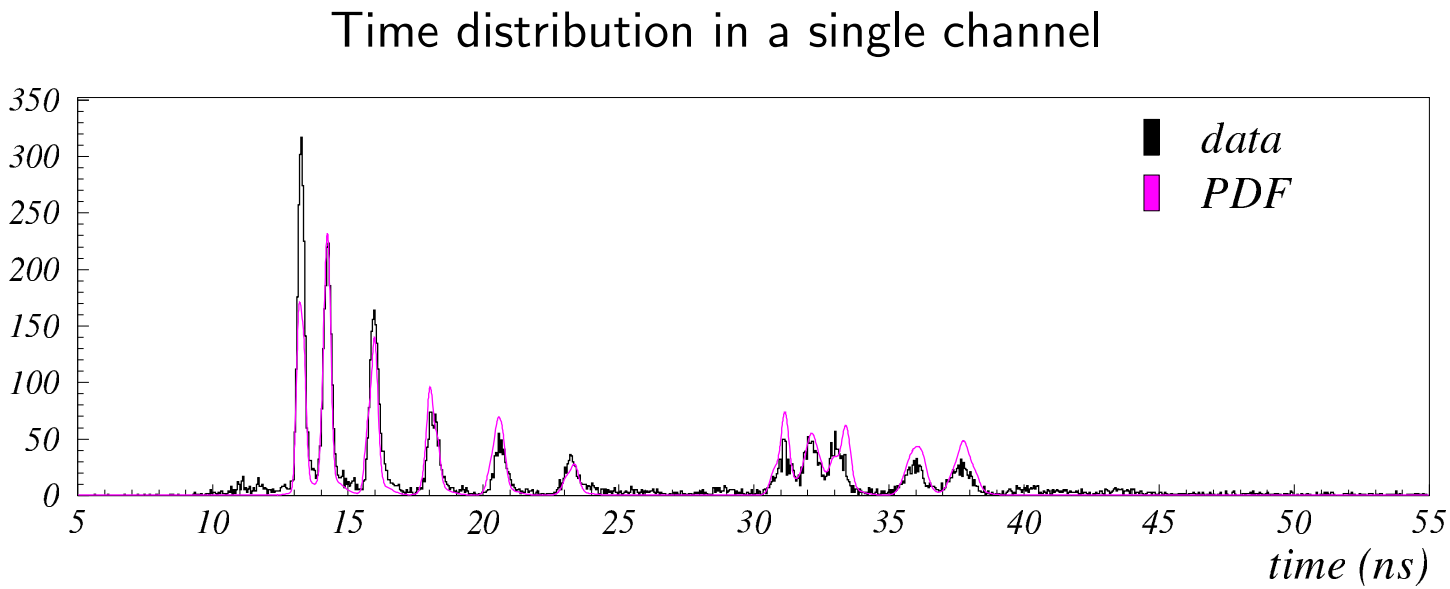
Simulation
2GeV/c, θ=90 deg.



Difference of path length → Difference of time of propagation (TOP)
~150-200ps from TOP + TOF from IP
with precise time resolution (σ~40ps) for each photon

Where did rings go?

Particle identification: using extended likelihood method



- PDF in a single channel described with a series of Gaussian distributions
  - positions, widths and normalizations determined analytically
  - method presented at RICH2010 (NIM A 639 (2011) 252-255)

But there are still “standard” RICHes coming. . .

BERGISCHE UNIVERSITÄT WUPPERTAL

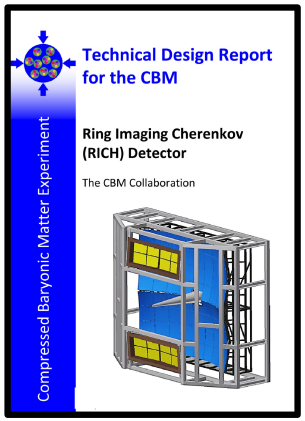
Summary and Outlook

CBM

- **New gas RICH** detector being developed **for the CBM experiment at FAIR**
- Focus: **e / π separation up to 8 GeV/c**, high rates, high ring multiplicity (secondary e-)
- Design concept established, **Technical Design Report submitted this summer**

- **Full-scale prototype** has been built and successfully **tested at CERN-PS**
- Results prove a **sound understanding of the prototype performance**
- Further results on:
  - Mirror (miss-)alignment
  - Photon sensor comparison and electronics
  - WLS efficiency
  - Ring reconstruction routines
  - Full system test: gas system, slow control, ...

