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Summary of Express Line TEC Module Results with ARC

III. Physikalisches Institut B

RWTH Aachen

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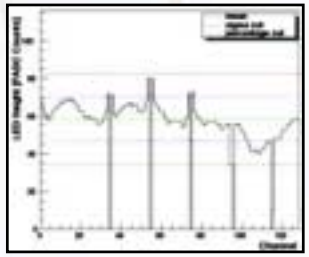
Overview

- Characterization of typical module defects
- Tabularly summary of module test results
- Measurements with a cosmic test station
- What we have learned...
- Outlook

Typical module defects

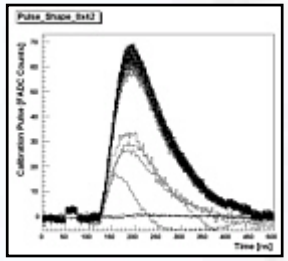
- Typical module defects: **open bonds, shorts, pinholes.** Other ones ?
- Each defect has its **characteristic symptoms** in different tests:



LED / Laser

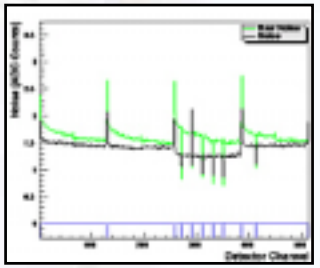
Visual Inspection

redundant ?



pulse shape

defect identification



noise/pedestal

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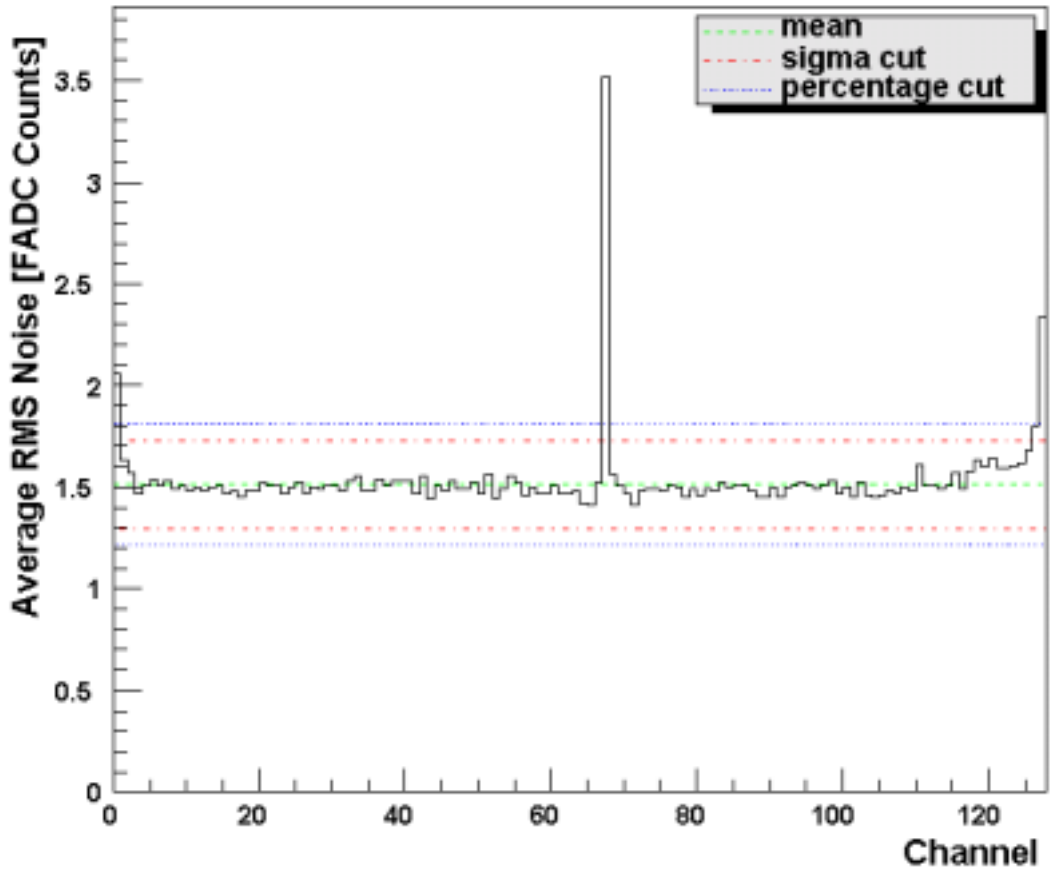
Open Bonds

Open Bonds I

- Most common defect and easy to detect.
- Noise: Conspicuously higher noise:



Open Bonds II

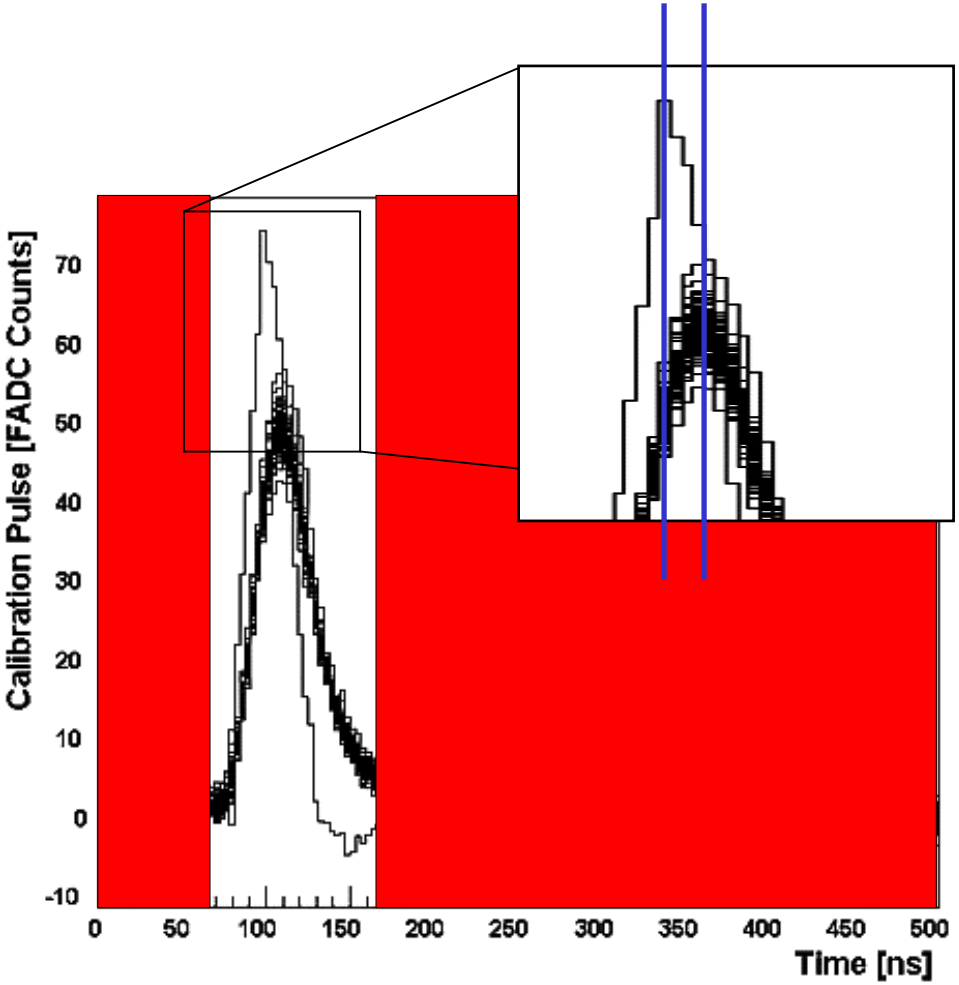
- Pulse Shape: Obviously different response to calibration pulse

- Higher maximum
- Faster rise time

- Is it sufficient to measure at the expected maximum only ?

