

# Status of DOM simulator

AMANDA/IceCube meeting in Bartol

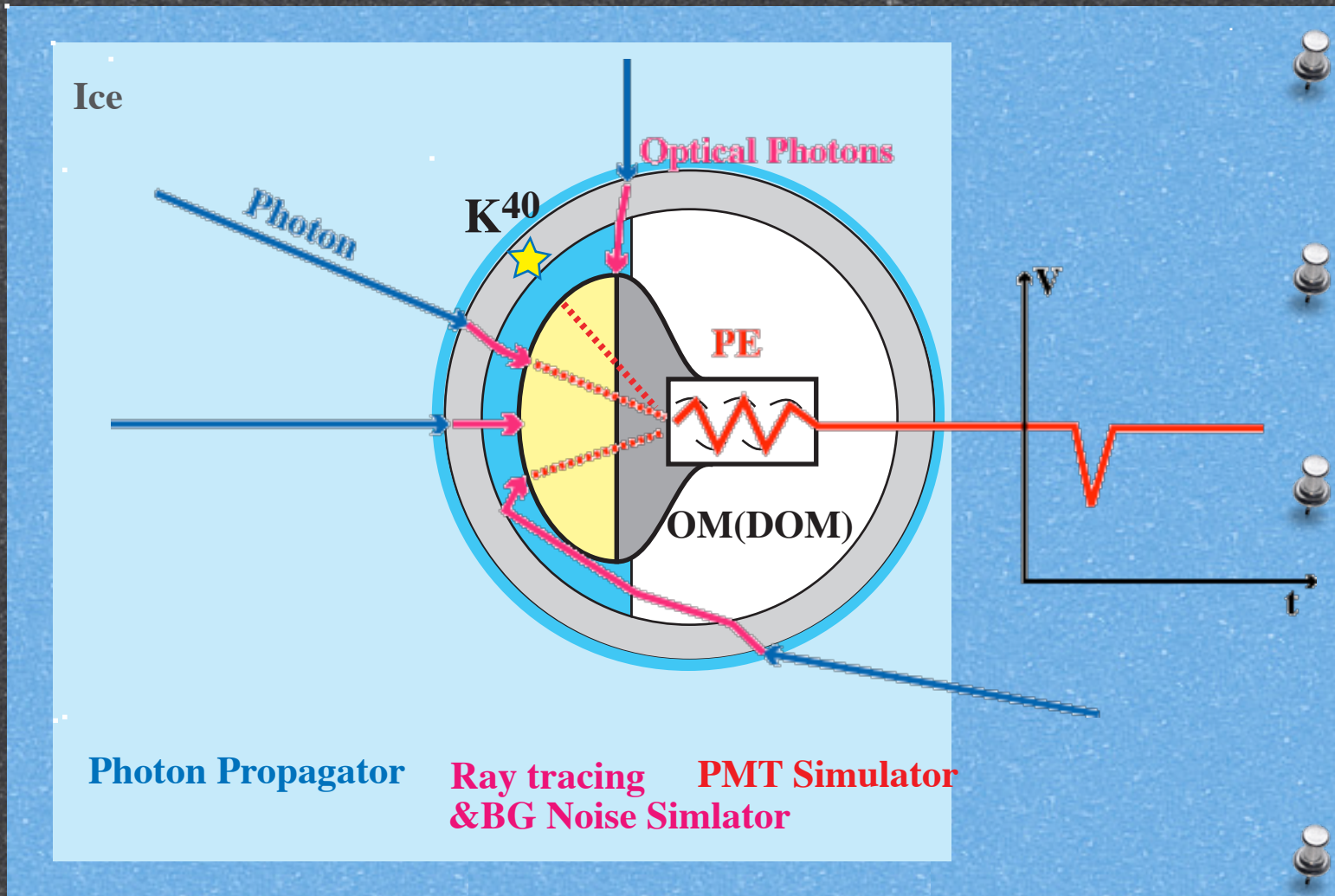
Mar. 24, 2004

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Chiba University

- Planed software spec
- Ray-trace simulator based on Geant4
- PMT simulator based on ROOT
- Summary



# Planned software spec



Ray tracing  
Simulator

BG Noise  
Simulator

Wave  
Length  
Shifter  
Simulator

PMT  
Simulator

Use Geant4 except for PMT simulator



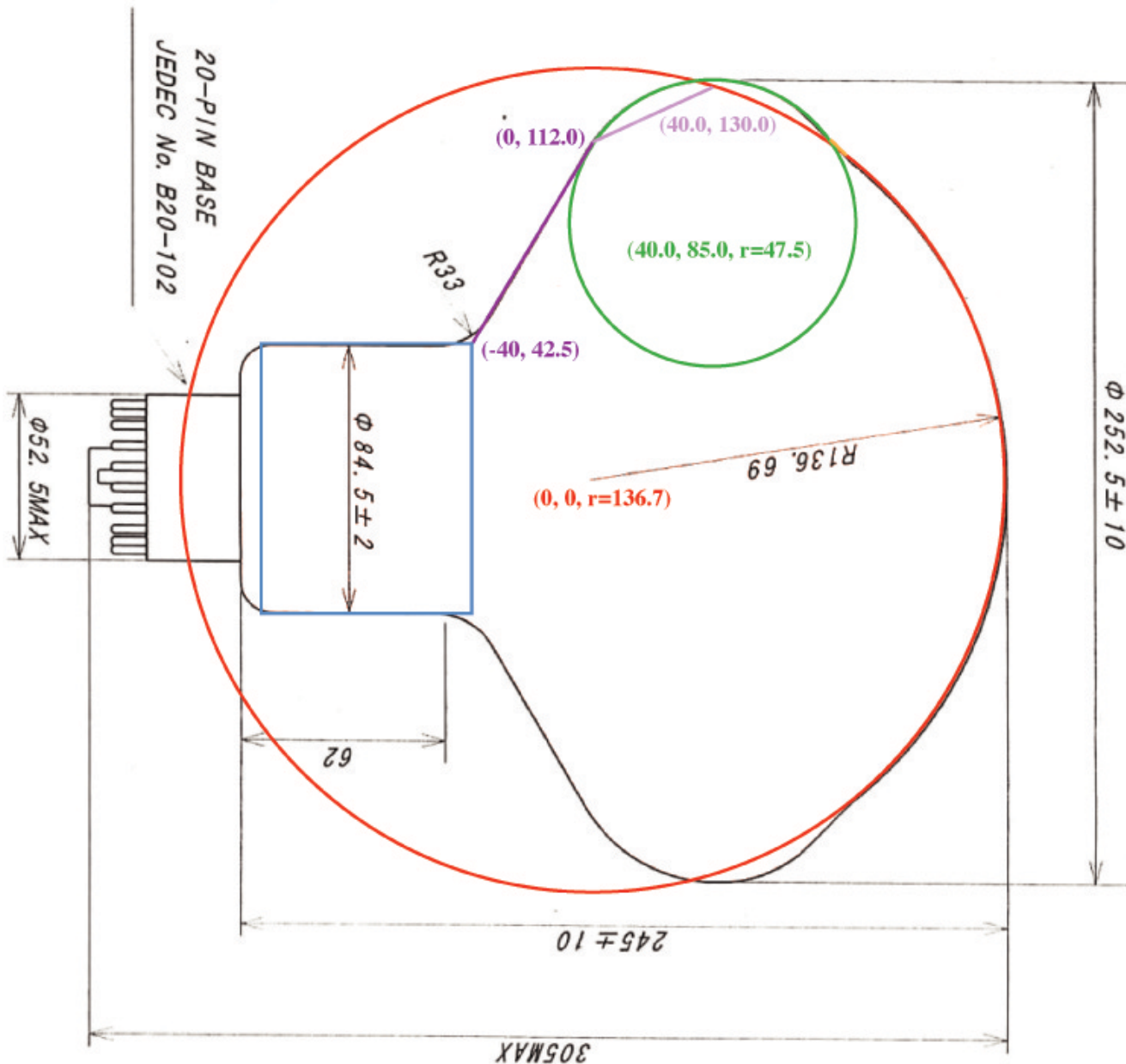
How can we get the PMT solid?



