

# Wireless Project

(“New Ideas” Talk for the HEP Division Retreat)  
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- The idea is related to **development of New Data and Power Transfer Techniques for detectors**.
- Have put together LDRD proposal “**Development of Wireless Data and Power Transfer Techniques for Large Instrumentation Systems**” → Funded.
- Have written an Early Career grant proposal “**Development of Data and Power Transfer Techniques for Large Neutrino Detector**” → Submitted to DOE in November 2010.
- Note the title difference in two proposals. The second one includes the first one.

# LDRD Proposal 2011-153-NO: Development of Wireless Data and Power Transfer Techniques for Large Instrumentation Systems

## Problem

- With the detectors increasing in its size and complexity 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.

## Approach

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

## Goal

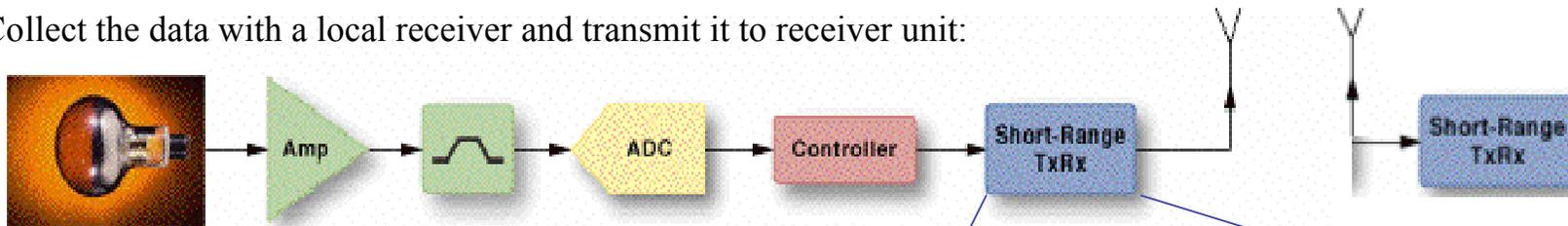
- Elimination of all cables: no physical connection to the detector.



## Data Transfer

- Develop a wireless data transfer application based on commercial cheap RF/cell-phone/WiFi tech.
- Technology exists but never used with a high channel count.
- Need to address possible channel interference when sending it over a distance.

Collect the data with a local receiver and transmit it to receiver unit:

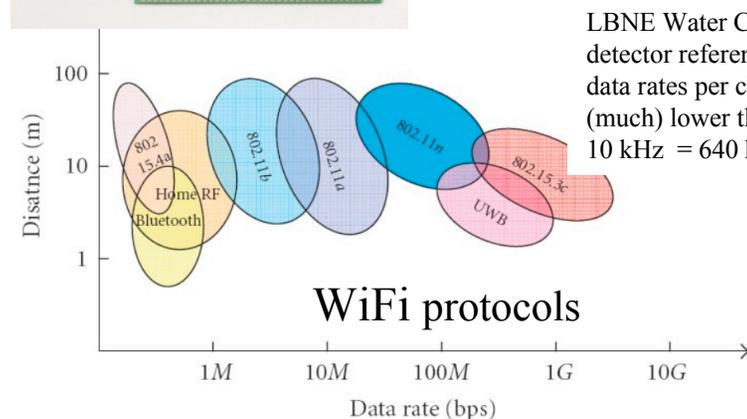


- Plan:**
- design a small network of several sources and compare to networking Monte Carlo.
  - explore transmission protocols



Candidate mother board for interface to PC + daughter board with RF transmitting/receiving unit.

Cell phone standards/protocols	Technology	Bandwidth	Data Rate/User (Theory)	Data Rate/User (Realistic)	Users/Cell	
	GSM	200 kHz	9.6 kbps	9.6 kbps		56 ↑ ↓ ~196
	GPRS	200 kHz	172 kbps	40 kbps		
	EDGE	200 kHz	474 kbps	100 kbps		
	CDMA2000 3x	3.75 MHz	2 Mbps	384 kbps		
	WCDMA	5 MHz	2 Mbps	1 Mbps		



- study performance of the system i.e. carrier frequencies, transmission data rates (i.e. bandwidth), source to receiver distances, and power consumption.
- input to design a larger network of ~100 sources (hardware setup of 128 PMT channels for measuring muons in hand for real data test.)
- extrapolate to larger system.