  No! The maximum is shifted (ca. 10 ns)

➡ Taking a 100 ns scan around the maximum (dec) should be sufficient!



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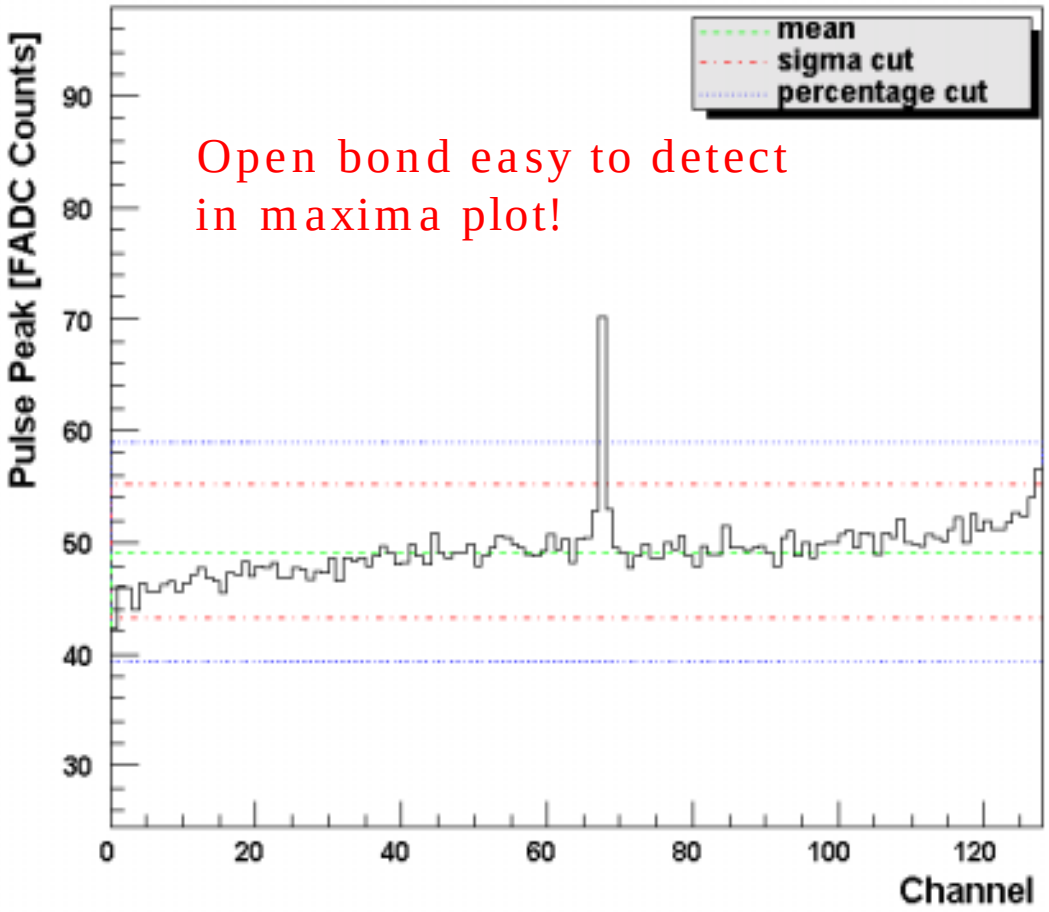
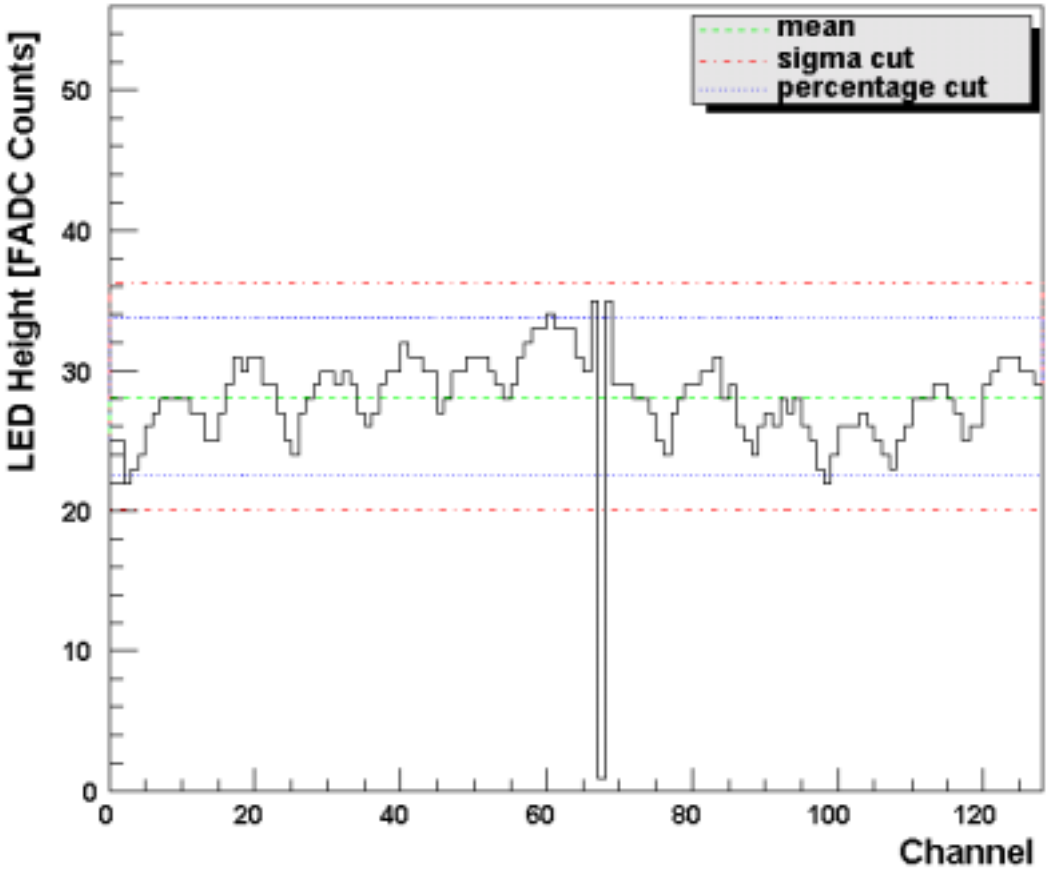


Open bond easy to detect in maxima plot!

