Detector Simulation Using GEANT4

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School of Physics

Outline

Priliminary Geometry Design

1. scintillator cubes $10 \times 10 \times 10$
2. flat film as neutron detector: 4layers
3. six light guide arrays
4. six PMT [SiPM] arrays

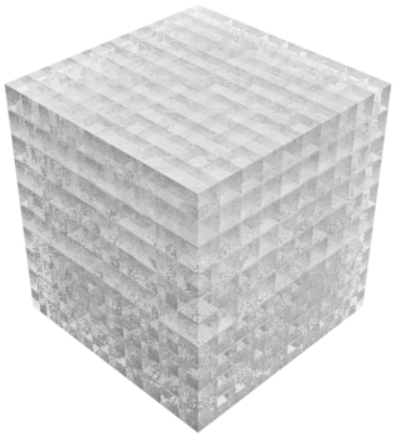


图: scintillator cube

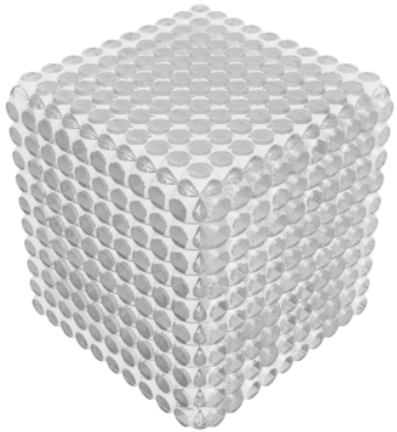


图: scintillator cube+light guide

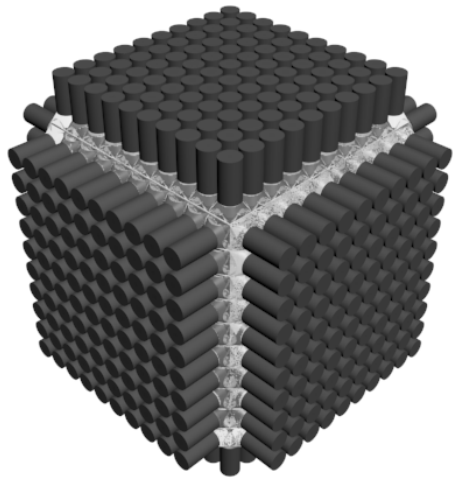


图: scintillator cube+light guide+PMT

Details about the Geometry Set-up

The structure of one dimention detector:

