Characterization of The Light Response of the Xenon-10 Dark Matter Detector

Roman Gomez

Rice University

Xenon Collaboration

A DOE and NSF Funded Project

Introduction

♣Xenon Scintillation

•Vacuum UV wavelength centered at ~178 nm

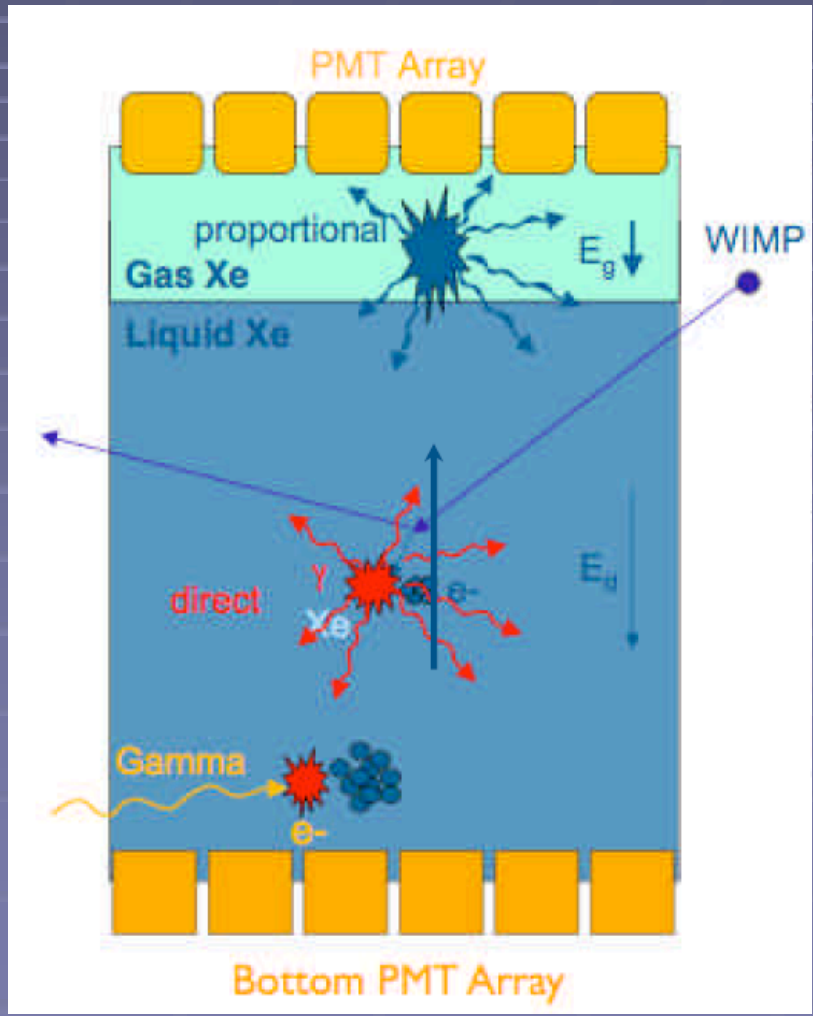
•S1- Primary Scintillation Signal occurs in Liquid Phase