Open Bonds III

- LED Test: Of course no signal !
- But which bond (PA-Sen, Sen-Sen) is missing ?
  (if interesting: LED tests on both sensors needed)



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Shorts

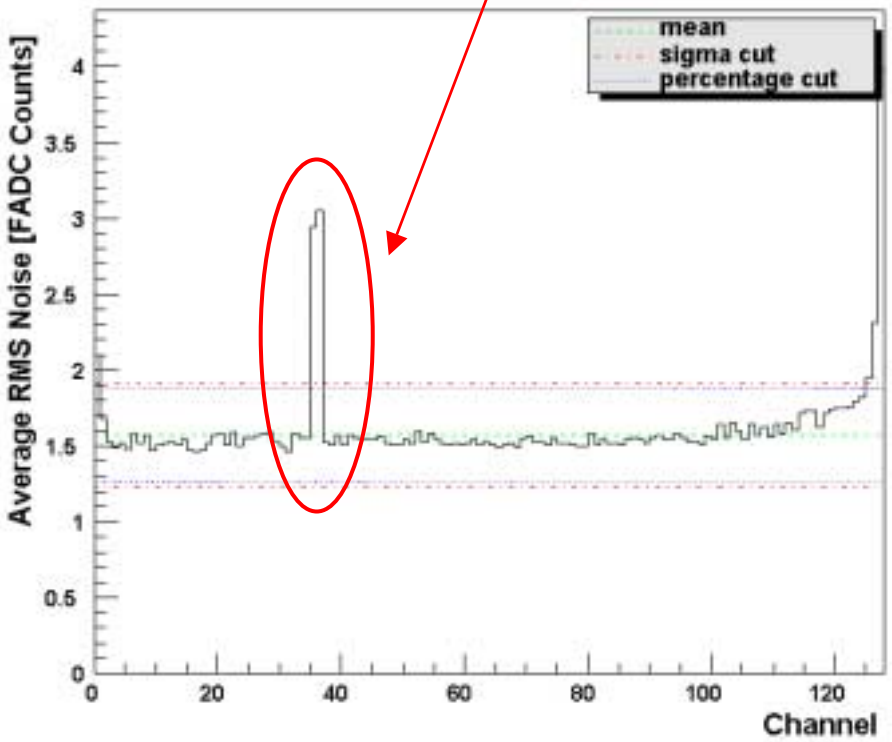
Shorts I

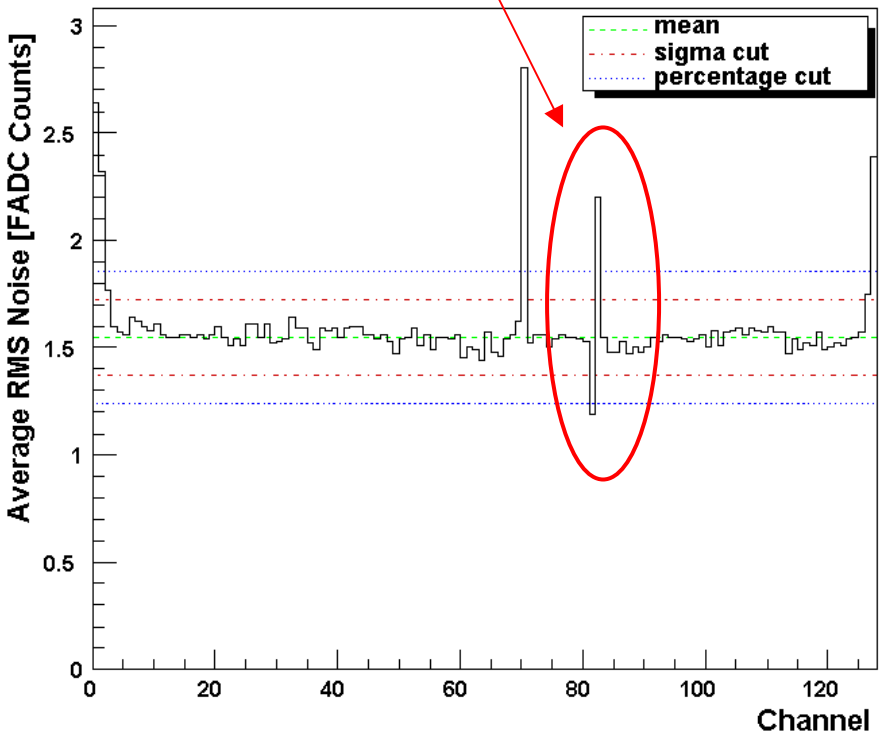
- Noise:

  Higher noise of a **pair** of two neighbouring strips:

  or

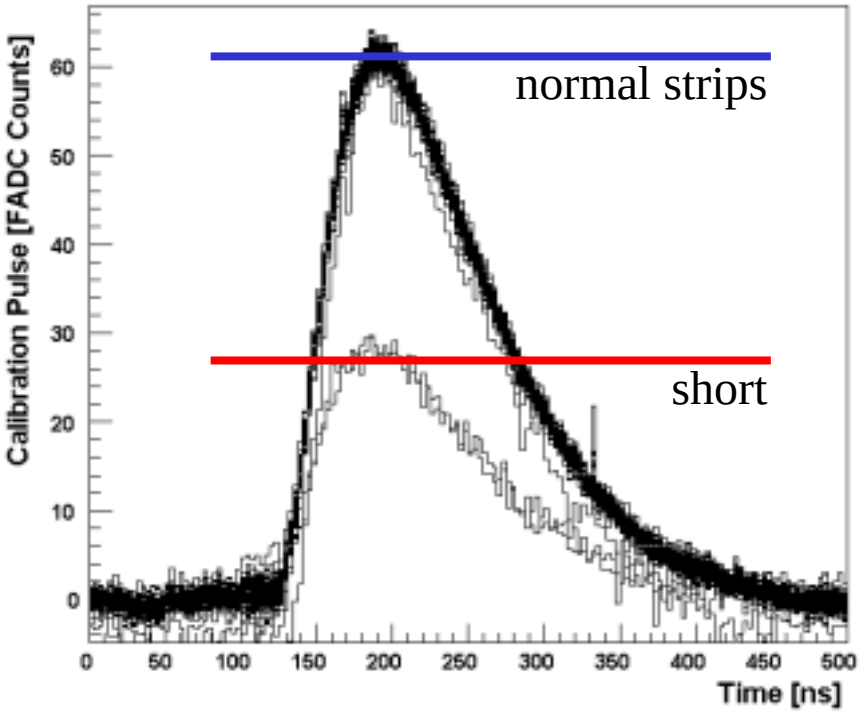
  pair of strips with higher and lower noise:

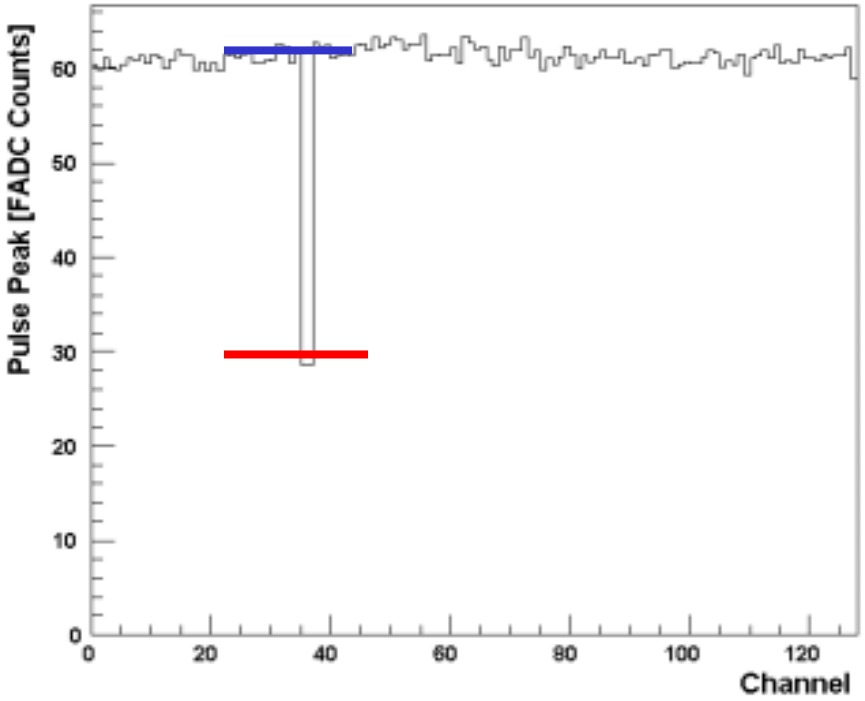




Shorts II

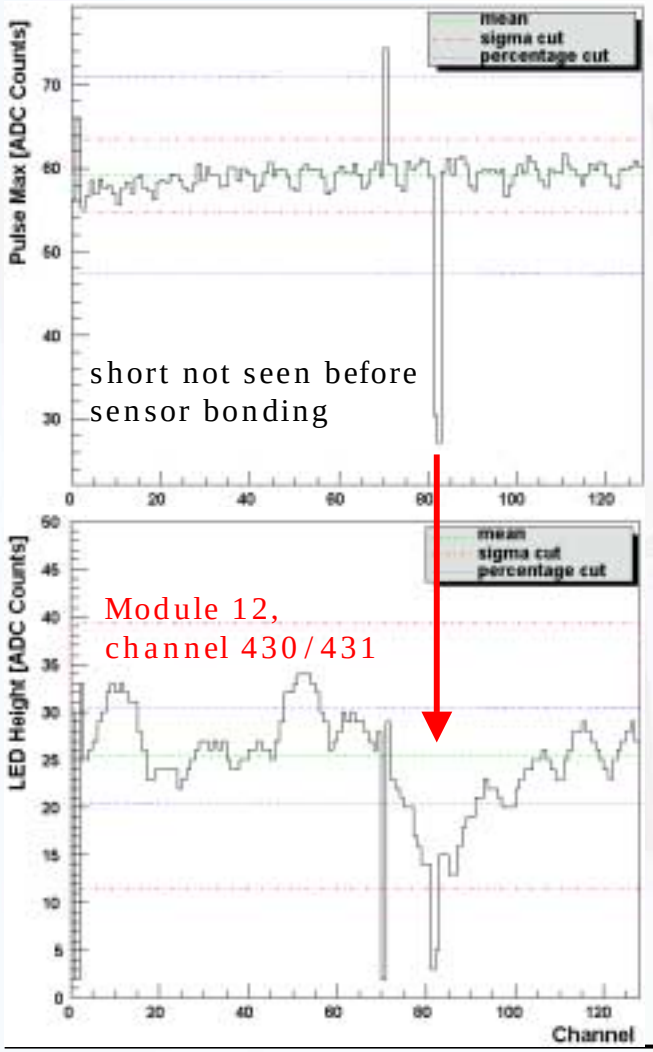
- Pulse Shape: Half the maximum of a “normal strip”





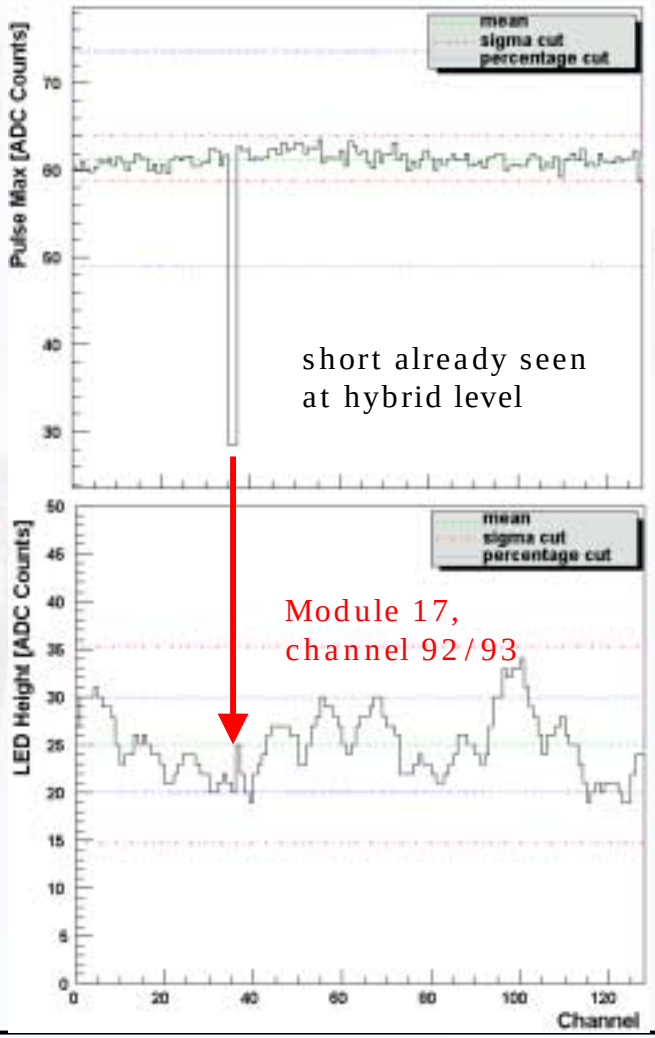
Shorts III

- Shorts do not have a certain significance in LED tests



same behaviour in pulseshape

different behaviour in LED test



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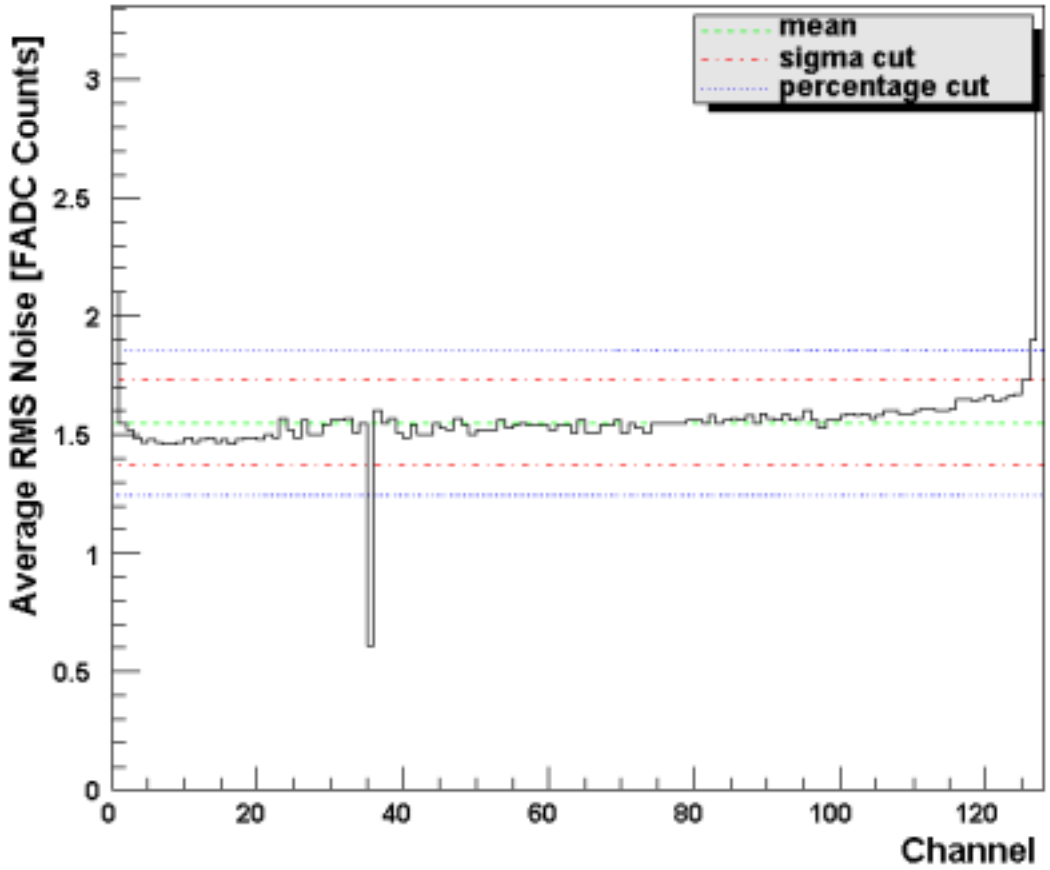
Pinholes