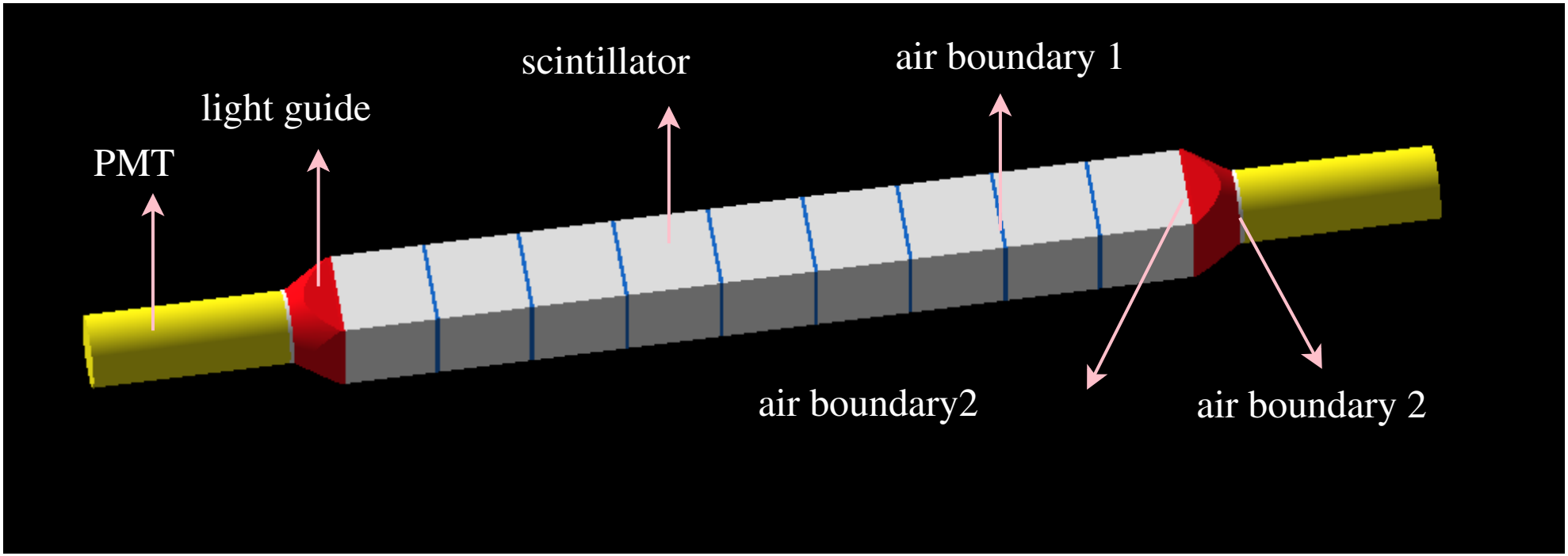


图: Geometry structure:PMT-lightguide-scintillator-air boundary between [scintillators;scintillator and lightguide;lightguide and PMT cathode]