•S2- Proportional Scintillation In Gas Phase

♣Data Comparison

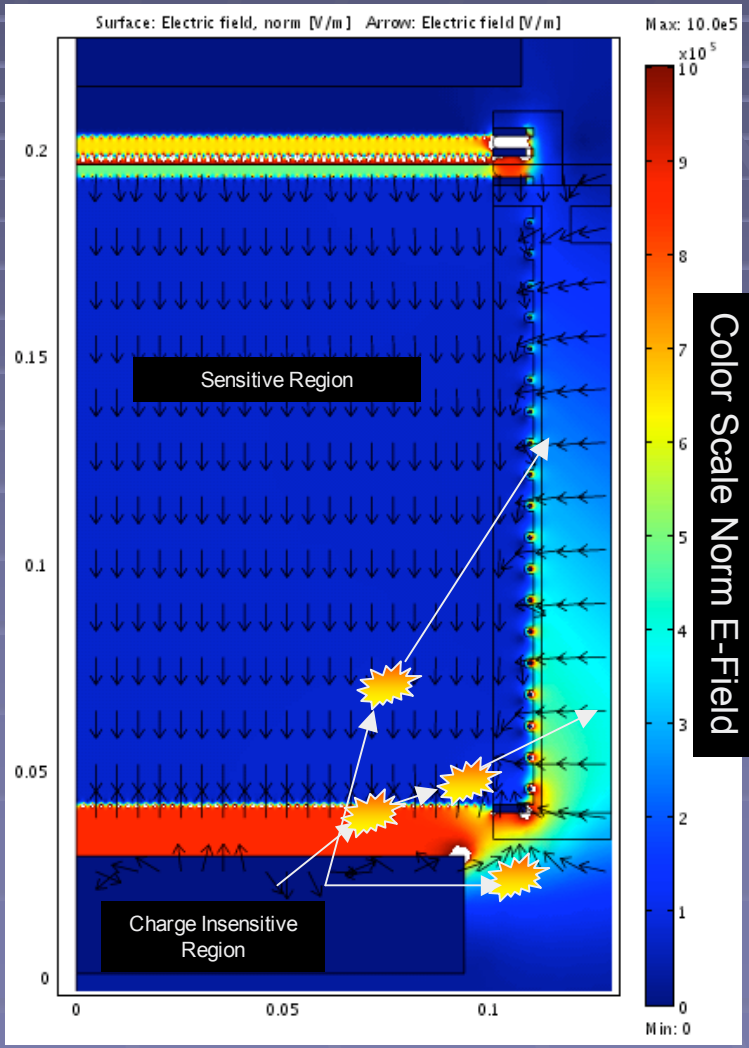
•Activated Xenon 160 keV

•Isotropic Distribution of Events

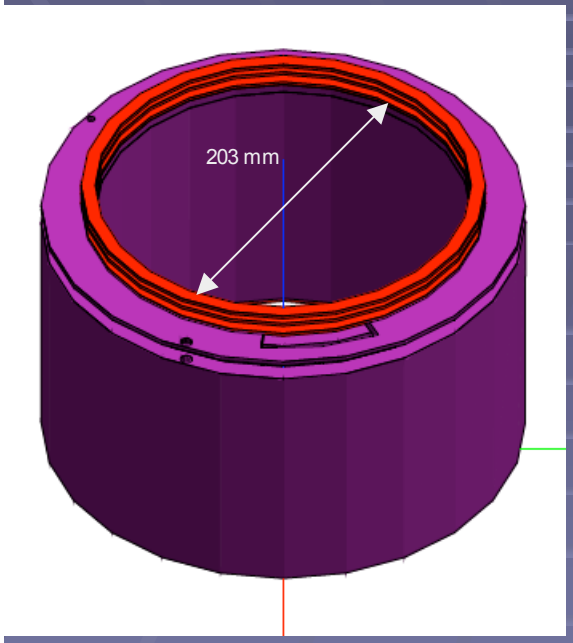


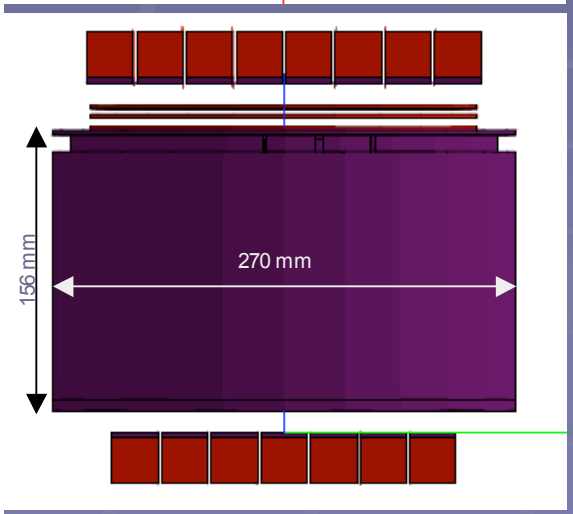
Motivations

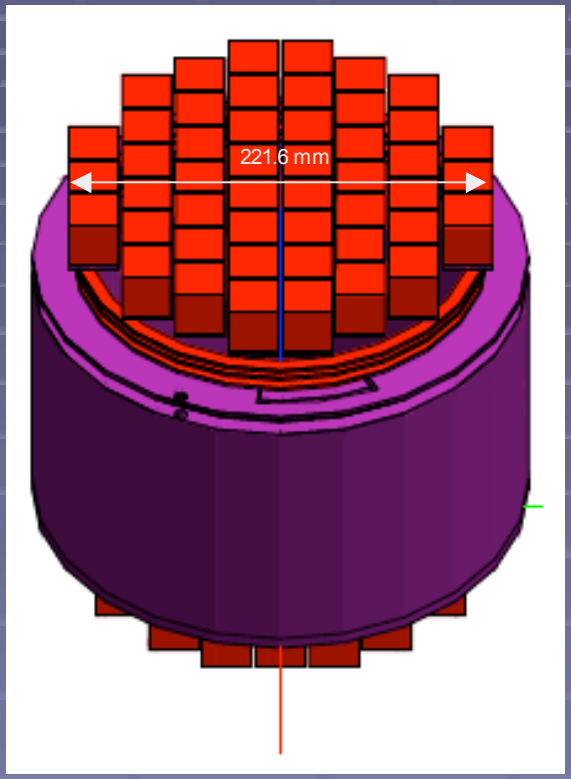
- Geant4 Monte Carlo Simulations Currently deal with Position Reconstruction using Proportional Scintillation Signals.
- S1 Collection Efficiency in the Sensitive Region.
- Understand Unusual Events in Sensitive Volume and Signal production in Charge insensitive Region.
- Improvement Possibilities for Upgrade to detector.