## Project budget

<b>Funding Profile</b>	2011	2012	2013	<b>TOTAL (All Years)</b>
<b>Hi-value Equipment</b>	\$0.00	\$0.00	\$0.00	\$0.00
<b>Materials &amp; Supplies</b>	\$50,000.00	\$50,000.00	\$0.00	\$100,000.00
<b>Post Doc Effort</b>	\$83,000.00	\$86,000.00	\$0.00	\$169,000.00
<b>Staff/STA Effort</b>	\$90,000.00	\$93,000.00	\$0.00	\$183,000.00
<b>TOTAL</b>	<b>\$223,000.00</b>	<b>\$229,000.00</b>	<b>\$0.00</b>	<b>\$452,000.00</b>

**Staff Effort** 4 man months/year: 1 month - design  
1 month - layout & build  
1 month - test

**Post-doc Effort** 2 years: year 1 - initial studies (explore communication protocols,  
simulation studies, build and test small prototype)  
year 2 - larger system build and test

## Status

LDRD funded. \$189000 allocated for 2011.

Occupied space in F-132 Electronics Lab in 362. Later move to F-116 (more space).

Purchasing Equipment.

Started studies of transmission protocols.

I hope to increase my involvement in this during the year.

Advertised a post-doc position.

## Expand ideas to Early Career grant proposal

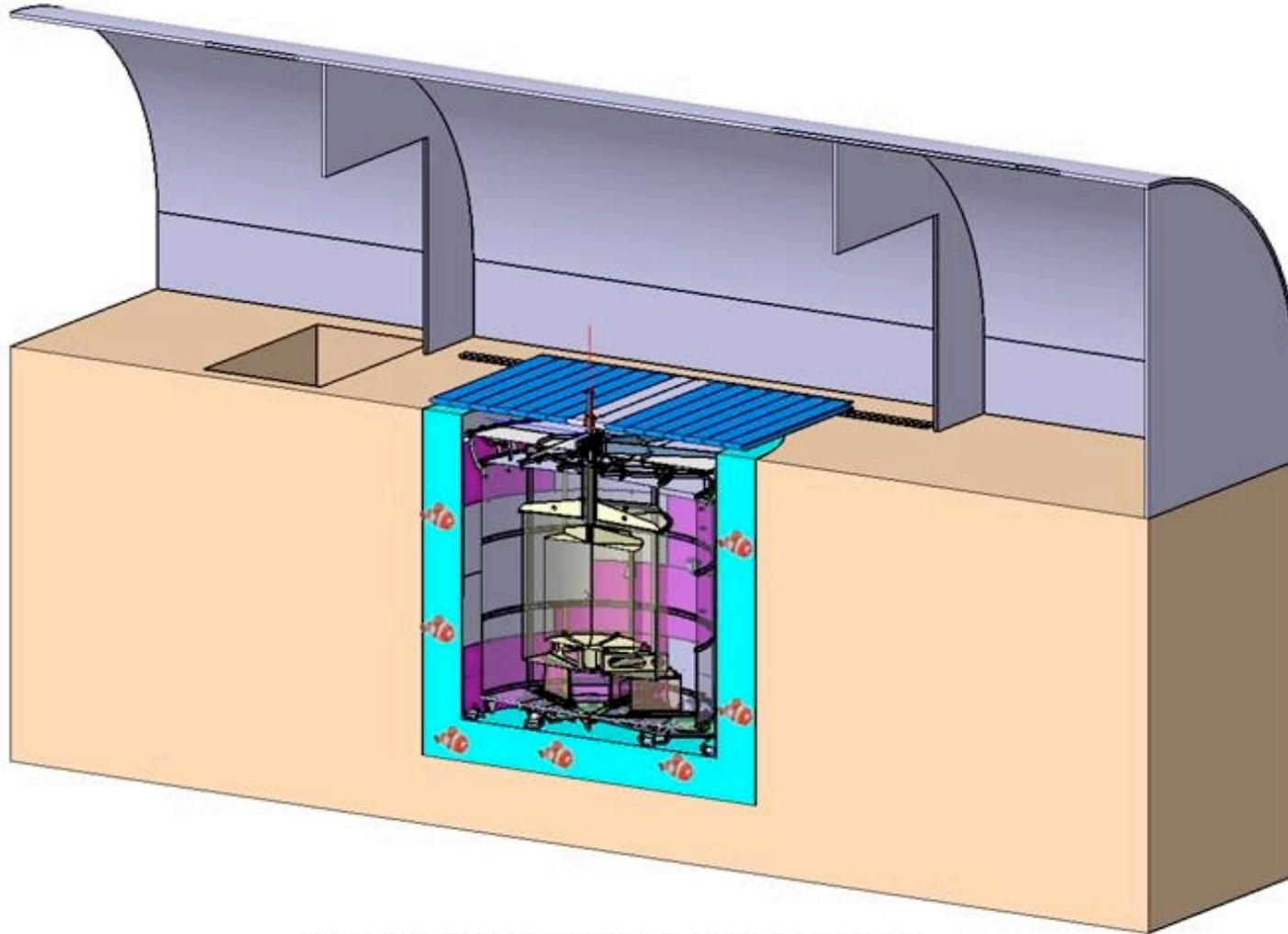
- Consider both traditional approach (cables) for novel techniques (wireless) for data and power transfer.
- Primary focus is Water Cherenkov detector in the LBNE experiment.
- Make advantage of “existing” infrastructure and our involvement in Double Chooz experiment.

