

Characterization of PMTs with the Photosensor Testing Facility at TRIUMF

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University of British Columbia

Water Cherenkov Satellite Meeting
NNN 2015, Stony Brook
Oct 27, 2015



Objectives and Motivation

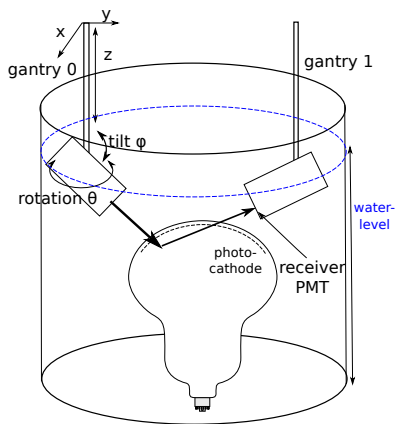


Characterize and study optical properties of PMTs in water.

- Measure PMT acceptance: PMT uniformity.
- Map reflectivity of PMT: important for reconstruction algorithms.
- Measure timing resolution as function of position on photocathode.
- Measure wavelength and magnetic field dependence.
- Measure properties of acrylic cover, tyvek, black sheet.

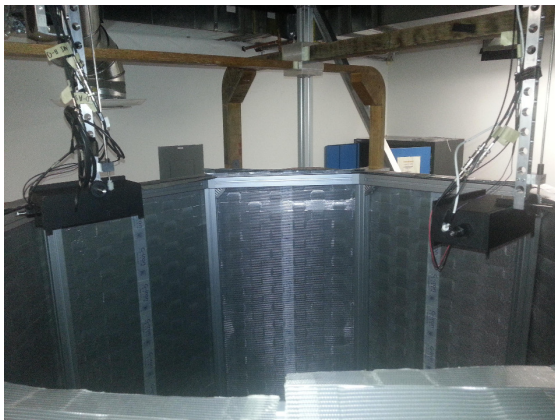
Designed for 20" PMT tests in air and water, but versatile.

The Photosensor Testing Facility



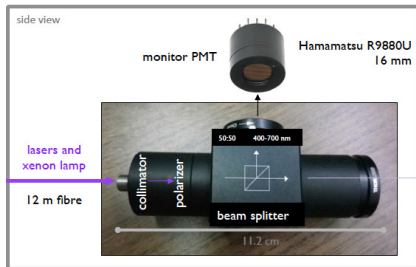
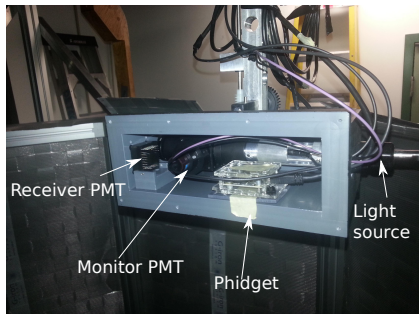
- PMT centered inside tank with ultrapure water.
- 5 stepping motors for each of two manipulator arms (gantries) \Rightarrow 5D (x, y, z , rotation, tilt)
- Waterproof optical box with laser, monitor and receiver PMT attached to the head of the gantry arm.
- Position accuracy: ~ 1 mm (x, y, z) and $\sim 1^\circ$ (rotation and tilt).

Mechanical system



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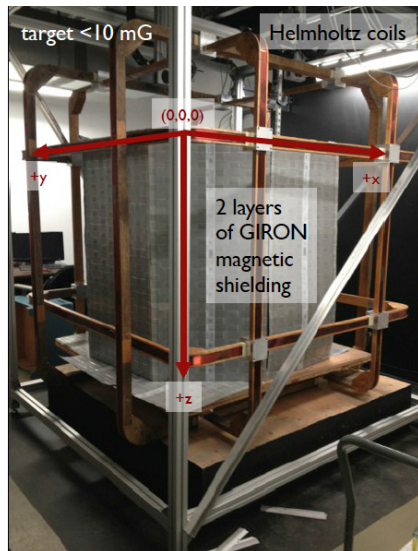
Optical system



- Light sources: 405/467nm pulsed laser and Xe lamp with filters.
- Connected through fiber to optical boxes.
- Collimator, polarizer, beam splitter.
- Monitor PMT and receiver PMT.
- USB powered board with 3-axis magnetometer, accelerometer and gyroscope (*Phidget*).

Magnetic field compensation

- In addition to the Earth magnetic field, presence of additional magnetic fields (eg. from TRIUMF Cyclotron).
- Active cancellation with Helmholtz coil, passive cancellation with two layer of g-iron.
- Field scans with phidgets mounted on gantry arms.
- Calibration of offsets in magnetometer on phidget using accurate Gaussmeter (up to 0.1mG).

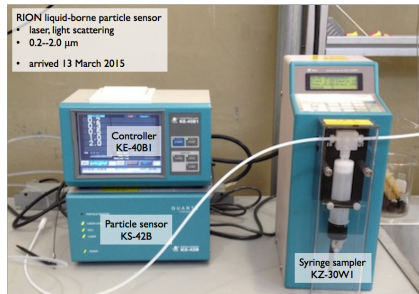
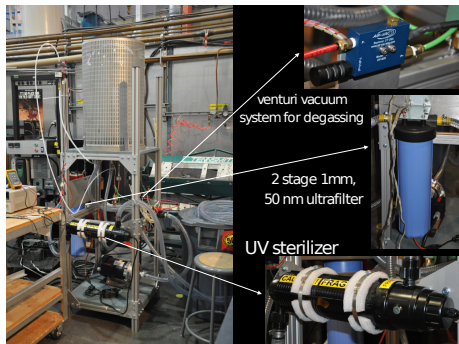


Light tightness



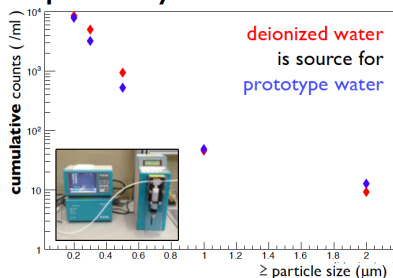
- Created an inner area in the PTF room with two layers of dark curtains in U-shape.
- Walls, floor and dominant reflective surfaces painted black.

