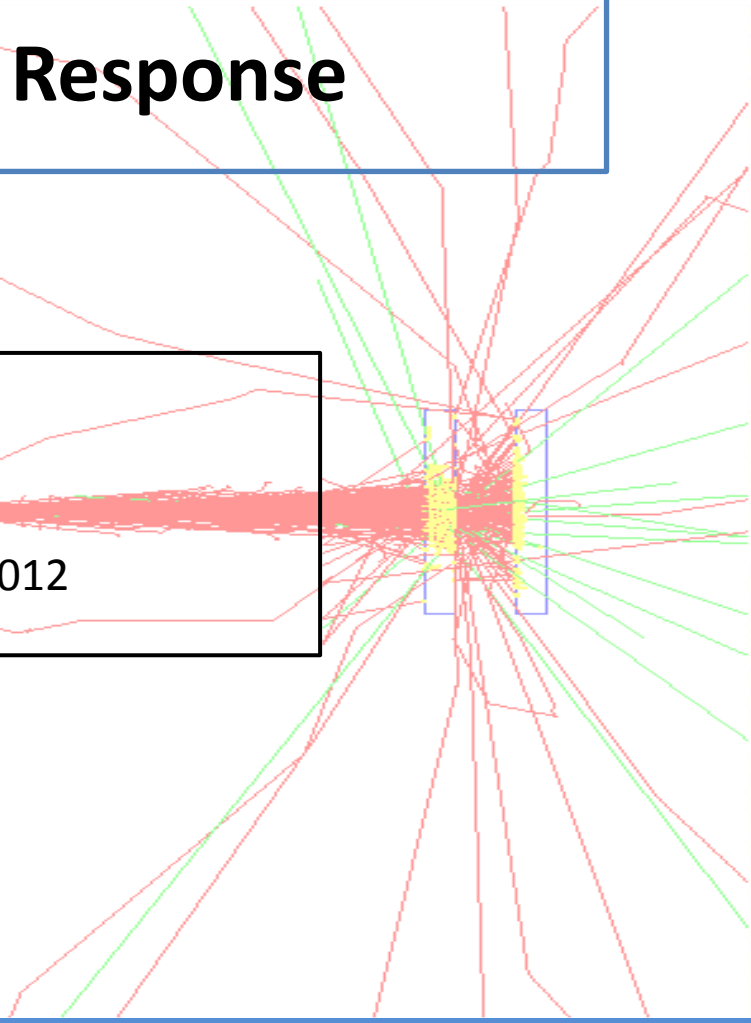
# Temperature Dependence of the Scintillator Tile Response



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CALICE Meeting Matsumoto 06.03.2012

# Outline

- Introduction
- Measurement Setup
- Measurement Results
- Summary & Outlook

# Introduction

- SiPM parameters (gain G, response R, $V_{break}$) depend on temperature
  - dG/dT and dR/dT due to temp. dependence of $V_{break}$ ($\rightarrow V_{over}$)
  - For const. $V_{over}$: dG/dT and dR/dT negligible (if not 0)

$\Rightarrow$Adjust bias-voltage to compensate temperature fluctuations

- How large is the required voltage range?

