Double Chooz and Other Activities

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DoE Site Visit
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Double Chooz

(work with M. D'Agostino, M. Goodman).

-Our group involved in detector calibration with deployed artificial calibration sources: calibration procedures will be conducted after start of data taking when all detector systems installed (outer veto, glove box, etc.).

-In preparation for the first/early data analysis we plan to use "natural" calibration sources (spallation neutrons and ^{12}B) to calibrate energy scale and monitor detector stability (commissioning phase).

-We contributed to the first production of simulated data within the collaboration: currently analyzing Monte Carlo in a form that data is expected with summer students (see next slide).

-Member of reactor working group: the goal is to accurately predict anti-neutrino flux (crucial for far-only detector phase).

-Working on Sensitivity Calculations: understanding systematics in Θ_{13} analysis.

-Acted as a Chair of the DC Calibration Systems Readiness Review.

Spallation Neutrons

Neutrons produced within the detector buffer region (not the neutrons coming in from the rock).

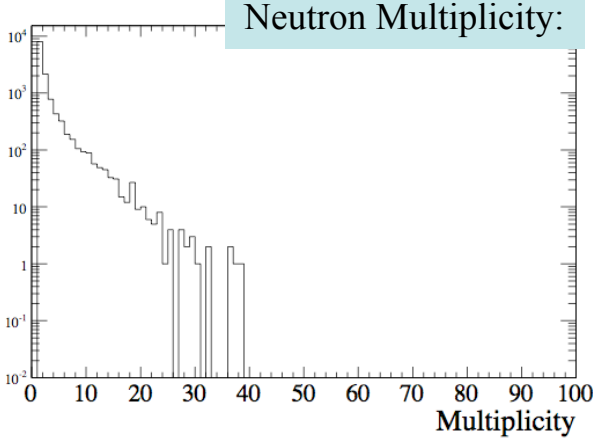
There is a spallation model implemented in Geant4; it takes a long (CPU) time to run with the full light propagation.

Starting with ~1.8x10^6 muons propagated through the inner detector (TG + GC + buffer + inner veto), one finds only ~10k of them producing neutrons.
Have written a neutron generator (→ neutron HEPevt file).

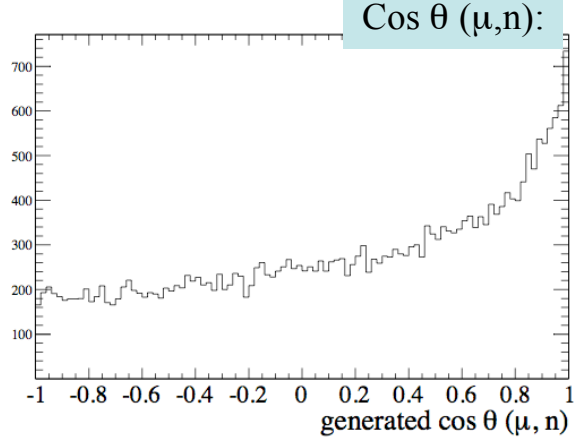
Goal

Speed-up simulation of neutrons but keep it realistic; have neutron sample for various studies (Data Challenge, callibration with cosmics, …)

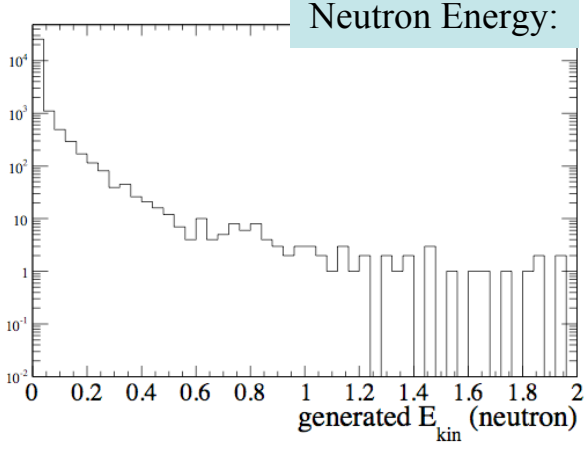
Neutron Multiplicity:

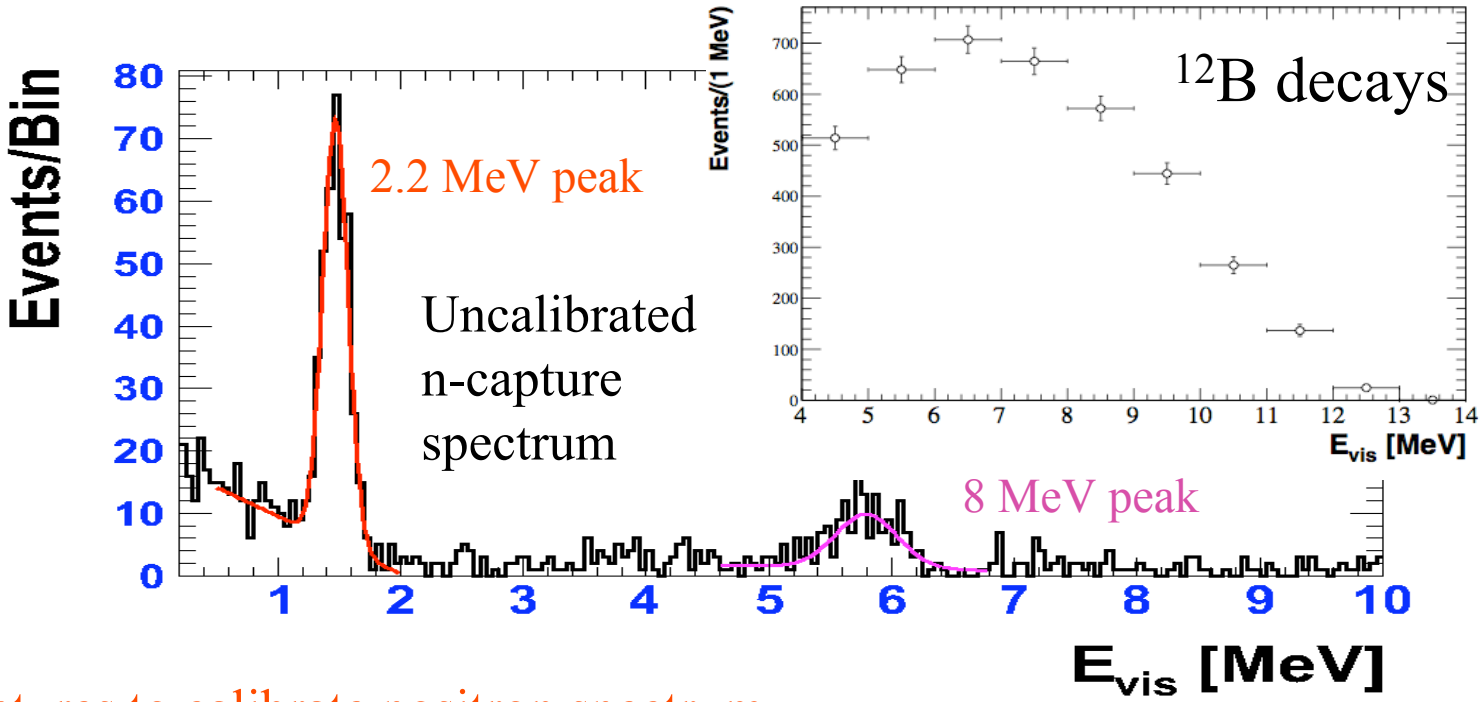


Cos θ (μ,n):

