Ultimate - Pixels + Discriminators digital characterization modes
Strasbourg November 2010

OUTLINE

- Ultimate / Mimosa 26 ?
- Discriminators characterization mode
  - Test protocol
  - Configuration
  - Steering & Readout
- Pixels + discriminators characterization mode
  - Test protocol
  - Configuration
  - Steering & Readout
- Characterization modes → Constraints on DAQ (Board + SW)

Ultimate vs Mimosa 26 → Mimosa 26

Mimosa 26 ?

- **Matrix of 663 552 pixels : 1152 columns x 576 lines – 21,560 mm x 13,780 mm – 18,4 µm pitch – 115,2 µs integration time**
  - Normal digital data stream after Zero Suppression (ZS)
  - **Digital test modes →Discriminator & Pixel + discriminator characterization**

Steering

- **Configuration (operating modes, bias etc …) by JTAG slow control**

- **Main clock 80 MHz**
  - **On board oscillator (single Mimosa 26 setup)**
- **Start command**
  - By JTAG slow control (single Ultimate setup)
  - **By external HW signal (Telescope or ladder setup)**

Readout

- **Digital test mode**
  - **Discriminators only → 2 Outputs @ 10 MHz - 1152 bits**
  - **Pixels + discriminators → 2 Outputs @ 10 MHz – 1152 bits x 576 lines = 663 552 bits**

Ultimate Vs Mimosa 26 → Ultimate

Ultimate ?

- **Matrix of 890 880 pixels : 960 columns x 928 lines – 19,872 mm x 19,210 mm – 20,7 µm pitch – 185,6 µs integration time**
  - Normal digital data stream after Zero Suppression (ZS)
  - **Digital test modes →Discriminator & Pixel + discriminator characterization**

Steering

- **Configuration (operating modes, bias etc …) by JTAG slow control**
- **Main clock 160 MHz**
  - **On board oscillator (single Ultimate setup)**
- **Start command**
  - By JTAG slow control (single Ultimate setup)
  - **By external HW signal (Telescope or ladder setup)**

Readout

- **Digital test mode**
  - **Discriminators only → 2 Outputs @ 20 MHz – 960 bits**
  - **Pixels + discriminators → 2 Outputs @ 20 MHz – 960 bits x 928 lines = 890 880 bits**

Ultimate Vs Mimosa 26 → Differences

Slow control

- Tests modes controlled in the same way
  - Slow control SW will have the same configuration options
  - Conclusion → We can use Mimosa 26 slow control screen shots to show how to configure Ultimate

Steering & Readout

- The protocol principle is the same but → Differences on RO frequency & data stream size & format
  - Mimosa 26 - 10 MHz / Ultimate - 20 MHz
  - Mimosa 26 – 1152 discri per line / Ultimate 960 discri per line
    - Mimosa 26 – 576 discri per link / Ultimate Discri 0..511 on D0, Discri 512..959 on D1
  - Mimosa 26 – 576 lines / Ultimate 928 lines
  - Conclusion → We can use Mimosa 26 signals scop screen shots to show how to control & read Ultimate

Ultimate → Steering & Readout signals

Ultimate discriminators test : Test protocol

- What do we test → One discri / column = 960 Discriminators
- How the test is performed ?
  - Pixels disconnected from discriminators
    → Pixel base level emulated via VTest2
  - Adjustable level VTest2 applied → Read = Calib = VTest2
  - Scan discriminator threshold (VRef1 – VRef2)
    → VRef1, VRef2, VTest2 → Provided by DAC configured via JTAG
- Test preparation
  - Play with threshold to find scan boundaries (all discri 0, all discri 1)
- Test procedure
  - Configure threshold by JTAG
    - Start Ultimate via a pulse on start signal
    - Store one event = state of 960 discriminators → 185,6 µs
    - Repeat until you get ~ 1000 events → 185,6 ms
  - Set next threshold - ~ 30 steps needed → 30 x 185,6 = ~ 5,6 seconds
  - Process data, extract → FPN, TPN

Ultimate discriminators test : Configuration

- **Ultimate test mode is selected via JTAG SW**
- **There are a lot of parameters …**
  - **Trivial ones like "Discri mode" Test (discri only) / Normal (= pixel)**
  - **Non trivial ones like Ultimate outputs configuration …**
- **But we provide configuration files**
  - **All parameters are well configured for the test**
  - **You specify the file, load it and write parameters to Ultimate**