$\Rightarrow$Measurement of temperature coefficient for 152 tiles

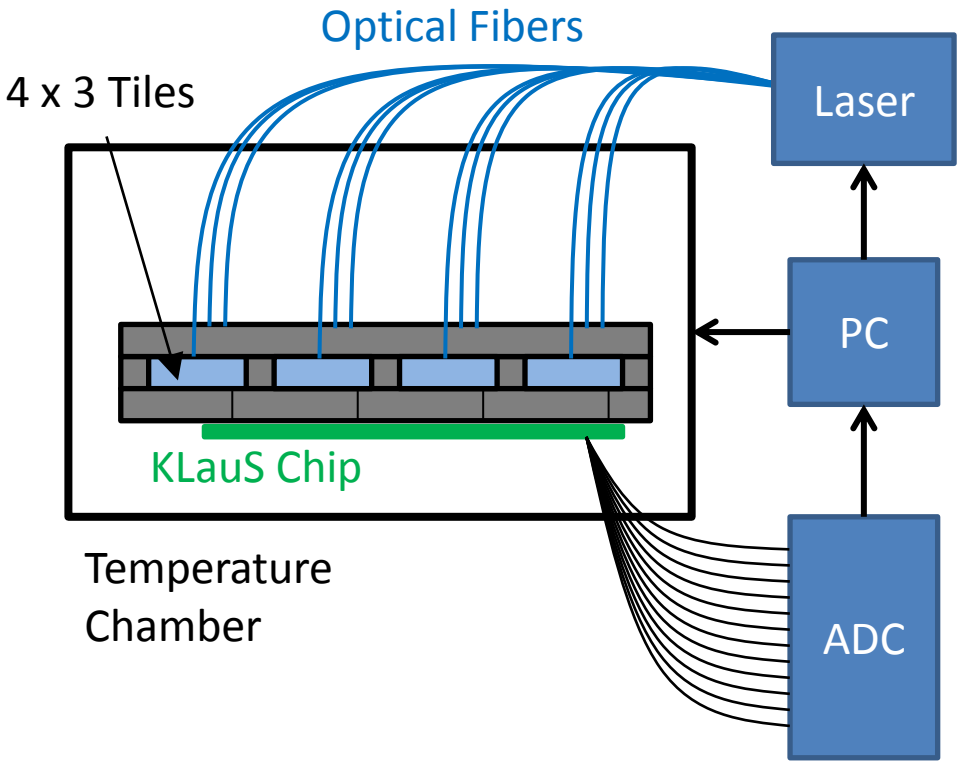
$\Rightarrow$Value of $dV_{break}/dT$

- Temp. coeff. cannot be measured for all 8 mio. tiles

$\Rightarrow$Tile-to-tile variations

# Setup

- Automated measurement with 12 tiles in parallel
- Picosecond laser with 12 optical fibers
- Readout with KLauS Chip + ADC
- T=10°C – 34°C (in ca. 3.5 hours)
  - ⇒152 tiles in 5 days
- SPS vs. $V_{bias}$ @ fixed $I_{Laser}$
  - ⇒Gain
  - ⇒**$V_{break}$**
  - ⇒Response
  - ⇒Cross-talk & after-pulses
  - ⇒Dark-rate



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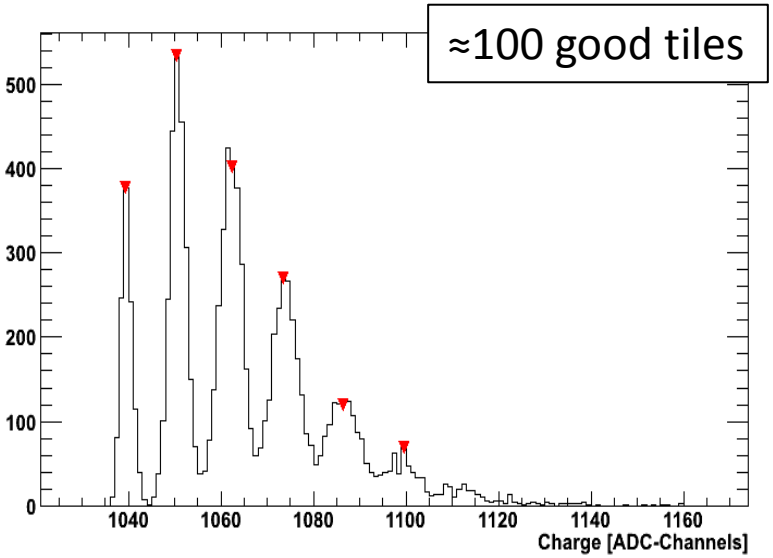
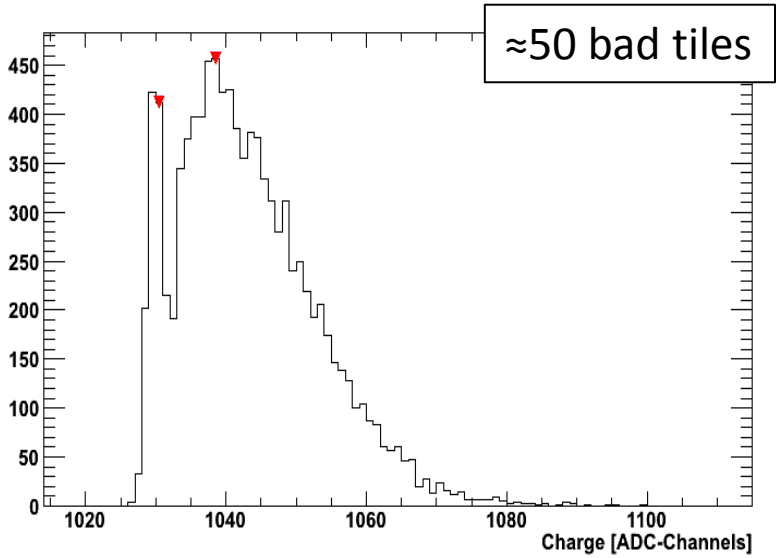
# SPS Quality

