Background estimation for FTOF detector

L. Burmistrov

Outlook

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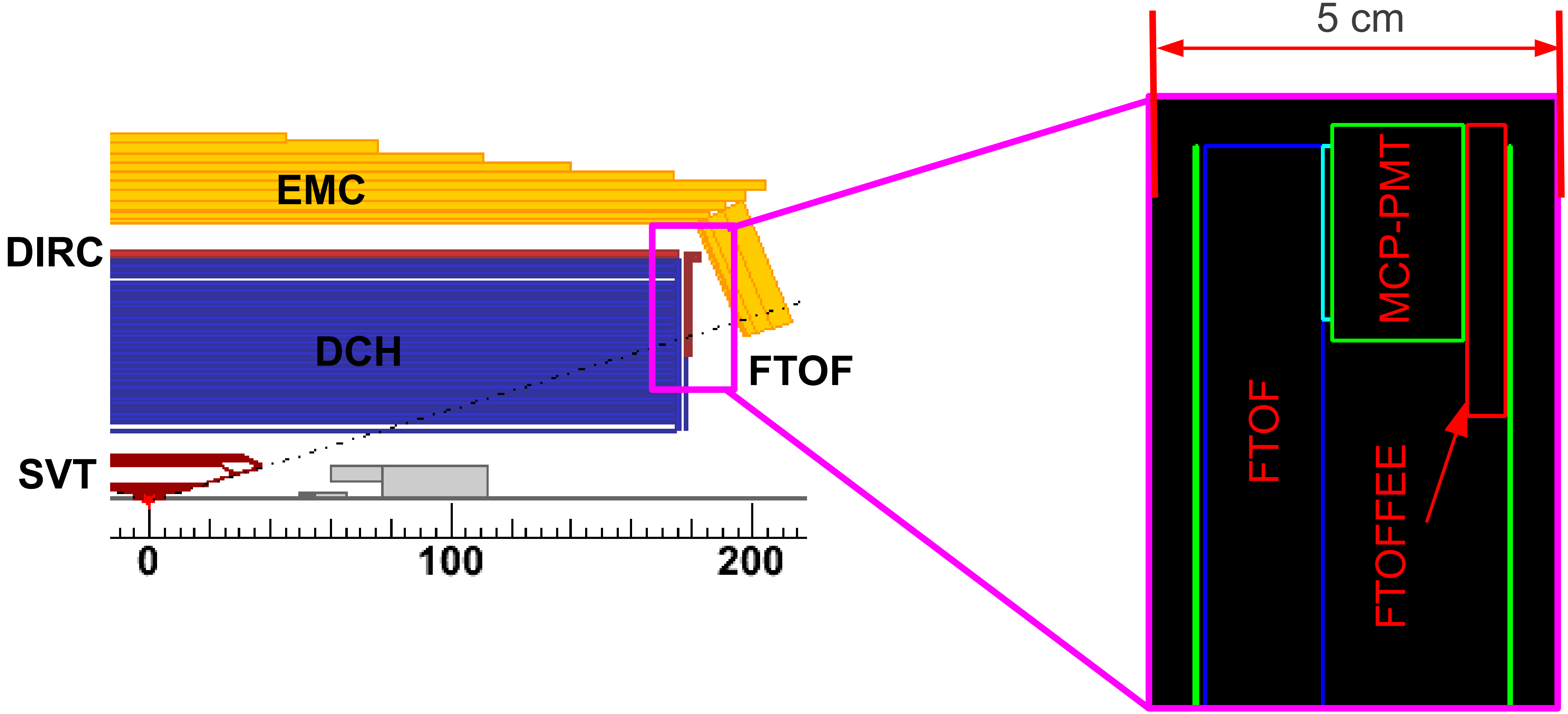
Geometry reminder