# **Ray-trace Simulator based on Geant4**



# The PMT solid



Use  
G4UnionSolid!

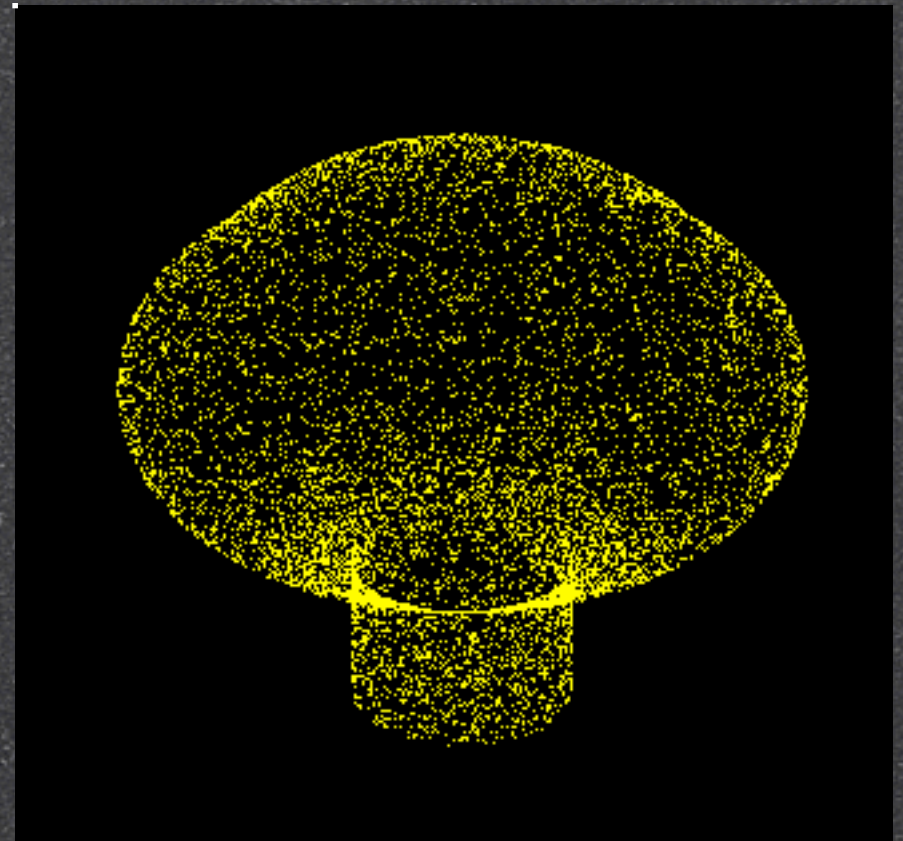
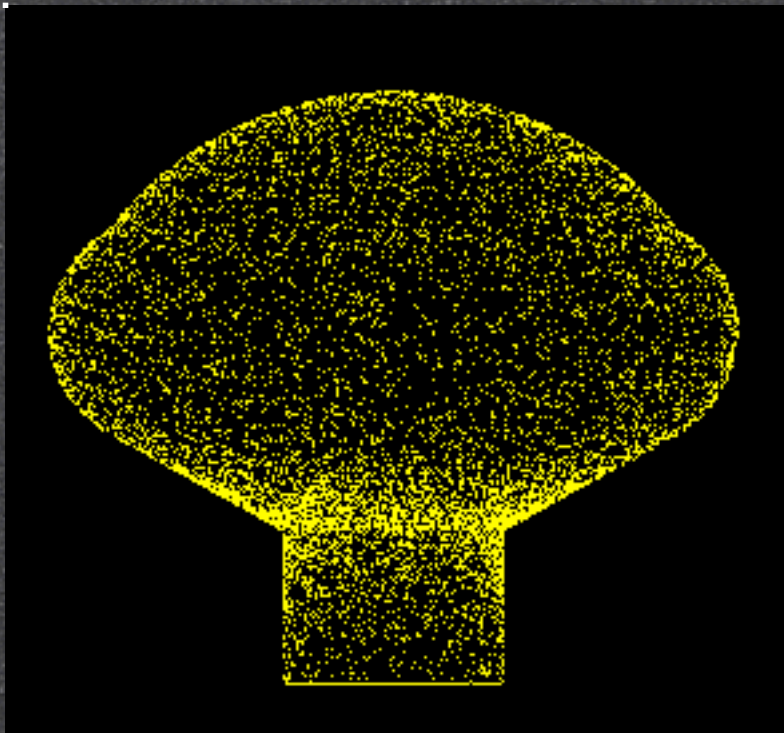
Problem:

- Complicated Boolean solids cannot be drawn correctly
- Computing time will be longer



