APEX LY estimates from Standalone Simulation

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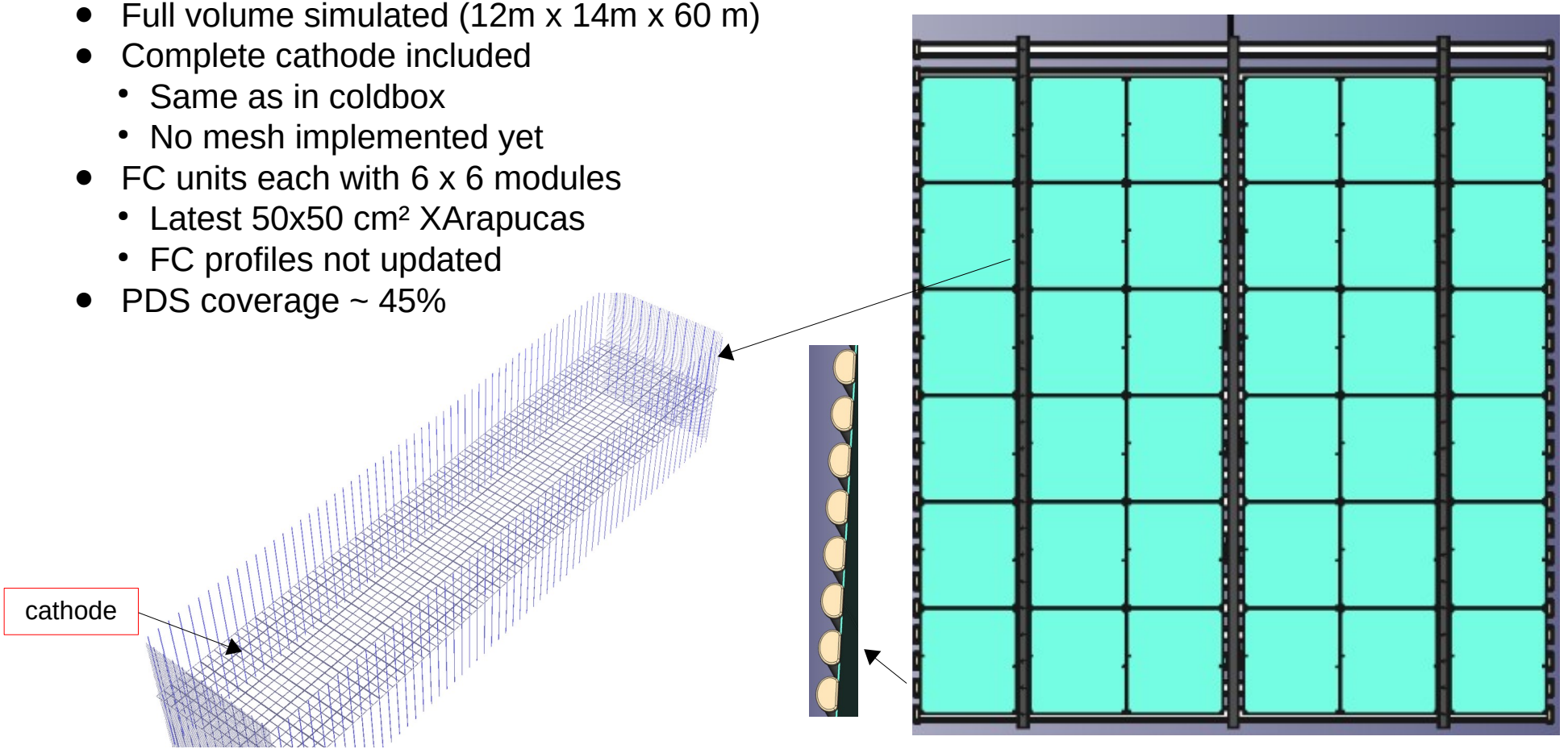
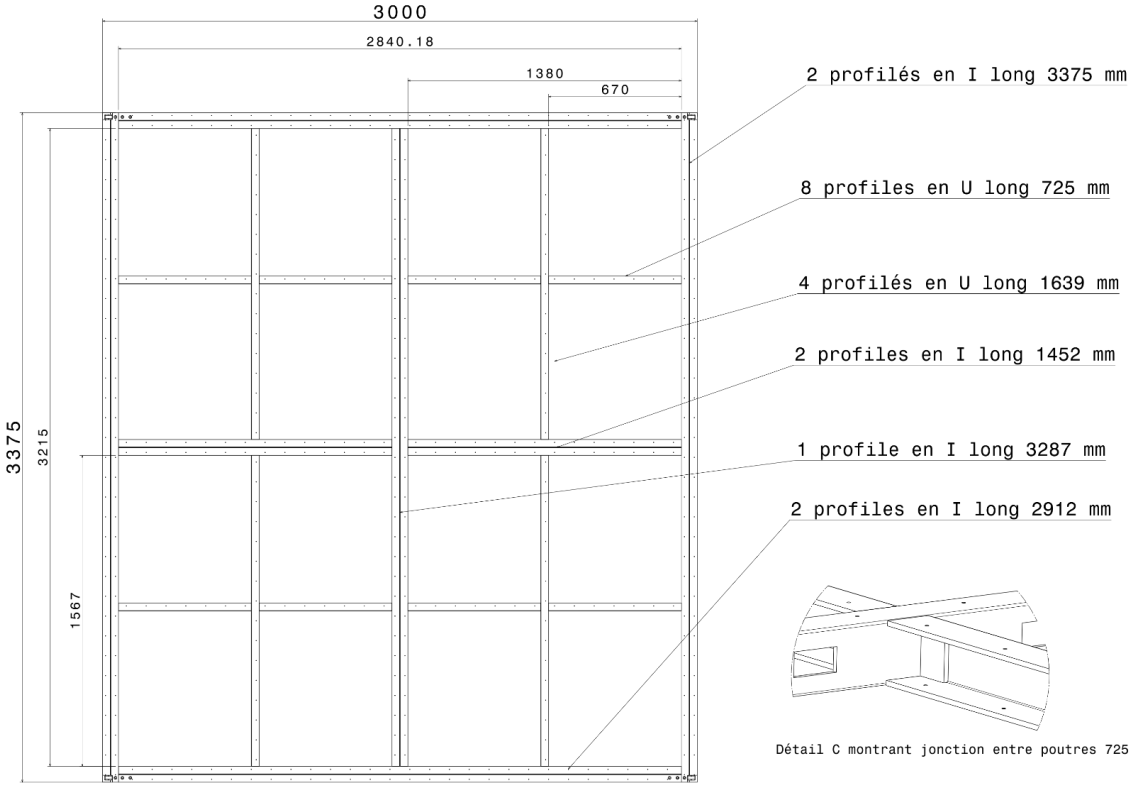
Geometry

