MiniCLEAN surface backgrounds

Boqian Wang, Richard Schnee
Syracuse University
April APS Meeting 2011

DEAP/CLEAN Collaborators

University of Alberta
B. Beltran, P. Gorel, A. Hallin, S. Liu, C. Ng, K.S. Olsen, J. Soukup

Boston University
D. Gastler, E. Kearns

Carleton University
M. Bowcock, K. Graham, P. Gravelle, C. Oullet

Harvard University
J. Doyle

Los Alamos National Laboratory
R. Bourque, V.M. Gehman, J. Griego, R. Henning-Yeomans, A. Hime, F. Lopez, J. Oertel, K. Rielage, L. Rodriguez, S. Seibert, D. Steele

Massachusetts Institute of Technology
L. Feng, J.A. Formaggio, S. Jaditz, J. Kelsey, J. Monroe, K. Palladino

National Institute Standards and Technology
K. Coakley

University of New Mexico
M. Bodmer, F. Giuliani, M. Gold, D. Loomba, J. Matthews, P. Palni

University of North Carolina/TUNL
M. Akashi-Ronquest, R. Henning

University of Pennsylvania
T. Caldwell, J.R. Klein, A. Mastbaum, G.D. Orebi Gann

Queen's University
M. Boulay, B. Cai, M. Chen, S. Florian, R. Gagnon, V. Golovko, P. Harvey, M. Kuzniak, J. Lidgard, A. McDonald, T. Noble, P. Pasuthip, C. Pollman, W. Rau, P. Skensved, T. Sonley, M. Ward

SNOLAB Institute
M. Batygov, F.A. Duncan, I. Lawson, O. Li, P. Liimatainen, K. McFarlane, T. O'Malley, E. Vazquez-Jauregi

University of South Dakota
V. Guiseppe, D.-M. Mei, G. Perumpilly, C. Zhang

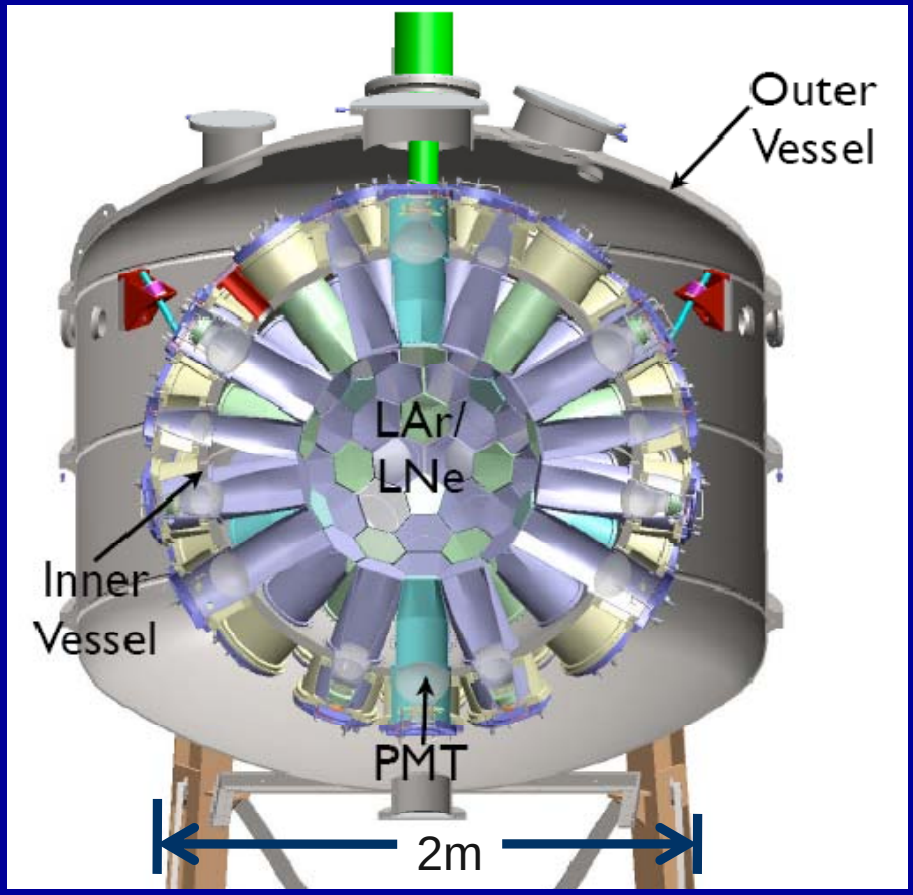
Syracuse University
M.S. Kos, R.W. Schnee, B. Wang

TRIUMF
P.-A. Amaudruz, A. Muir, F. Retiere

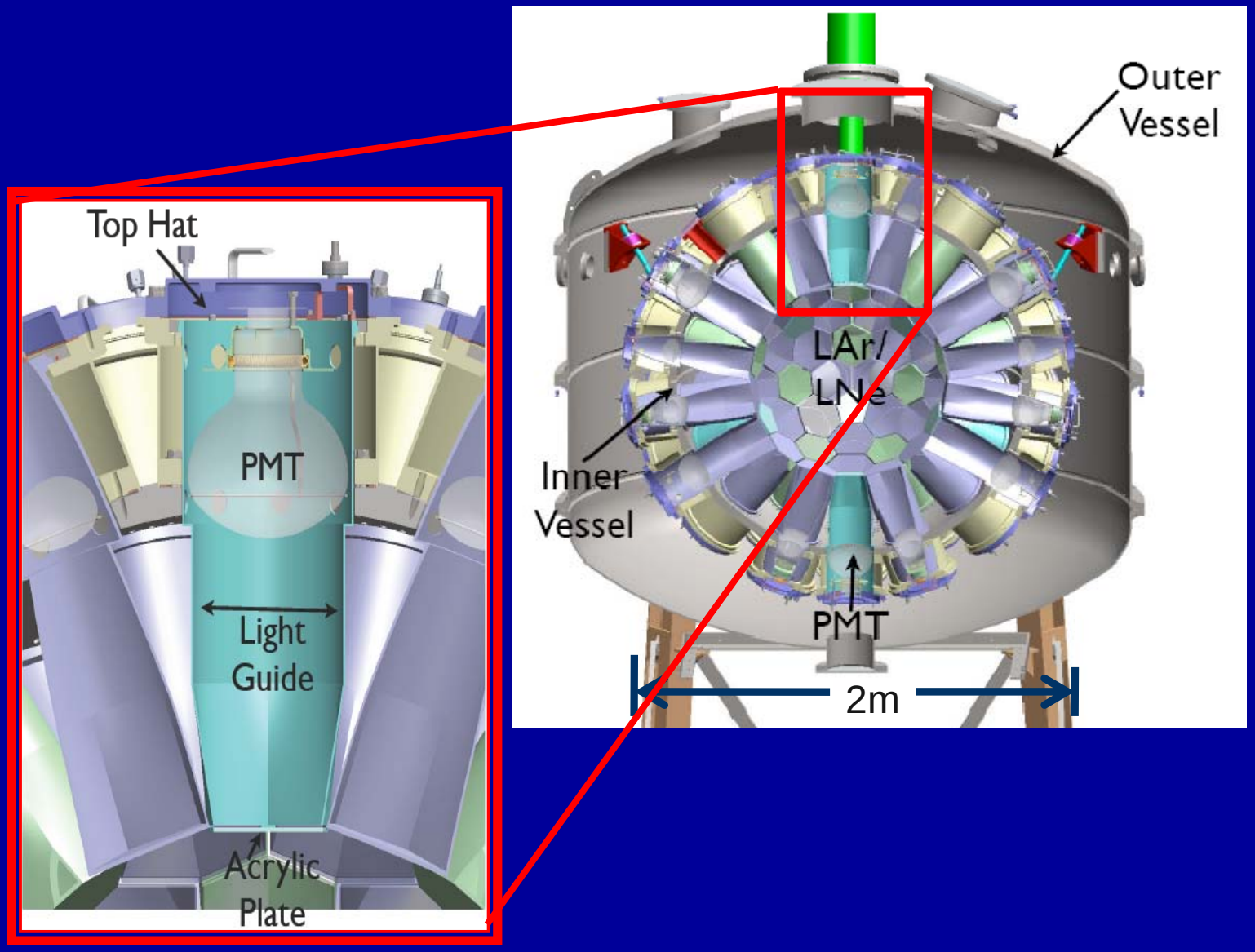
Yale University
W.H. Lippincott, D.N. McKinsey, J.A. Nikkel, Y. Shin

