



## US CMS EMU meeting

# Anode Front-End electronics status.

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FNAL  
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## 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

	CY2001					CY2002												Made	Total needed	Balance	Shipped out.	Total at FNAL												
	prev.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov	Dec																	
Delivered to FNAL	1109			747	2446																													
				984	1825																													
				833	684																													
				1066	226					1400	800										12200	800												
Burned in		250	750	1200	1600	1800	1400	1600	1200	1200	800	400									12200													
Assembled		250	600	900	580	475	1300	2456	1700	0	0	1300	1300	1339							12200													
Tested		250	600	900	583	475	1300	2456	1700	0	0	1200	1200	1000							11664													
Packaged			248			1008	1074	3636				1440	1440								8846													
Shipped to:																																		
UF				124				539		360																							1023	
UCLA				124				535		360																							1019	
PNPI						1008		1152																									2160	
IHEP/flat								720						864																			1584	
IHEP/tray								864						563																			1427	
																					Total shipped out:													7213

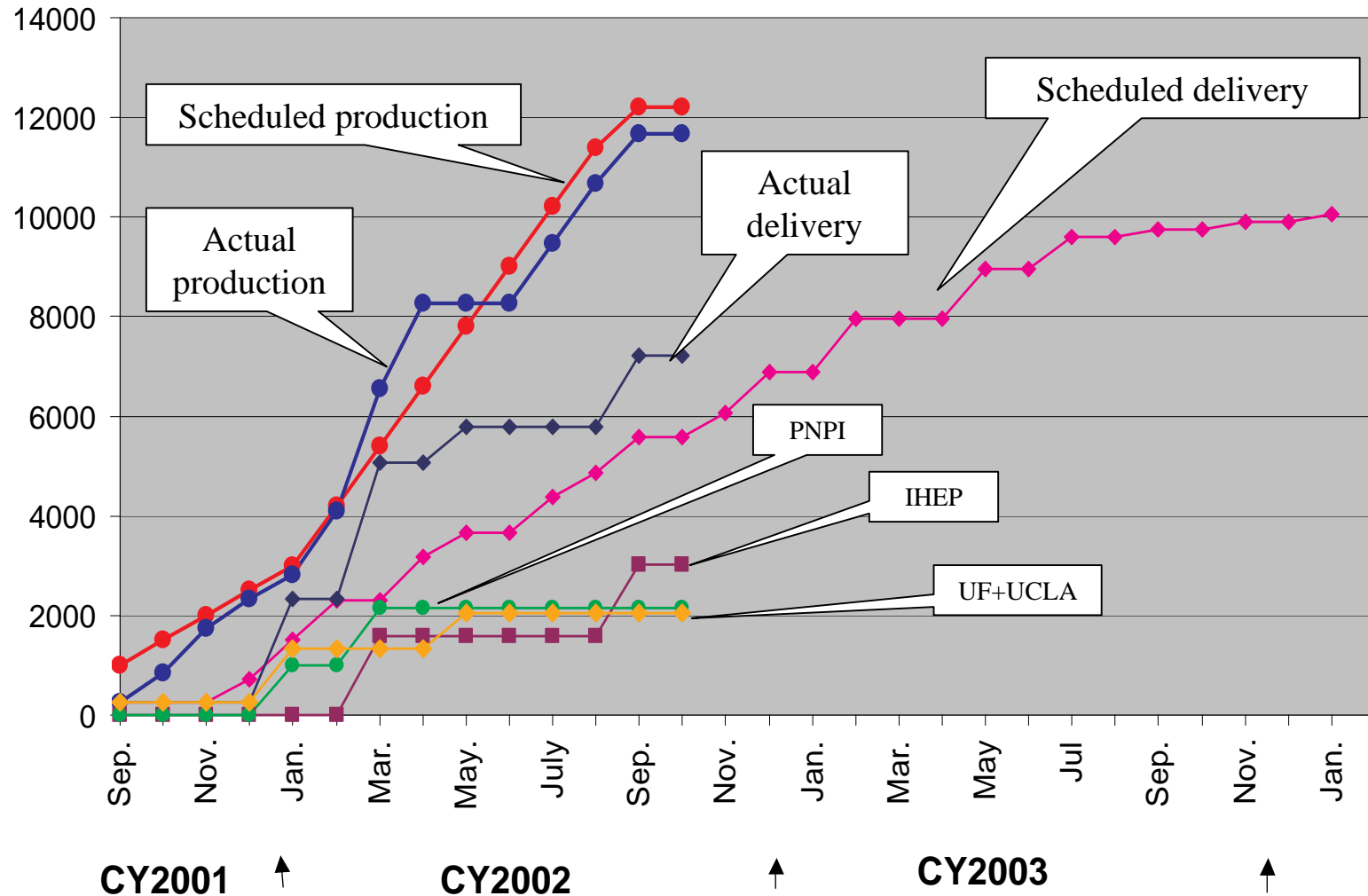
Need to produce                      12,000  
 Total ordered                           12,200  
 Total delivered to FNAL             12,200  
  
