# ITS OB HIC Production Test & QA

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# Outline



## OUTLINE

① Introduction

② Improvements of Test Software

③ Quality Control

④ Conclusions

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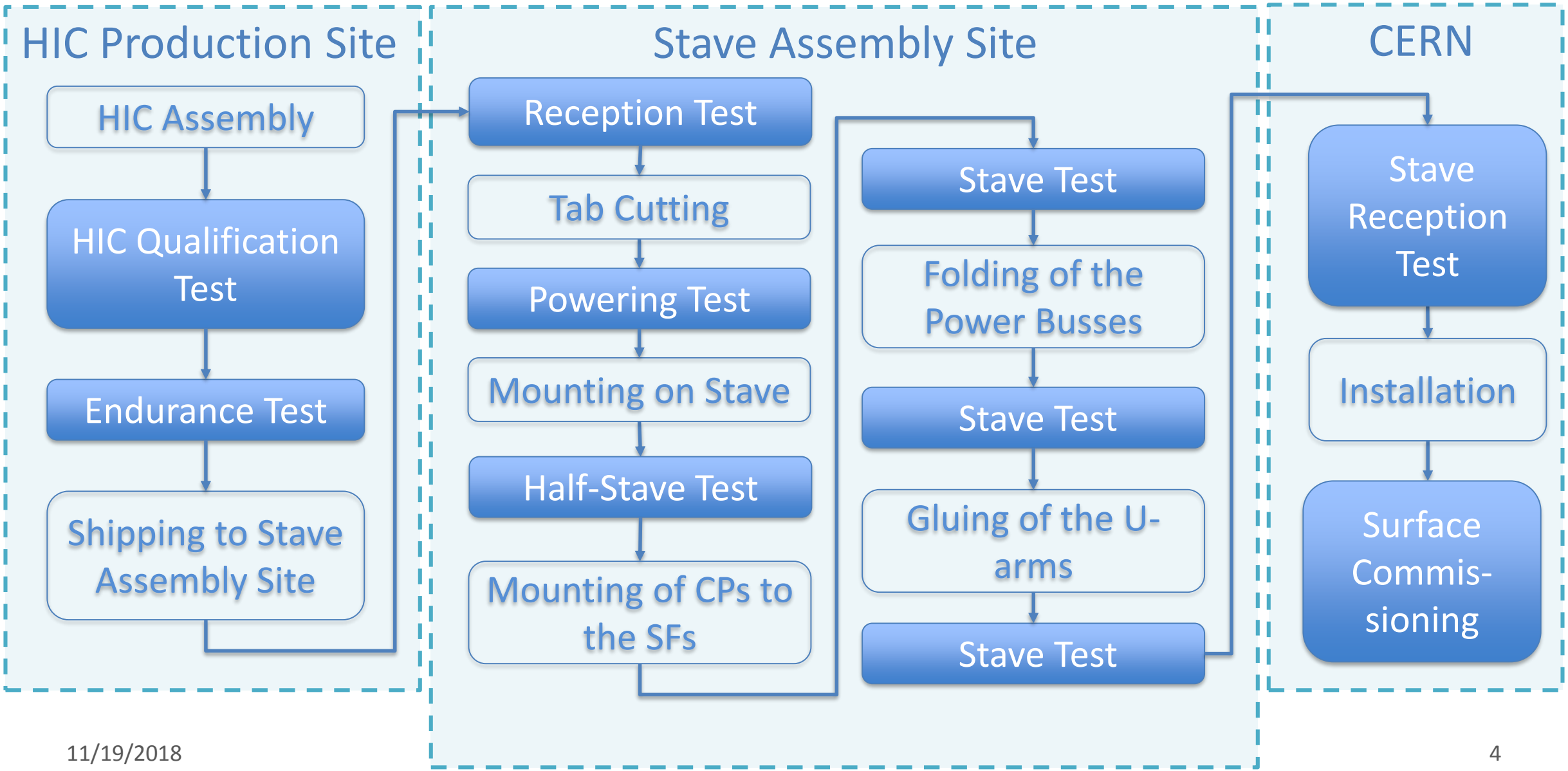
# Test Overview

