“Fast Simulation” of the Dirc

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Outline

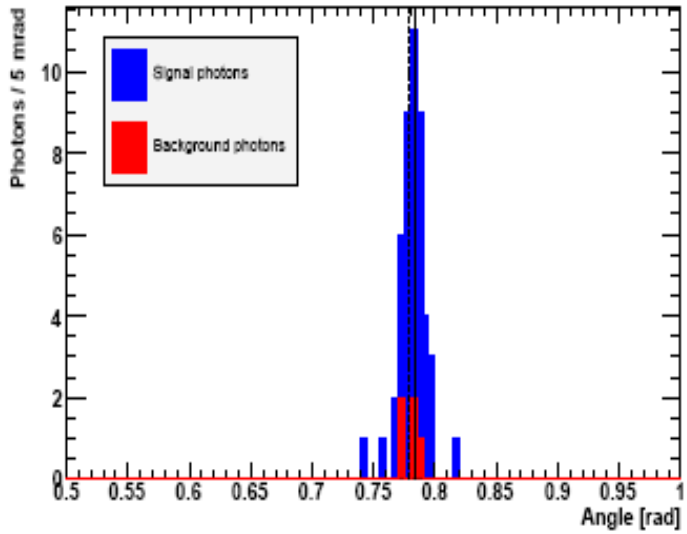
- Overview
- Performance cf Babar G4
- Configuration options
- Programming interface
- Known Problems
- Plans

Overview of Algorithm : Ring generation

- PacBaBarDrcModel generates a number of photons based on track momentum and type from BaBar ring dictionary
- Photons are stored as (θ_c, ϕ_c) pairs with respect to track momentum.
  - θ_c's are generated with a Gaussian distribution around the nominal Cherenkov angle, with errors from the DIRC geometry and quartz achromaticity.
  - ϕ's are generated uniformly within the range for which internal reflection will occur.

Overview of Algorithm : Ring generation

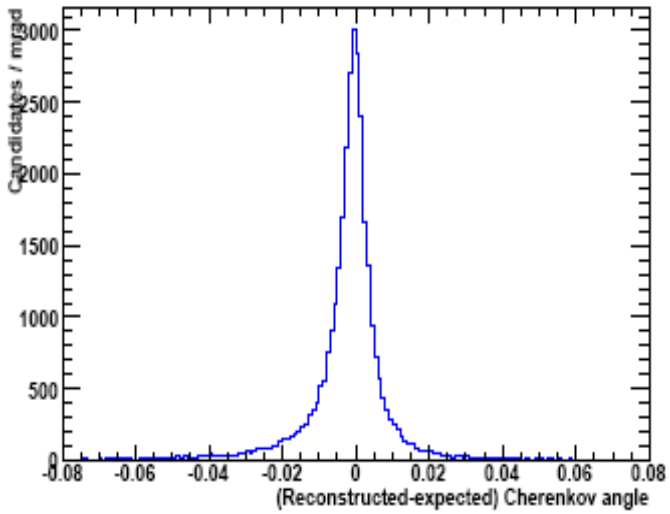
- Various Effects – justified on basis of experience with the Babar Dirc are included:
  - 50% of photons are generated with respect to the outgoing track momentum, to account for errors from scattering.
  - Background photons are generated uniformly in a window around the nominal Cherenkov angle.
  - An additional, large error is applied to some tracks to account for "mysterious in-time background" whose origin has never been understood.



Distribution of Cherenkov photons for a single track. The solid line indicates the true Cherenkov angle, the dashed line is the reconstructed angle. Notice that the 25-mrad window includes all photons for this track.

Overview of Algorithm : Reconstruction

- Given angles with respect to the true momentum, PacDircFitter calculates angles with respect to reconstructed momentum.
- Reconstructed Cherenkov angle θ_c is the arithmetic mean of the θ_c for individual photons
- Outlying photons are excluded by means of a sliding window. A window of width 25 mrad is moved across the distribution of Cherenkov angles θ_c, and only those falling within the most populous window are used.



