Long-Term Stability and Recalibration Requirements of iseg HV Modules

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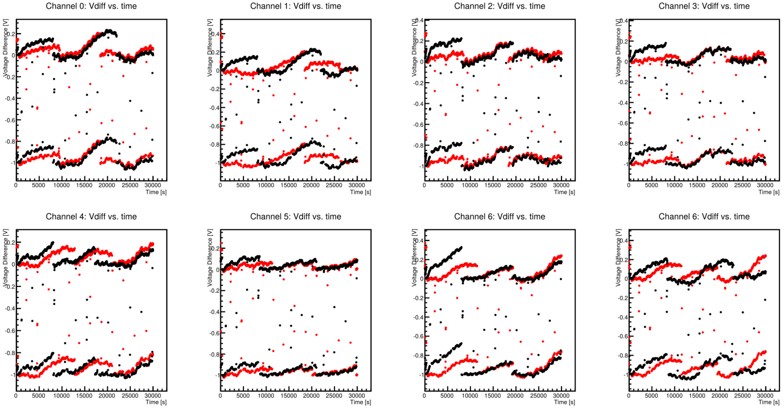
High Voltage Supplies for the EMC

- iseg EHS high voltage power supplies foreseen to power VPTTs and APDs within the $\overline{\text{P}}$ANDA EMC
- Already in use at Proto192 and several teststands at Bochum as well as by other $\overline{\text{P}}$ANDA groups (e. g. Gießen)
- Two different hardware versions in use
  - Distinguishable by number of digits in serial number
  - Old: 6 digits; New: 7 digits
- At Bochum, only "old" modules in use so far

Problem Investigation

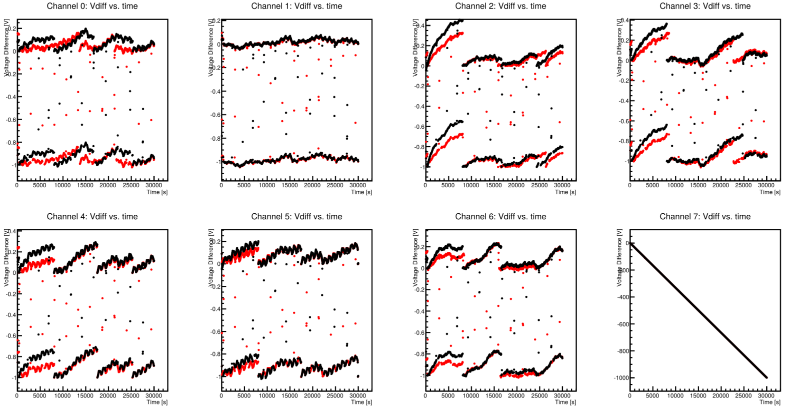
- Problem came up in teststand for APD units
- Power supplies do not reach set voltage
- Set up test application for HV modules:
  - Connect ohmic resistors to half of the channels, leave other ones with open SHV connector
  - Log measured voltage, set voltage and measured current for each channel every second
  - Increase set voltage for all channels every 30 s by 1 V.
  - Cover whole set voltage range of HV module (e. g. 0 V to 999 V for a 1 kV module)
  - Plot difference between measured voltage and set voltage
  - Caveat: HV needs time to react after change of set voltage $\Longrightarrow$ second curve shifted by $-1\,\mathrm{V}$

Result example: EHS 8 210p-F S/N 720090



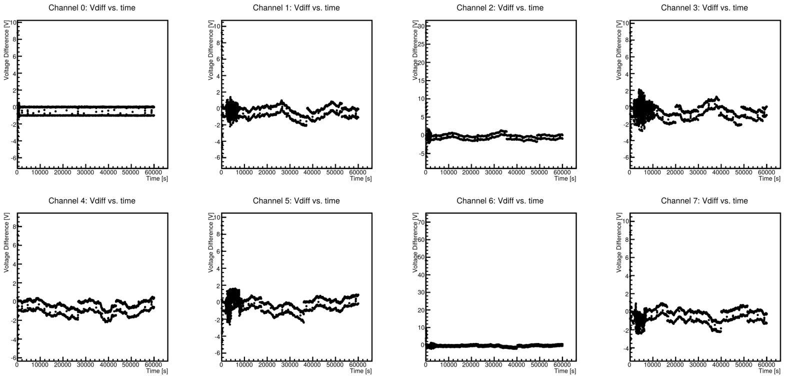
Same measurement done twice to check reproducibility: first one red, second one black