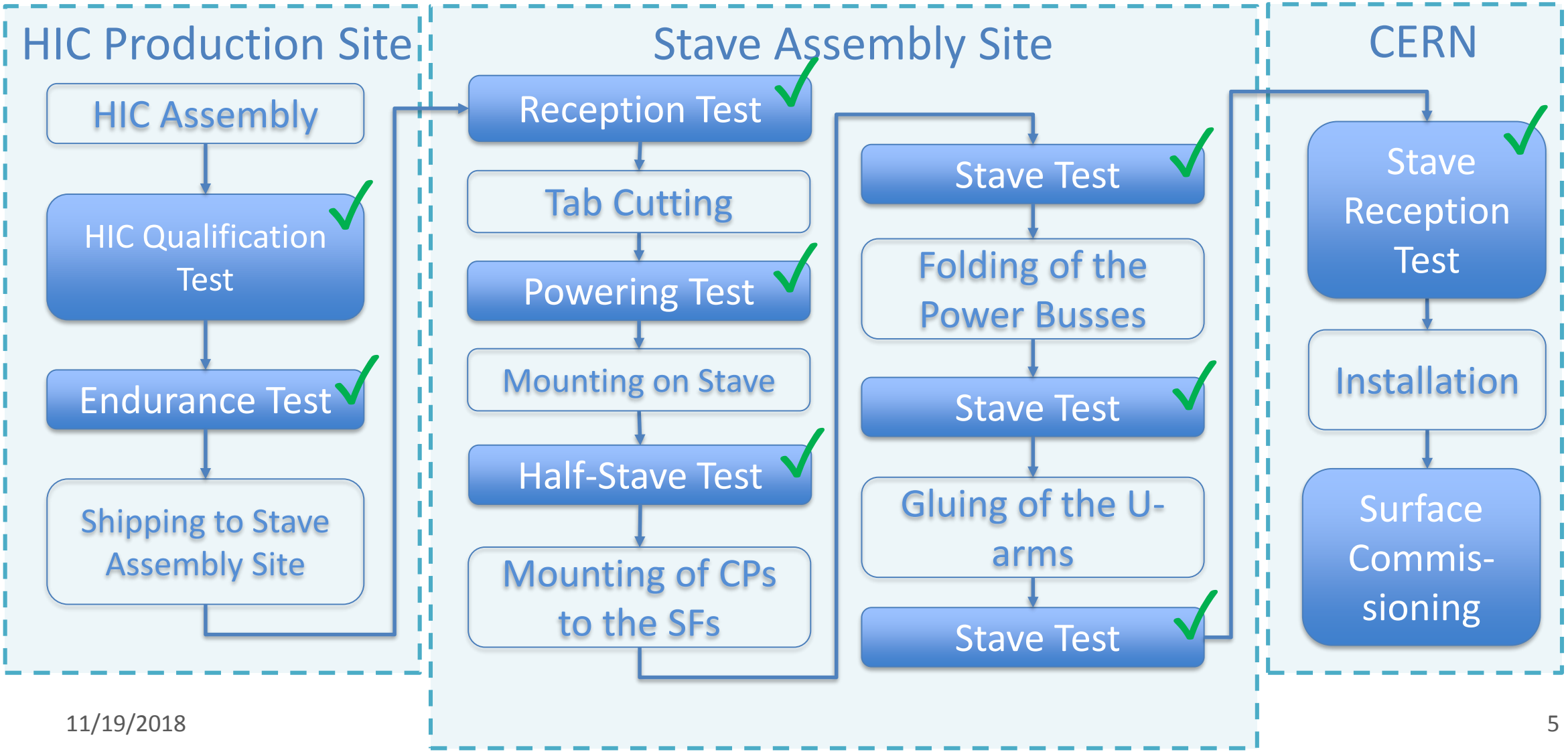




# Test Overview



- All test steps implemented in new-alpide-software



# Test Overview



All tests from HIC assembly to reception test at CERN implemented in new-alpide-software

- Large variety of scans, scan list depends on type of test
- Software works for all component types: OB HICs, IB HICs, OL Half-staves, ML Half-Staves
- Results are analysed on the fly and HIC is qualified according to configurable cuts
- Results are written to production DB, full data copied to eos

Work in last months concentrated on:

- Improvements for smoother and quicker production flow
- More detailed information for the operator
- DB integrity
- Quality Control

# Test Overview



Alpide Testing

Actions

OB HIC Qualification Test

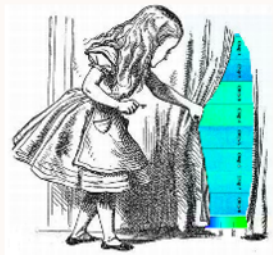
**ITS Upgrade HIC and Stave Characterisation Software**

| | scan | status |
|---|---|---|
| 1 | Power Test | Waiting |
| 2 | Fifo Scan | Waiting |
| 3 | Fifo Scan, V +10% | Waiting |
| 4 | Fifo Scan, V -10% | Waiting |
| 5 | Digital Scan BB 0 | Waiting |
| 6 | Digital Scan BB 0, V +10% | Waiting |
| 7 | Digital Scan BB 0, V -10% | Waiting |
| 8 | Digital White Frame BB 0 | Waiting |
| 9 | Threshold Scan 0.0 V | Waiting |
| 10 | Tune VCASN Scan 0.0 V | Waiting |
| 11 | Tune ITHR Scan 0.0 V | Waiting |
| 12 | Threshold Scan 0.0 V | Waiting |
| 13 | Noise Occupancy 0.0 V | Waiting |
| 14 | Noise Occupancy 0.0 V | Waiting |
| 15 | Digital Scan BB 3 | Waiting |
| 16 | Digital White Frame BB 3 | Waiting |
| 17 | Threshold Scan 3.0 V | Waiting |
| 18 | Tune VCASN Scan 3.0 V | Waiting |
| 19 | Tune ITHR Scan 3.0 V | Waiting |
| 20 | Threshold Scan 3.0 V | Waiting |
| 21 | Noise Occupancy 3.0 V | Waiting |
| 22 | Noise Occupancy 3.0 V | Waiting |

Object Layout

OUTER BARRELHIC

| | | | | | | |
|---|---|---|---|---|---|---|
| Chip14 | Chip13 | Chip12 | Chip11 | Chip10 | Chip9 | Chip8 |
| Chip0 | Chip1 | Chip2 | Chip3 | Chip4 | Chip5 | Chip6 |