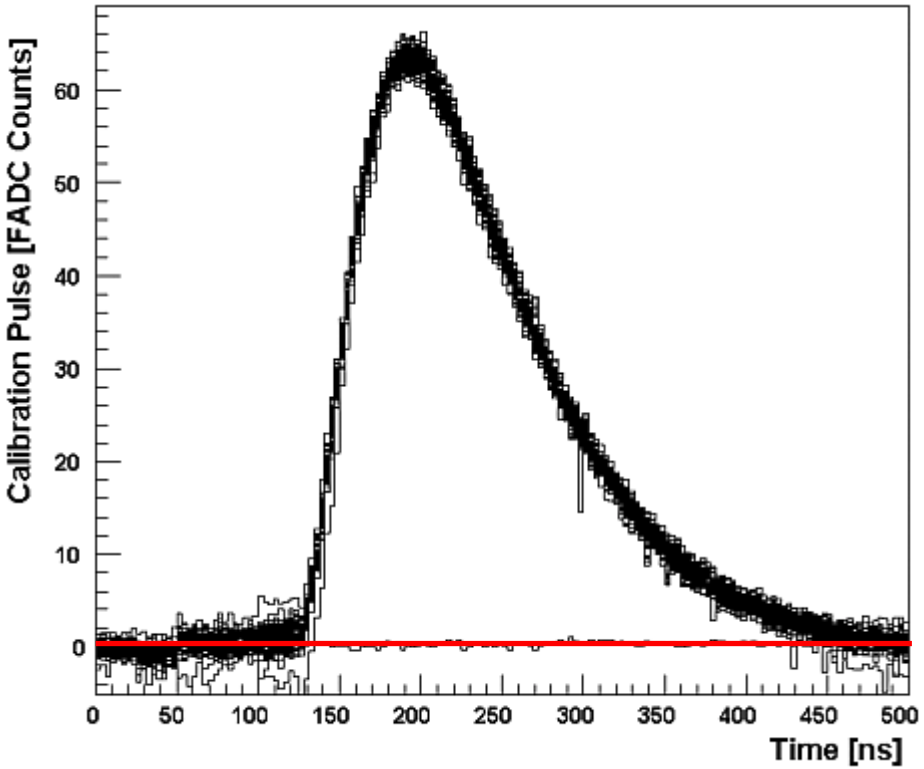
Pinholes I

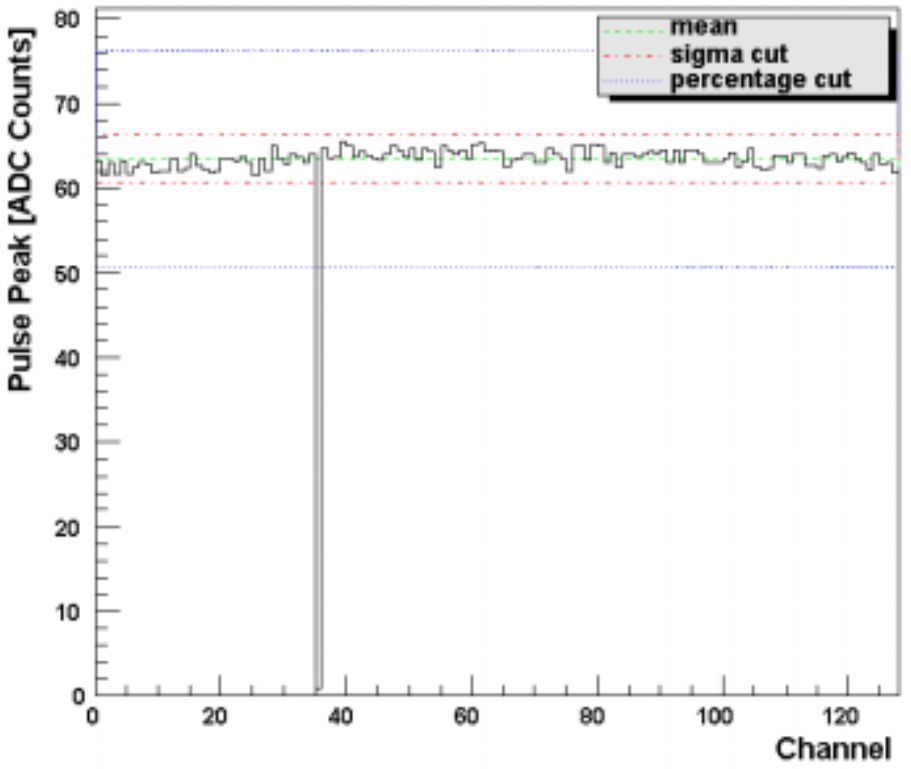
- Noise: Lower noise



Pinholes II

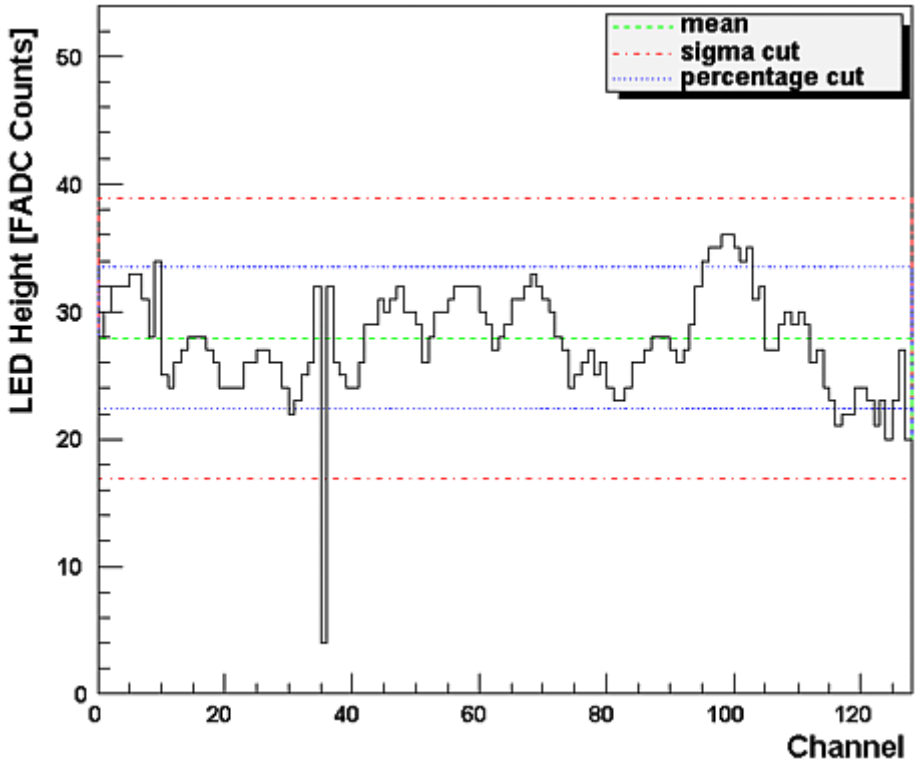
- Pulse Shape: Low Signal resp. no signal (depending on pinhole resistance)





