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FAST SIMULATION OF THE UPGRADED PID DEVICE

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The fast simulation of the PID device will do the following:

- use generated track information as input
- as output return likelihoods for individual particle hypotheses

Fast simulation, main building blocks

- propagate tracks (helix) to the entry point of the device
- generate (in a simplified way) the detector response
- estimate and generate background (again in a simplified way) depending on how close the nearest charged track or high energetic photon crosses the device
- calculate likelihood for each hypothesis

Fast simulation, parameters

Proximity focusing RICH:

- ✦ detector response: from the beam test measurements take the average number of photons for $\beta = 1$ tracks, and Čerenkov angle resolution; scale as required by particle momentum and identity.
- ✦ background distribution:
  - scattered photons from the same track (parameters from beam test measurements),
  - from the near neighbours (similar, includes the ring photons and direct track hits in the PMT)
  - from backscattering from the calorimeter.

TOP: in principle very much the same general structure, different parameters; part of it will have to be determined in advance by a dedicated MC.

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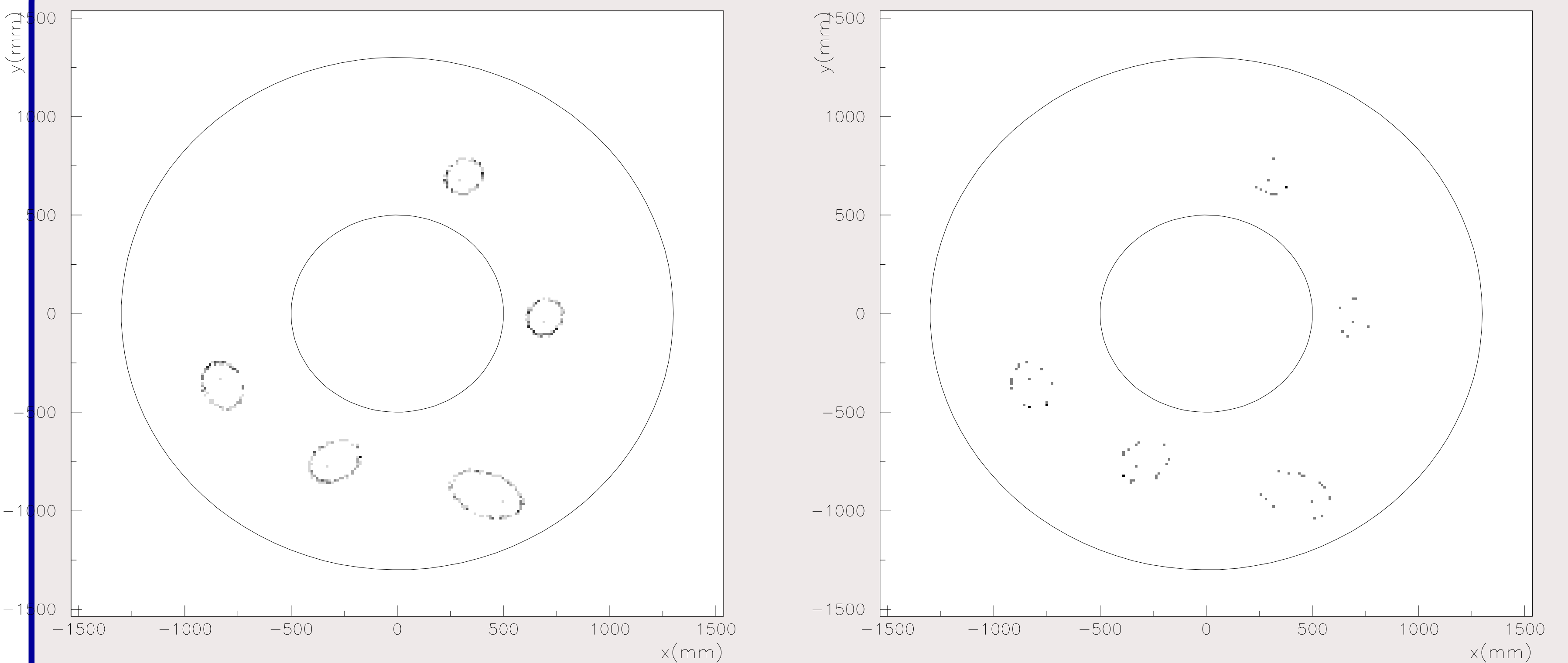
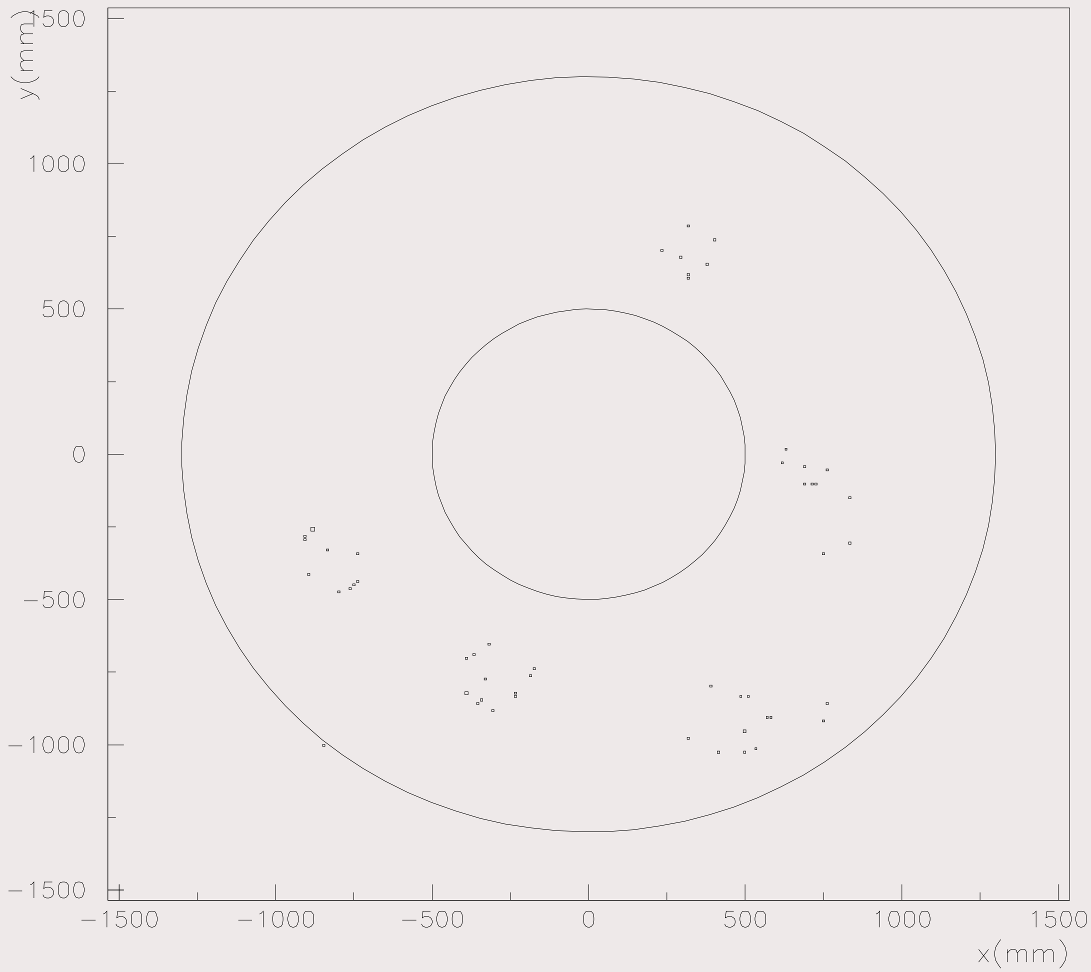
Event



