UNI BASEL

Manual/Datasheet Preamplifier SP883d

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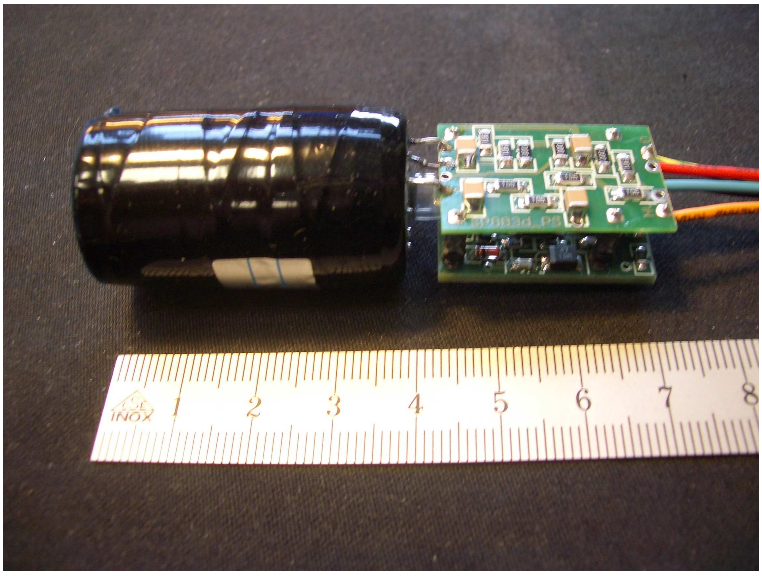

Photo: Preamp SP883d soldered to Hamamatsu VPT

Main Features of low noise/low power charge preamplifier model SP883d

- Low noise (high resolution) relative to power consumption
- For Vacuum Photo Triodes (VPT), Photo Tetrodes (VPTT) & APD
- Completely analog electronics
- Single ended, AC-coupled 50Ω positive signal output
- Integrated low power HV-Divider(Bleeder/Bias) for up to 1,5kV. Space saving, significant less cables (1 instead of 3)!
- Integrated low & high voltage power supply filter
- Reduced dimensions (length 28mm), short “stamp” format
- Two separate boards (PCB), without PCB-connectors
- Low cost with components of the shelf
- Operation at -25°C, radiation and magnetic fields
- Fast rise time (<20ns) for energy & time measurements
- Single range: reduces ADC-channels (cost), power, space
- Driver for signal transmissions integrated (drives 50 Ohm standard coaxial cables)
- Easy operation: Power supplies (LV+HV) in -> Signal out

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Precautions

Electronic circuits can be damaged by Electrostatic Discharge, ESD. It is strongly recommended that all devices be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from performance degradation to complete device failure, sudden or while operated.
ESD is produced by walking on floors, through friction on isolating surfaces, shoes, clothes, etc.
Basic methods are not to touch, use conductive ESD-bags to store and grounding strips when handling the device.

Concept of the Panda Electromagnetic Calorimeter EMC readout

The Low Noise / Low Power Charge Preamplifier (LNP “Basel”-Preamp) is a discrete charge preamplifier which has an excellent noise performance in combination with low power consumption. It is designed for the readout of Photodetectors for the Panda Electromagnetic Calorimeter (EMC). The Photodetectors (LAAPD, VPT, VPTT) are attached to the end face of the lead tungstate scintillating crystals (PWO-II) which have a typical geometry of (200 x 20 x 20) mm^3. In comparison to a photomultiplier, theses photodetectors are working better in a strong magnetic field. Further, the vacuumphotodetectors as Vacuum-Photo-Triode (VPT) and the Vacuum-Photo-Tetrode (VPTT) are better for high radiation which occurs in the center of the forward endcap than the semiconductor device LAAPD. Therefore the barrel and the backward endcap of the EMC is equipped totally with LAAPDs and the forward endcap works with VPT/T’s and LAAPD’s dependent of the region. These devices act as photo detectors converting the scintillating light to an electrical charge. Then, the LNP-Preamp linearly converts the charge signal to a positive voltage pulse which is transmitted via a 50 Ohm line to the subsequent electronics.
Since the complete EMC including the preamplifiers will be cooled to -25℃ (to increase the light-yiel d of the PWO-II crystals), the power dissipation of the preamplifier has to be minimized. Low power dissipation leads to a smaller cooling unit and thinner cooling tubes; it also helps to achieve a uniform temperature distribution over the length of the crystals. The LNP-Preamp has a quiescent power consumption of 45 mW. The power dissipation is dependent on the event rate and the photon energy; at very high rates combined with the maximum photon energy, the power consumption is increased up to 90 mW.

Introduction

This LNP Preamplifier was built for applications where low noise and low power consumption is essential, as specially for the PbWO-crystal read-out of Panda Calorimeter at GSI, Darmstadt. Other preamps with lower noise are on the market but with higher power consumption.

The model SP883d is the latest version of a family of preamps originally designed for APD with a capacitiy of up to 500pF (f.e. two paralleled Hamamatsu S8664-1010 or S11048).
The output is a positive low noise single ended 50Ω-signal, useable for energy and timing measurement. Therefore no shaping is on board, this must be done externally. The shaping time for energy measurement defines then the noise. While the signal/noise ratio with VPT is comparable to those with APD, the absolute signal and noise level is much lower and therefore the sensitivity is higher and all activity to prevent from noise must be even better.
The influence of the noise from the preamplifier is proportionally higher in relativity to the vacuum photodetector with lower capacitance.

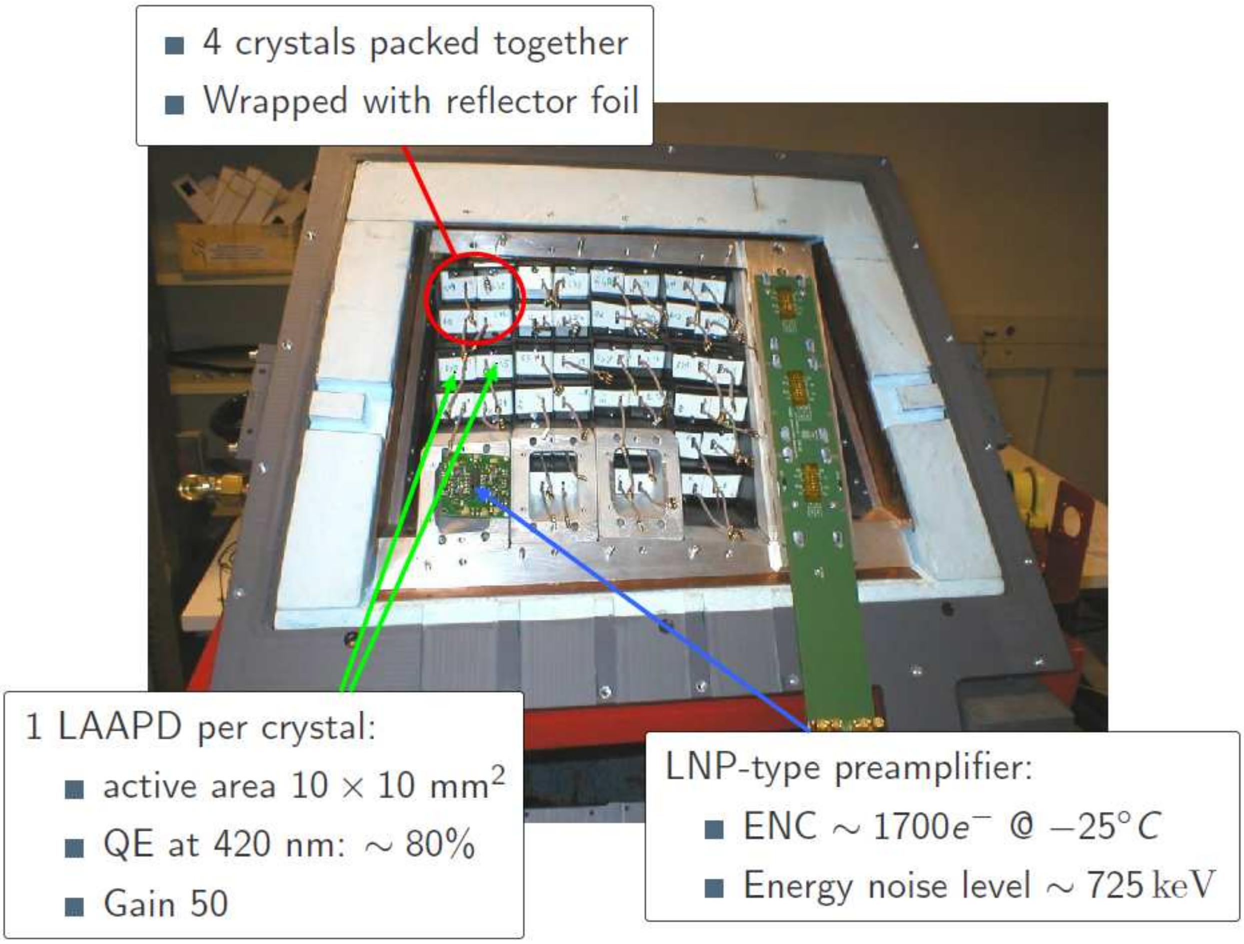
The realized mechanical shape was choosen to fit into the foreseen space for the Proto 192 (ca. 200 channel) for the Panda FW endcap also with the longer glass-tubes from Hamamatsu. The Preamp is foreseen to work at -25℃, but can al so be operated at higher temperatures, but with more noise (around +20% @ 20℃).
Vacuum Photo Tubes are not highly temperature sensitive in comparison to the APD's and isolate the Preamp termally from the crystal. With APD's an additional temperature barrier or distance is necessary.

A low power HV-divider circuit for up to 1.5kV is also implemented. This low power circuit is a new method, because manufacturers of tubes recommends higher power consuming bleeder circuits. Hence it was possible to implement the divider on the preamp itself in the cooled - and therefore power loss critical sector- of the detector. This innovative concept reduces not only problematic temperature gradients to the photodetector and the crystals, but also the amount of HV-cables and therefore space and cooling losses.
To implement the additional HV-circuit on the reduced area, the preamp was split into two PCB's. In addition, it prevents from leakage currents to the input of the amplifier stage. Each type of photodetector needs his very own typical divider-circuit which is placed on one of the two boards. As tradeoff this results in slightly more noise.
A precise power-on-point HV-generation onboard ("active base") is not foreseen due to additional heat generation and the magnetic fields at that point. The use of unshielded magnetic components as inductors for power conversion and filtering is problematic.

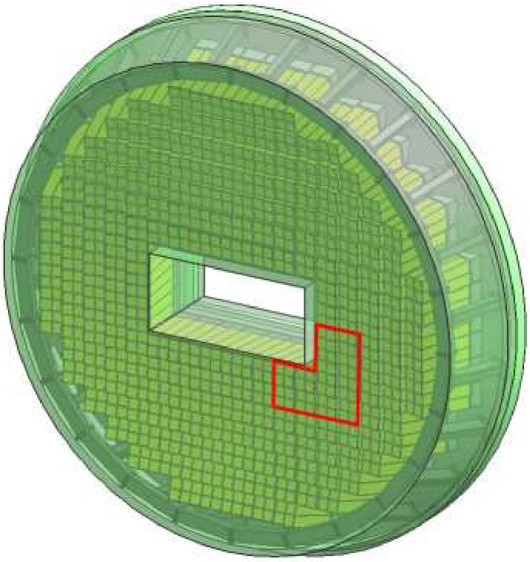
The leave out of connectors reduces material, volume, costs and weight and increases reliability. The preamp is connected to the next signal chain stage (either a shaper or a distribution panel) via short wires/cables/PCB and the connection to the photodetectors is also short.
The preamplifier is made of commercial standard low cost components of the shelf.

An adapted version for use with APD's is also available. The appropriate HV-circuit (filter) which works also as an interconnection to the APD's is designed for two preamps/crystal of either type SP883d (18x28mm) or SP883a02 (18x48mm).
This version has reduced series filter resistance to reduce the voltage drop at high rates.

Panda EMC Barrel Proto60 (Picture Tobias Eissner)
Uni Basel, IPN Orsay, Uni Giessen, etc.



Panda EMC Forward Endcap Proto 192 (red marked)
Uni Basel, Uni Bochum, etc.



Main Challenges

- Low noise at low power
- Signal transmission/output voltage/dynamic range
- Low overall cost/easy operation
- Energy and time measurement (no onboard-shaper)
- Max. Rate/pile-up
- Low power loss HV bleeder for operation in cooled areas
- Flexible design for different photodetectors APD/VPT/VPTT

Family of LNP preamplifiers

Since the APD-Version of the preamplifier was developped years ago and many measurements and tests were performed with it, refer to the datasheet SP883a02 or the TDR 2008 for specific data for use with APD's. The actual version SP883d and the new types of vacuumphotodetectors were developed in 2010. Therefore they are still in test phase. Below an overview is shown:

Model/Type No.	Photodetector	max. HV	Description
SP883a			APD single channel family, 18x48mm, PCB: 0.8mm
SP883a01	APD 10x10mm	500V	
SP883a02	APD 10x10mm	500V	compensation for up to 500pF
SP883a02_1000V	APD rectangular	1000V	With 1000V capacitors (Bias APD: ca. 650V) compensation for up to 500pF
SP883b	APD 10x10mm	500V	quad channel (Proto60), 46x46mm
SP883c	VPT metal Hamamatsu	1000V	without onboard HV divider, PCB: 4-Layer 1.6mm
SP883(c)d		1500V	Prototyp: Umbau von SP883c auf Funktion v. “d“
SP883d		1500V	Combi family (APD/VPT/VPTT), “stamp-format”, 2 PCB à 18x28mm, with onboard HV-Divider
SP883d_VPT(Ham)	VPT glass, Hamamatsu	1500V	with onboard HV-Divider for VPT (750V)
SP883d_VPTT(Ham)	Tetrode glass, Hamamatsu	1500V	with onboard HV-Divider for VPTT (750V)
SP883d_VPTT(RIE)	RIE	1500V	with onboard HV-Divider for RIE VPTT's (1200V)
SP883d_APD	APD rectangular	450V	3MΩ-filter for 2 APD-Bias, mit 100pF*compensat.

100pF*-Compensation value is implemented (designed for VPT/T). This may cause to a little slower rise time but better stability. Standard value for APD is 47pF.

Note: type number key, Example SP883d01_APD:

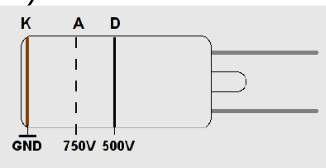
SP Schematic Plan
883 Projectnumber Electronics Lab Physics Basel for the Panda EMC Preamp
d Model/Type/Version
01 Revision 1
_APD variante/adaption

For use with Photodetectors, f.e. for following devices:

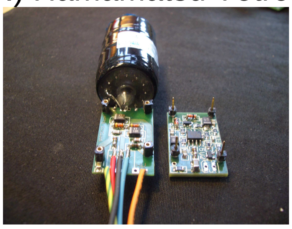
Model	Type	Notes
Hamamatsu LA APD S8664-1010	APD, ca. 450V	270pF, square 13.7x14.5mm(10x10)
Hamamatsu LA APD S11048	APD, ca. 450V	270pF, rectangular 9x18mm(6.8x14)
Hamamatsu LA APD Low capacity (not radiation hard)	APD, ca. 630V	…pF, rect. 9x18mm (6.8x14)
Hamamatsu Photo-Triode R2148, short glass (Proto)	VPT, 750V	
Hamamatsu Photo-Triode R2148MOD, short metal	VPT, 750V	(shielded “Kovar” FeNiCo can), ∅24x 30mm
Hamamatsu Photo-Triode R11375 MOD3	VPT, 750V	∅24x 40+10mm
Hamamatsu Photo-Tetrode R11375 MOD	VPTT, 750V	∅24x 40+10mm
Research Institute Electron (RIE, St. Petersburg) Photo-Tetrode	VPTT, 1200V	∅22x 32+…mm
RIE FEU-189 (21mm), IHEP/MELZ	VPT	
RIE FEU-190 (25mm), IHEP/MELZ	VPT “CMS”	
Other: Photonis, ET, …	Prototype	