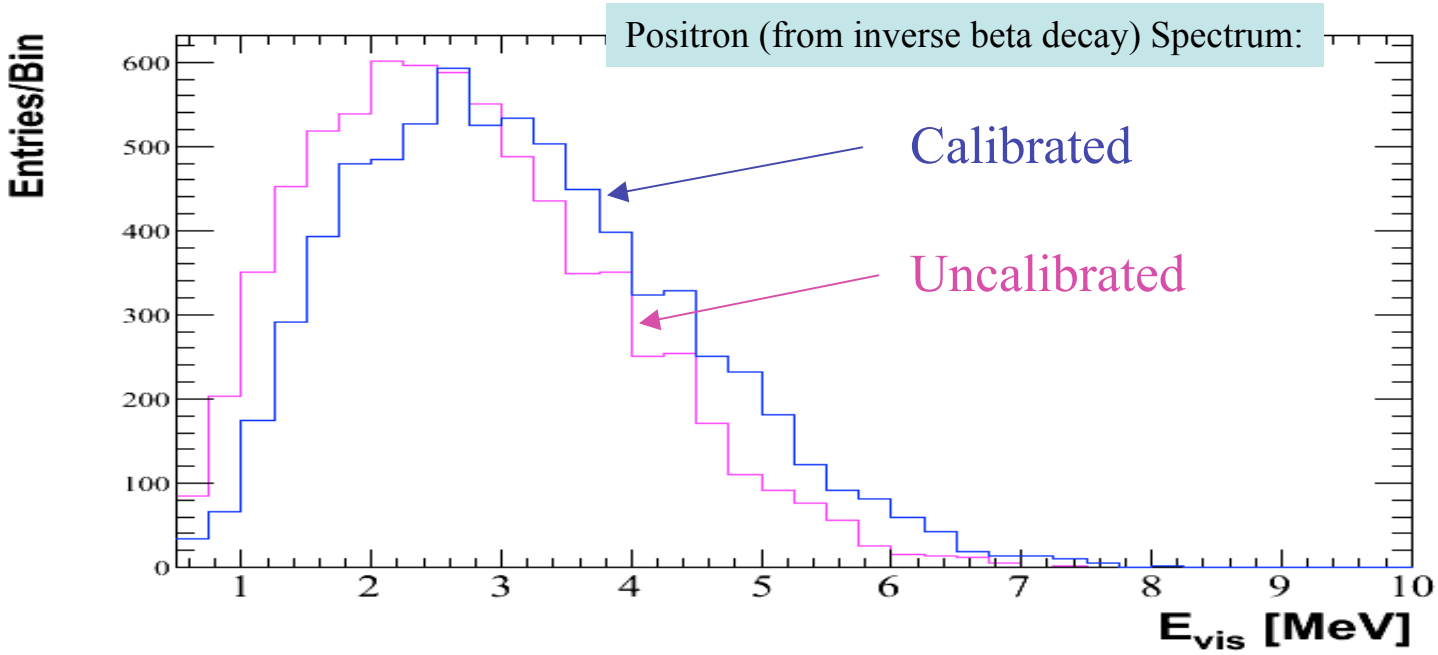


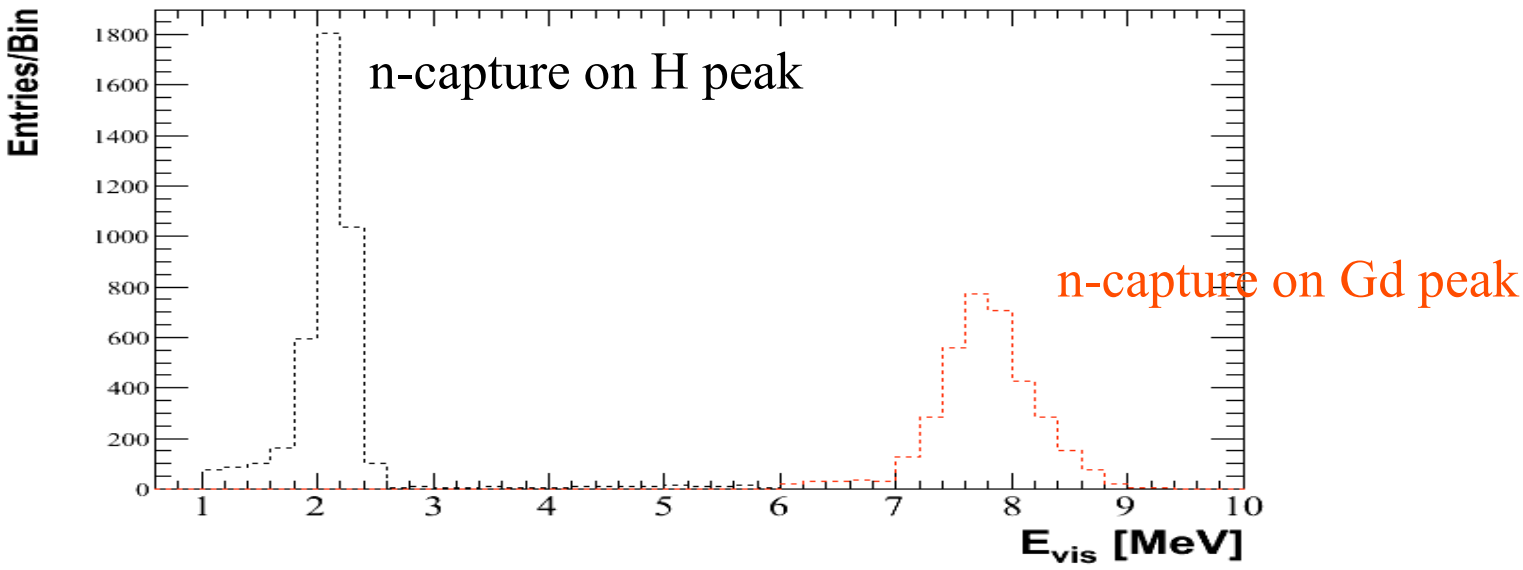
Neutron Energy:





Use n-captures to calibrate positron spectrum





Next Steps:

-Complete cosmics calibration studies

-Study spatial and energy
distribution of neutrons, compare to those from IBD,
vary detector parameters including attenuation length, Gd%, etc,
and calibrate with n and ^{12}B.
(have two undergraduates over the summer at ANL with Z.D. and M.D.).

NOνA

Activities:

-Leak tests of the modules for NOνA near detector (with S. Budd et al.).

-Designing a new robust leak test system to be used for NOνA far detector (with V. Guarino, A. Zhao), first tests performed earlier this week.

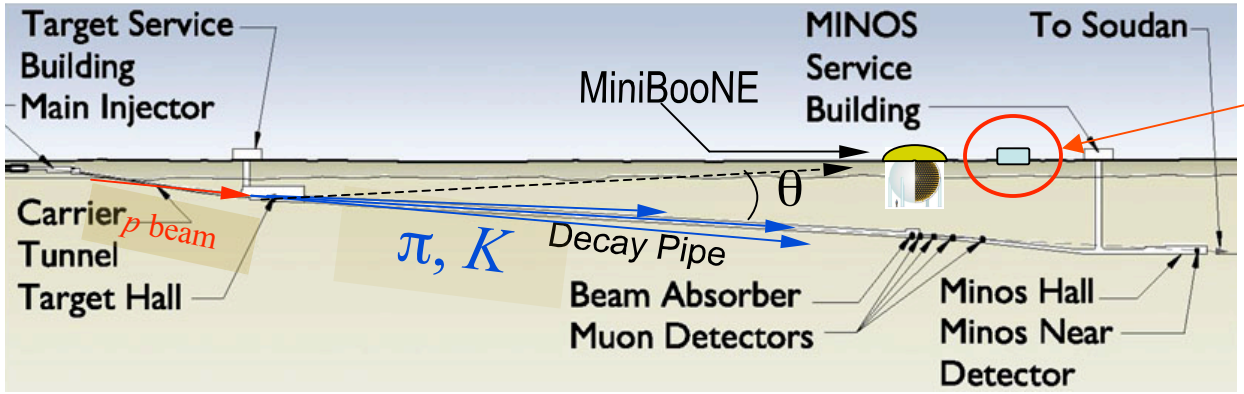
-Performed a preliminary analysis of MiniBooNE cosmic muon data and scale to NOνA case for cosmic background estimate.

-In preparation for the first physics analysis: calculated fluxes and expected event rates at NOνA near detector at surface (NDOS) from NuMI beamline and Booster beamline.

-Need precise knowledge of the flux at NDOS off-axis location (= MiniBooNE off- axis location): leading analysis of NuMI neutrinos at MiniBooNE as MiniBooNE/MINOS collaborative effort (see next slide).