Details about the Geometry Set-up

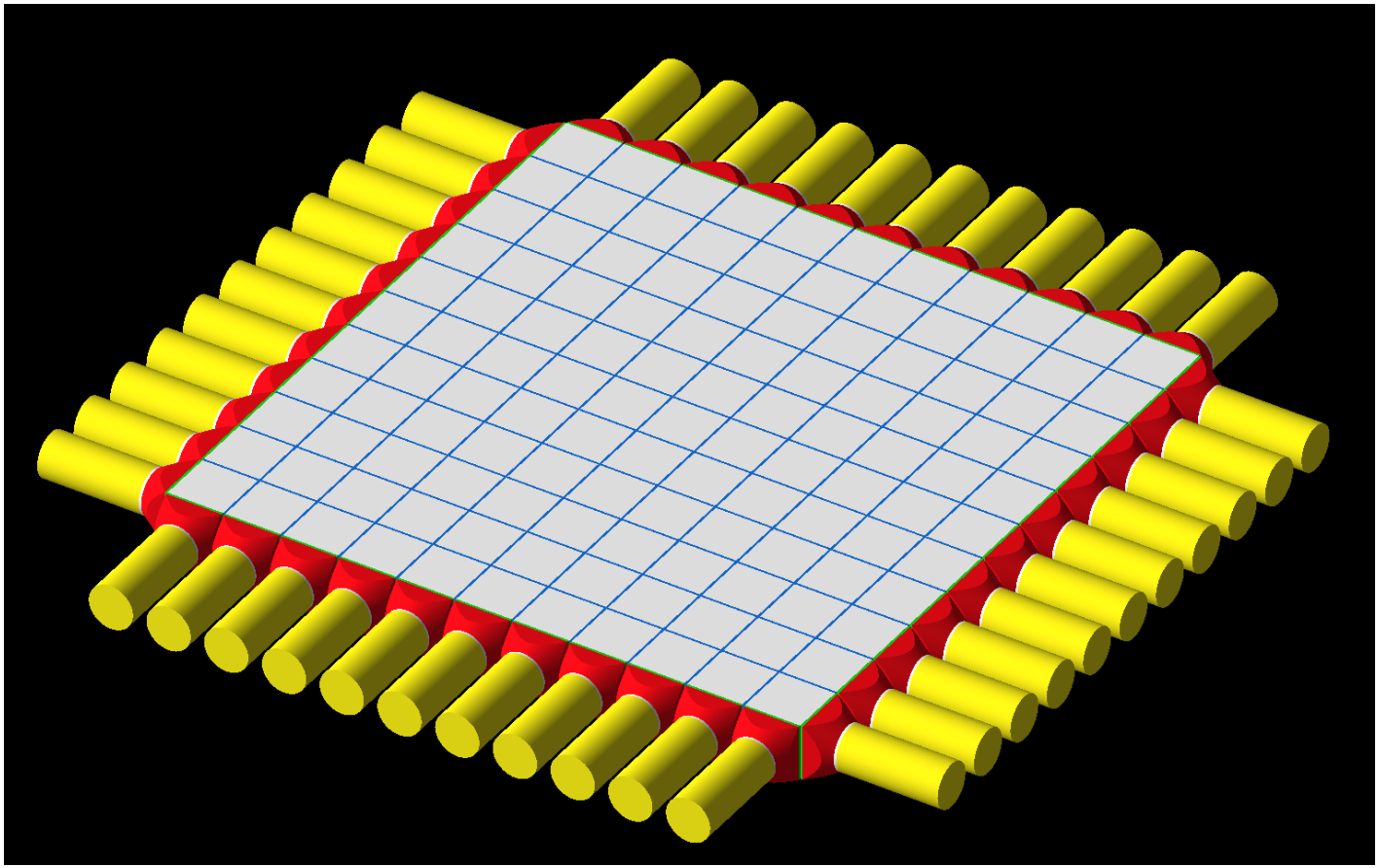


图: two dimention detector layout

Details about the Geometry Set-up

Not finished yet.