Result example: EHS 8 210p-F S/N 720060



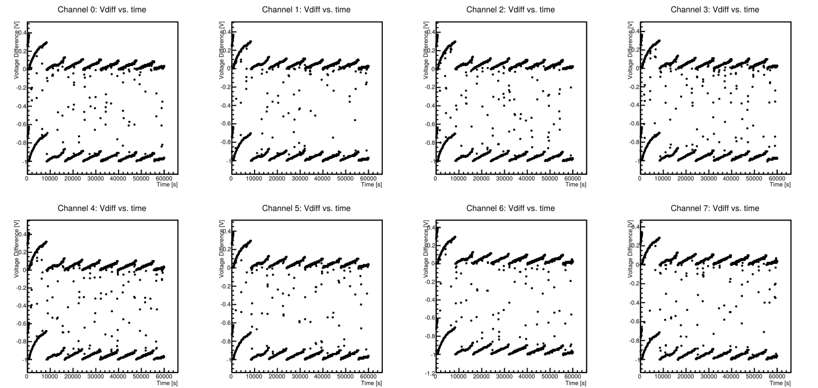
Same measurement done twice to check reproducibility: first one red, second one black

Result example: EHS 8 620p-F S/N 740930



2 kV module, not from high precision series, manufactured Dec 2008

Result example: EHS 8 220p S/N 780890



Module delivered from Basel a few months ago, never used before, manufactured Jan 2013

Lessons Learned

- Modules loose ability to proper voltage regulation over time
- Even if they sit in the wardrobe unused
- Problem seems to grow exponentially
- Voltage measurement not included in regulation logic
- Complete failure of voltage measurement does not raise error in HV firmware
- If operated at $V_{\mathrm{set}} < 1\,\%\,V_{\mathrm{max}}$, standard precision modules can generate *any* output voltage – maximum observed difference $68\,\mathrm{V}$ ($V_{\mathrm{set}} = 2\,\mathrm{V} \Rightarrow V_{\mathrm{mom}} = 70.0919\,\mathrm{V}$)

Repairing Modules

- Three modules sent to iseg to be repaired
- One module had communication issues, bug in iseg driver fixed
- Modules 720060 and 720090 repaired
- Explanation from iseg for regulation issues: "Channel regulation reserve was exhausted."
- Costs for recalibration: 340 € per module
- Repaired modules not yet returned from iseg
- Modules will be tested again after delivery

Questions to be Discussed

- Are the iseg HV supplies in this form suitable for use at $\overline{\text{P}}$ANDA?
- Are the costs for apparently needed regular recalibration and repairs included in the $\overline{\text{P}}$ANDA operation budget?
- How will the logistics for the regular repair of the modules be accomplished?
- How do we ensure proper operation of the teststands and prototypes at our institutes?

$\overline{\text{P}}$ANDA-wide Numbering

- Lots of things to label in $\overline{\text{P}}$ANDA:
  - Detector units
  - Cables (power, data, network,...)
  - Sensors (temperature, humidity,...)
  - Crates, ADCs, power supplies
  - Pumps, pipes, valves
- Solution: $\overline{\text{P}}$ANDA-wide numbering scheme for barcodes
- Proposed at the XLVIII. CM and approved by the Technical Board at the XLIX. CM

Numbering Scheme I

13 09 12345 2

subsystem category device number check digit

- First two digits: Subsystem
  - Assigned $\overline{\text{P}}$ANDA-wide
  - 100 subsystem numbers, but 20 subsystems

  $\Rightarrow$ Subsystems can have up to 5 numbers if needed
- Category: Identifies class/type of device, cable,...
  - Assigned by each subsystem individually
  - Recommended size 2 digits
  - Each subsystem can make own decision

Numbering Scheme II

13 09 12345 2

subsystem

category

device number

check digit

- Device number
  - Usually consecutive number
  - Identifies indivdual device, cable, sensor
  - Linked in database to device information
- Total barcode length:
  - Recommendation: 10 digits ($\Longrightarrow$ 100,000 devices/category)
  - Not fixed, can be decided by each subsystem for each category

List of Subsystem Identifiers

01	Pellet Target	16	Forward Shashlyk Calorimeter
02	Cluster Jet Target	17	Luminosity Detector
03	Micro Vertex Detector	18	Target Spect. Barrel μ Det.
04	Straw Tube Tracker	19	Target Spect. Endcap μ Det.
05	Planar GEM Trackers	20	Muon Filter
06	Silicon Lambda Disks	21	Forward Range System
07	Barrel DIRC	22	Hypernuclear Primary Target
08	Barrel Time of Flight	23	Hypern. Secondary Act. Target
09	Forward Tracking	24	Hypern. Germanium Detector
10	Endcap Disc DIRC	25	Solenoid
11	Forward RICH	26	Dipole
12	Forward TOF	27	Interaction Region
13	Forward Endcap EMC	28	Infrastructure
14	Barrel EMC	29	DAQ
15	Backward Endcap EMC	30	Computing

Barcode Labels

- Type of barcode: 2 of 5 interleaved (2/5i)
- Barcode length: $\approx$ 30 mm for 10 digits, but not fixed
- Standardized checksum algorithm
- Available for purchase from several companies
- Labels resistant against chemicals available
- Manufacturer used by EP1: Servopack (`http://www.servopack.de/`)
- We paid 1250.20 € for 4000 FEMC unit labels
- Labels not fallen off since two years
- Self-printed labels also possible (open source software)

The End

Thank you for your attention!