 Certification statistic: Total measured                      12,200  
     Total certified                      11,600  
     Yield rate after cuts                96%  
     Final yield rate (including chip selection)                ~89%

Current situation is weekly updated on the following WEB page:  
<http://www-hep.phys.cmu.edu/cms/MASSPRTEST/AFEB/passmp.html>



# AFEB production and shipment rate

## AFEB production rate

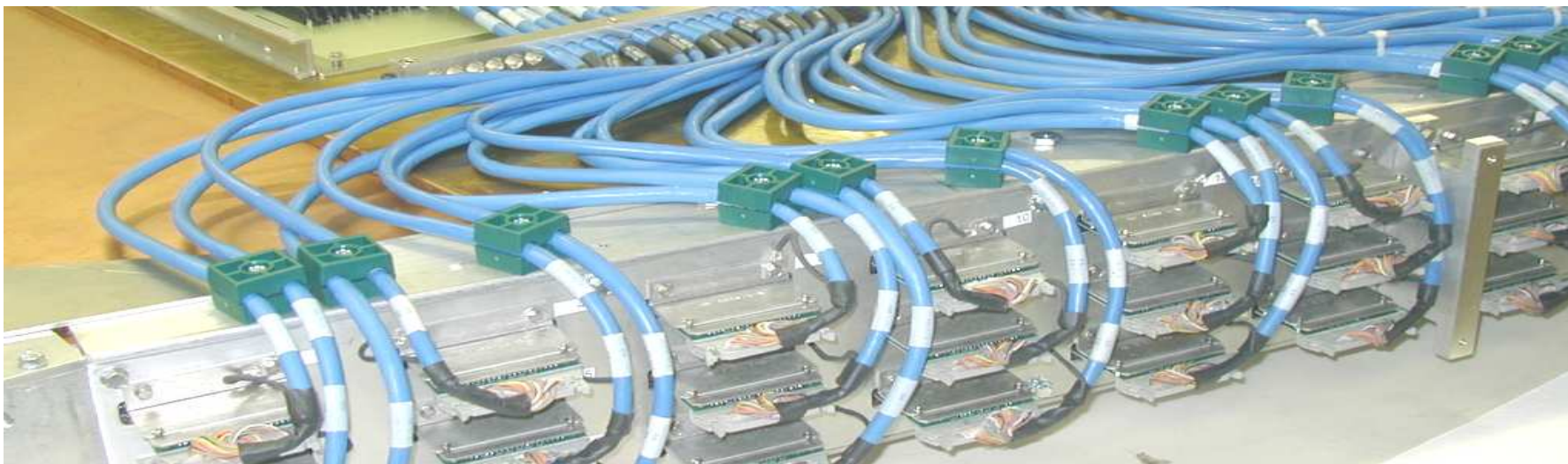




## Anode electronics assembly instructions.

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

Prepared by N. Bondar  
Last revision 10/01/02

Chamber type	FAST site	CY2001											CY2002										Made	Total needed	Balance	Ship.	Stored at FNAL
		Mar	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul	Aug	Sep	Oct						
ME 234/2	deliv.	8	10	10	10			10	10	10		10	10	10			10					108	148	40		25	
	UF						15				16				12											43	
	UCLA					1	15				14				10												40
ME1/2	deliv.	9	10	10	10			10	10	10		5										74	74	0		0	
	IHEP												74													74	
ME1/3	deliv.							1	5	9		9	10	10			10					54	74	20		1	
	IHEP													44						9						53	
ME2/1	deliv.		9	10	10			8														37	38	1		1	
	PNPI											36														36	
ME3/1	deliv.								6	6		6	8	8								34	38	4		0	
	PNPI											18	16													34	
ME4/1	deliv.	/	/	/	/	/	/	/	/	/	/	/	/	/	/	1	/	/	/	/	/	1	38	37		1	
	PNPI	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/				0	