Simulation Geometry and Procedure

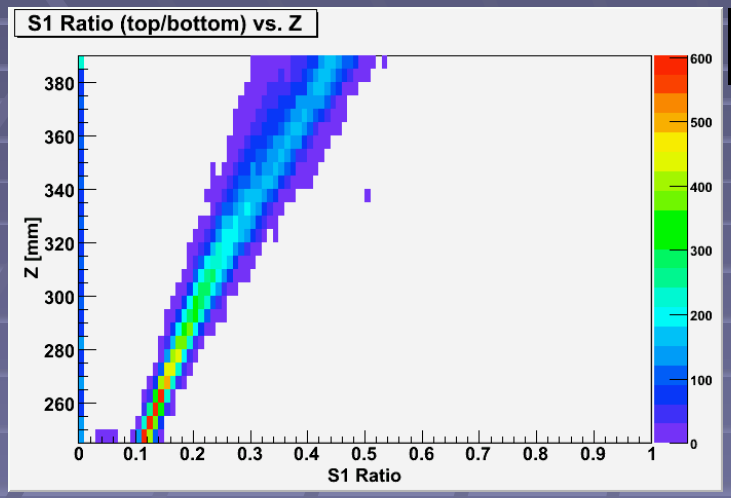




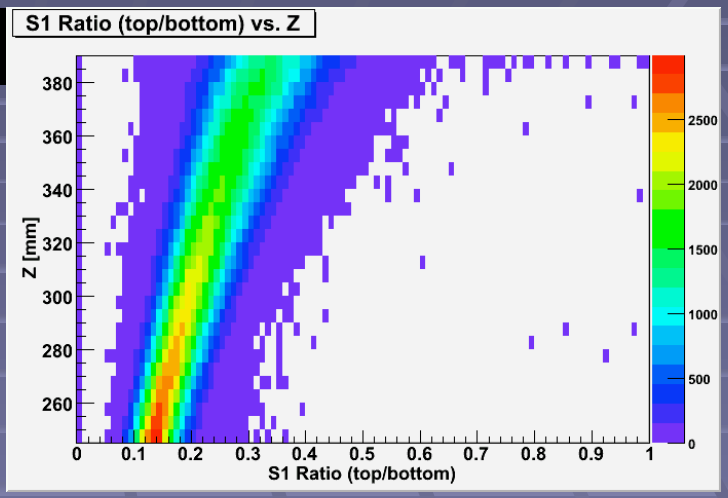


- 10 keV Alpha particles
- 5 mm steps in x,y,z
- ~10000 photons at each point
- Charge Sensitive and Insensitive Regions