Measurement of the off-axis NuMI Neutrinos at MiniBooNE

Analysis goal:
-NOvA will be using NuMI beam off-axis; detector target is liquid scintillator similar to MiniBooNE.
-MiniBooNE can measure beam components far off-axis (at NDOS location) and constrain expectation for NDOS first physics.
-At 110 mrad particular beam features (i.e. Kaon contribution) are pronounced, can Be precisely measured and then extrapolated to NOvA later (14.5 mrad) position.
-Also check if there is MiniBooNE effect in the data.

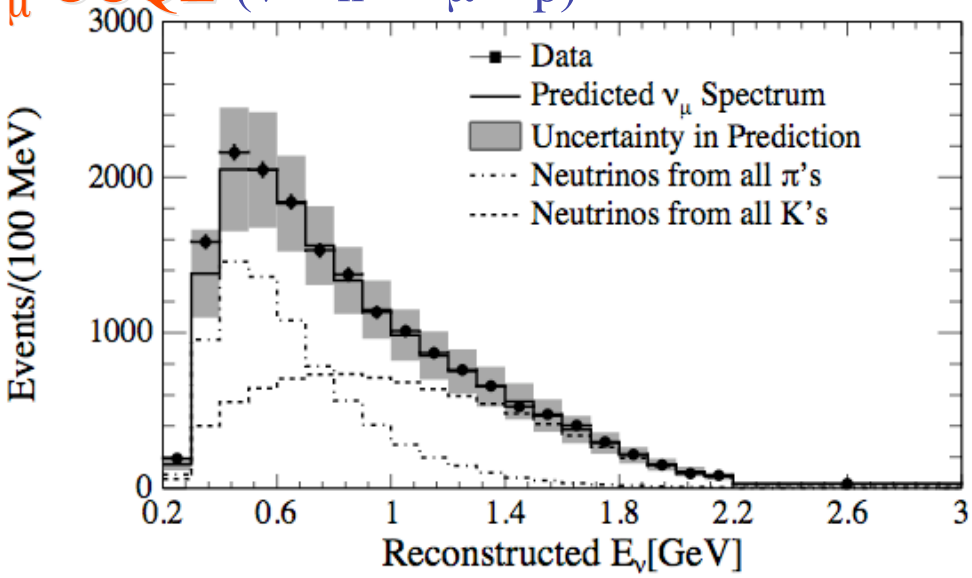


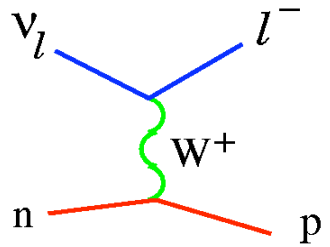
NDOS

MiniBooNE detector is 745 m downstream of NuMI target.
MiniBooNE detector is 110 mrad off-axis wrt NuMI decay pipe.

Analyzed ν_μ CCQE and ν_e CCQE samples from NuMI

ν_μ CCQE ($\nu + n \rightarrow \mu + p$)



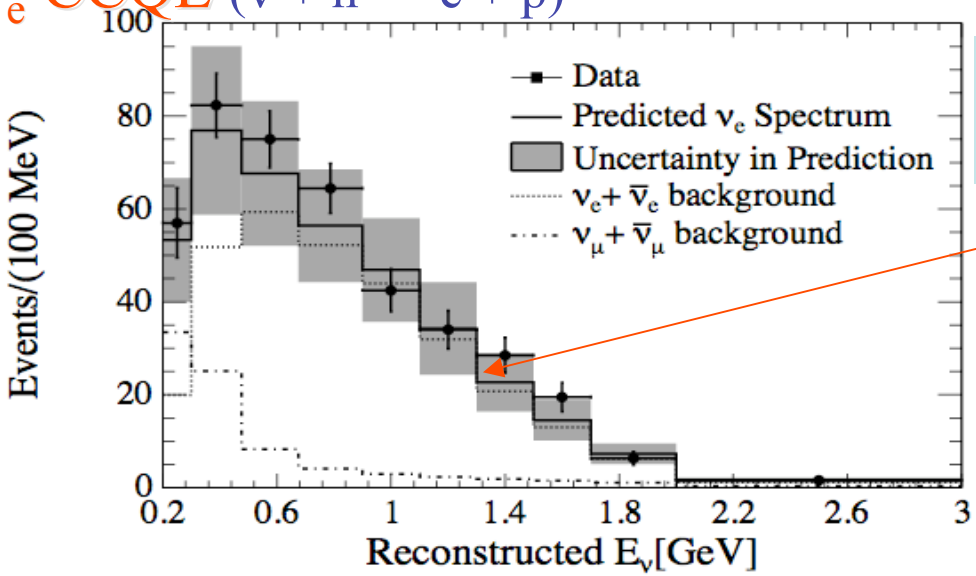


The first results show that reliable predictions for an off-axis beam can be made.