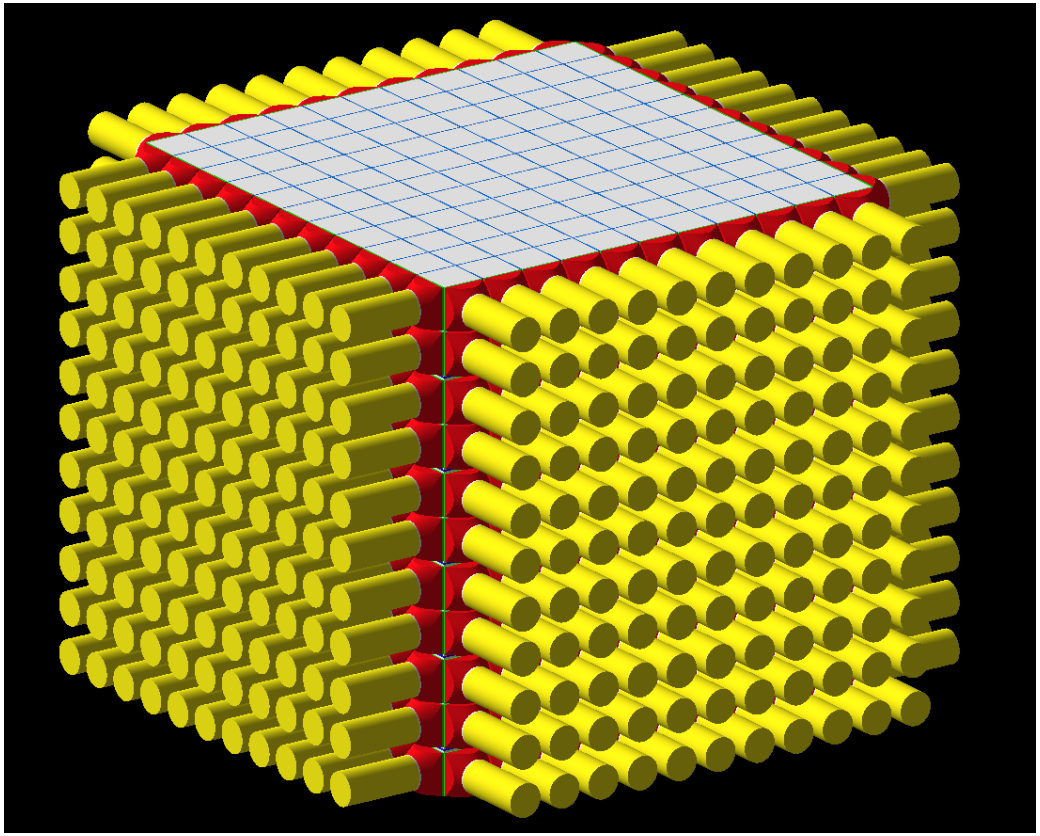


图: 3 dimention detector layout

Details about the Geometry Set-up

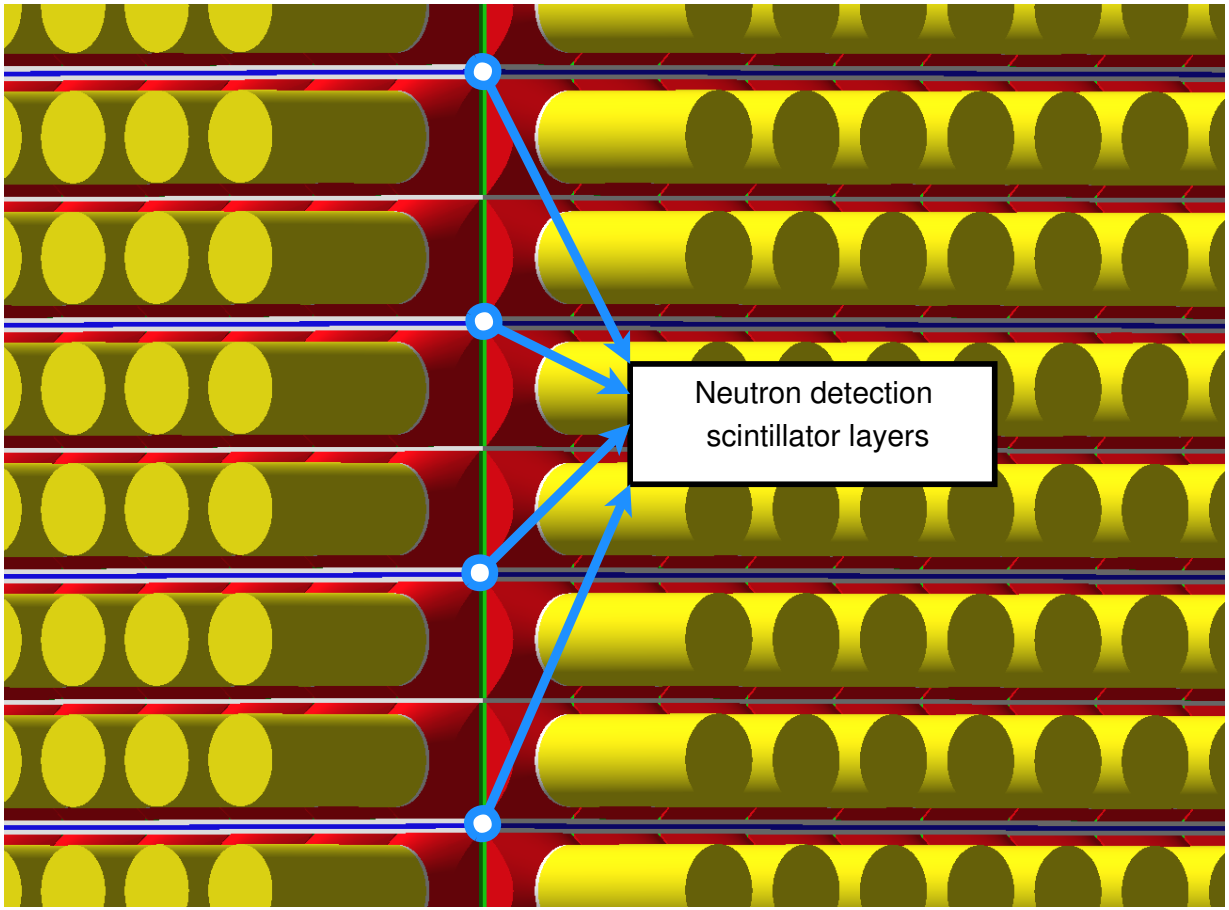
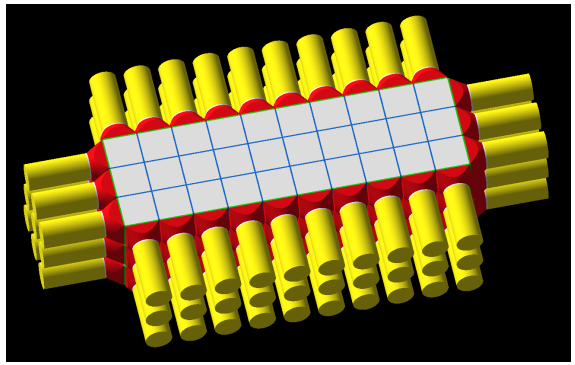
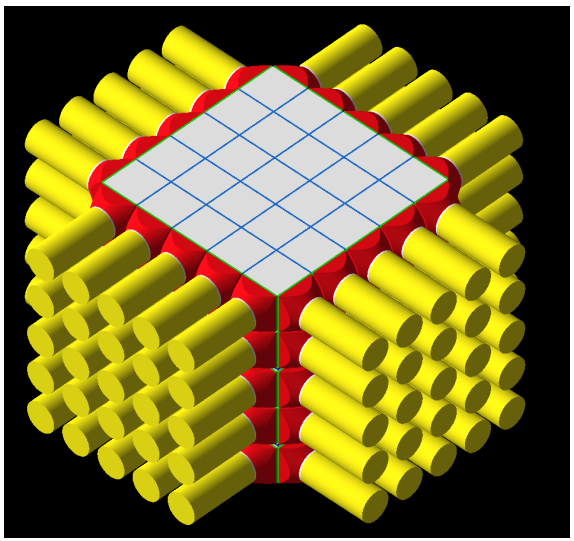