- Lab tests of brand **new Multianode PMT H12700: very promising results...**



More work needed on:

- **Shielding of magnetic stray fields** from CBM dipole
- **Final choice of photon sensor**
- Development of **FPGA-TDC based readout** electronics
- **WLS behavior under neutron irradiation**, aging

Another prototype currently being developed and tested at Pusan National University, PNU

- Test different radiator gases
- Test high rate conditions

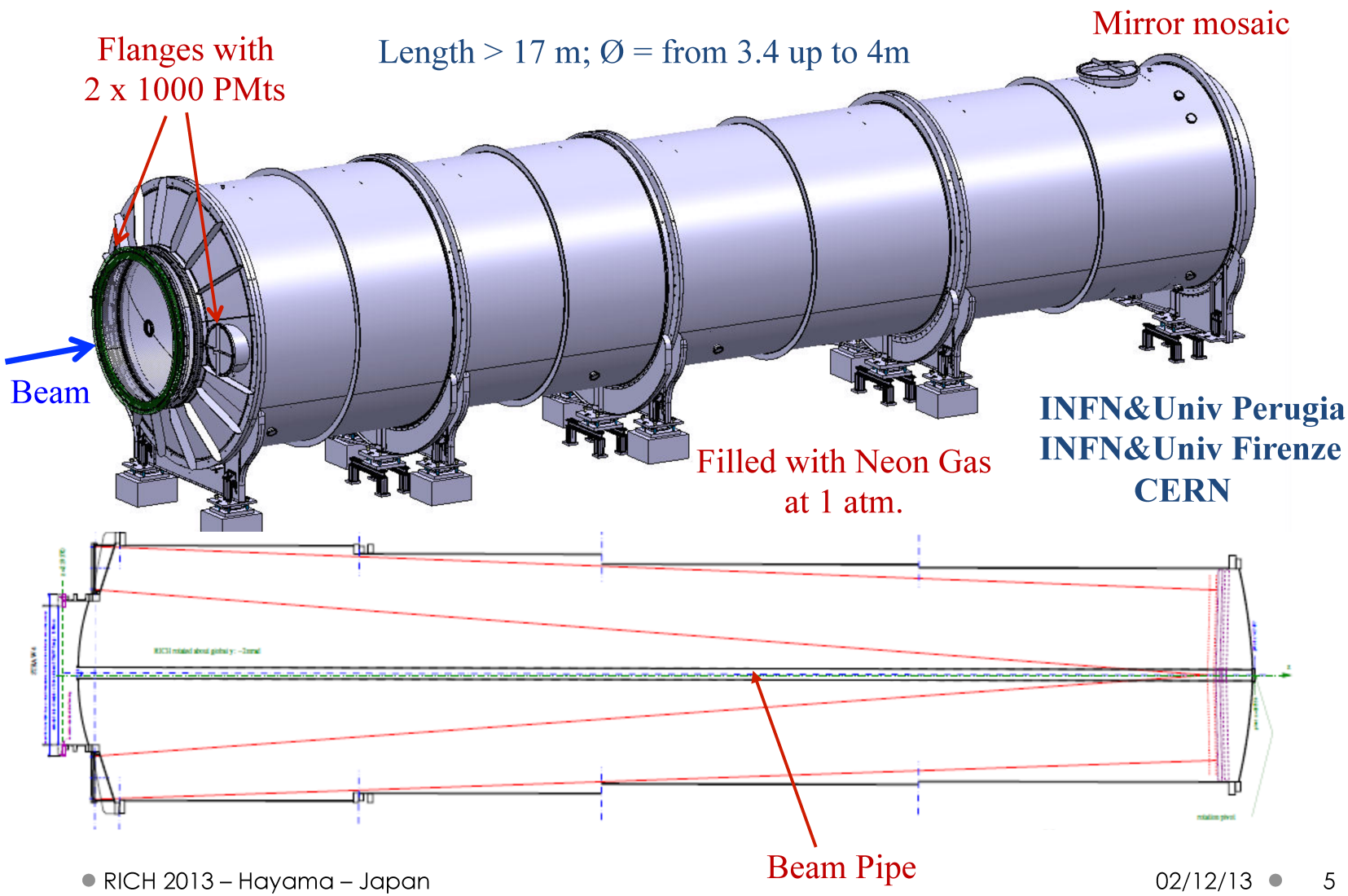
Timeline: first beam end of 2018 !