### From Abstract:

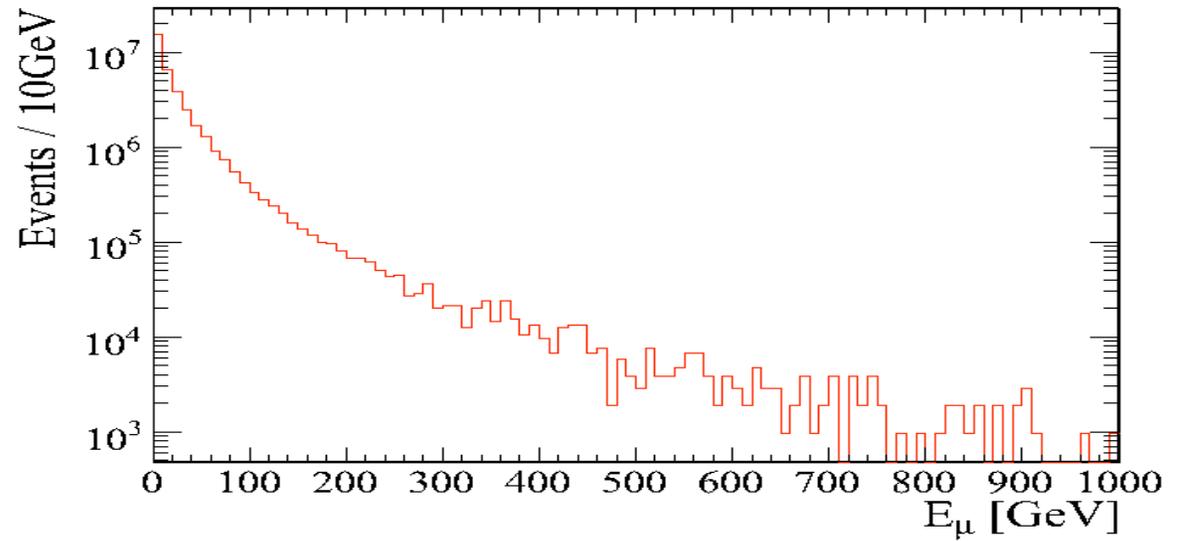
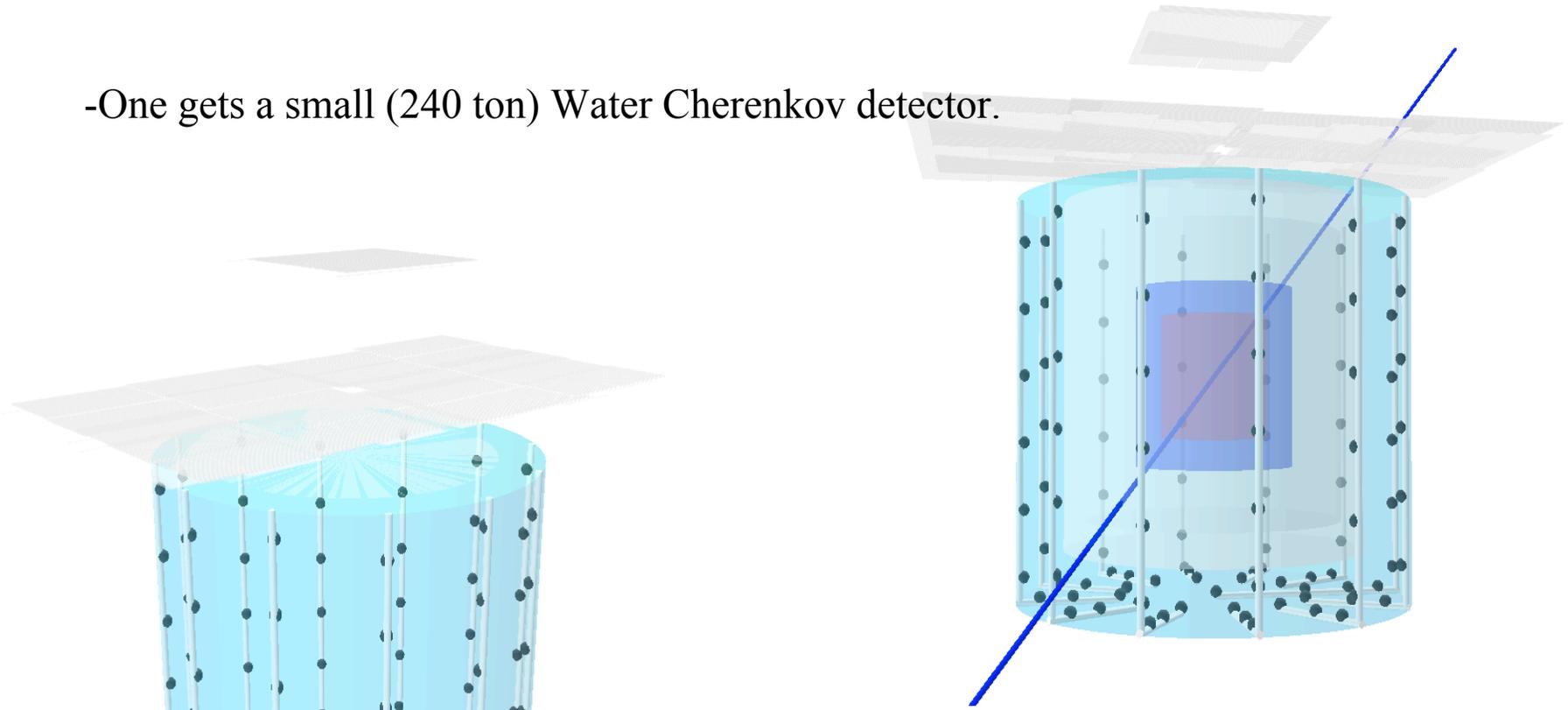
“The primary objective of this proposal is to develop new technologies and explore new techniques for the data read-out of a large neutrino detector, including in-water electronics, data transfer and power distribution with traditional and wireless approach. The proposal takes advantage of the laboratory and infrastructure under construction for the Double Chooz experiment at Chooz Nuclear Power Station in France. This project has a major advantage in that it offers the opportunity to develop new electronics ideas that might be used in a future water Cherenkov experiment such as LBNE, including in-water electronics, data transfer and power distribution. This detector would allow the careful evaluation of these new read-out technologies, while providing a valuable contribution to the Double Chooz experiment.

These approaches have not been realized before. The goal is to establish a reliable and low cost per channel wireless data transfer in this application. Double Chooz near outer water veto detector would therefore serve as a demonstration experiment to establish this novel approach. This technology has a potential to significantly reduce the cost and complexity of the infrastructure needed for the instrumentation of experiments such as LBNE.”

