



XIX Meeting of Physics

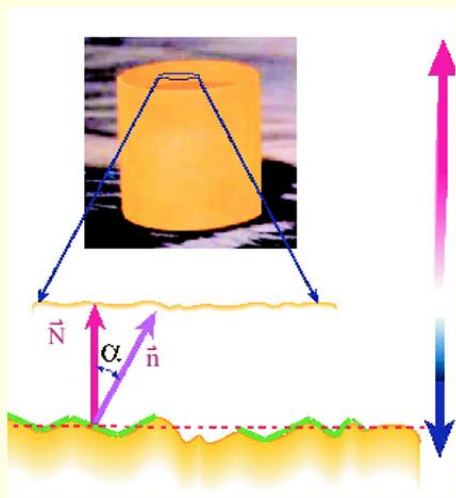
24 th- 26 th September 2020

OPTIMIZATION OF THE GEOMETRY OF INORGANIC SCINTILLATORS APPLIED TO HIGH ENERGY PHYSICS

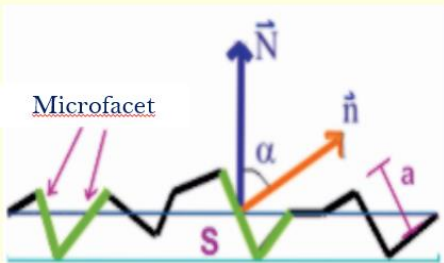
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PHYSICAL FOUNDATION



Geometry and parameters of a rough surface



$$I_U(\theta_i, \theta_r, \phi_r) \approx R(\theta'_r, n_1, n_2) [C_{ls} G(\alpha_r; 0, \sigma_\alpha) +$$

$$C_{ss} \delta(\theta_i - \theta_r) \delta(\phi_r) +$$

$$C_{bs} \delta(\theta_i + \theta_r) \delta(\phi_r) + C_{ld} \cos(\theta_r)]$$

$$+ T(\theta'_t, n_1, n_2) G(\alpha_t; 0, \sigma_\alpha)$$

$G(\alpha_r; 0, \sigma_\alpha)$ is a Gaussian normal distribution with a mean of 0 and standard deviation σ_α

C_{ss} : Specular Spike probability Constant.

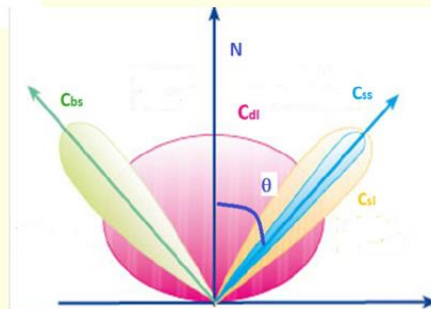
C_{ld} : Diffuse Reflection probability constant.

C_{bs} : Retro-reflection probability constant.

C_{ls} : Lobular reflection probability constant.

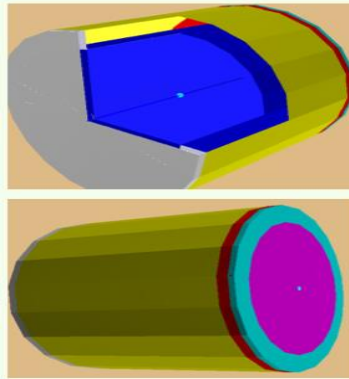
Reflectance (R)

Transmittance (T).

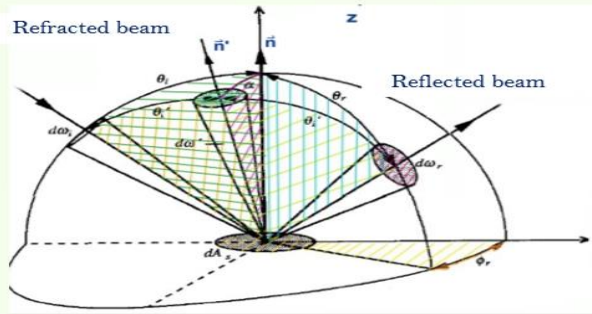


Probability constants C_{nm}

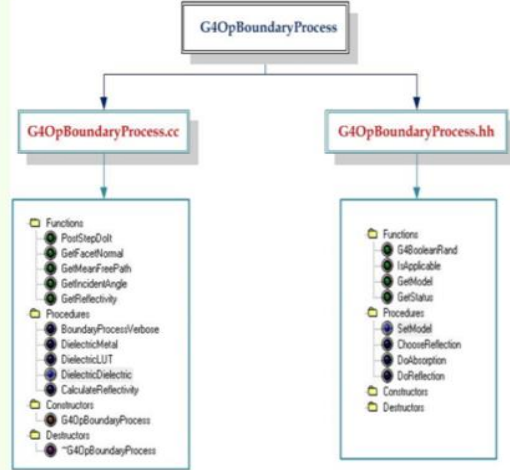
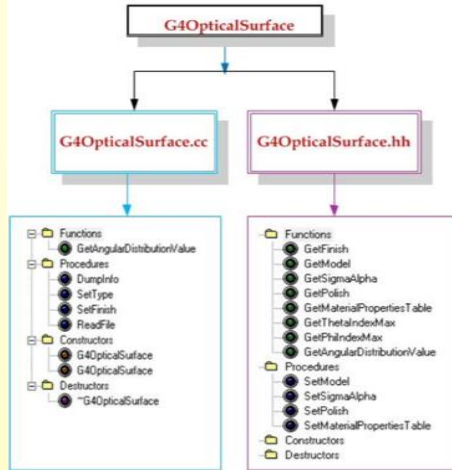
Methodology