Additional information:

talk S. Lebedev:	Ring finding (**Thu. 18.05h**)
poster T. Mahmoud:	mirror, gas system
poster J. Kopfer:	WLS studies

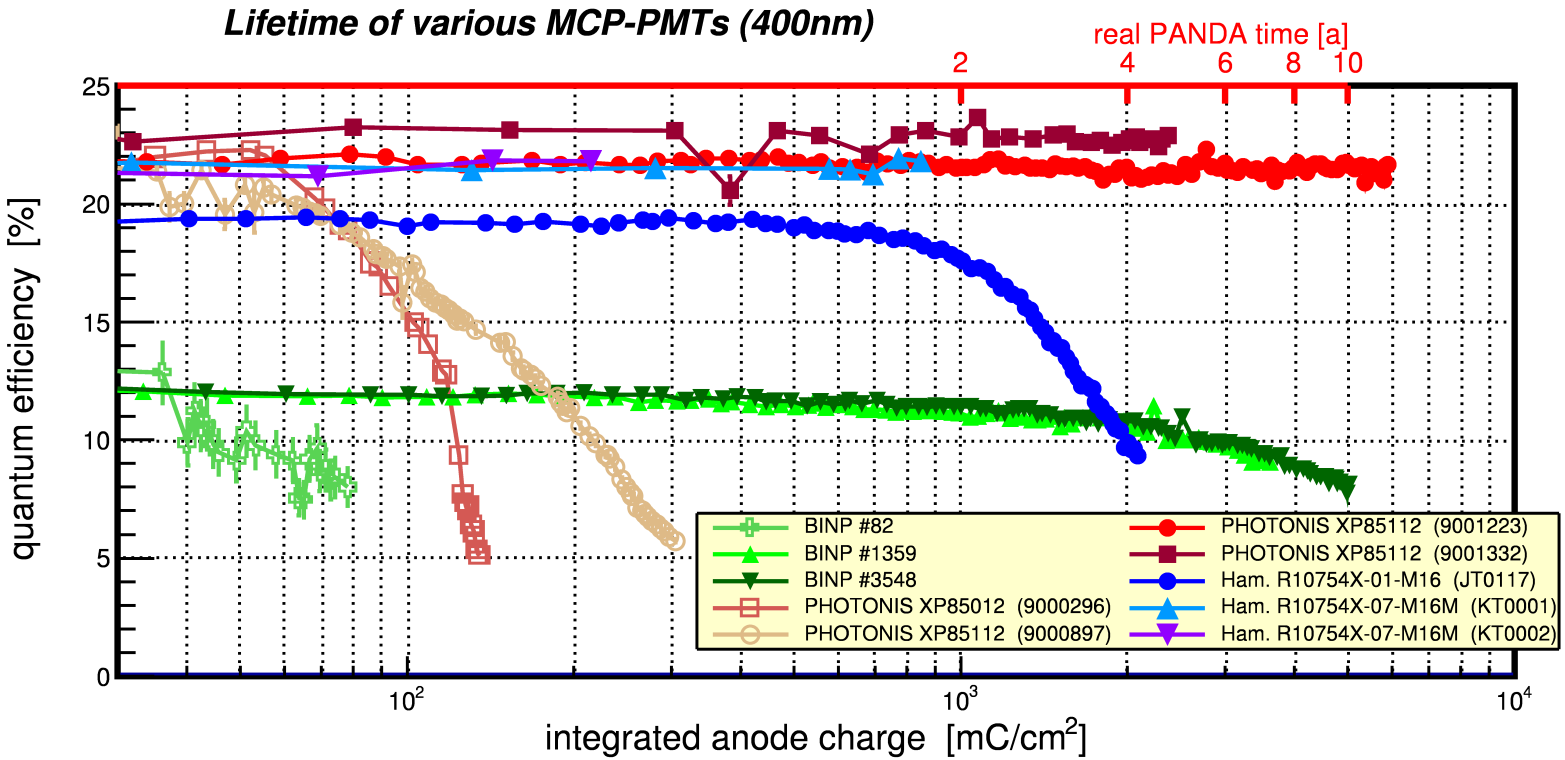
But there are still “standard” RICHes coming. . .

