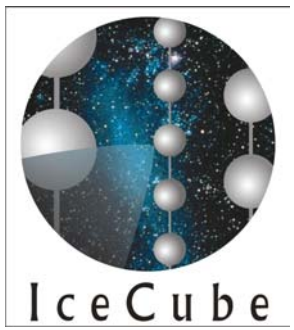
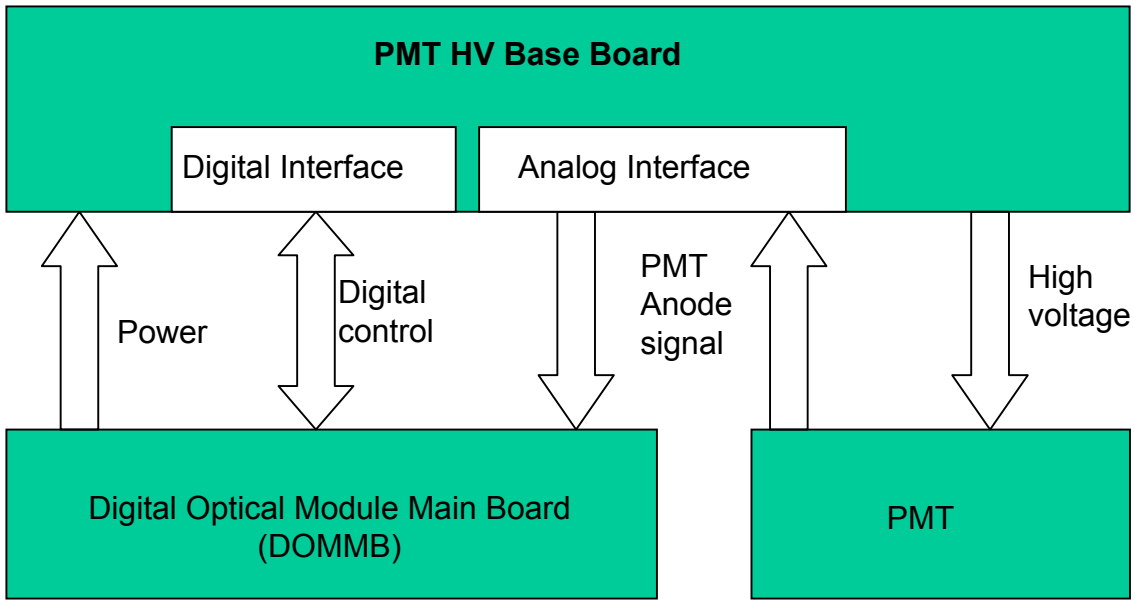
PMT High Voltage Power Supply Status