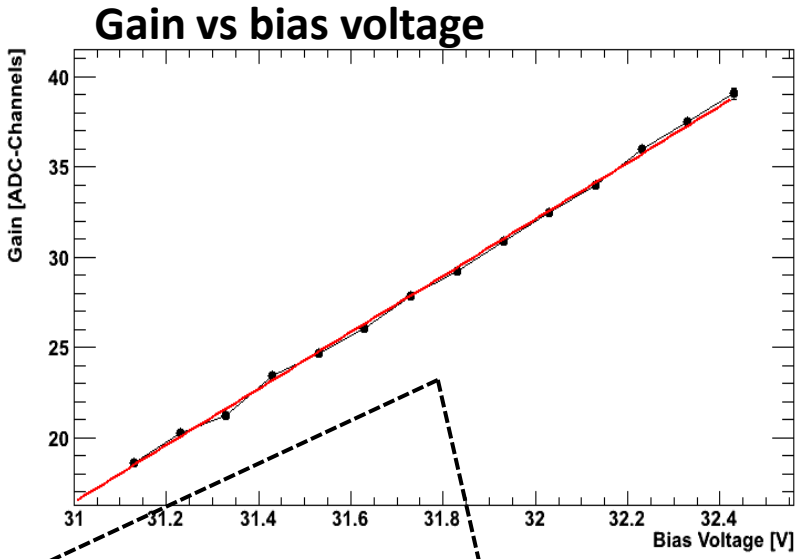
- ≈50 out of 100 tiles with no clear SPS
- Measurement cannot be optimized for individual tiles
  - ⇒Problem for tiles with small gain or response
- Small non-linearity in readout chain
- Gain extraction from SPS not 100% stable yet
  - ⇒Uncertainty in Vbreak
  - ⇒Working on improved analysis

