

Status of Automatization of Measurements and Logging for the Mass Testing

21st DEPFET Workshop Ringberg

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Goals for Automated Mass Testing

- use central **configDB** instead of local ini-files
- use **automatic power-up**
- several testing packages define **pass** or **fail** and a **grading**
- automated **logging** using Archiver and Elog
- **result**: commitID of fully optimized module parameters

For information on the hardware side (construction and status of test setups), see talk by Philipp Leidl.

Automatic Start-up and ConfigDB

When a new module is going to be connected.

configDB templates

<https://confluence.desy.de/pages/viewpage.action?pageId=45740588>

- ① generate a configDB entry from templates using
~/epics/templates/generateTemplate.py
- ② specify device type (IB,OB,IF,OF) and name (e.g. W31_IF)
- ③ contains working values for the respective module type
- ④ commit to configDB and obtain a new **commitID**

[INFO] configDB

- using configDB server running in Heidelberg
- one file per module for mass testing
→ for the experiment, 40 module files are simply merged

When a new module is going to be connected. (2)

hostconfig

- change the module type for the DHH IOC in
~/epics/settings/host-HOSTNAME.ini
- specify device_module (pxd9, hybrid5) and module_type
(ib,ob,if,of)
- described here <https://confluence.desy.de/display/BI/Use+the+start-epics+script>

What needs to be done to power up a module.

automatic powerup and configuration

With using the ps-sequence, dhh-sequence and ps-control IOCs, bringing the module in the running state is fully automatized.

- set the commitID obtained earlier to the system
 - via **caput PXD:B:config-commitid 123**
 - or via
- bring the system from state **OFF** to state
 - **STANDBY**: ASICs powered and configured
 - **PEAK**: matrix powered

Global State

Current state: **PEAK**

Requested state: **PEAK**

OFF STANDBY PEAK

Module	Current state	Related OPIs	Module	Current state	Related OPIs
1011	Disconnected	Disconnected PS DHE	1012	Disconnected	Disconnected PS DHE
1021	Disconnected	Disconnected PS DHE	1022	Disconnected	Disconnected PS DHE
1031	UNKNOWN	<input type="checkbox"/> Follow global PS DHE	1032	PEAK	<input checked="" type="checkbox"/> Follow global PS DHE

Measurement-Analysis-Update Cycle

Starting the testing of a module.

- make sure that the DHE \leftrightarrow DHP data transmission is working
→ optimize the highspeed links (*HS links*)
- per DHP, three parameters are used to tune the HS link
→ vary parameters and **measure** link survival for 5 min
- for each DHP, **analyze** data to find optimal parameters
- **update** the respective parameter values to the current system
and update the configDB commit

measurement \Rightarrow analysis \Rightarrow update

Same procedure as last year, James...

- with optimized HS links, optimize DCD \leftrightarrow DHP data transmission (*delays*)
 - with optimized delays, optimize DCD analog part (*ADC curves*)
 - *etc.*
- ⇒ provide unified interface to individual measurements

[INFO] coding guidelines

- each measurement type is one package
- same interface for calling each measurement defined in guidelines
<https://confluence.desy.de/display/BI/Coding+Guidelines>
- ini-files steer measurement/analysis per package
- a set of default ini-files is provided for each package for the mass testing

Automated Logging

Keeping track of what we are doing.

There are several services that log the system during the testing and that provide the output of the individual optimization steps.