MiniCLEAN: dark matter detector

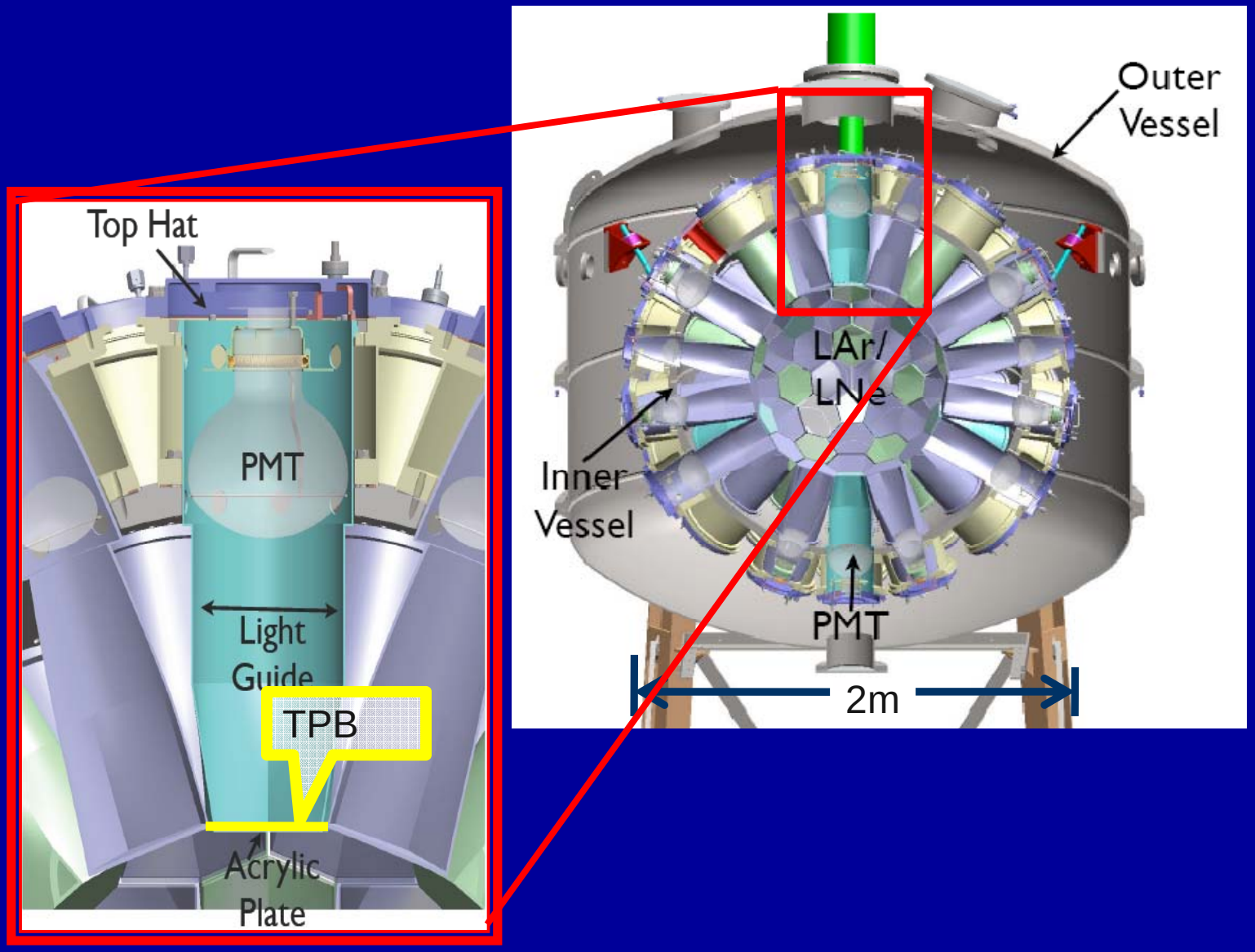
- liquid argon scintillation
- 500kg target mass
- 150kg fiducial mass
- 92 PMTs
- Start taking data at 2012
- 2000m underground SNOLAB
- O(10^{-45}cm^2)