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

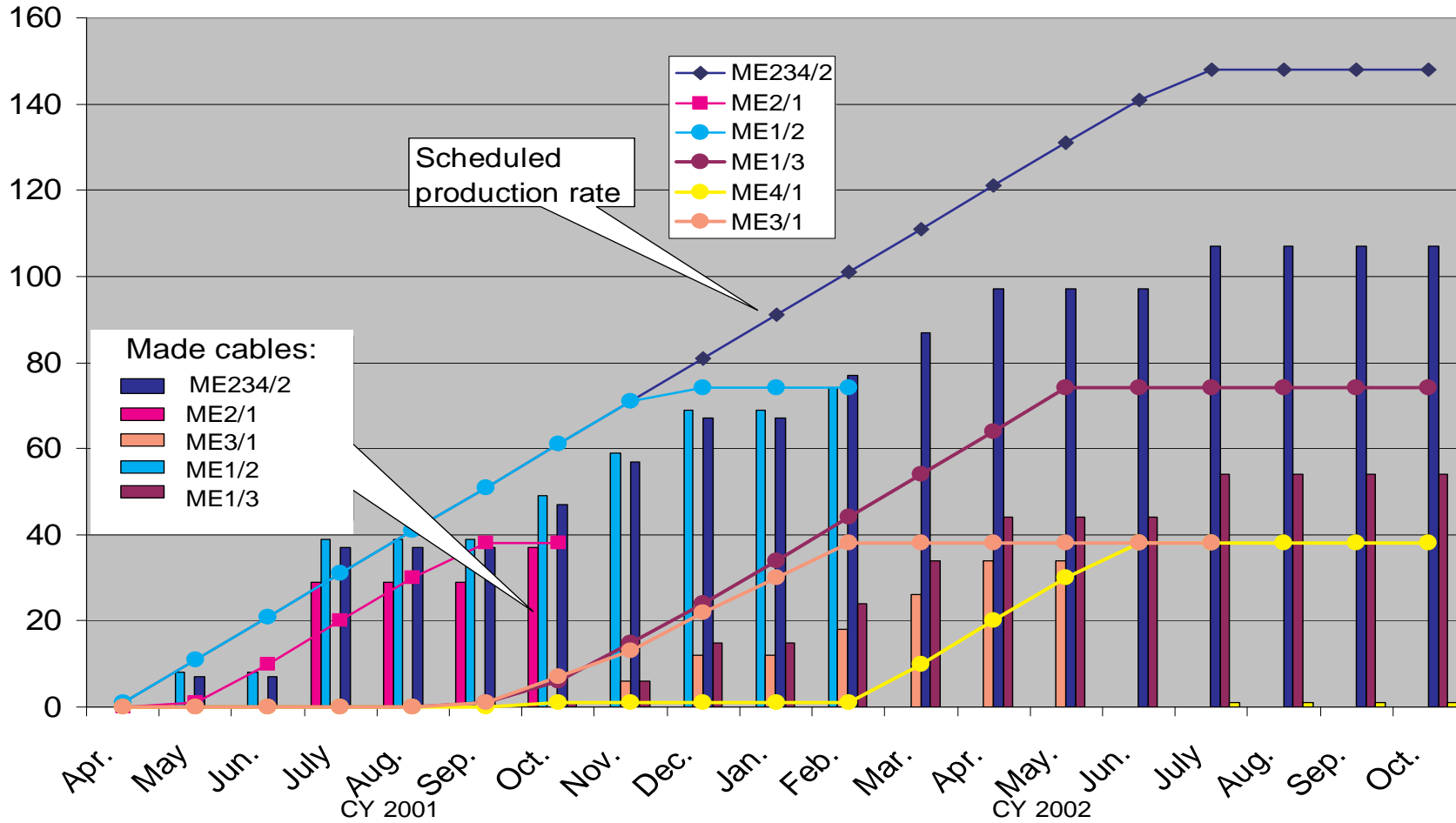
**Company scheduled to complete the cable production to the end of October**

ME4/1 - 37 sets (1332 cables) standby position.