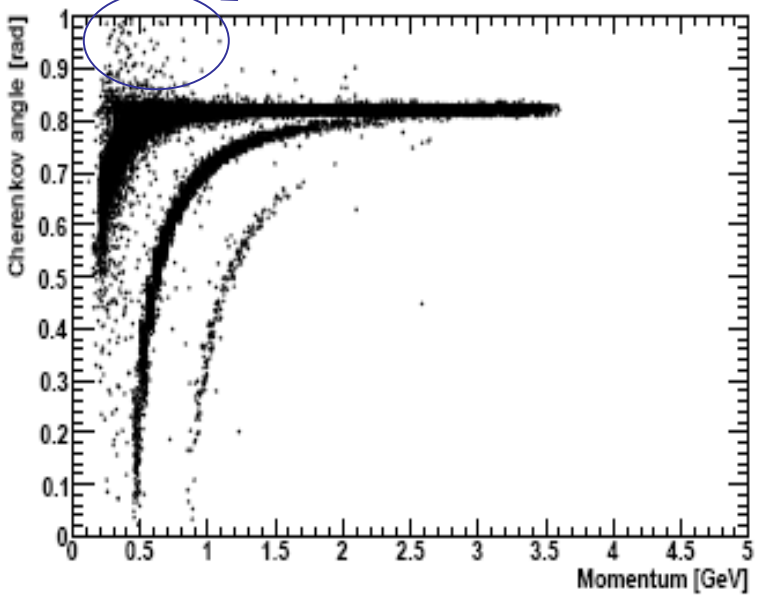
Program Features : Configuration Options

- All configuration parameters can be found in PacDetector/DircConfig.xml. These include
  - QuantumEfficiency given in units of the BaBar quantum efficiency.
    Raise it to 1.05, get 5% more photons. Default is 1.
  - ExtraScatterProb and ExtraScatterSize govern the additional Gaussian applied to some photons. The first (defaults to 20%) is the probability of a photon being extra scattered; the second (defaults to 0.02) is the amount added to the Gaussian sigma, in radians.
  - WindowWidth is the size of the sliding window used in the reconstruction, in radians. Default is 25 mrad.
  - DircModel and DircFitter are the names of the class to use in generating and reconstructing Cherenkov rings.
  - BkgWindow and BkgAmount are used in generating background photons. Background photons are generated uniformly.
    BkgWindow is the extent in either direction from the nominal Cherenkov angle. BkgAmount is number about which background photons are Poisson-distributed. By default the values are 20 mrad and 4.
  - AchromConstant and GeometricError are the size of the per-photon errors in Cherenkov angle, in radians. Defaults are 4.2 mrad and 4 mrad.

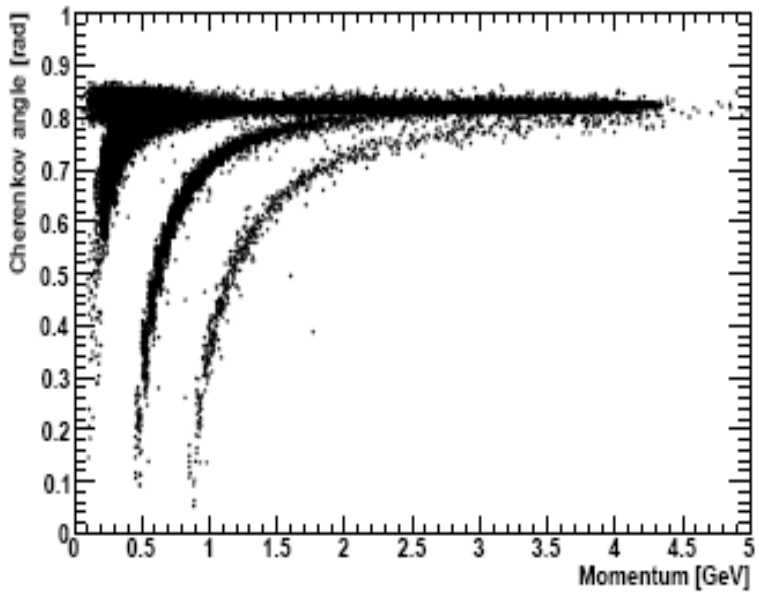
Comparison with Geant4 (Babar)