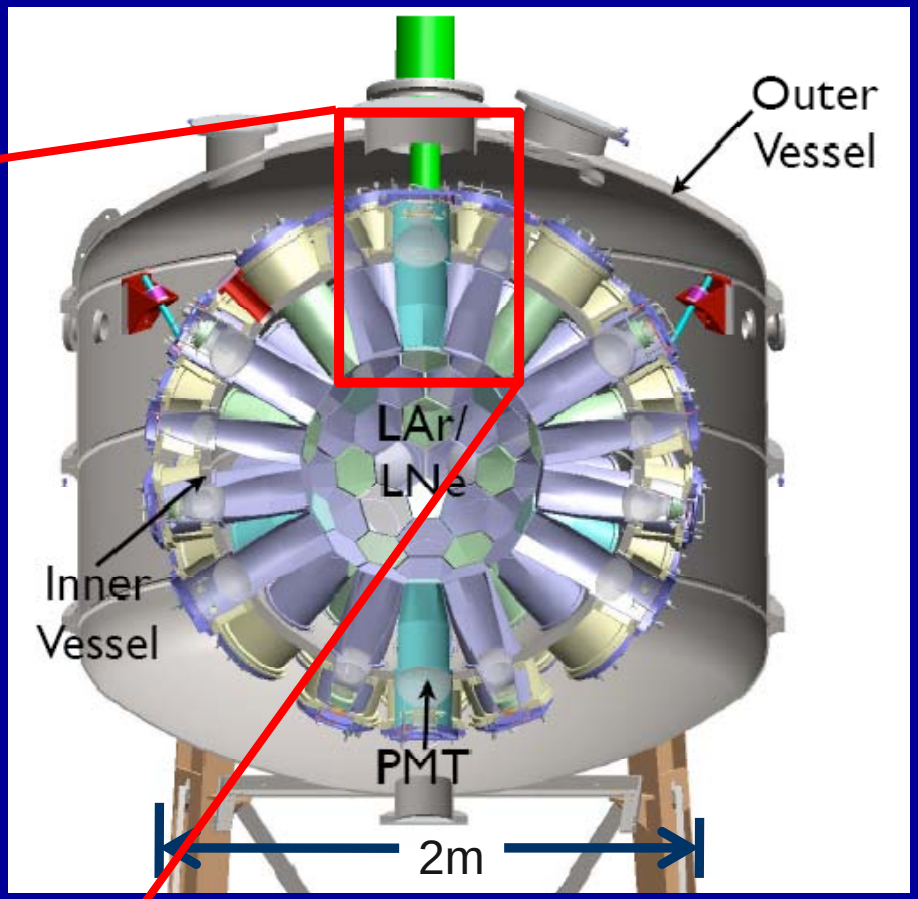
MiniCLEAN: dark matter detector

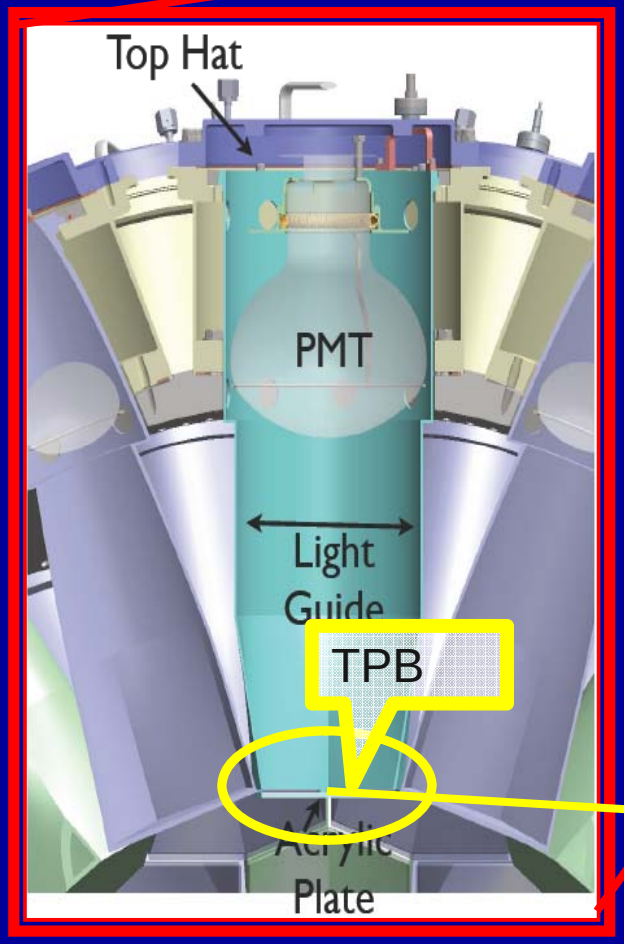


MiniCLEAN: dark matter detector



MiniCLEAN: surface alpha decay

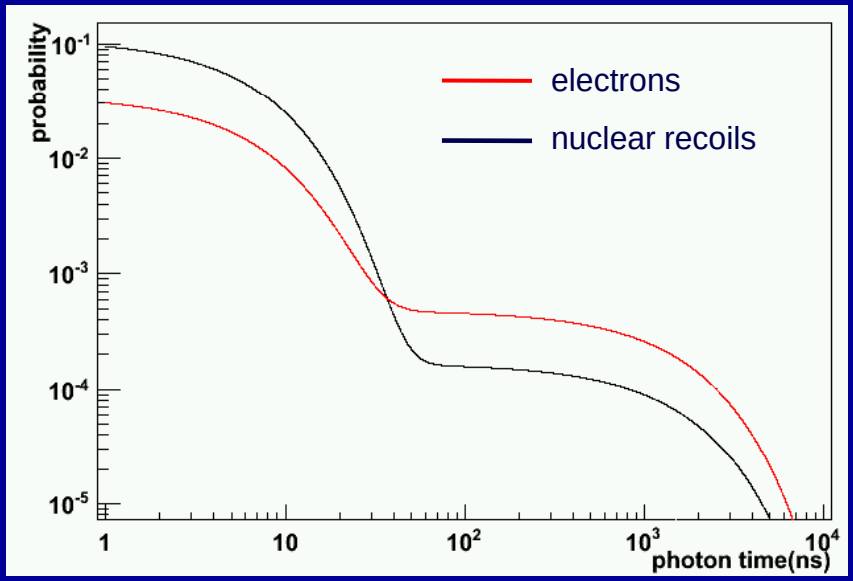




Alpha decay from ^{238}U, ^{232}Th, ^{222}Rn daughter

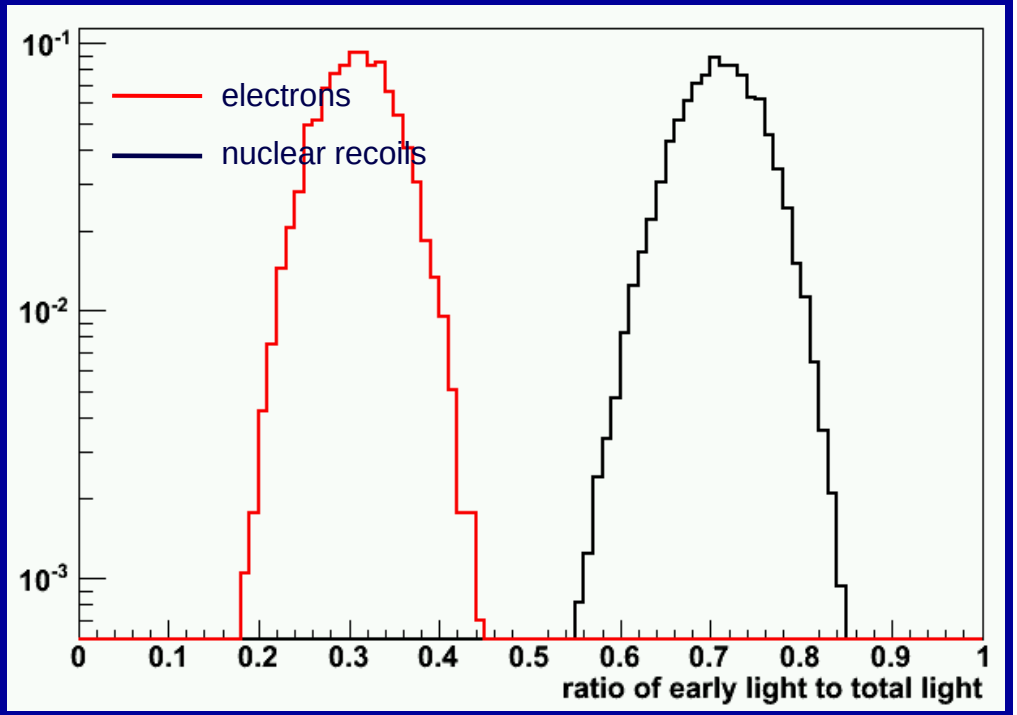
^{210}Po -> alpha(5.3Mev) + ^{206}Pb(103keV)

Pulse shape discrimination(PSD)

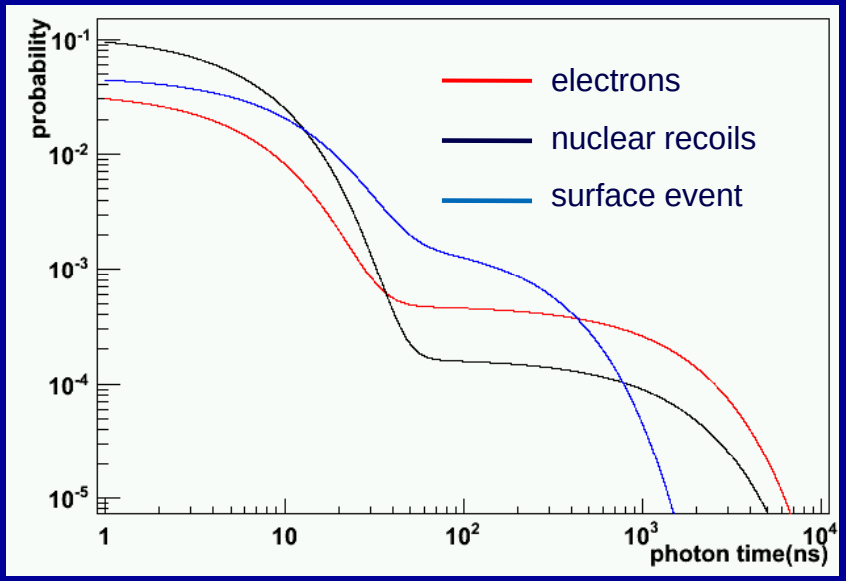


Boulay and Hime, Astropart. Phys. **25, 179 (2006)**

Fprompt: % of light detected in first 100ns



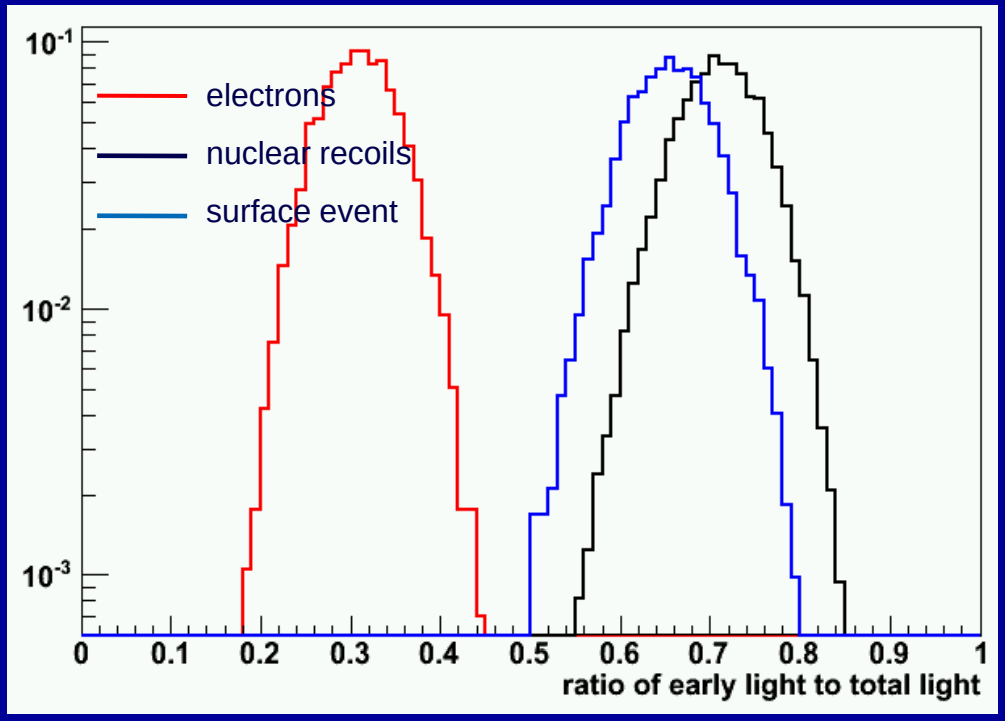
Pulse shape discrimination(PSD)