Simulations Compared to Data: Sensitive Region: Light Response

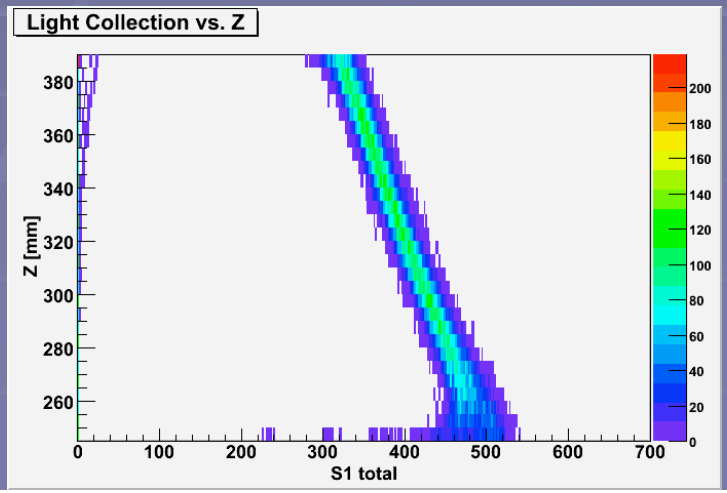


S1 Ratio vs. Z



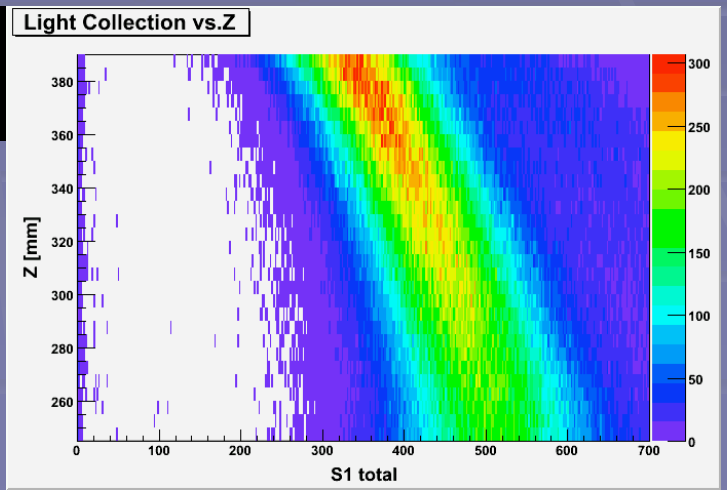
Geant4 Simulation

Activated Xenon

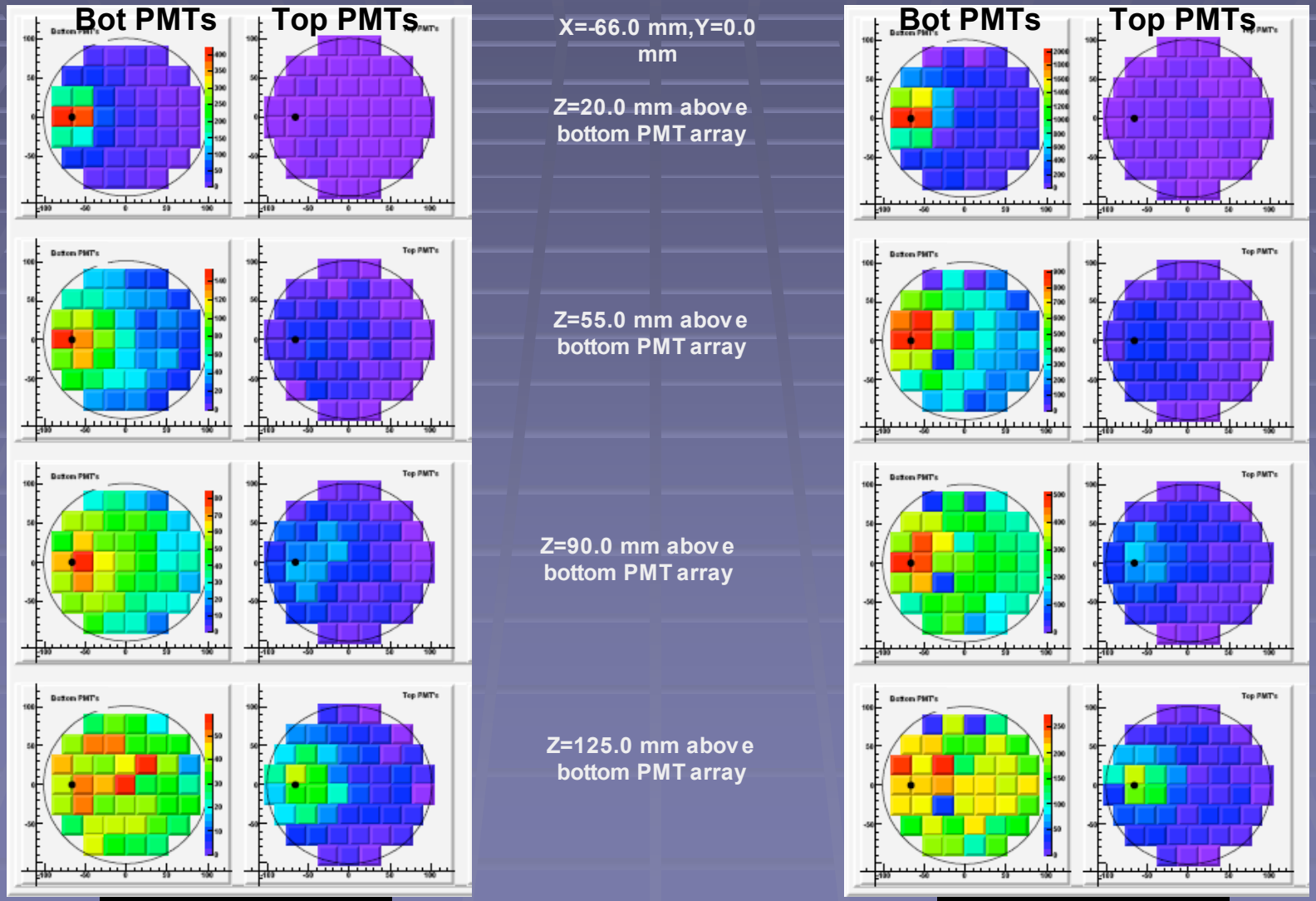


Light Collection vs. Z

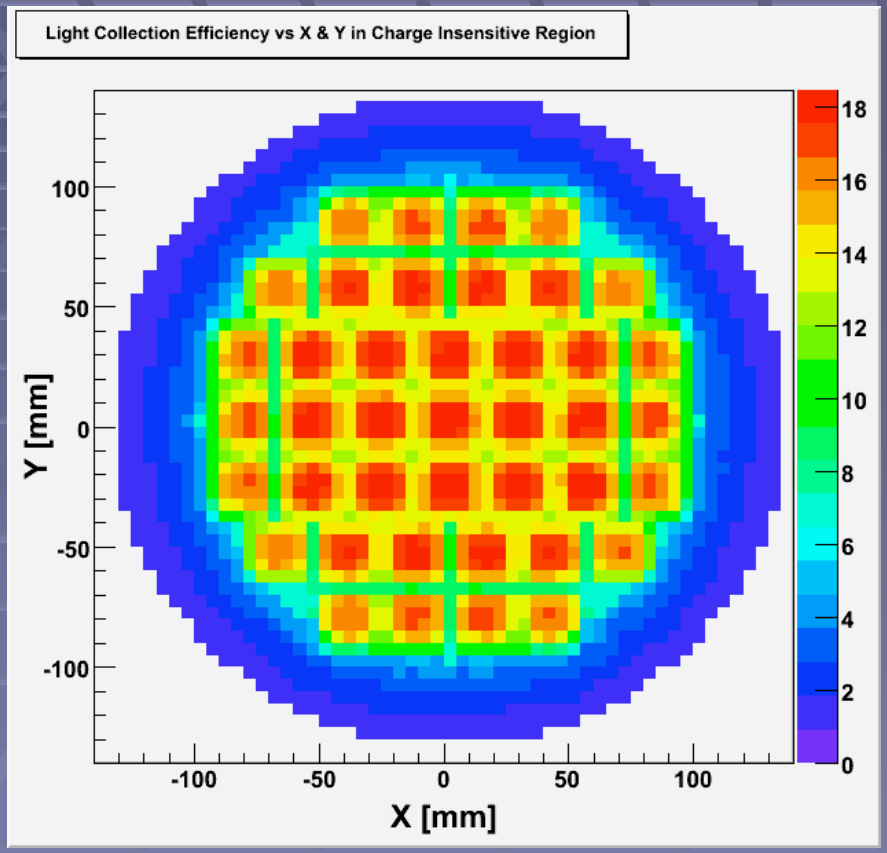
160e3(.22/21.3)*(S1tot/10000)