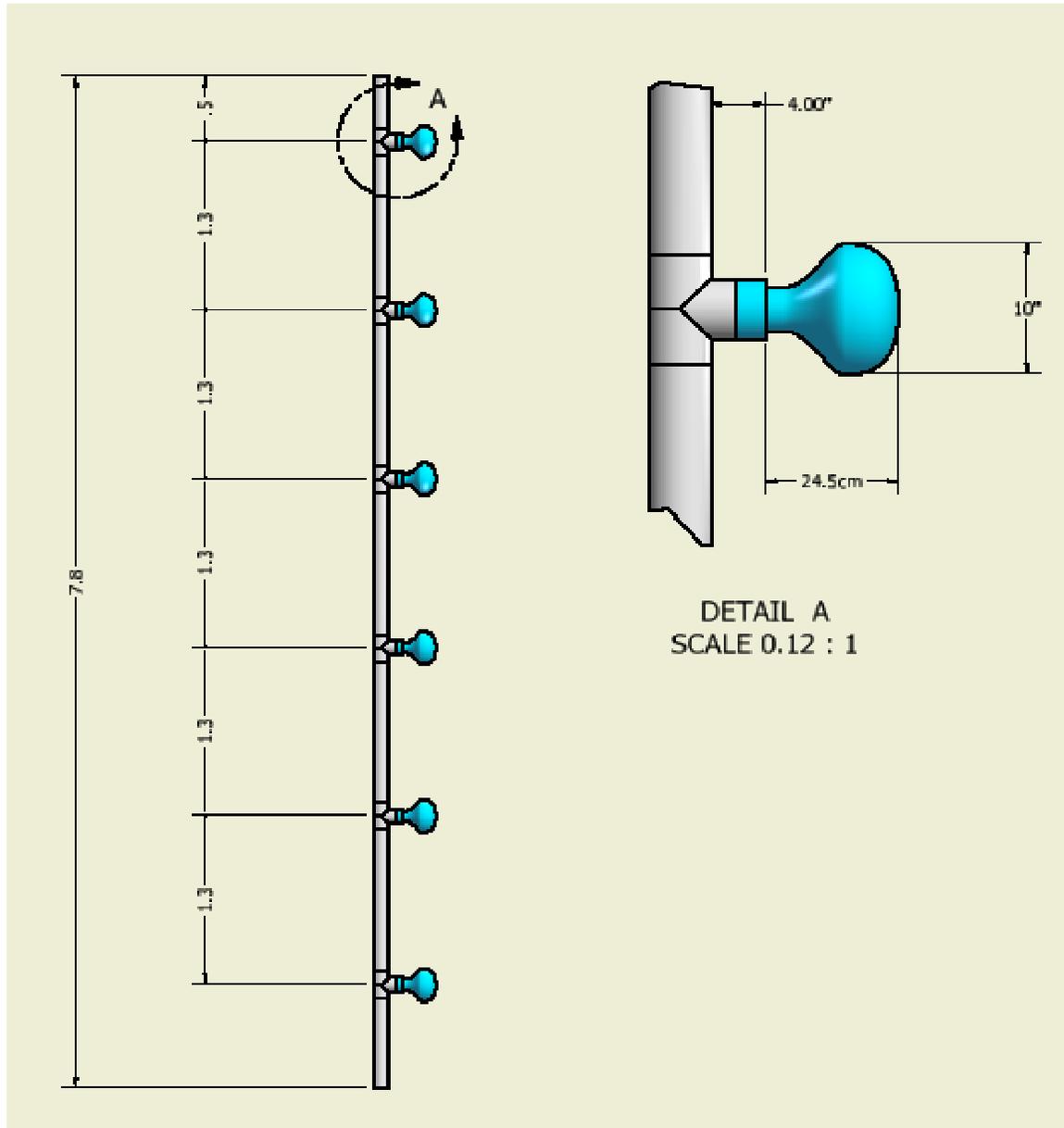
- Instrument the water pit (to be built) at Chooz near detector site.
- Initially not planned to be instrumented.
- Use PMTs identical to those considered for LBNE WC.