# Test of PMT solid

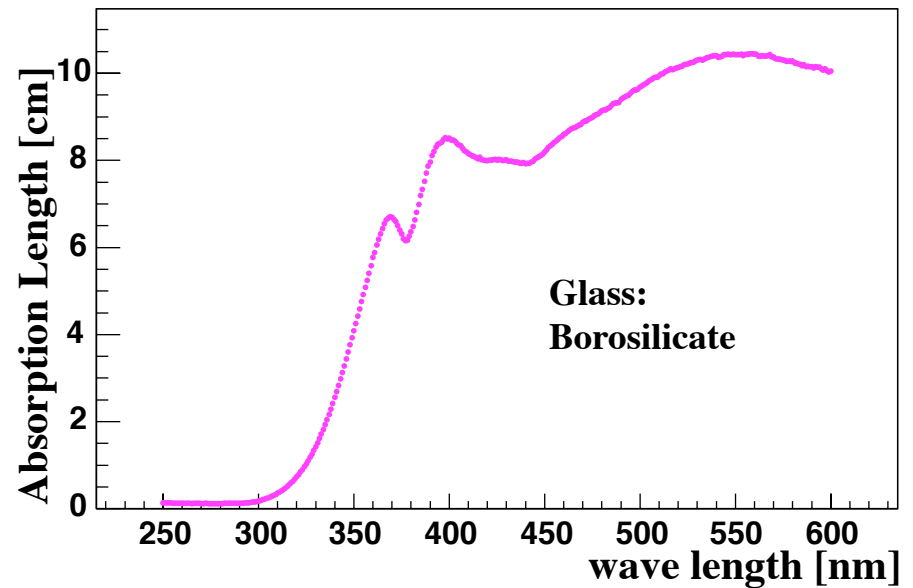
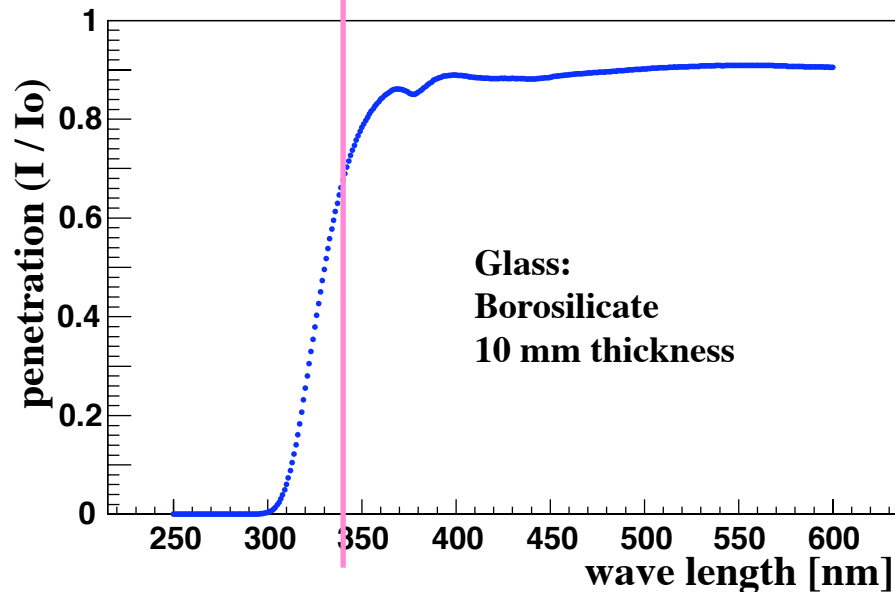
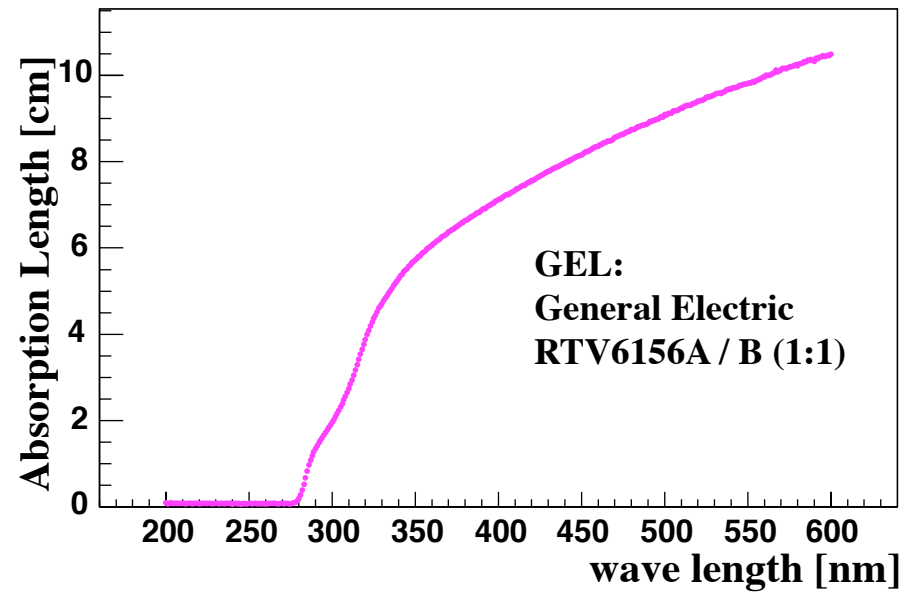
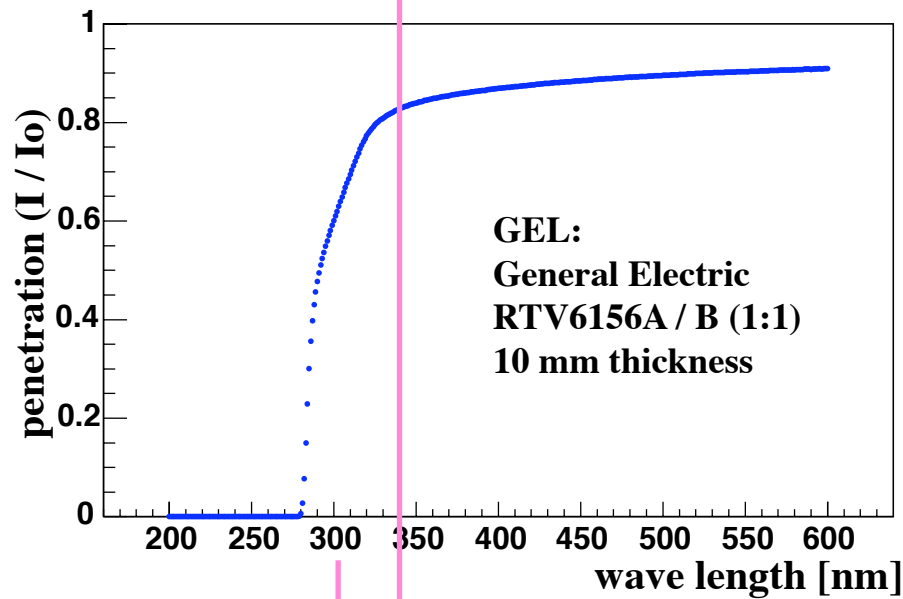
- Test the solid by geantino
- Kill tracks at the surface of PMT



Next :  
Install material properties!