Nobuyoshi Kitamura

University of Wisconsin-Madison

Overview

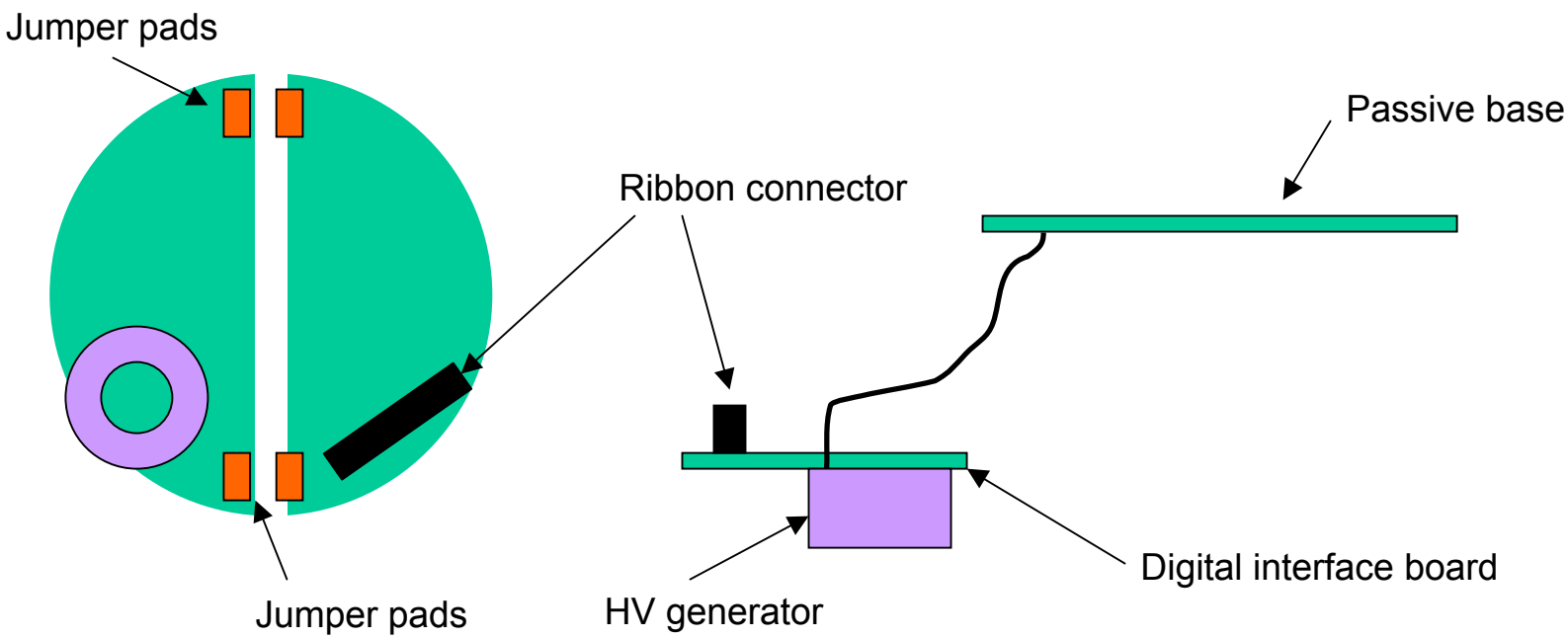

PMT HV Base Board
Digital Interface
Analog Interface
Power
Digital control
PMT Anode signal
High voltage
Digital Optical Module Main Board (DOMMB)
PMT

The Three Prototypes

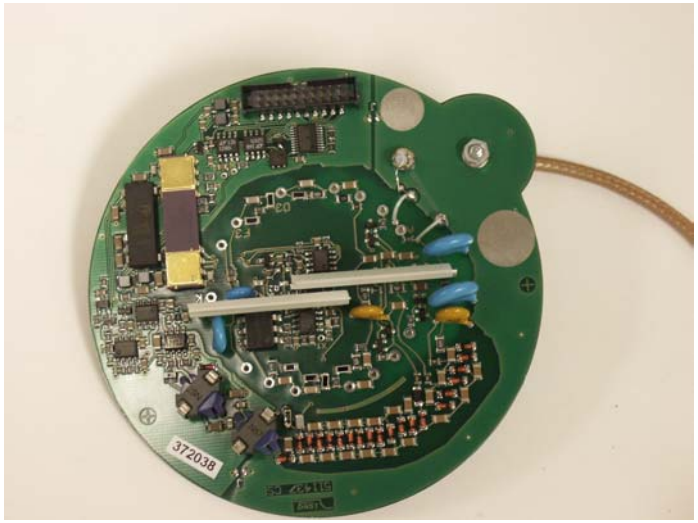
"**Old Iseg**"—Aug. 2002 prototypes

"**New Iseg**"—Split ground implemented.

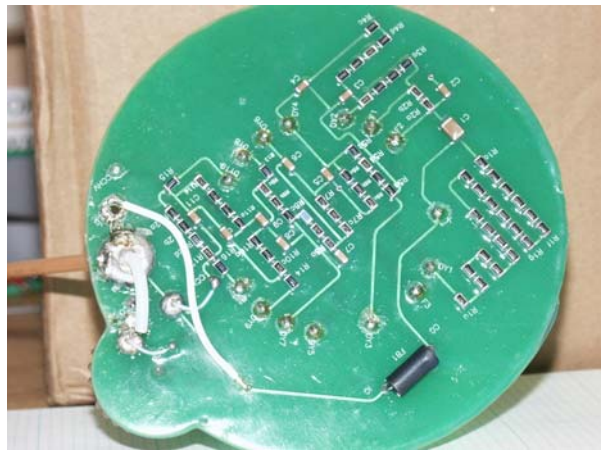
"**EMCO**"—Passive base approach consisting of three components:
Passive base, HV generator, & digital interface.



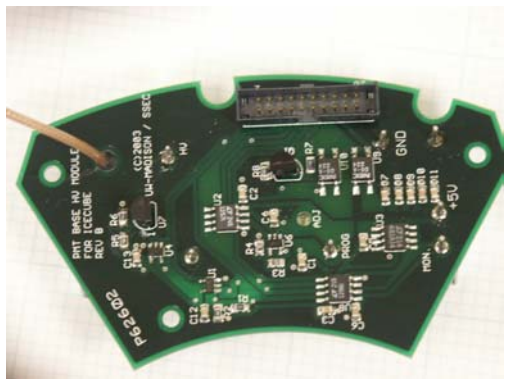
Photos



"New Iseg"



EMCO Passive Base



HV Control Board

EMCO HV Generator

Treat Them Equally

Every effort was made to make the DOMMB interface uniform among the three prototypes.

