

Status Report of the DiscDIRC PandaRoot Implementation

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PANDA Collaboration Meeting LII.

Outline:

- Geometry of Disc DIRC
- Simulation
- Digitization
- Summary & Outlook

Using material silicon dioxide for lightguide volumina

Defining refraction with the sellmeier equation:

$$n^2(\lambda) = 1 + \frac{B_1\lambda^2}{\lambda^2 - C_1} + \frac{B_2\lambda^2}{\lambda^2 - C_2} + \frac{B_3\lambda^2}{\lambda^2 - C_3}$$

Setting the coefficients with

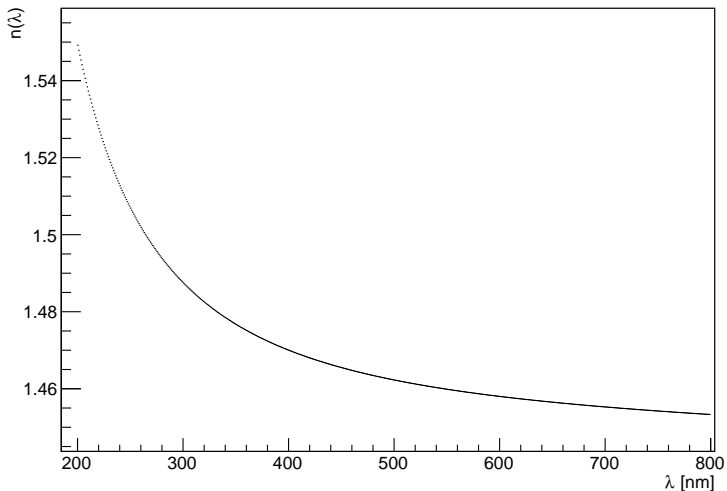
```
Double_t sellmeier_coeff[6] = {0.473115591, 0.631038719,  
0.906404498, 0.012995717, 0.0041280992, 98.7685322};
```

and defining parameters as follows:

```
for(i=0, lambda_um = 0.8; i<n_entries; lambda_um-=0.001, i++) {  
    photon_momenta[i] =1.239841939*1E-6/lambda_um;  
    Double_t rindex    =n_phase(lambda_um, sellmeier_coeff);  
    rayleigh_length[i]=1E6/(45962092085.3903 *  
        pow(rindex, 8.)/pow(lambda_um*1000.0, 4.)) *10.0;  
}
```

Refraction index as function of wavelength:

Refraction index

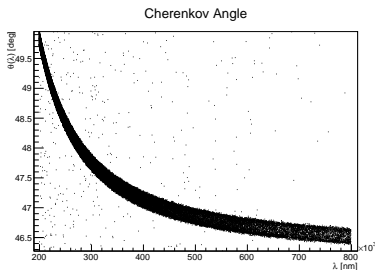


Equation of azimuthal angle θ for Cherenkov light cone:

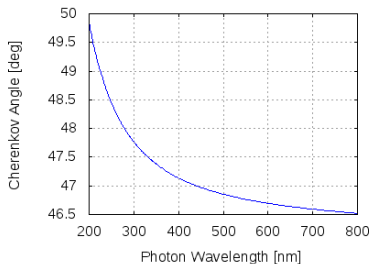
$$\cos \theta = \frac{1}{n(\lambda)\beta}$$

Comparison between theoretical and simulated results:

PandaRoot results:



Theoretical values:



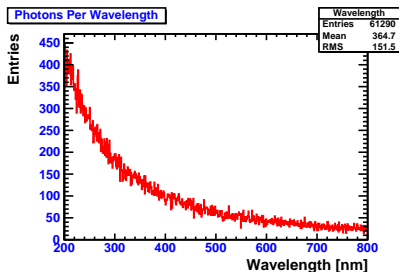
Number of photons per track length according to Frank-Tamm-Formula:

$$\frac{dN}{dx} = 2\pi\alpha z^2 \int_{\lambda_1}^{\lambda_2} \left(\frac{1}{\lambda^2} - \frac{1}{n^2(\lambda)\beta^2\lambda^2} \right) d\lambda$$

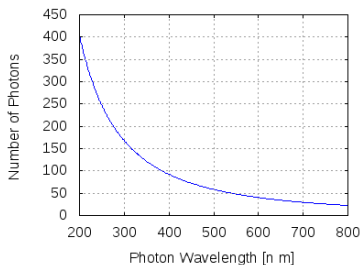
with $\alpha \approx 137$ and $z = 1 \Rightarrow 61290$ photons with PandaRoot and 56596 photons according to numerical integration.

Parameters: $\lambda_1 = 200$ nm, $\lambda_2 = 800$ nm and $\Delta x = 2$ cm.

PandaRoot results:



Theoretical values:



Simulations

Defining two classes:

- `DiscDIRC_SensorMCPoint` for optical photons
- `DiscDIRC_ParticleMCPoint` for non-optical particles

Given information to `cbmsim-tree`:

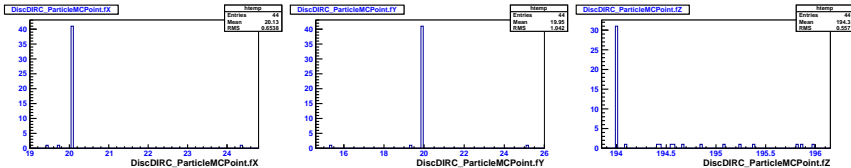
<i>DiscDIRC_SensorMCPoint</i>	<i>DiscDIRC_ParticleMCPoint</i>
<ul style="list-style-type: none">• Track number• Copy number• Volume ID• Internal reflection angle• Position vector• Momentum vector• Track time• Tack length• Energy loss	<ul style="list-style-type: none">• Track number• Copy number• Volume ID• Ingoing position• Ingoing momentum• Outgoing position• Outgoing Momentum• Track time• Tack length• Energy loss• Track charge• Track PID• entered inside?• Is primary?