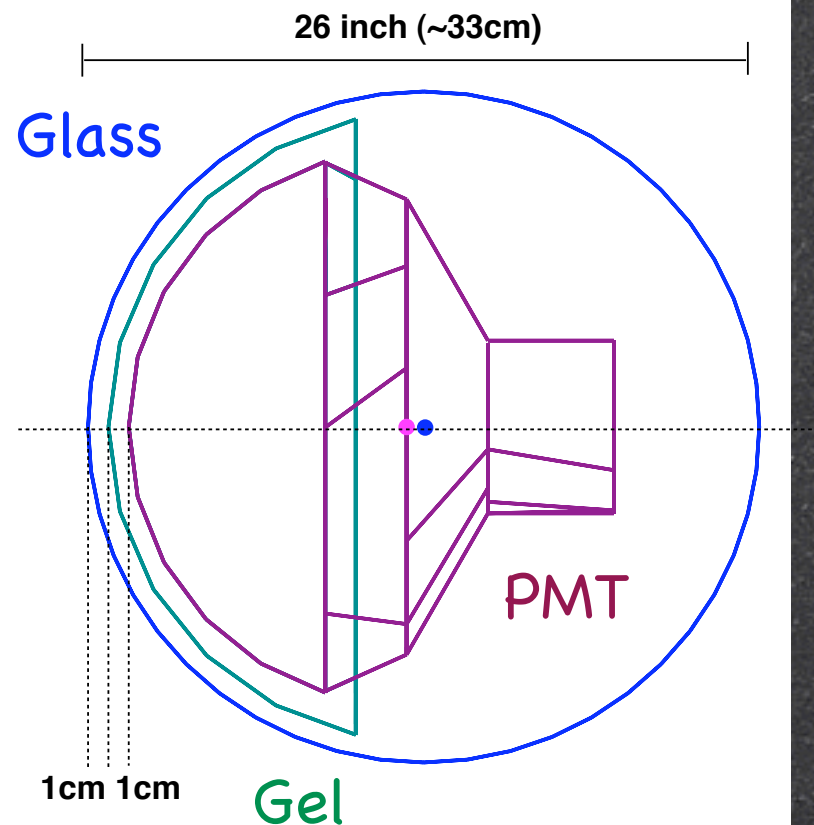
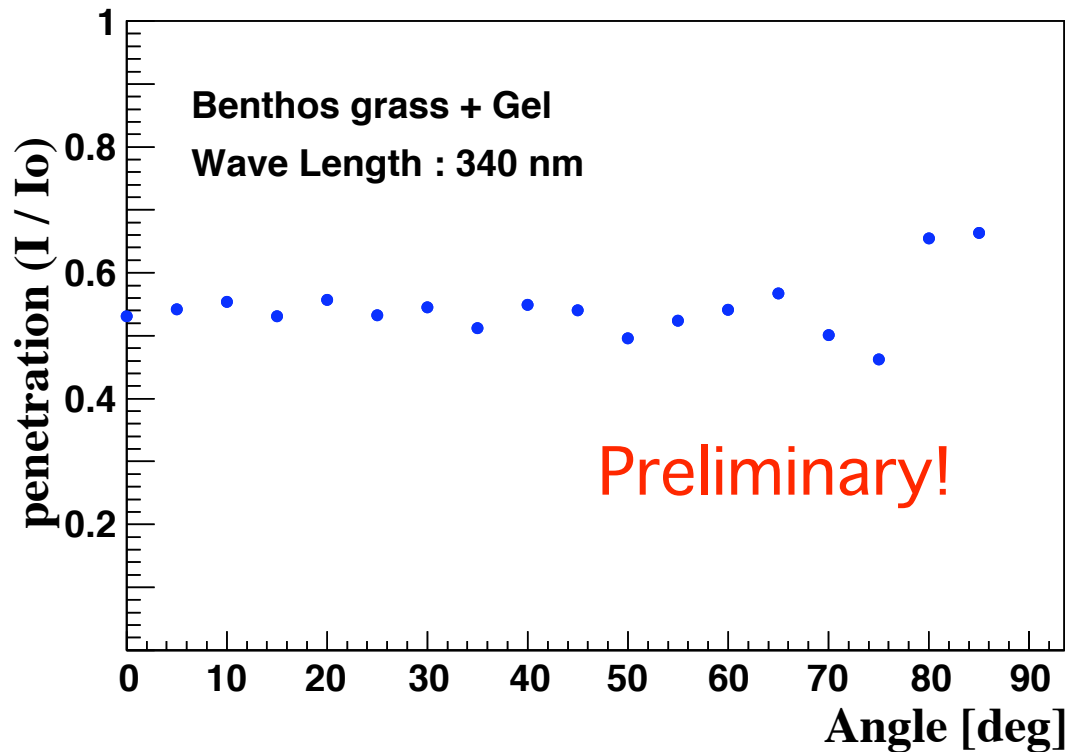


# Material properties



penetration data taken by Eliza Resconi

# Material properties (DOM setup)



$$0.8(1\text{cm Glass}) \times 0.7(1\text{cm Gel}) = 0.56(\text{at PMT})$$

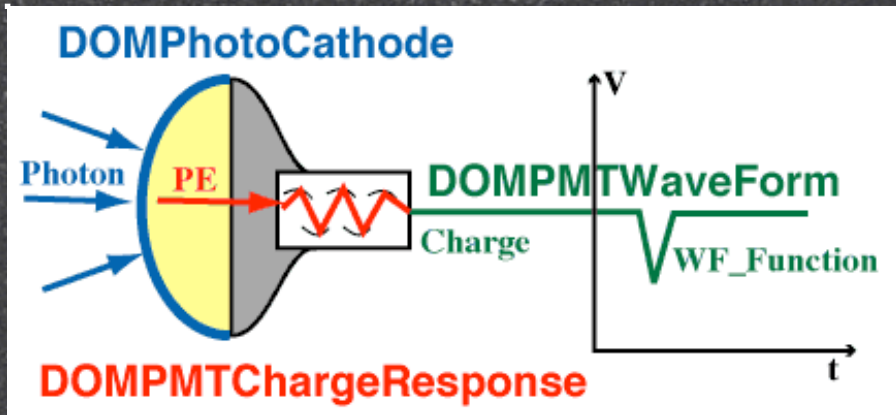
**Problem: Polarized photons go into the infinite loop :-)**