Start test | Power Off | Quit

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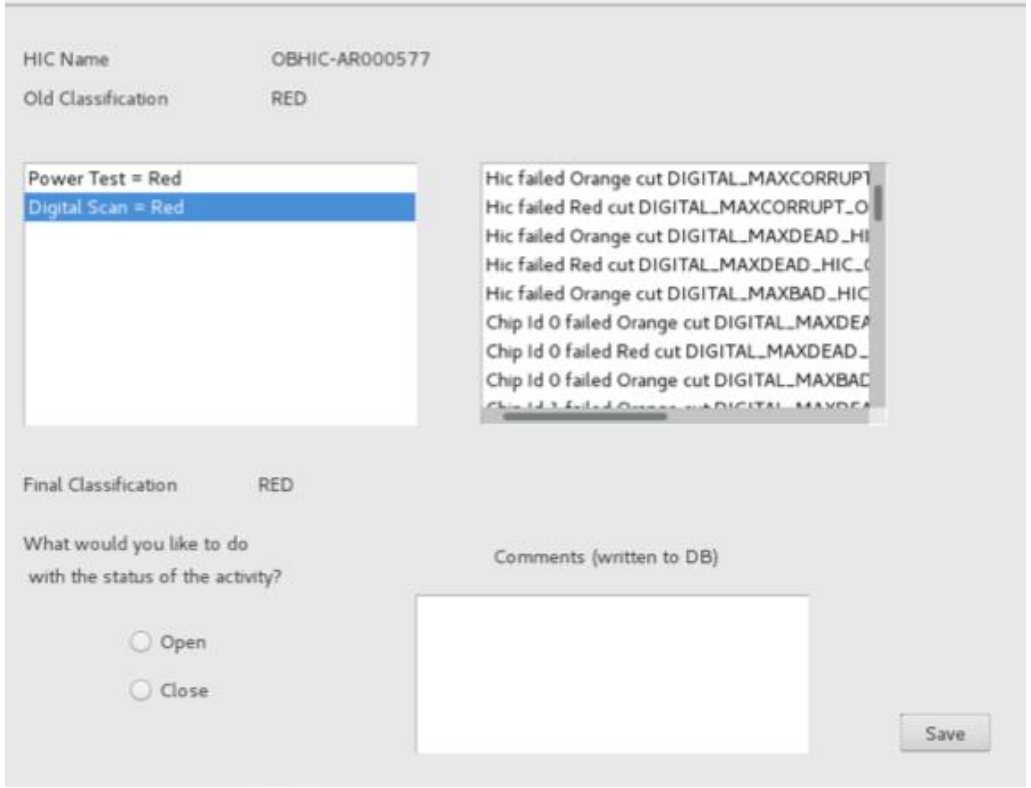
# Result Overview



Detailed overview of the single scan results

- Which scan got which classification
- List of failed cuts, including cut value and measured value
- Goal: allow operator to understand in detail why a HIC got a certain classification