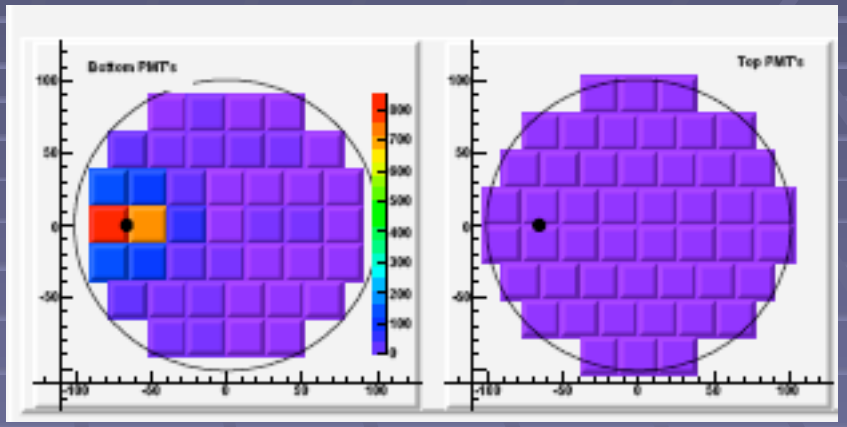


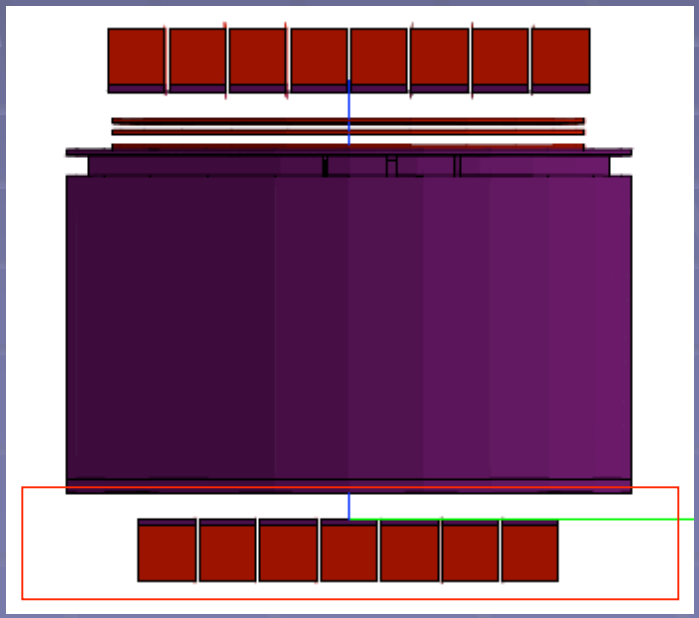
Simulations Compared to Data: PMT Patterns