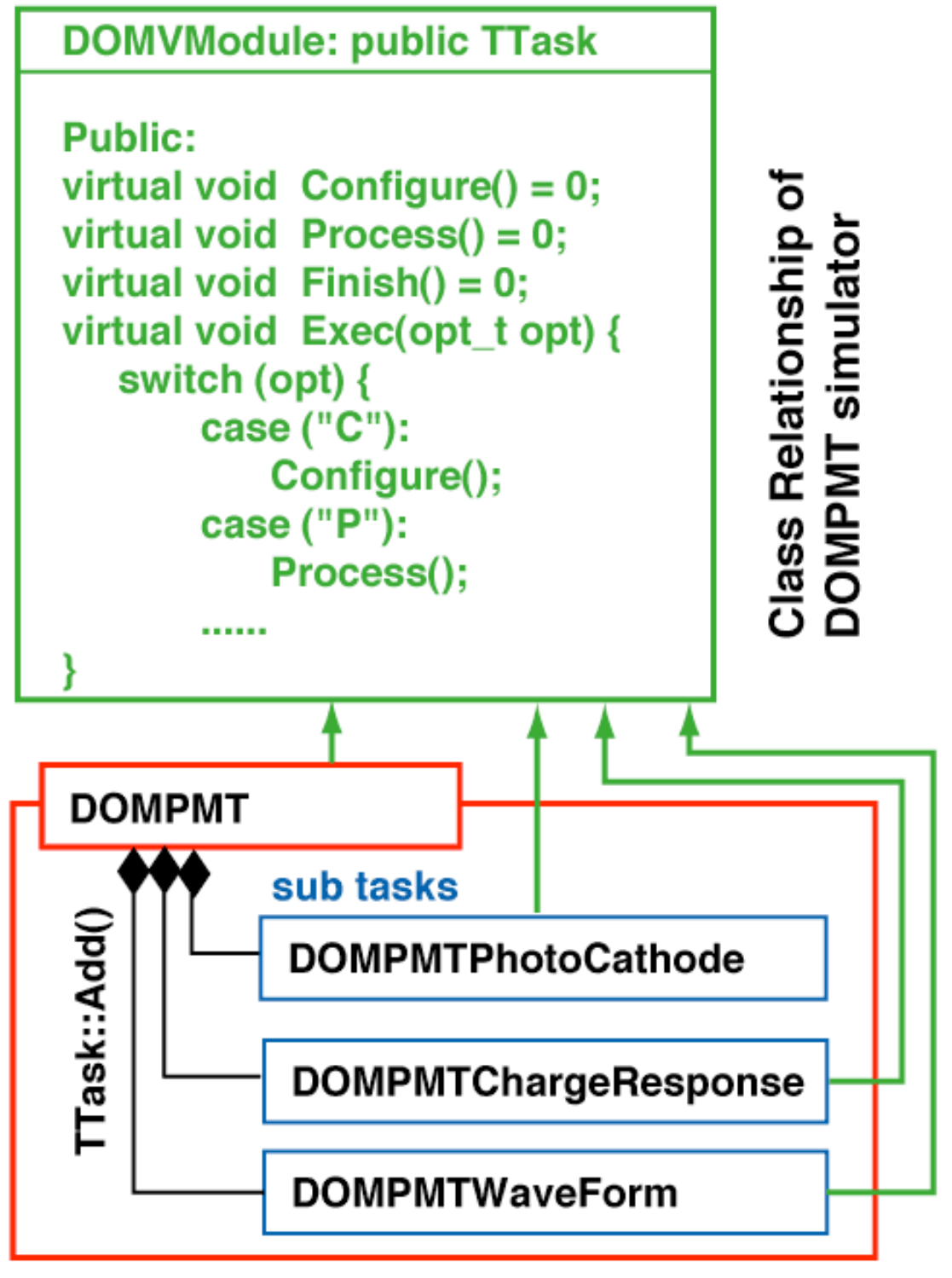
# **PMT Simulator based on ROOT**



# Software Structure



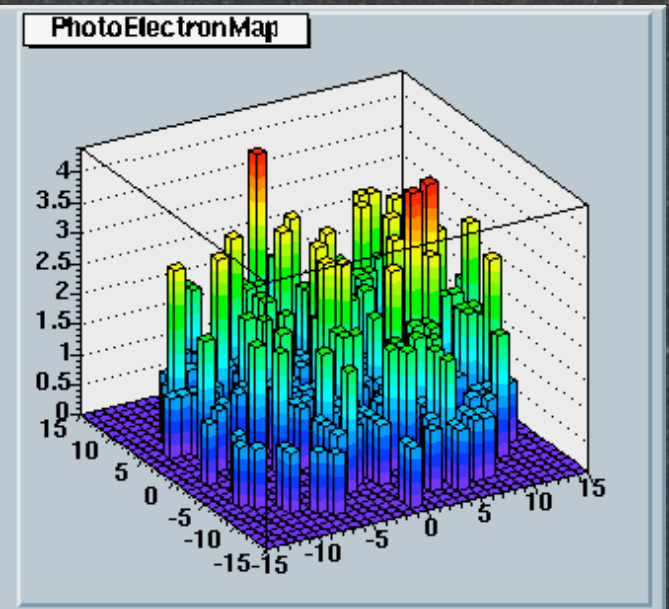
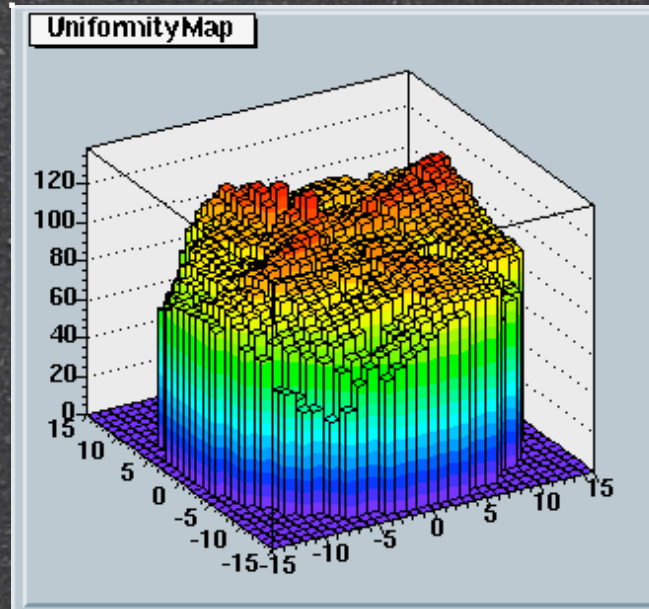
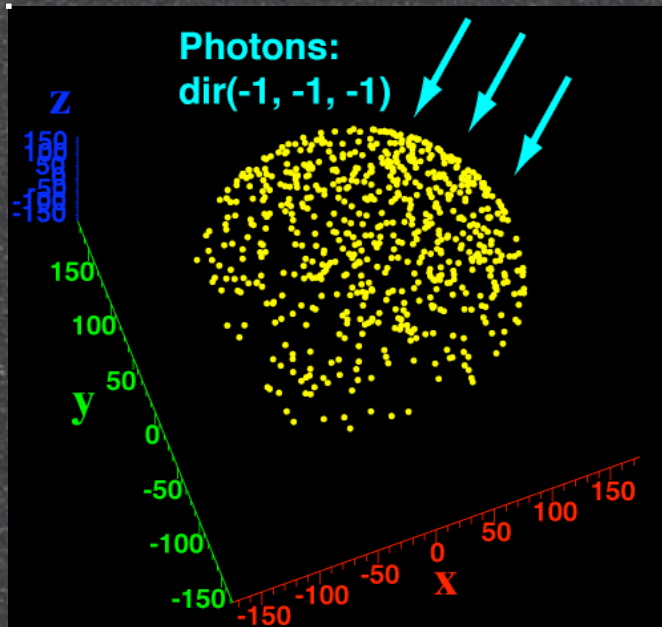
- Well - Modularized
- Equip wrapper class (DOMVModule) for future framework
- I/O facility -> Not yet! wait new framework