- **How to take data → Characterization automation ?**
  - **Ultimate configured, modify threshold via VRef1 (4 matrices → 4 VRef A,B,C,D)**
  - **You can control JTAG SW from DAQ SW via COM interface**
    - **Load configuration file**
    - **Modify threshold**

Ultimate discriminators test : Steering & Readout

- **Same output pads as for normal readout**
  - **CLKD, SYNC, D0 & D1**
- **Start pulse initiates continuous readout of 960 discriminators**
- **CLKD = CLK source / 8 = 20 MHz - Sync on first bit**
- **Data provided on CLKD rising edge**
- **Data multiplexed over two links D0 & D1**
  - **Discriminators 0 to 511 on link D0 – 511 to 959 on link D1**
  - **Different data size → 512 bits on D0 and 448 on D1**
- **Readout time = Ultimate frame time = 185,6 µs**
  - **512 bits @ 20 MHz = 25,6 µs < Frame time = 185,6 µs !!!**
  - **Frame = 185,6 µs = 3712 clocks @ 20 MHz**
  - **One readout = 3712 bits / link but only 512 useful !**

Ultimate Pixels + Discriminators test : Test protocol

- **What** do we test → All pixels = **960 col x 928 row = 890 880 pixels**
- **How** the test is performed ?
  - **Pixels connected** to discriminators
  - **Scan** discriminator **threshold** (VRef1 – VRef2)
    → **VRef1**, **VRef2**, **VTest2** → Provided by DAC **configured via JTAG**
- Test **preparation**
  - Play with threshold to **find scan boundaries** (all pixels at 0 / 1)
- Test **procedure**
  - **Configure threshold** by JTAG
    - **Start Ultimate** via a pulse on start signal
    - **Store one event** = 928 lines → 928 x 185,6 µs **= ~ 172,237 ms**
    - **Repeat until** you get **~ 1000 events** → **172,237 seconds**
  - Set next threshold (~ 30 steps) → 30 x 172,237 = **~ 86 minutes !**
  - **Process data**, extract → **FPN, TPN**

Ultimate Pixels + Discriminators test : Configuration

- **Ultimate test mode is selected via JTAG SW**
- **There are a lot of parameters …**
  - **Trivial ones like "Discri mode" Test (discri only) / Normal (= pixel)**
  - **Non trivial ones like Ultimate outputs configuration …**
- **But we provide configuration files**
  - **All parameters are well configured for the test**
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- **How to take data → Characterization automation ?**
  - **Ultimate configured, modify threshold via VRef1 (4 matrices → 4 VRef A,B,C,D)**
  - **You can control JTAG SW from DAQ SW via COM interface**
    - **Load configuration file**
    - **Modify threshold**

Ultimate Pixels + Discriminators test : Steering & Readout 1/2

- **Same output pads as for normal readout**
  - **CLKD, SYNC, D0 & D1**
- **Start pulse initiates a scan of 928 lines → See next page**
- **CLKD = CLK source / 8 = 20 MHz - Sync on first bit**
- **Data provided on CLKD rising edge**
- **Data multiplexed over two links D0 & D1**
  - **Discriminators 0 to 511 on link D0 – 511 to 959 on link D1**
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  - **Frame = 185,6 µs = 3712 clocks @ 20 MHz**
  - **One readout = 3712 bits / link but only 512 useful !**

Ultimate Pixels + Discriminators test : Steering & Readout 2/2

- **Start pulse initiates a scan of the 928 lines : line 0 to 927**
- **Readout time of one line = Ultimate frame time = 185,6 µs**
- **It takes 928 x 185,6 µs = 172,237 ms for one scan**
- **It requires to store 928 x 3712 = 3 444 736 bits / link**
  - **But only 928 x 512 = 475 136 are useful !**

Characterization modes → Constraints on DAQ

Discriminators characterization

- Acquire two links @ 20 MHz
- Store 3712 bits / link – Only 512 are useful (512 on D0, 448 on D1)
  - Extract useful part of data either by SW of FW on board
- Don't need to generate a start for each event → Continuous readout on Ultimate side

Pixels + discriminators characterization

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- Store 3 444 736 bits / link – Only 475 136 are useful
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