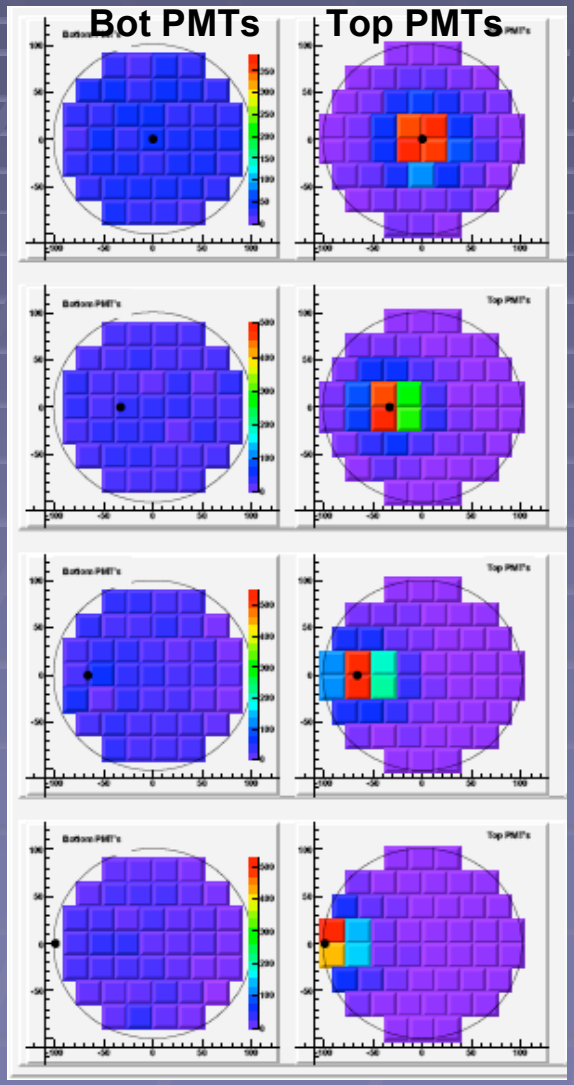
Simulations: Charge Insensitive Region







Comparison S2 Patterns: Simulation and Data



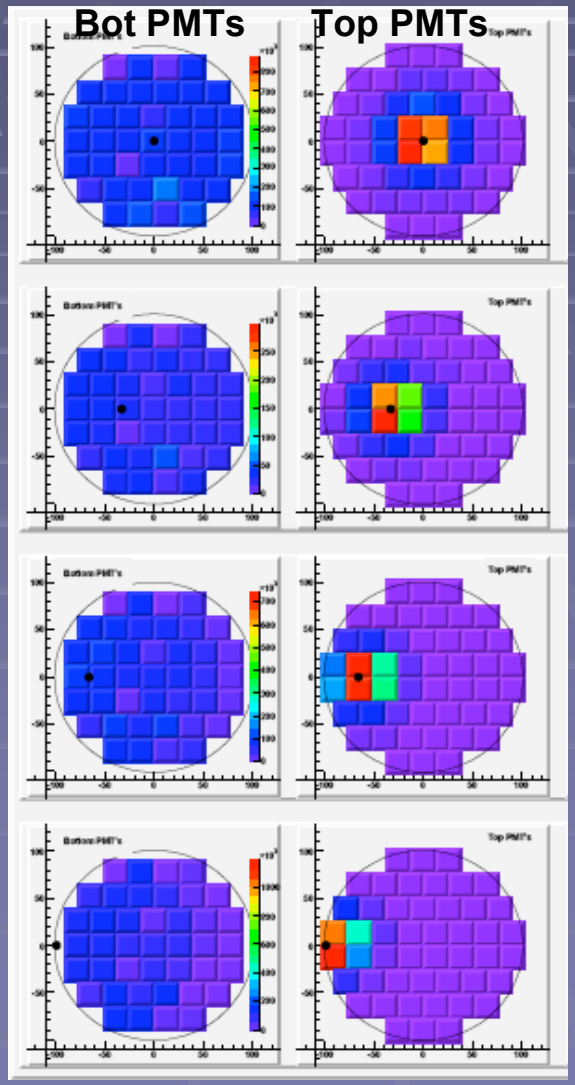
S2 Map (simulation)