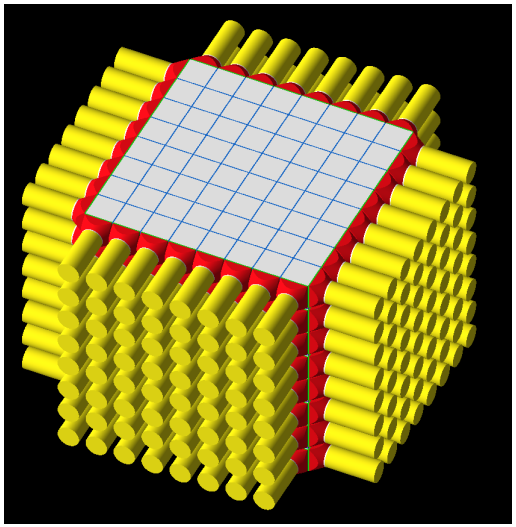
图: neutron detection scintillator layers in the y direction.

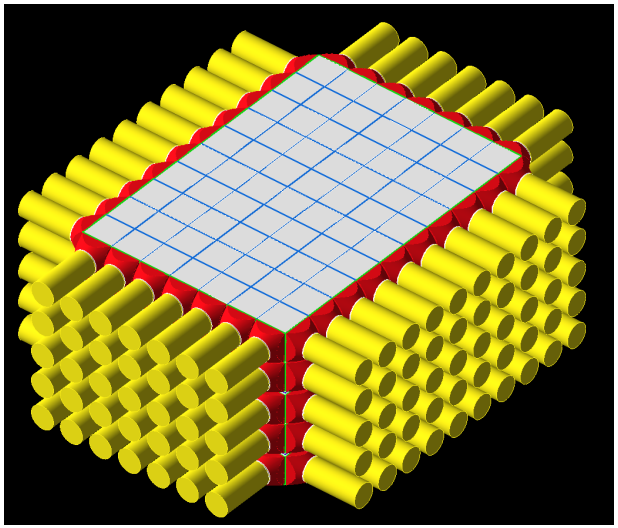
flexiable size adjustment

Easy to change the full detector size according to experimental requirements.









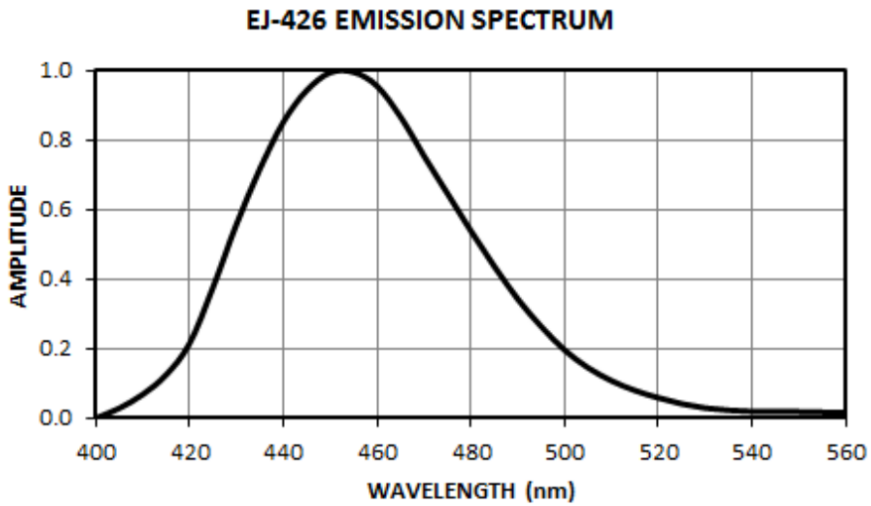
THERMAL NEUTRON DETECTOR

- the neutron detector EJ-426.
- flat white thin sheet,^{6}LiF :(ZnS:Ag)

detection princeple:

$$^{6}Li +^{1} n \rightarrow^{3} H +^{4} He + 4.78MeV \quad (1)$$

The resulting triton and alpha particle are detected by ZnS:Ag phosphor with the broad blue fluorescent spectrum.