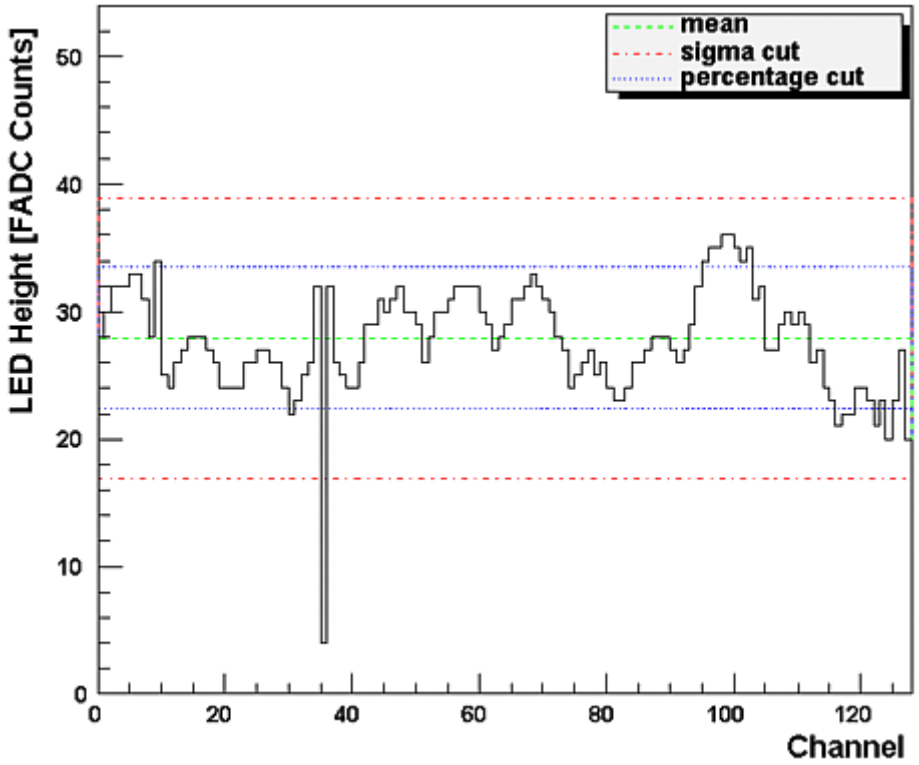
Pinholes III

- LED Test: Lower Signal



Pinholes III

- LED Test: Lower Signal



Defect statistics

- Tabularly summary (pinhole, faulty bond, short):

Module	Channel	Noise		Pulse Shape				LED Test		Visual Inspection	Description Karlsruhe
				rise time		maximum		signal			
		higher	lower	shorter	longer	higher	lower	higher	lower		
7	-	-	-	-	-	-	-	-	-	-	(Vienna)
12	511	x		x		x			x	missing bond	
	442	x		x		x			x	open bond	
	431		x	x			1/2		x	-	
	430	x		x			1/2		x	-	
	375	x		x		x			x	open bond	lost in cooling tests
	371	x		x		x			x	open bond	
	346	x		x		x			x	open bond	
	344	x		x		x			x	open bond	
	209		x	?		?		x			pinhole
13	-	-	-	-	-	-	-	-	-	-	(Vienna)
17	443	x		x			1/2		-	-	short on hybrid
	442	x		x			1/2		-	-	
	93	x		x			1/2		-	-	short on hybrid
	92	x		x			1/2		-	-	
20 (PSI)	6	x		x		x			x	open bond	
22	318	x		x		x			x	missing bond	missing bond
23 (PSI)	412	x		x		x			x	?	
	350		x	-			0		x	bonded pinhole	artificially bonded
	330		x	-			0		x	bonded pinhole	
	310		x	-			0		x	bonded pinhole	
	290	x		x			1/2		x	bonded short	
	289		x	x			1/2		x		
	270		x	x			1/2		x	bonded short	
	269	x		x			1/2		x		
26	480	x		x		x			x	missing bond	
27	248	x		x		x			x	missing bond	pinhole (unbonded)
	93		x	-			0		x		pinhole
29	189	x		x		x			x	missing bond	
	7		x	-			0		x		pinhole
48	9	x		x		x			x	missing bond	pinhole (unbonded)
56 (PSI)	486	x		x		x			x	open bond	
	307	x		x		x			x	open bond	

12 faulty bonds, 3 shorts, 5 pinholes in total out of 6144 channels: < 0.4 %

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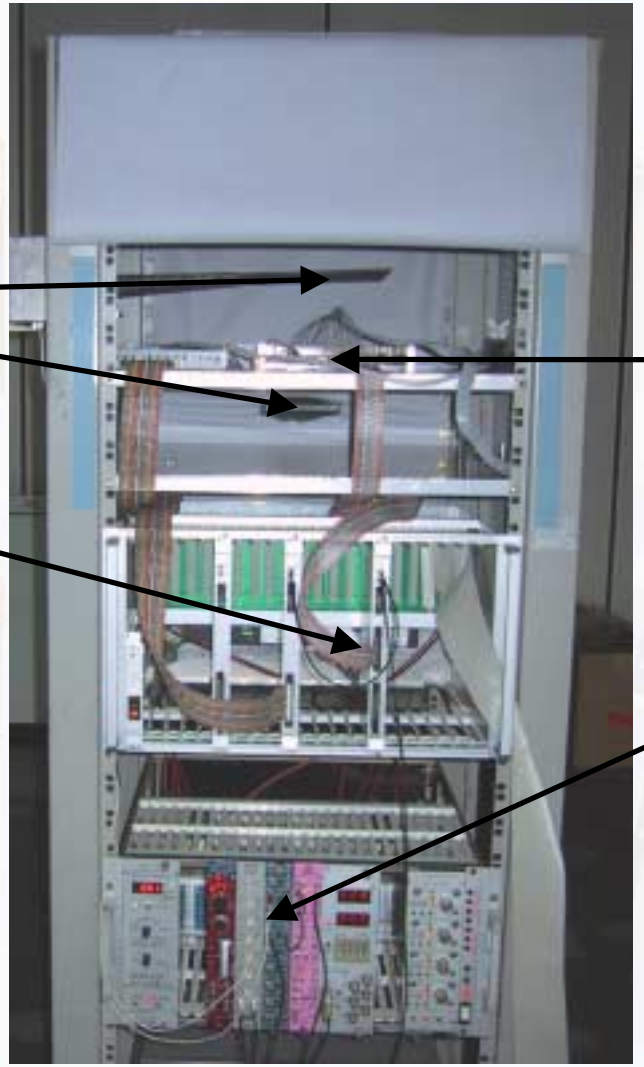
Measurements with cosmics

Measurements with cosmics

- Our cosmic test station:



- Measurements:

  How do pinholes and shorts “react“ on MIPs ?