e^- – perhaps δ-rays

θ_c



θ_c

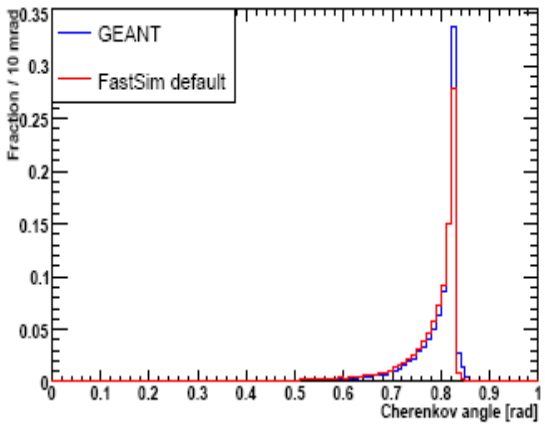


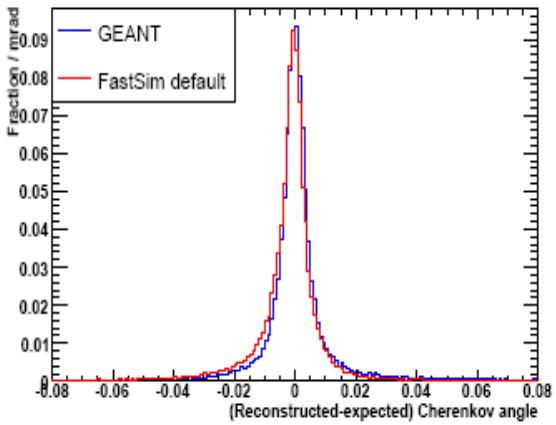
Momentum (GeV/c)

BaBar G4 **FastSim**

Comparison with Geant4 (Babar)

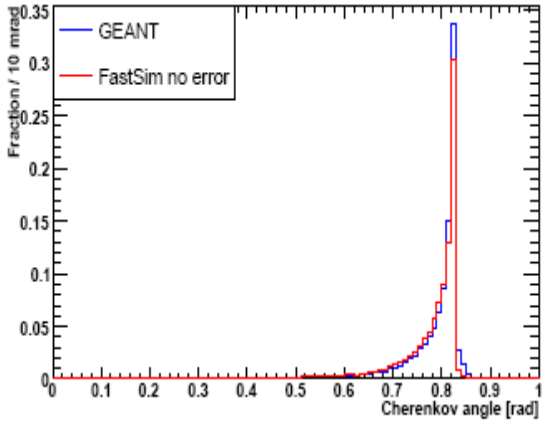
Default

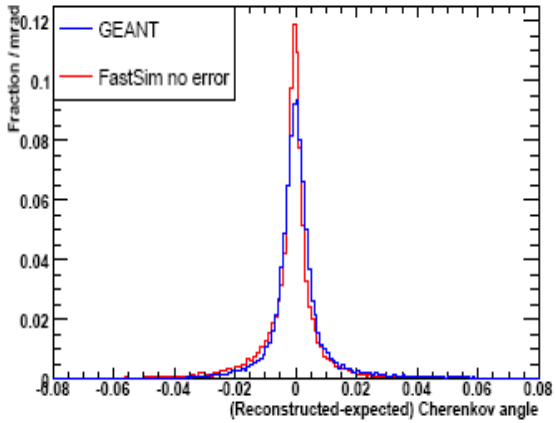




Default distributions.

No error





No errors - geometric, achromatic, and extra error terms all set to zero.