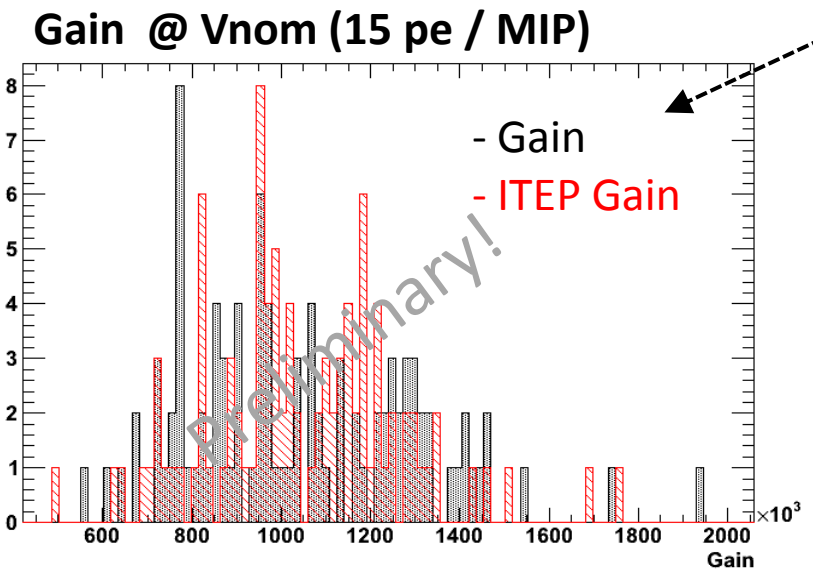


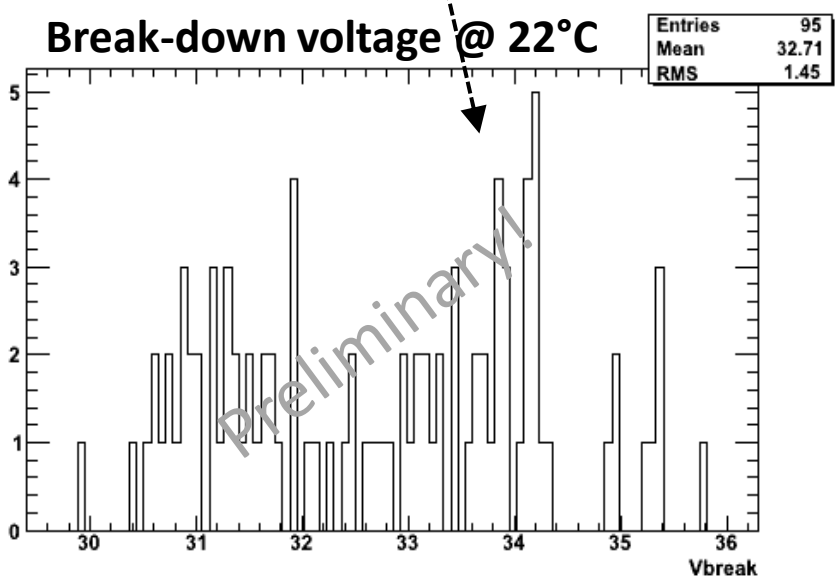



# Gain & $V_{break}$

- Gain distribution agree with ITEP values
- $V_{break}$ from Gain vs $V_{bias}$
- $V_{break}$ @ 22°C ≈ 32.7 ± 1.4 V



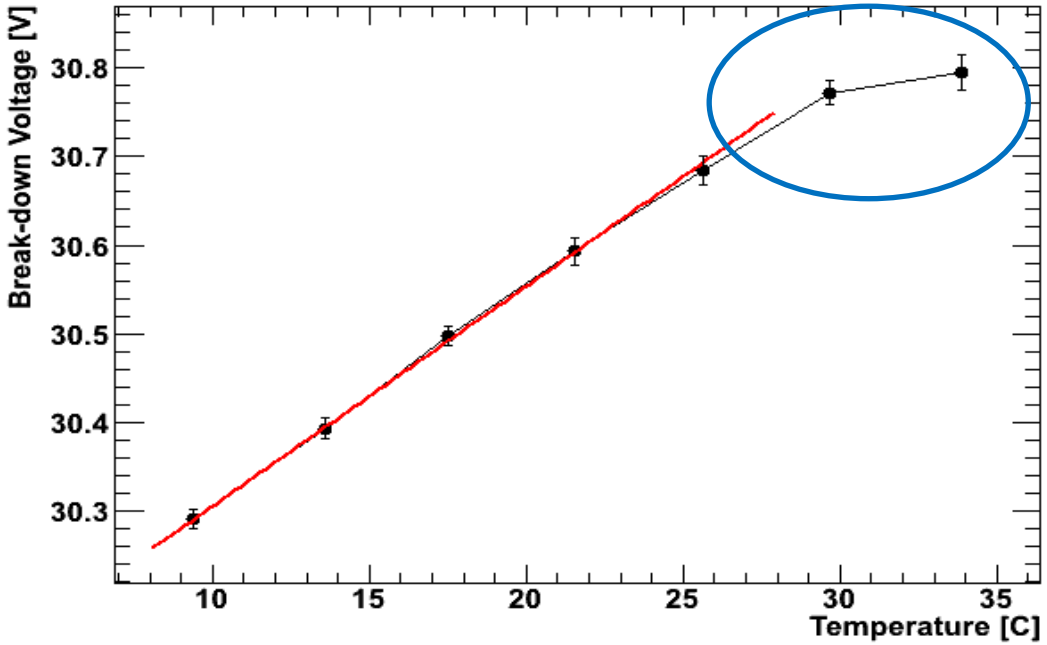



# Temp. Coeff. Of Vbreak

- Linear up to T ≈ 28°C
- Non-linearity for T > ≈ 28°C
  - Degree of non-linearity varies from tile to tile
  - Cross-checks with different readout and Hamamatsu MPPC