- Full volume simulated (12m x 14m x 60 m)
- Complete cathode included
  - Same as in coldbox
  - No mesh implemented yet
- FC units each with 6 x 6 modules
  - Latest 50x50 cm² XArapucas
  - FC profiles not updated
- PDS coverage ~ 45%



Etude faisabil
cadre cathode
Projet cathode
DUNE - 07/12/2
Rosier-IJCLAB



2 profilés en I long 3375 mm

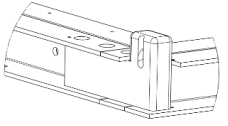
8 profiles en U long 725 mm

4 profilés en U long 1639 mm

2 profiles en I long 1452 mm

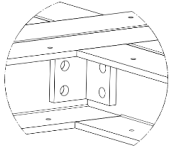
1 profile en I long 3287 mm

2 profiles en I long 2912 mm

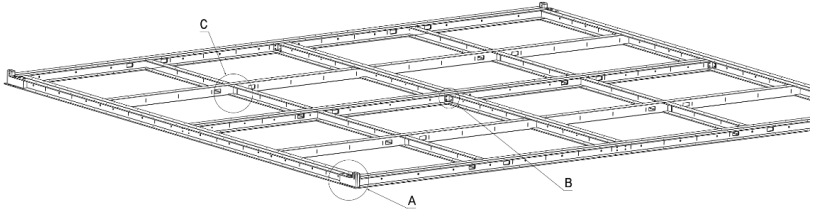


detail A montrant le renfort a

Détail C montrant jonction entre poutres 725 mm



Détail B montrant angle de r



Ensemble à assembler et à coller sur marbre

Collage époxy 2011 chargé en verre

Simulation setup

- Photons shot from the center of voxels.
- Isotropic direction and polarization
- Voxel size: 0.5 x 0.5 x 0.5 m^3
- Same optical properties as for ProtoDUNE-VD simulations
  - LAr refractive index, Rayleigh scattering, absorption
  - Reflectivity of membrane, anode, field cage, etc
  - pTP emitted photons are also tracked
- All sensors detecting any level of light for evaluation
  - No cut on #pe applied
  - No sensors clustering required

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- Isotropic directions and polarization
- Voxel size: 0.5 x 0.5 x 0.5 m^3