X=0.0 mm,Y=0.0 mm

X=33.0 mm,Y=0.0 mm

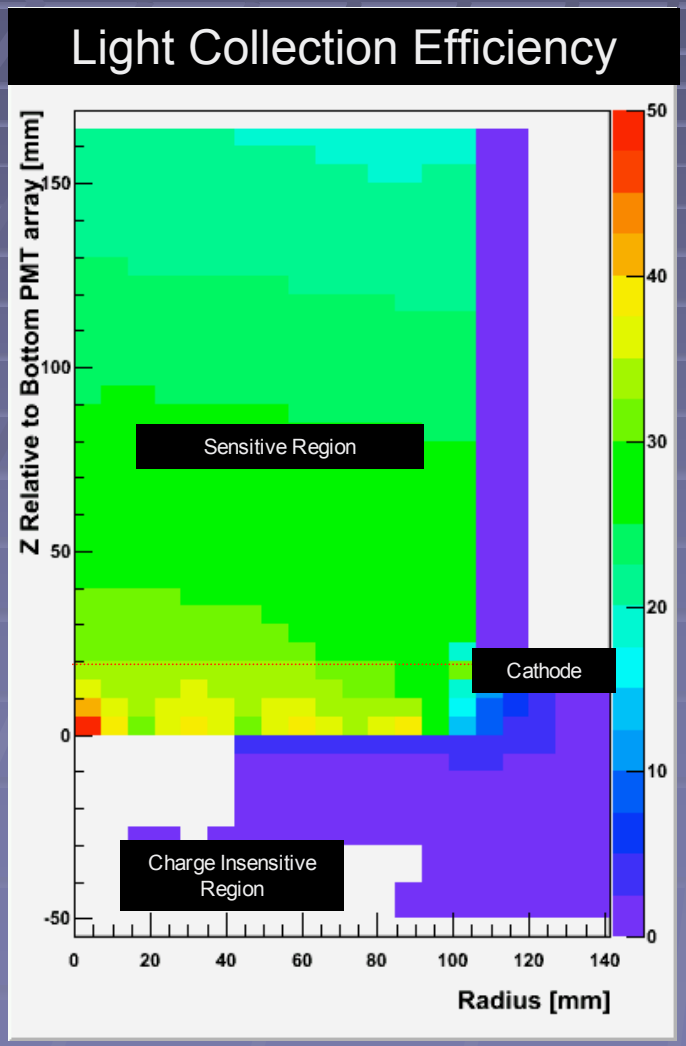
X=66.0 mm,Y=0.0 mm

X=99.0 mm,Y=0.0 mm



Activated Xenon

Summary

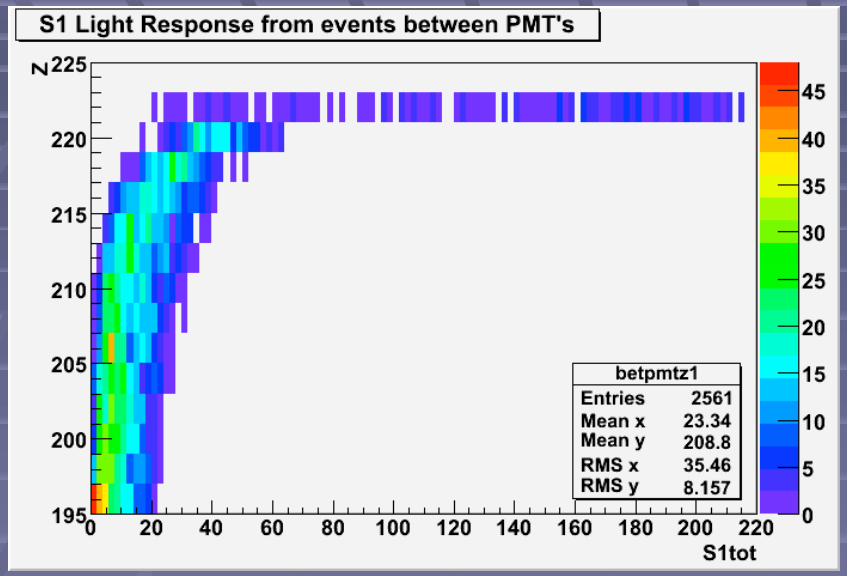


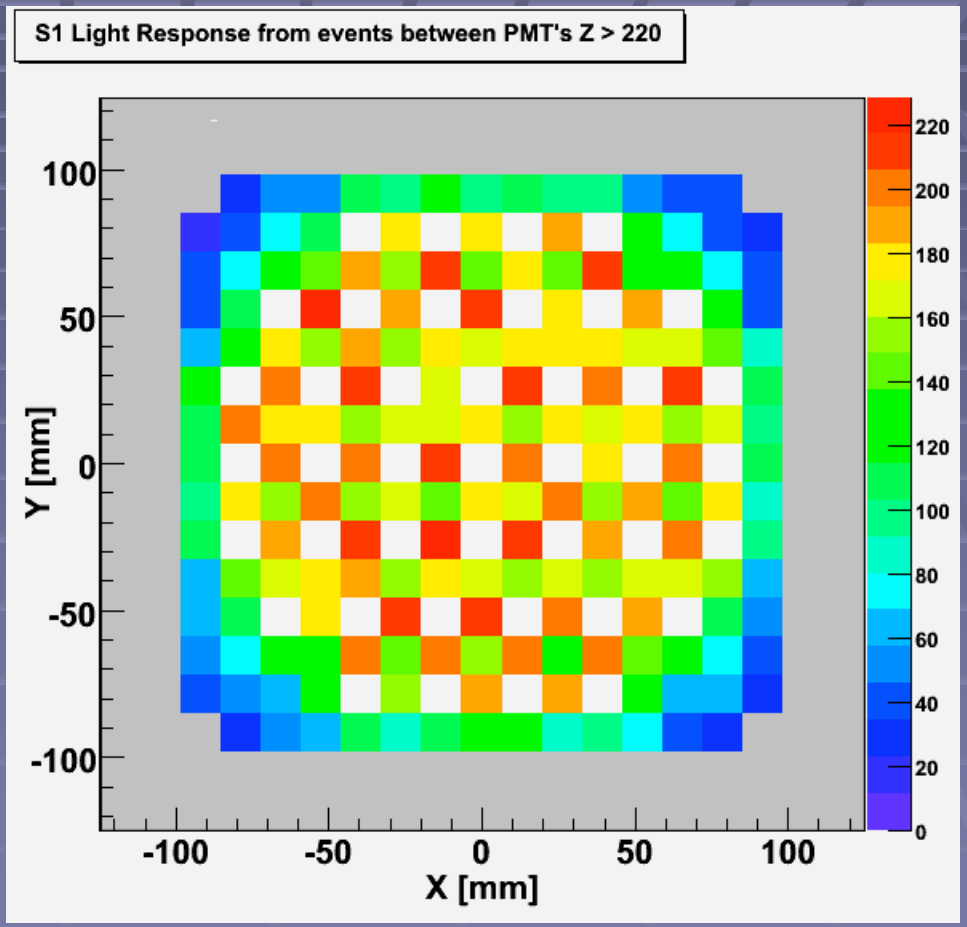
- Simulations and data show similarities in profiles
- Need to understand what causes the “turning over” effect at higher Z values
- Good concordance between Hit patterns for simulation and data

Acknowledgements

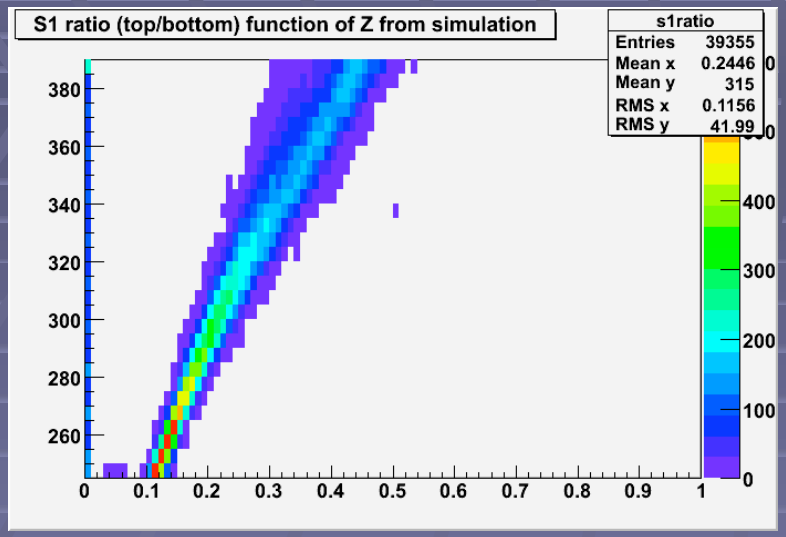
- XENON Collaboration
- Guillaume Plante, Angel Manzur, Kaixuan Ni, Masaki Yamashita
- Uwe Oberlack