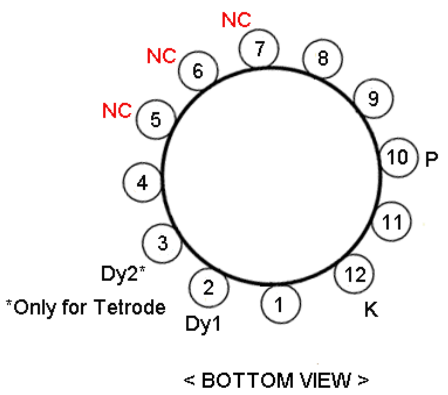
Photodetectors

a.) Hamamatsu Triode R11375MOD3



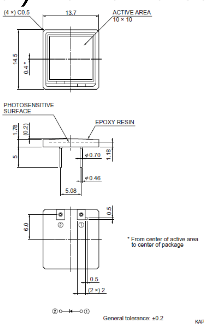
b.) Hamamatsu Tetrode R11375MOD

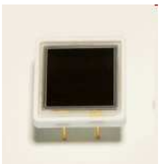


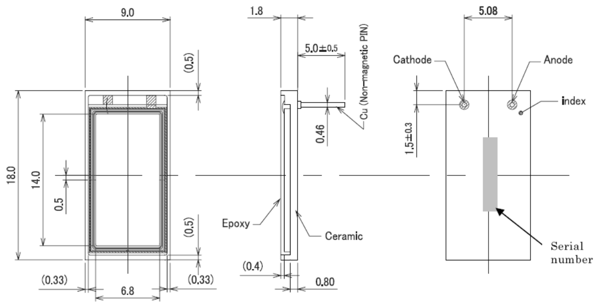


Hamamatsu Pin numbers (new version)

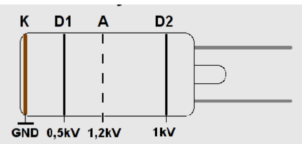
c.) Hamamatsu APD S8664-1010 and S11048 ("rectangular"), datasheet available

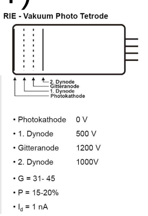


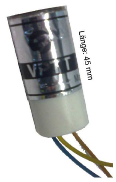




d.) RIE Tetrode (VPTT)



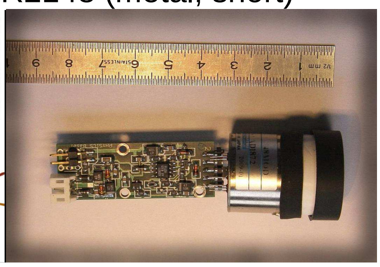


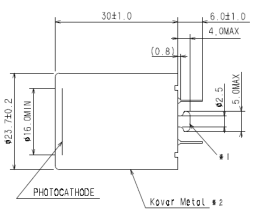


Thanks to Michael Leyhe, RUB, 29.1.2010
VPTT (RIE) with silicone Isolation and protection

VPTT (RIE) without silicone potting

e.) Hamamatsu Triode R2148 (metal, short)





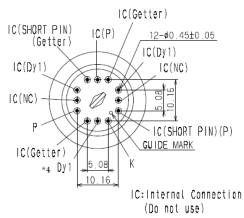


Photo: R2148MOD connected to LNP Version SP883c

Short Data

Max. Bias Voltage	+1500VDC
Power Supply, floating	max. +/-6V, +6mA/-1.5mA
Quiescent power consumption	45mW
Power consumption (depending on rate and energy)	90mW
Max. single pulse input charge	4pC
Max. 500 kHz burst event rate input charge	0.3pC
Max. continous 500kHz event rate input charge	8pC
Output Signal	ca. +0.5V/pC@50Ω
Max. output voltage	>+2V@50Ω
Output impedance	50Ω
Rise Time (with input load/detector capacitance 22pF)	ca. 15…<20ns
Feedback time constant	25µs
Input Load/detector capacitance	0…300pF
(SP883a02	80…500pF)

Typical noise performance

with RIE-Tetrode/1100V (Ti=250ns, Td=2µs)	ca.625e-RMS(1mVRMS)@+25℃
with Cd=270pF (Ti=250ns, Td=2µs)	ca.2500e-RMS@+25℃
*Typical noise performance @ Cd=22pF (shaping 200ns)	ENC 450/300e-RMS @-25℃
*Noise floor (shaping 200ns)	3MeV RMS
*Practical energy range/Dynamic Range (@VPT: 16aC/MeV)	6MeV…10GeV(250GeV)/1650

Typical noise performance with APD-Preamp SP883a02	ca.2100e-RMS@+25℃
APD Hamamatsu S8664-1010 (Ti=250ns, Td=2µs)	ENC = 1'700 e^-_{RMS} @ –25 ºC
Cd = 270 pF (Ti=250ns, Td=2µs)	ENC = 1'250 e^-_{RMS} @ –25 ºC
Cd = 82 pF (Ti=250ns, Td=2µs)	ENC = 510 e^-_{RMS} @ –25 ºC

Shaping (Integration 250 ns /Diff. 2 µs: Measured Noise RMS	@270 pF:2600e (@82pF: 900e)
Shaping 250 ns /250 ns Measured Noise RMS	@270 pF:2870e (@82pF: 1360e)

Operating Temperature	-25℃ …70℃
Humidity	non condensating
Dimension without wires	18 x 28 x ca. 10mm
Weight	>4g

*Measured on a modified single board prototype, by Michael Steinacher, 2008, Uni Basel

General remarks for operation

- This Preamplifier was designed to work directly with the VPT or VPTT from RIE or Hamamatsu, but can also be adopted for other detectors and mechanical designs.
- To save space, cables are soldered directly onto the PCB.
- The use of an AC coupled device has many advantages, as to prevent common mode GND-level problems and crosstalk, but might also cause problems, because the shift of the signal baseline on the trigger branch side at high and fast changing rates. To prevent this, the signal output is terminated with 50Ω. The transmission line (PCB/shielded flat or coaxial cable) and the input of the following shaping amplifier must have also 50Ω impedance.
- The output signal is about 0.5V/pC when terminated with 50Ω (1V/pC unterminated).
- The peak output is an optimised voltage for ADC-Inputs (2V).
- The Preamp has one single ended output and is therefore optimized for ADC‘s with 2.5V Inputs (f.e. Wiener, Struck, CAEN, etc.).
- The signal must be measured relative to its proper ground, as it is widely used in critical signal processing. Baseline restoring with shaper. Ref.: E. Kowalski “Nuclear Electronics”, Springer-Verlag, p.106ff, 163
- Prevent the preamp from electrostatic discharge (ESD), specially if the input is open (no VPT).
- Do not touch the boards because of creepage currents through salts from hands..
- Floating power supply +/-6V, f.e. from a NIM-Chassis, the Basel model SP903b or a laboratory power supply (alternatively +/-5V).
- Floating HV low noise power supply (often a linear regulated HV power supply as the Fluke 341A).
- The filter-circuit of the preamplifier is designed for positive HV, Max. voltage is +1500VDC
- The voltage divider is placed on the preamplifier with only one HV-wire to save space and thermal conductivity.
- The power consumption of the voltage divider is significantly lower than the original circuits recommended from manufacturers, to make an on-board divider possible for cooled experiments.
- The power consumption of the voltage divider is in competition with fewer cables/copper.
- A good 6-side shielding around the preamp must be provided to insure low noise operation. Connect the case shield to the preamp via mounting holes, cable shields, Supply-GND.
- To proceed low noise measurements all coaxial cables and connectors must be in perfect condition. Prefere BNC before Lemo for low level analog signals. Warm-up the instruments.
- The short rise time allows precise timing measurements (timing resolution down to under 2ns possible, depending on read-out
- NP0 Ceramic Capacitors are used in the critical signal path, X5R/X7R with appropriate temperature behaviour are used for decoupling and power supply filtering.
- Test pulse coupling via a 1 pF Capacitor
- For use in high magnetic fields (tested up to 1.2T, but more expected)
- The rectangular APD with smaller capacitance and higher bias-voltage (typ.+630V) is also possible, but they are less radiation hard.
- Radiation Hardness is not yet fully tested. Implementation of suitable technology: CMOS+JFET
- The "long tail" of the LNP-Preamp output results from the feedback-network (1 pF//25Meg). The resulting 25 us is a compromise between low-noise performance and high-rate capability (pile-up). In principle this time-constant can be reduced, but you will get more noise. The shaper after the preamplifier can reduce this fall-time without any problems as long as the preamp doesn't go to saturation due to pile-up.
- The "undershoot" of the signal results from the AC-coupling of the output. Proper adopting of the signsal by the shaper can solve this.

Power–up procedure

Low Voltage power supply (+/-6V) should switched on first, before the HV and therefore with signal. Normal operation is given with a supply current of around 6mA on +6V and 1mA on -6V. A higher supply current indicates ringing or defect.
Power up the HV via a ramp. If not, the ISEG HV-supply will switch off, because of relatively high current from loading the capacitors.

Application Hints for best operation

To get lowest possible noise it is essential to take extremely care of the construction.
A real measured noise level is: with good ground-connection 2.9mV (Ground via case and Power Supply), with a poor GND (only via coax-shield) 4.3mV. That's a difference of roughly +50%!

Source/Effect	Typical source	action
General		
Noise pick-up	wires to detector	Connect as close as possible to tube, f.e. VPTT (RIE) with socket/without silicone
Noise conducted	Switchmode Power Supply, motors, pumps, etc.	Low noise floating power supply, well filtered, shield cables
Noise radiated	Switchmode Power Supply, Digital electronics, PC	Distance, shielding
Noise exceeded		Increase shaping time (tradeoff pile-up)
Hum, noise	Ground loop	Only floating power supplies, starpoint ground
Cut-off	HV current limit	Ramp-up HV
HV changes	ISEG HV CAN Bus	Ignore result while traffic on CAN Bus
noise	ISEG HV CAN Bus	Ignore result while traffic on CAN Bus
Crosstalk/induction	Monitors, oscilloscopes, PC's	Distance, short shielded cables
Signal transmission	Reflections	50 ohm termination
Phantom pulses	Dielectric absorption/leaks in capacitors?	
	Schrotrauschen/Shot noise	
"Firework" of pulses	multiple HV Power supply voltages	1HV with HV-Divider ("Bleeder" circuit) instead
Afterpulses (duration 20 …100ns)	Luminous reactions of electrodes due to electron bombardment	Blanking if systematic time correlated
Afterpulses (0.1…10us)	Ionization of residual gas traces	Blanking if systematic time correlated
	Light leak from ambient	cover
Noise typ. 100kHz	noise of oscilloscope input amplifier, display +shaper	Calculate difference
Noise factor 2	Mismatched Impedance	Use correct termination (50ohm)
rms noise value	Capturing time/time base	use histogram mode rms
EMC		
Magnetic field	Stray fields (trafo, motor, pump)	Shield
Magnetic field	magnets	Shielded tube (f.e. Hamamatsu R2148)
Electric field	FL-ballast, Switchmode PS	6-side shield
Electrostatic damage	Triboelectricity, touching	Conductive packaging, don't touch
Ambient		
Microphony	Sound, vibration, shock	Silence, mech. decoupling
Humidity/moisture	Cold-warm cycles/bedewing	drying
Temperature		Cooling for noise reduction
Creep currents	Dust/grease/salt (from hands)	don't touch preamp & photodetector
Spontaneous avalanche		
Spurious pulses	Myon	With crystals
Defects photocathode	Light	Do not operate & wait after exposure
Arcing	HV	Isolate preamp
	contamination	

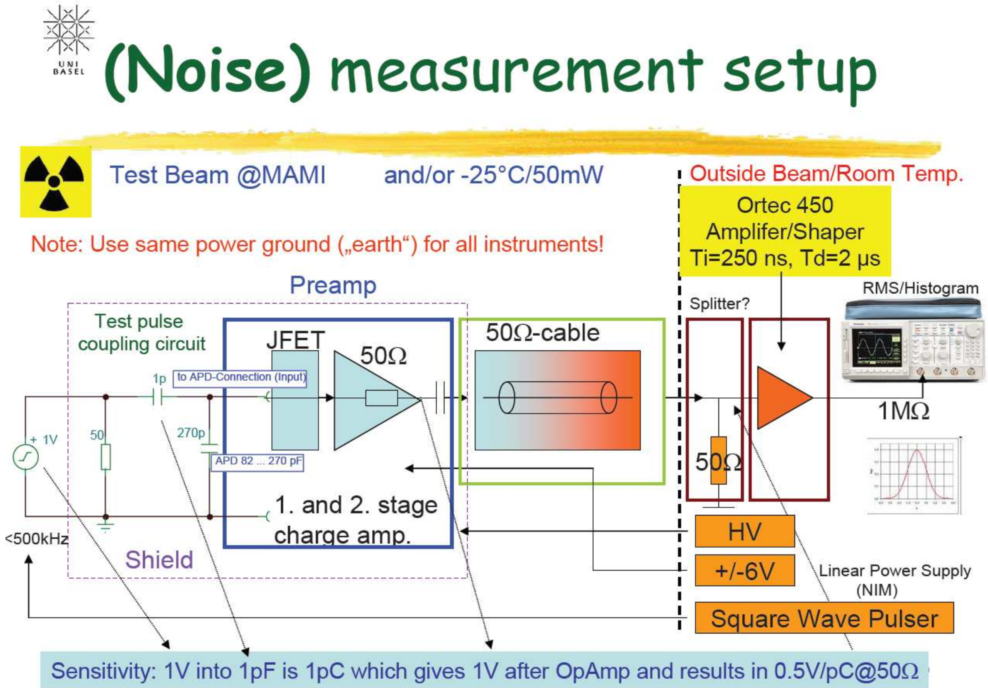
Comparing noise measurement results

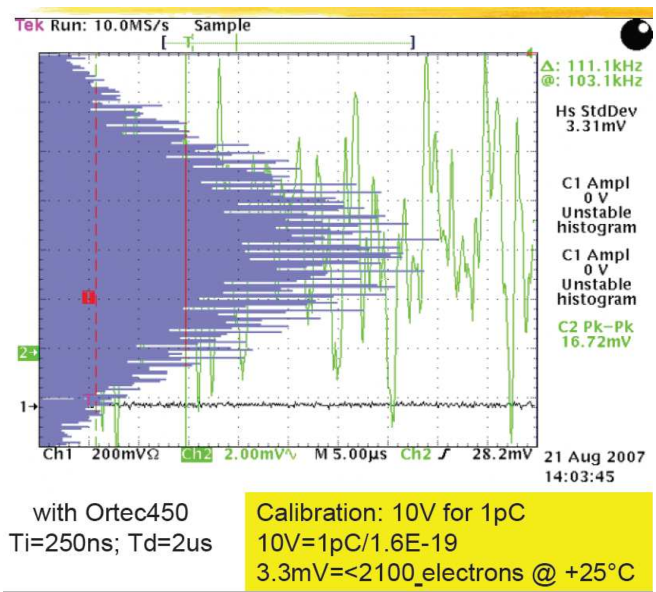
To get comparable noise measurement results, take care of following points :

- Measure V rms (if Vpp on oscilloscope divide by 9), standard deviation
- Photodetector : Capacity and gain
- Crystal : Light yield, wrapping, glue
- Subtract noise floor of equipment (measure test setup without preamp)
- Calibrate signal chain with 1V signal pulse (or LED-Pulser or Gain of photodetector)
- Multiply with gain of shaper
- Temperature : Decide cooled at -25℃ or at room te mperature
- Grounding of preamp (if only via signal coax) multiply with a factor of around 1,5
- Shielding: 5/6-side metal, neighbourhood (FL-lamp, PC, VME, cooler, pump, etc.)

Noise measurement setup

Noise R.M.S.=SQRT [(measured value)^2-(noise floor)^2]
Noise p-p viewed on the oscilloscope is approximately 9 times higher than the real rms-value.

