# Development of a 3D FE-I4 Quad Plane for AIDA telescopes and of an FE-I4 stand-alone telescope

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Beam Telescopes and Testbeams for Detector R&D, DESY July, 2014

#### **Development of a 3D FE-I4 Quad Plane for AIDA telescopes**



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### Introduction

Increase telescope size • ATLAS FEI4 Row MIMOSA26 smaller than some DUTs 0.9 300 MIMOSA26 0.8  $\rightarrow$  Full device efficiency studies are time consuming 250 0.7 (different runs for same DUT) 200 0.6 SALAT/QUAD: ~4x4 cm<sup>2</sup> telescope planes 0.5 150 0.4 Region Of Interest (ROI) 100 0.3 Sometimes, only a certain region of DUT is wanted 50 to be studied 0.1 10 20 30 40 50 60 70 80 No selection of ROI currently available Column  $\rightarrow$  Too many uninteresting triggers in data set crossed scintillators DUT FE-I4 plane 1 plane 0 plane 2 plane 4 QUAD not trig. track  $2x2 FE-14Bs \rightarrow \sim 4x4 cm^2$ region track interest Fast HitOr signal (20-30 ns) Region of interest can be chosen particle beam plane 3 plane 5 plane 1  $3D \rightarrow \sim 20 V$  operational voltage  $\rightarrow No HV$  needed T. Obermann, Master Thesis 2012

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#### QUAD PCB for FE-I4 single chips

- No plan to make a 3D QUAD single tiles
  - Slim single sensors (~300 μm of dead region between sensors)
- PCB designed for 4 single FE-I4B chips
- Tested with 2 leftover sensors of IBL production (proof-of-principle)
  - Able to cover all hybridization and module assembly line at IFAE!



#### **QUAD PCB first results**



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### Conclusions I

- A 2x2 single chip FE-I4B PCB was designed: QUAD
  - 4x4 cm<sup>2</sup> area for AIDA implementation and ROI
- Full assembly and hybridization (except UBM (IZM)) was successfully performed at IFAE
  - Source scans showed no disconnected bumps region
- Able to operate QUAD device with 2 FE-I4 sensors
- Outlook:
  - Test QUAD PCB with 4xFE-I4
  - Provide QUAD prototype for July CERN TB?
    - How many mounted chips needed?





## Development of an FE-I4 stand-alone telescope



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#### Introduction

- Test beam in November for AFP at CERN (see J. Lange's presentation)
  - Not clear if ACONITE telescope is available
  - Back up plan  $\rightarrow$  build our own stand-alone telescope!
- Material used:
  - 1. USBpix (tabletop ATLAS DAQ system for pixel operation)
  - 2. Burn-In adapter Card (allows the readout of 4 sensors in parallel)
  - 3. 2 scintillators
  - 4. 3 FE-I4A devices
  - 5. Climate chamber
  - 6. Power supplies
  - 7. DAQ PC

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8. NIM crate for triggering Very easy to set-up! Goal is integration test (tracking+timing)
But track reco. needed as cross check

Good resolution is not needed:

But track reco. needed as cross-check of integration tests



Beam T

#### The Telescope

- Uses USBpixl4 5.0.1 software for operation
  - Multi-chip parallel testing
  - Useful as training for QUAD operation (same principle as telescope)
- And a self-made software for analysis
  - Takes .raw data from Source Scan output
  - Used for:
    - Masking
    - Clustering
    - Track reconstruction
    - Alignment
    - Efficiency





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#### The Telescope: first tests with cosmics

- First tests → Cosmics
  - Able to perform track reconstruction
  - With enough time (O(weeks)!), able to study overall efficiencies
- Limitations
  - Only DUTs with same chip flavour (FE-I4A/B) than telescope planes
    - Software limitation?
  - Burn-in Card → Maximum of 4 planes (e.g. 3 telescope planes + 1 DUT)
- Question:
  - Can the USBpix+BIC system deal with the SPS testbeam rate?



Track reconstruction of cosmics for alignment  $\rightarrow$  Only tracks with hits in all planes



### Conclusions II

- November AFP test beam at CERN
  - Likely not to have telescope  $\rightarrow$  built our stand-alone telescope
- Uses USBpix set-up/software + self-made software for track reco.
  - Analysis software still under development
- First tests with cosmics
  - Able to cluster, align, reconstruct tracks ...







### Back-up



### CNM 3D IBL sensors

- Sensor fabricated at CNM-Barcelona
- Double sided process, p-bulk 230 µm thick
- 210 µm columns do not fully penetrate the substrate
- 3D guard-ring with probe pad for IV measurements
- FE-I4 front-end for IBL
  - Array of 80x336 pixels, 50x250 µm<sup>2</sup> each





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#### The Telescope: first tests with cosmics