The NA62 RICH



Lifetimes of MCP-PMTs

Lifetime of Different MCP-PMTs



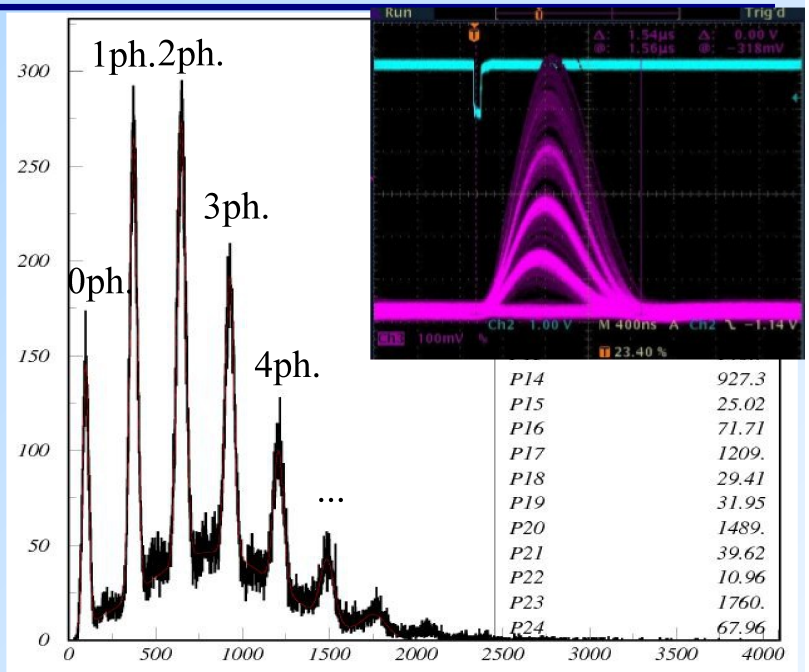
- older BINP and PHOTONIS MCP-PMTs: rapid Q.E. degradation
- new PHOTONIS XP85112: **almost no Q.E. drop at 6 C/cm^2**

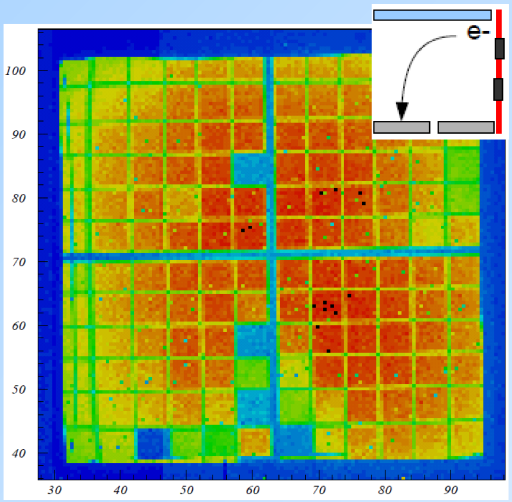
Excellent single photoelectron resolutions

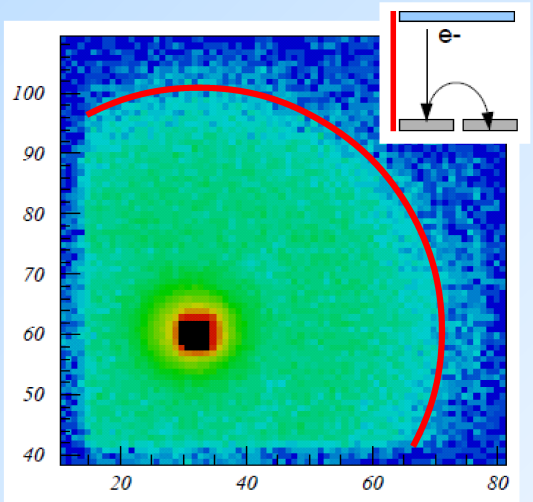
Excellent single photoelectron resolutions

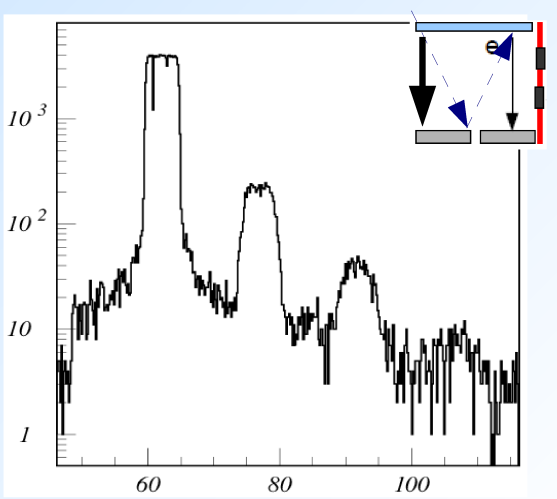
HAPD performance @ B=0T

- excellent photon counting affected only by photo-electron back-scattering → high single photon counting efficiency
- sharp transition between channels
- image distortion due to a non-uniform electric field at the edge
- back-scattering induced cross-talk
- optical cross-talk by reflection from APD surface → weak echo ring