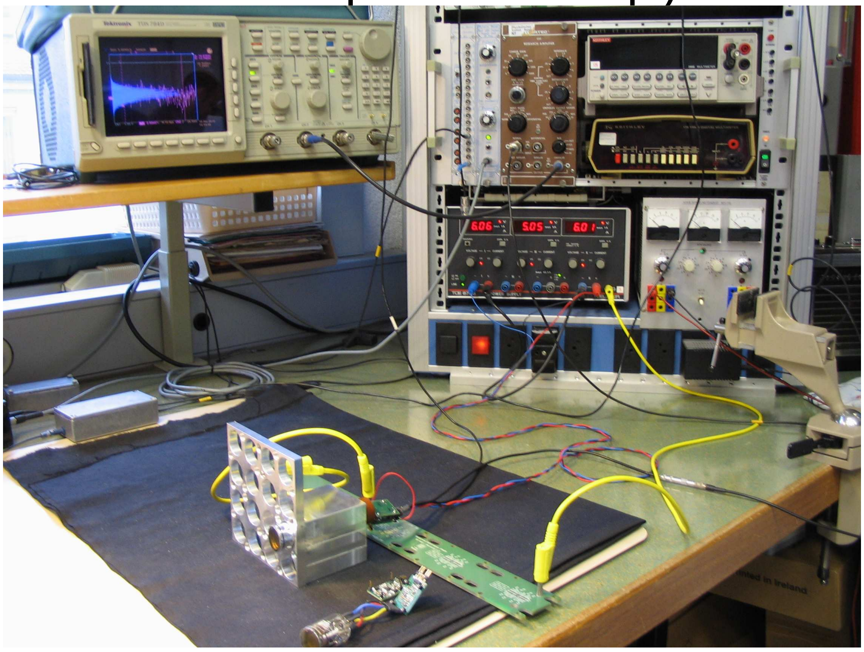




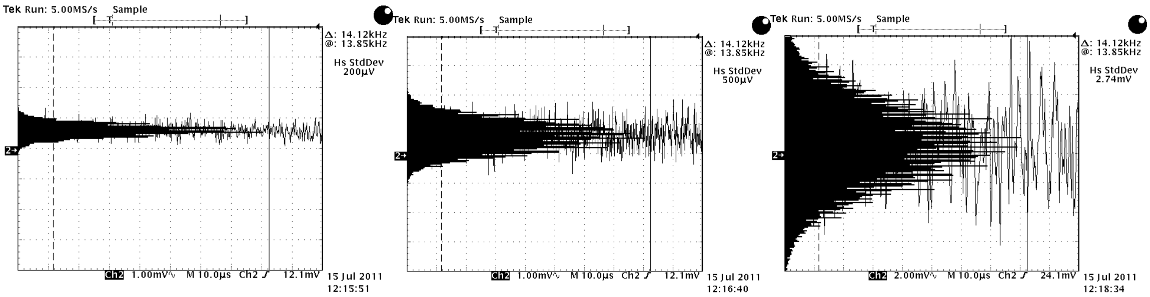
Q[pC]xU[mVrms]/10/1.6E-19=Noise [electrons] above: explanation EDN
z.B. Noise in mV Std.Dev. x 1000/1.6= electrons

Measurements taken with approx. peaking time of 650ns (Ti=250ns, Td=2µs**)**
Similar test results are taken with peak sensing ADC (see test setup SP903c below)

Example (Noise measured with shaper and oscilloscope)

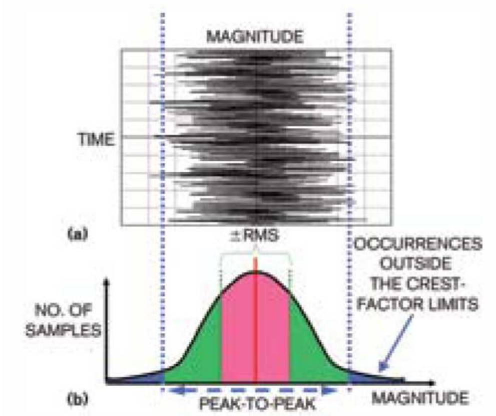


Source of the noise



Left: oscilloscope input: 0.2mV rms
Middle: measurement setup: 0.5mV rms
Right: with amplifier +270pF: 2.7mV rms

Method:



Wiring & Assembling

Diffences between SP883d Prototypes and Serie –Version.

On Prototypes the LV-Filter and Pads for wires were on the thin PCB. For series this LV-circuit was moved to the thicker Amplifier-PCB (to enable the possibility to use it autonomously for APD's). This increases also convenience for assembling.

Wiring for series-version:

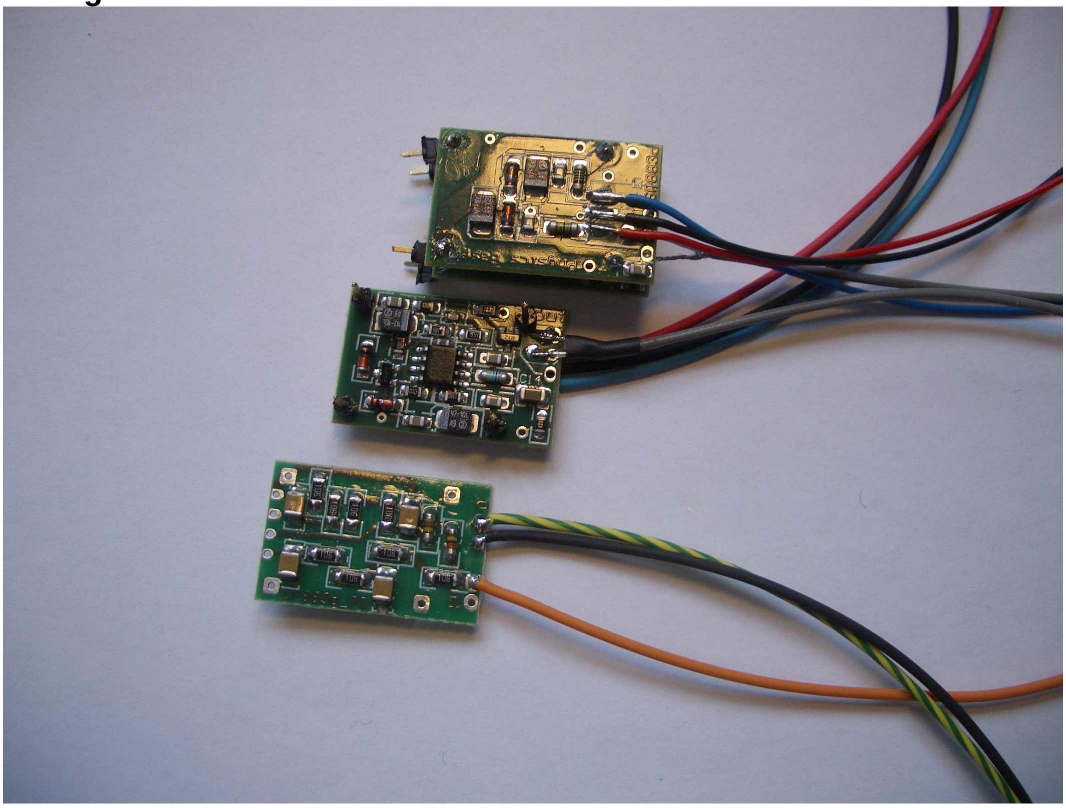
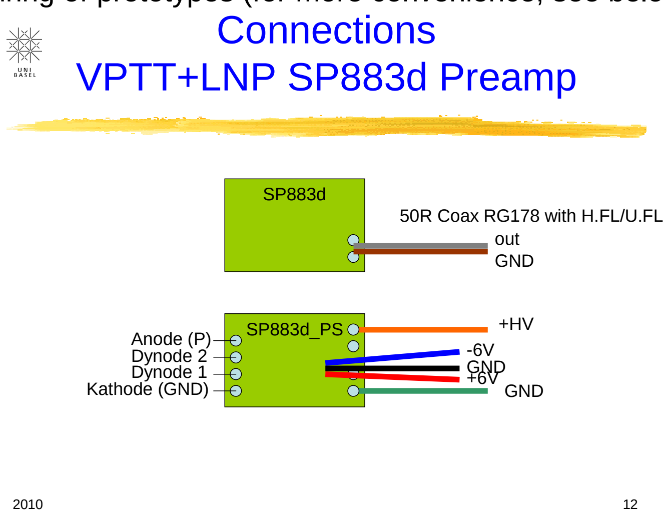


Photo shows from top to down:
1. LV (red:+6V/black:GND/blue:-6V)
2. Signal (50 Ω coax), direct to the PCB or via a ITT-crimp part
3. HV (orange) and GND (black and optional yellow/green)

Wiring of prototypes (for more convenience, see below):



Note:
The GND of the Preamps is connected via the green/yellow litz-wire to the Power-Distribution-PCB.

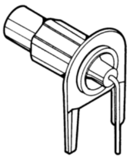
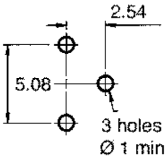
The shield (f.e. Aluminium-tube, d=25mm?) is also connected through the spring.

1. Connecting/wiring of power supply

Because the Hamamatsu Triode/Tetrode R11375 MODx is significantly longer than previous versions (f.e. R2148), there is no space for connectors on the PCB. Therel
ore, wires are soldered directly to the PCB. For assembling, the connectors will be mounted to the free end of the wires to connect to the power supply distribution board (and shaper).
Use a floating output power supply (f.e. laboratory power supply Toellner 8735), SP903b from Basel, in some cases via a NIM-Crate Adapter or similar.

The signal output should be wired with a 50 Ω coaxial cable (f.e. RG178). The 2nd edition of the PCB (series) includes the additional possibility to solder a RG178 (∅1.8mm) coax-cable via ITT Cannon 055-939-9039-AR6, available at Avnet Express or Newark, Part Number: 95F6346. For RG174 (∅2.8mm) via 055-939-9049FCD (Farnell: 121-5645).



Another solution for connecting the coax shield is to solder the shortened shield of the partly dismanteled cable to the testpoints (keystone test points/compona.ch 220 202) and the inner conductor direct to the PCB:


2. Isolation

There is high voltage on the board and the VPT/T. Isolate for up to 1.5 kV. Isolation can provided by shrinking tube or plastic tube.

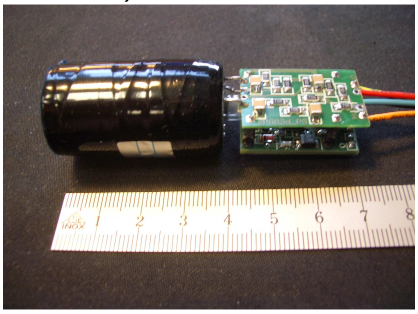
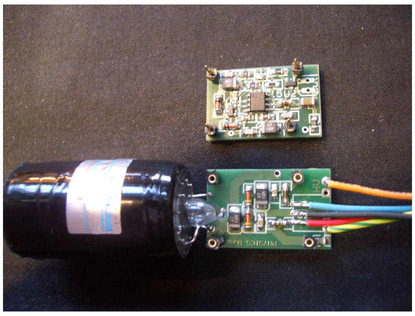
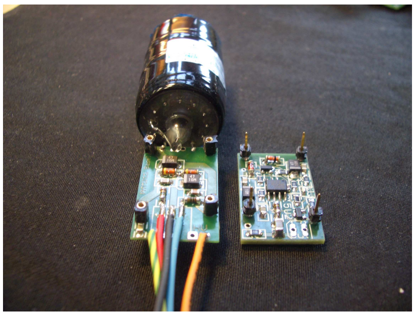
3. VPT/T connection

a.) Because the original semi flexible wires from Hamamatsu for the R11375 are not delivered with a socket and therefore not constructed for space-critical use. Because of the advice from the manufacturer, not to cut the pins and not to solder near the glass body, we preferred flexible litz-wires, but nevertheless it is not the optimum to save space in depth.

Anyhow, due to the fact that the manufacturer cuts and solders the pins of the tubes close to the glass body (as they are delivered in fact), there is obviously a possibility to connect them in a much better way, but it has to be proceeded very carefully:
Solder the pins for A(P) and K of the tube directly to the solder points of the preamp and bend the Dynode pin under no force at the glass (take the pressure off the glass with pliers) in a way, that a short wire can be soldered to the PCB. This is the most space-saving solution and also best for noise and stability.
Ambient light tight protection also from rear side is absolutely necessary. If not, the tube will get damaged, when operated.

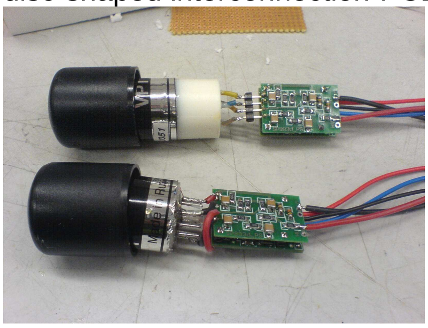
4. Assembling VPT/VPTT

To achieve maximum flexibility in connecting the different photodetectors and mechanical construction, the two PCB's of the preamp are delivered separately and have to be soldered together with four solder joints by the user. Several variants are possible:
Variant 1: VPT soldered via litz wire
Variant 2: VPT soldered to Preamp with a PCB-distance of 4mm (overall length: ca.78mm)
Variant 3: VPT soldered close to Preamp with a PCB-distance of 10mm (overall length: ca.73mm), see Photos below

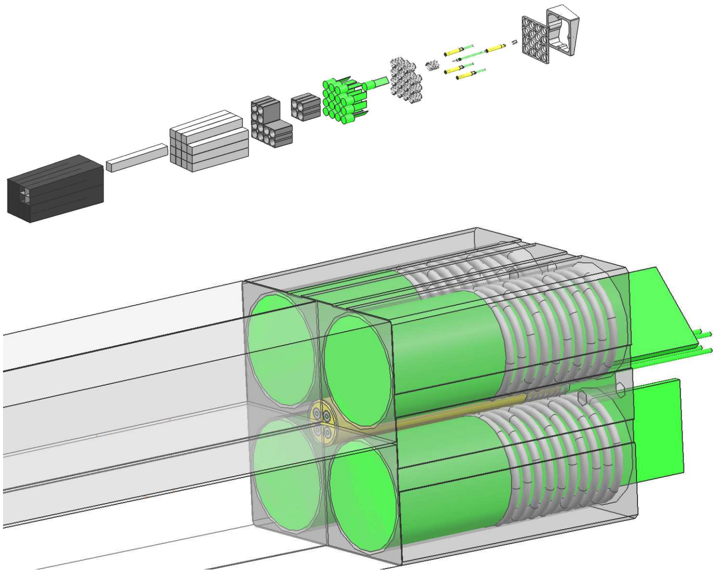




Length of Preamp+R11375MOD Hamamatsu-Tubes: 73mm (with very carefull handling down to 70mm) if distance of PCB's is 8-10mm (the glass exhaust is then overlapped by both Preamp-PCBs).
If you choose a 4 mm PCB-distance, the overall length is then 5mm more, let's say around >75mm.

b.) The Hamamatsu R2148 and the RIE-Tetrodes (without silicone potting) are tubes with a pin-socket, which allows proper space-saving construction, f.e. via a socket or direct soldering to a disc-shaped interconnection-PCB.



comparison of connections for RIE VPTT (Photo: Tomas Held, RUB)



5. Adapter-PCB for Dual APD/crystal

For “short” preamplifier SP883d (might be usefull also for “long” version SP883a02)
An additional ca. 18x18x1.6mm (depends on capsule), double-sided PCB was built**.**

Features:

- Protects the APD-Pins when mounting/dismounting from the crystals
- Planar mounting of the APD-frontsurface (equalize differences through mounting aid, then solder and glue it to the PCB).
- Holds the two preamplifiers to the capsule
- Holds HV-Filter and Connector for APD
- Connection and filtering for both HV’s
- GND-Plane of Dual APD-PCB is the 6th side of the electromagnetic shield!
- Could be soldered to copper tube (via two 2mm holes)
- Temperature shield (decoupling)/radiation barrier (similar as in Proto60)

Glueing the APD to the PCB: maybe with an additional soft silicone sheet (removable?)

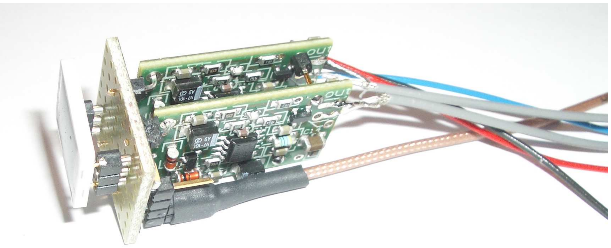
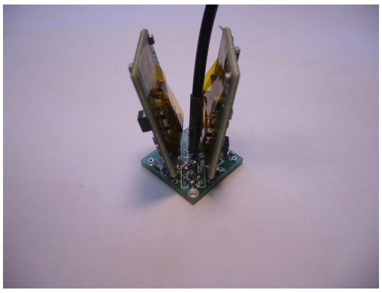
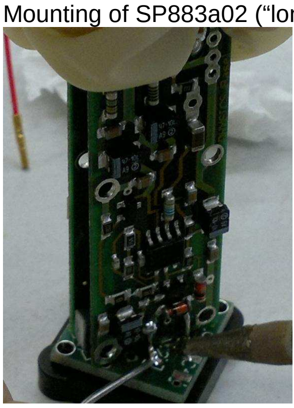
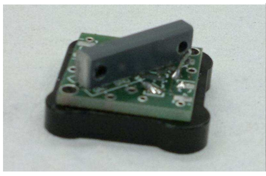



Photo left: two “short” preamps SP883d+prototype DualAPD-PCB 20x20mm +“old” quadratic APD in a socket + cables
Photo right: two “short” preamps SSP883d+dual APD adapter SP883d_APD 18x18mm, with a HV-Cable RG174

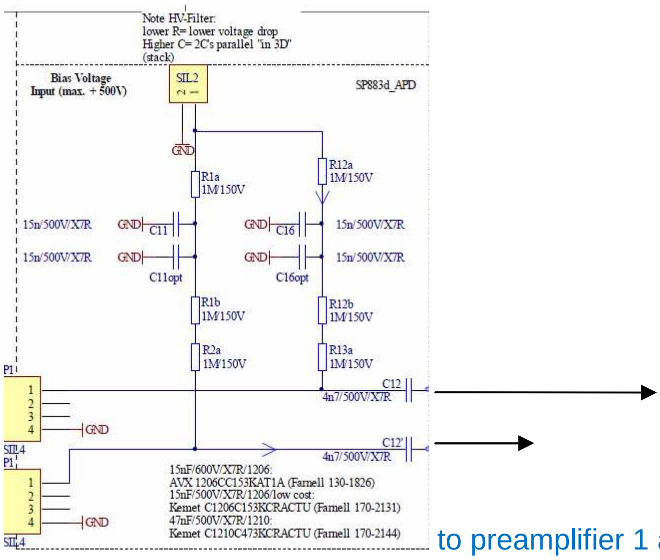
Mounting of SP883a02 (“long”)


Filter and decoupling

The change of the values for the HV-filter (3M instead of 32M and 15nF instead of 4n7) was made to decrease rate dependency of the bias voltage HV (and therefore APD-Gain).
The resistors are now 3x 1M/150V (total of 450V) in a 0805 case because of lack of space for the 2x 500V resistors in the 1206 case.
The reduced series filter resistance to reduce the bias voltage drop at high rates is partly compensated by a higher capacitor (15nF/500V in 1206 case, instead of 4,7nF). Additional capacitors on the external PCB might be usefull to keep low noise performance.