# PhotoCathode Simulator (DOMPMTPhotoCathode)

## INPUT: Arrival Photons



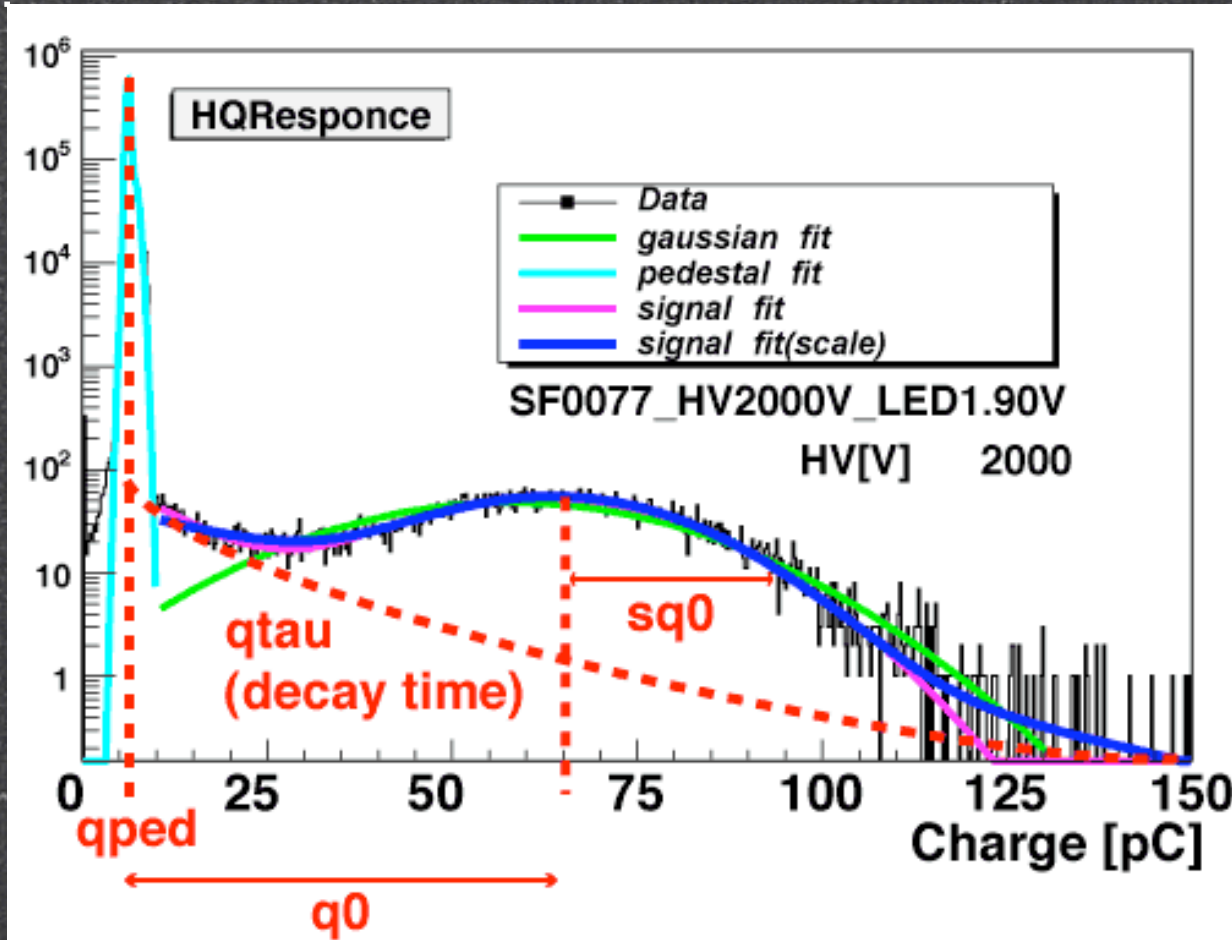
## OUTPUT: PhotoElectrons



Generate photo electron(s) from arrived photon(s) with taking into account of the Uniformity Map



# Charge Response Simulator 1 (DOMPMTChargeResponse)



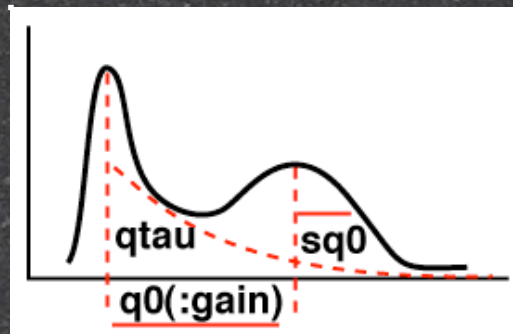
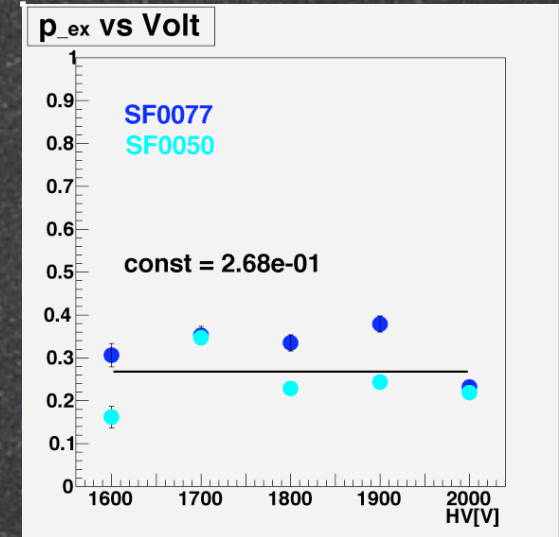
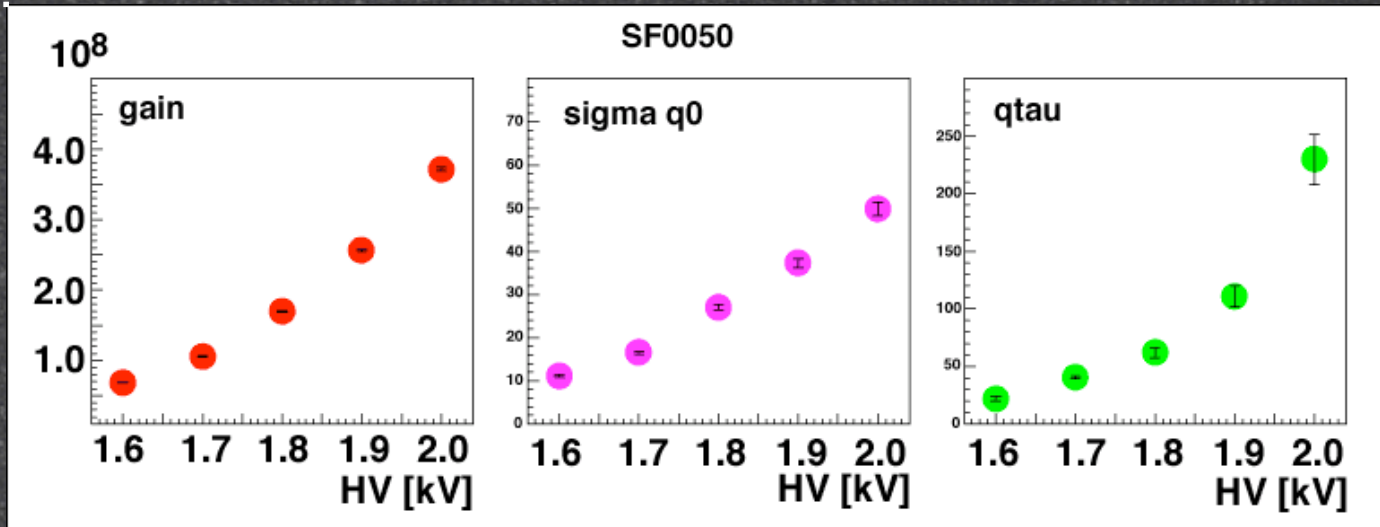
$$f = \frac{P_{ex}}{q\tau} \text{Exp} \left( -\frac{q - q_{ped}}{q\tau} \right) + (1 - P_{ex}) \frac{1}{\sqrt{2\pi} sq_0 N} \text{Exp} \left( -\frac{q - (q_0 + q_{ped})}{2 sq_0^2} \right)$$