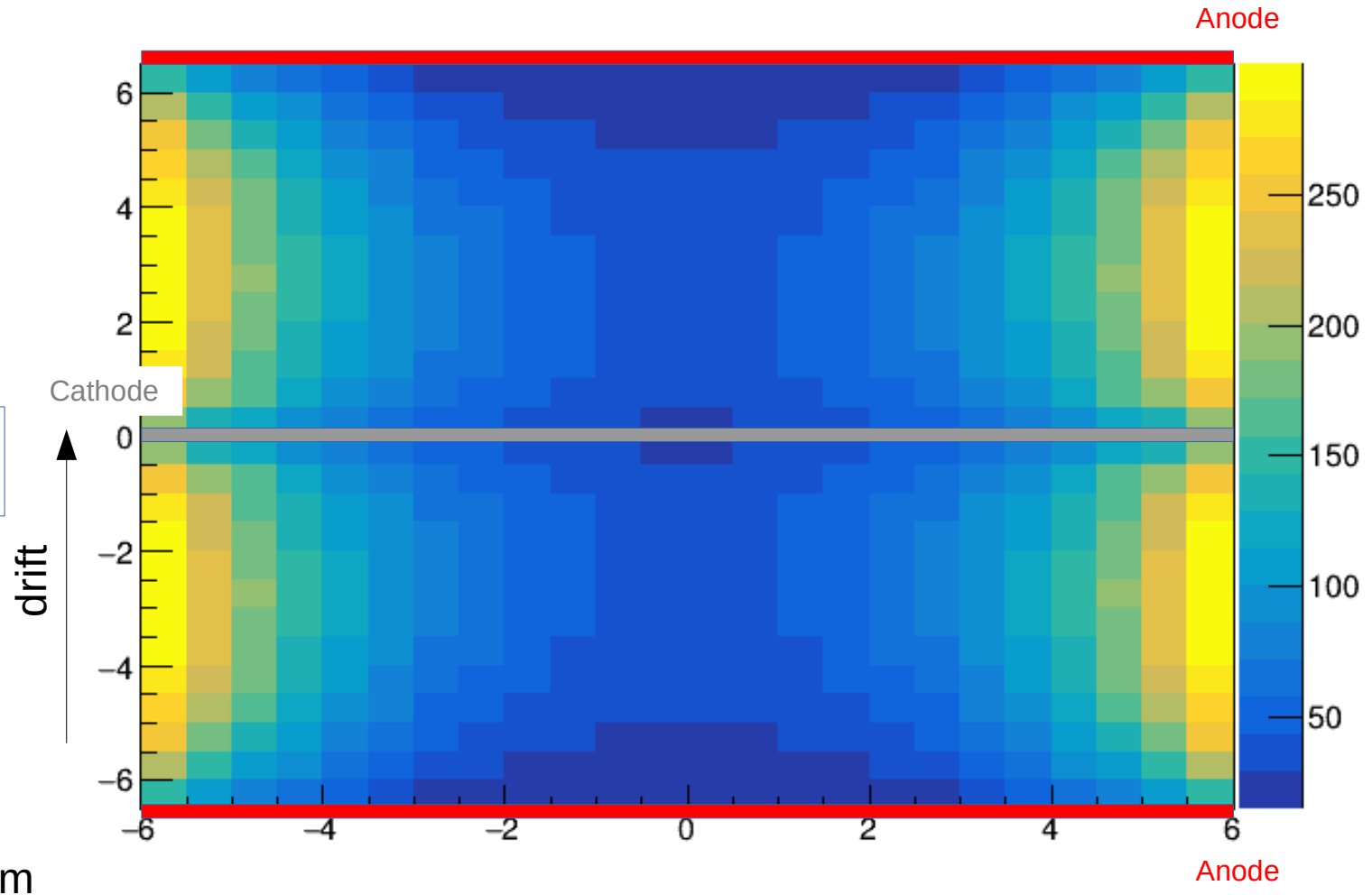
Parameter	Value
LAr Photon Yield (mip, 500 V/cm)	25,000 ph/MeV
Xe doping in Ar	10 ppm
Rayleigh Scattering Length	$\lambda_R(128\,\mathrm{nm}) = 1\,\mathrm{m}$
	$\lambda_R(176\,\mathrm{nm}) = 8.5\,\mathrm{m}$
Absorption Length	$\lambda_{Abs}(\mathrm{N_2}@128\,\mathrm{nm}) = 20\,\mathrm{m}$
	$\lambda_{Abs}(\mathrm{N_2}@176\,\mathrm{nm}) = 80\,\mathrm{m}$
X-Arapuca Tile det. Efficiency	$\epsilon_D = 2\%$
Field Cage Reflectivity	R=70%
Cryostat Reflectivity	R=30% @128 nm, R=40% @176 nm
Anode	R=0% @128 nm, R=20% @176 nm

Argon only LY map

pTP emission back into cryostat accounted.