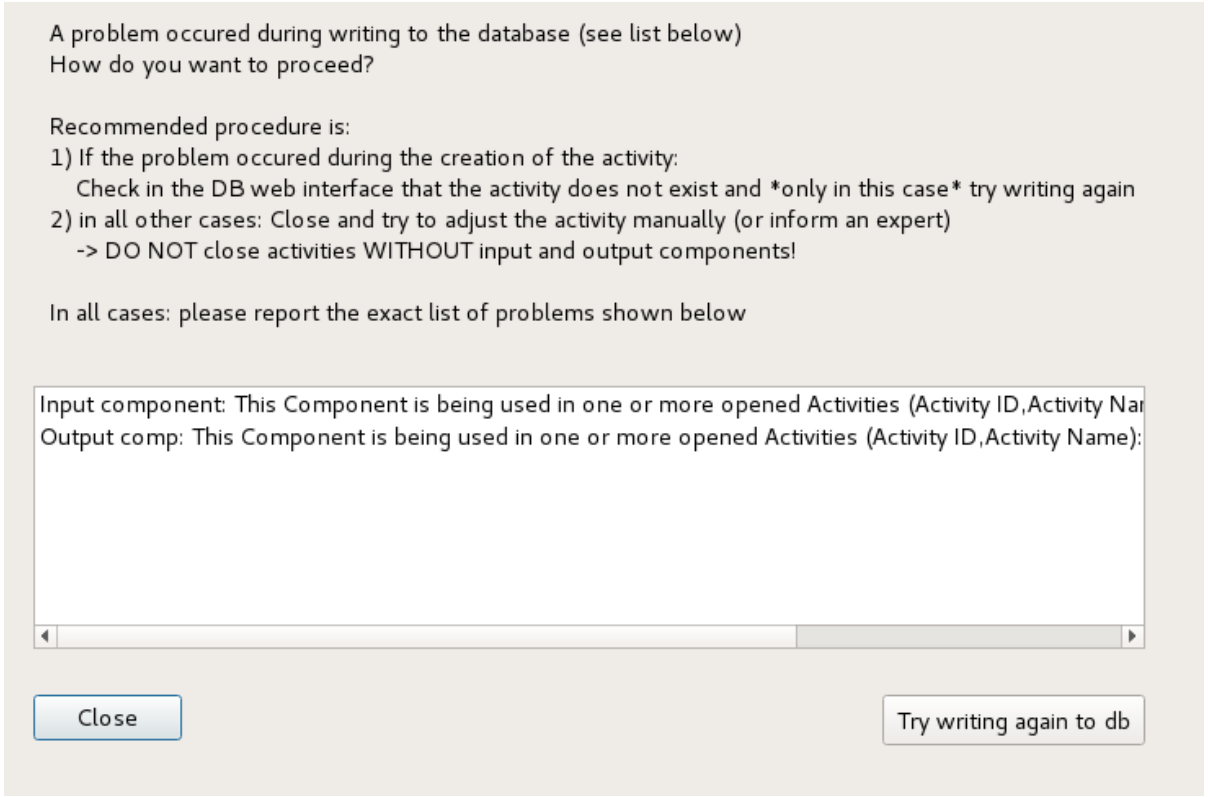


# Database



Improved database interaction to enhance both user information and integrity of data in DB

- By default test software completes the database record of the test activity and closes it
- In case of problems the activity stays open (closed activities cannot be modified) and the user is informed of the nature of the problem
- User is informed at the beginning of the test in order to resolve problem before writing to DB
- Invalid xml-responses from the database are dumped into a log file to facilitate debugging



# Production Flow Improvements



Several improvements to speed up production flow:

1) Auto Repeat:
   - In case of an exception (e.g. communication error with readout board) will prompt the user for decision: repeat scan or abort test
   - Auto repeat allows to automatically retry tests without user intervention
   - Number of automatic retries configurable
   - Allows to run test overnight, without operator present all the time

2) Endurance Test Recovery
   - Endurance test takes 7 days (now reduced to 3.5), tests 10 HICs at a time
   - Even if not frequent, program crashes significantly impact schedule, if one has to restart the test from the beginning
   - For quick recovery all test data is written to a recovery file
   - In case of crash, file can be loaded and test is continued from last cycle before the crash

# Production Flow Improvements



3) Eos synchronisation decoupled from test GUI
   - Up to now data directory of test was synched with eos at the end of each test, when writing the data to database
   - OK at CERN, but for remote sites this can take a significant amount of time, during which the GUI is busy and cannot be used for the next test
   - Now: separate script that does the synching of all data with cron job
   - Currently being installed in all sites; once running, eos synching will be removed from test software -> text of next HIC can be started much faster

-> Time used for testing reduced to mere testing time, no overhead due to data transfer, UI waiting for operator interaction etc.