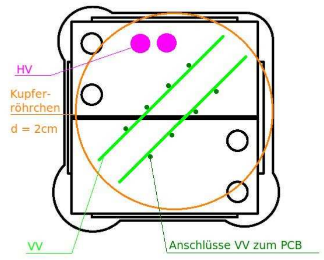
Differences	SP883a02	SP883d_APD
HV-Filter	32 MΩ/4,7nF	3 MΩ/15nF
Adapter	No filter on Adapter	Filter on Adapter
Compensation	47pF	100pF

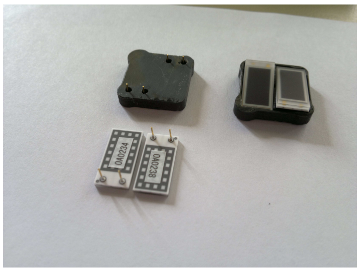


to preamplifier 1 and 2

Capsule
The capsule works as mechanical interface for the APD's to the crystal. When mounting the APD's into the capsule, take care because the capsule reaches around 0.2mm over the APD.

Material: for Proto192 milled from POM, later for better radiation hardness PEEK is foreseen.



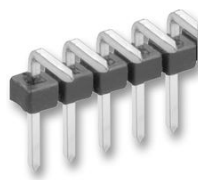
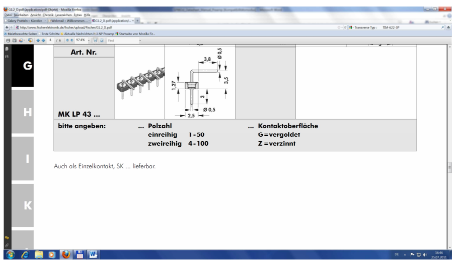


Note: The HV is soldered directly to the PCB (placed around the center of the PCB between the preamps). To save cabling, only one HV is available for both APD's . Therefore they must selected for gain-conformity.
The cabling for LV (+/-6V) can also be reduced when both preamps are interconnected.

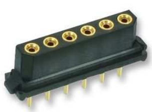
The capsule and the Dual APD-PCB can be integrated optionally for high volume production as one unit made from Epoxy/FR4 as a "3D"-PCB. Also space can be saved that way.

The two holes with 2mm diameter are connected to GND and can be used to mount the copper tube or similar.

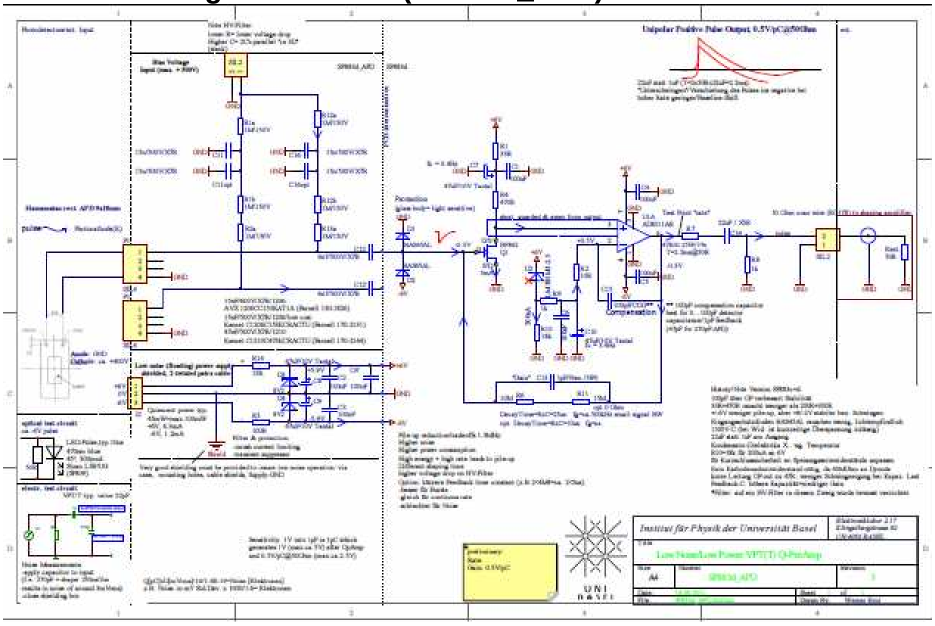
Connectors
Contacting the preamps to the « Adapter-PCB » SP883d_APD is achieved by soldering the boards direct with a rigid wire or a 1 pin-connector (f.e. Farnell : 972-9151).
For SP883a02 („long") use Ø 0.5mm-rigid wire or the Fischer Elektronik MK LP 43.
Note: Solder the pins on the component side, because on the APD/Capsule-side is no space for pins or solder joints. So cut the pins in a way that they do not reach out of the PCB.

or alternatively with a connector :
Board to Board, 8 contact, single row 2mm-pitch connectors (male 90° THT, female: SMD)
Harwin Datamate L-Tek (f.e. Farnell: 177-6199/177-3791).
Molex Series 55932, shrouded header, Part-No. 0559320810


Schematic Diagram for APD (SP883d_APD)

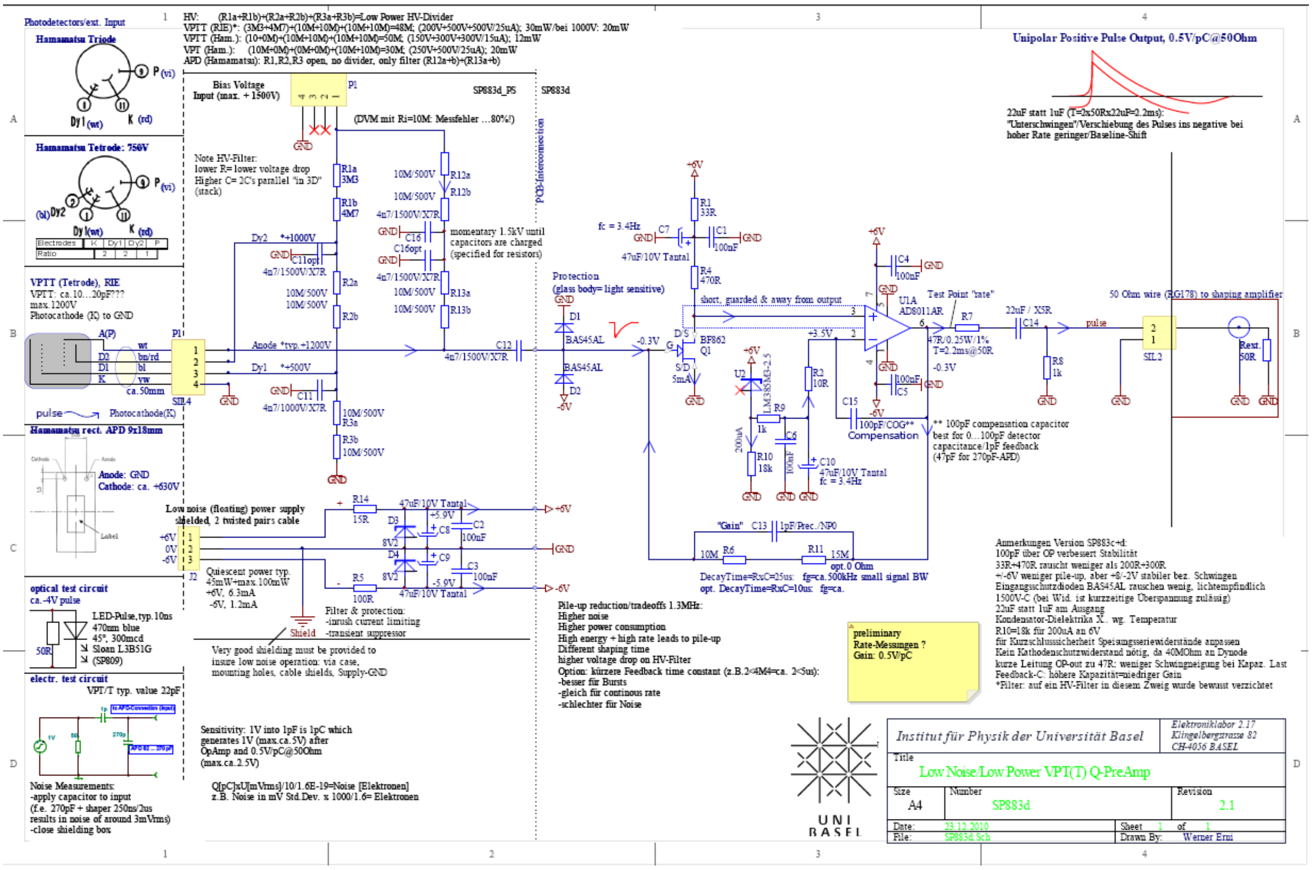


Operating Temperature

The lower the temperature (typ. -25℃), the lower the noise of the system.

Please note, that for a constant internal APD-gain (M) the APD voltages must be decreased while decreasing the temperature. This is due to the temperature dependence of the gain vs. reverse voltage of the APD; see the graph of the APD data sheet. Each APD has to be controlled individually.

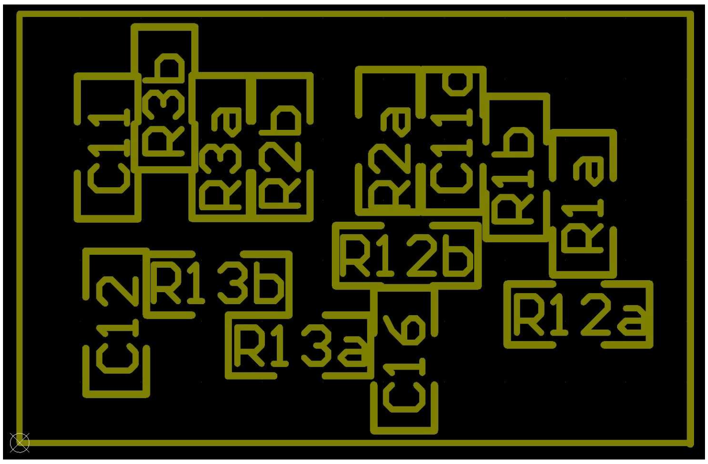
Schematic diagram SP883d (for VPT/VPTT)



Differences between the versions of SP883d_PS (VPT, VPTT, ...)

	R1a	R1b	R2a	R2b	R3a	R3b	max U/ I	Power consumption
VPTT (RIE)	3M3	4M7	10M	10M	10M	10M	1200V/25uA	30mW (20mW with 1000V)
VPTT (Ham.)	10M	0	10M	10M	10M	10M	750V/15uA	12mW
VPT (Ham.)	10M	0	0	0	10M	10M	750V/25uA	20mW

Note: all resistors 10M are 500V rated



Circuit/component function description

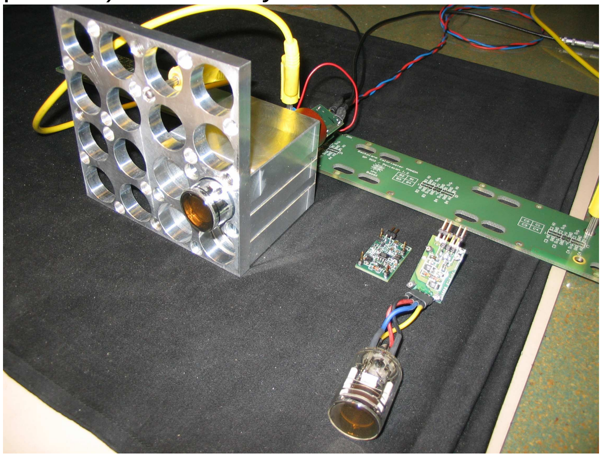
The circuit is described in detail in the Panda TDR from June 2008, chapter 6.4.2.

R5, R14	MiniMelf resistor	Inrush current limit (tantal protection), filter
D3, D4	Zener Diodes	Input protection device, transient overvoltage, polarity
D1, D2	Low leakage diodes	FET input protection
Ceramics	X5R, X7R, C0G, NP0	low temperature operating range
Tantal		

Additional notes:
Gain: lower gain = higher feedback capacity (+ change value of compensation capacitor)
Dynamic range, higher positive power supply voltage (while lowering the negative), f.e. +8V/-2V
Compensation: 100pF best for 0…100pF detector capacitance, min. 47pF for APD (270pF). A higher cap value slows down the pulse rise time.
A high Feedback resistor lowers the Johnson noise

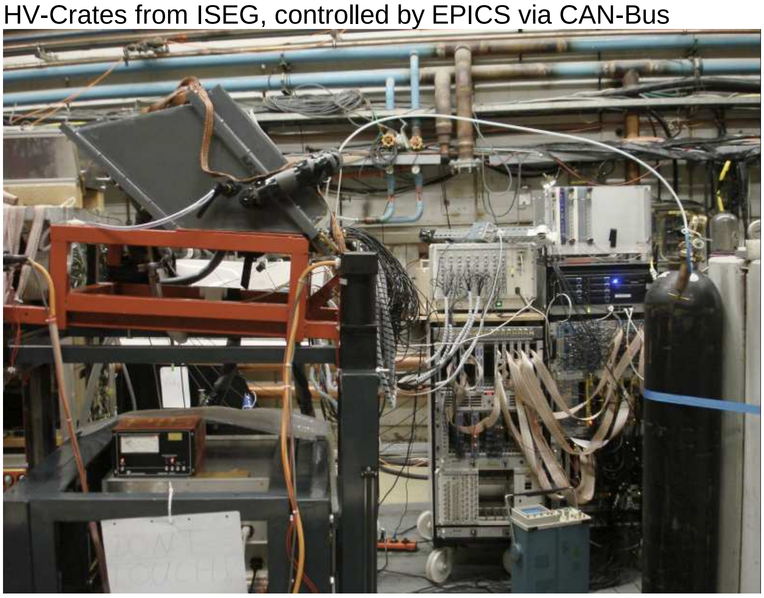
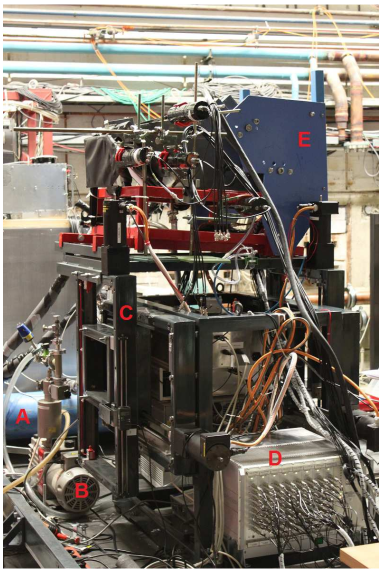
Distribution of Power Supplies

The distribution of LV and HV can be done via a PCB (Model SP903a for Proto60 shown in pictures) or as "daisy chain" via loose wires.