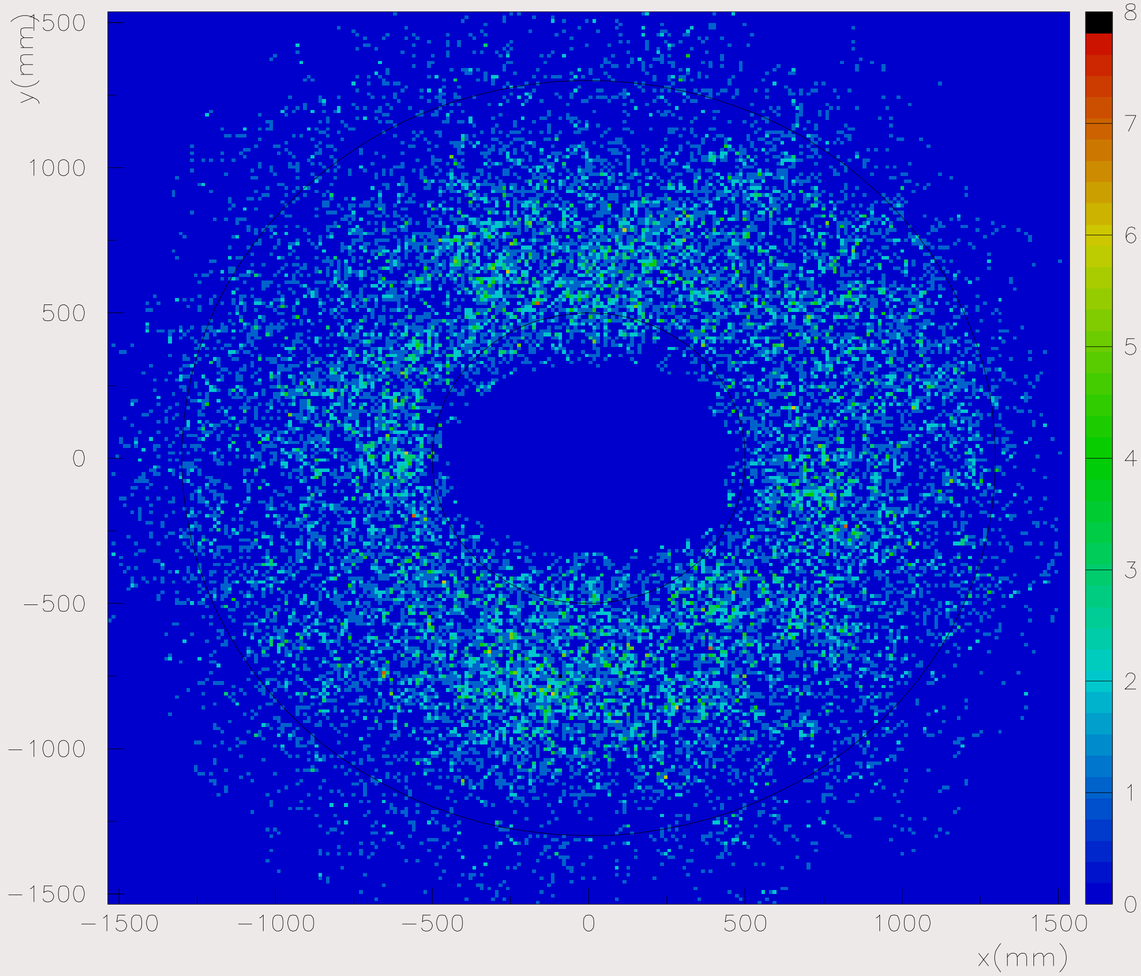
Generated event: rings with too many photons (left), same with the expected number of photons (right)