Excellent single photoelectron resolutions

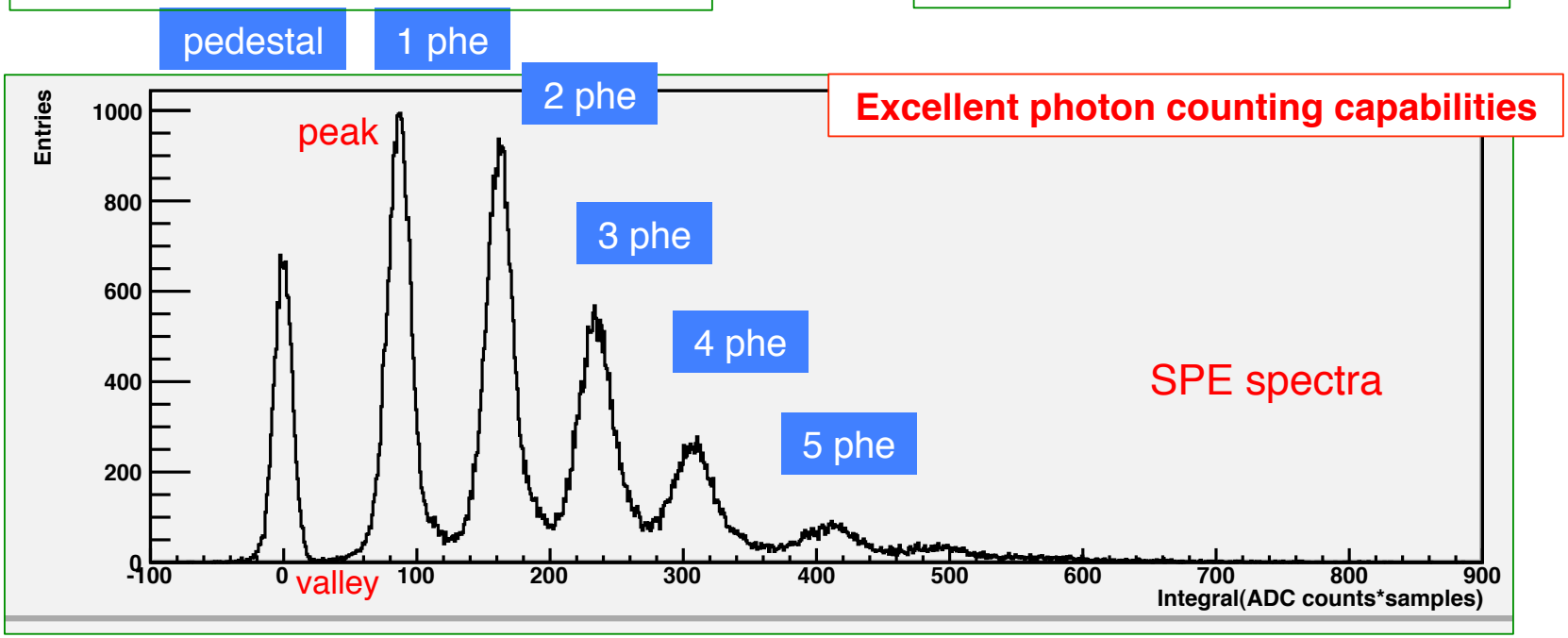
SPE spectra

100.000 waveforms for each acquisition run with low laser intensity.

Integral of the waveform in a window of 100 ns after subtracting the baseline.

DAQ ADC CAEN V1720E
12 bit – 4 ns sampling
Laser TRG 10kHz

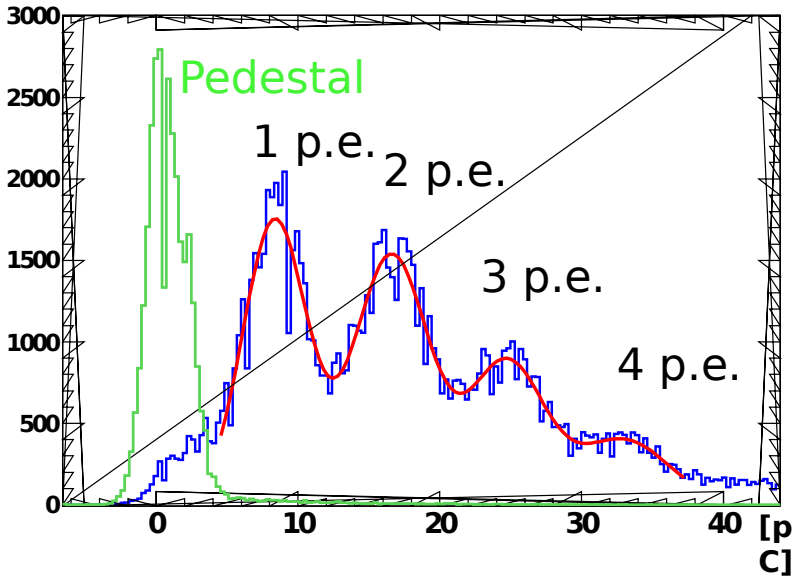
VSiPMT working point
V_{bias}= 72.5 V – HV = 4 kV
Amplification x20