Chronology—2003

Feb.	20	EMCO reps visit UW-Madison
Mar.	11	Iseg head visits DESY / Zeuthen
Apr.	28	EMCO generators (20) and bases (20) arrive
May	9	Operate EMCO generator with DOMMB
	29	New Iseg bases arrive (8)
June	24	New Iseg bases arrive (22)
July	23-24	LBNL Workshop ➔"Old Iseg will do!"
Aug.	12	IceCube report on proto evaluation by NK
	14	Comments on proto sent to Iseg
	22	Request for technical information from Iseg
	26	The "crack incident"
Sep.	8	NK report ➔"Refocus on EMCO"
	19	Trip to EMCO
Oct.	1	PO for samples (4) sent to EMCO

The Three Prototypes (summary)

Old Iseg or New Iseg?

- New Iseg with isolated grounds performs *badly*
- New Iseg with directly connected grounds performs *badly*
- New Iseg with 1MΩ jumper performs very similarly to Old Iseg
- Old Iseg is cheaper than New Iseg
- Old Iseg consumes less power then New Iseg

➔Old Iseg

Iseg or EMCO?

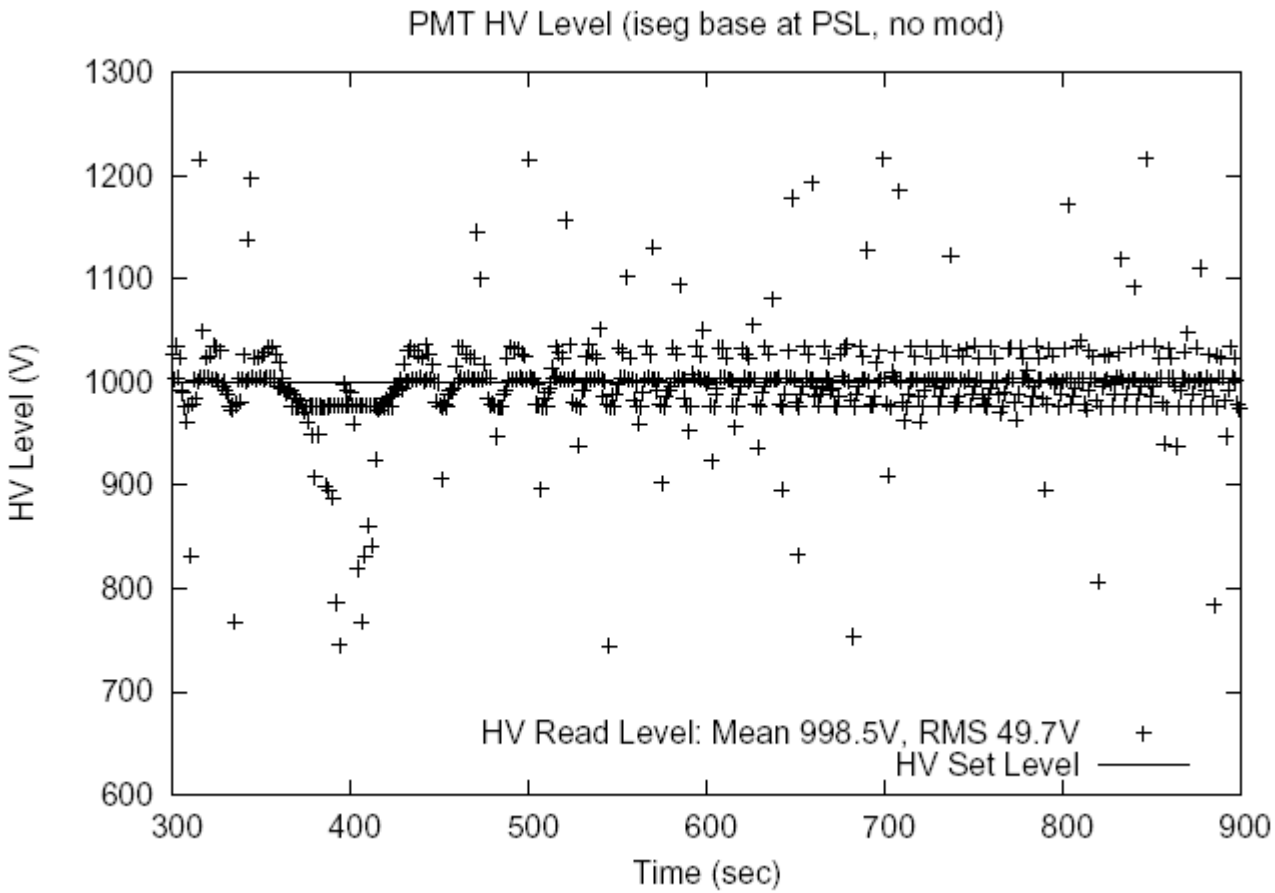
- Both have similar noise levels
- Vdy1 is fixed in Iseg approach
- Iseg is cheaper than EMCO