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# QA using DB Parameters

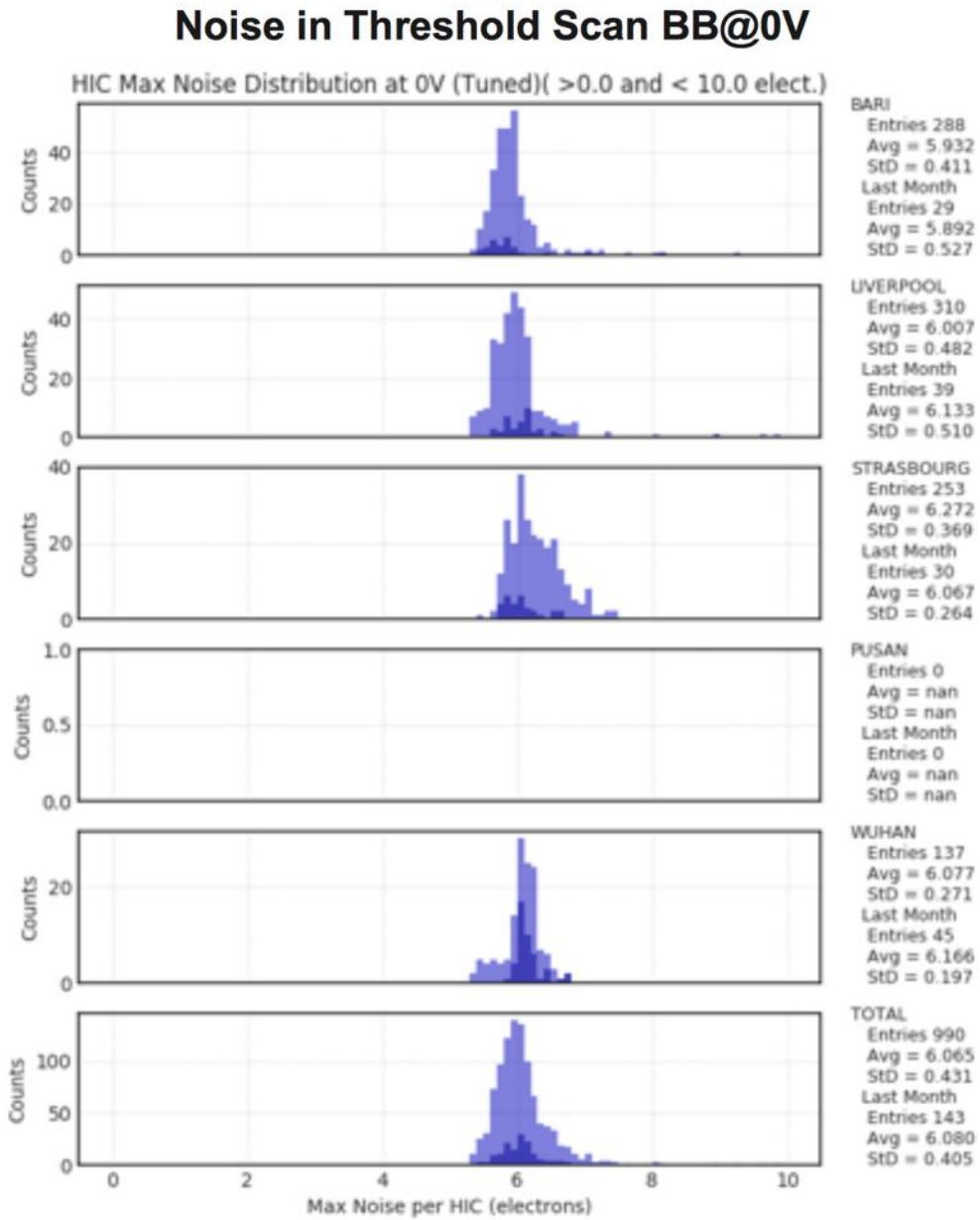


Many summary variables are stored directly as parameters in the database

Defined a set of quality control plots that are prepared weekly from the database parameters

- Here: noise in threshold scan without back bias

- Plots are prepared as summary (bottom) and site by site
- Each plot contains histogram of all HICs and production of last N weeks (here: 1 month) to easily spot changes in HIC quality



# Analysis Framework for Test Data



Analysis

- Data are analysed during the scans, yielding summary variables (DB Parameters) and HIC Qualification (Gold, Silver, Bronze, No backbias …)

But:

- Online analysis aimed at making a decision on component quality based on as-is state of the component, usually cuts based on summary variables

Collected data allows to extract much more:

- Comparisons along the production flow of the components
- Analyses pixel-by-pixel
- Comparisons of the different setups
- Correlations of results and scan conditions

# Analysis Framework for Test Data

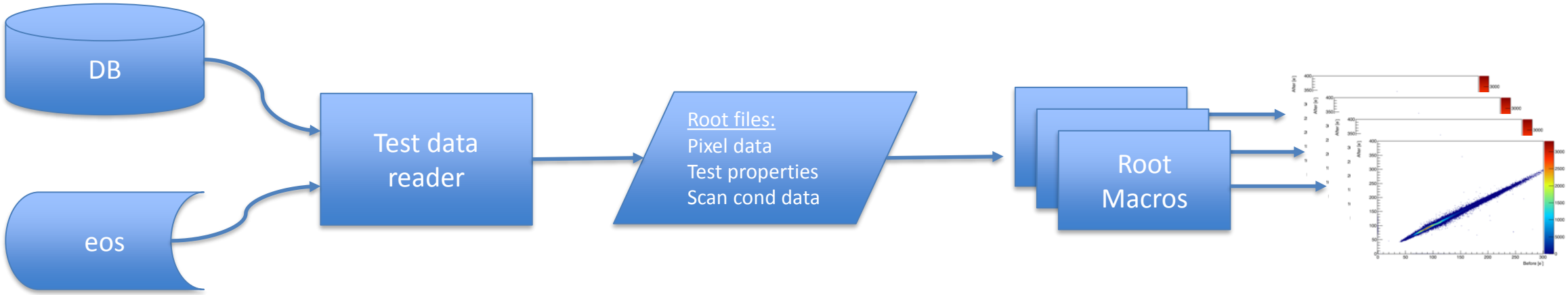


Main goal: Pixel-by-pixel comparison of test data between different test steps, including chip test

Implementation:

- Test data reader: reads data both from eos and from DB and fills into root files
  Can run both on full data set (i.e. all HICs present in DB) and on single HIC data
- Analysis macros: do the analyses and prepare plots

Byproduct: any other analysis of test data (e.g. comparisons back-bias / no back-bias …)