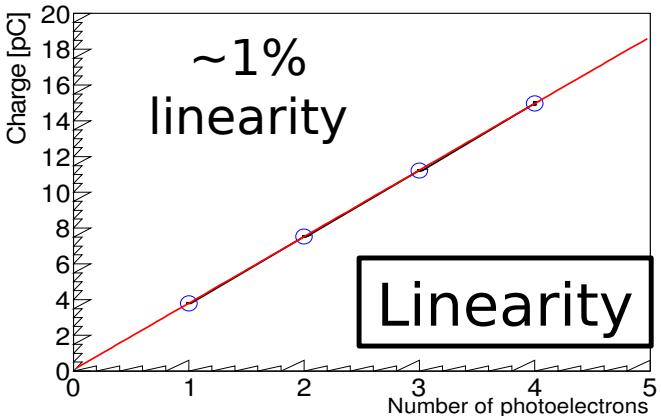
Excellent single photoelectron resolutions

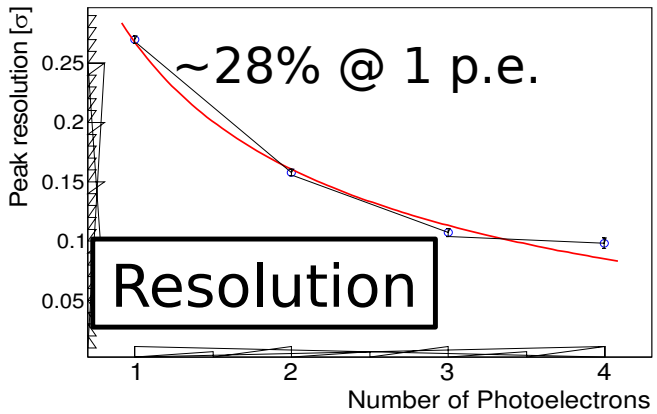
.3

HPD Multi p.e. measurement

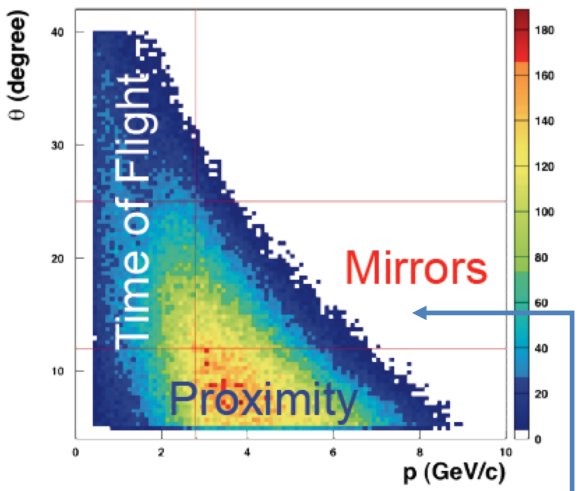


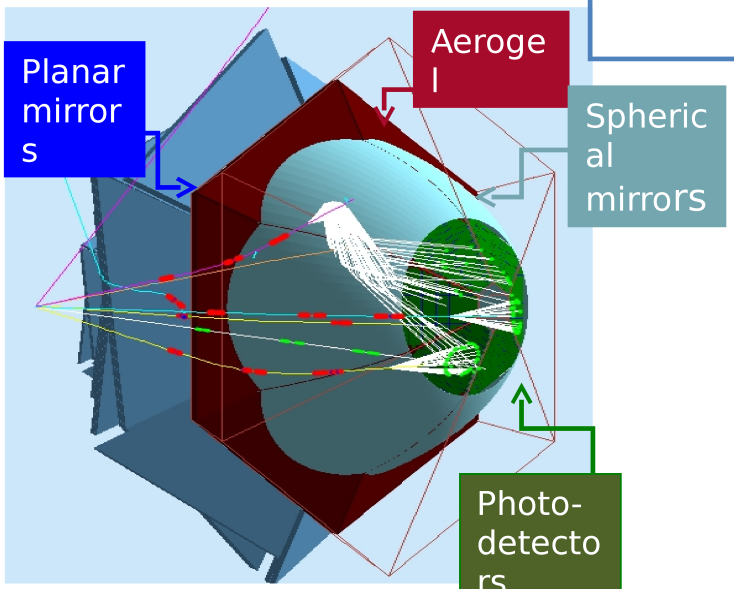
- Multi p.e. can be recognized by HPD due to its good p.e. separation.
- Linearity of output can be seen in few p.e. region.



