X-ARAPUCA Photon Collection

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on behalf of the WG
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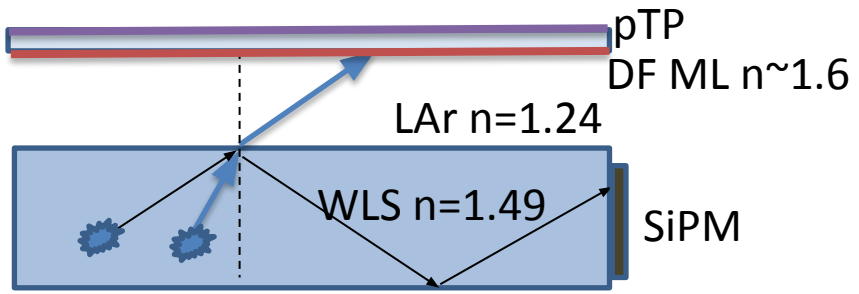
PDE enhancing

The two XA photon collection mechanisms:

- Lightguiding (LG): For θ > θc (=56°) pTP downshifted photons are trapped into the LG and guided to SiPM.
- Dichroic Filters (DF): For θ < θc photons leave the lightguide and may reach the SiPM by multiple bounces onto the DF & reflectors



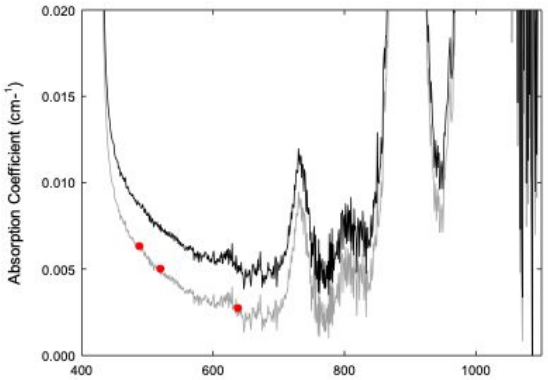
	PDE		
config	bl 0.5mm	VB 0.5mm	VB 0.1mm
dich ON	0.95%	1.33%	1.46%
dich OFF	0.78%	1.19%	1.33%
ON/OFF	~+20%	~+13%	~+9%

contribution to PDE from light guide + dichroichs

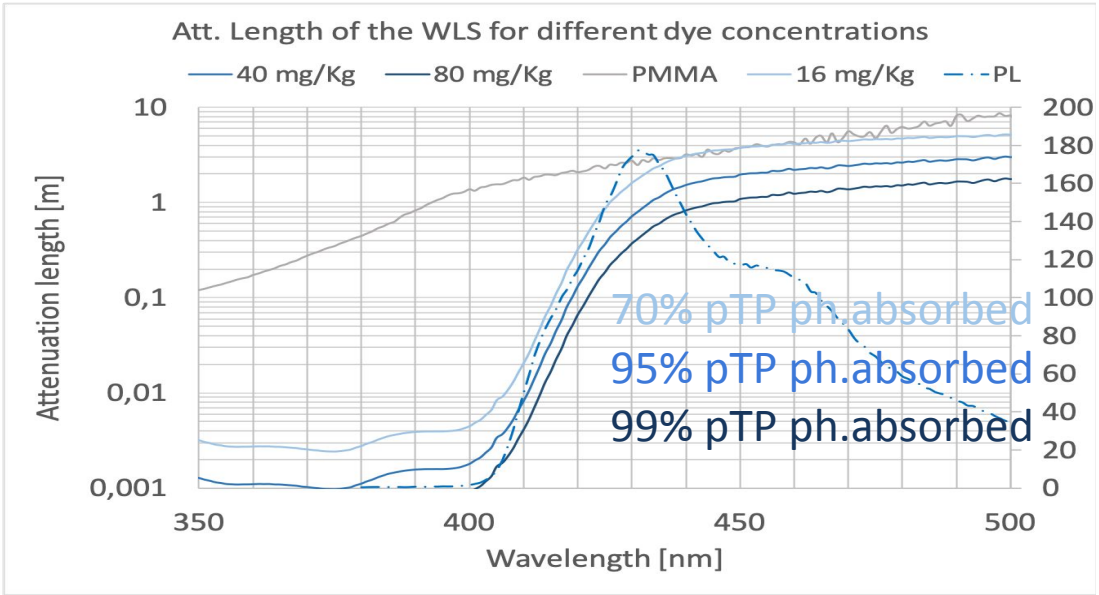
contribution to PDE from dichroichs only