Details

P.Adamson et al, PRL 102, 211801 (2009)
arXiv:0809.2447 [hep-ex].

ν_e CCQE ($\nu + n \rightarrow e + p$)



Now updated with new flux

Very different backgrounds compared to BNB (Kaons vs Pions)!

Systematics not yet constrained!

There more data from NuMI at MiniBooNE now.
Beam components measurement and ν_e appearance analysis is underway.

Long Baseline Neutrino Experiment

Activities:

-Interested in Electronics for Large Neutrino Detectors - recently submitted LDRD at Argonne (with G. Drake, M. Goodman, J. Paley).
(see next page).

-Studying options for improving a signal read-out from Large Cerenkov detector (with Gary Drake).

-Getting Lab space in Bldg 362, i.e. Lab F-116 for initial R&D.

-Have an idea for Early Career Research Program, related to both Double Chooz and LBNE.

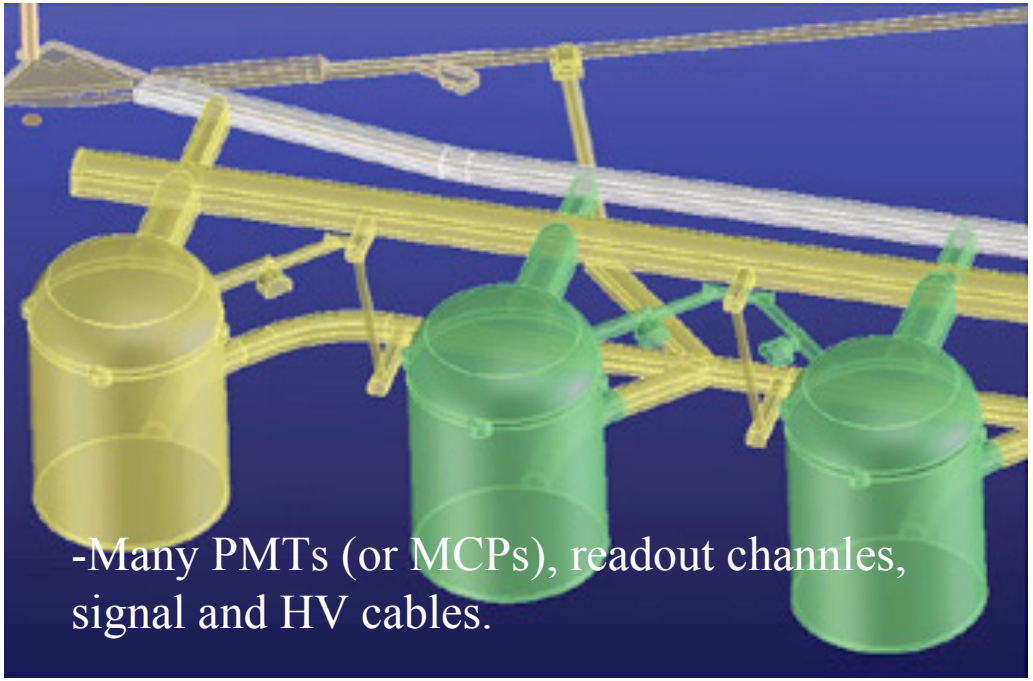
LDRD Proposal: Development of Wireless Data and Power Transfer Techniques for Large Instrumentation Systems

-With the detectors increasing in its size and/or being built in remote areas (no Lab infrastructure, electrification,..) it is complication to use traditional approach where the signal and the power are distributed with electric cables.
-Cabling may represent a significant cost and complication in experiments and leads to signal attenuation and deterioration.