Testing code with macro *sim_complete.C* and FairBoxGenerator:

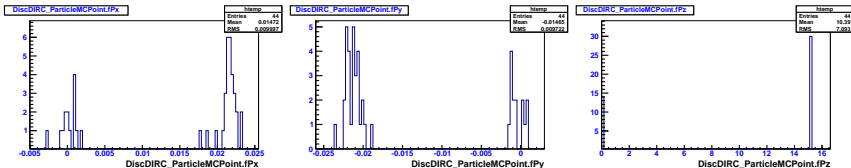
```
sim_complete(Int_t nEvents = 10, TString SimEngine =  
"TGeant4", Float_t mom = 15.0)  
FairBoxGenerator* boxGen = new FairBoxGenerator(13, 3);  
boxGen->SetPRange(mom,mom);  
boxGen->SetPhiRange(0., 0.);  
boxGen->SetThetaRange(0., 0.);  
boxGen->SetXYZ(20., 20., 0.);  
primGen->AddGenerator(boxGen);
```

Creating 3×10 muons with momentum 15 GeV/c and starting coordinates (20 cm, 20 cm, 0 cm).

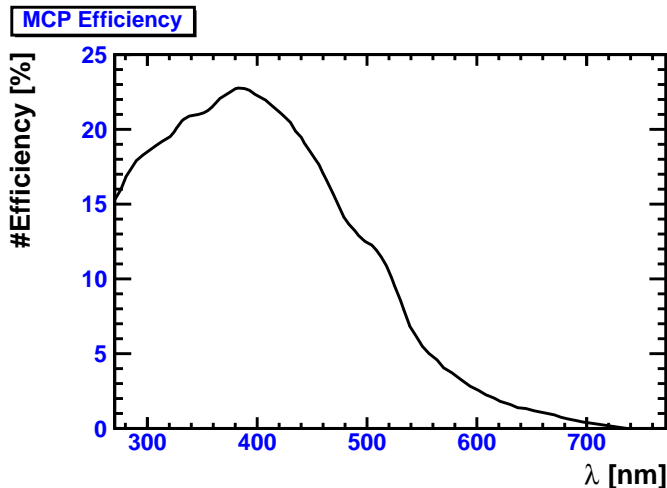
Position of muons entering radiator disc:



Momentum of muons entering radiator disc

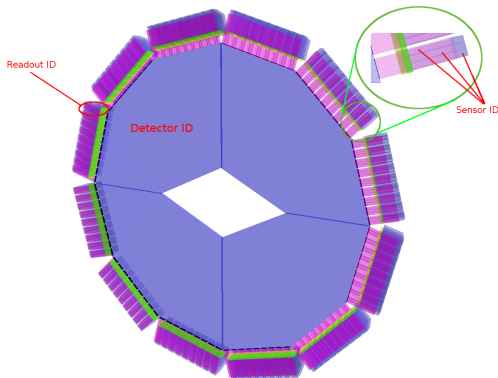


Defining quantum efficiency for MCP sensors: Probability for detecting photon as function of wavelength

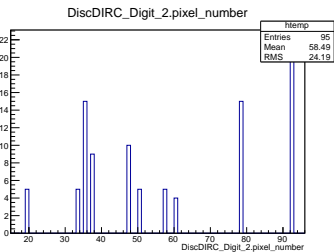
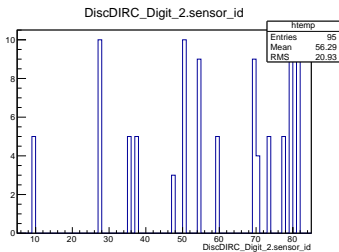
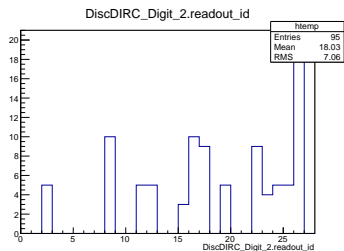
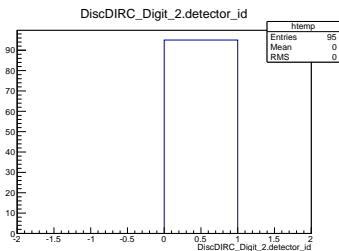


Creating class `DiscDIRC_DigitizedHit` for writing into `cbmsim` tree in digitization output:

- Detector ID
- Readout ID
- Pixel grid column
- Pixel number
- Pixel grid row
- z coordinate of hit
- TDC time in ns
- Absolute time in ns



Sample output of digitization script:



- Parameters in simulation code cross-checked and verified
- Digitization not completely checked until now
- Reconstruction procedure (DDRECON) missing → next step in development
- Adjusting optical and geometrical parameters according to results from testbeam in May 2015
- Changing code according to PandaRoot coding standards and upload into repository