



Scintillator time profile measurements using an LAPPD

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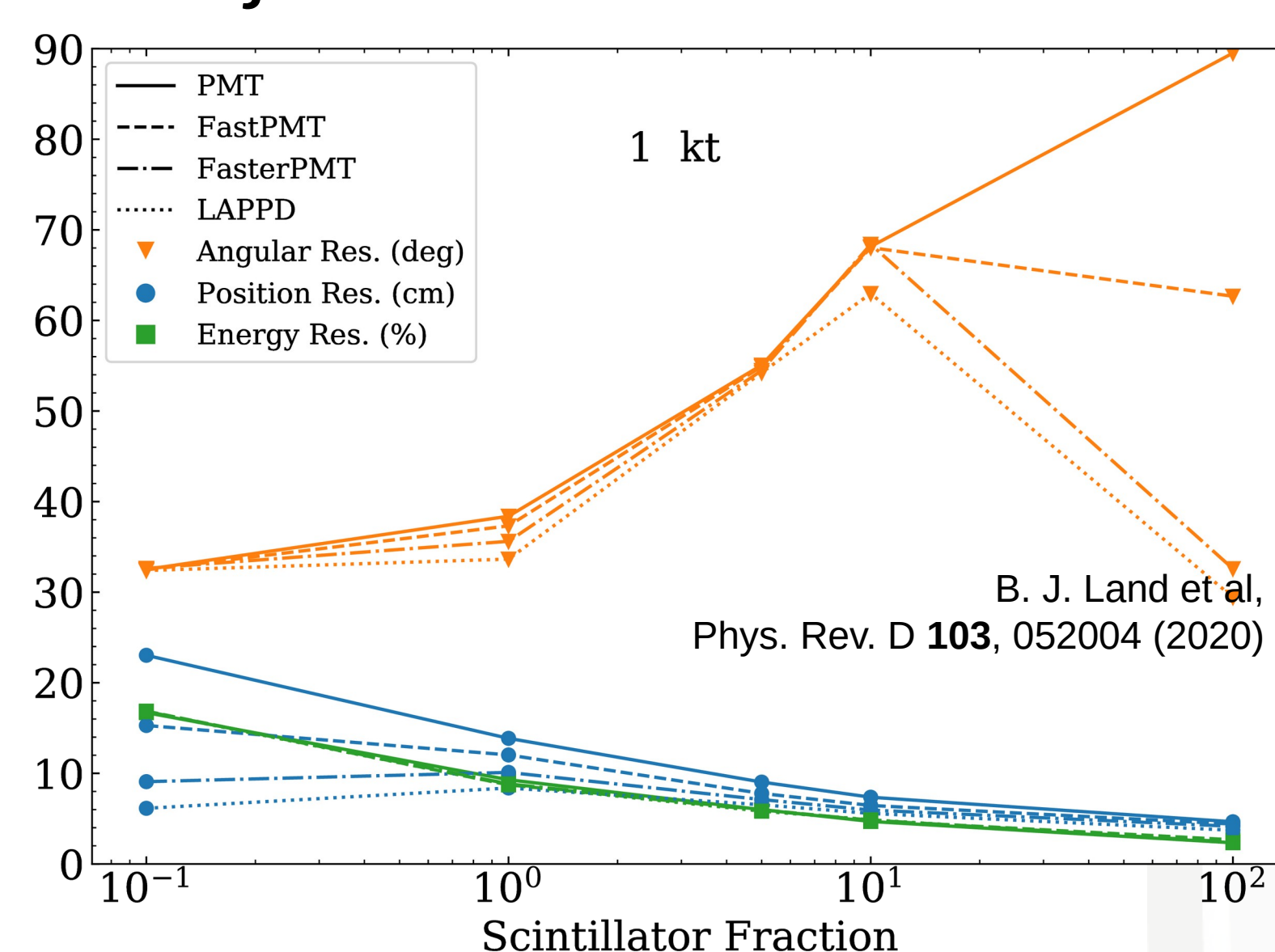
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Consortium for Monitoring, Technology, and Verification (MTV)