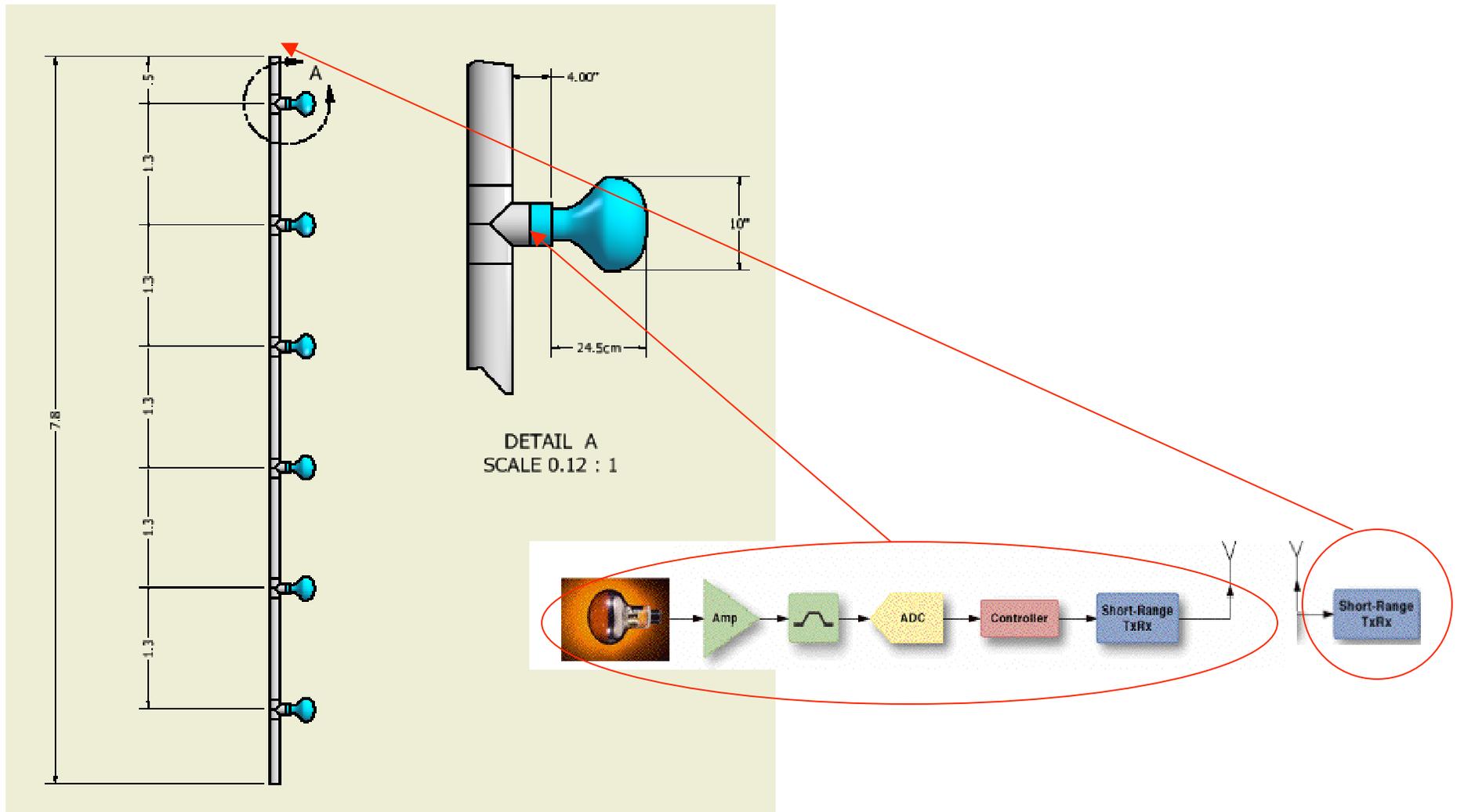
-One gets a small (240 ton) Water Cherenkov detector.