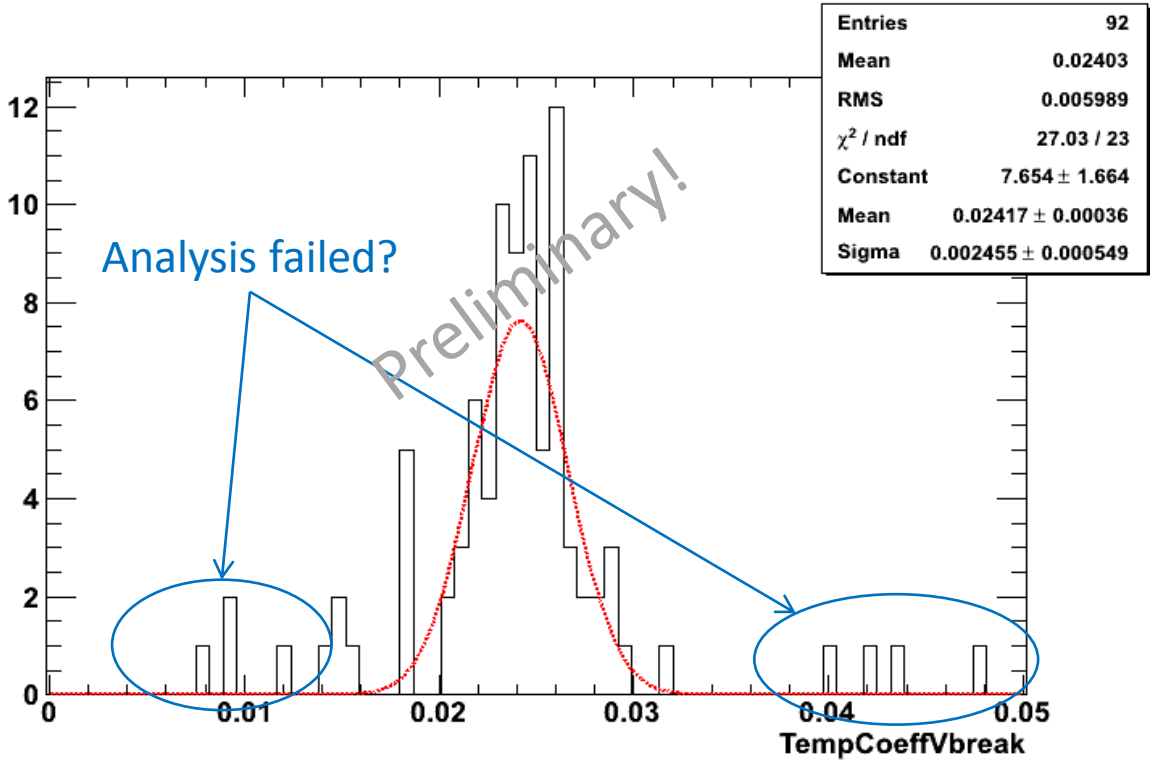
  ⇒Seems to be feature of the SiPM

  ⇒Further cross-checks planned



# Temp. Coeff. Distribution

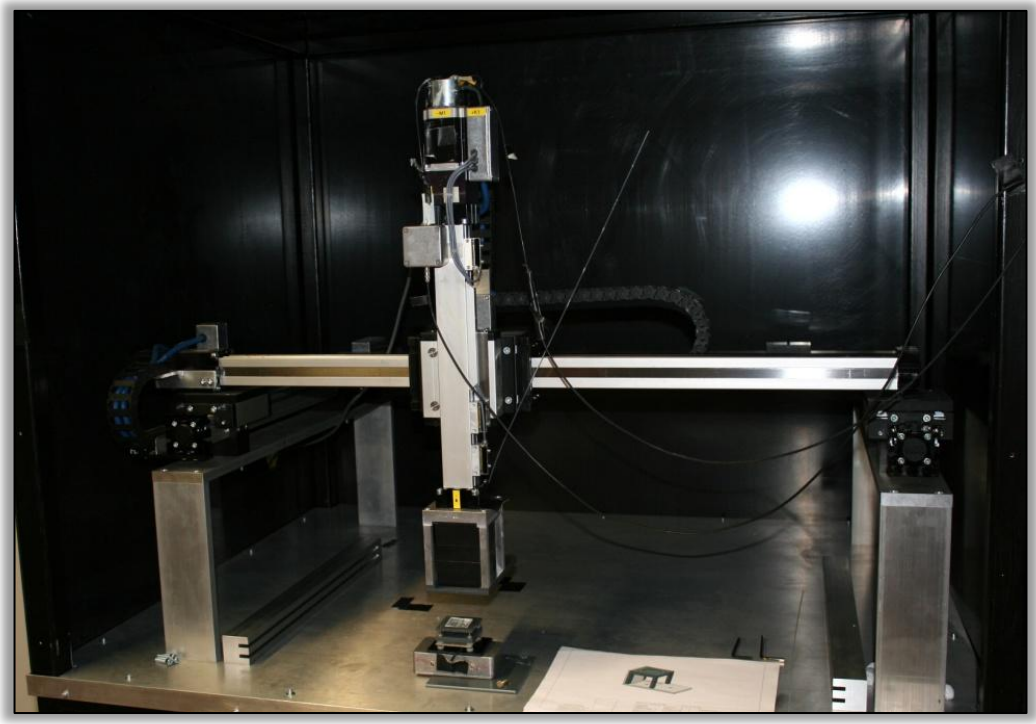
- $dV_{break} / dT \approx$ **0.024 V/K**
- Spread ≈ **10%**
  - Contains measurement uncertainty
- Probably contains some tiles with failed analysis
- More precise results with improved SPS analysis possible