Boulay and Hime, Astropart. Phys. **25, 179 (2006)**

Pollmann, Boulay, Kuzniak arXiv:1011.1012v1

Fprompt: % of light detected in first 100ns



Ways to discriminate against surface background

1. Energy range 75-150 #PE ~20-40keVee
2. Pulse shape discrimination
3. Position reconstruction

   30% fiducial volume

Screening to ensure clean acrylic, radon construction

Screening to ensure samll plate-out on TPB-surface after detector construction

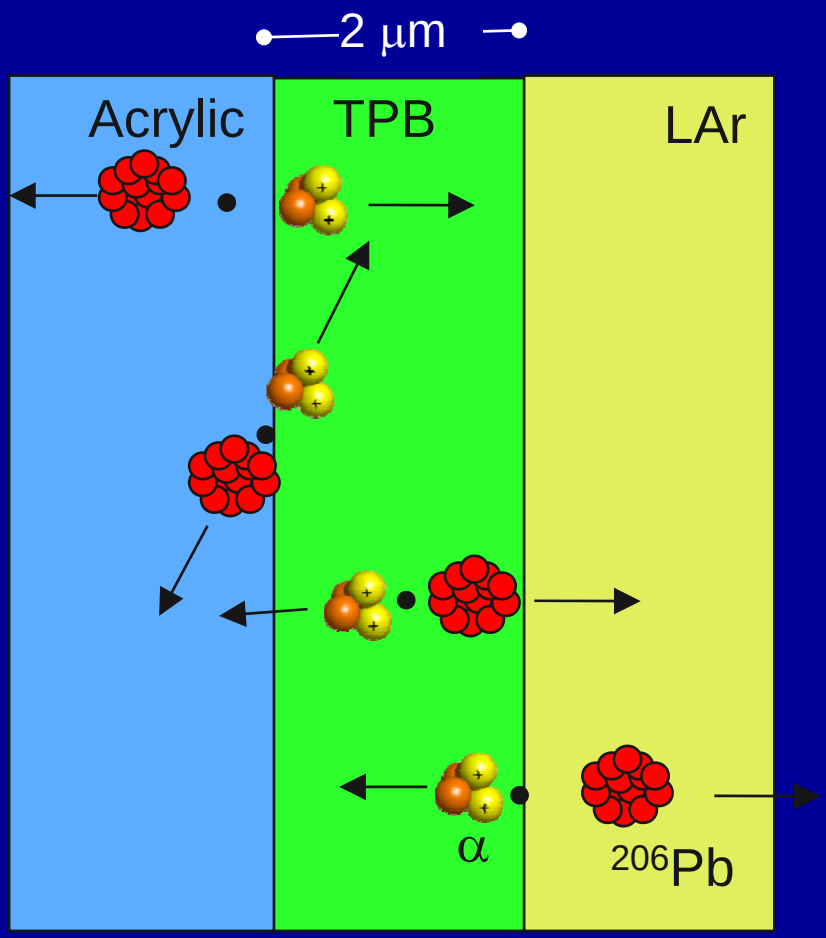
Surface alpha background

^{238}U,^{232}Th dacay in bulk of acrylic

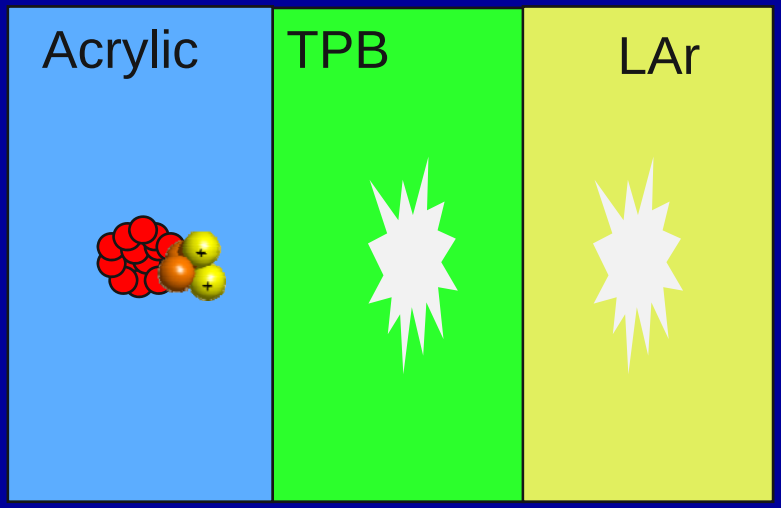
^{222}Rn daughter dacay on surface of acrylic