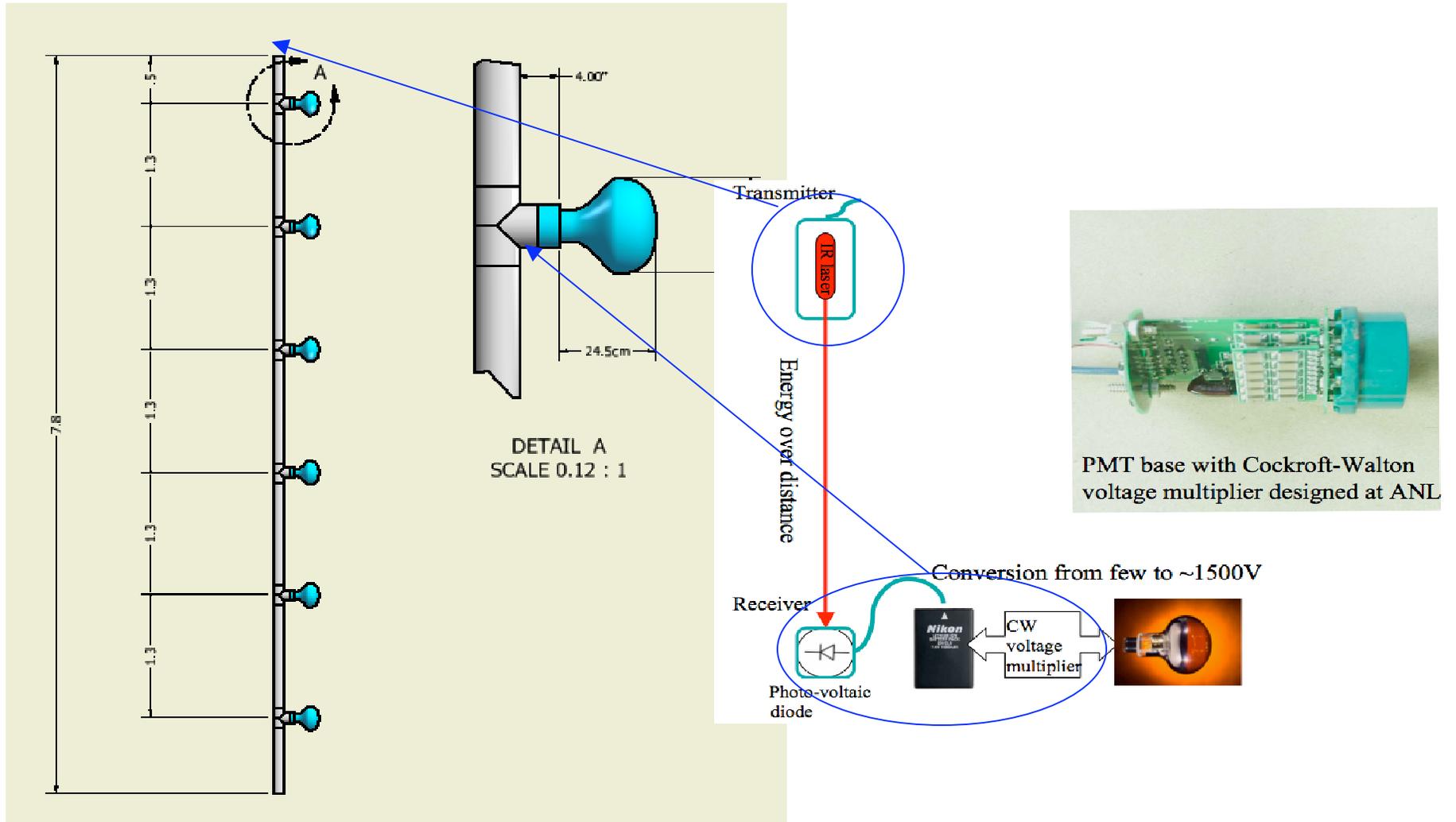
-Implementation: pack electronics in transmit signals through the PVC tube (air).



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## Phased approach

The development plan would have four stages:

1. Conventional instrumentation in the PMT base.  
Use discrete parts to start.  
Use conventional readout using a data cable, connected through the PVC pipe.  
Use conventional power over cables, connected through the PVC pipe.
2. Same as 1, but implement wireless data transmission, no data cables.  
Use conventional power over cables, connected through the PVC pipe.
3. Same as 2, but implement wireless power transmission.  
No cables at all in the PVC pipe.
4. Implementation of an ASIC. Depending on time and funding, engage the development of a custom integrated circuit that incorporates features of the above. The nature of the ASIC would depend on that learned through the first three stages of R&D.

## Conclusion

- This proposal aims at new developments in high speed data acquisition system in high energy physics with goal of eliminating cables in large systems.
- Complementary to D. Underwood's approach.
- This technology has the potential to significantly reduce the cost and complexity of the infrastructure needed for the instrumentation of experiments such as LBNE or dark matter experiments (or other applications).  
Jose would be happy to have this for RPCs
- Generic R&D program: may be considered as not linked to particular experiment.
- This positions our group uniquely in development of large wireless DAQ systems in next decade.
- The technology could generate funding for possibly multiple full-scale instruments such as LBNE.
- I hope to rump up my time on this.
- LDRD funded. Early Career proposal may or may not be funded.  
There are other funding opportunities after concept is demonstrated.