Calibration of ARC Readout, ARCS stability test, signal to noise

Measurements with cosmics

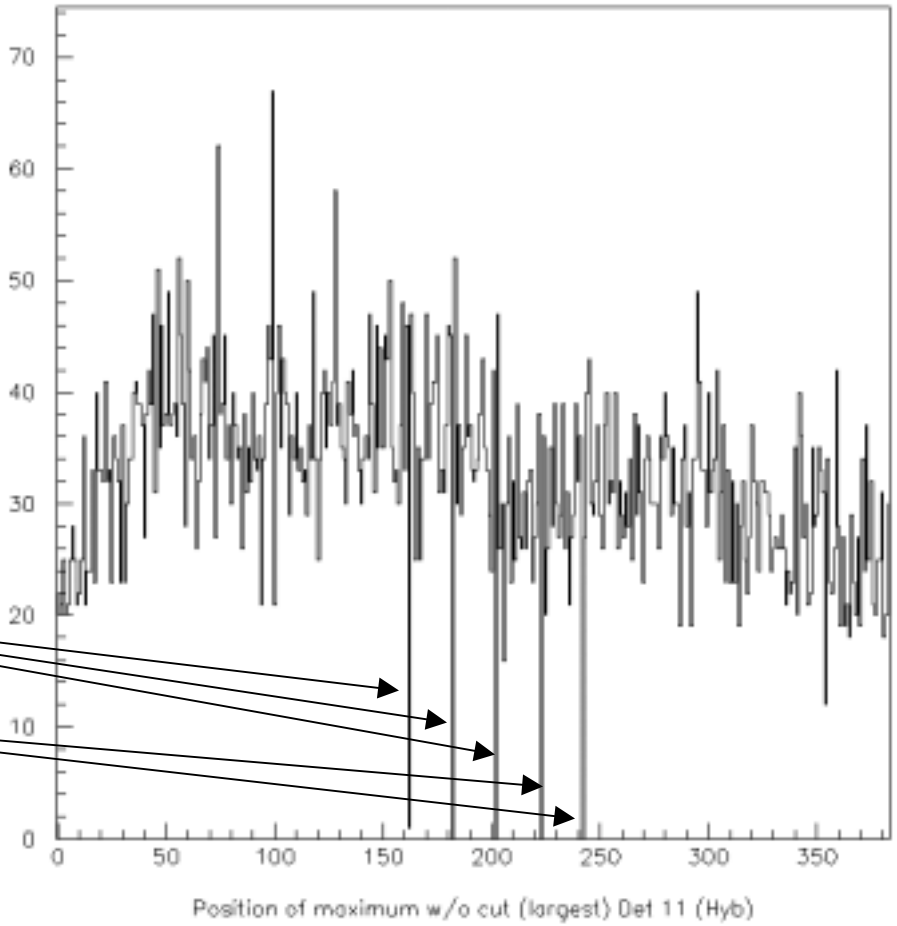
- Module 23 with **2 bonded shorts** and **3 bonded "pinholes"**

- Obvious in a maxima plot:

Shorts and pinholes are completely „blind" for MIP particles !

Pinholes

Shorts



Measurements with cosmics

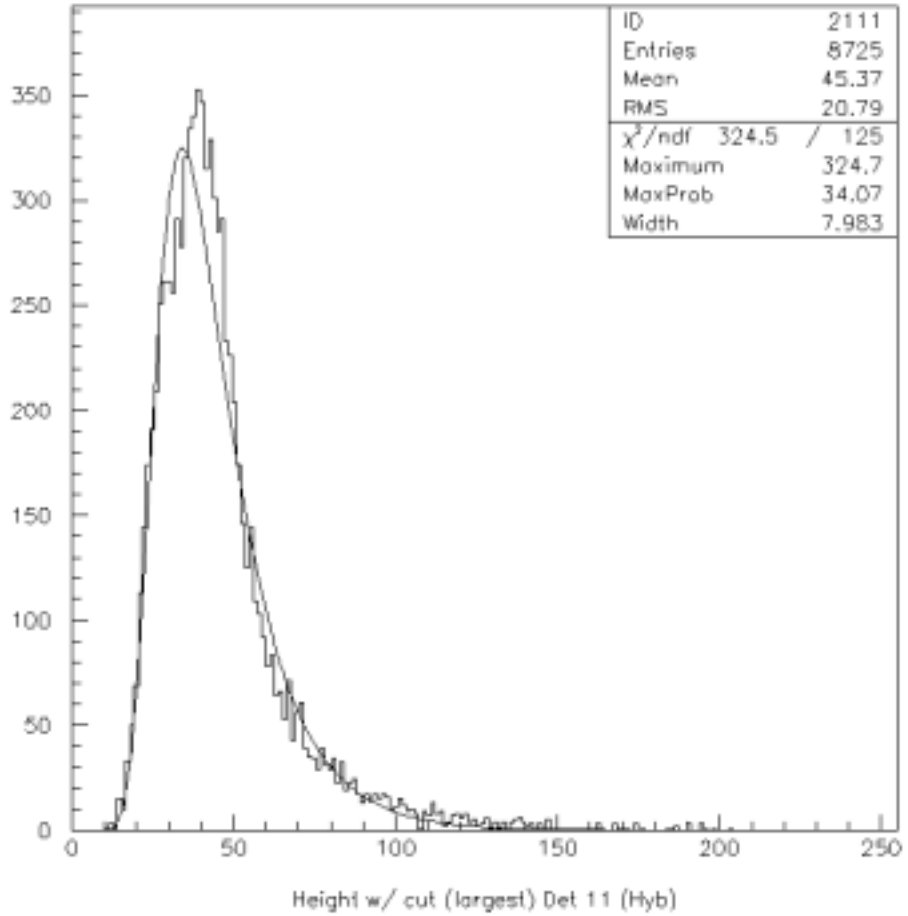
- peak mode, V_{depl} : 100 V
- 3 parameter Landau:

  MaxProb: **34 ADC counts** (peak mode)

  1 MIP ~ 35000 electrons (500 µm silicon)

  Therefore in ARCS:

  1 ADC ~ 1000 e- (peak mode)



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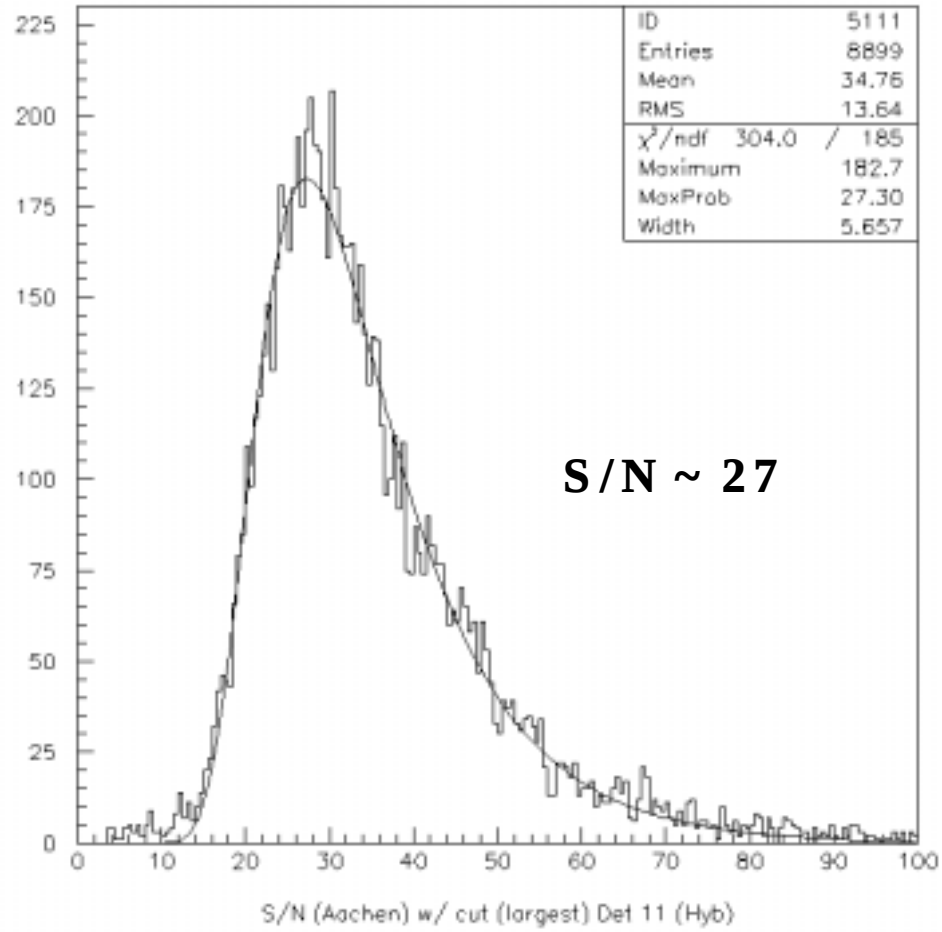


What we have learned...