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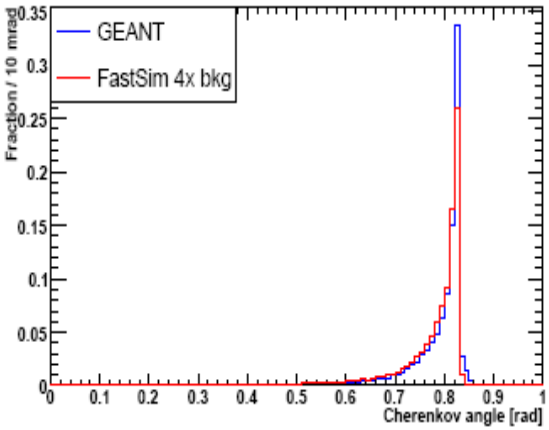
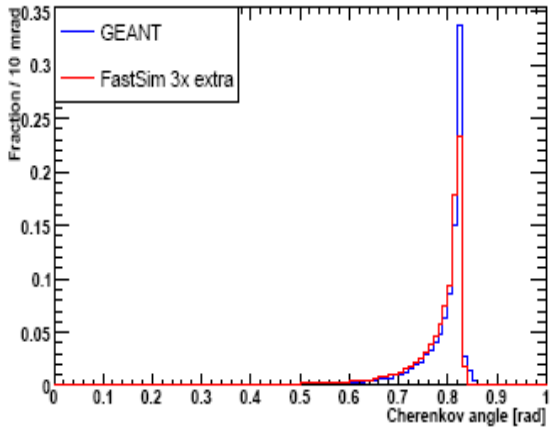
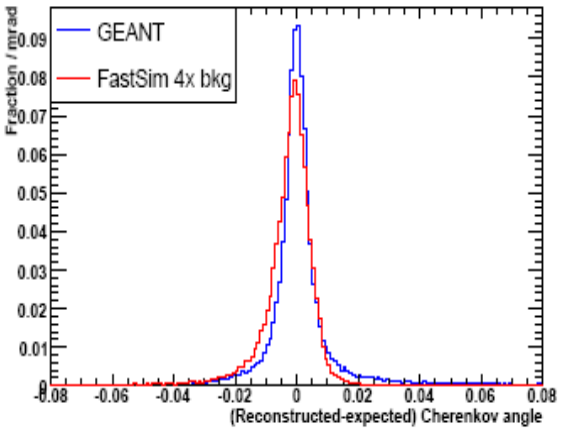
Comparison with Geant4 (Babar)

4 x Background

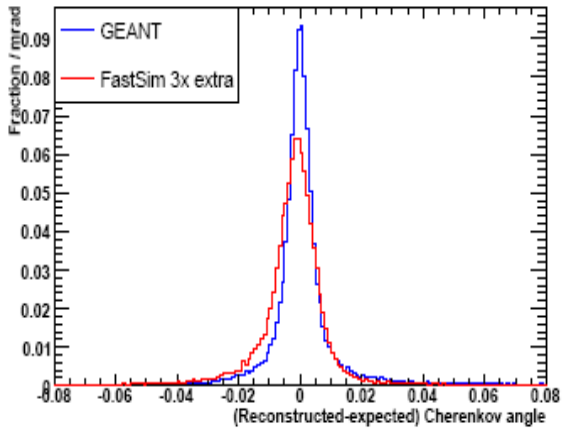


3 x Background





Background increased by factor 4.



Extra scatter probability set to 60%.

Program Interface: Extracting Information

- Basic information like reconstructed Cherenkov angle is contained in PacMicroAdapter object and can be extracted just as in old BaBar code.
- The underlying information of individual photon angles is stored in PacDircResponse.
- To get the PacDircResponse associated with a track, use new PacMC/PmcMaps class:

```
const PacDircResponse* getRecoDirc (const PacSimTrack*);
const PacDircResponse* getRecoDirc (const BtaCandidate*);
```

- Old PacDircMaps class still exists, but is deprecated:

```
static PacDircResponse* get (const PacSimTrack* tr);
static PacDircResponse* get (const BtaCandidate* tr);
```

PacDircResponse

- PacDircResponse has five public methods for extracting information:

```
std::vector<double> getThetas () const;
```

```
std::vector<double> getPhis () const;
```

Return lists of the individual photon angles, with respect to the true momentum. Zero ϕ_c lies along the cross product of the track momentum and the z axis.

```
std::vector<double> getBkg () const;
```

List of the apparent Cherenkov angles of the background photons. This is with respect to the reconstructed momentum, hence no ϕ_c angle is given.

```
int getExpPhotons (PdtPid::PidType species) const;
```

```
int getExpPhotons (int species) const;
```

Returns expected number of photons.