- **Archiver** (local)

- archives the status of all PVs of the system over time
- can follow and recall the system status in great detail to investigate problems
- simple web interface
- <https://confluence.desy.de/display/BI/Setup+of+the+EPICS+Archiver+for+Lab+Setups>

- **STOMP server**

- stores log messages (errors, warnings, infos, ...)
 - from base software EPICS/CSS/...
 - from measurement and analysis scripts
 - logging library available
- <https://confluence.desy.de/display/BI/Logging>

Archiver

EPICS Archive Viewer: <save>

Q

ADD FUNCTION

C/PLT COMP

Del	Plst	Name	DBType	Units	Processing	Scale	Time (sec)	Value	Notes
*		PIX P1332 gate on1-load VOLTage	DBF_SCALAR_DOUBLE	mV		Error	2017-05-26 18:58:14	3000	

WINDOW SIZE: 1 year 1 month 2 w 1 w 2.5 d 1 d 30 h 12 h 6 h 3 h 2 h 1 h 30 m 15 m 5 m 1 m 30 s END: 2017-05-26 18:58:35 NOW x

AUTO

Tseries

Wave

Cycle

H-gram

Data



Keeping track of what we are doing. (2)

- **automated eLog entries**

- collects measurement information (type, module, starttime, duration, ...)
- collects analysis results (plots, statistics, ...)
- elog library available
<https://confluence.desy.de/display/BI/Automated+ELOG+entries>

- **config_utils Configuration class**

- saves state of all PVs before measurement
- restores state after measurement
- dumps all PV values at specific point in time to file

[INFO] eLog server

- eLog server running at DESY (elog.belle2.org)
→ central eLog server for TB, cosmic runs, ...
- one logbook for mass testing, one per lab

eLog - Measurement

Message ID: 9 Entry time: 2017/05/26 Fri 18:25 CEST

Author:	Belle2
Category:	Scan
Type:	ADC Scan
Device:	hybrid5
Module:	H5006
Moduletype:	None
CommitID:	323

ADC Scan started at 17:6:49.

Swept parameters are:

dacipsource from 80 to 100 in steps of 5

dacipsource2 from 80 to 100 in steps of 5

In total 20 channels were scanned. Starting from 64 up to 83, every 1 channel.

Measurements stored at: /run/media/belle2/DATA2/measurements/H5006/adc_curve/dhe/ipsource-ipsource2/2017_05_26_003

CommitID: 323

DHE: H1032

PS: P1032

ADC Scan stopped at 17:25:18.

Total time passed: 0:18:29

- details of measurement (modules, scan ranges, duration)
- attach PV dump files

eLog - Analysis

Message ID: 10 Entry time: 2017/05/26 Fri 18:29 CEST

Author: Belle2

Category: Analysis

Type: ADC Analysis

Device: hybrid5

Module: H5006

Moduletype: None

CommitID: 323

ADC Analysis started at 17:27:15.

Analyzing files, located at /run/media/belle2/DATA2/measurements/H5006/adc_curve/dhe/ipsource-ipsource2/2017_05_26_003

Swept parameters are:

dacipsource from 80 to 100 in steps of 5

dacipsource2 from 80 to 100 in steps of 5

In total 20 channels were analyzed. Starting from 64 up to 83, every 1 channel.

Best settings found by analysis:

sweep_ipsource = 100

sweep_ipsource2 = 100

Details analysis shows:

Good channels: 19

Bit error channels: 0

Comparator error channels: 1

Range error channels: 0

Median LSB: 136.94 nA

Median INLpp: 5.90

ADC Analysis stopped at 17:29:55.