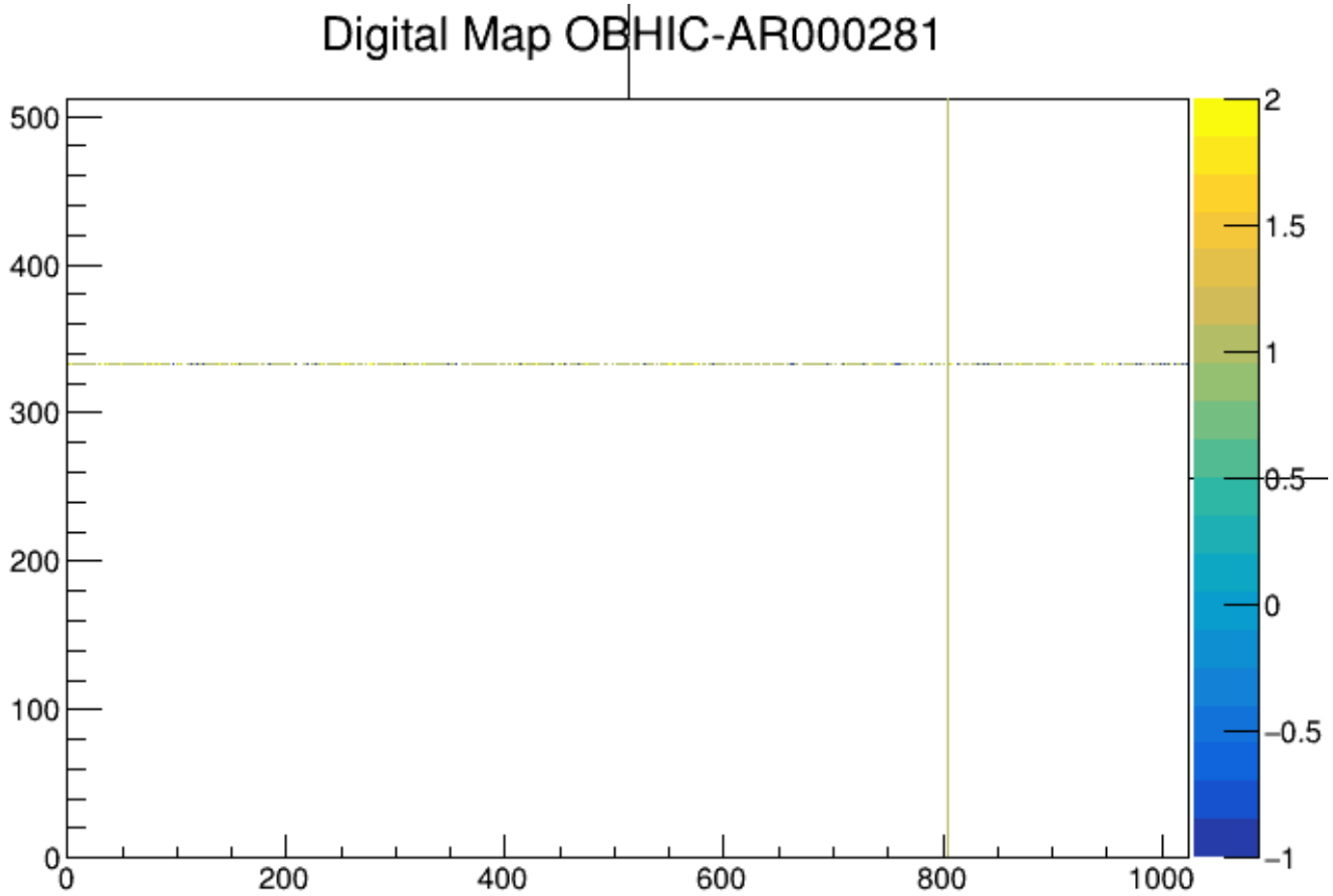


# Analysis Framework for Test Data



Example for pixel-by-pixel comparison:

- Check for two successive tests, which pixels are dead in one but not in the other
- 1: both tests (Qualification + Reception), 2: Reception test only, 0: Qualification test only