HV

HV-Crates from ISEG, controlled by EPICS via CAN-Bus

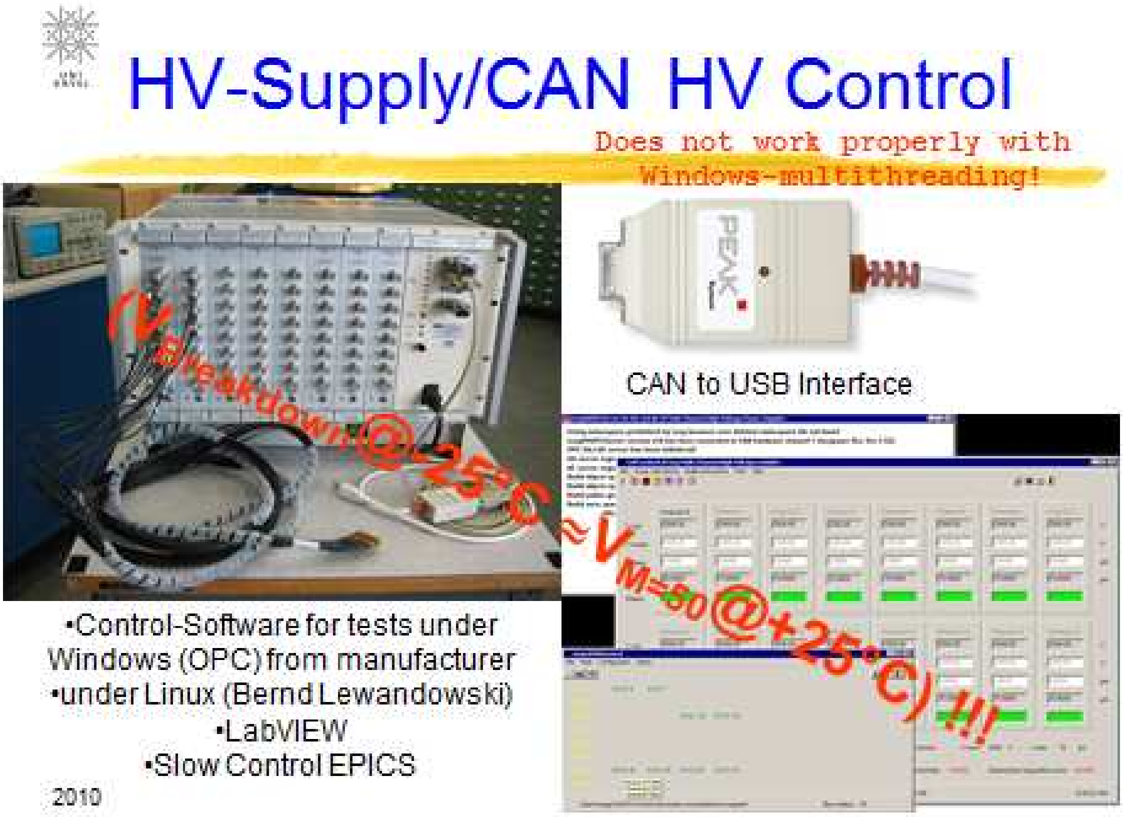



Left: Proto60 with HV; Right: Tests in Mainz; Tank with dry nitrogen gas (A), Vacuum pump (B), X-Y-Support (C), High Voltage Supply (D), Proto60 (E)

HV for Proto192

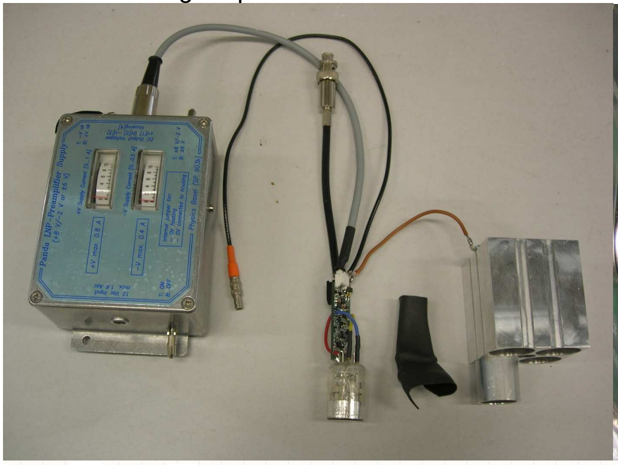
APD: HV-Module ISEG EHS8 210p-F, +1kV/8mA, High Precision
VPT/T: HV-Module ISEG EHS8 620p-F, +2kV/4mA
35 channels for VPT/T HV (sharing 1 HV among 4 channels) and 64 channels for APDs (sharing 1HV among 2 channels). Control Software is EPICS. Bus is CAN.

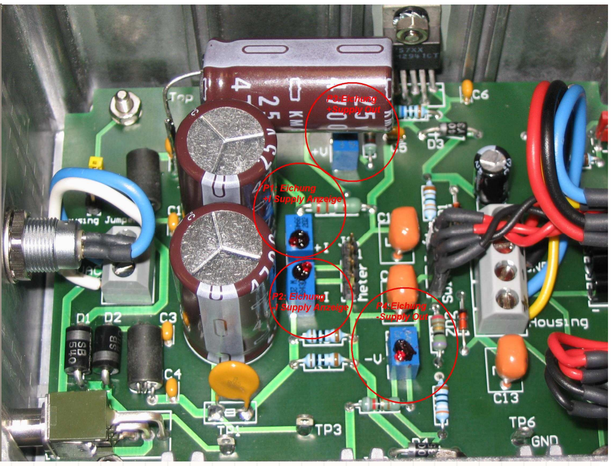
Test beam at Bonn is preliminary scheduled end of July 2011. Delivery by the end of June to Bochum:
5 HV modules ISEG for VPT/T use
8 HV modules ISEG for APD use
2 crates ISEG with CAN-Bus for the modules

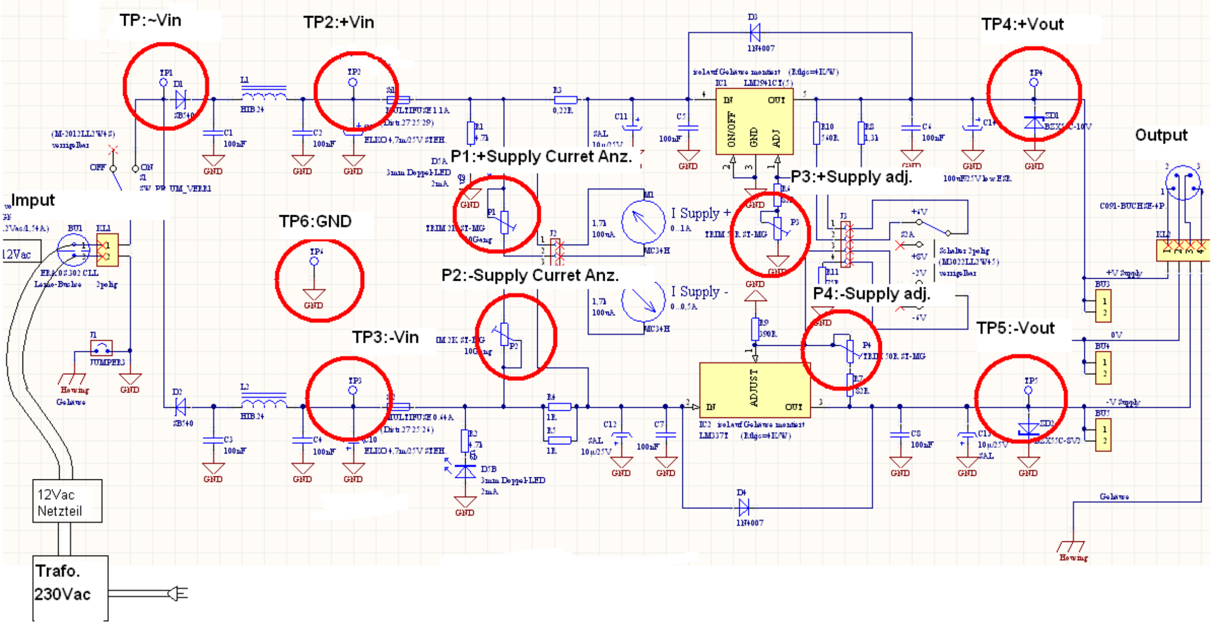

HV-Supply/CAN HV Control
Does not work properly with Windows-multithreading!
CAN to USB Interface
(VBreakdown@-25°C ≈ VM=50@+25°C) !!!
•Control-Software for tests under Windows (OPC) from manufacturer
•under Linux (Bernd Lewandowski)
•LabVIEW
•Slow Control EPICS
2010

LV (+/-6V or +8/-2V)

- Low noise, linear regulated
- Floating output







Power Supply type „Basel SP903b“ (shown in photo above) for up to 64 preamps at high rate (here with SP883c and VPT).

Alternatives

- +/-6V Adapter from NIM Crate
- Wiener mpod (control by EPICS via CAN-Bus)
- CAEN 8800
- other

Pulse Processing

Quiet high continous rates (see plot below) are possible, especially at low energies (low charge), but is limited by pile-up.

Gain

The Gain was set equal for all models. In peripheral regions of Proto192 (and FW endcap) APD's are used. The gain for these photodetectors is 50…100. If the bias voltage is individually regulated for both APD, a wider range can be covered in each crystal.
With VPT/T in the center of the FW-Endcap the output signal with 15GeV is expected around 1V (depending on Gain of photodetectors).

Dynamic Range

The lower end of the dynamic range of the preamp/photodetector system is given by the noise floor of the readout chain. The upper end is limited by the positive power supply voltage of the preamp.
In areas where much light is arriving (at high energies), the gain of the photodetectors can be reduced.
The gain of the photodetector is varied simply by the bias supply voltage (via slow control system). This way different gains for different regions of the EMC can be achieved simply by calibration and controlled by the slow control as wished.
Where the gain of the photodetector itself should not be reduced, the gain oft he preamp can be reduced by modifying the component values in the circuit.

Rate

To cope with the expected event rates in the barrel of maximum 100 kHz per crystal, the LNP-Preamp has a concerted feedback time constant of 25 µs. This feedback time constant is a trade-off between noise performance and pile-up problematic.
For a single pulse (or very low rates) the LNP-Preamp accepts an input charge of up to 4 pC; for a continuous event rate of 100 kHz an input charge of up to 8 pC is allowed. This discrepancy is due to the following reason: A single output pulse starts from zero output voltage and is limited by the positive supply voltage (+6V) of the LNP-Preamp. At high continuous event rates the output pulses will swing between the negative (–6V) and the positive (+6V) supply voltage; therefore the maximum input charge is doubled. If a 100 kHz event rate is applied abruptly (burst) to the LNP-Preamp it takes around one second until a continuous input charge of up to 8 pC is allowed. During that transition period, a maximum input charge of 1 pC can be handled. With this charge restriction, the output voltage of the preamplifier stays always in the linear range and is never limited from the power supply voltages. Nevertheless, the electronics after the preamplifier has to perform a good base-line correction, because at higher rates it is likely that one pulse sits on the trailing edge of the previous one.

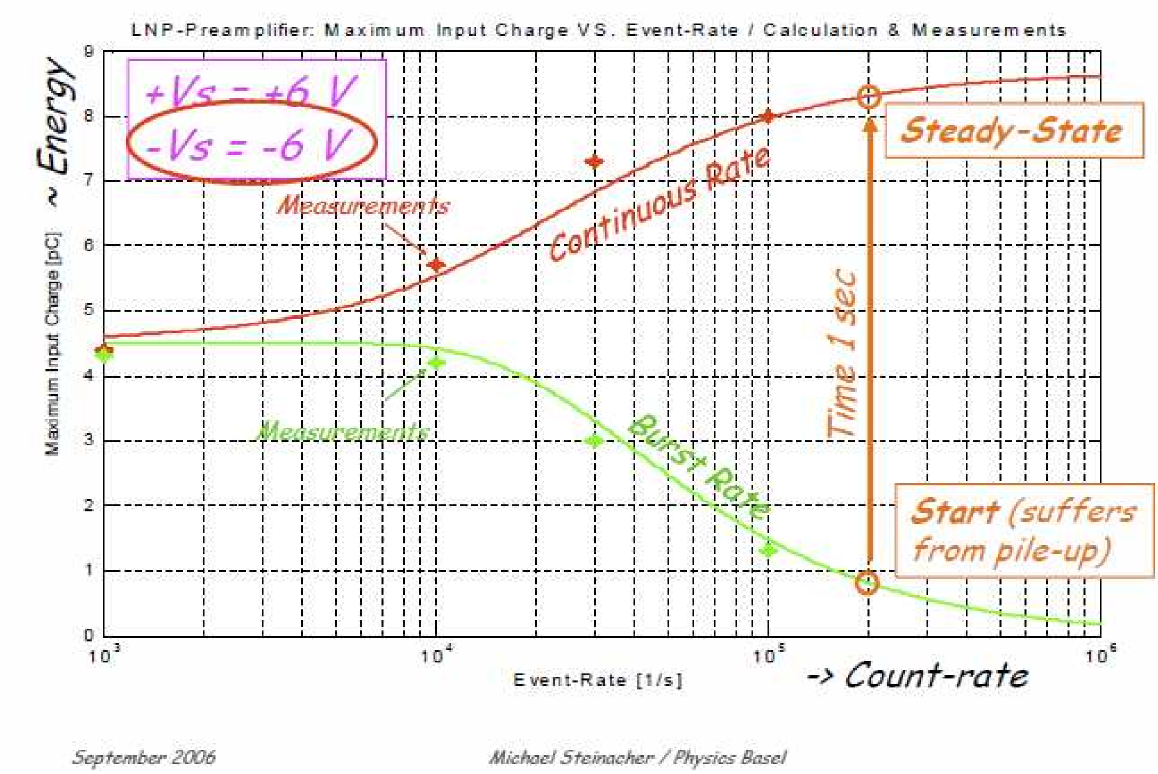
Pile-up

High energy and high rate leads to pile-up.
To increase the maximum possible burst rate (reduce pile-up) the decay time can be reduced, but then tradeoffs are:

- Higher noise
  and also:
- Higher power consumption
- Higher voltage-drop over HV-filter
- Other shaping time is needed

Version for 1…1.3MHz
A shorter feedback time constant (f.e. 2MOhm<4M4 = ca. 2<5us)

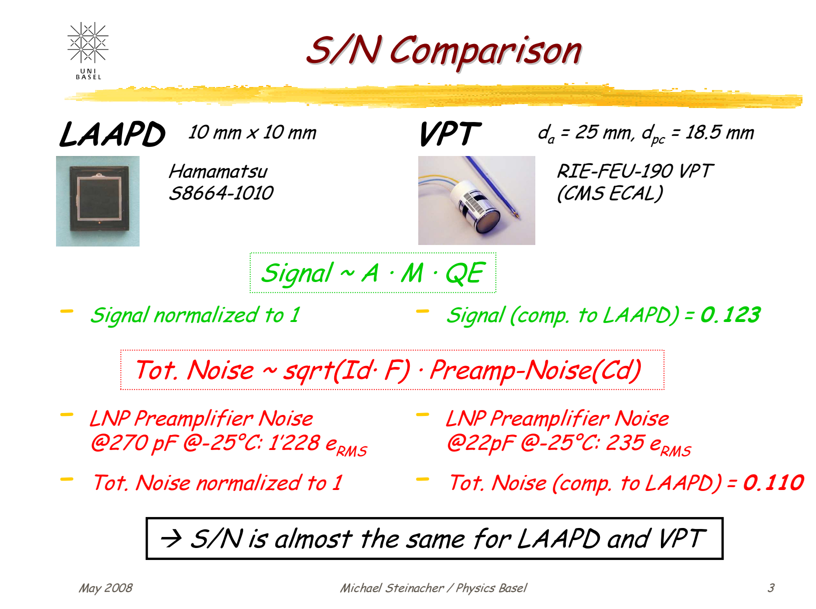
- Better for bursts
- Same for continuous rate
- Higher noise



The "long tail" of the LNP-Preamp output is determined by the feedback-network (1 pF // 25 MegOhm) of the charge preamplifier. The resulting 25 us are a compromise between low-noise performance and high-rate capability (pile-up). In principle the time-constant can be reduced, but results in more noise (at least if you use a shaping-time of around 700 ns). The shaper after the preamplifier can reduce this fall-time without any problems as long as the preamp doesn't run into saturation due to pile-up.

The "undershoot" of the signal results from the AC-coupling (22 uF) at the output of the LNP-Preamplifier. Proper adjusting of the shaper eliminates this "undershoot".

Signal to Noise ratio



Noise vs. Cooling vs. detector capacitance

Data from Panda TDR, March 2008 with SP883a02

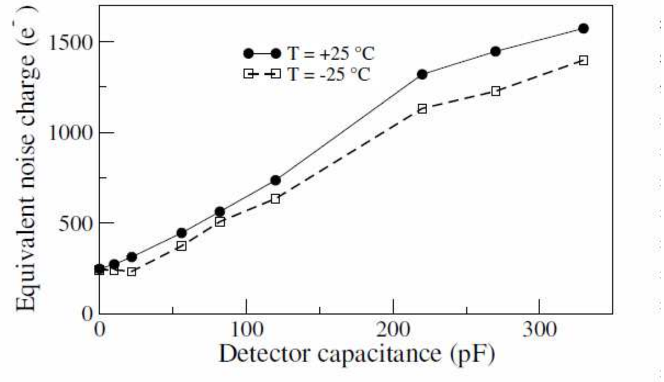
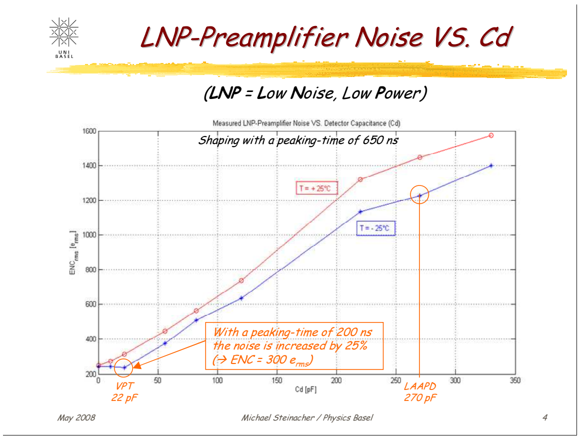
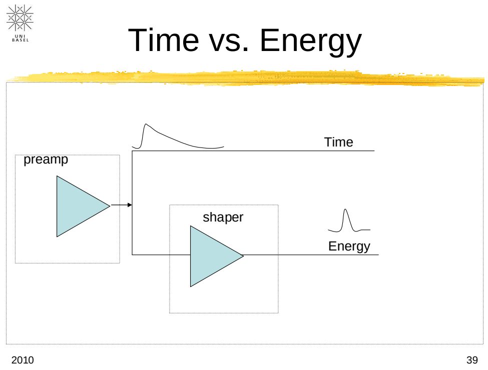
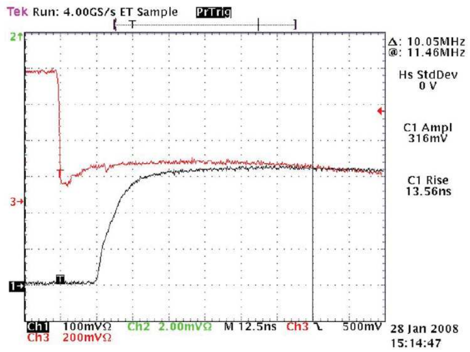


Figure 14: The measured noise performance of the LNP as function of the detector capacitance (C_d) at room temperature and at -25°C. Measurements are performed by using an ORTEC 450 Research Amplifier with an integration time constant T_{int} = 250 ns and a differentiation time constant T_{diff} = 2 μs, which corresponds to a peaking-time of 650 ns.