➔Iseg

Trouble with the “New Iseg”

New Iseg--Isolated Ground

Output voltage is *very* unstable with no ground-connecting jumper

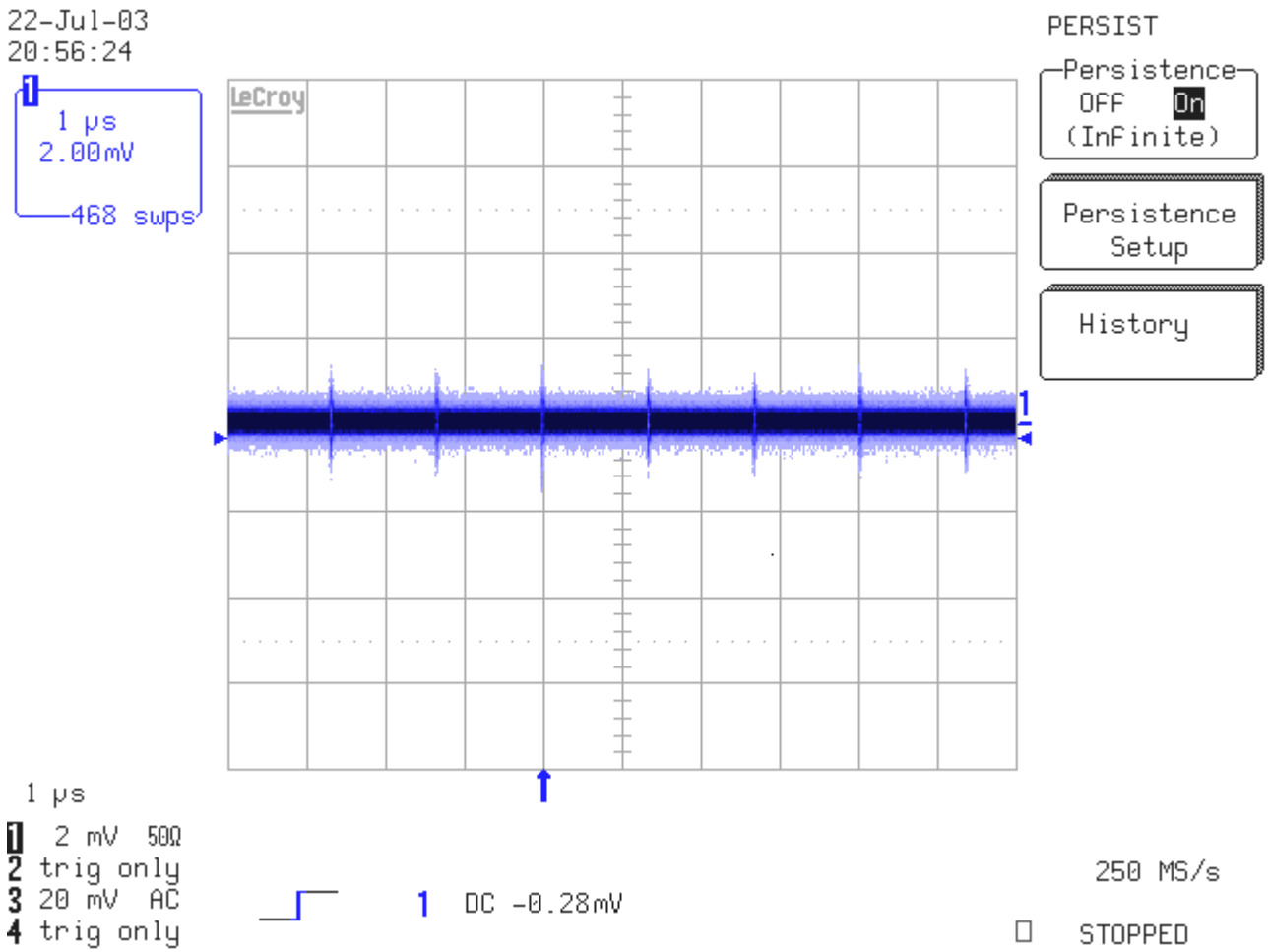


Previously reported at LBNL Workship (July 23-24, 2003)

