

Design of a test station for silicon strip sensors for PANDA*

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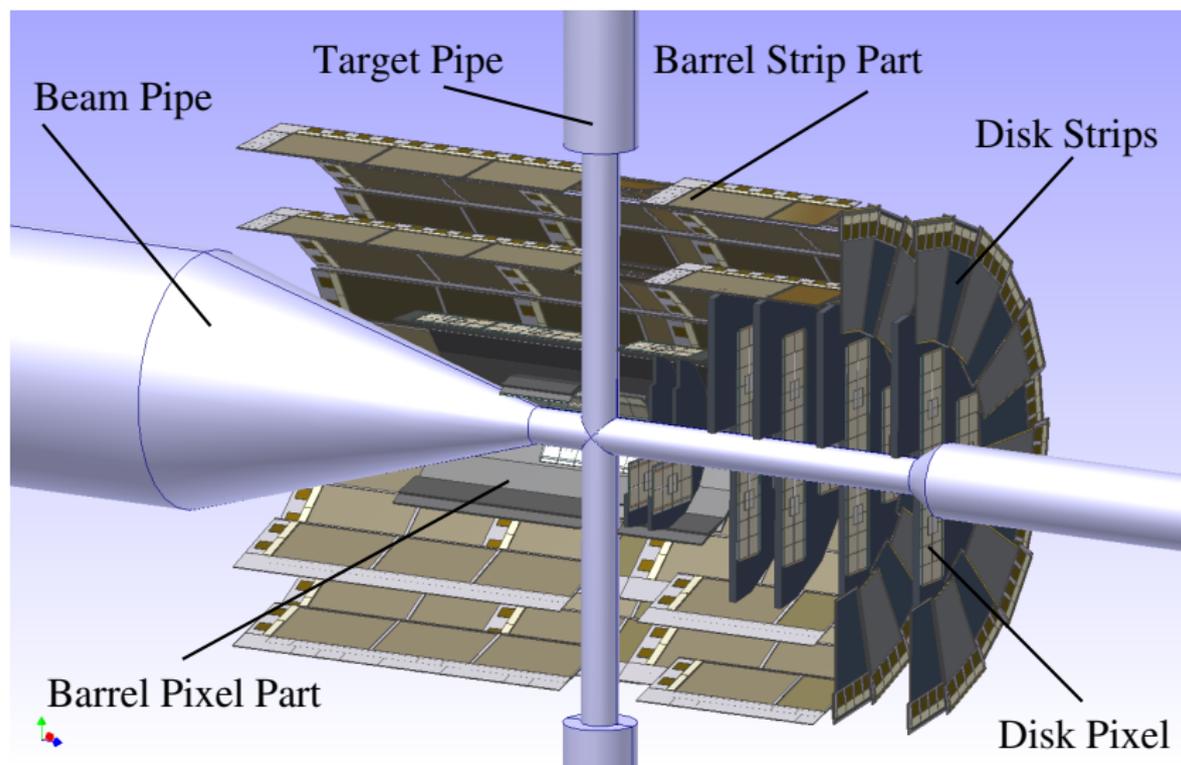
* supported by BMBF and EU

DPG spring meeting, HK40, March 17, 2009

Outline

- 1 Introduction
- 2 Test Station for Silicon Strip Sensors
- 3 Characterisation of Si-Strip Sensor Modules

The PANDA Microvertex Detector



- 12 million pixel channels → about 120 pixel modules
- 160,000 strip channels → about 200 strip modules

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need for solid tests of functionality of sensor modules

- fast characterization of all modules
- determination of bad channels or defunct frontends
- determination of leakage current and depletion voltage
- possibility to decide which modules may be used