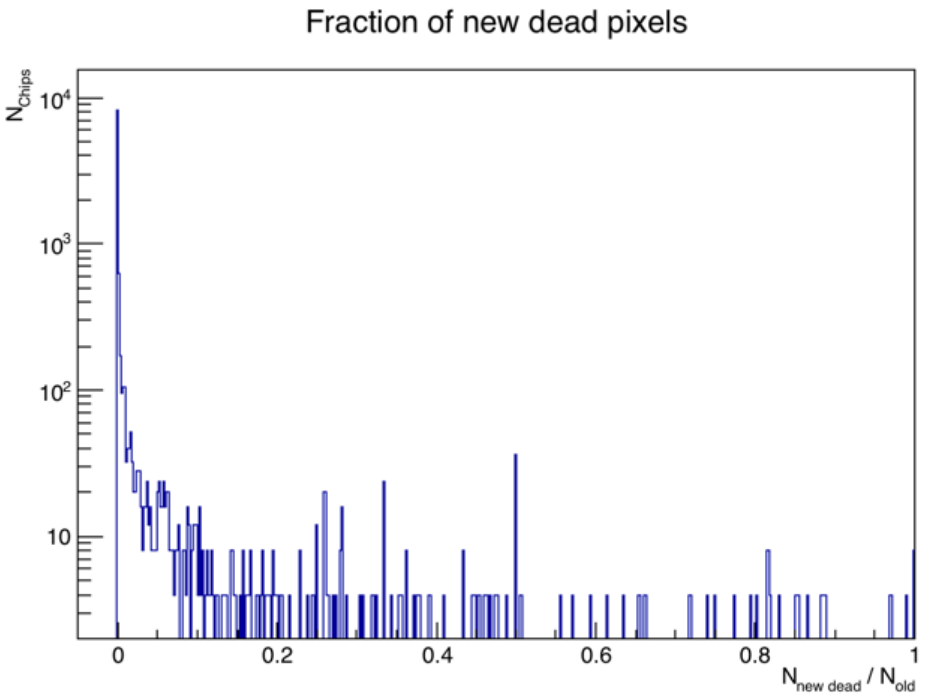
# Analysis Framework for Test Data

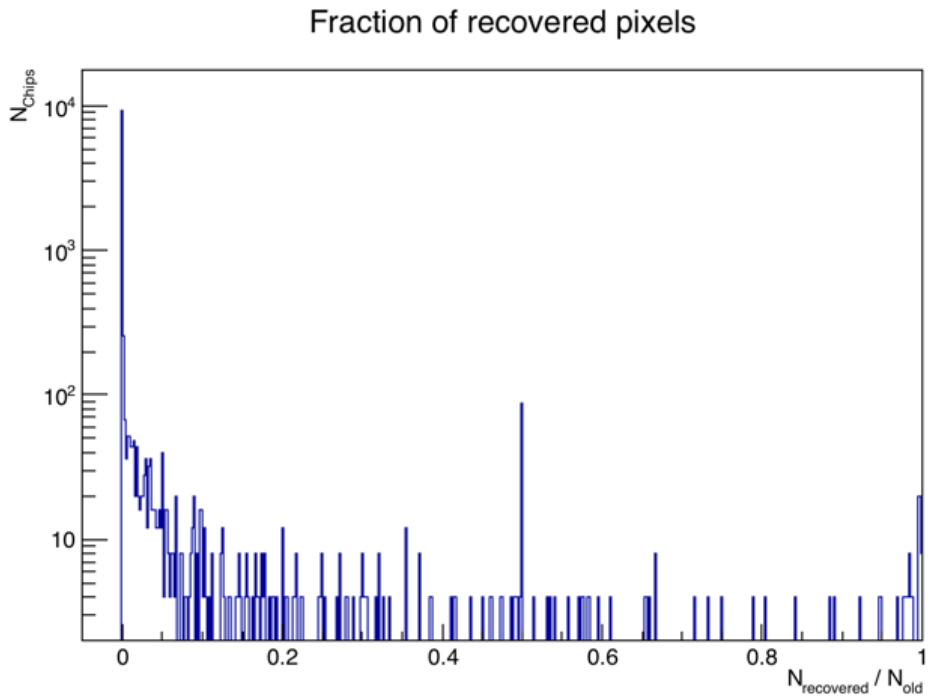


Example for pixel-by-pixel comparison:

- Check for two successive tests, which pixels are dead in one but not in the other
  - In majority of cases no only few % of new dead pixels
  - Similar amount of recovered pixels