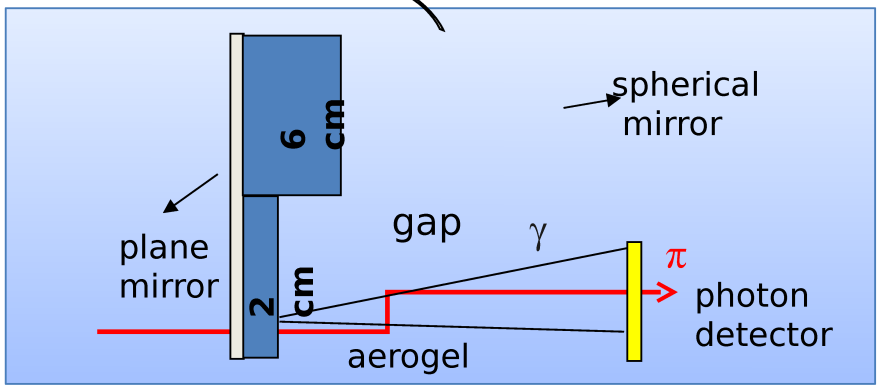


The Hybrid Optics Design

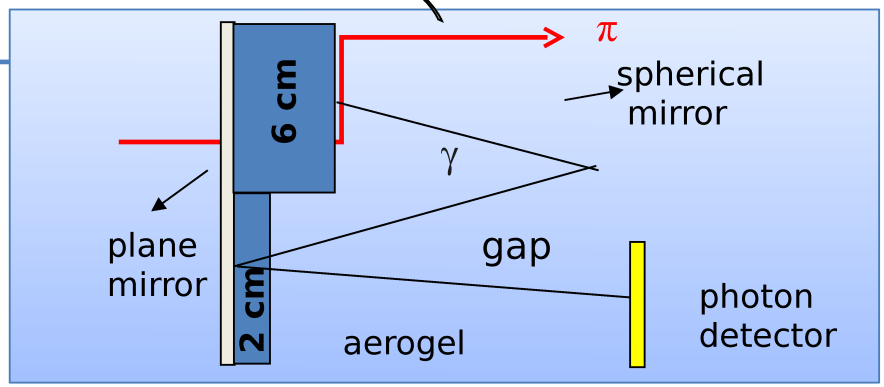




Direct rings and best performance for high momentum particles



Reflected rings for less demanding low momentum particles



- Minimize active area (cost) to about 1 m2
- Material budget concentrated where TOF is less effective
- Focalizing mirrors allow thick radiator for good light yield
- Time resolution < 1 ns to distinguish direct and reflected patterns

Systems which just work...