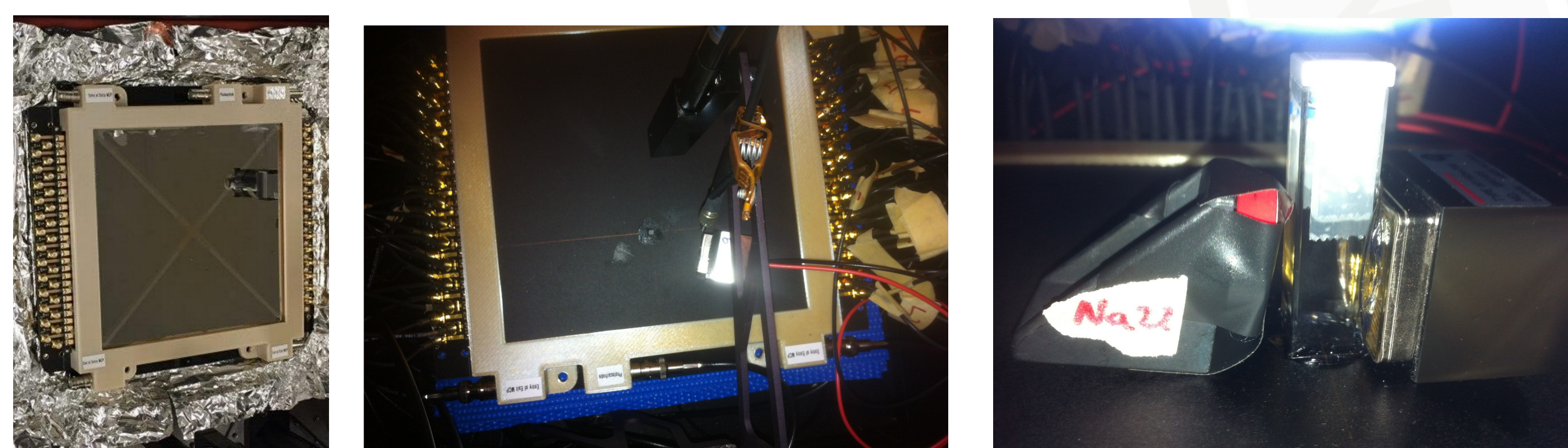


Introduction and Motivation

- Neutrino Experiment One aims to demonstrate reactor monitoring through antineutrino detection via inverse beta decay
- Dominant inverse beta-decay (IBD) background is beta/gamma decays--- from isotopes in photomultiplier tube (PMT) glass, e.g. ^{208}Tl
- Improved timing resolution leads to improved background rejection



- Large Area Picosecond PhotoDetectors (LAPPDs) offer O(50 ps) resolution in detection time over ~400 sq. cm sensitive area