~ 50% of light increase

Average LY: 97.4 PE/MeV
Min: LY: 14.7 PE/MeV



Z = 0 m

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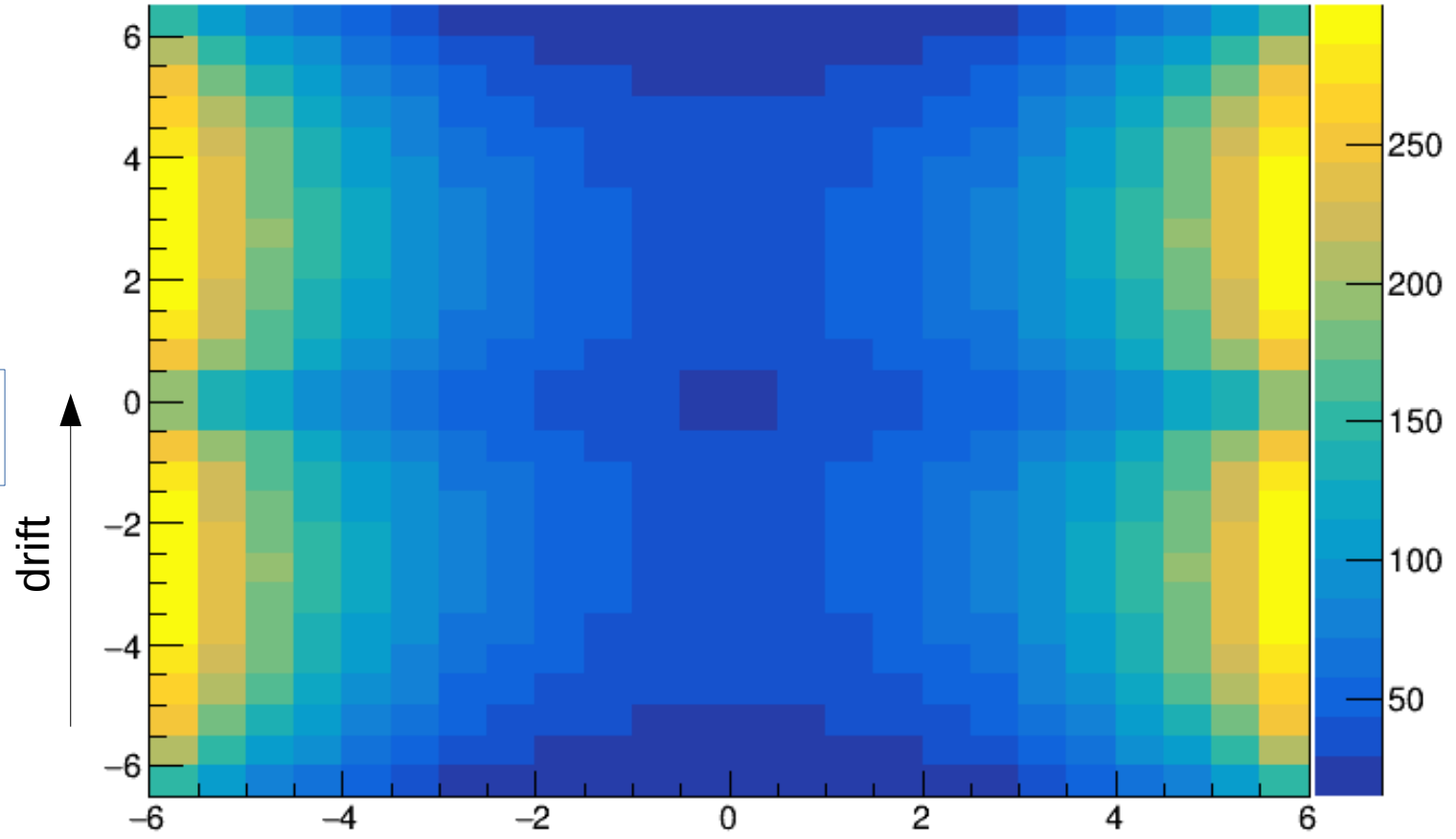
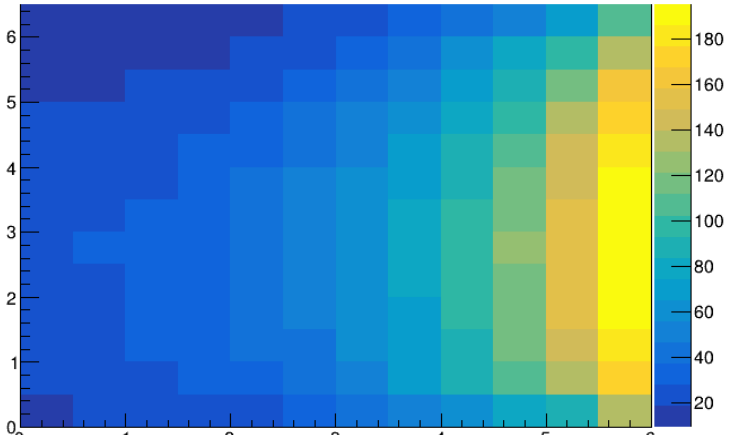
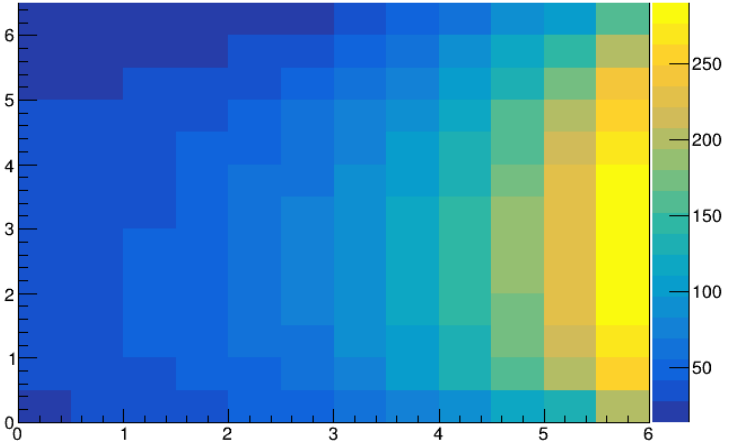