# AFEB-ALCT cables display

## AFEB-ALCT cable production rate



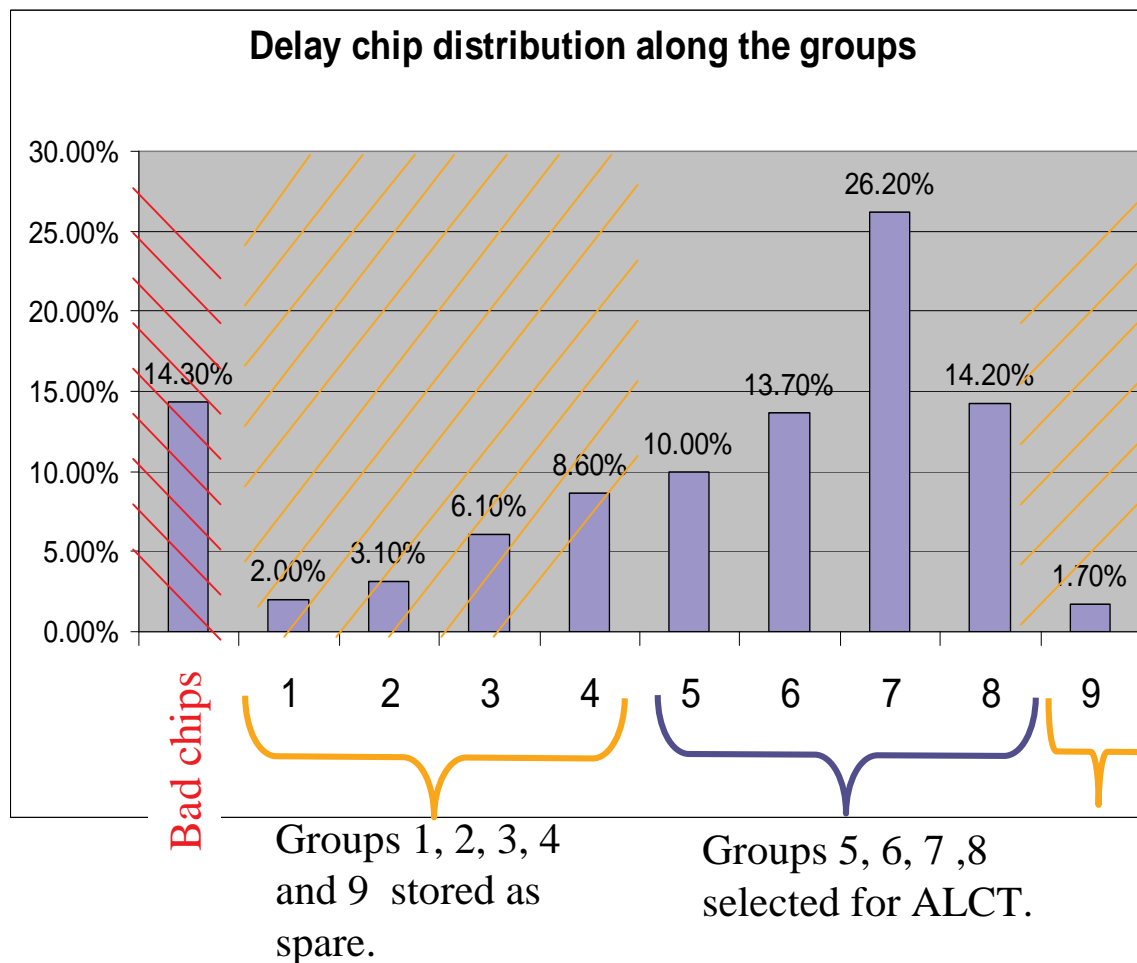




# Delay chip DEL16 status.

**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



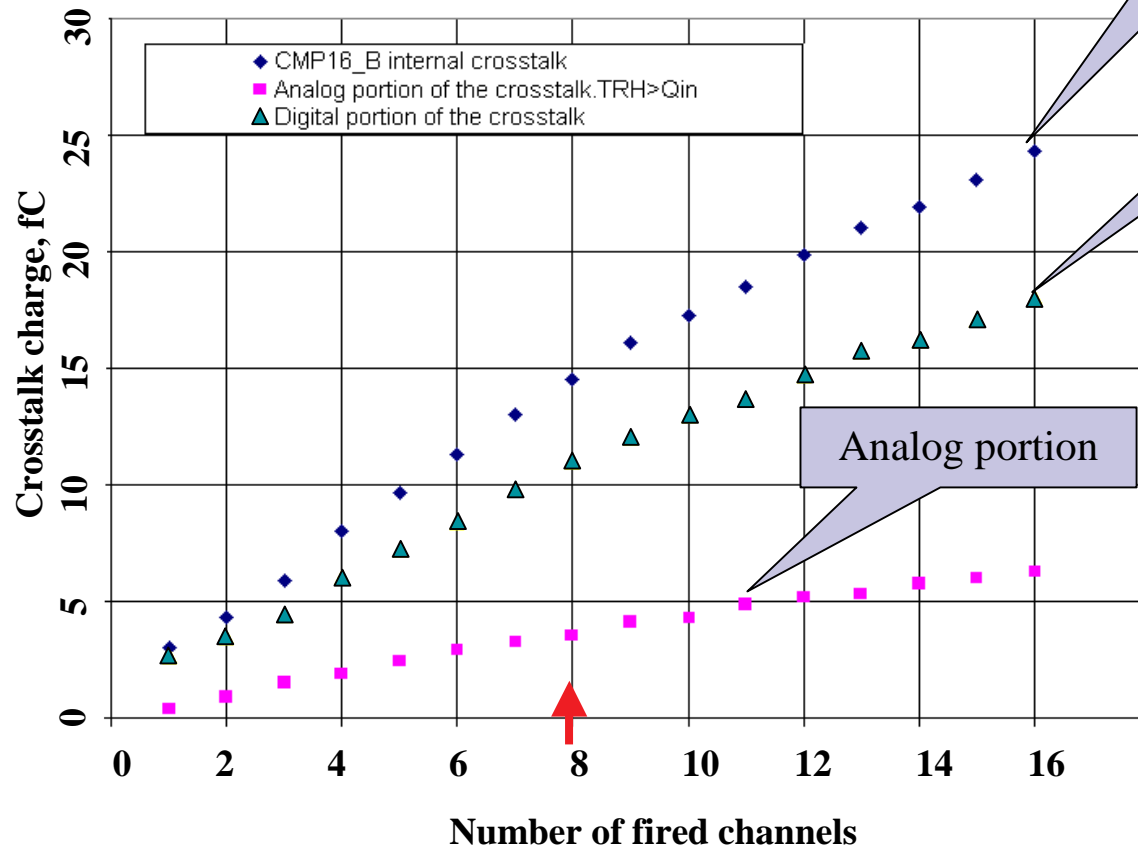
Current situation with the delay chip test is located at the following WEB site:  
<http://www-hep.phys.cmu.edu/cms/MASSPRTEST/D16GMP/passmp.html>.