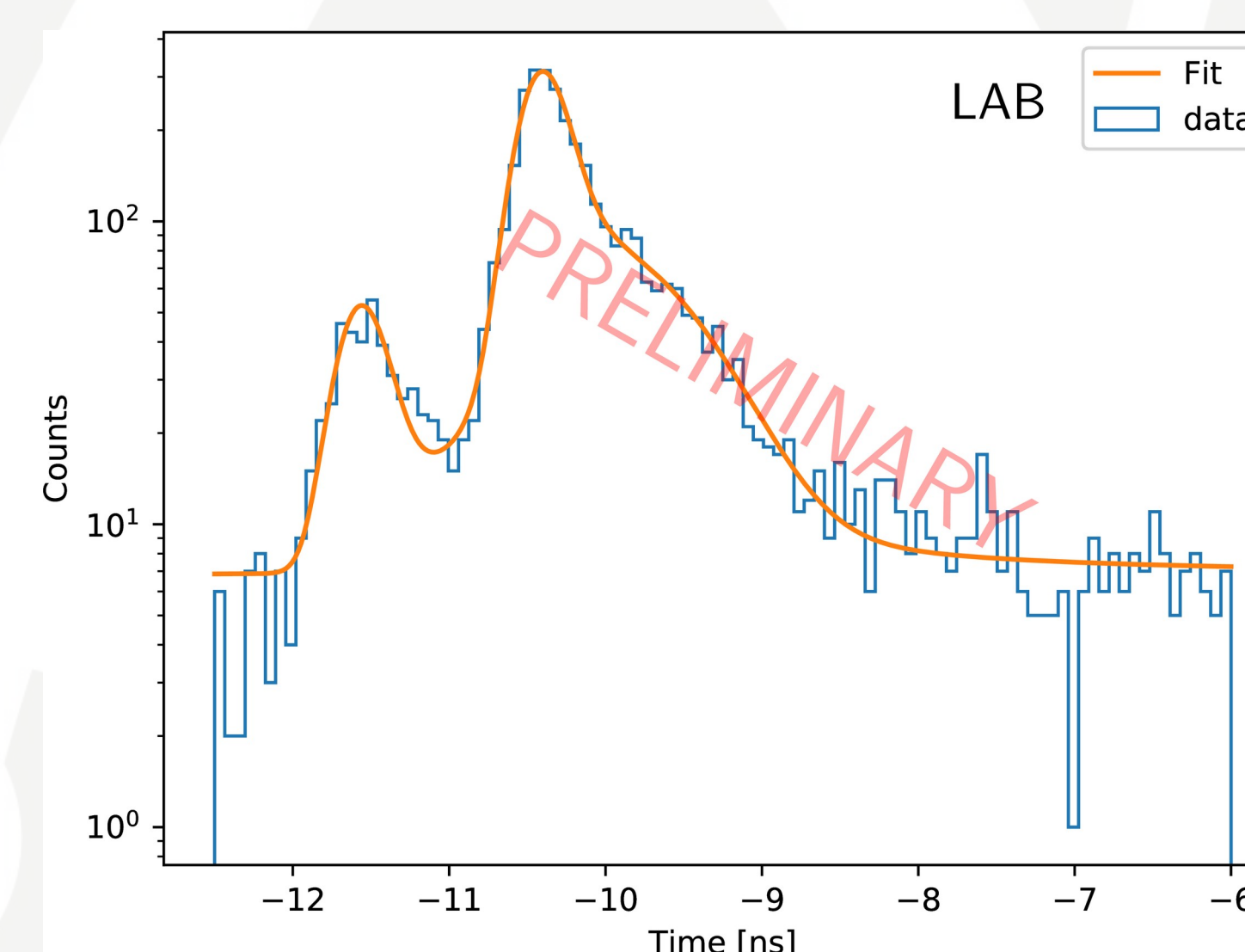
Mission Relevance

- Facilitates new capabilities for nuclear reactor discovery and exclusion at large stand-off
- Supports monitoring and verification of reactor operations for proliferation detection