Program Interface: Adding Features

- New DIRC models (for creating Cherenkov rings) and fitters (for reconstructing them) may be added as follows:

  Write a class extending PacAbsDircModel or PacAbsDircFitter.

  Edit initialisation code in PacDircInitializer to include your new class:

  ```
  PacAbsDircFitter::addFitter(PacAbsDircFitter::defaultFitter, &PacDircFitter::create);
  PacAbsDircModel::addModel(PacAbsDircModel::defaultModel, &PacBaBarDircModel::create);
  ```

  Change parameter DircModel or DircFitter in DircConfig.xml to "MyModelName".

- New models must implement a getDircResponse method which returns a PacDircResponse object containing a list of photon angles.

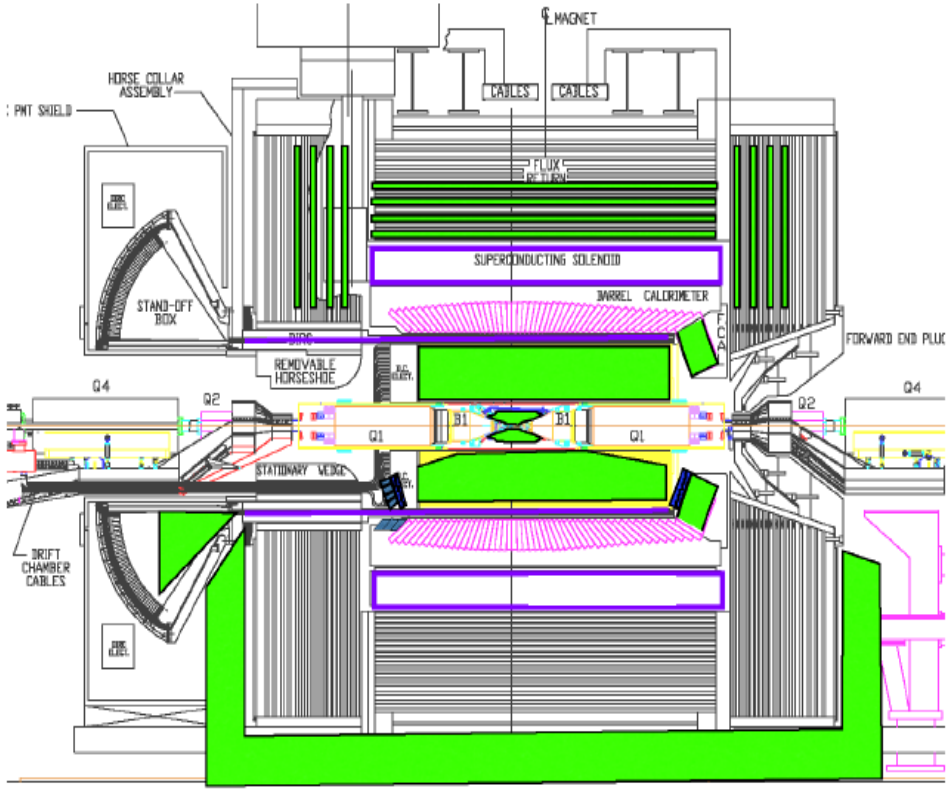
Future Plans

The ring dictionary has been something of an “albatross”

- It used to require the continued use of the Babar conditions database
- If the Dirc geometry changes, it will probably need reproducing – a major chore but not impossible.
- We note, however, that unless the Dirc bars and their boxes are changed, the dictionary is a good representation of the photons produced.

- Since the Frascati workshop, we have managed to separate it from the Babar CDB making it unnecessary, now, to use the CDB
- If the bars are to change, then we would need to study the possibility for an alternative. At present, this appears to be unlikely.

Future Plans



Options for forward PID and re–design of DIRC photon detectors are still to be explored