# Crosstalk on the ME234/2 chambers

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

Crosstalk vs. number of fired channels



Total crosstalk

Digital portion

Analog portion

Conditions:

All channel inputs connected to ground through 220 pF capacitors.

The crosstalk amplitude is measured with an oscilloscope on one AFEB test channel.

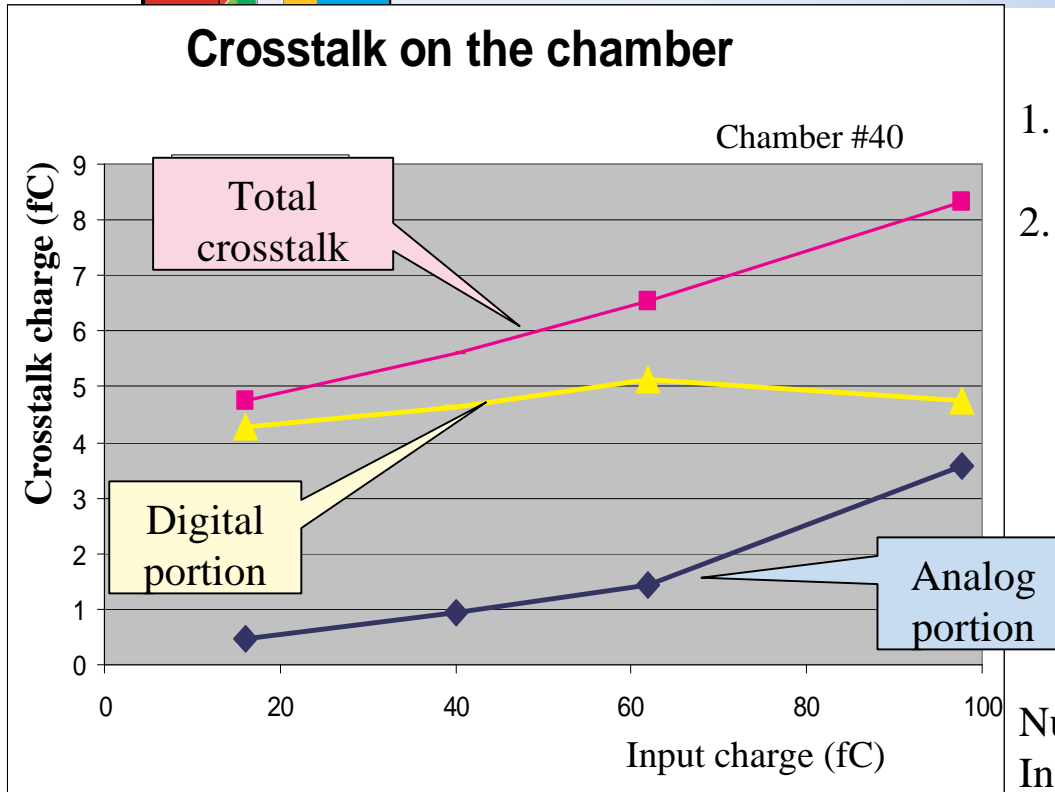
The input charge for all channels is set to 100 fC.