Water system



- Objective is same quality ultrapure water as Super-Kamiokande (and Hyper-K).
- UV sterilizer and 2-stage filtering system.
- RION particle counters for measuring water quality: sensitive between 0.2 and $2\mu\text{m}$.

preliminary first measurements



DAQ software

The screenshot displays the DAQ software interface with the following sections:

- Run Status:** Shows the current run status as 'Run 988 Stopped Start'. The start time is 'Wed Apr 8 14:49:15 2015' and the stop time is 'Wed Apr 8 14:50:18 2015'. The experiment name is 'midptf'. A message at the bottom indicates: '15:01:32 [feMove,INFO] Program feMove on host midptf01 stopped'.
- Equipment:** A table listing various equipment components and their status.
- Logging Channels:** A table showing the logging channel 'run0097su001.mid.gz' with 45571234 events, 1578.704 MB written, 78.9% compression, and 4.7% disk level.
- Clients:** Lists the 'Logger [midptf01.triumf.ca]' and 'mhhttpd [midptf01.triumf.ca]'.

Equipment	Status	Events	Events[/s]	Data[MB/s]
Motors00	(frontend stopped)	0	0.0	0.000
Motors01	(frontend stopped)	0	0.0	0.000
Move	(frontend stopped)	0	0.0	0.000
Scan	(frontend stopped)	9462	0.0	0.000
PTFDVM	(frontend stopped)	0	0.0	0.000
PtWiener_Old	(frontend stopped)	0	0.0	0.000
Scaler	(frontend stopped)	0	0.0	0.000
EnvTemp	(frontend stopped)	34285	0.0	0.000
Trigger	(frontend stopped)	45.410M	0.0	0.000
FEV173ORAW	(frontend stopped)	0	0.0	0.000
Phidget00	(frontend stopped)	0	0.0	0.000
Phidget01	(frontend stopped)	0	0.0	0.000
Phidget02	(frontend stopped)	343101	1.0	0.000
Phidget03	(frontend stopped)	343102	1.0	0.000
Phidget04	(frontend stopped)	343105	1.0	0.000
PtWiener	(frontend stopped)	0	0.0	0.000
Motors	(frontend stopped)	0	0.0	0.000

Channel	Events	MB written	Compr.	Disk level
run0097su001.mid.gz	45571234	1578.704	78.9%	4.7%

- DAQ through MIDAS: steering and readout of the motors, sensors, voltages and PMTs.
- Collision avoidance for gantry heads implemented in software
- User friendly interface for taking measurements.
- Several measurement sequences (“scans”) can be easily defined in user interface.
- Automatic MIDAS to ROOT file conversion for fast analysis.

Installation of PMTs in PTF for measurements in air

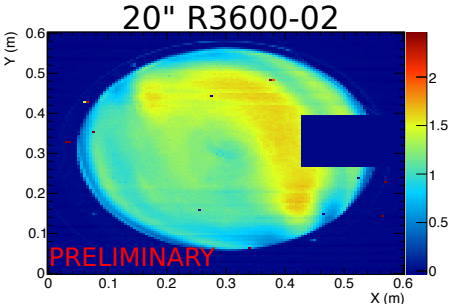
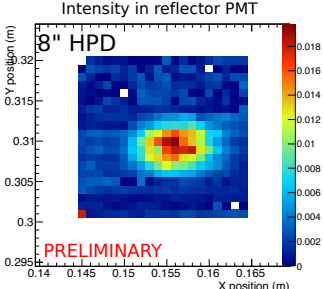
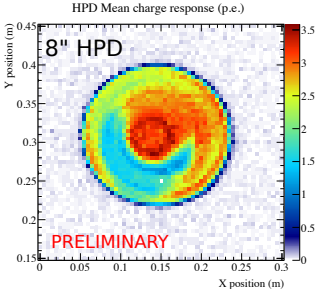


- Prototype 8" HPD arrived July 2014.
- 2 20" SK PMTs and 1 HQE 20" PMT arrived February 2015.
- Performed first test measurements of 20" PMT in water in Summer 2015.
- Currently performing measurements on 8" DEAP PMT in air.

Super-K PMT in water in the PTF



Measurements at the PTF



Summary

- The Photosensor Testing Facility is operational and performing detailed measurements of the optical properties of large area PMTs in water.
- First Super-K 20" PMTs measurements in water started last Summer.
- The PTF is versatile: Currently performing some short term 8" PMT studies for DEAP.
- Fall 2015 - Spring 2016 : Continue detailed measurements of standard and HQE 20" PMTs in air and water.

THANKS

UBC, TRIUMF and visitors:

Sophie Berkman, Ben Krupicz, Patrick de Perio, Wayne Faszler, Tom Feusels, Mark Hartz, Akira Konaka, Harish Kugel, Thomas Lindner, James Linqiao Liu, Philip Lu, Andy Miller, David Morris, Corina Nantais, Yasuhiro Nishimura, Carl Reithmeier, Fabrice Retière, Sourav Sarkar, Mark Scott, Nils Smit-Anseeuw, Yusuke Suda, Hiro Tanaka, Shimpei Tobayama, Peter Vincent, Michael Walters, Michael Wilking, Stan Yen, Aaron Zimmer