Data by John Kelly
(hv_2000_iseg_psl.pdf)

N. Kitamura 7/23/2003

Connecting Grounds with a Zero Ω Jumper



Previously reported at LBNL Workship (July 23-24, 2003)

N. Kitamura 7/23/2003

Comparison using DOMMB ATWD

http://www.ssec.wisc.edu/~kitamura/HVstatus081203/PMTBaseComparisonWithATWD1.pdf

Noise Comparison

All the bases have similar random noise levels observed at the secondary side of the signal coupling transformer.

		ISEG OLD	ISEG NEW	EMCO
NOISE AT OUTPUT*	mVpp	1.22 ± 0.13	1.26 ± 0.13	1.12 ± 0.21
	μVrms	214 ± 18	208 ± 18	215 ± 31

*At 50Ω oscilloscope input using a 50Ω cable. 100 nsec window (400 pts.)
The scope background is 1mVpp, 190μVrms over 100 nsec.

Previously reported at LBNL Workship (July 23-24, 2003)

Overall Comparison

		ISEG OLD	ISEG NEW	EMCO
NOISE AT OUTPUT*	mVpp	1.22 ± 0.13	1.26 ± 0.13	1.12 ± 0.21
	μVrms	214 ± 18	208 ± 18	215 ± 31
1ST DYNODE VOLTAGE		FIXED (600V)		SCALE WITH OUTPUT
POWER AT MAX OUTPUT (mW)		130	280	250
COST (US$)		~150	~260	~600

*At 50Ω oscilloscope input using a 50Ω cable. 100 nsec window (400 pts.)
The scope background is 1mVpp, 190μVrms over 100 nsec.

Previously reported at LBNL Workship (July 23-24, 2003)

