

Considerations for Calibration Source Deployment in Hyper-Kamiokande

H. A. Tanaka (UBC/IPP)

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Motivation:

- The calibration program at SK is the natural starting place for developing the HK calibration program
 - the physics topics and detectors are to first order the same
 - to first approximation we should consider reproducing all the calibration capabilities that are present in SK
- The detectors/physics goals are not exactly the same
 - opportunity for optimization in capability and efficiency
- The capability to deploy various sources (radioactive/optical) at various places in the detector is needed
 - Enables PMT calibrations, water optical studies, reconstruction performance, etc.

SK calibration portals



Nucl. Instrum. Meth. A501(2003)418-462



- Portals situated radially across the top of the detector
- Motorized spool precisely translates source vertically to any depth
- Dark environment provided by moveable tent positioned above the portal



Detector Geometry

CROSS SECTION Measurement Facility Area 48000 F.W.L 30000 -5500 54000 8000 R30000 P27095 Detector Concrete Lining(5mm) Bedrock **Outer Water Tank** Δ 24000



 10 optically isolated detector modules must be individually calibrated

• Volumes under curved areas are difficult to access vertically

• From time/manpower and "dynamic range" considerations automation may be desirable

F. Duncan Neutrino 2000, "The SNO Optical Calibration System"



- Deployment system to position source in two planes of the detector
- Movement effected by tension in ropes
 - fully automated and remotely controllable
- "Universal Interface" with glove box allows source interchange in light/air-tight environment
- "Umbilical cord" provides services such as optical fibers and power
- Electric touch plates deployed to calibrate position

- Disclaimer:
 - I am not a SNO collaborator nor have ever used this system
 - SNO collaborators tell me that the system was use reliably and effectively throughout the experiment's lifetime.



thanks to R. Helmer (TRIUMF)

SNO(+) UI



New UI for SNO+ at TRIUMF

- "Universal Interface"
 - provides light/air tight portal into the detector
 - glove box to interchange sources



Umbilical Cord



 watertight conduit for optical/ electrical services to the source

• as source moves:

- mechanical protection for optical fiber from bending/ stretching/crushing
- allows friction-free "slipping" between fibers
- Technical tour-de-force in order to pass elements through 30.5 meter outer silicone tube before silicone compound sets (~hours).
- May be less complicated if manipulation of light source is not needed.

KamLAND Manipulator



B.E. Berger et al. JINST 4 (2009) P04017

 Different concept using "pole" rotated/positioned by cables







Conclusions

- Calibration strategy may affect detector design/technology choices
 - and vice versa (e.g. water circulation)
- A calibration manipulator system may be well-suited as a Canadian contribution to HK.
 - Two generations designed/built for SNO/SNO+
 - Control systems also within TRIUMF expertise.
 - about the right "size" for Canadian contribution
 - collaboration with other groups is desired/essential to explore possibilities and find the most effective solution
 - solutions may not be exclusive
 - more than one solution may be desired to achieve goals