-> Fluctuation from test to test on %-level, but no systematic increase



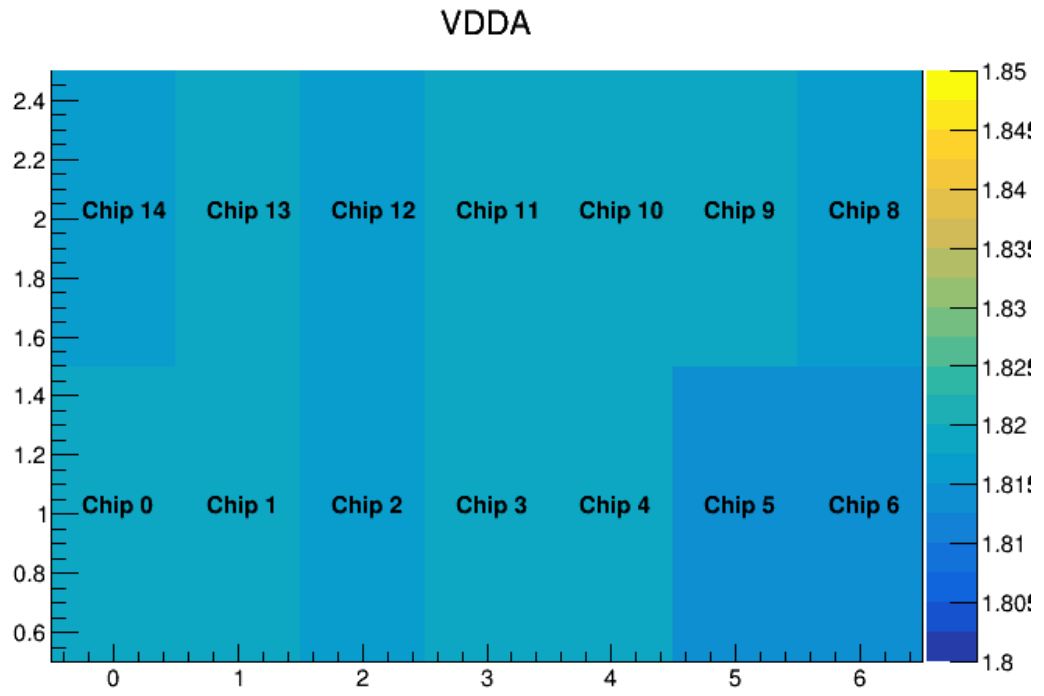
# Analysis Framework for Test Data

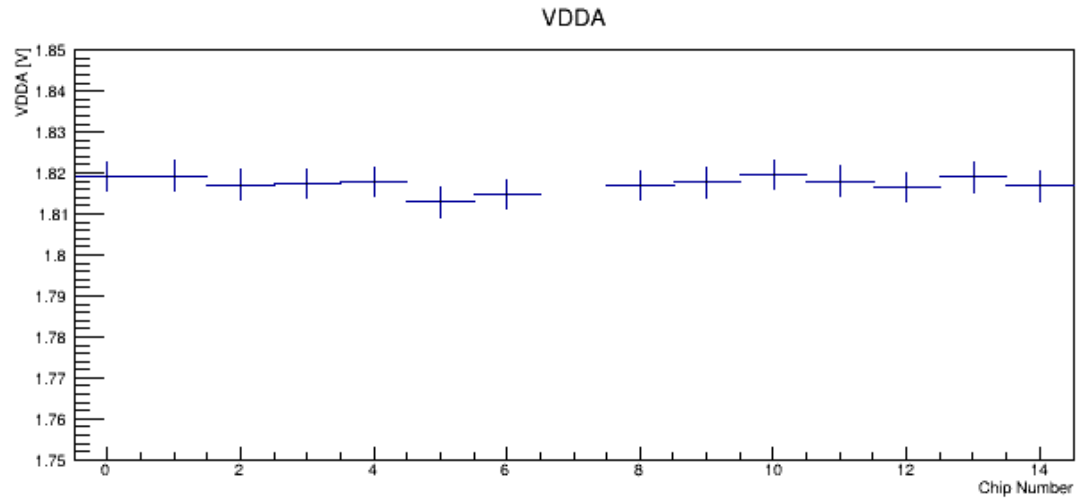


Example for the use of conditions data:

- Result files contain the analogue voltages measured by the ALPIDE chips
- Precision of single measurement <~ 50 mV, but much better when combining all test data

- Example: check that analogue voltage is same for all chips, i.e. no systematic variation due to voltage distribution on FPC
  -> Variation within few mV



# Analysis Framework for Test Data



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- Example: check that analogue voltage is same for all chips, i.e. no systematic variation due to voltage distribution on FPC
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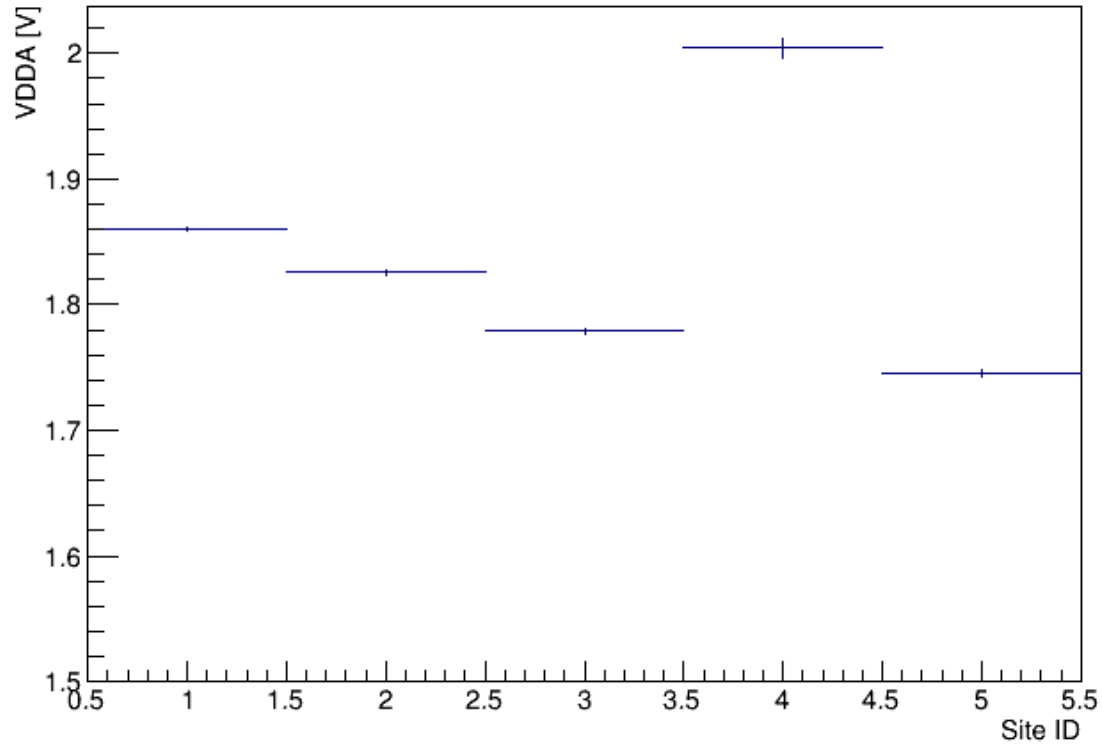
- But: some variation from setup to setup
  -> redo calibration in site 4
  (low statistics up to now)



# Analysis Framework for Test Data



Analysis framework is simple but powerful to study test data in detail, complementing the direct database readout

Currently defining a complete set of plots to compare the quality after important assembly steps:

- Chip test vs HIC Qualification test (HIC assembly)
- Reception test vs HS Qualification test (Half-Stave assembly)
- Chip test vs Stave Reception test (Degradation start to finish)
- …

Can also be used in single HIC mode:

- “Why is HIC XY now Bronze”?

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# Conclusions



New-alpide-software now implements all tests of the full production cycle, from HIC assembly to reception of the staves at CERN

Significant improvements have been made to

- Speed up production testing
- Give the operator full insight into HIC qualification and possible problems

Quality assurance procedures have been set up, based on

- Direct database readout
- Analysis framework of complete test data (DB and eos)
  -> Definition of histos to use full potential ongoing