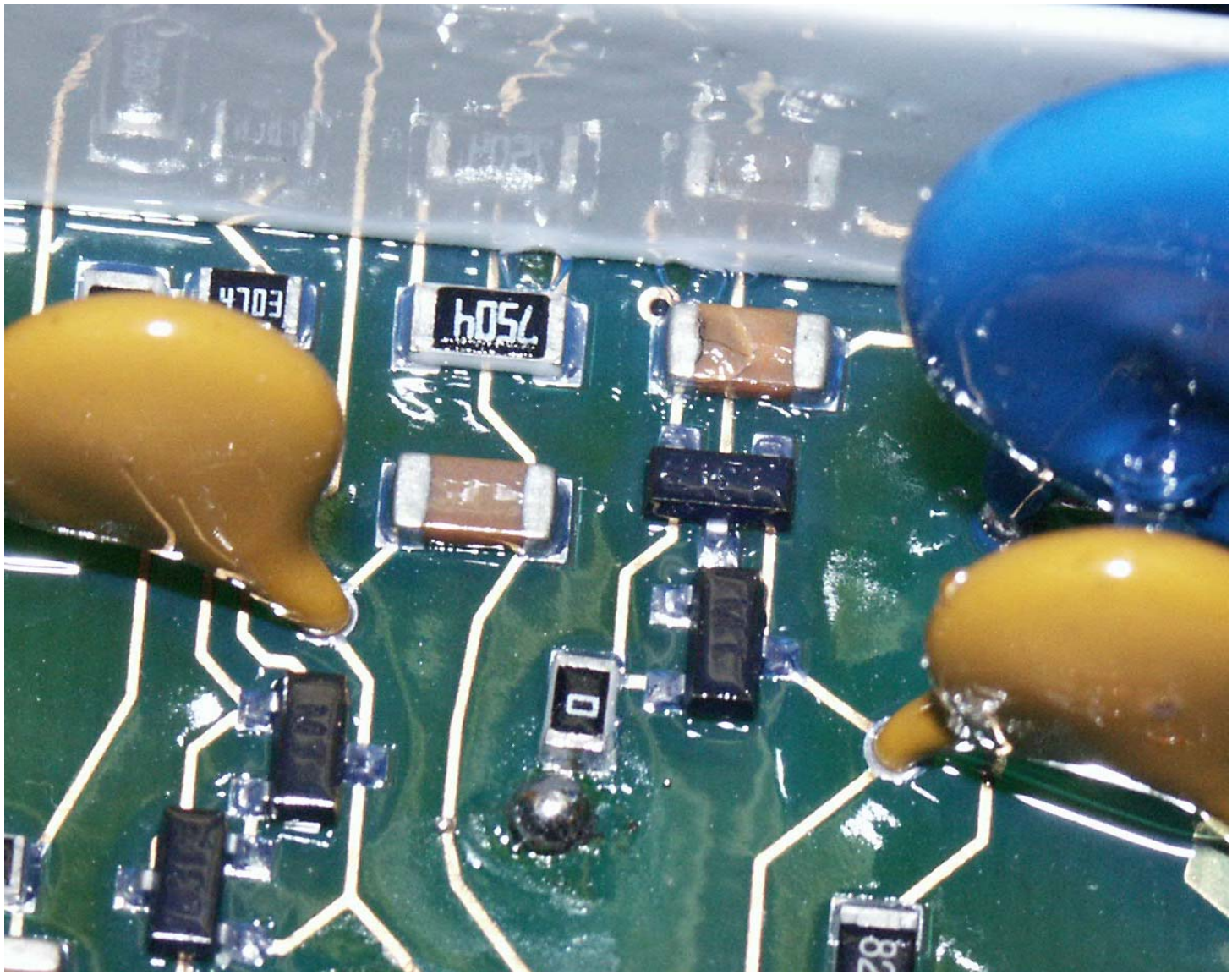
Thoughts at the End of July, 2003

- Select and pursue “Old Iseg”-style design
- Need further tests
- Must improve communication with vendor
- Must examine design details
- Conduct Failure Modes and Effects Analysis (FMEA)

Layout Examination

http://www.ssec.wisc.edu/~kitamura/HVstatus090803/lseg_photos2.pdf

Failure of an Old Iseg Board



Recommended Action

... drop Iseg as our primary candidate of the PMT HV Base board supplier and bring the alternative vendor to our focus.

--NK's report dated September 8, 2003

http://www.ssec.wisc.edu/~kitamura/reports/HVstrategy.pdf

EMCO High Voltage Corporation

- Located in Sutter Creek, California, USA
- In HV business for 30+ years
- Has delivered twenty (20) each of HV Generator and PMT Base Board
- The prototypes performed as specified in all tested parameters

Trip report by NK:
http://www.ssec.wisc.edu/~kitamura/reports/EMCO_trip_rpt.pdf
Trip report by George Anderson:
http://www.ssec.wisc.edu/~kitamura/reports/Emco%20Meeting%20Report%209.19.03.pdf