Total time passed: 0:02:39

- summarize analysis results and attach plots

Status of Measurement Packages

Status and Responsibilities

measurement	responsibility	tested on new PXD9	comply with coding guidelines	to do	comment
HS Link Scan	Bonn	TESTED @ TB	NO		
HS Link iBert Scan	Bonn/Munich	IN DEVELOPMENT	NO		
Delays	Bonn	TESTED @ TB	NO		
ADC Optimization (also calibration (DHE current source))	Gö	TO BE TESTED @ PERSY	YES	<ul style="list-style-type: none"> test on new PXD9 modules, confirm multi-ASIC functionality add logging 	
Offset DACs & Pedestals	Bonn/Munich	TO BE TESTED @ PERSY	NO		
Gated Mode (& clear efficiency)	HLL/MPP	MEASURED @ HLL	NO		setup specific, like pulse generator and laser control
Source Scans	HLL/MPP	TO BE TESTED @ PERSY	NO		
Laser Scans	HLL/MPP	TO BE TESTED ON PXD9	NO		setup dependent (control of laser)
DHP Temperature Diode	Bonn	IN DEVELOPMENT	NO		
DEPFET IV-curve	Gö/Munich	IN DEVELOPMENT	NO		characterization of DEPFET, determine threshold voltage for radiated modules
sample point curve	Bonn/Munich	IN DEVELOPMENT	NO	verify fast enough DCD sampling time	
mapping.py and Plotting	Gö	IN DEVELOPMENT	NO	use u-v coordinates, label ASICs in plots, rotate by 90°	decided to use Belle II mapping and displaying of matrix frames
number of bad pixels	IFIC/Munich	IN DEVELOPMENT	NO	compare pedestal maps for different gate on voltages	should be part of the probe card testing before the kapton attachment

<https://confluence.desy.de/display/BI/Responsibilities>

Status and Responsibilities (2)

- **HS links**

- ETA: next week

- **DCD↔DCD delays**

- ETA: next week

- **ADC curves**

- running on Hybrid5 and PXD9
- no results on PXD9 yet due to data reception problems

- **offset DACs**

- ETA: ?

- **gated mode**

- see talk by Felix

- **source scans**

- ETA: ?

- **DHP temperature**

- see talk by Leo

- **DEPFET IV-Curve**

- ETA: four weeks

- **sample point curve**

- ETA: ?

- **mapping and plotting**

- ETA: two weeks

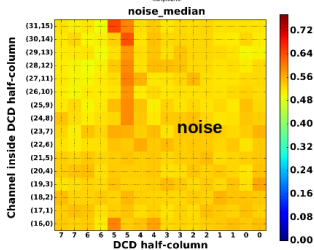
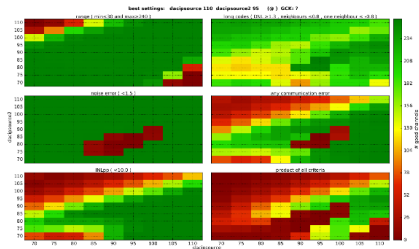
Example: ADC Curve Package

purpose:

- optimize the DCD analog performance

idea:

- sweep current source (DHE or DEPFET pixels) and record 256 ADC curves per DCD
- vary DCD parameters IPSource, IPSource2, IFBPBias (DACs) and supply voltages RefIn and AmpLow
- analyze curves for linearity, noise, missing codes, communication errors
- define quality criteria and find parameter space point where most of 256 channels fulfill requirements



settings:

dacipsource=110, dacipsource2=95

swept parameters:

dacipsource dacipsource2

total channels: 256

good channels : 245

bit error channels : 2

comp error channels : 9

range error channels : 1

INL error channels : 0

channel statistic

(bit error channels only) : 2

(comp error channels only) : 9

(comp error channels only DNL>6.0) : 0

(range error channels only) : 0

(bit + comp error channels) : 0

(bit + range error channels) : 0

(comp + range error channels) : 0

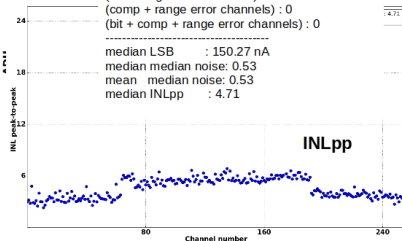
(bit + comp + range error channels) : 0

median LSB : 150.27 nA

median median noise: 0.53

mean median noise: 0.53

median INLpp : 4.71



Example: ADC Curve Package (2)

status:

- complies with coding guidelines
- automated eLog logging implemented
- tested on Hybrid5 and running on PXD9
- PXD9 results still pending

scan ranges and time requirements:

- have proven on Hybrid5 with DCD4.X that optimal parameter space point is very similar among several chips
- can reduce scan ranges and current source granularity
⇒ aim for 10 h per module

Module	IPSource	IPSource2	IFBPBias	Refln [mV]	AmpLow [mV]	gain/Clock	comment
H5.0.24 (DCD4.1)	70	60	75	690	200	En30, 76MHz	DHE source
H5.0.13 (DCD4.1)	70	60	75	690	200	En30, 76MHz	DHE source
H5.0.14 (DCD4.2)	75	65	70	680	200	En30, 76MHz	DHE source, same for gate source
H5.0.15 (DCD4.2)	70	55	60	700	200	En30, 76MHz	strange gain behaviour
H5.0.26 (DCD4.2)	70	60	70	650	200	?	

- scan ranges:

	start	end	step
IPSource/2 [DAC]	50	90	5
Refln [mV]	600	800	50
AmpLow [mV]	100	300	50
IFBPBias [DAC]	55	85	5
IPSourceMiddle [DAC]	IPSource-5	IPSource+5	1

- gain: En90 ($\approx 100 \text{ nA/ADC slope}$, $\approx 25 \mu\text{A range}$)

Module Summary and Grading

Is it working?

Need to define quality criteria and how to handle problematic modules.

- each measurement package defining ✓ or ✗
and producing a condensed plot/table of optimization result
- if a module fails a standard scan procedure with standard scan ranges
 - redo with larger scan ranges?
 - put aside/send to another lab for detailed investigation?
- automatically collect condensed per module information on summary eLog page
- ideally: mass testing of module follows a clear checklist and can in principle be done by anyone

Summary

- moved from ini-files to automatic power-up
 - greatly simplifies operational module handling
 - using configDB as centralized configuration service
- coding guidelines implemented to standardize and automate measurement scripts
- several services logging and collecting optimization results
 - Archiver running in all labs
- ADC curve package
 - reworked according to coding guidelines
 - automated eLog summaries
 - final tests on PXD9 pending

Backup

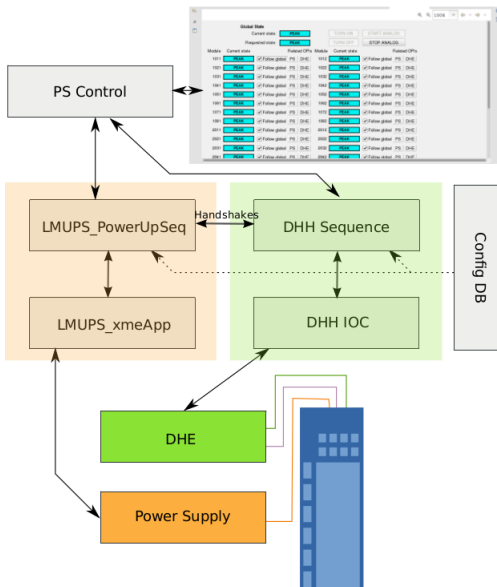
Testing of Latest DHE Firmware

firmware 20170523-

- large memory for taking memdumps of 4 ASICpairs simultaneously
 - gated mode support
 - internal trigger
 - internal DHE current source
-
- successfully configured Hybrid5 setup in Gttingen
 - taking memdump/pedestals working fine
 - taking zero-suppressed data manually via DHH ADV widget and internal trigger working fine
 - ADC curve measurement: no data recorded
 - suspect IPBus triggering or DHE internal trigger interface changed
 - under investigation

oooooooooooooooooooo

IOCs Interplay



ADC Curve Package - Plans

[INFO] possible ADC curve improvements

- speeding up DHE current source measurements on DHE level
- use non-linear multi-dimensional optimization algorithms to optimize in 5D parameter space
 - Bachelor student Jonas Pöhls working on that in Göttingen
- tidy up code and identify and improve bottle-necks