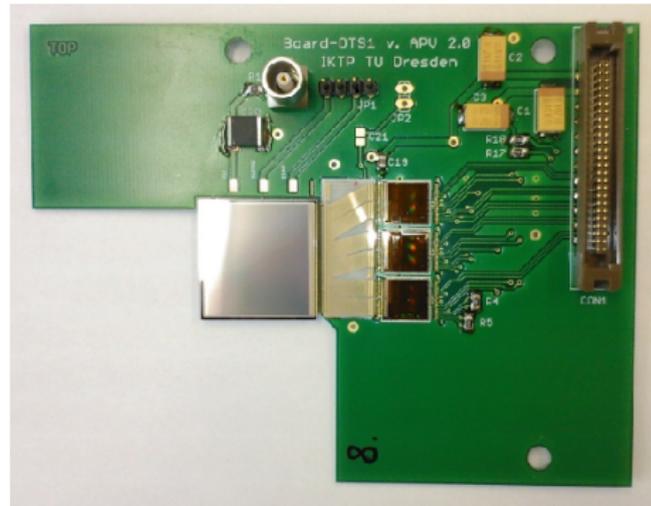
A setup for characterisation of Si-strip sensors and frontends



- handling Si-strip sensors and frontend electronics
- development of readout software
- measurements with ionizing radiation

Sensor Module

- L-shaped PCB for double sided mounting
- Sensors with area $2 \times 2 \text{ cm}^2$, thickness $320 \mu\text{m}$, $50 \mu\text{m}$ pitch, 90° stereo angle
- Frontend APV25-S1



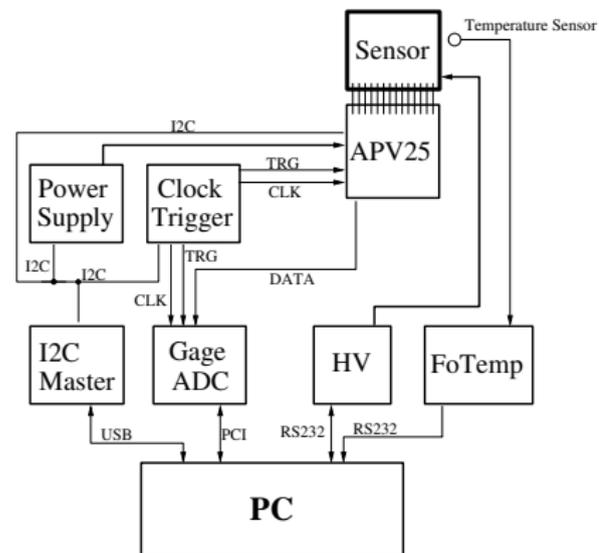
Readout and Feature Extraction

■ hardware

- modular setup
- standard connections to PC
- easy parameter setting and readout of all components

■ software

- zero suppression
- identify pedestals and noise
- find hits and save to file
- clustering for online monitoring



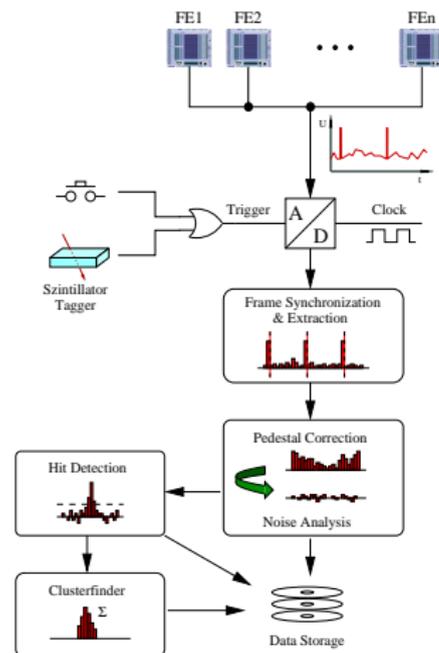
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Online Monitoring and Parameter Settings

- APV25 parameter settings
- raw data and pedestals / noise
- online energy deposit monitoring and clustering