Buying 5000+

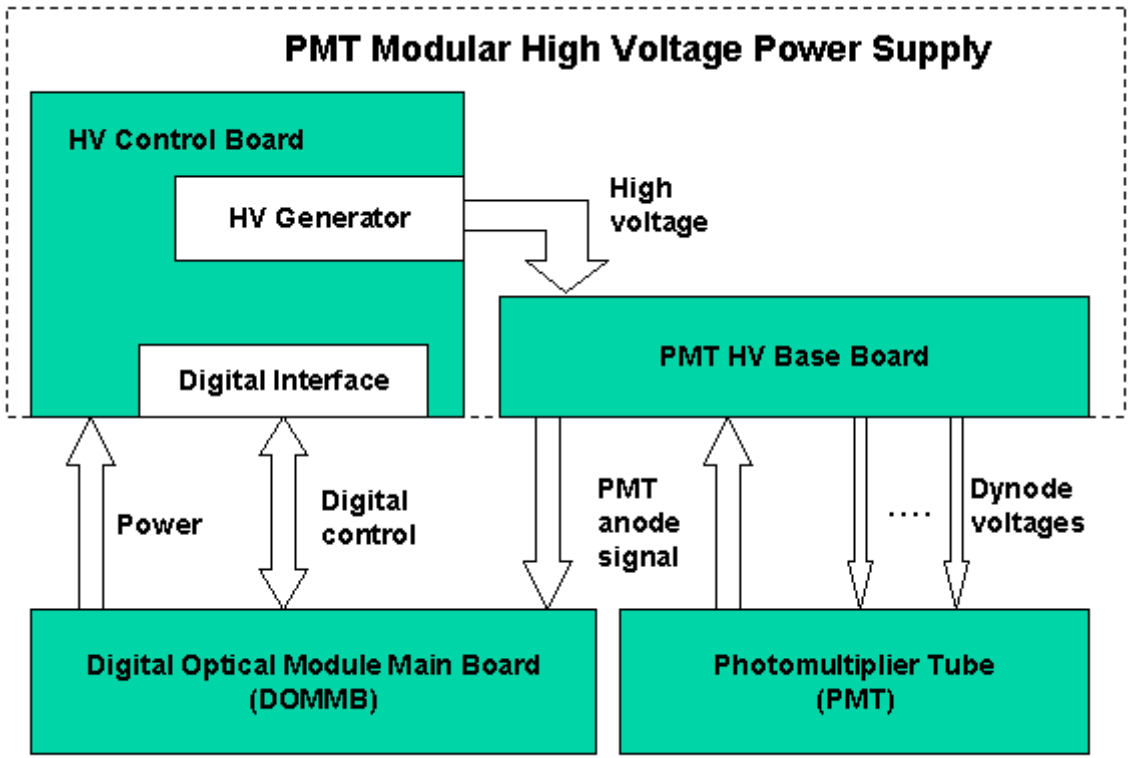
Bidding process is necessary

In process:

Define / refine specifications

Requirements & Specifications

- PMT Modular HV Power Supply ERD
- HV Control Board Specification Control Drawing
- PMT HV Base Board Specification Control Drawing
- HV Generator Source-Controlled Drawing



Requirements Documents

PMT **Modular** High Voltage Power Supply Requirements Document (9000-0039-02*)

"Passive Base"

PMT High Voltage Board Requirements Document (9000-0039*)

PMT High Voltage Power Supply Requirements Document (9000-0039-01*)

*George Anderson has been maintaining these documents.

Improved Specifications

- **PMT Base Board**
  - New pulse-coupling transformer design
  - Through-hole components
  - Additional RC filter at HV entry
  - Improved output cable attachment

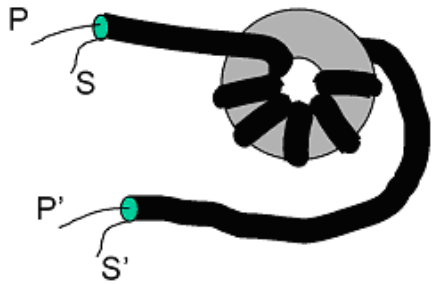
- **HV Generator**
  - "HV_DISABLE" pin is added
  - Modified MON and PROG analog range
  - Higher-voltage-rated output cable
  - Eliminate GAIN_ADJ trim-pot

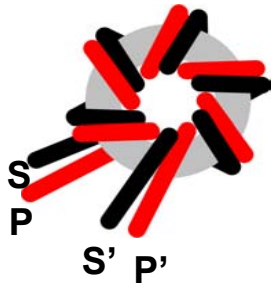
- **HV Control Board**
  - Higher reliability due to fewer components (delete three ICs)

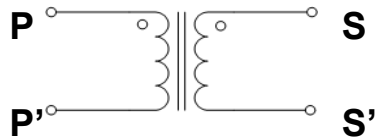
http://www.ssec.wisc.edu/~kitamura/HVReview_091603.htm