PDE increase from dichroichs

WLS for FD1&FD2: Attenuation length (l_{att})



- The T(λ) measured at the spectrophotometer on a 4 mm sample are corrected (shifted) by the laser measurements
- The att.length (l_{att}) is derived (the method and the results will be published)



$A = \log_{10}(1/T)$

$T = I/I_o \exp(-d/l_{att})$

$A = \varepsilon\, c\, d$

ε = molar extinction coeff.

c = concentration

d = optical path

Chromophore concentration

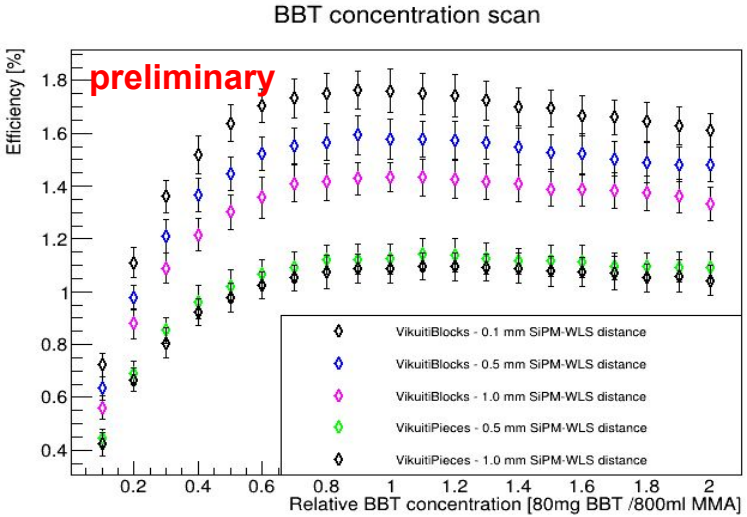
- chromophore concentration determines:
  - % of photons downshifted from ~350nm to ~450nm
  - blue light (~450nm) bulk absorption

    - the higher the conc. the higher the WLS and absorption
      - we want maximum WLS and minimum absorption
      - need to find an optimum
        - depends on the module configuration

- another way to increase WLS is to thicken the light guide
  - does not impact the absorption
  - constraints? <5mm?

HD-XA configuration

- **HD-XA**: **short** possible optical paths
  - **480mmx93mm**
  - **attenuation length @ 430nm is now 37cm**
    - if properly trapped **light can be reflected at the edges 3-5 times** before being absorbed



- for the SuperCell, chromophore concentration is not critical
- an optimum can be easily achieved
  - ok as it is now

VD-XA possible configurations

- **VD-XA**: much **longer** possible optical paths (O(m) -> reflections?)
  - but an att. len. O(m) would mean very low WLS (<70%)

- 2 possible ways of optimizing the MegaCell (just a guess for now):

  - **HD-XA like**: reduce chrom. conc. & thicken lg & **maximize trapping** (**would require high optical path O(m)**)
    - may not be effective: optimum **PDE possibly still too low**
      - most of (?) the light is absorbed in the light guide trying to be reflected from side to side if acceptable WLS has to be kept

  - att. length O(1m) & **maximize extraction at lg edge**
    - ~100% WLS
    - diffusive light guide edges?
    - diffusive frame around SiPMs? PTFE? TiO2 paint?
      - sort of an integrating sphere (but half open)