# Large Scale Tile Tester

- Gained experience in large scale tile testing
- Concept of setup can be transferred to XY stage for large scale tile QA & characterization (without temperature chamber)
  - Laser UV + 12 coupled fibers
  - Klaus readout

- ToDo List:
  - Improve uniformity of optical fiber output
  - Reduce electronic noise
  - Better / stable SPS analysis
  - Eliminate non-linearity in readout



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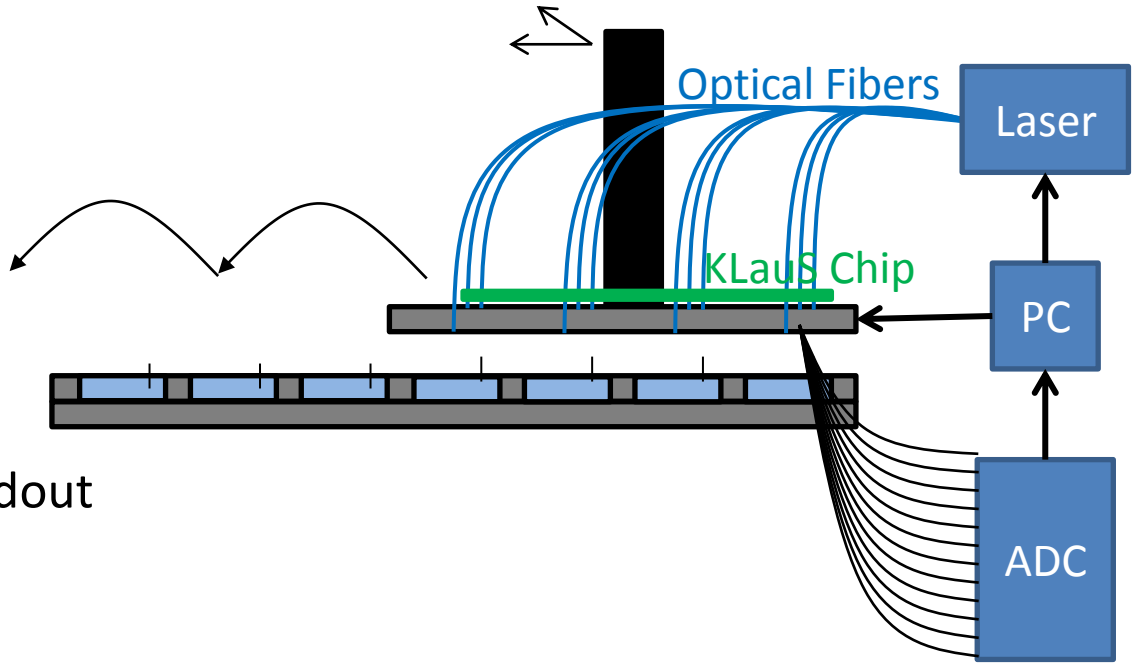