Single PE response can be represented Exp + gaussian

4 parameters:  
How can we reduce the number of parameters?  
---> see Next!



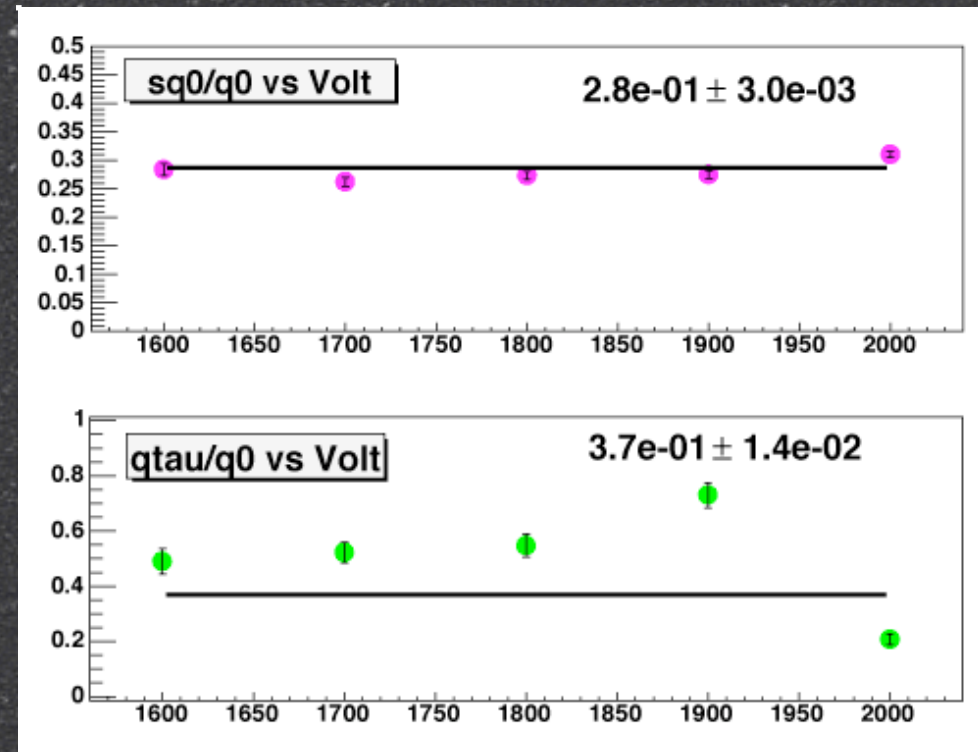
# Charge Response Simulator 2



Gain curve: required measurement

sq0, qtau: get from scaling factor and Gain!

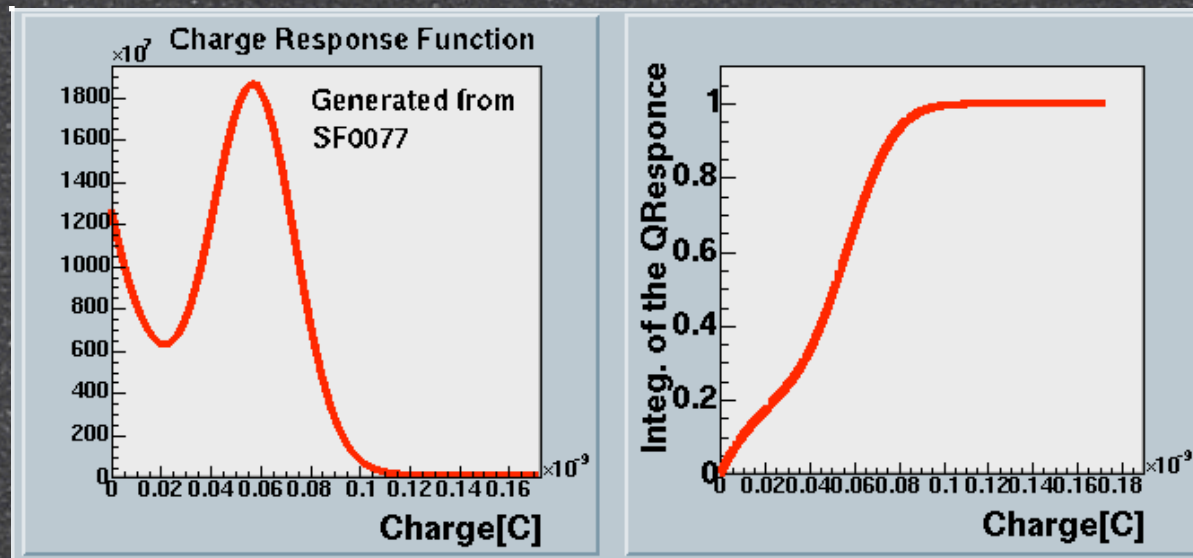
P<sub>ex</sub> : const!



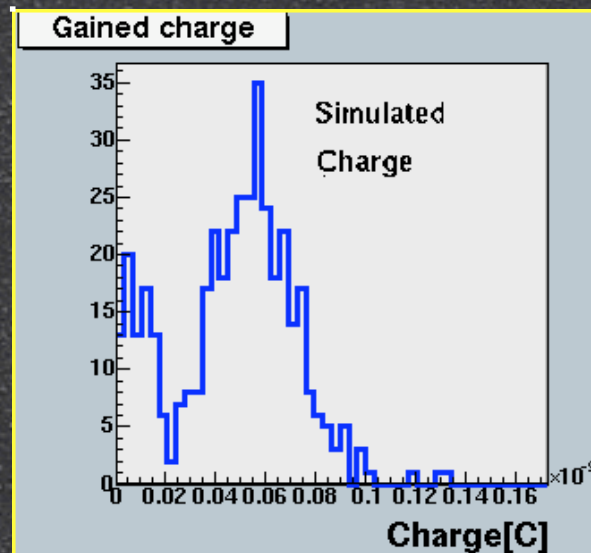
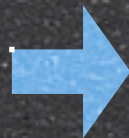