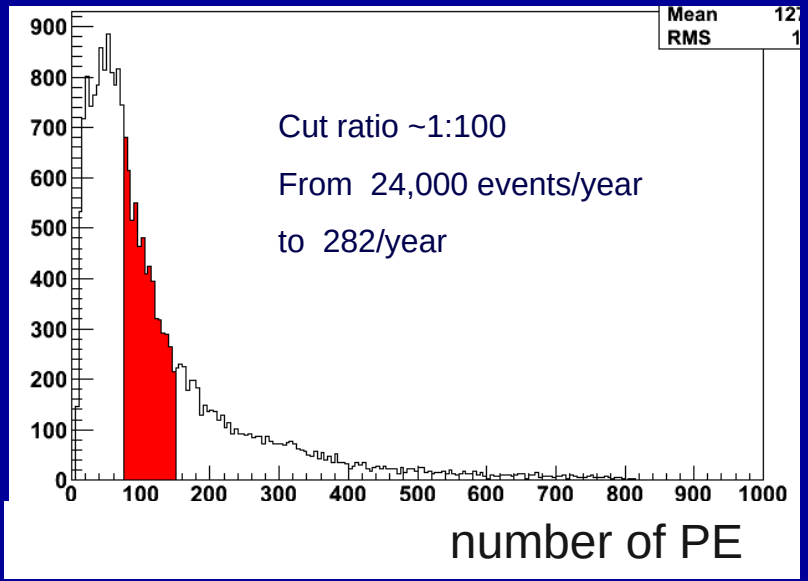
^{238}U,^{232}Th dacay in bulk of TPB

^{222}Rn daughter dacay on surface of TPB

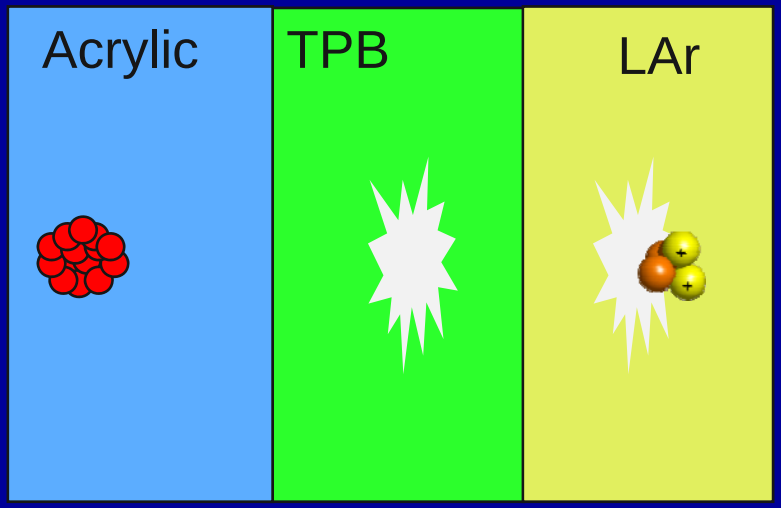


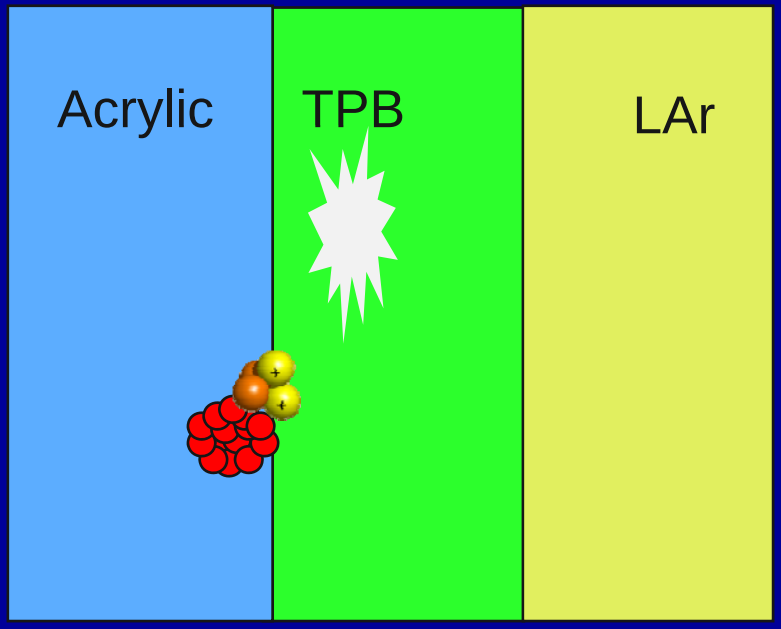
Energy range cut

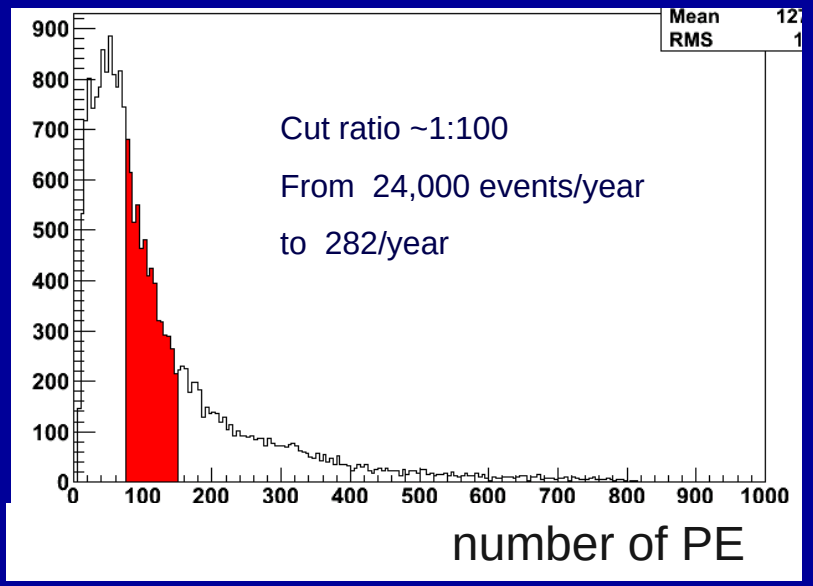


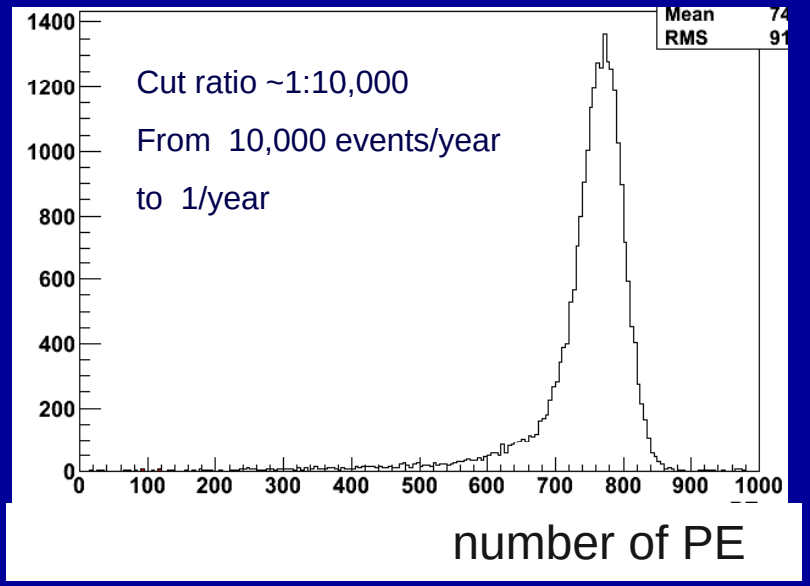


Energy range cut

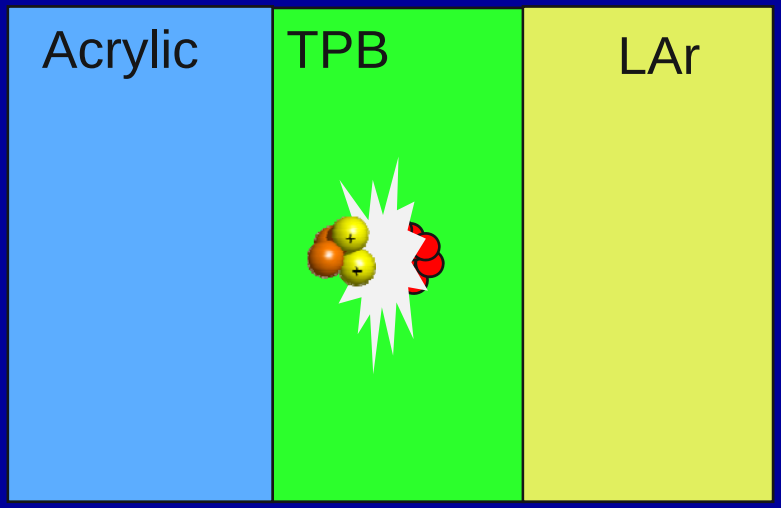


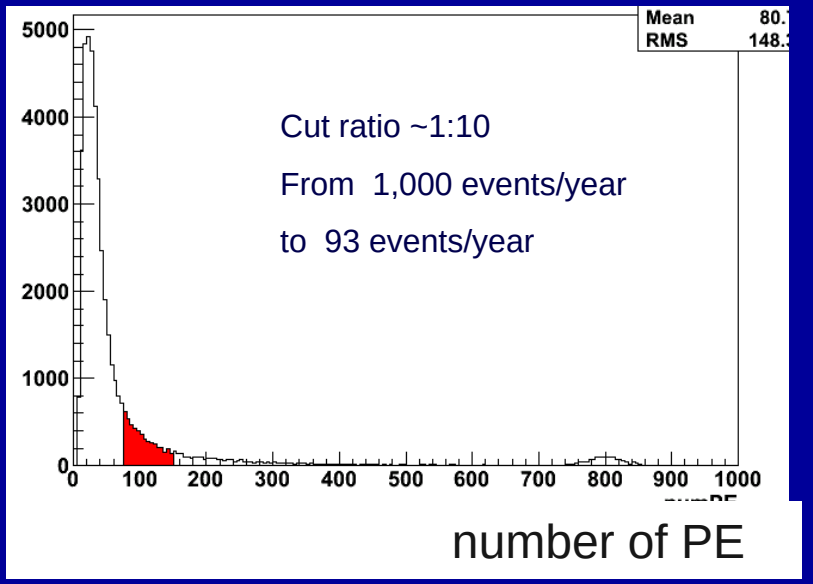




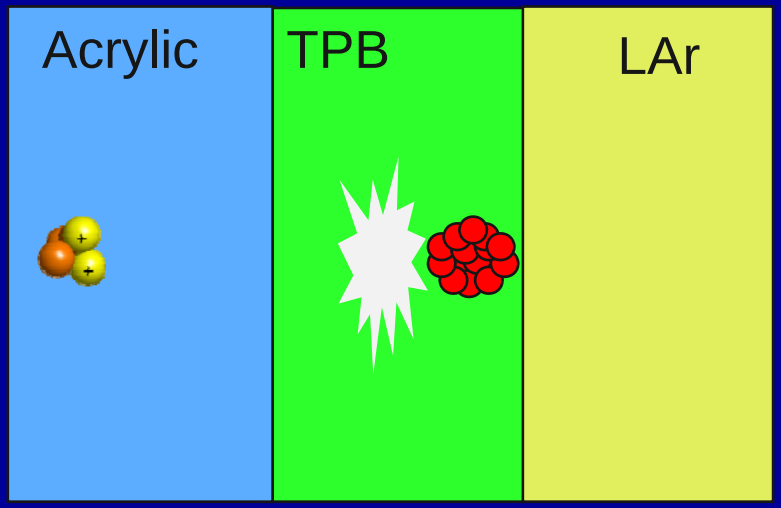


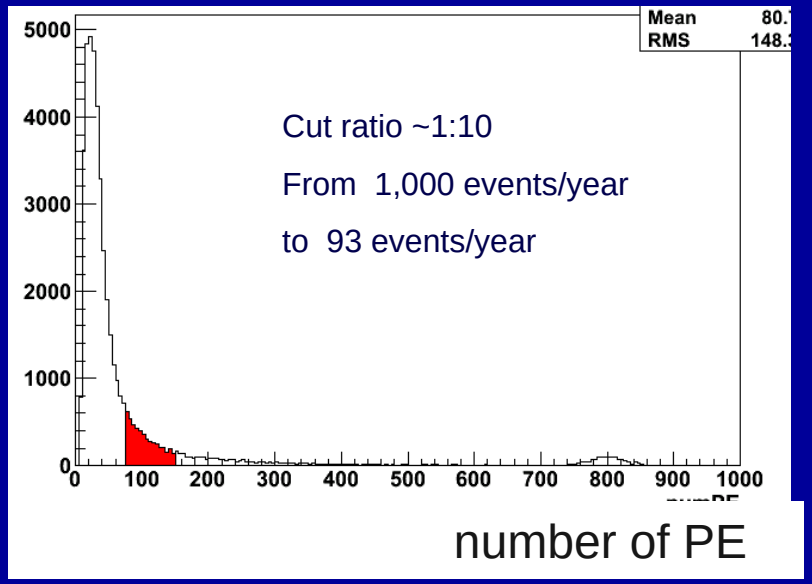