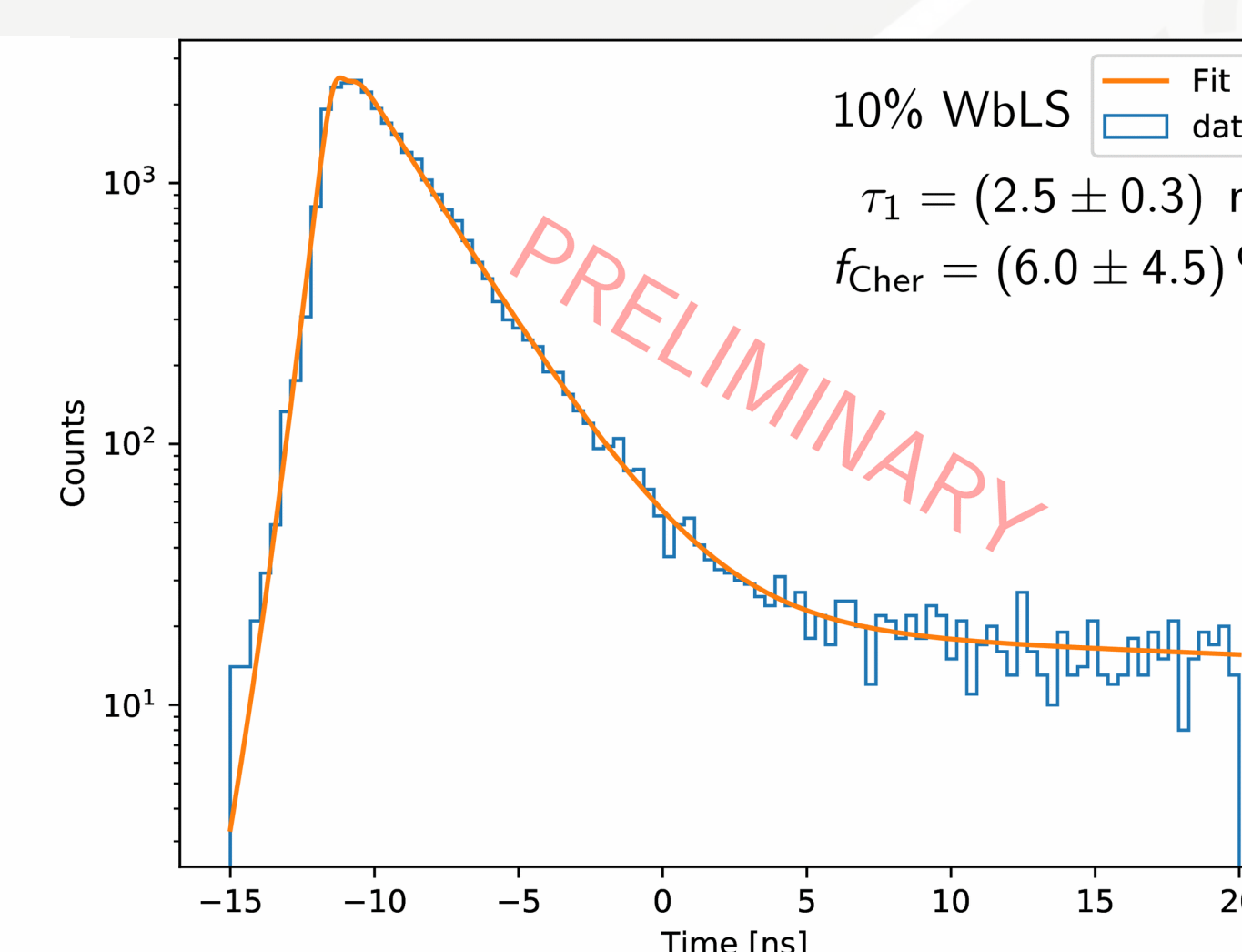
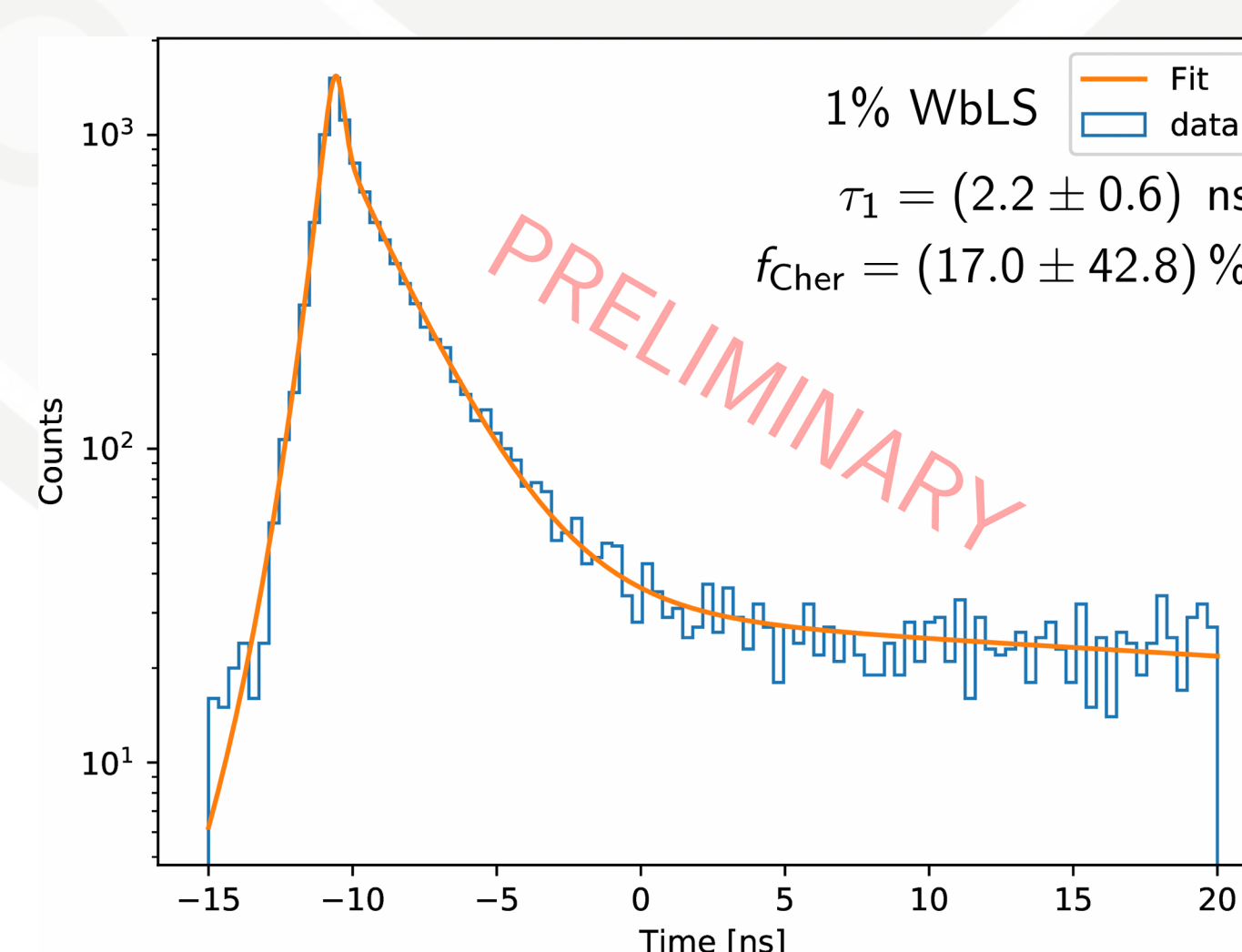
Technical Approach