Z = 0 m

LY_{LAr} [#pe/MeV]



No backward emission

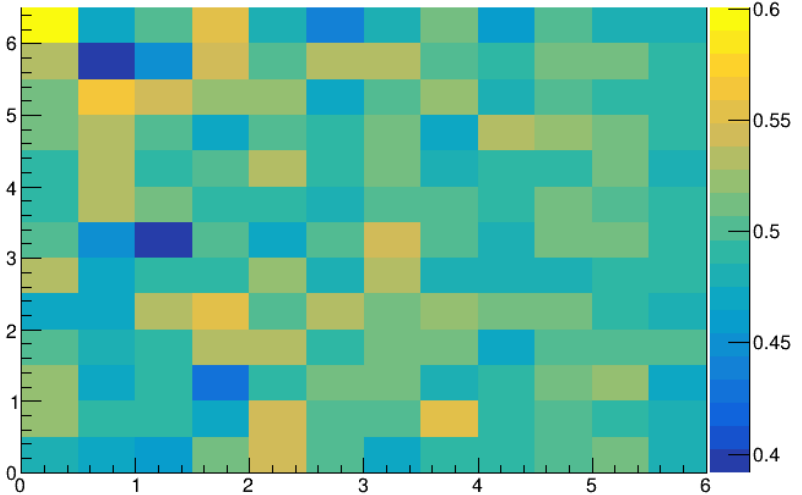


Including backward emission

- Direct LAr light yield contribution increase due to backward ptp emissions

  Increase: $(LY_{LAr}^{ptp} / LY_{LAr}^{no\ ptp}) - 1$

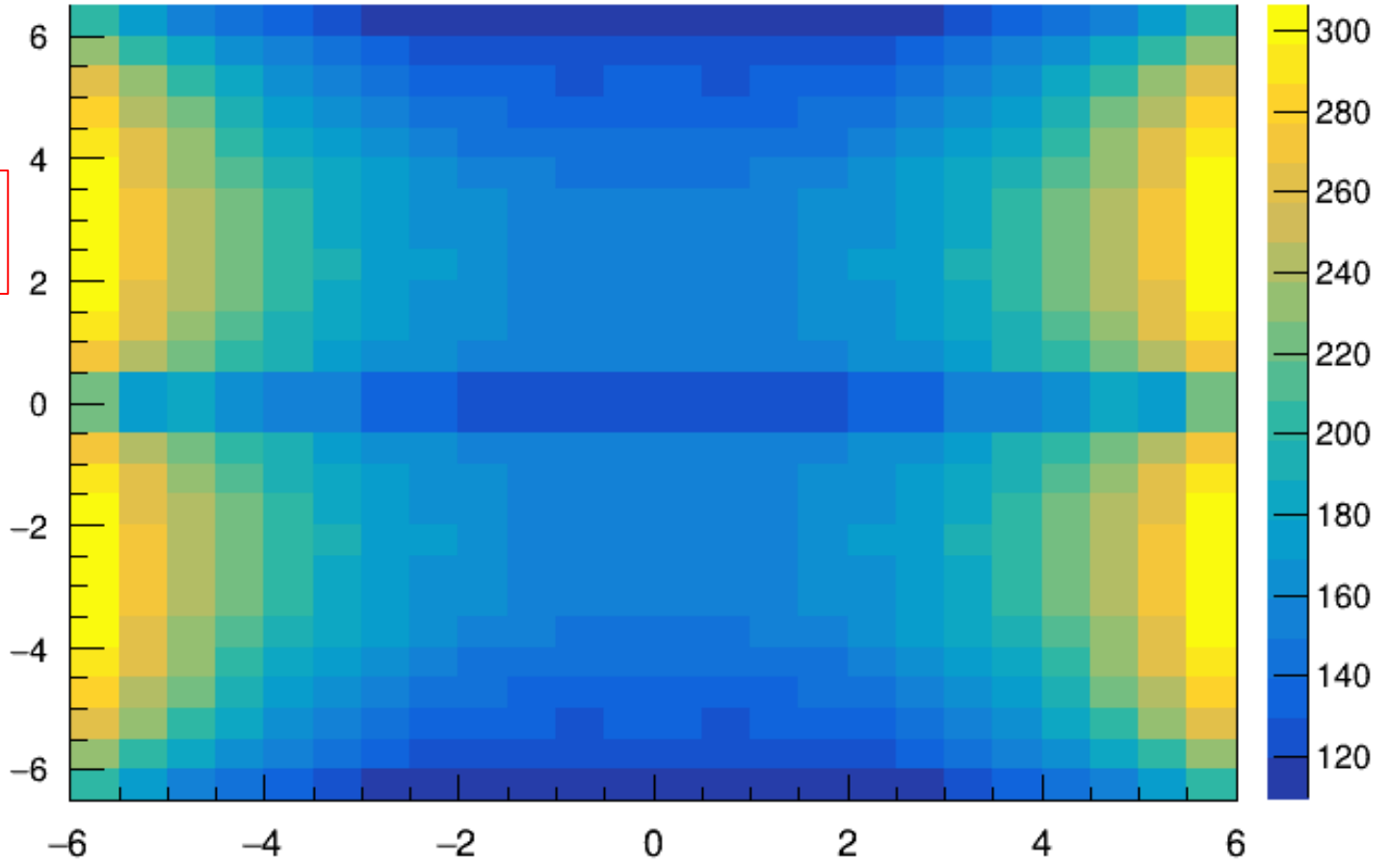
- Percentage ~50 %