Energy range cut

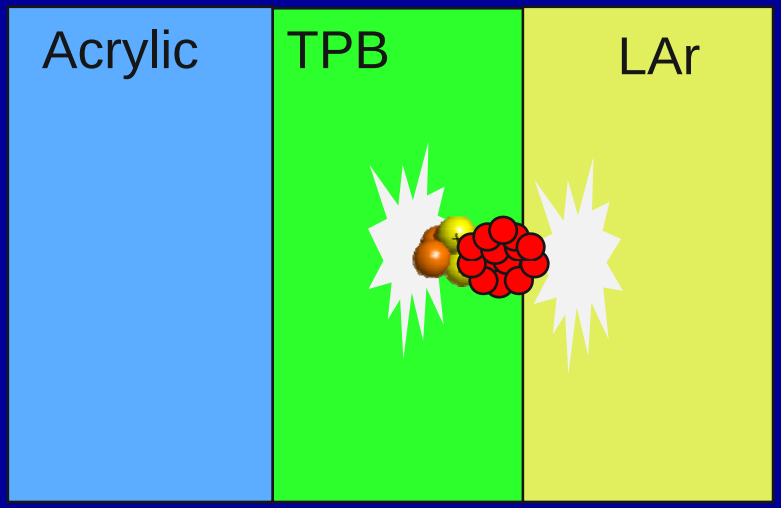


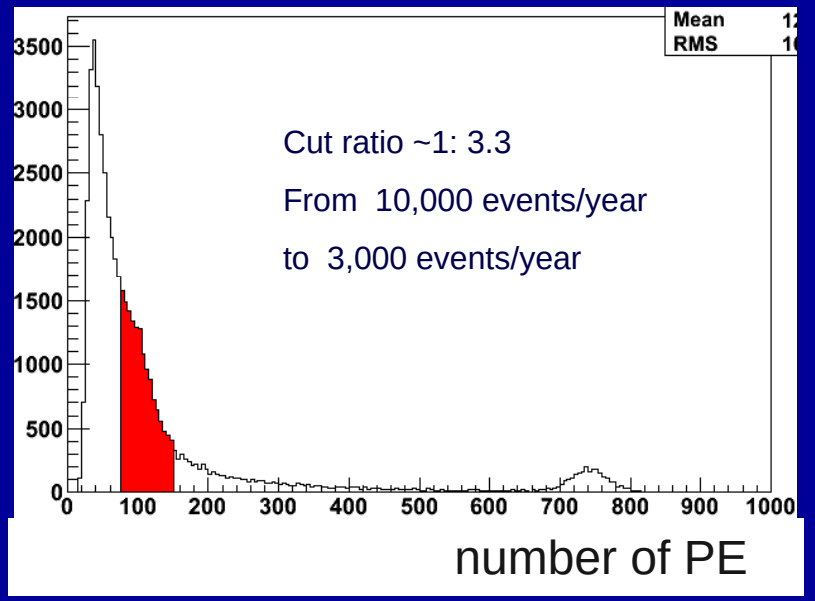


Energy range cut

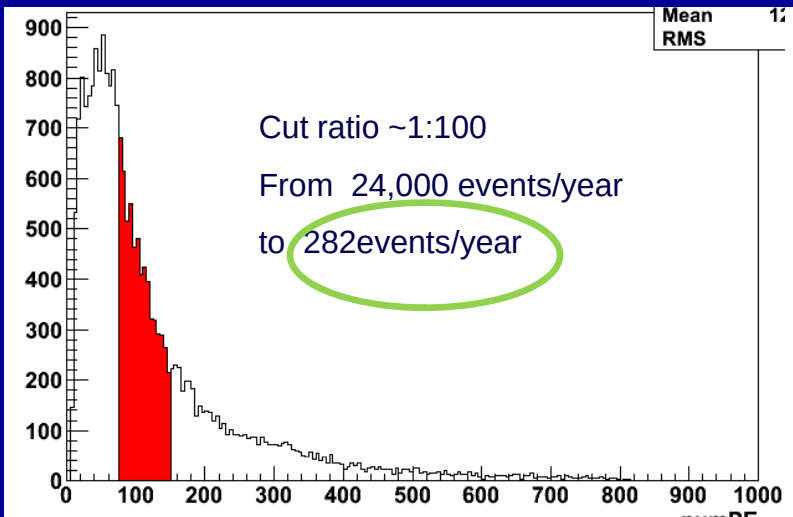


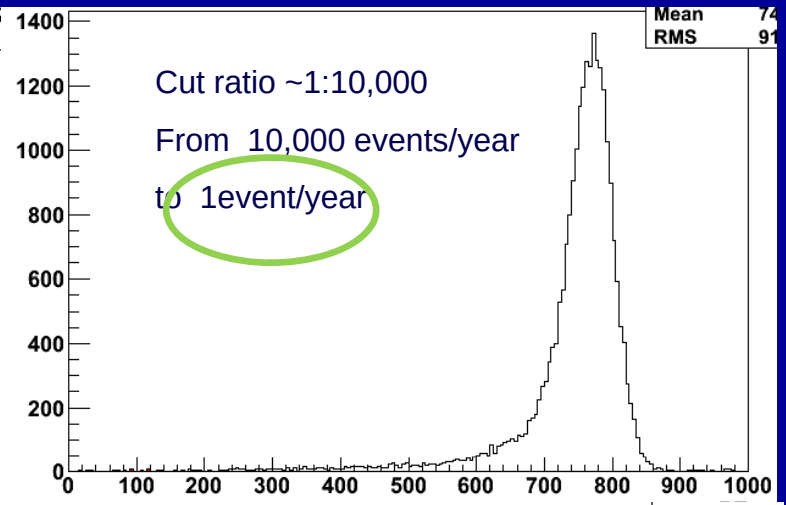


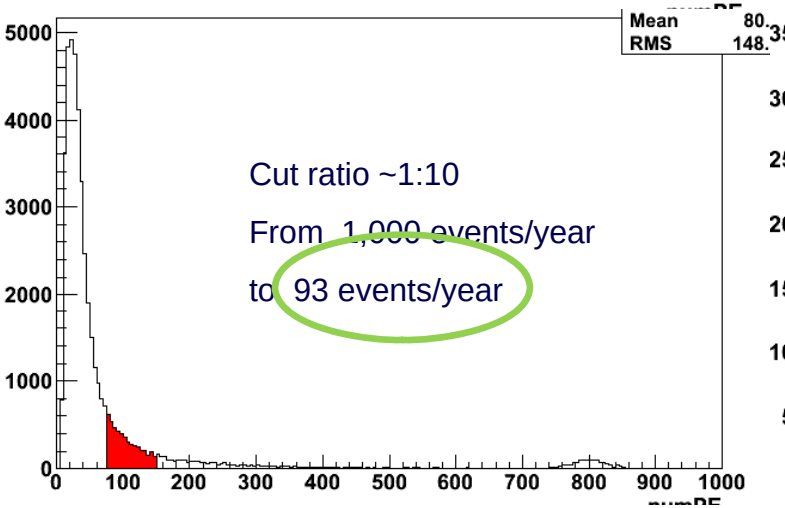


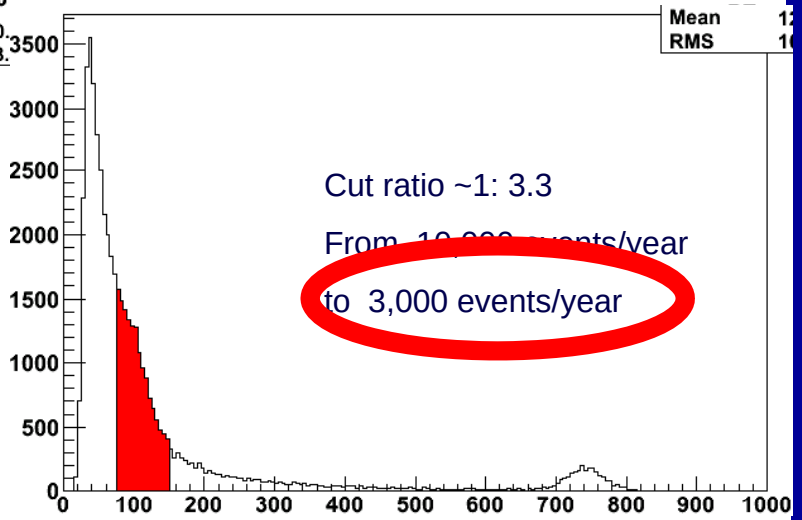


Energy range cut





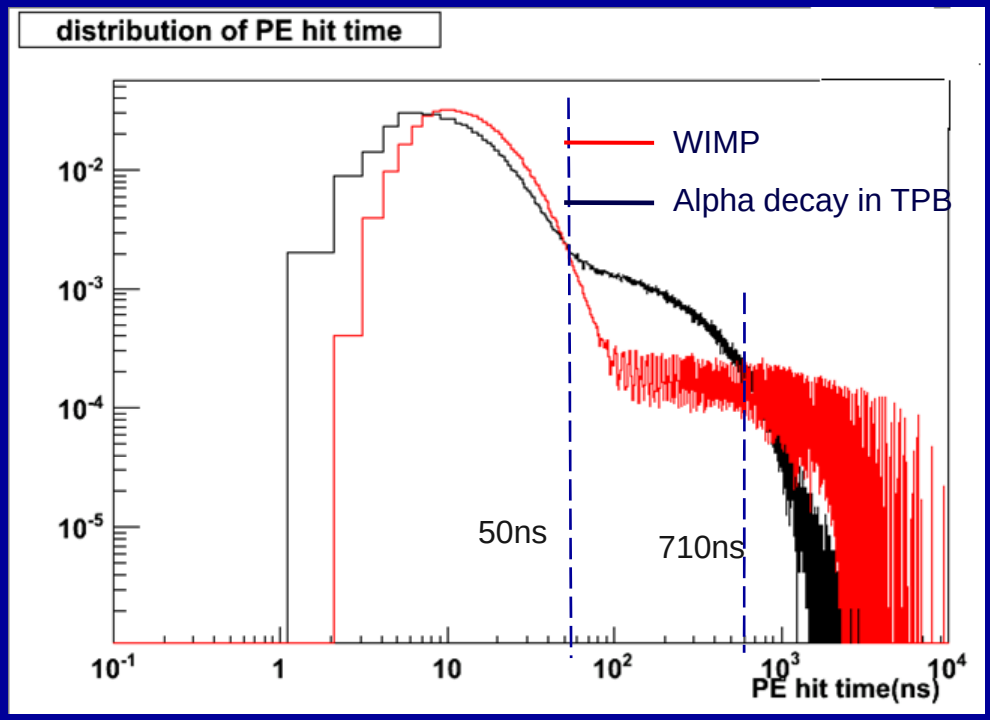




number of PE

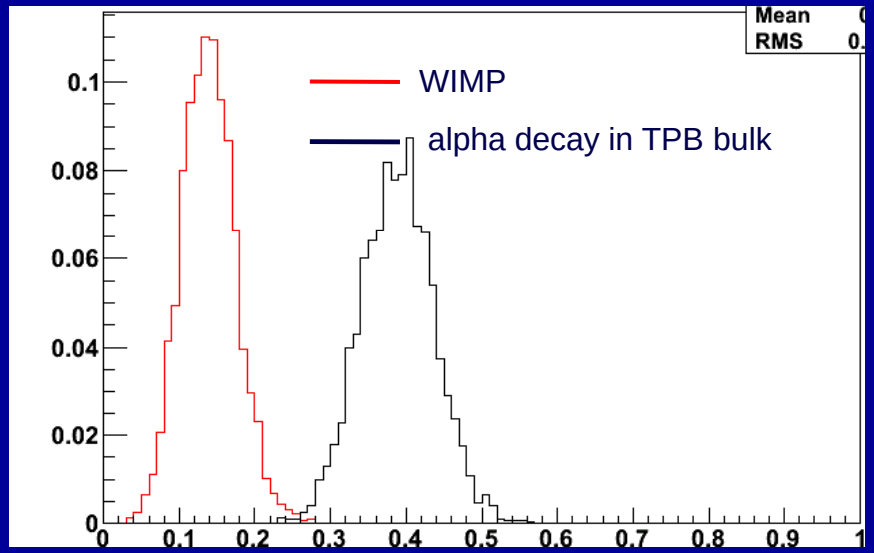
number of PE

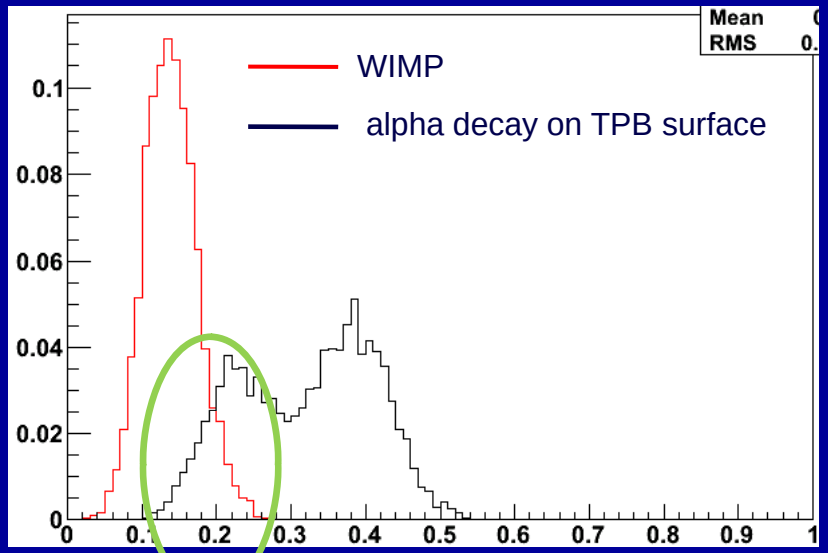
Pulse shape discrimination