- First step to demonstrate benefit of LAPPD deployment is measurement of scintillation time profiles using ^{22}Na (positron + gamma) source
- Incom LAPPD #22 on loan from Sandia National Laboratory (SNL); LAPPD #93 newly purchased by UCB/LBNL with MTV support
- Unbinned fit of parameterized likelihood to observed detection times
- Signal likelihood based on multiparameter model considering scintillation and Cherenkov light separately incident on trigger PMT and LAPPD

Results



- Triggering on Cherenkov light from LAB, gamma interactions in LAPPD itself establish effective timing resolution of PMT and LAPPD of 142 ps



- Triggering on, and measuring, scintillation light from Water-based Liquid Scintillator (WbLS) samples reveals timing correlated with scintillator loading

Expected Impact

- Potential deployment in Advanced Instrumentation Testbed (AIT)
- Improved understanding of LAPPD operation and scintillator time profiles

MTV Impact

- Professional development through use of new technologies, such as LAPPDs
- Collaboration with SNL and LBNL scientists
- Support cutting-edge detection technologies for potential use in AIT detector

Conclusion

- Confirmed precision time resolution of LAPPD in real application
- Developed model of scintillation time profile in regime where Gaussian trigger response is insufficient

Next Steps

- Incom LAPPD #93 acquired by Orebi Gann group
- Gain and resolution characterization underway
- Dedicated measurements to be performed using an in-situ beta source for improved signal-to-background ratio
- Explore statistical imaging capabilities



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