Event + intrinsic background



Detector occupancy

1000 events



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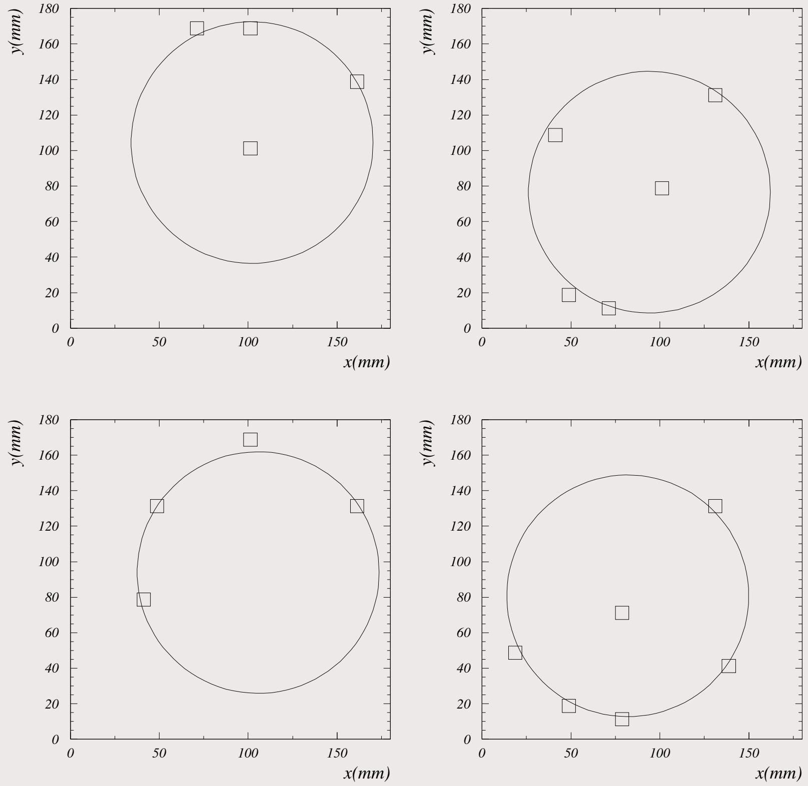
Fast simulation, status

- ✦ events were generated (QQ98, generic sample and signal MC for $B \to \pi\pi, K\pi$), and are read in as input to the program
- ✦ generation of events in the RICH:
  - generation of signal photons - done
  - generation of background photons (Rayleigh scattering, neighbours) - done
- ✦ background generation - other sources: only rough ideas how to do it, input needed from experience from the present spectrometer (e.g. gamma conversions, backscattering from the calorimeter)
- ✦ likelihood calculation: done

Construction of the Likelihood function

For each charged track calculate probabilities for different particle hypotheses hyp: e,μ,π,K,p, background



Background level is low, most of the background photons come from scattered photons in the aerogel radiator.

The probability density for a particular hit i: $p^{hyp}(\theta_i) = N_{det}S(\theta_i, \theta^{hyp}) + N_{bgr}B(\theta_i)$

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Signal: $S^{hyp}(\theta_i) = \frac{1}{\sqrt{2\pi}\sigma_i} e^{\frac{(\theta_i - \theta^{hyp})^2}{2\sigma_i^2}}$ Background (flat): $B(\theta_i) = B_0\theta_i$

Normalisation to expected number of photons: $\int_{\theta_0}^{\theta_1} p^{hyp}(\theta)d\theta = N_{det} + N_{bgr} = n_e$

Poissonian nature of the process: $\frac{(n_e)^n}{n!}e^{-n_e}$

Construction of extended likelihood function

$$L^{hyp} = \frac{(n_e)^n}{n!}e^{-n_e} \cdot \prod_i^n p^{hyp}(\theta_i)$$

Normalisation: $\lambda^{hyp} = \frac{L^{hyp}}{\sum_k L^k}$, where $k = e, \mu, \pi, K, p, background$

Timing

Reference machine f9pc43.ijs.si
processor : 0
vendor id : AuthenticAMD
model name : AMD Athlon(tm) XP processor 2100+
cpu MHz : 1733.470
cache size : 256 KB
RAM : 512MB
OS: RedHatLinux 8.0 kernel Linux release 2.4.18
compiler: gcc version 2.95.2

28.05.2003 status
CPU usage for 10000 events:
Total 12.12 s

Particle Tracking 0.3 s
Photon Emission 1.5 s
Photon Tracking 1.0 s
Digitization 0.03 s
ParticleID 9.2 s
→ not fast enough

Fast simulation, plans

Issues for fast simulation:

- add other background sources (e.g. gamma conversions, backscattering from the calorimeter)
- check particle ID performance on the generated samples, arrive at a very much simplified parametrisation of the PID performance
- provide the interface for TOP
- provide the interface to the FSIM main frame (when available)

Issues for further detector planning

- vary detector parameters (number of photons, resolution, background level) to see the effect on PID

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