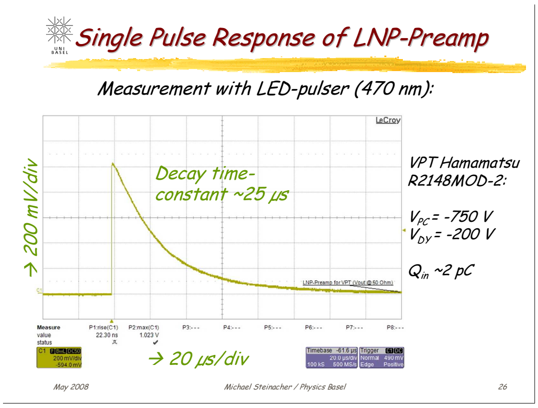


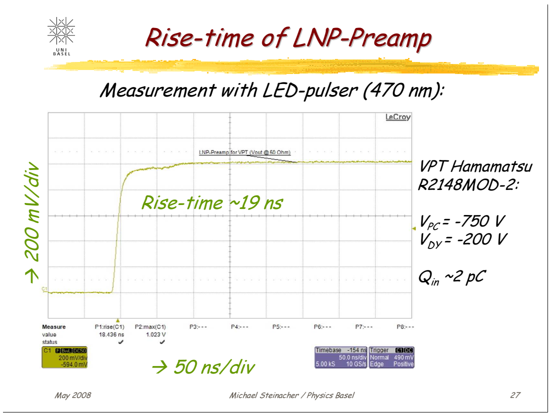
Rise Time/Timing Information





Precise time information





Shaper

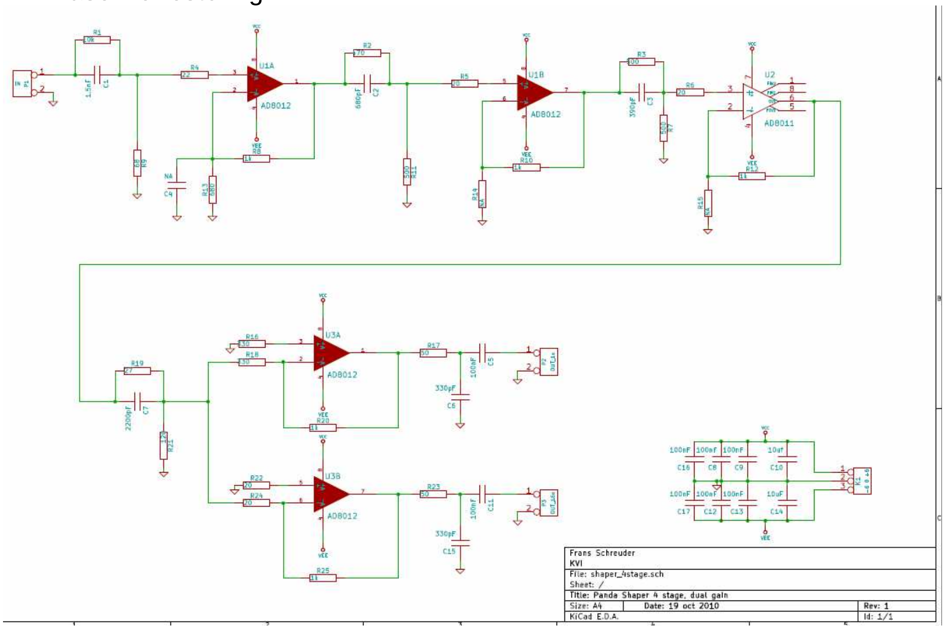
For operation with slow ADC's a shaper is needed.
Developed at KVI, Frans Schreuder in 2010 (MOD0111): Power supply from VME connector modified)
Performance: A peaking time of 100ns results in too high noise.
Note: Peaking time defines the time, the signal reaches its peak amplitude. Peaking time depends on integration/differentiation time, but is not the same as the integration time.
VME-crates with switch mode power supply usually generate more noise than NIM-Crates, both, radiated and conducted. Good filtering of the power supply tracks and shielding is important.

Cable

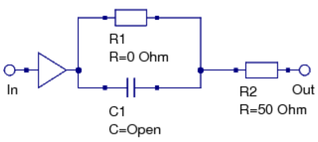
Signal Connector: IPX; U.FL; Amphenol-Typ**:** A-1PA-113-200G1 (Distrelec 13 82 60) with a tail of 1.15mm coax or Farnell 168-8075 (cut the 300mm long 1.37mm coax cable in the mid, then you get two cables with one U.FL-connector each).
Other side Lemo00-connector, f.e. Typ 11_QLA-01-2-11/122_NE from Huber&Suhner
Option: For use with RG-178 cable, System MMT von Radiall might be usefull:
RADIALL - R210408012 Farnell Best.Nr.:3044154
RADIALL - R284008001 - KABEL, Farnell Best.Nr.:3044142

Possible additional features could be:

- Signal polarity inverting (neg. output) and or differential driver to fit the ADC from Pawel Marciniewski.
- adj. gain (compensate VPT/T-gain) + multiple gain ranges (dynamic range)
- scaleable peaking time optimised in relation to the rate
- Baseline restoring



Passive „Preshaper" not implemented (not yet tested).
Helps to shorten the pulse, but changes signal (energy) amplitude frequency dependent and output impedance and is therefore probably not suited for the use in Panda.

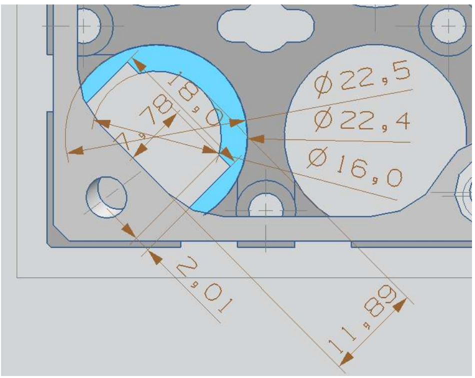


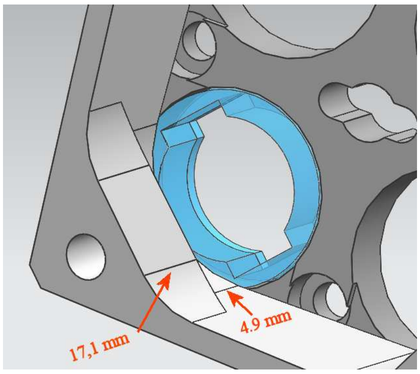
drawing: KVI

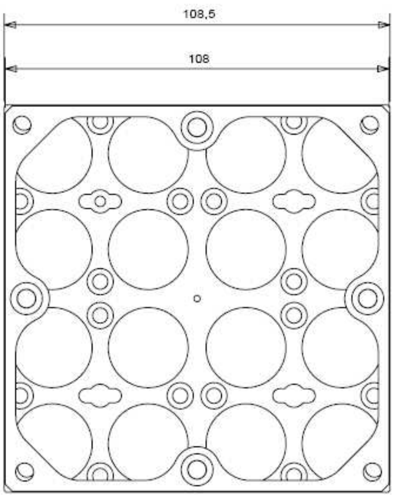
ADC

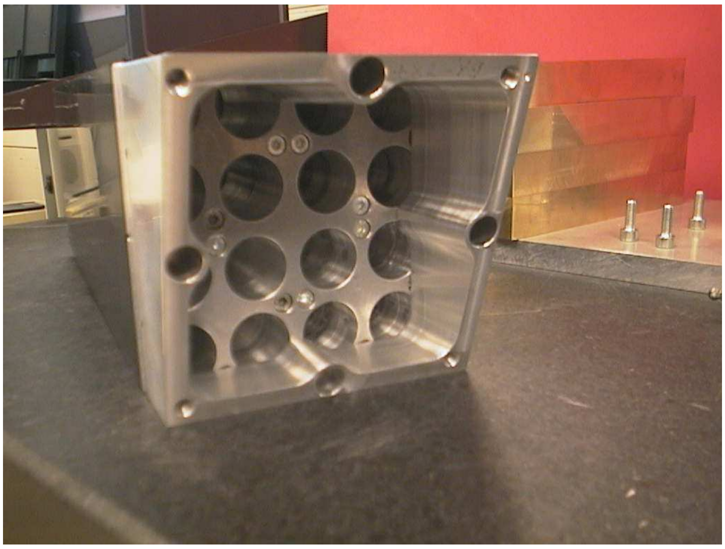
Uppsala Pawel Marciniewski/Wiener (Input matching via Shaper)
Struck SIS3301/02, 14 bit
SADC SIS3350
CAEN V1724, 14 bit

Mechanics





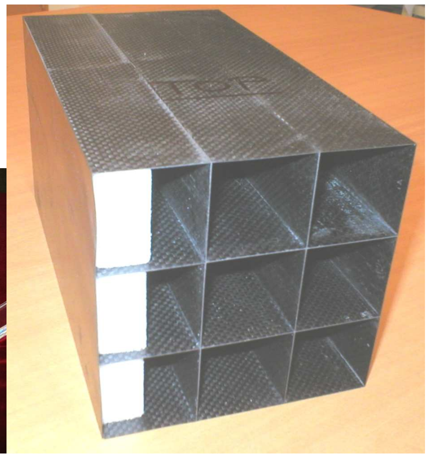




Drawings for Panda EMC Forwar Endcap Proto 192: Bochum Group

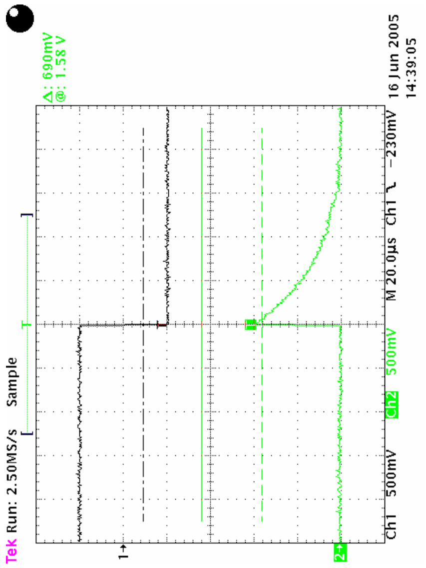
Crystal & Alveoles

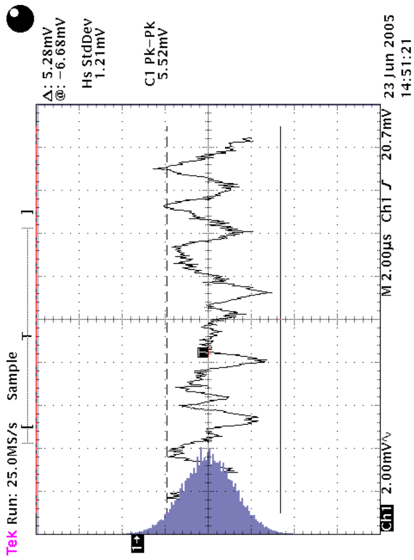
Crystal Design: Tapered (11 different shapes) PWO crystals, Length 200mm, front face 20x20 mm2,
Carbon fibre alveoles as housing



Test Setup (Recommended)

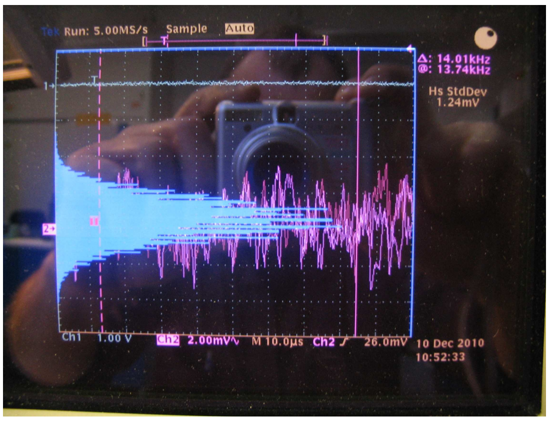
Instrument	Model/Type	Lab2.17-Nr.	Phys.-Nr.	Serie-Nr.
Testadapter (1pF/50Ω/270pF)	Own built			
Metal box	6-side			
Oscilloscope	Tektronix TDS784D	109		
Research Amplifier + 50Ω	Ortec 450		4257	783Rev.13
Float. HV–Source/Calibrator (not SRS PS325)	Fluke 341A	15		
Pulse Generator	HP 33120A	85		

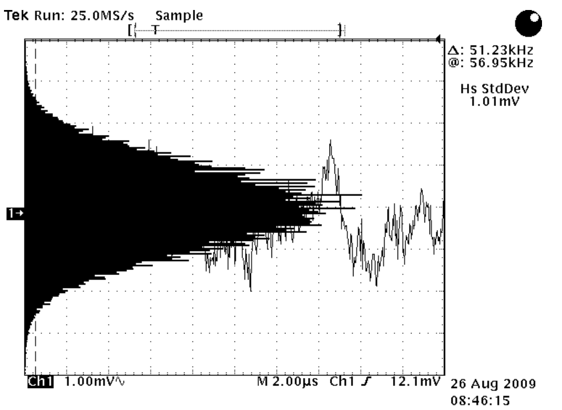
Pulse/Function: 

Noise: 

Prüfung	**SERIAL-NO.**	**POWER CONSUMPTION**	**PULSE/ FUNCTION**	**NOISE W. VPT**	**NOISE W. 270PF***	**LEAKAGE CURRENT**	**AUSLIEFERUNG/ BEMERKUNG**
25°C/"50% R.F."		*+6V/6MA -6V/1MA*	*(ORTEC 450 KALIBRIEREN)*	*[MV RMS]*	*[MV RMS]*	*[NA]*	
HISTOGRAMM				*STD. DEV.*	*STD. DEV.*		
TYPICAL VALUES	1	OK	10V	1.19*	3.0*		REP/JUNI 09

* Including noise floor of oscilloscope and shaper 0.5V rms





Marking

After Testing, every unit gets its own marking. It is a manually engraved number, beginning with 1.

Reliability

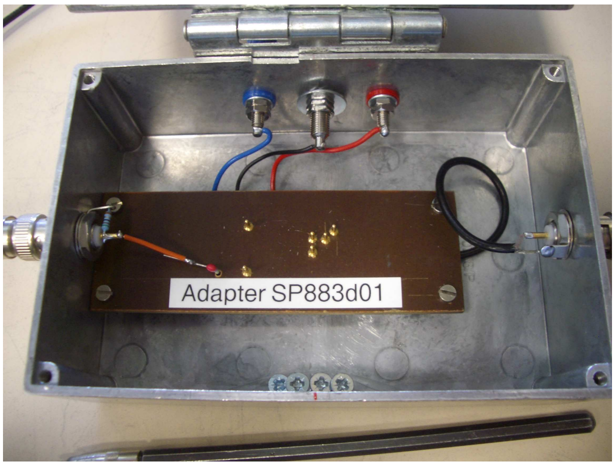
Quality

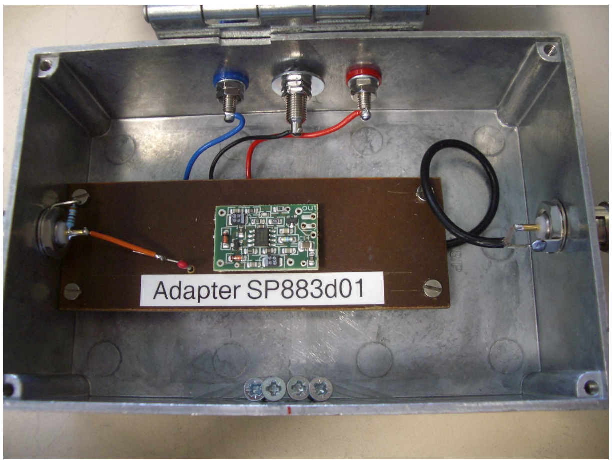
- 100% of the parts are tested for their function, but not for all parameters (f.e. temperature).
- We have not used leadfree solder to improve the long time continuous low temperature (-25℃) operation. We used a traditional Sn/Pb 60/40 alloy.
- Do not use halogenidated or chlorinated cleaning solvents as f.e. Trichlorethylen to prevent damage of solder joints through activation of “tin pest”. We use Inventec “Topklean EL 10F” for SP883d & Elma “Clean 225 Sonic” for SP883d_PS.
- Universal conformal coating for printed circuit boards « Plastik 70 ». A transparent acrylic resin based, transparent insulating coating. Protects against normal atmospheric influences. Soldering for repair is possible.
- Over 100 channels up to the year 2010 are in use at different sites/institutes, under different conditions (in beam, low temperature). Over 200 channels more will be built in at Bochum (Proto192) and Uppsala in 2011.
- In the past, defects occurred with FET’s and Tantalum Capacitors. Reliability can dramatically increased through prevention from ESD and other good handling practices.