Total surface of the FTOF detector (quartz tiles) is = 1.71×10^4 cm^2

Mass of the FTOF is = 60 kg

Total sensitive surface of the MCP-PMTs is = 813.12 cm^2

Total surface of the FTOFFEE is = 1.31×10^3 cm^2

Mass of the FTOFFEE is = 1.5 kg

Analyzed background

Background	Geometry
- Rad-bhabha	Geometry_CIPE_V00-00-02 (Tungsten 3.0 cm)
- Rad-bhabha	Geometry_CIPE_V00-00-02_Tungsten4.5cm
- Rad-bhabha	Geometry_CIPE_V00-00-02_CSI_Tungsten4.5cm
- Pairs	Geometry_CIPE_V00-00-02_Tungsten4.5cm
- Toushek-HER	Pairs Geometry_CIPE_V00-00-02_Tungsten4.5cm
- Toushek-LER	Pairs Geometry_CIPE_V00-00-02_Tungsten4.5cm
- BeamGas-HER	Pairs Geometry_CIPE_V00-00-02_Tungsten4.5cm
- BeamGas-LER	Pairs Geometry_CIPE_V00-00-02_Tungsten4.5cm

Not yet done

Summary: background rates (FTOF)

Table 1: FTOF

Backg. type	γ, $\frac{kHz}{cm^2}$	n, $\frac{kHz}{cm^2}$	e^-, $\frac{kHz}{cm^2}$	$Photons_J$, $\frac{kHz}{cm^2}$	Photons, $\frac{kHz}{cm^2}$	Dose, $\frac{kRed}{year}$
RadBB	52.0	14.2	27.9	497.7	299.8	0.8600
$RadBB_{tung}$	21.7	12.5	10.0	159.1	95.40	0.2800
$RadBB_{CSI}$	22.0	12.3	10.4	154.0	91.60	0.2800
Pairs	11.8	1.60	6.40	30.40	19.60	0.0770
$Tous_{HER}$	1.90	0.12	0.82	19.20	0.120	0.0002
$Tous_{LER}$	1.30	0.30	0.77	1.230	0.045	0.0003
$Beam_{HER}$						
$Beam_{LER}$	1.07	0.19	0.62	1.080	0.094	0.0005
Total	37.8	14.7	18.6	211.0	115.3	0.3580

The tungsten shield decrease the rate of the background p.e. by factor of 3.

Jerry method for number of Cherenkov p.e. estimation (see backup slides for more information.) gives a factor of two more detected light than Geant4 (Cherenkov simulation).

Summary: background rates (FTOFFEE)

Table 2: FTOFFEE

Backg. type	γ, $\frac{\text{kHz}}{\text{cm}^2}$	n, $\frac{\text{kHz}}{\text{cm}^2}$	e^-, $\frac{\text{kHz}}{\text{cm}^2}$	Dose, $\frac{\text{kRed}}{\text{year}}$
RadBB	43.2	16.7	6.9	0.6000
$\text{RadBB}_{\text{tung}}$	18.9	15.1	2.9	0.2900
$\text{RadBB}_{\text{CSI}}$	21.8	12.6	2.4	0.2000
Pairs	9.60	2.00	1.5	0.0750
Tous_{HER}	1.40	0.13	0.2	0.0004
Tous_{LER}	0.94	0.36	0.2	0.0004
Beam_{HER}				
Beam_{LER}	0.70	0.22	0.1	0.0005
Total	31.5	17.8	4.9	0.3663