To study the analog portion of the crosstalk (crosstalk with disabled discriminator), the threshold of the board 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.

	Bench	Chamber
Number of firing channels	8	8
Injected charge per channel	100 fC	98 fC
Analog crosstalk charge	~3.8 fC	~3.8 fC
Digital crosstalk charge	11 fC	5 fC

### 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).

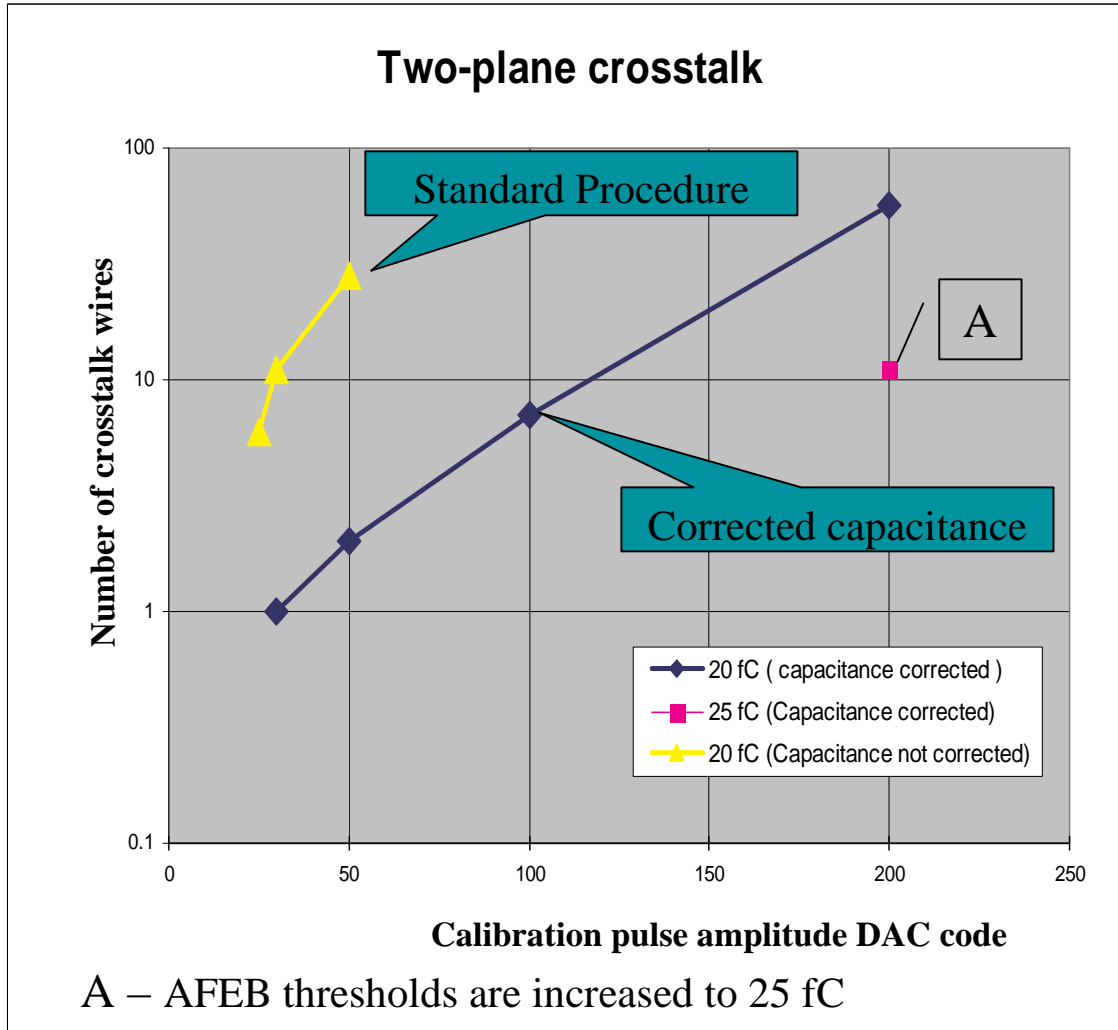
The crosstalk amplitude is measured with an oscilloscope at the AFEB test channel, connected to the anode wire group.

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



Crosstalk wire – wire with crosstalk level  $\geq 5\%$ .  
FAST site connectivity test #12.

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  $\pm 20\%$ . As a result, the thresholds may be set with an error up to  $\pm 20\%$ .

This effect leads to extra crosstalk.