  - uniform across volume



Argon-Xenon mixture LY map

53% of total light emitted @176nm
and 35% of light loss @128nm

Average LY: 180.1 PE/MeV
Min LY: 109.5 PE/MeV



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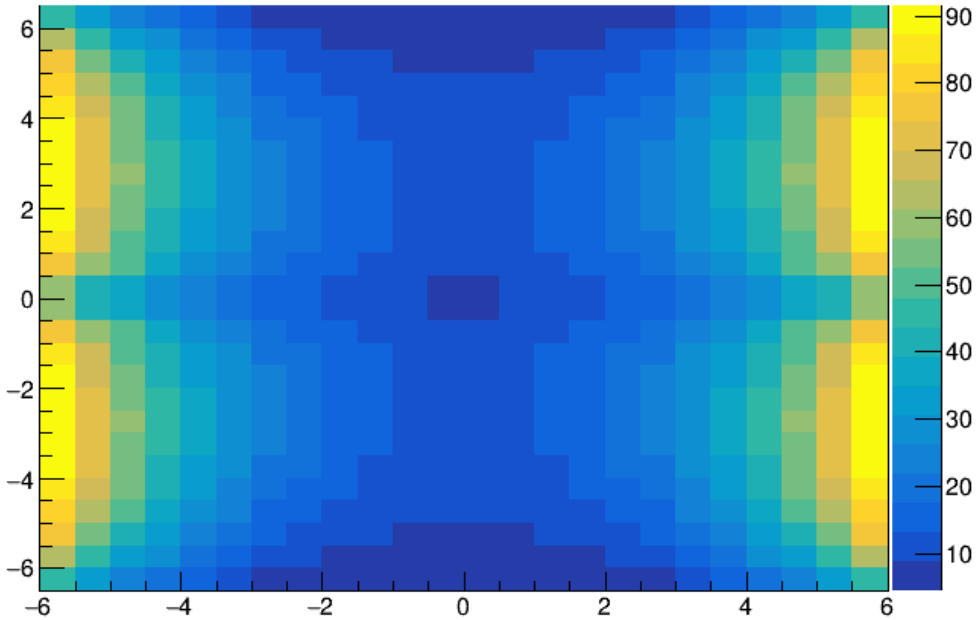
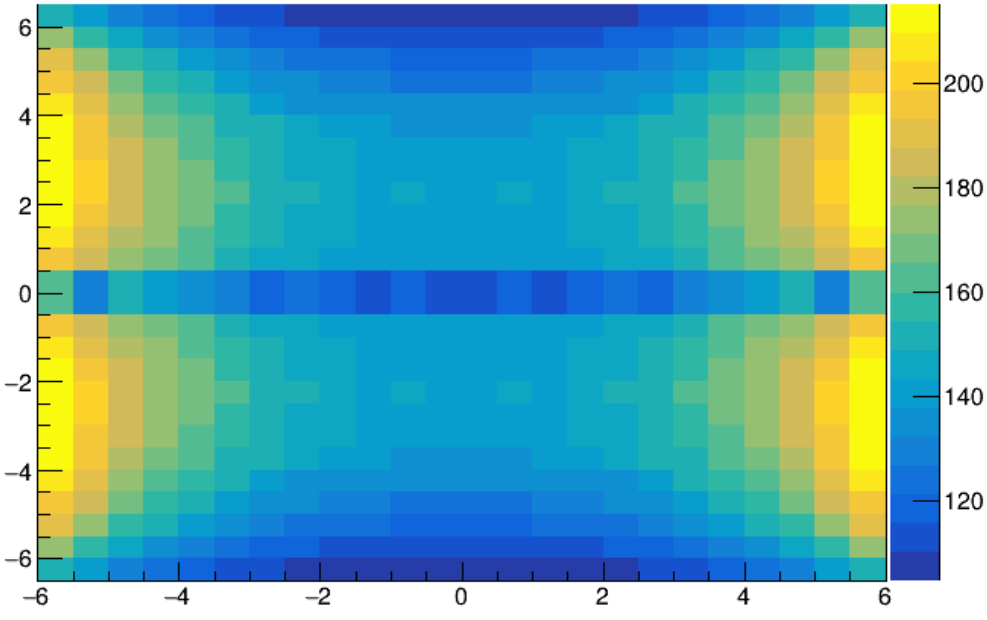
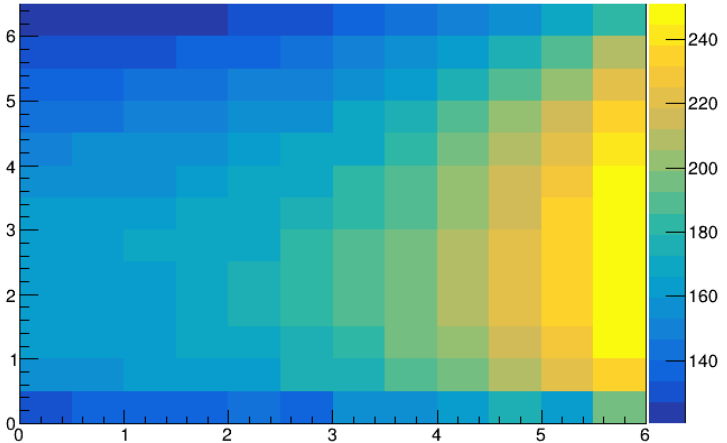