PMT Base Board

Toroidal Transformer



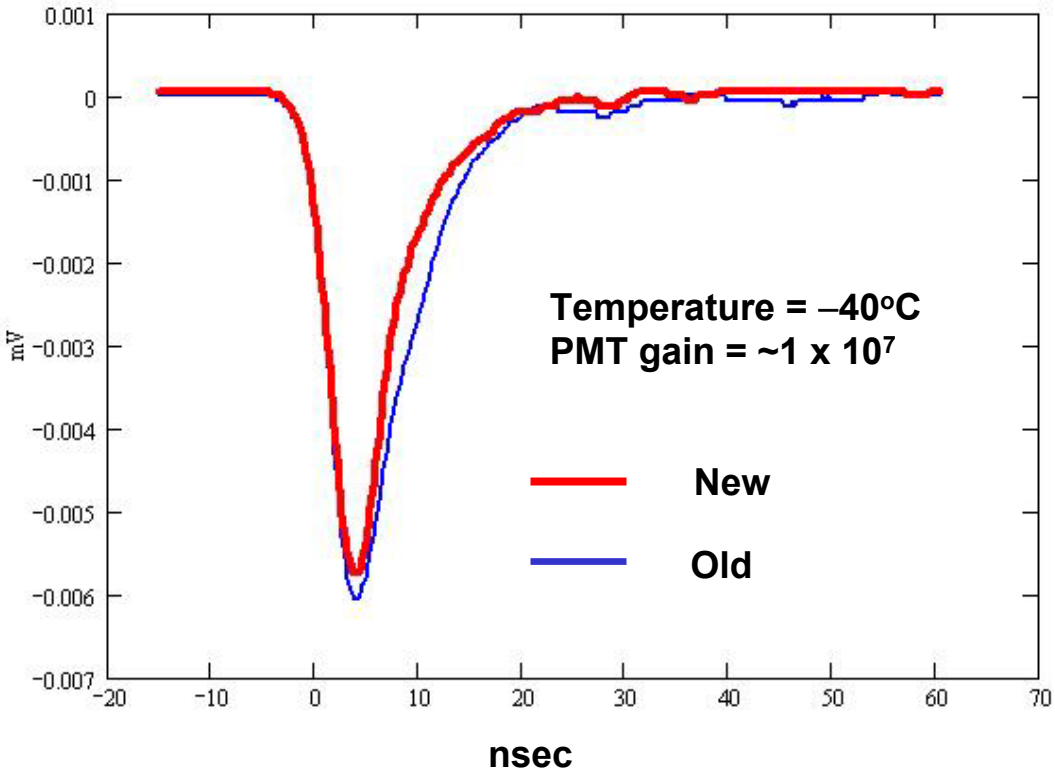




Old Transformer
RG178 coaxial cable
➔Rated at 1000Vrms

New Transformer
22 AWG silicone-insulated bifilar
➔Rated at 10kV

Toroidal Transformer Response



Each curve is an average over 1000 triggers.

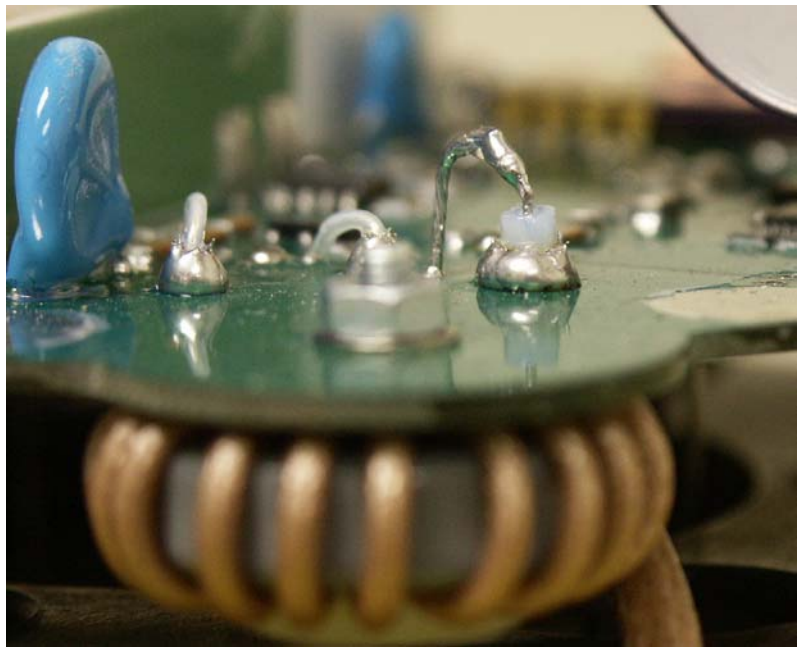
Laboratory HV supply with an EMCO passive base was used.

The bifilar transformer performs better!

http://www.ssec.wisc.edu/~kitamura/toroid.htm

Output Cable Attachment

Proposed



Iseg

EMCO

HV Generator

Spec changes:

- Change PROG range from 0..4095V to 0..2047V
- Change MON range from 0..4095V to 0..2047V
- Add “HV_DISABLE” pin (No reliability penalty. Optional usage)
- Eliminate GAIN_ADJ trim-pot (No need for absolute accuracy)
- Use higher-voltage-rated output cable

➔ Overall simplicity and increased reliability

HV Control Board

Spec changes:

- Change PROG range from 0..4095V to 0..2047V
  - ➔ Eliminates x 2 OP-AMP
  - ➔ Eliminates –5V power switch

- Change MON range from 0..4095V to 0..2047V
  - ➔ Eliminate 0..4096V REF

➔ Overall simplicity and increased reliability

Tasks Ahead

- Test Rev 3 Main Boards with the EMCO passive base / HV generator.
- Test new EMCO samples (4) with Rev 3 Main Boards
- Have EMCO deliver 60 each of the PMT Base Board and the HV Control Board (including the HV Generator)
- Complete specification control drawing for the bid package
- Create verification plan

Conclusion

Just as System concluded after the recent PDR, mature in design but weak in verification.