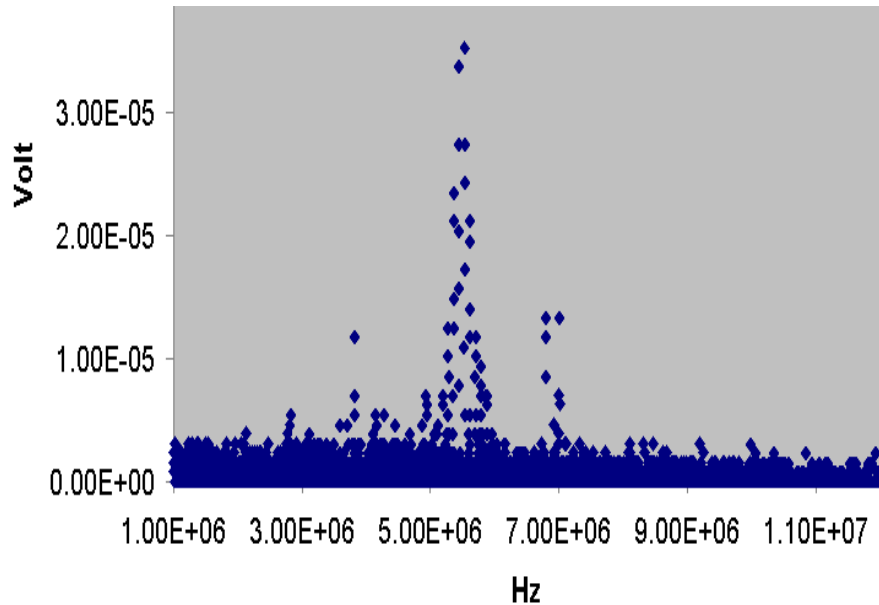
**Using of the measured value of the test capacitance reduces measured crosstalk value up to 10 times.**



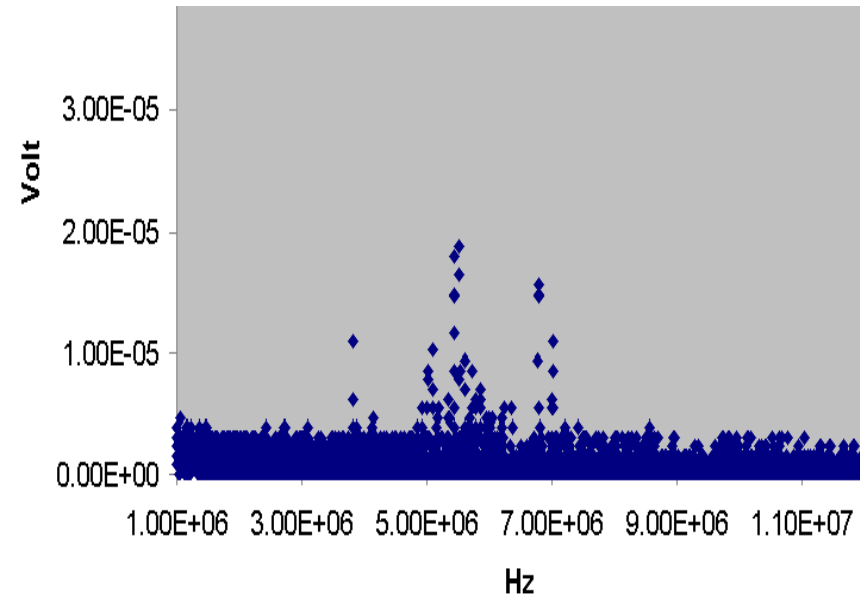
# Anode electronics grounding influence.

(Early measurement, November 1999)

Noise spectrum for “poor” grounding



Noise spectrum for “good” grounding



**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.**

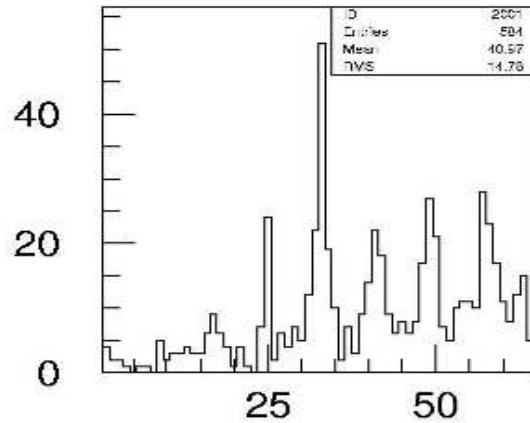


# Crosstalk on the ME234/2 chambers

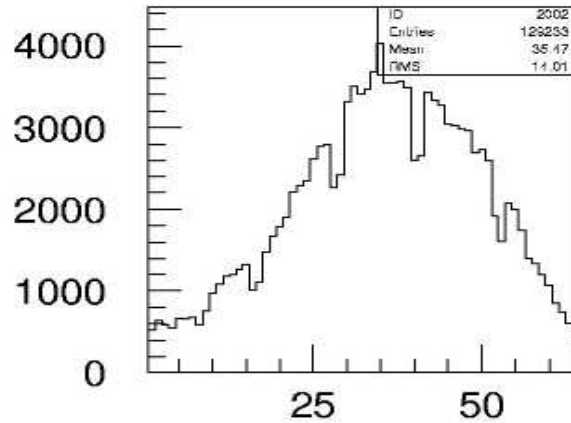
Crosstalk measured by using cosmic rays.