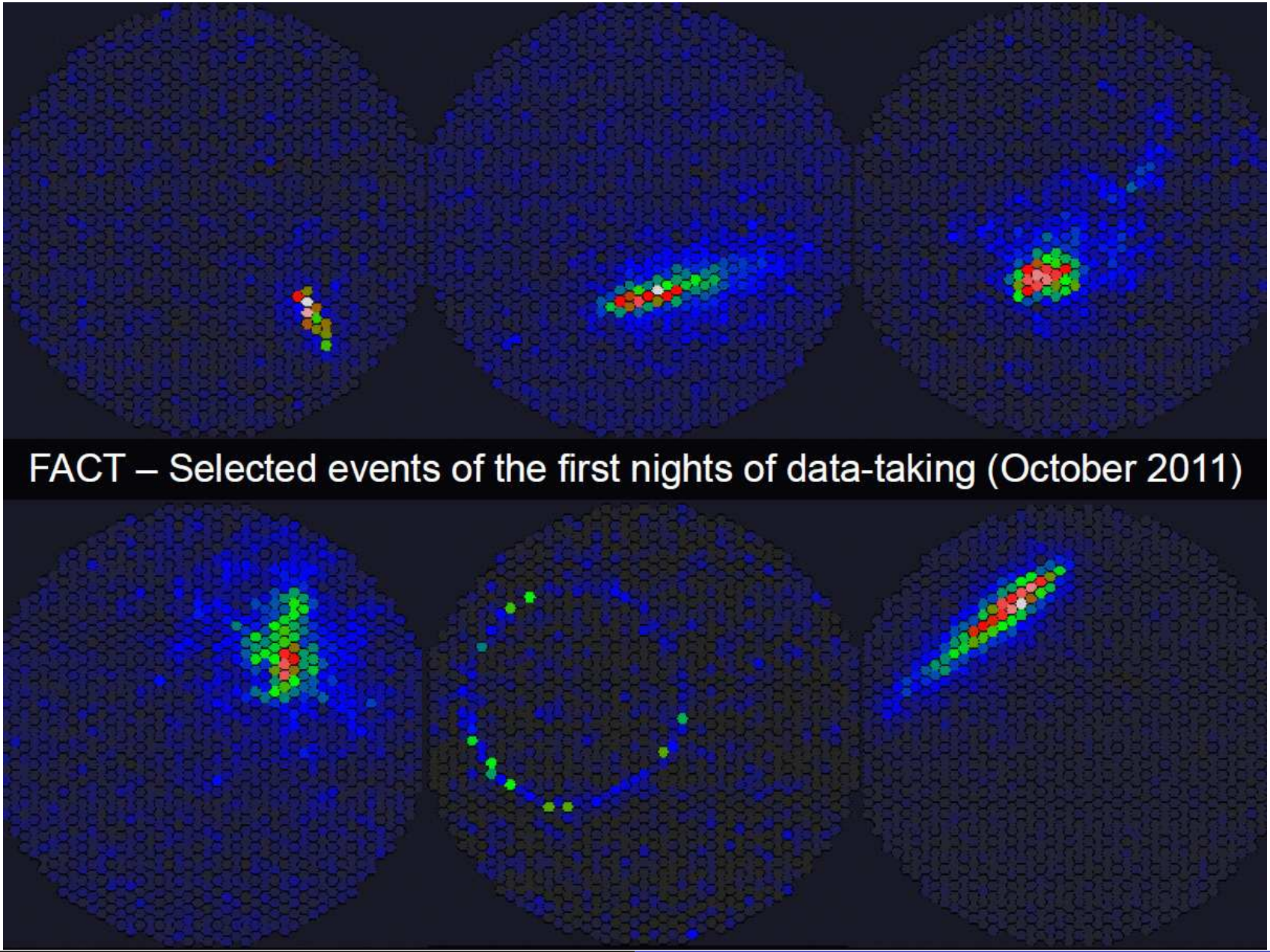
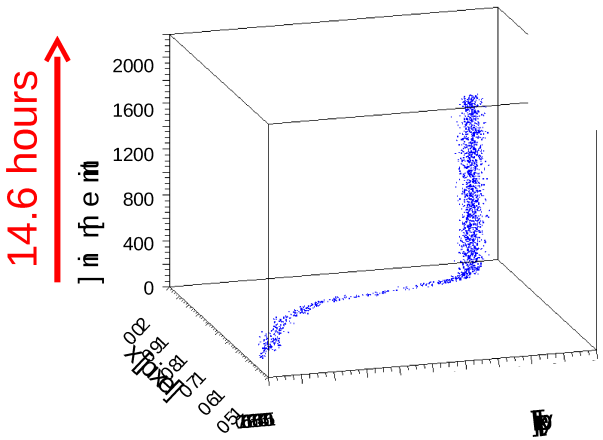


Image Drifts

- Observation of image drifts for some HPD
  - correlation in time between x- and y-movement, but not linear



- Solution: automated monitoring
  - fit image position from be
    - using Sobel algorithm for ed
      - online correction

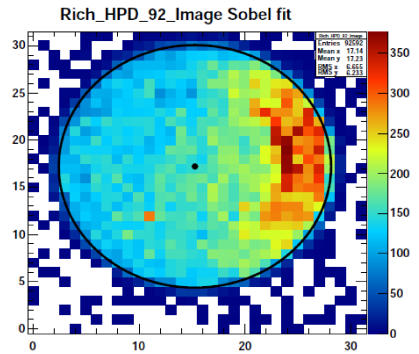


photo cathode image on anode with edge from Sobel fit

Posters calling my Attention

- Most of the posters describe very interesting technical details

- Proximity Focusing RICH to select (in 10^{-6}!) neutron-rich nucleus
  ($\tau \sim 100$ msec, 20 n more than stable isotopes)
- Cherenkov light in dense transparent media (usually used in EM Calorimeters) to improve TOF PET (Poster)
- History of Nobel Prices in Russia

Summary

- RICHes were extensively studied and used in the last $\sim$ 30 years
- RICHes are very well understood devices
- Use and sophistication is still incrementing
- New Photon Detectors open new possibilities in RICHes

- **There will be lot more RICH conferences to come!**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