Scintillator (blue), Detector (magenta), Aluminium (light blue), Air (yellow)



Incidence and reflection of a light beam in space



Modeling of the optical part of a rough scintillator in Geant4

SciCil

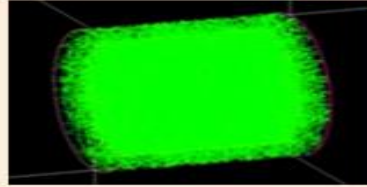
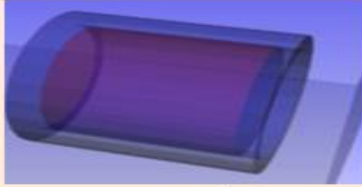
- gun
 - include
 - phys
 - src
 - directory
 - GNUmakefile
 - History
 - optPhoton.mac
 - README
 - scil.cc
 - vis.mac
- SciCilDetectorConstruction.hh
 - SciCilEventAction.hh
 - SciCilPhysicsList.hh
 - SciCilPhysicsListMessenger.hh
 - SciCilPMTHit.hh
 - SciCilPMTSD.hh
 - SciCilPrimaryGeneratorAction.hh
 - SciCilPrimaryGeneratorMessenger.hh
 - SciCilRunAction.hh
 - SciCilStackingAction.hh
 - SciCilSteppingVerbose.hh
 - SciCilUserTrackInformation.hh

Modeling of a cylindrical and parallelepiped scintillator in Geant4

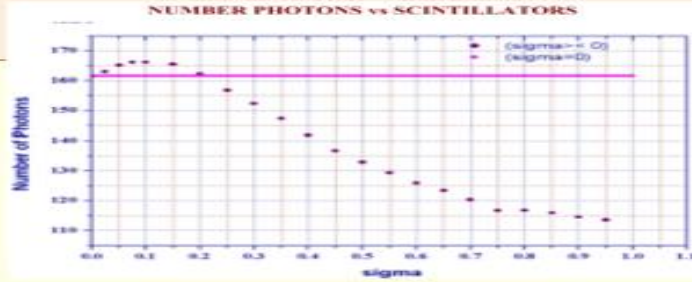
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 - readme
 - scipar.cc
 - vis.mac
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 - SciParEventAction.hh
 - SciParPhysicsList.hh
 - SciParPhysicsListMessenger.hh
 - SciParPMTHit.hh
 - SciParPMTSD.hh
 - SciParPrimaryGeneratorAction.hh
 - SciParPrimaryGeneratorMessenger.hh
 - SciParRunAction.hh
 - SciParStackingAction.hh
 - SciParSteppingVerbose.hh
 - SciParUserTrackInformation.hh

Results

Scintillator simulation

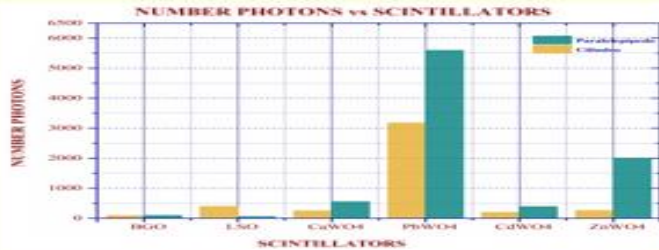


Material_Geometry	Number of photons detected	
	Cylinder	Parallelepiped
BGO	79.95	96.50
LSO	363.69	528.15
PWO ₂	1504.08	5536.05
ZnWO ₄	240.21	2011.48
CdWO ₄	181.19	386.64
CaWO ₄	313.53	530.92

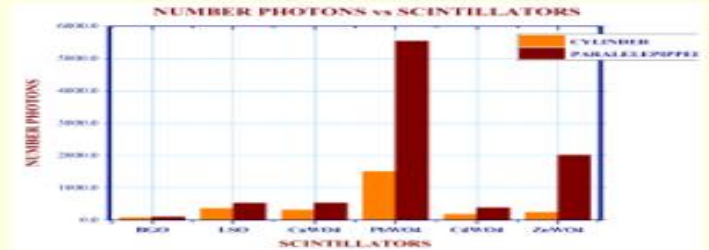


Comparison between a polished and a smooth surface.

Scintillator with aluminium cover



Scintillator with air cover



CONCLUSIONS

The result of the simulation for different crystals and geometries, is obtained

- 1.- The geometry of the parallelepiped obtains a greater quantity of photons compared with respect to the cylinder.
- 2.- Among scintillators, the ZnWO_4 is better at reflecting photons.
- 3.- It is verified that the aluminum cover does not let the photons out of the scintillator.
- 4.- A rough surface allows to collect more photons compared to a smooth surface.

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