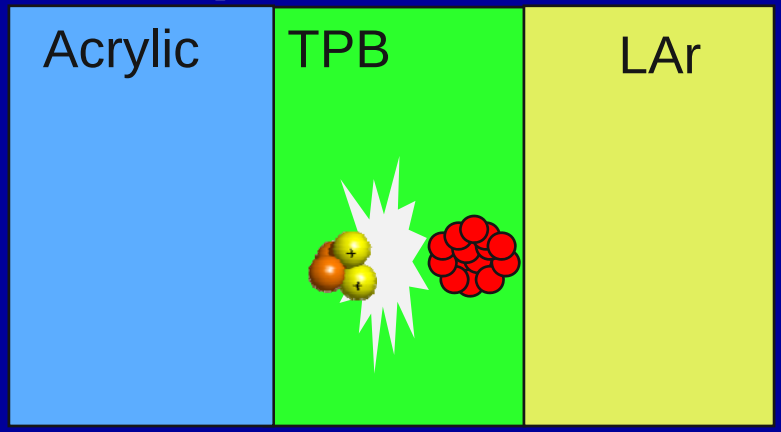
PE hit time distribution

Pulse shape discriminator
ratio of light from [50,710ns] window to total light

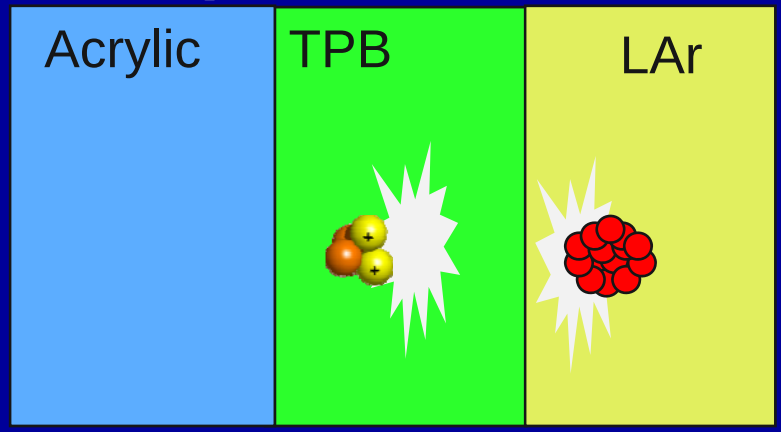




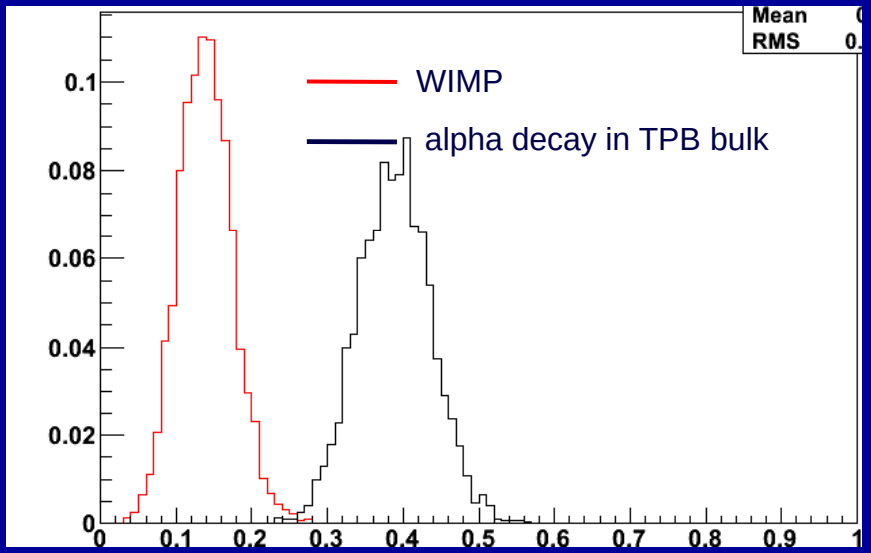
Alpha decay in TPB bulk

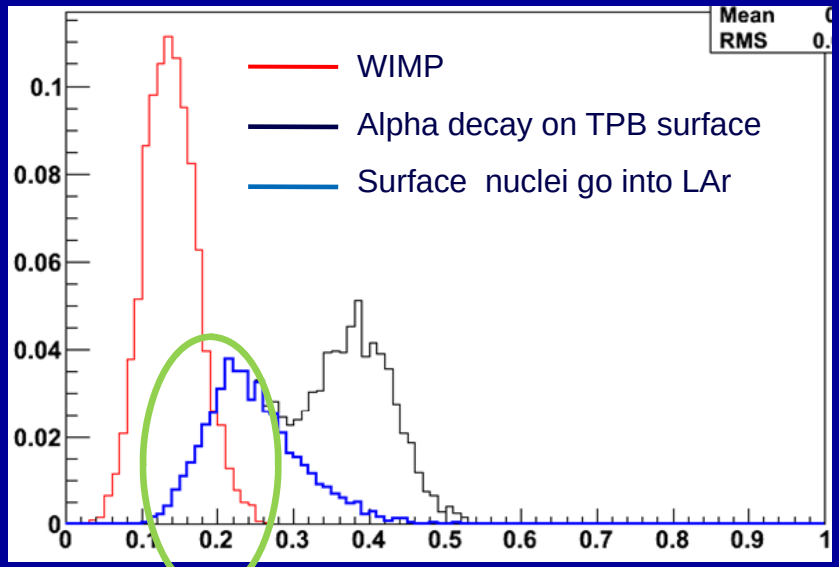


Alpha decay on TPB surface

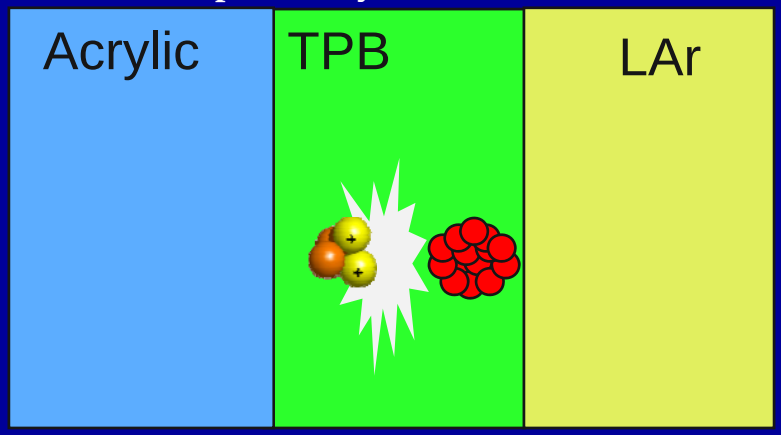


Pulse shape discriminator
ratio of light from [50,710ns] window to total light

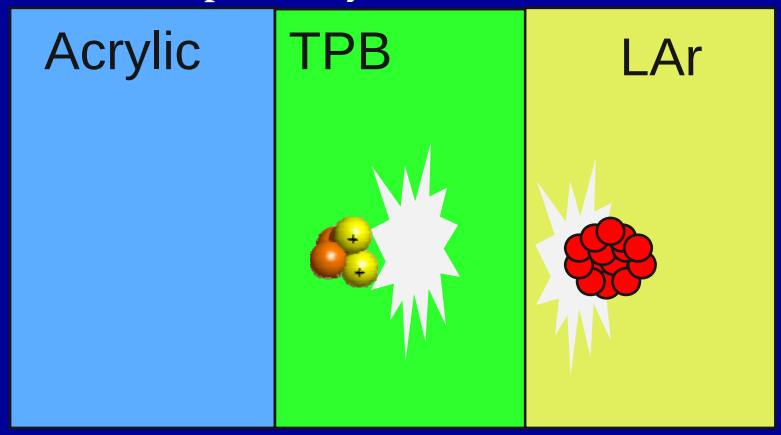