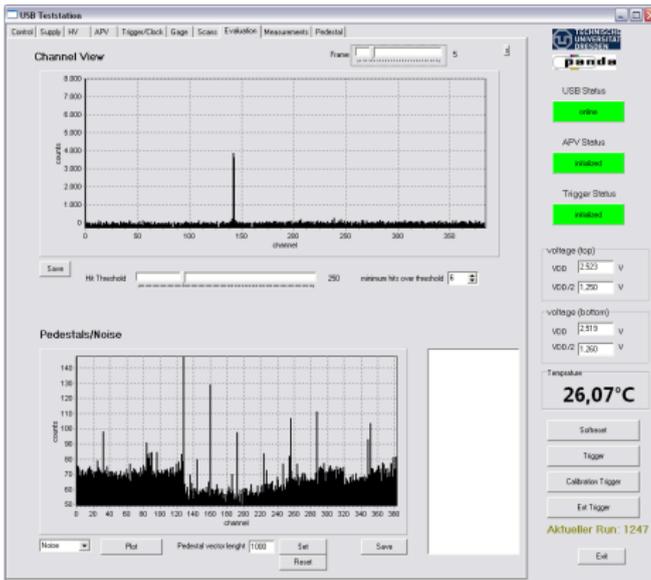
The screenshot shows the 'USB Teststation' software interface. The main window has a menu bar with 'Control', 'Setup', 'HW', 'APV', 'Trigger/Clack', 'Gage', 'Scans', 'Evaluation', 'Measurements', and 'Pedestal'. The 'Active APV' section shows a list of addresses and their status, with a green bar indicating 'Initialised'. The 'Mode Register' section has several checkboxes: 'Blow On' (checked), 'Disconnect' (unchecked), '3 Samples' (checked), '40 MHz' (checked), 'Call Inhibit' (checked), and 'Inverting' (unchecked). The 'Channel Select' section has a row of checkboxes. The 'Call Delay' is set to 3.125 ns. The 'Bare' section has 'Decimal' (checked), 'Hex' (unchecked), and 'Binary' (unchecked). The 'APV List' table shows the following data:

| Nr. | Addr. | Status | Error |
|-----|-------|--------|-------|
| 1 | 98 | ok | 0 |
| 2 | 102 | ok | 0 |
| 3 | 106 | ok | 0 |
| 4 | | | |
| 5 | | | |
| 6 | | | |

The right-hand panel shows 'USB Status' (green 'online' button), 'APV Status' (green 'connected' button), 'Trigger Status' (green 'connected' button), 'voltage (top)' (VDD: 2.525 V, VDD/2: 1.261 V), 'voltage (bottom)' (VDD: 2.310 V, VDD/2: 1.150 V), and 'Temperature' (26.07°C). There are buttons for 'Substent', 'Trigger', 'Calibration Trigger', 'Exit Trigger', and 'Exit'. The status 'Aktueller Run: 1247' is displayed at the bottom right.

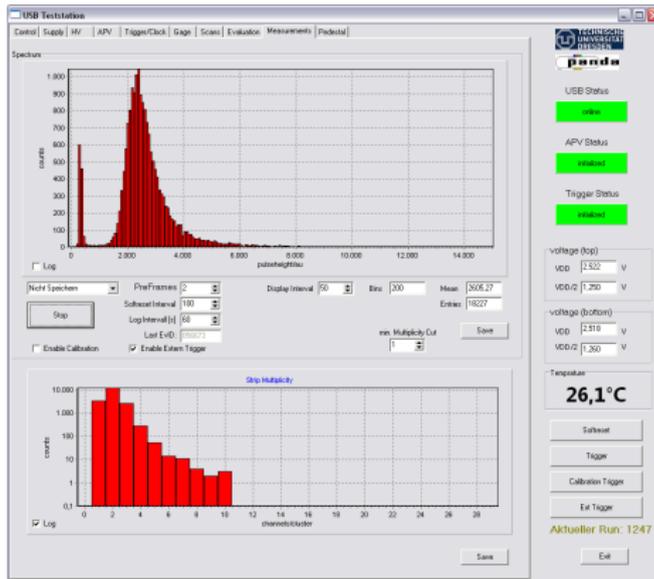
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Characterisation of Si-strip sensors modules