Production tests

To test production volume of the electronic functions we have built a test adapter with spring contacts, because there are no connectors available.
Tests include:

1. power supply current, both +/- 6V
2. gain: calibration of the test instrument chain with pulse
3. noise output with 270pF at input





Applications

Proto	Panda EMC Type	Photodetectors	models
Proto 60, 2007	Barrel,1APD/Crystal	60 APD	SP883b
Proto 50?, 2010	Backward Endcap	60 APD	SP883a02
Proto 192, 2011	Forward Endcap	ca.50VPTT+64VPT+128APD	SP883d
Proto 120, 2012	Barrel,2APD/Crystal	240 APD	ASIC?

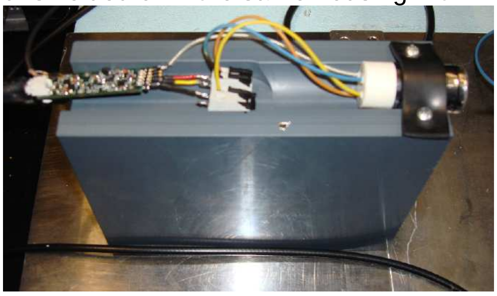
Radiation Hardness

Specially in the center of the Forward Endcap radiation is not negligible. Therefore APD’s can not be used. Tests in Spring 2010 at Mainz (Dr. Irakli Keshelashvili) showed that the Preamp will not be destroyed in a Beam. Online-Tests with quantisized radiation will be proceeded.

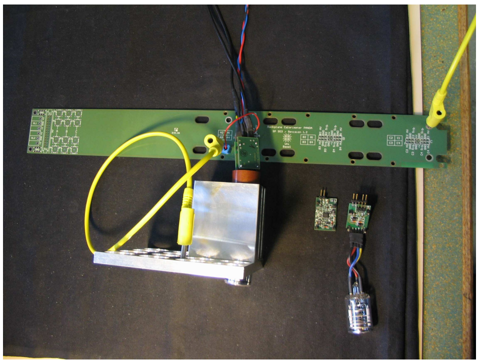
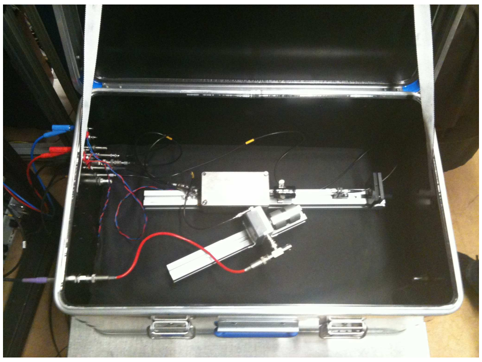
Addendum

Experimental Setup

Beware of Noise pick-up. The Preamplifier is a very sensitive instrument and therefore works similar to an antenna. For low noise operation, it is not recommended to operate the photodetectors and the preamp unshielded or in the same housing with motors.



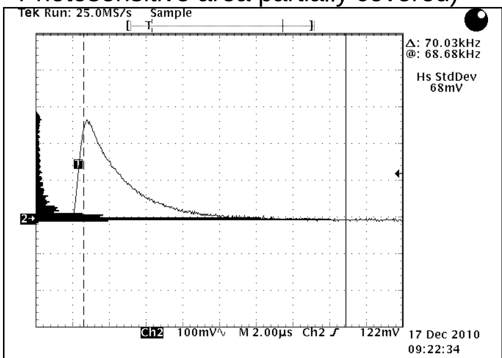
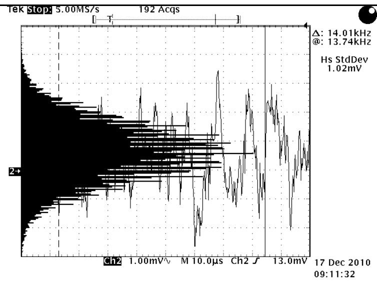
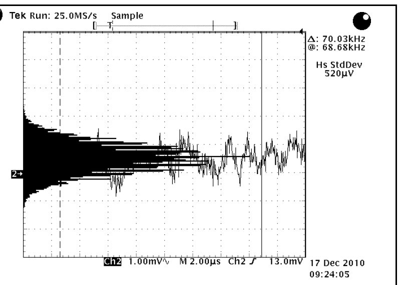

Better:

Left: Distribution Board (6 Layer multilayer Board for LV & HV distribution with signal shield and matched 50 Ohm impedance); Right: light tight, shielded Alu-Box with LED & reference PMT

Measurements taken December, 17, 2010 @20°C, Preamp SP883d,S/N #3, with setup as shown above, GND-connection to Alubox,
Shaping with Ortec450, Gain=ca.x10, Ti=250ns, Td=2us
HV: 1100V from Fluke 341A

VPTT (RIE), no serial number. Prototype received March 2010 from Mr. Iouri Gousev/ RIE (no silicon/ Photosensitive area partially covered)

	 
above: VPTT (RIE), LED-Puls from SP771, optical coupling undefined	Left: Noise= sqrt (1^2mV–0.5^2mV)= ca.0.9mVrms/10/1.6E-19=562e-) Right: Noise floor Ortec 450 with 50 ohms on input + KO; No light to VPTT (RIE)

Beam Tests

In August 2011 tests are proceeded with a beam of 15GeV.

Distribution of Power consumption

Most of the heat produced is coming from the FET. The power from the signal output is distributed half on board and the other half on the receiving side (over the 50 Ohm resistors).

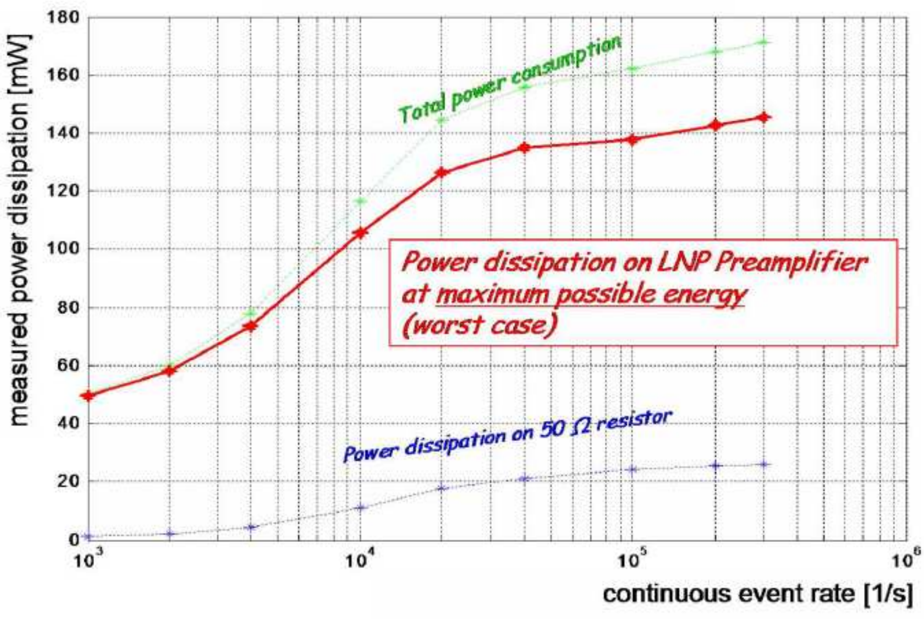
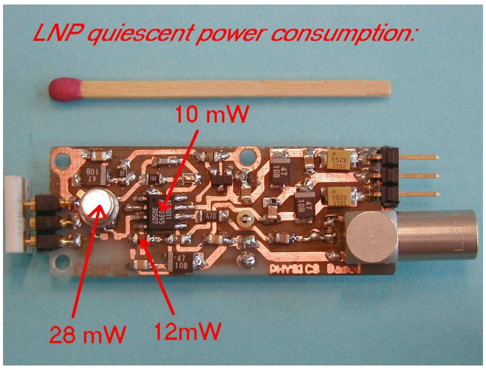
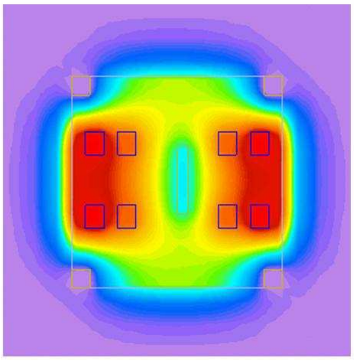


Figure 11: Power dissipation as function of continuous event rate for the LNP preamplifier.





red area: FET's

Left: Prototype SP883

Right: simulation quad version SP883b(Proto60)

Magnetic fields

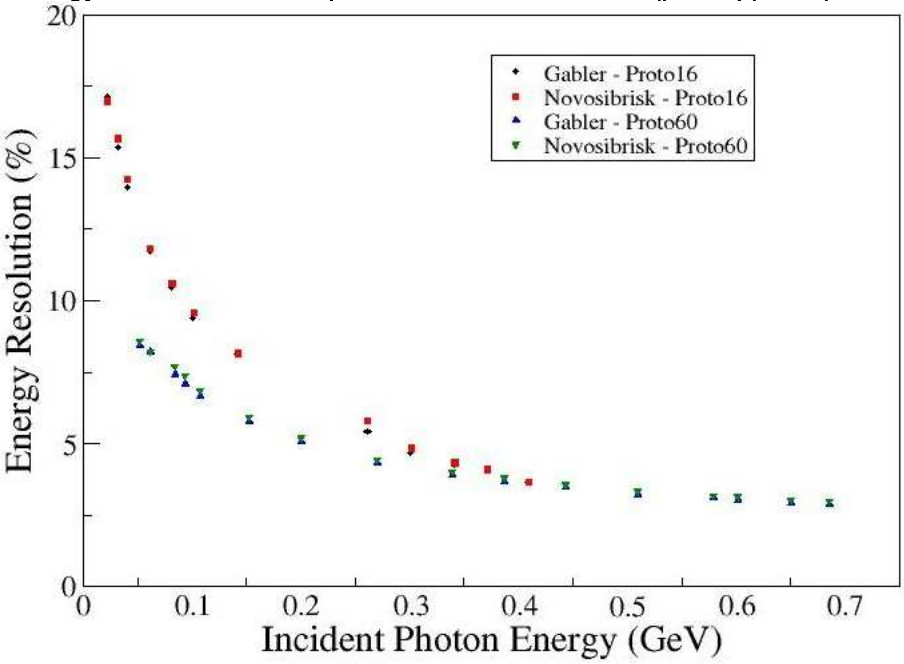
The magnetic field is not changing abruptly. There are no massive connectors and no inductors on the preamp which can cause a high deformation of the field, but several components contents a low amount of magnetic materials (as f.e. nickel) as well as the vacuum photo detectors.
Pretests with no effects on the preamp were executed with 1 Tesla.

Options

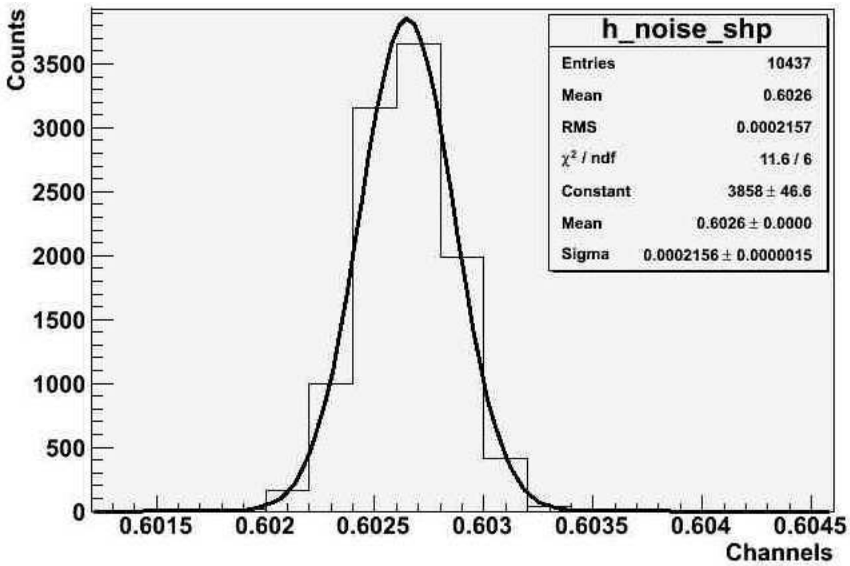
Noise and power consumption is a trade-off. Optimizations are possible in both directions.
Noise and pulse rate/decay time is a trade-off. Optimizations are possible in both directions.
Noise and shaping time is a trade-off. Optimizations are possible in both directions.

Results
G.Tambave, XXXVth PANDA Collaboration Meeting, 30 Nov. 2010, GSI, Darmstadt

Energy resolution: Comparison of ASIC readout (prototype 16) & LNP readout (Proto60)



→ At lower energies the energy resolution is worst for Proto-16



Noise Level – 4 Stage Shaper with LED light pulser
→ Noise level ~ 1.1 mV, Sigma * 5V ~ 1.1mV

References

Glenn F. Knoll: "Radiation detection and measurement", 4. Auflage, 2010
E. Kowalski: "Nuclear Electronics", Springer-Verlag, p.106ff, 163
W.R. Leo: "Techniques for Nuclear and Particle Physics"
Panda: EMC Technical Design Report (Oct. 2008) http://www-panda.gsi.de/framework/det_iframe.php?section=Calorimetry
2008: Technical Design Report GSI Panda ECAL, electronics: chapter 6.3. to 6.7. and 6.9.2
2008: Technical Design Report GSI Panda ECAL, for photodetectors: chapter 5

Myroslav Kavatsyuk et al., Feb. 9, 2011: Performance of the prototype of the electromagnetic calorimeter for Panda, ("Proto60"), accepted Ms. Ref. No.: NIMA-D-11-00181R1, Nuclear Inst. and Methods in Physics Research, A, It will appear on ScienceDirect
2005: Technical Report GSI Panda ECAL p. 203-207
2007: IEEE Transactions on Nuclear Science: Performance of PWO-II Prototype Arrays for the EMC of PANDA

Delivery Model SP883d (without model SP883a02)

Delivery	Pieces	Version	
December 2010	10	VPTT (RIE)	Bochum (Proto 192)
January 2011	2	VPT (H.)	Uppsala/Stockholm
January 2011	16	VPTT (RIE)	Bochum (Proto 192)
January 2011	2	VPTT (H.)	Bochum (Proto 192)
January 2011	2	VPT (H.)	Bochum (Proto 192)
April 2011	16	VPTT (RIE)	Bochum (Proto 192)
April 2011	16	VPT (H.)	Bochum (Proto 192)
May 2011	34	VPTT (RIE)	Bochum (Proto 192)
May 2011	48	VPT (H.)	Bochum (Proto 192)
May 2011	25	VPT (H.)	Uppsala/Stockholm
May 2011	2	VPT (H.)	Giessen
July/August 2011	96	APD	Bochum (Proto 192)