-Example of basic science
i.e. neutrino physics
application: LBNE@DUSEL

-If the cables are used with Water Cerenkov detectors in Fig one would need 60000 x100 m of the cable length per detector

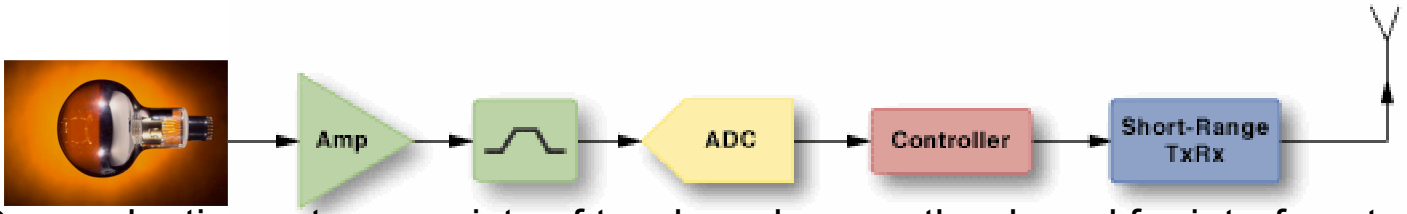
-Simpler applications: need to measure radioactivity, muon rates, or seismic activity in underground cavities before setting a lab or an underground waste storage facility, etc).



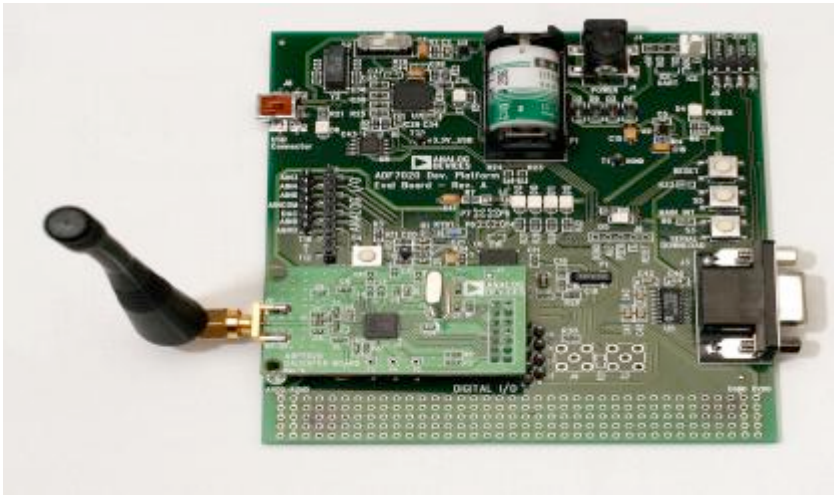
Proposal has two components, to be addressed separately:
-data transfer (RF technology)
-power transfer (optical beam?)

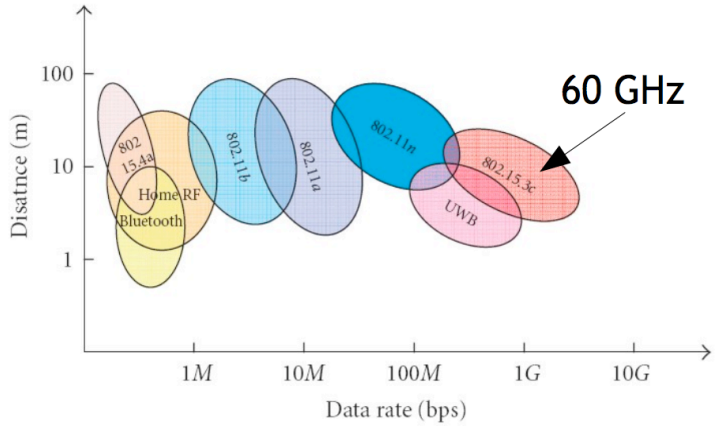
Data Transfer:

Idea is to develop a wireless data transfer application based on commercial RF cell-phone tech.
We would collect the data with a local receiver and then transmit it upwards.
We expect the data transfer to be less than 500 kbps per PMT channel.