LY_{LAr} component

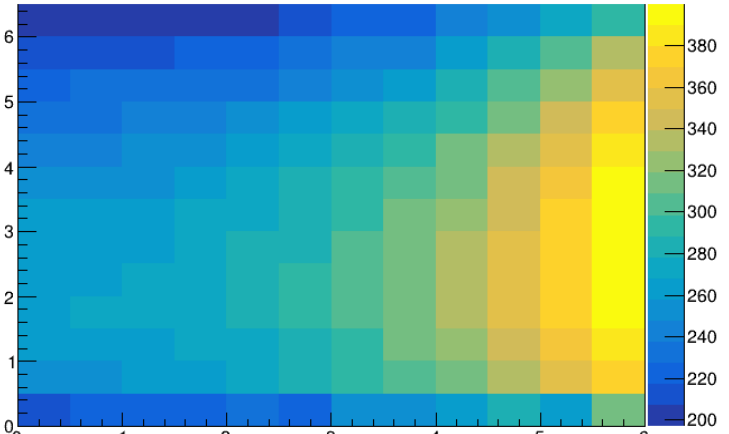


LY_{Xe} component

LY_{Xe} [#pe/MeV]



No backward emission

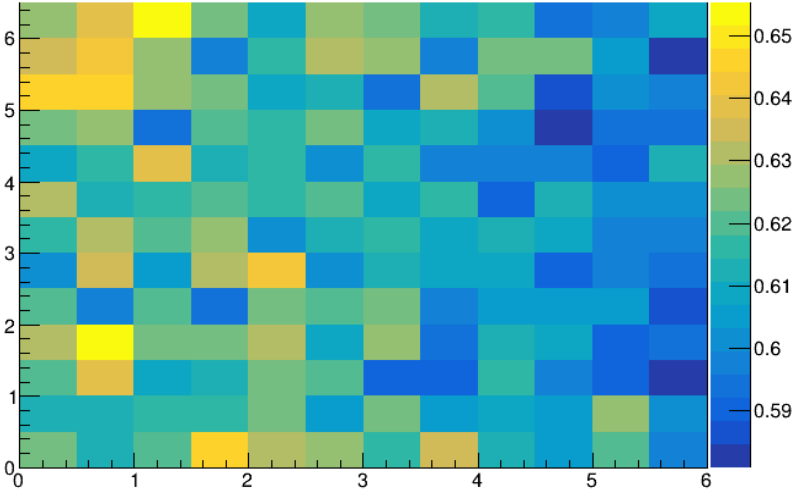


Including backward emission

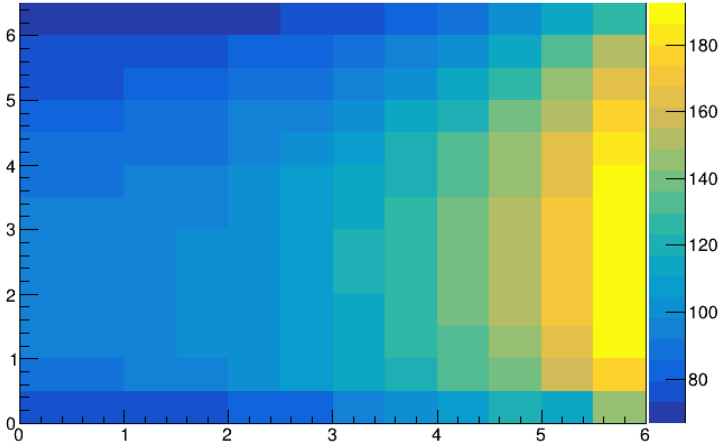
- Xe doping light yield contribution increase due to backward ptp emissions

  Increase: $(LY_{Xe}^{ptp} / LY_{Xe}^{no\ ptp}) - 1$

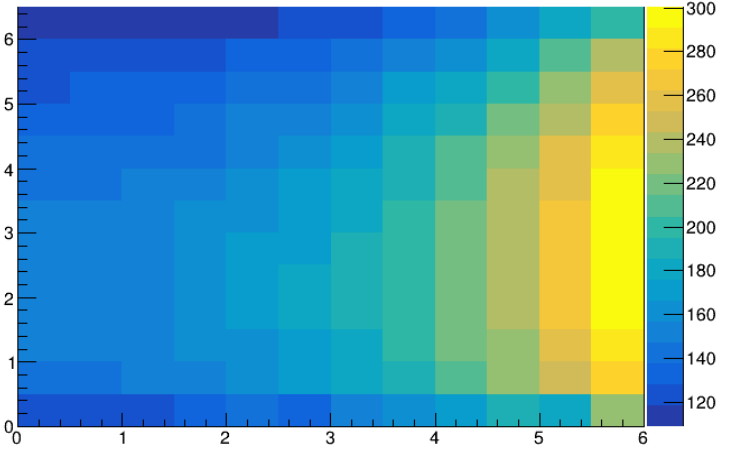
- Percentage >60 %
- Higher impact noticed closer to the lower LY region



LY_{total} [#pe/MeV]



No backward emission

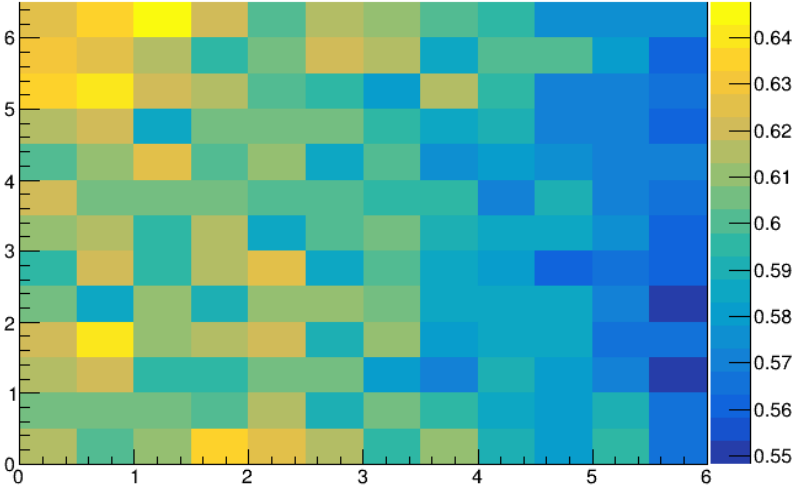


Including backward emission

- Total light yield increase due to backward ptp emissions
  $LY_{total} = 0.31\ LY_{LAr} + 0.53\ LY_{Xe}$

  Increase: $(LY_{total}^{ptp} / LY_{total}^{no\ ptp}) - 1$

- Percentage ~60 %



Conclusions

- Fairly complete standalone simulation implemented
- Estimates indicate high light yield:
  - Xenon scintillation emission characteristics
  - Combination of large PDS coverage and pTP emissions into cryostat
- Next studies:
  - Resolution on deposited energy, position, timing and so
  - Early background and physics based analysis