Update on HD-XA SC simulation

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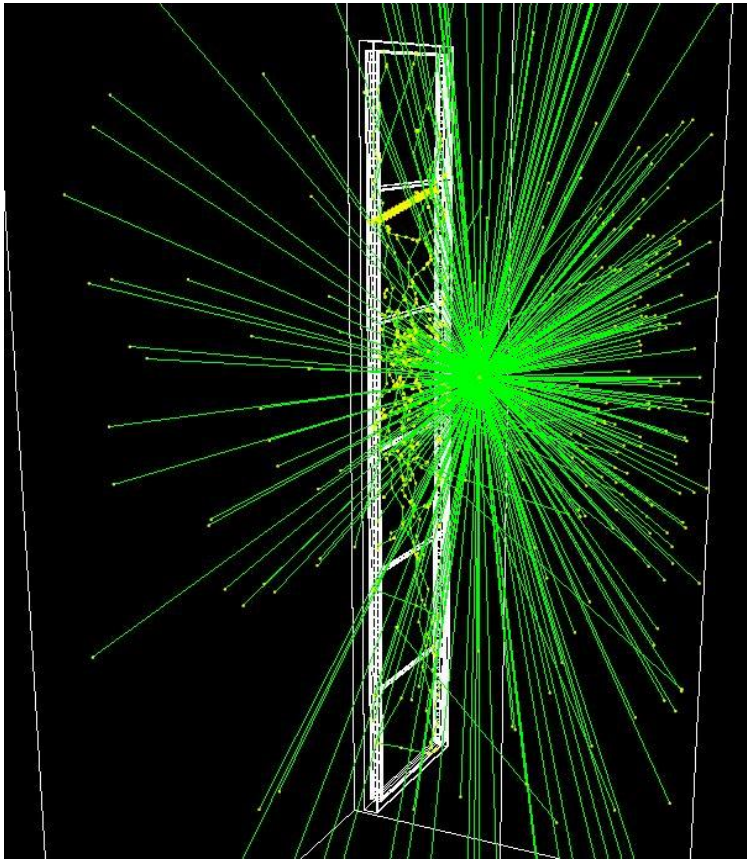
Geant4 HD-XA Supercell simulation

- photons from alpha particle scintillation in lAr (5cm from SC surface)
  - no Rayleigh scattering or absorption in lAr for simplicity
  - PDE is computed on photons hitting the pTP layer
- shifting by pTP
- interaction with the dichroic surface (measured curves)
- shifting by WLS light guide
- trapping by lightguide, dichroic coating and vikuiti
- photons reaching the SiPM are detected according to the SiPM efficiency curve



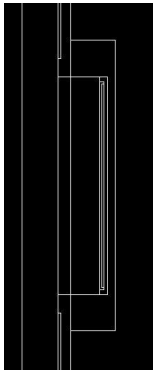
Dimple comparison: square vs cylindrical

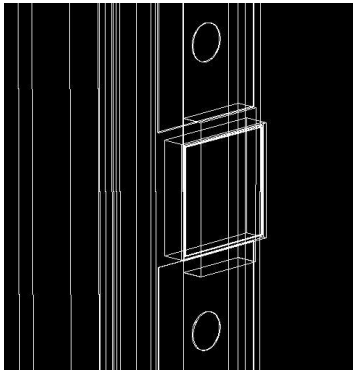
- absolute efficiency values are not accurate because of the pTP-glass-dichroic modeling (see last slide)

- square dimples are 8mm wide by 1.2mm deep
  - SiPMs are 0.1mm away from the dimple surface
- cylindrical dimples have a 4mm radius
  - SiPMs are inside the dimple, SMB are 0.1mm away from the WLS light guide

- square and cylindrical dimples give better PDE than a flat lightguide
  - better light sealing of the light guide
  - focusing effect helps with the HD style rectangular SC

Dimple	PDE	% wrt flat
flat	**1.25%**	**-**
cylindrical	**1.46%**	**+17%**
square	**1.41%**	**+13%**





Vikuiti distance from light guide

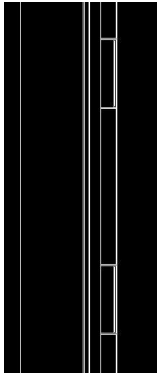
- absolute efficiency values are not accurate because of the pTP-glass-dichroic modeling (see last slide)

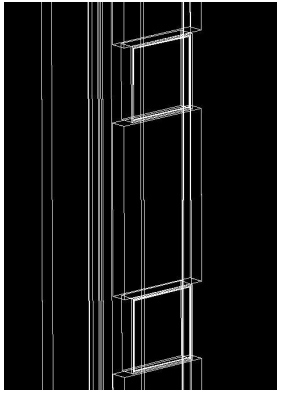
- most of the advantage given by the dimples comes from the better light sealing of the light guide