# Summary & Outlook

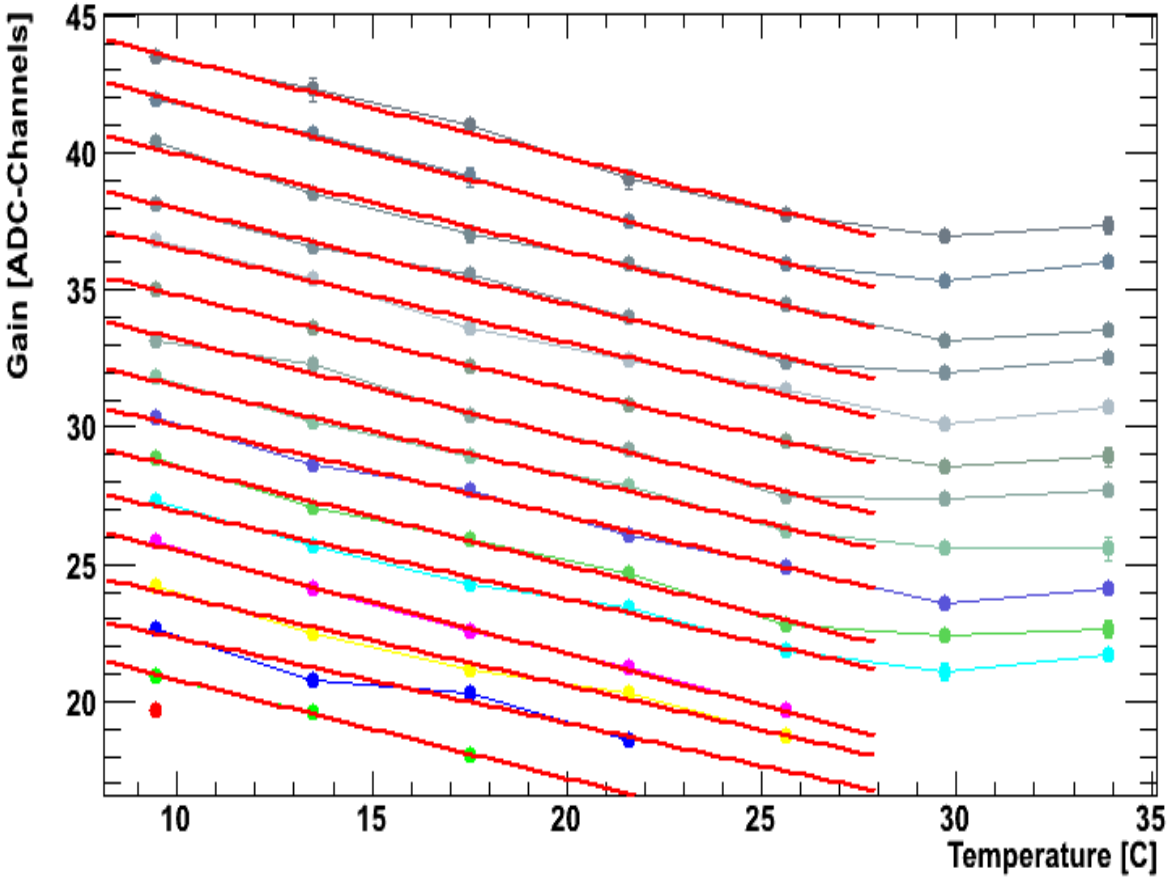
Summary:

- Setup for temperature measurement of SiPM response developed (≈40 tiles / day)
- $dV_{break}/dT \approx 0.024$ with ≈10% tile-to-tile spread
- Non-linearity in temperature dependence for T > 28°C
- Many concepts of setup, readout & analysis can be used in the large scale tile tester