■ Tests of functionality of sensor modules

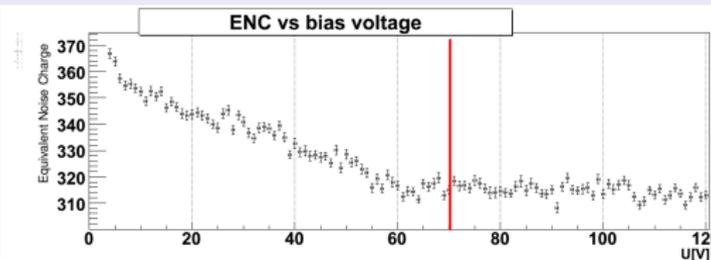
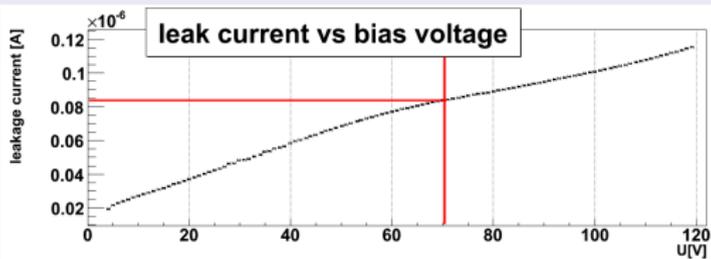
- 1 Analysis of leakage current and noise to determine optimal depletion voltage
- 2 Detailed calibration of each channel with APV internal charge generator
- 3 Measurements with ^{90}Sr to get response of sensor strips

■ Store results in MySQL-database

leakage current and noise characteristics

$$ENC = f(d(V_{Dep})), I_{Leakage} = f(V_{Dep}, d(V_{Dep}))$$

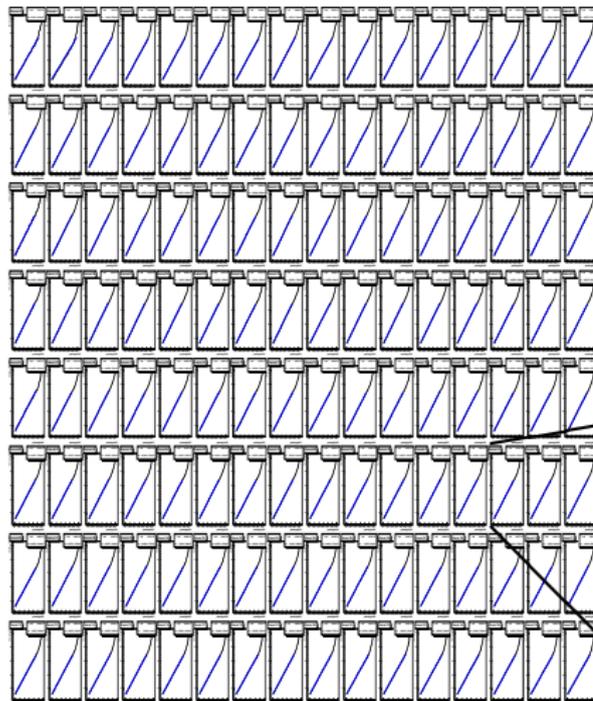
e.g for Module 09



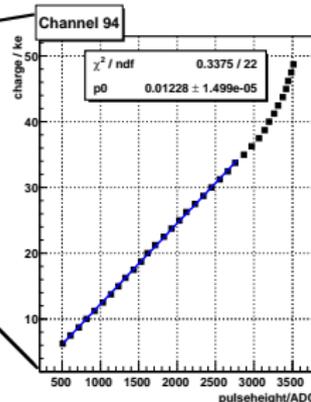
- $V_{Dep} \approx 70V$
- $I_{Leakage} \approx 85nA$

Calibration

- injection of defined charge into FE preamps
- store slope parameters for later charge reconstruction