Our evaluation setup consists of two boards, a mother board for interface to PC, and a small form-factor radio module or daughter board with transmitting/receiving unit:





Another part of R&D would be to address the Power Transfer:

-One idea is to adopt a low-voltage power supply to FEE board, and Cockroft-Walton bases to the PMTs. The Cockcroft-Walton base converts the low-voltage output from the board to the very high voltages needed to operate the PMTs (~1000 V). (We have experience with CW!)

-The low voltage power supply may be realized with a high-efficient lithium-ion battery that will be recharged by use of an optical wireless electricity system attached to it.

-The wireless electricity system uses optical transmitters and receivers to deliver power.

-Use Infra Red laser diodes to turn the electricity into optical, then detect with photodiodes.

-Similar to a solar cell, but higher efficiency.

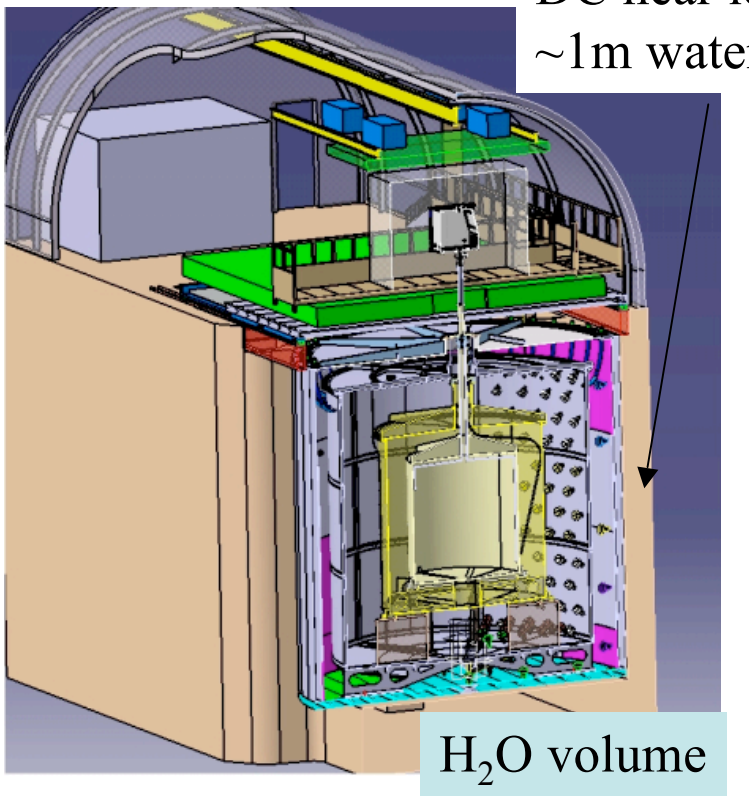
-The method was recently demonstrated by Power Beam, Inc. (www.powerbeaminc.com)

The beneficiaries and customers of this project are the scientific communities, including HEP, homeland security, and others that use detection devices in remote areas without laboratory infrastructure will benefit from this work.

Early Career Research Program

One idea involves both Double Chooz and LBNE (Water Cerenkov), and is related to mentioned LDRD proposal.
-now is at pre-pre-proposal stage (i.e. Lab decides if go forward with pre-prop to DoE).

DC near identical to DC far but additionally surrounded by ~1m water pit around it.



-Not planned to be instrumented.
-We could use it for as a LBNE Water Cer. prototype by instrumenting with PMTs (and later LAPDs?).
-Test various electronics schemes, including cabling, in-water electronics, wireless data transfer, etc.
-Learn about Water Cerenkov at small scale.
-Plays well with LDRD at Argonne to study feasibility of wireless data transfer.
-Useful for DC: near detector is at shallow depth, this would make it identical with far by reducing bkgds further.

Other Activities

Student Supervision:

-currently supervising A. Rozvi, UIC undergrad working on Double Chooz MC analysis.

Review Committees:

-review of funding proposals: Subject Matter Expert reviewer of Laboratory-Directed Research and Development proposals at ANL.

Outreach:

-Sigma Xi, honorary scientific research society, nominated and promoted to Full Membership in 2010.