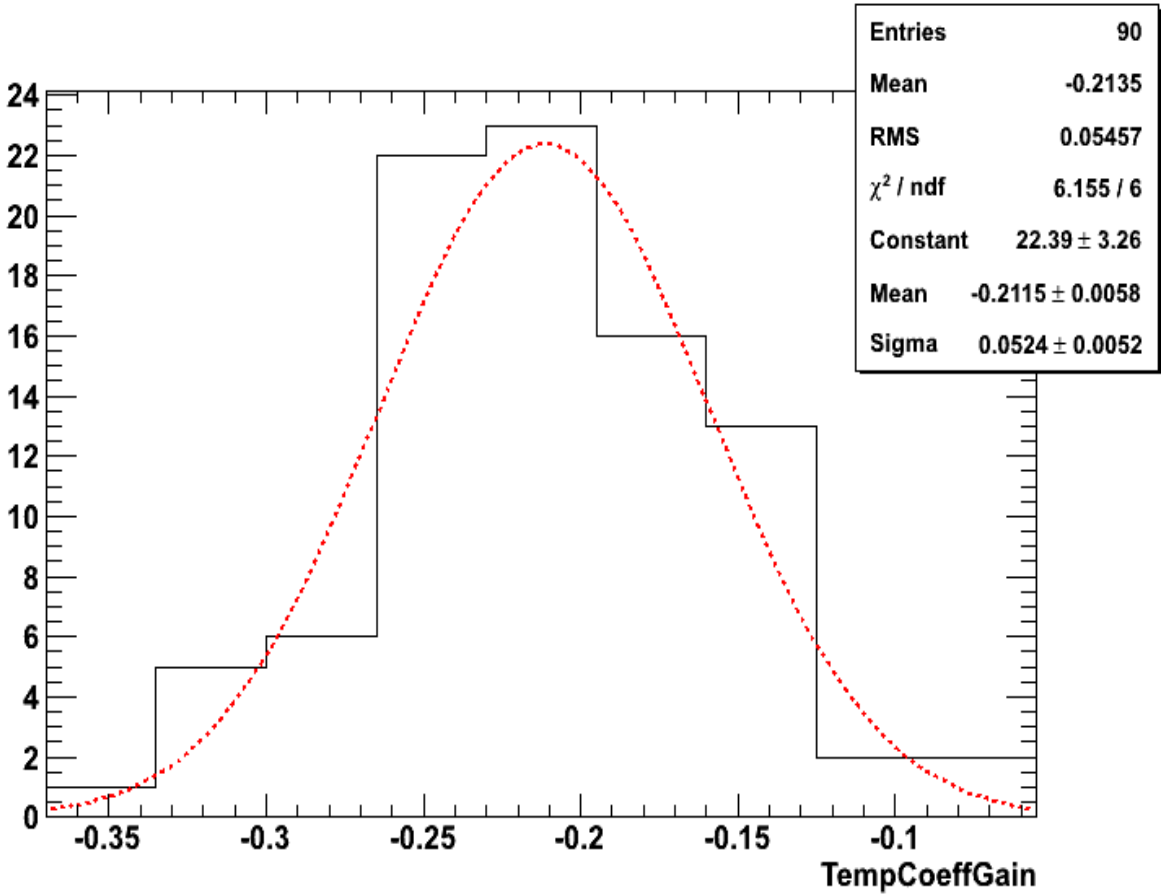
Outlook:

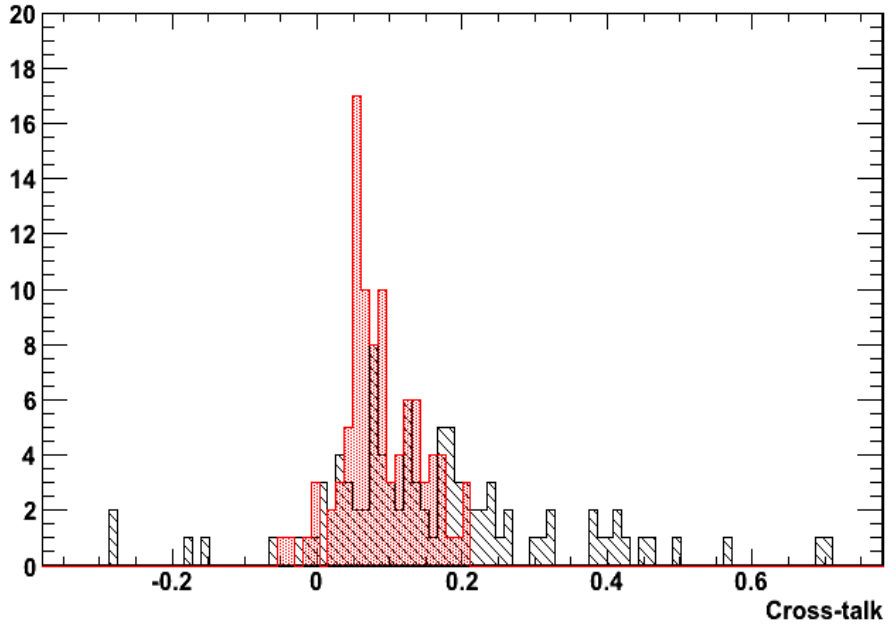
- Improve precision with better SPS analysis
- Study non-linearity in temperature dependence
- Determine temperature coefficient for gain and response

# Backup


Gain [ADC-Channels]
45
40
35
30
25
20
10
15
20
25
30
35
Temperature [C]

# Backup


Entries 90
Mean -0.2135
RMS 0.05457
χ² / ndf 6.155 / 6
Constant 22.39 ± 3.26
Mean -0.2115 ± 0.0058
Sigma 0.0524 ± 0.0052
24
22
20
18
16
14
12
10
8
6
4
2
0
-0.35
-0.3
-0.25
-0.2
-0.15
-0.1
TempCoeffGain


20
18
16
14
12
10
8
6
4
2
0
-0.2
0
0.2
0.4
0.6
Cross-talk