## ALCT Wire Occupancy

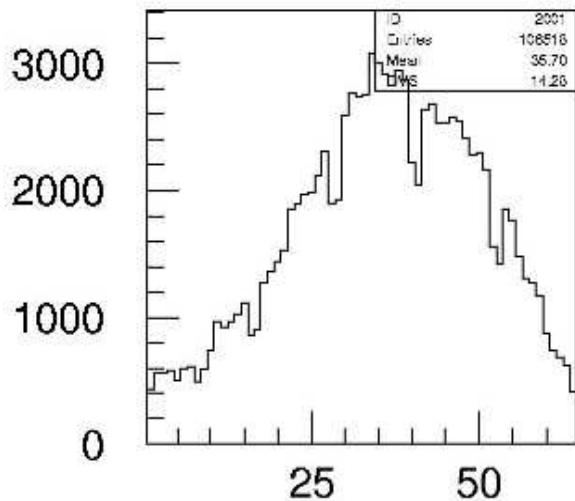
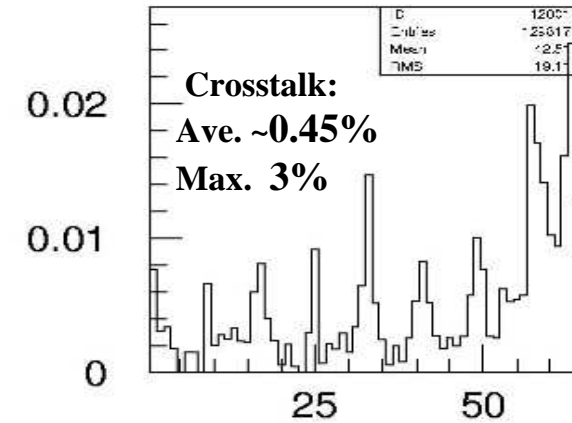
## Crosstalk Profile.



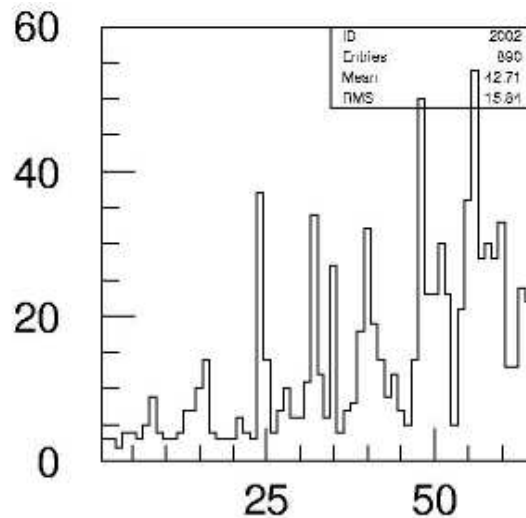
Layer 1: HV=0V; 732 events



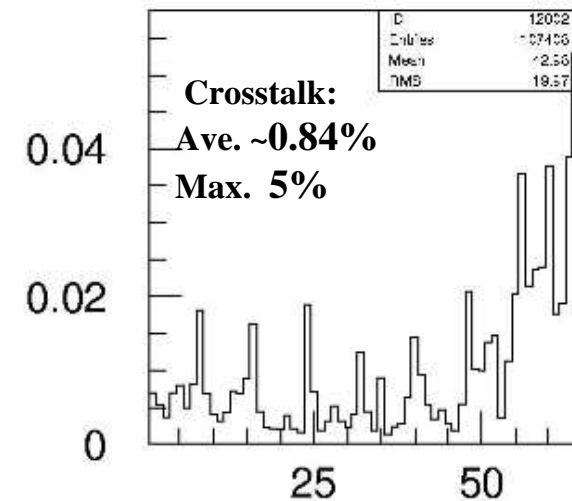
Layer 2: HV=3.8kV; 160,679 events



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



Layer 2: HV=0; 890 events





## 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  $\sim 0.5\%$  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.