The dose on the FEE electronics is small

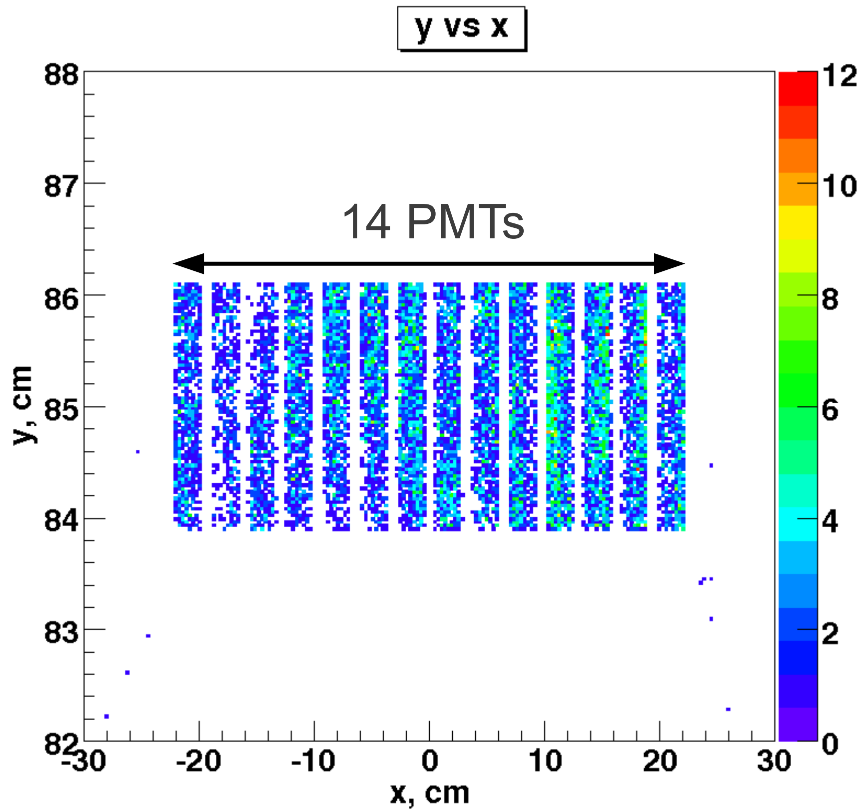
Backup

Simulation of the Cherenkov light in Brn (FTOF)

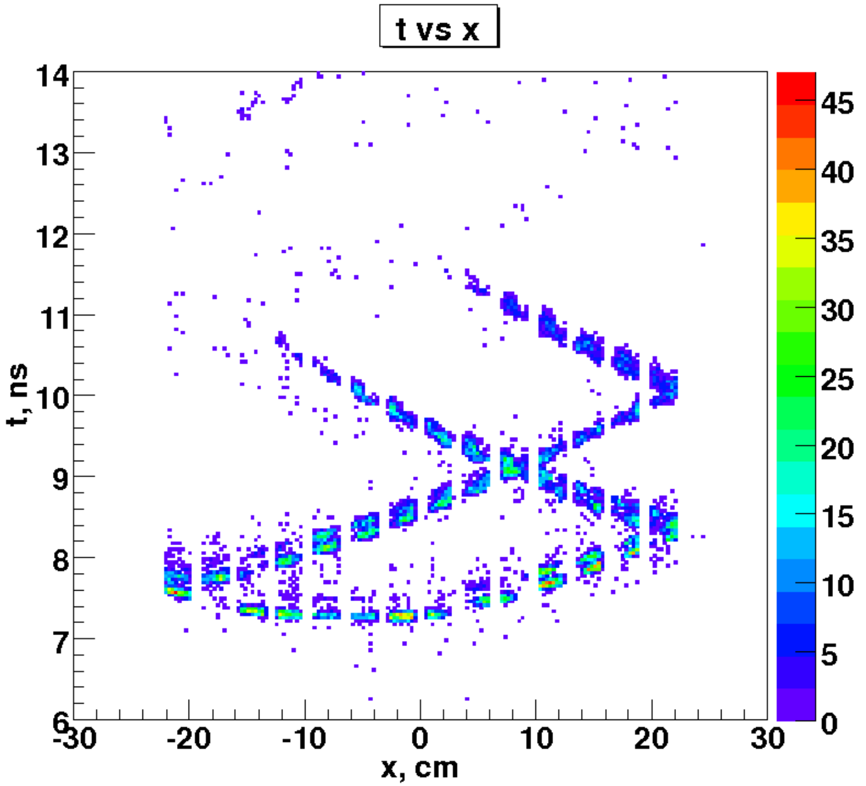
../bin/Linux26SL5_x86_64_gcc412/BrunoApp -G Geometry_CIPE_V00-00-02 -O OpticalPropertiesFTOF.mac -m singleparticle.mac

```
/generator/gun/particle 13
/generator/gun/energy 5 5
/generator/gun/position 0 0 0 0 0 0
#theta 20 deg FTOF
/generator/gun/direction 0 0.34202 0.939693
```