# Charge Response Simulator 3 (DOMPMTChargeResponse)

INPUT: 1PE



Random  
Seed



Multiple PE  
Charge  
Response is  
not yet  
implemented

Just add one  
function to  
adopt  
Multiple PE

OUTPUT:  
Charge[C]

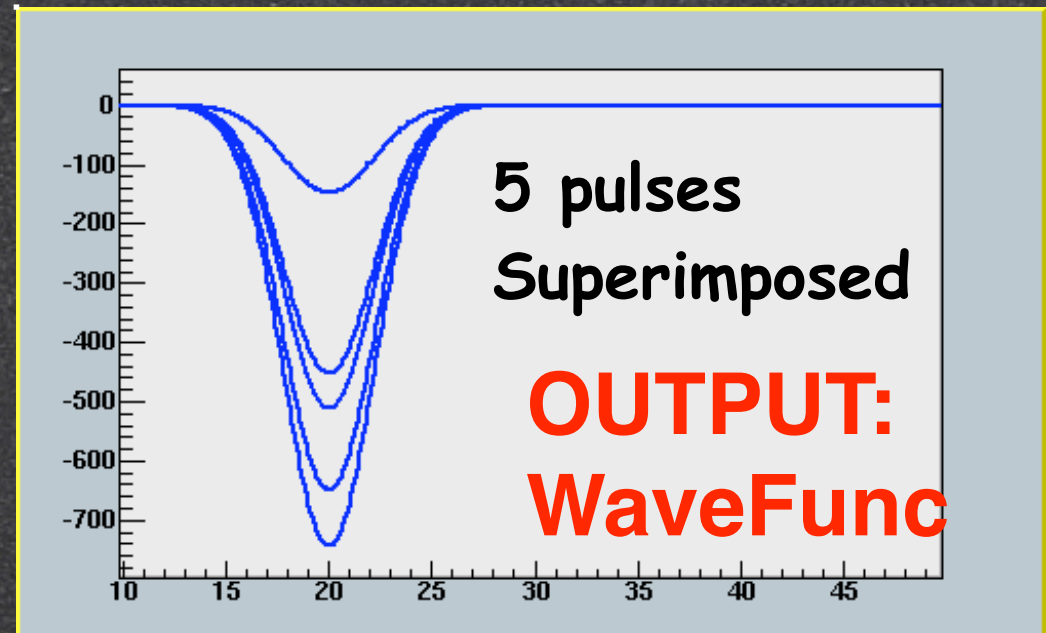
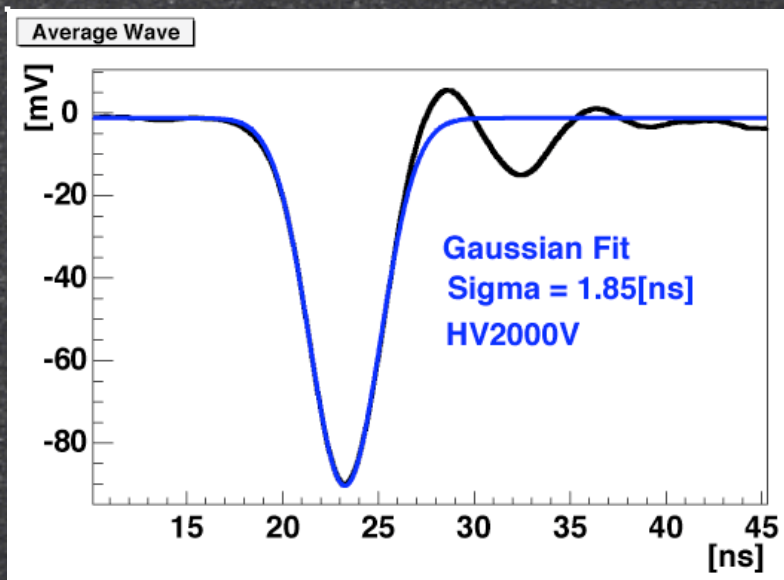
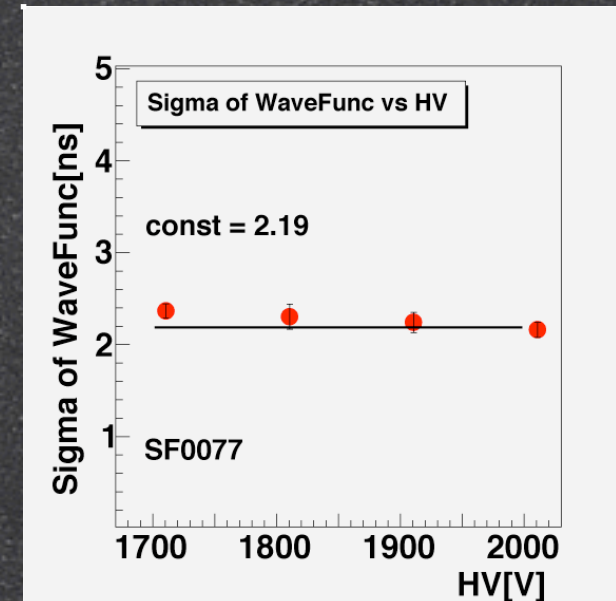
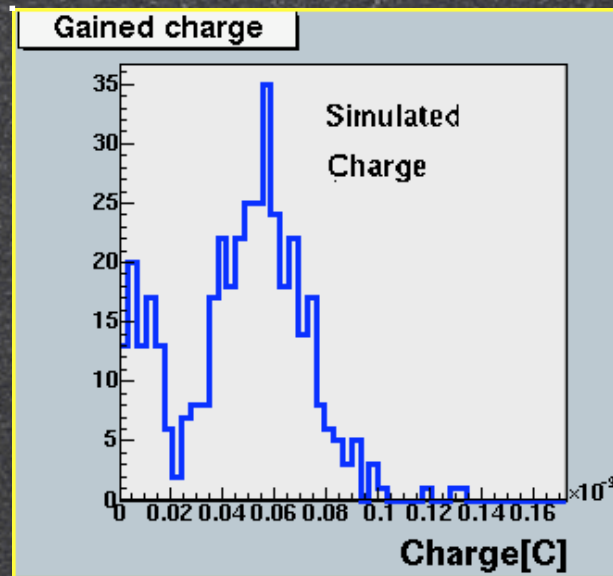


# WaveForm Simulator (DOMPMTWaveForm)

INPUT:  
Charge[C]



Get Norm.  
factor form  
Charge





# Summary

- Geometrical implementation of Ray-trace simulator based on Geant4 is almost finished, however, there are remaining problems inside Geant4.
- Base structure of the PMT simulator based on ROOT has developed. Currently, only single p.e. response can be simulated.
- Next step:
  - Ray-trace sim: fix the geometrical problems and append optical properties to the materials (reflection, wavelength shift, etc)
  - PMT sim : install multiple p.e. response and adopt new framework