US CMS EMU meeting

Anode Front-End electronics status.

N.Bondar, T.Ferguson, A.Golyash, N.Terentiev

FNAL
October 2002
Anode Front-End electronics status

- AFEB production status
  - CMP16-G ASIC
  - AFEB production
  - AFEB certification
  - AFEB shipment
- Documentation
- AFEB-ALCT cable production
- Delay chip DEL16 test status
- Crosstalk on the ME234/2 chambers
AFEB production status

CMP16_G ASIC

- Produced quantity: 28,000
- Tested: 25,000
- Assembled at USA: 12,300
  sent to Dubna: 1,472
- Stored on shelf: 11,228

- Yield rate: 90%

We have to test more 3,000 chips
## AFEB production display

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<th>CY2002</th>
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<th>Total needed</th>
<th>Balance</th>
<th>Shipped out</th>
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- **Need to produce**: 12,000
- **Total ordered**: 12,200
- **Total delivered to FNAL**: 12,200
- **Certification statistic**: Total measured 12,200
  - Total certified 11,600
  - Yield rate after cuts 96%
  - Final yield rate (including chip selection) ~89%

Current situation is weekly updated on the following WEB page:
AFEB production and shipment rate

AFEB production rate

Scheduled production
scheduled delivery
Actual production
Actual delivery

UF+UCLA
PNPI
IHEP

N.Bondar, October 4, 2002
Anode electronics assembly instructions.

The following instructions and manuals were prepared and located at the following WEB site
http://www-hep.phys.cmu.edu/cms/ :

😊 AFEB AD16_F user manual
Instruction for AFEB installation
Instruction for AFEB-ALCT cables installation for ME234/2 chamber
Instruction for AFEB-ALCT cables installation for ME1/2 chamber
Instruction for AFEB-ALCT cables installation for ME2/1 chamber
Instruction for AFEB-ALCT cables installation for ME3/1 chamber
Instruction for repair broken M4 thread
Instruction for AFEB-ALCT cables installation for ME4/1 chamber

😊 Preparation in progress:
Instruction for AFEB-ALCT cables installation for ME1/3 chamber - the chamber in Lab 7.
### AFEB-ALCT cables display

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**Total cables to produce**     - 10760  
**Total produced cables**       - 7950  
**Production balance (ME4/1 included)**     - 2810

- **ME234/2** - 108 sets made, 83 shipped to FAST sites  
- **ME2/1** - completed, shipped to PNPI.  
- **ME3/1** - 34 sets made, shipment to PNPI.  
- **ME1/2** - completed, shipped to IHEP  
- **ME1/3** - 53 sets made, shipment to IHEP

**Company scheduled to complete the cable production to the end of October**

- **ME4/1** - 37 sets (1332 cables) standby position.
AFEB-ALCT cables display

AFEB-ALCT cable production rate

- Made cables:
  - ME234/2
  - ME2/1
  - ME3/1
  - ME1/2
  - ME1/3

- Scheduled production rate

- Chart showing production rates from April 2001 to October 2002, with peaks and trends indicated.
Delay chip DEL16 status.

This part of work - completed

Produced 23,700  
Tested 23,700  
Good chips 20,811  
Rejected 2,890  
Yield rate (pass all cuts) ~ 88%  
Spare (groups 1-4, 9) 4,873  
Sent to UCLA (groups 5-8) 15,938

Current situation with the delay chip test is located at the following WEB site:  
Crosstalk on the ME234/2 chambers

AFEB Crosstalk studied on the bench
(Early measurement, November 1999)

Crosstalk vs. number of fired channels

Conditions:
All channel inputs connected to ground through 220 pF capacitors.
The crosstalk amplitude is measured with an oscilloscope on one AFEB test channel.
The input charge for all channels is set to 100 fC.

To study the analog portion of the crosstalk (crosstalk with disabled discriminator), the threshold of the board is set to its maximum value of 1.2 V.

The results for 8 fired channels from this plot are used for comparison with the “on chamber” crosstalk measurement.
Crosstalk on the ME234/2 chambers

1. The digital crosstalk is proportional to the number of the firing channels.
2. The analog crosstalk is proportional to the total charge injected into the board.

In our case, the number of firing channels – 8 and the digital portion is practically constant.

Crosstalk comparison.

| Conditions: |
| Fired 8 channels (one connected plane). |
| To measure the analog portion of the crosstalk, the AFEB threshold is set to its maximum value (1.2 V). |
| The crosstalk amplitude is measured with an oscilloscope at the AFEB test channel, connected to the anode wire group. |
| The accuracy of this measurement is about 20%. |

Summary: AFEB crosstalk on the chamber is about the same level as on the bench.
Crosstalk on the ME234/2 chambers

The standard procedure for testing crosstalk on FAST sites is the connectivity test #12. The AFEB thresholds are set to 20 fC using the “on chamber” threshold calibration. Currently for this calibration the average value for the test capacitance of 0.25 pF is used. Due to technological process variation, this capacitance value may vary by up to +/-20%. As a result, the thresholds may be set with an error up to +/- 20%. This effect leads to extra crosstalk.

Using of the measured value of the test capacitance reduces measured crosstalk value up to 10 times.

Crosstalk wire – wire with crosstalk level >= 5%. FAST site connectivity test #12.

A – AFEB thresholds are increased to 25 fC
Anode electronics grounding influence.
(Early measurement, November 1999)

Proper grounding of the anode front-end electronics reduces twice the noise level and, as a result, the crosstalk probability.

Crosstalk level measured during the connectivity test #12 is a good evidence of the chamber grounding performance.
Crosstalk on the ME234/2 chambers
Crosstalk measured by using cosmic rays.

ALCT Wire Occupancy

Layer 1: HV=0V; 732 events
Layer 2: HV=3.8kV; 160,679 events

Crosstalk Profile.

Layer 1: HV=3.8kV; 106,518 events
Layer 2: HV=0; 890 events

Crosstalk:
Ave. ~0.45%
Max. 3%

Crosstalk:
Ave. ~0.84%
Max. 5%
Crosstalk on the ME234/2 chambers
Summary

1. The AFEB crosstalk has two components an analog portion and a digital portion.
   The analog portion is proportional to the injected charge.
   The digital portion is proportional to the number of fired channels.
   The “on bench” measurements (performed in November 1999) and the new “on chamber” measurements are in a good agreement. The analog crosstalk value is ~0.5% of the injected charge. The portion of the digital crosstalk from one fired channel is 1.2 fC for the “on bench” measurements and 0.6 fC for the “on chamber” measurements.

2. The crosstalk value and the pickup noise depend on the grounding and shielding performance.
   For good grounding and shielding, the estimated crosstalk charge for the standard test (8 fired channels) is about 9 fC.
   The minimum allowed threshold for any AFEB to pass this test is 16 fC (crosstalk charge plus noise).

3. The 20 fC AFEB threshold on the chamber is a very close to the minimum allowed level.
   The accurate setting of the AFEB threshold by using of the calibrated internal test capacitances allows us to minimize crosstalk probability.

4. The crosstalk measured with cosmic muons at the maximum working HV=3.8 kV and with the anode threshold of 20 fC (accurate setting) is less than 1%. The main cause of crosstalk is a hit with a large ionization charge. At the nominal working HV=3.6 kV we expect the anode crosstalk to be negligible.

5. The AFEB threshold setting of 20 fC is a good test of the chamber input grounding and shielding performance.