Detection of the Cerenkov photons



Time vs position distribution of the Cerenkov photons



400 events

Background photoelectrons estimation

The number of detected photoelectrons can be described with this formula:

$$N_{d.p.e.} = \int E_g E_c N_0 \sin^2(\theta_c) / \lambda^2 \, dx \, d\lambda$$

x - is the length of the track in the radiator

λ - wavelength of the photons

E_g - geometrical efficiency of the photon collection. In general this is a function of the position and direction of the track.

E_c - conversion factor from photons to photoelectrons. This is defined by the quantum efficiency of the photocathode and the collection efficiency of the PMT.

θ_c - Cherenkov angle

Production and propagation of the Cherenkov light is not implemented in Bruno yet for FTOF. Consequently the most precise method to estimate number of detected p.e. is to use a standalone full simulation of the FTOF detector and the information from Bruno about particles entering FTOF as input.

Other method (Proposed by Jerry) is to sum up at each step the number of detected p.e.:

$$N_{d.p.e.} = 26 \sum L_i [cm] (1 - 1/n^2/\beta_i^2)$$

L_i, β_i are available in Bruno

<u>NOTE</u> this formula valid only for BaBar DIRC detector

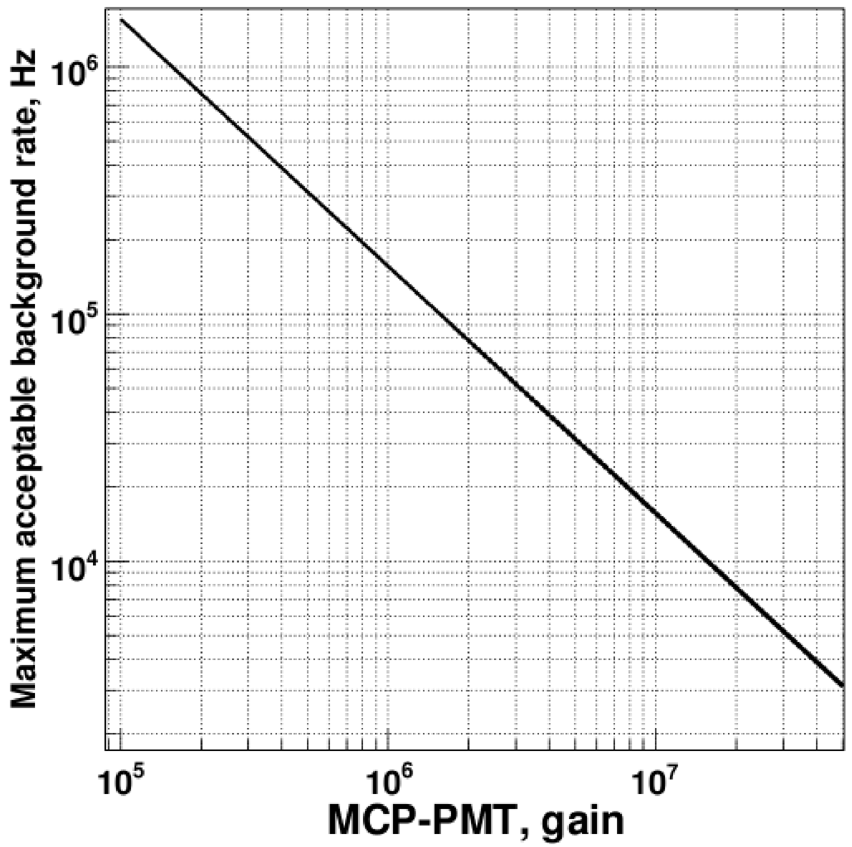


Figure 4.17: Maximum acceptable p.e. rate $/\mathrm{cm}^2/\mathrm{s}$ as a function of MCP-PMT gain to keep the integrated charge below 2.5 C after 5 years of running at nominal luminosity.