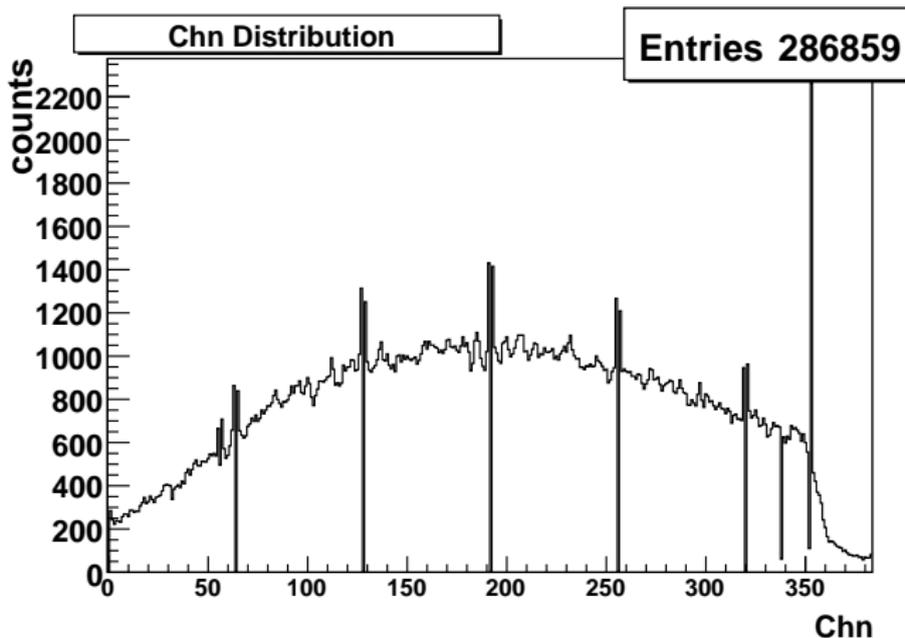


response characteristics
of all FE channels

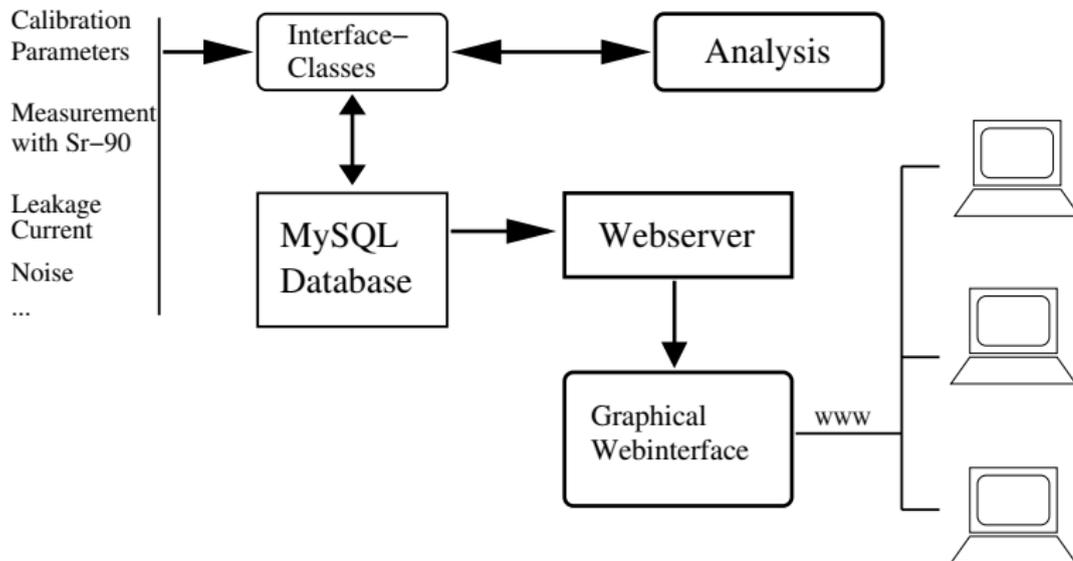


Measurement with ^{90}Sr

- detect noisy / defunct channels or FE
- channels 0, 64, 128, 192, 256, 320 not bonded



Database Structure



module test results

- until now 15 modules tested
- leakage currents between 85nA - 700nA
- depletion voltage about 35V - 75V
- < 1,5% bad channels per module
- 1 module with defunct frontend

Summary

- stable test station to characterize silicon strip sensor modules
- measurements with radioactive sources
- simple tests to confirm functionality of sensor modules
- database interface to store results
- base for energy loss, scattering and tracking studies

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Outlook

- tests with different sensor types
- possibility to bond single strips to learn more about depletion, leakage current and radiation damage
- web server planned for better compatibility among different groups within PANDA (connections from Bonn, Mainz and Dresden)