Low Noise/ Low Power Charge Preamplifier-Family overview + Accessories

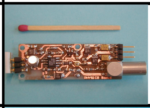
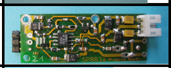
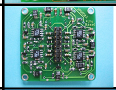
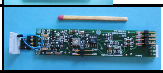
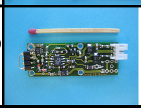
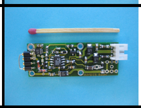
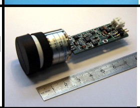
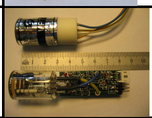
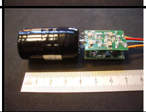
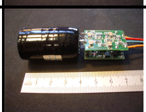
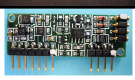
ID-Nr.	**Application**	**Description**	**Status/Application**
SP883-	Single APD		Prototyp
SP883a	Single APD		use no longer
SP883a01	Single VPT	Without HV-filter	Tests in Bochum
SP883a02	Single APD	Improved	
SP883a02(1kV)	Single APD	New rectangular APD	
SP883a03	*Single APD*	*High Rate (1 MHz)*	*Project R. Novotny, BESSIII*
SP883a0x	Single APD	20mW-Version	Prototype, Sample available
SP883b	Quad APD	48x48mm	
SP883b0x	Quad APD	Preamps + 50 Ohm-Backplane	60 Channels in Proto 60
SP883a01_VPT	Single VPT	+1kV, with HV-Filter for glass Housing, 18x48mm	
SP883c	Single VPT	+1kV, with HV-Filter for Metal Housing, 18x48mm	4 in Test @Bochum
SP883d_VPTT(R)	Single VPTT	For RIE VPTT 1200V, Glass Housing	Proto192
SP883d_VPTT(H)	Single VPTT	For Hamamatsu VPTT 750V, Glass Housing	Proto192
SP883d_VPT(H)	Single VPT/T	For Hamamatsu VPT Glass Housing	Proto192
SP883d_APD	Dual APD	With adapter-PCB for two rectangular APD	Proto192
SP917	Single APD	With shaper, Diff. Driver, temp.-regulated HV	Crystal Barrel
SP917c	Dual APD		Crystal Barrel
SP903a	12 channel	Backplane 50Ω	Proto60
SP903b	Universal	Floating linear LV Power Supply +/- 6V	5 built and in use
SP903c	Teststand	With 2 PMT's for tests	Basel
SP931	DriftChamber	For tests	Basel

Contributions Basel group to Proto192
Preamps SP883d_VPTT
Preamps SP883d_VPT
X from total 100 Stk. Rectangular APD's
VPT's
VPTT's
8 16ch. Shaper (via KVI)
LV-Power Supplies

7 ISEG High Precision HV Module	Juli 2011
1 HV-Rack mit Controller +8 ISEG HV Module	
+ in addition (as substitute for missing ASIC preamps) :	
Ca. 20 Stk. Preamps SP883a02	
96 Stk. Preamps SP883d_APD	11.8.2011
70 Stk. Adapter PCB f. Dual APD	Juli/Aug. 2011
70 Stk. Capsule	Juli/Aug. 2011

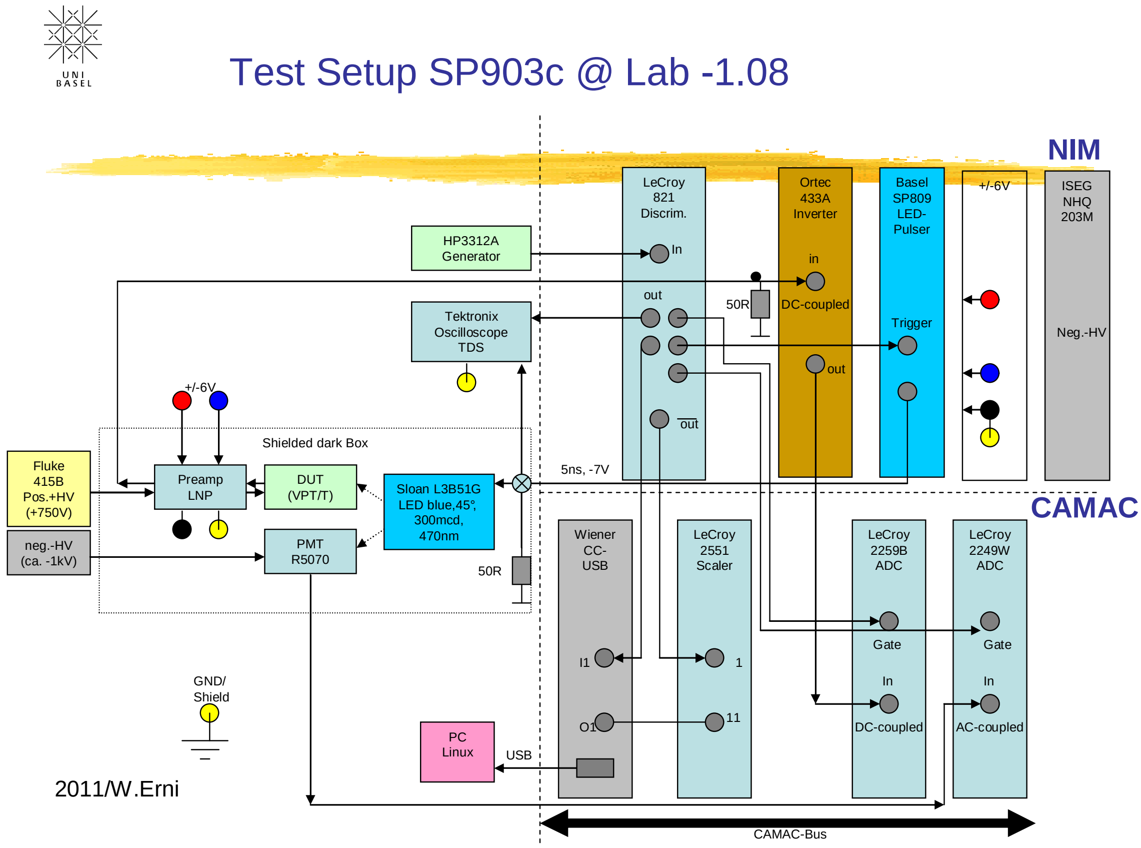
(earlier) Contributions to Proto60 (Barrel)
Quad APD-Preamps
Distribution-PCB's
ISEG HV
LV Power Supplies

Overview LNP Preamplifier “Champ” (Charge amplifier) -Familiy (Evolution Chart)

Model/Type Photodetector	Photo:	2004/2005	2006/2007	2008/2009	2010	Done 2011	Planned 2011	2012
SP883- Single for APD		Prototypes						
SP883a Single for APD		5x5 array Giessen	15 pcs. tests panda					
SP883b Quad for APD			15x4 Ch. Proto60 array					
SP917 Single APD				Protos		Protos Ver.C Crystal Barrel		
SP883a02, single rect. APD improved, 1kV				20xGiessen 1x Beamtest 2x for KVI	60xBW Endc. 3xZwieglinski 2xIgorKonorov 1x A.Wilms	51x Bochum		
SP883a03 APD higher rate (1MHz)							2x Rainer? For BESSII	
SP883c 1kV, short metal VPT (Ham.)				4x Bochum June09				
SP883(c)d VPTT (RIE) 1.5kV				1x Bochum Dez.	3x Bochum			
SP883d VPTT (RIE) 1.5kV					10x Bochum	52 Bochum		
SP883d VPT (Ham) 1.5kV						66 Bochum 27 Stockholm 2 Giessen		
SP883d VPTT (Ham) 1.5kV						10x Bochum delivered		
SP883d_APD Dual APD 500V						50 Bochum		
SP917c, Dual APD/ paralleled							20 Crystal Barrel	
Silicon Strip Gr. Ritman	???						Proto ???	FZ-Jülich

Test Setup (SP903c)

a.) A light tight, alu-shielded Test-setup with NIM- and CAMAC-Electronics and Linux PC is built. Operation with LED light-pulses and two PMT's as reference and trigger.



b.) Database for test results, datasheets, etc.: http://jazz.physik.unibas.ch/panda/

c.) The two PCB's dismounted (with 2.54mm SIL-connectors for production testing purpose)

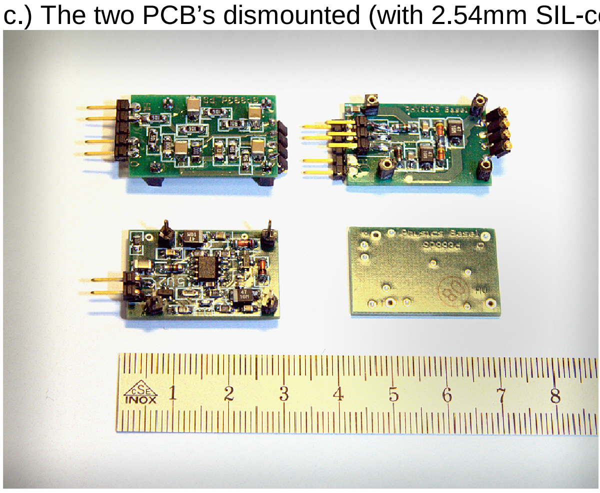


Photo: I.Keshelashvili

The Prototype SP883(c)d

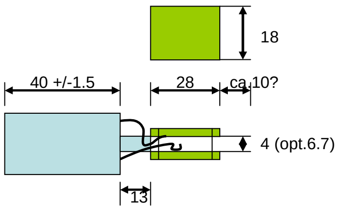
Built for Pretests for VPTT(RIE) with 1.5kV

VPTT+LNP (c)d Preamp

Prototype in „Sandwich"-Technique for Hamamtsu VPT based on a modified VPT-Preamp SP883c –> SP883(c)d

This solution provides:

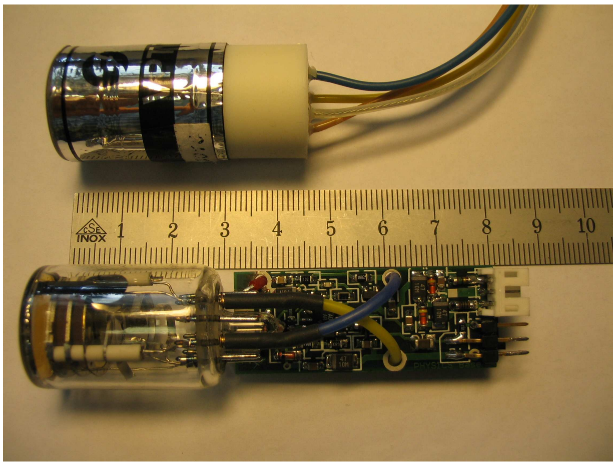
- Voltage Divider is now integrated on preamp. Rtot 30 MegOhm (=25 uA*750V=19mW) instead of 3x220kOhm (=1.14mA/850mW)
- HV-Caps are 1.5kV
- Total length (without cables) between ca. 70…83 mm (VPT 55mm+Preamp 28mm).
- This should be sufficient, based on a total length with shortest mechanical Interface X5 and Y4 (19mm) of 88mm.
- Contacting without space consuming tube socket or silicone potting
- The wires are soldered direct to the PCB, to fit into the aluminum insert also at the corners
- Short lead connection/lowest capacity from VPT to Preamp provides lowest noise and best immunity.
- A plastic holder provides HV-Isolation.

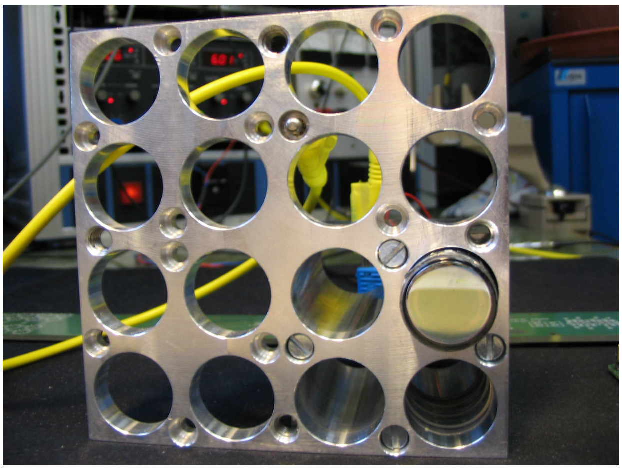


VPT-Body:	40+/-1.5mm
Exhaust cap:	<13mm
PCB:	28 mm
Space for cable:	10mm?

Dimensions in mm, not to scale

2010 11





Glossary/Abbreviations

LNP	Low noise, Low Power Preamplifier
PCB	Printed Circuit Board
VPT	Vacuum Photo Triode
VPTT	Vacuum Photo Tetrode
(LA)APD	(Large Area) Avalanche Photo Diode
PMT	Photomultiplier Tube
RIE	Research Institute Electron, St.Petersburg
Ham./H.	Hamamatsu

Links

Universität Basel, CH http://jazz.physik.unibas.ch/panda/
GSI Darmstadt, D http://www-panda.gsi.de/
http://panda-wiki.gsi.de/cgi-bin/view/SPC/WebHome
http://forum.gsi.de

Thanks to

Fritz-Herbert Heinsius, Thomas Held, et al. Ruhr Universität Bochum, D
Andrea Wilms, GSI; Herbert Löhner, Myroslav Kavatsyuk, Frans Schreuder, et al. KVI Groningen, NL

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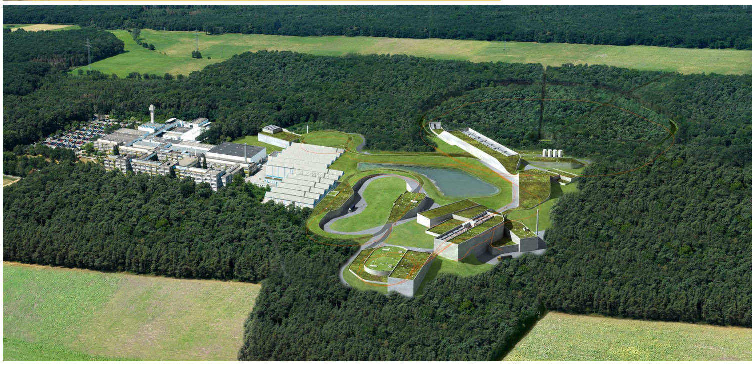
Figure: GSI, Darmstadt, Germany with FAIR-project

GSI Helmholtzzentrum für Schwerionenforschung

FAIR Facility for Antiproton and Ion Research



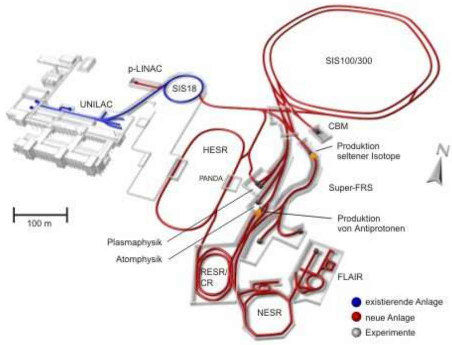
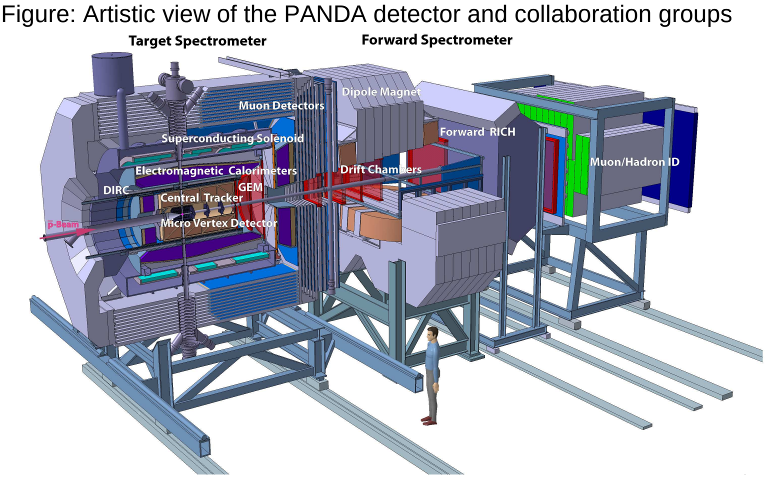
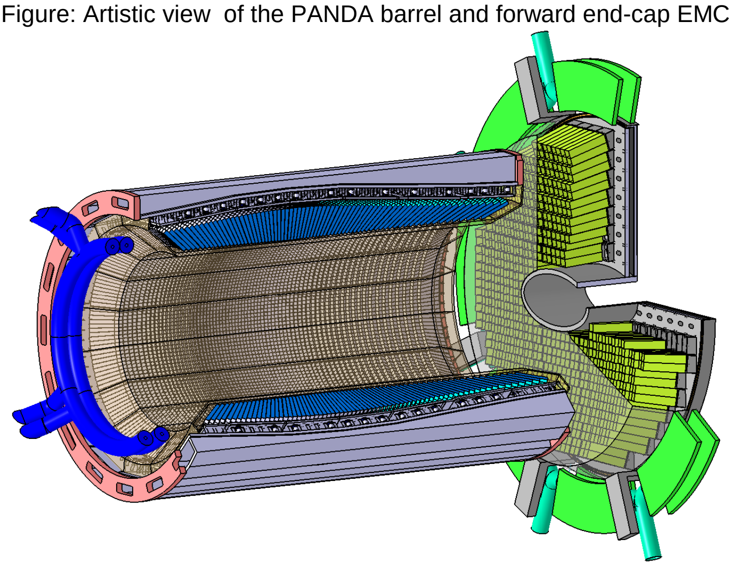


Figure: Artistic view of the PANDA detector and collaboration groups



panda

Figure: Artistic view of the PANDA barrel and forward end-cap EMC



Barrel: 11360 PWO Crystals (11 different shapes), 22720 APDs
Forward Endcap: 3600 PWO Crystals, Vacuum Photo Detectors (Triode or Tetrode)/APD's
Backward Endcap: 592 PWO Crystals, APDs