Final Note: Events Between PMT's

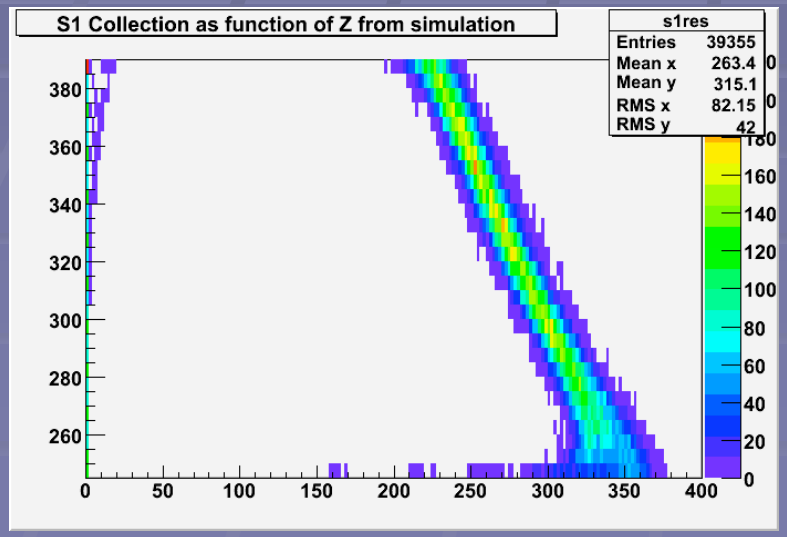


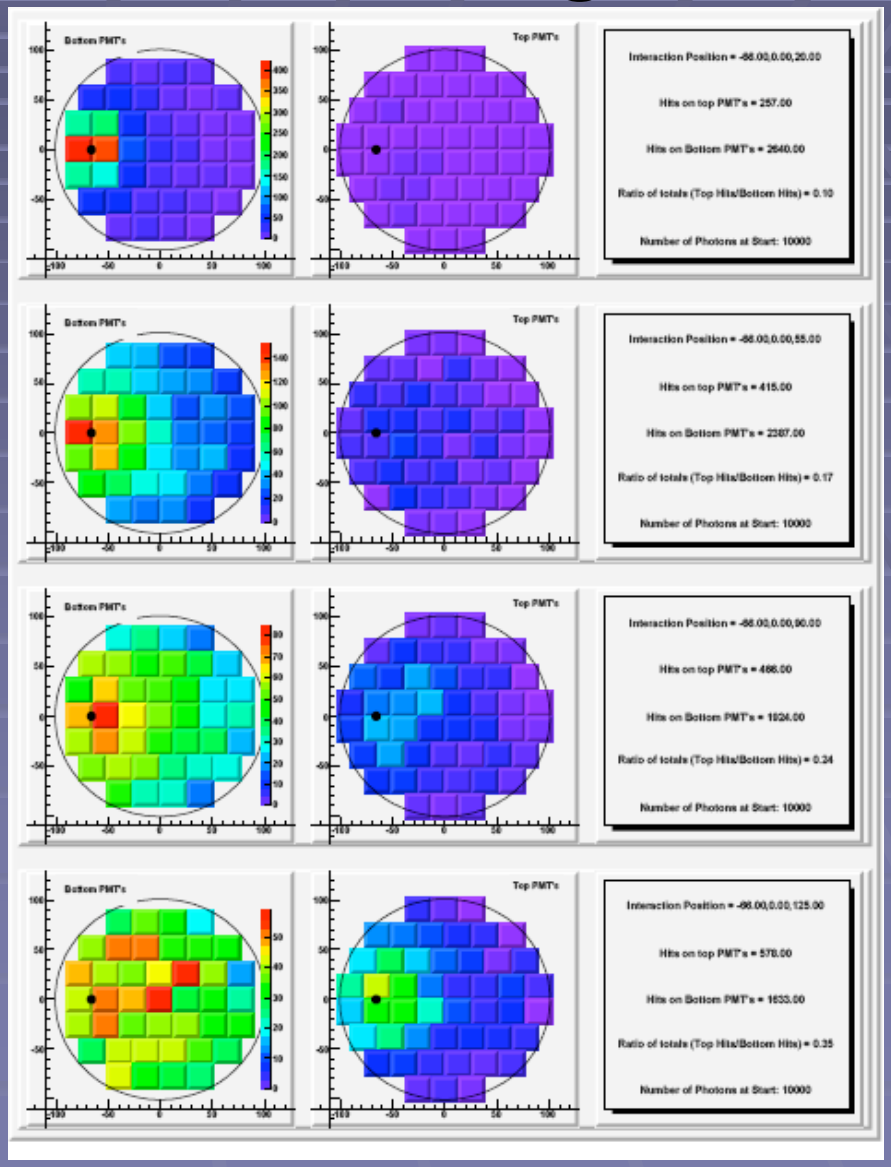


Simulations: Sensitive Region



Geant4 Simulation





Monte Carlo Process

- 10 KeV Alpha Particles Released at 5 mm intervals in x,y,z.
- Scintillation Yield In liquid Xenon Set to 1e6 photons/MeV~10000 photons at each point.
- Probe both Reverse Field and Sensitive Regions.