DETECTION PROPERTIES			
Screen Type		EJ-426-0	EJ-426HD2
^{6}LiF:ZnS Mass Ratio		1:3	1:2
^{6}Li Density (atoms/cm^{3})		8.81×10^{21}	1.39×10^{22}
Theoretical NTH Efficiency	**0.32 mm thick**	0.23	0.34
	0.50 mm thick	0.34	0.48

parameter adjustment

1. choose the formula: EJ-426-0 or EJ-426HD2 ?
2. switch the thickness: 0.32mm or 0.5mm?
3. sheet size: 60mm$\times$ 60mm?
4. do we need backing material?

BACKING		
MATERIAL TYPE	**DESCRIPTION**	**SUFFIX**
Aluminum Foil	50 µm thick foil	(none)
Clear Polyester Sheet	0.25 mm thick sheet	-PE
	Laminated between two 0.25 mm thick sheets	-PE2
Aluminized Mylar	0.12 mm thick sheet	-AM
Pure Aluminum	0.5mm thick plate	-PA
High Reflective Aluminum	0.4mm thick plate	-A

next to be done

- detector construction .
  - add remain geometry [lightguides and PMTs].
  - attach correct material to each logical volume.
  - other components
- adjustment of physis list
  - about scitillator material and their optical properties
  - optical performance of lightguides
  - response of PMT [SiPM]
  - optical boundaries
- add different primary paticle sources
  - alter the particle type,position,momentum,energy etc.
  - use gps to control theparticle source
- sensitive detector and scoring
- more useractions for output and analyze.

update of work

finished

- finish the geometry.
- finish the material
- add GPS
- add sensitive detector (SD)
- priliminary analyze codes

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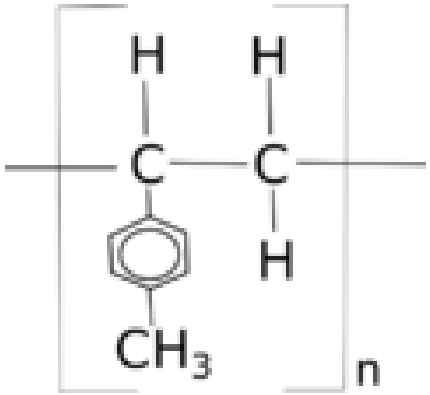
next to be done

- more details about the optical photons(optical properties and optical boundaries)
- update the analyzing class

material of detector components

- gamma scintillator:EJ-200
  Base: Polyvinyl toluene formula : [CH2CH(C6H4CH3)]n



Density: 1.023 g/cm^3
Refraction Index: 1.58
Light Output: No change from -60°C to 20 °C

- thermal neutron scintillator:EJ-426HD2
  $^6LiF : ZnS\ MassRatio 1:3$
  ^6Li Density(atoms/cm^3) : 1.39×10^{22}
  ^{6}Li enriched to minimum of 95 atom percent.

details about detector components

1. material of lightguide: H-K9L
2. material of gaps between scintillators: air
3. PMTs around the scintillators as sensitive detectors
4. currently PMTs work as ideal detectors with 100% PDE

density of EJ-426

formula: (^6LiF)(ZnS:Ag) density of ^{6}Li : 1.39*10^{22} atoms/cm^3
atomic mass of ^{6}Li: 6.0151amu
atomic mass of ^{7}Li: 7.0160amu
atomic mass of Fluorine : 18.9984amu
^{6}LiF:ZnS Mass Ratio: 1:2
density:(6.0151*.95+7.0160*0.05+18.9984)*3*0.139/6.022=1.7355/cm^3

sensitive detector

1. optical photon with single wavelength(energy)
2. PMT record the time and count of photon hits.
3. do I need to attach SD to scintillators inside?

optical simulation part

response curve v.s photon energy(wavelength)

- scintillator emission spectrum
- reflectivity of materials
- refractive index
- attenuation length
- PMT detection effictiency

wave length range:350nm ,650nm,step 1nm. active the rise time. the scintillation process. absorption and re-emission of photons; Boundary Process

play around- the 2D case

summary

- almost finish simple detector geometry.
- other parts of simulation program still in progress.

BACK-UP