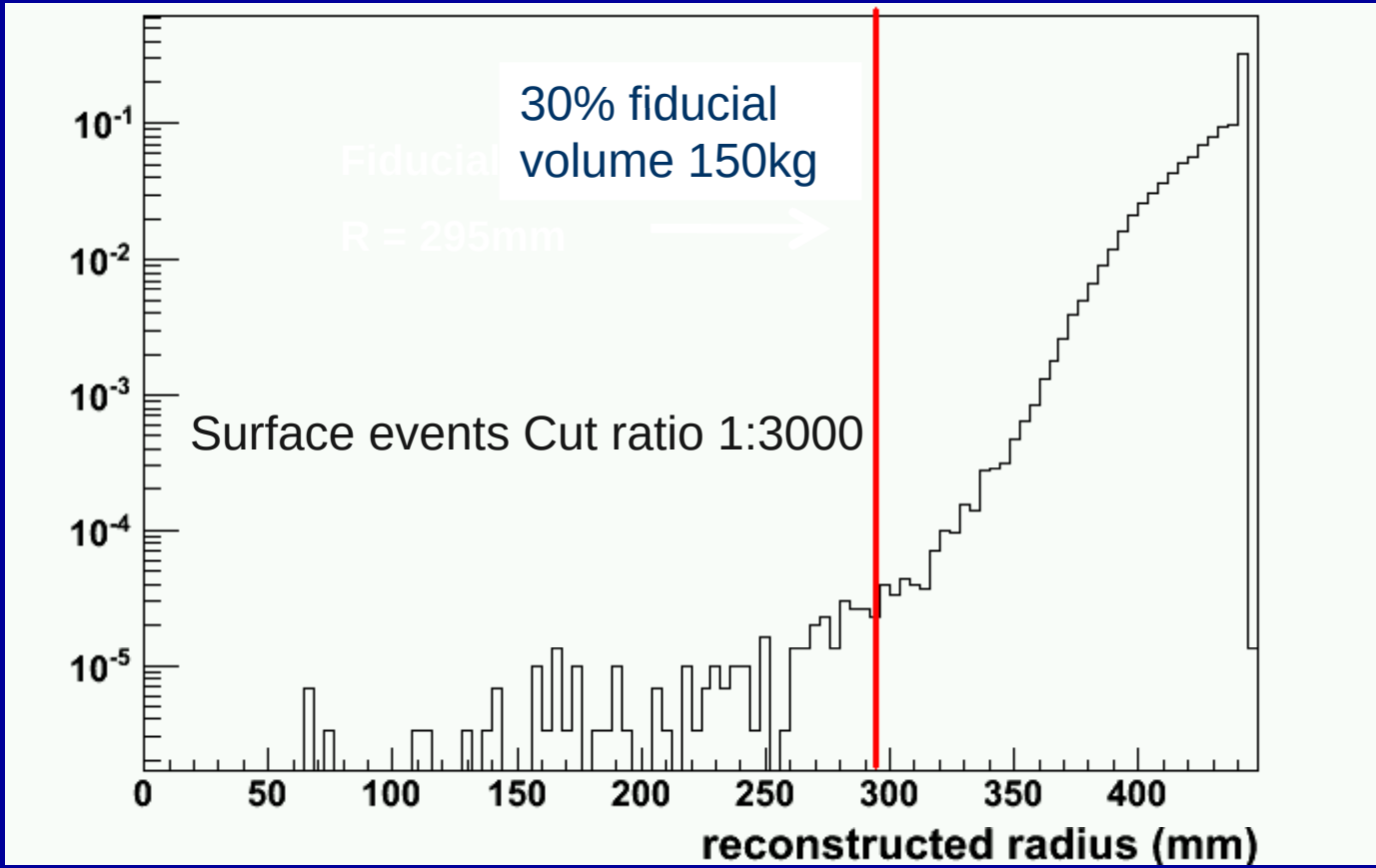
Alpha decay in TPB bulk



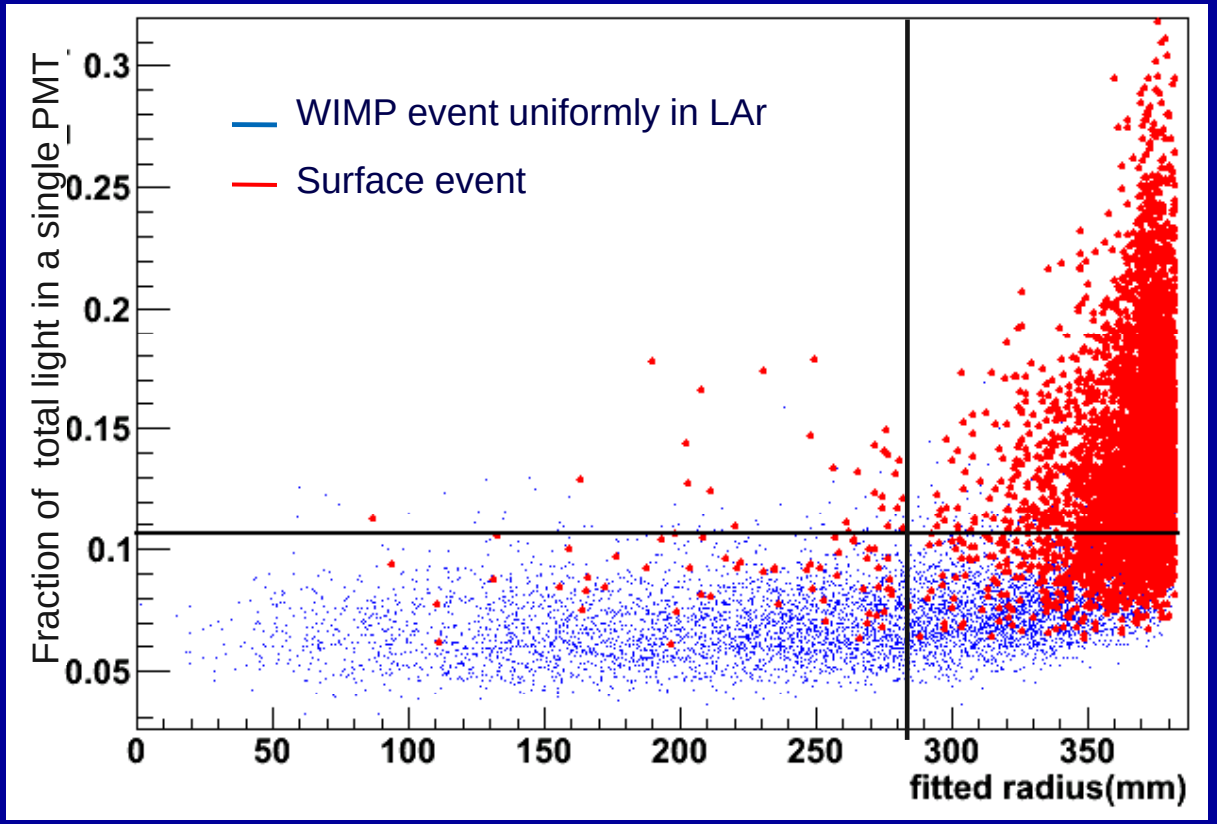
Alpha decay on TPB surface



Position reconstruction



fraction of total light in a single PMT



help to distinguish misreconstructed surface event

Conclusion

- The most dangerous surface background is alpha decay on TPB surface with nucleus goes into LAr
- By using the energy range cut, PSD, position reconstruction, the amount of surface background reduced from estimated 50k events/year to 0.2/year