- putting G10 blocks covered with vikuiti between each SiPM (0.1mm from lg) gives a better result
  - avoids light being absorbed by the SiPMs sides

- **__post talk note__: this value is for 0.1mm Vikuiti-WLS distance. Realistically the HD style XA SC, having boards fixed to the frame, has a bigger gap. The simulation, with a 0.5mm gap gives a PDE increase of 38%. From the measurement (next slide) we hope to see a >30% improvement due to imperfections in Vikuiti application*

Dimple	PDE	% wrt flat
flat	**1.25%**	**-**
cylindrical	**1.46%**	**+17%**
square	**1.41%**	**+13%**
vikuiti blocks	**2.09%***	**+67%***

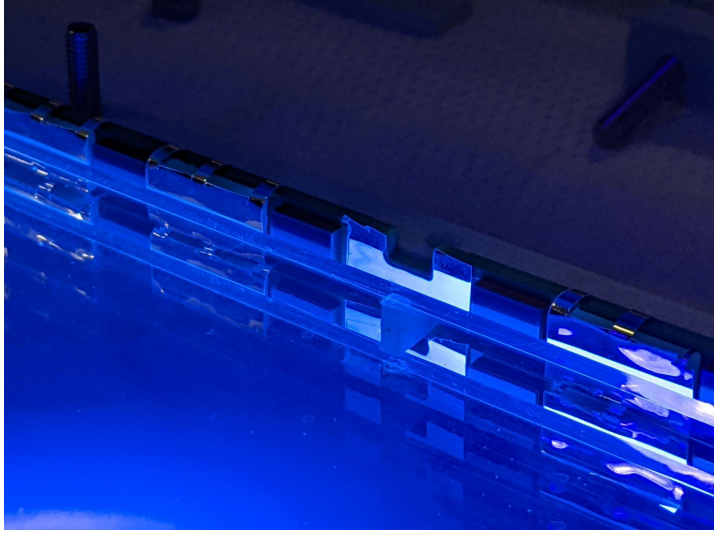




HD-XA Supercell with Vikuiti blocks

- placing Vikuiti closer to the light guide provides better light sealing
    - could be the reason the previous 2-cell XA version had better PDE

- this week we will measure a SC with Vikuiti on G10 blocks between the SiPMs to verify
- we also planned a measure with half the SiPMs blinded with Vikuiti to check if a better light sealing could allow a lower number of SiPMs to collect the light
    - dependent on the PMMA absorption (known only a lower limit)



Supercell dimple comparison measurement (nov22)

- from the measurement done last november in Milano Bicocca, we observed little difference between flat, square and cylindrical dimples

Dimple	PDE	% wrt flat
flat	**2.18%**	**-**
cylindrical	**2.25%**	**+3%**
square	**2.21%**	**+1%**

- a possible explanation could be the light guide edges finish
  - the edges are rougher due to the cutting
  - the dimple edges are even rougher

- a first attempt to model this in geant gives a compatible result (roughness values are arbitrary)
  - flat large surfaces are polished (no roughness)
  - cut edges have 0.2 alpha
  - machined dimple edges have 0.5 alpha

Supercell dimple comparison measurement (nov22)

- roughness on the edges gives a better result for the flat lg
  - light is more likely to escape on a SiPM or Vikuiti

- cylindrical dimple advantage in better light sealing is limited by the distance between the dimple surface and the SiPMs
  - surface roughness reduces the theoretical PDE since the light escapes the light guide edge more diffusely

- square dimples give a worse result wrt cylindrical ones due to worse light sealing
  - being 1.2mm deep the SiPM (1.35mm deep) touches the dimple surface, preventing the light guide to get close to the vikuiti on the flex

Dimple	PDE	% wrt flat
flat	**1.36%**	**-**
square	**1.43%**	**+5%**
cylindrical	**1.47%**	**+8%**

simulation results are still off from the measurement ones but roughness could explain the lack of improvement with the dimpled light guide

[pTP - glass substrate - dichroic] modeling

- in geant4 the modeling of the pTP deposit and dichroic filter is difficult:
  - need to know pTP refractive index and opacity
    - determine the amount of light able to escape the pTP volume
  - only one dichroic surface can be defined…
    - at least 2 needed since the dichroic behaviour should depend on the material the light is travelling through (lAr or glass)

- i.e. a large improvement in geant4 is given by an increased glass substrate refractive index
  - this changes the a.o.i of the light coming from the pTP to the dichroic
  - a change in the dichroic behaviour wrt material RI could negate this improvement

ZAOT nov22 substrate RI	PDE	% wrt 1.49
1.49	2.30%	-
1.55	2.74%	+19%
1.7	4.02%	+75%
1.8	4.35%	+89%

=> for now the amount of light entering the SC is not accurately modeled…