- **Faulty Bonds** are easy to detect in all tests, due to higher noise, higher pulse shape maxima, shorter rise time, lower light response. Seen in visual inspection

- **Shorts** always have conspicuous noise on neighbouring strips, half maximum height in pulse shape, shorter rise time

- **Pinholes** can be characterized by lower noise, low pulse shape maxima, lower light response (one behaved differently !)

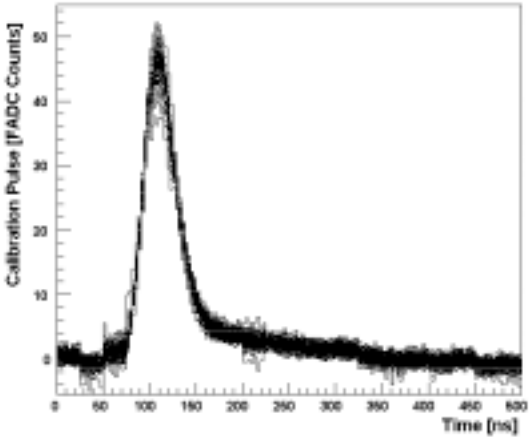
  (**BUT:** An faulty APV channel has the same characteristics, so: For pinholes, light tests with high leakage currents a la Karlsruhe could help...)

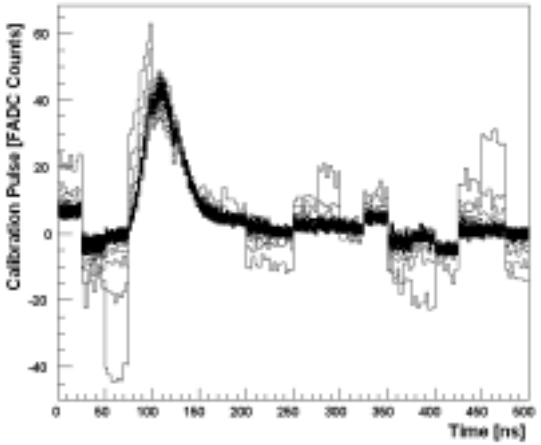
- The **calibration pulses** are a **powerful tool** for module defect diagnostics (LED/Laser redundant !?)

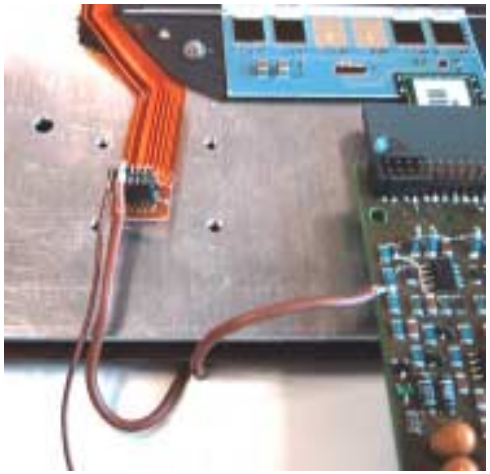
- **Same grounding point** essential for comparable data !

Different Grounding:

- A “bad grounding” can cause strange effects (e.g. pulse shape):

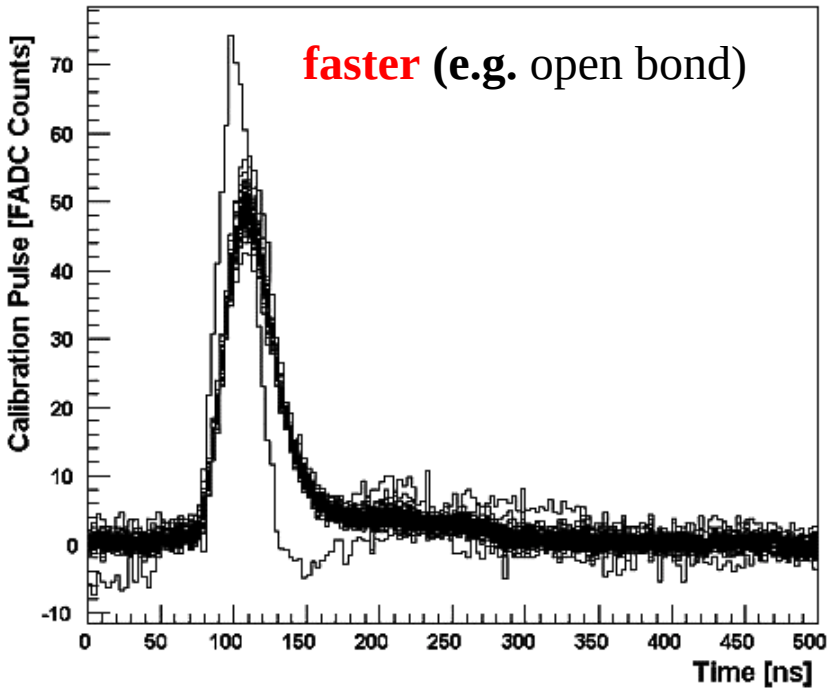


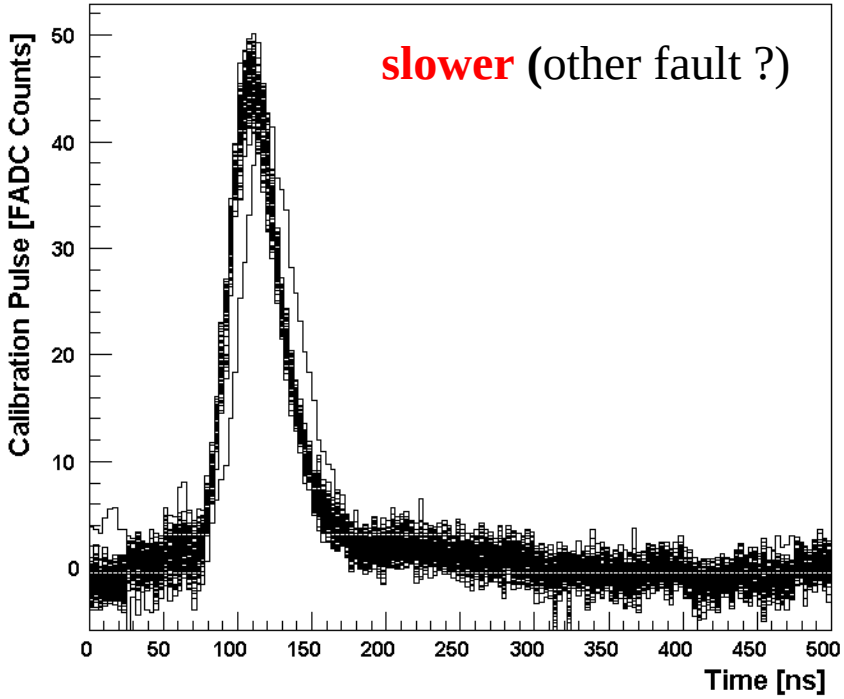




Different rise time

- The rising/peak time of the calibration pulse can be another indicator for a fault:





Has to be implemented in ARCS...

Outlook

- ARCS 5 is ready for all tests (duration ca. 15 minutes per module), except rise/peak time measurements
- We are currently working on the automation routine
- Database connection has to be implemented !!!
- Suggestions are welcome...