

THMP and Temperature Sensor Production

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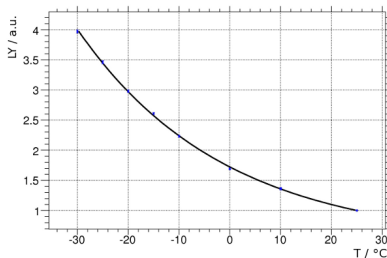
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Why and How Do We Measure Temperatures?

PWO-II: LY depends on T with $\frac{d(LY)}{dT} = 3\%/^{\circ}\text{C}$ at 20°C



- Goal for $\overline{\text{PANDA}}$: $\Delta T < 0.1^{\circ}\text{C} \rightarrow$ sensors with $\sigma_T < 0.02^{\circ}\text{C}$
- R vs T relation of platinum quite linear

$$R(T) \approx R(0^{\circ}\text{C})(1 + \alpha_{\text{Pt}} \cdot T), \quad \alpha_{\text{Pt}} = 3.89 \cdot 10^{-3} \text{K}^{-1}$$

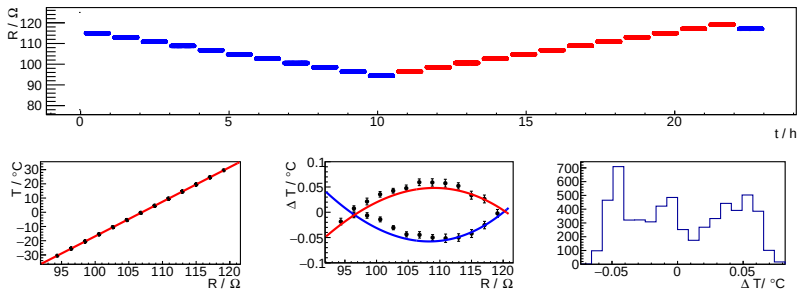
- Accuracy for temperature sensors translates to accuracy for R measurement with the THMP: $\sigma_R \approx \frac{\partial R(T)}{\partial T} \cdot \sigma_T \approx 7.8 \text{ m}\Omega$

Status of Temperature Sensor Production

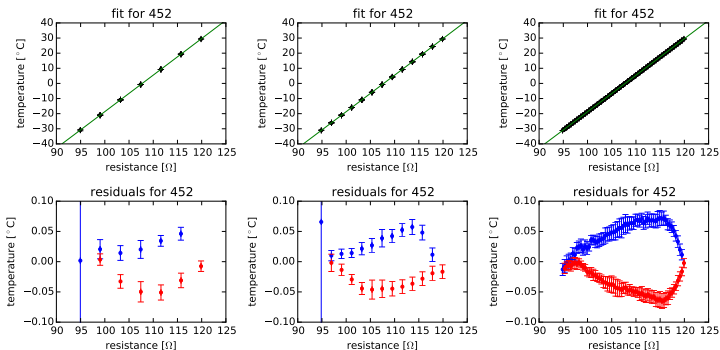
- Need:
 - 482 temperature sensors designated for forward endcap
 - 1152 temperature sensors designated for barrel (72/slice)
(Mainz is taking care of backward endcap)
- Status:
 - 683 temperature sensors produced
 - 612 temperature sensors calibrated (up-to-date setup!)
(61 shortcut / bad connection)
 - 83 high quality sensors provided for test slice (11 spare)
 - Adapter boards for test slice delivered to Gießen
 - Sufficient amount of platinum wire bought and delivered
 - Boards (plugs) delivered, ≈ 350 already soldered
- Keep running:
 - Copper coated polyamid foil for 240 cables ordered
 - Conductive adhesive ordered

Temperature Sensor Calibration

- Data selection: Consider all data except first 10 minutes after change of temperature set value
- Split the data into two sets to take hysteresis into account



Hysteresis Studies

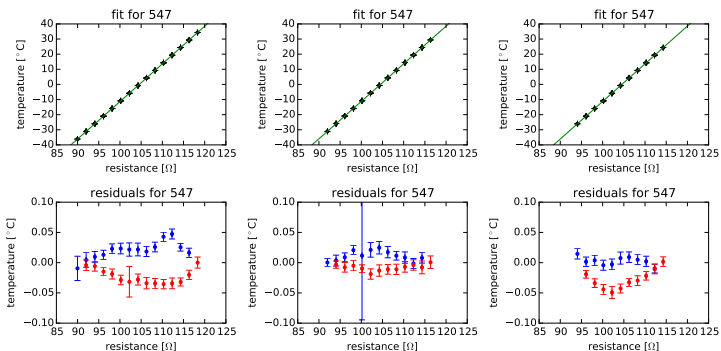


t 1 h
 ΔT 10°C
 $T_{\min}$ -30°C
 $T_{\max}$ +30°C

t 1 h
 ΔT 5°C
 $T_{\min}$ -30°C
 $T_{\max}$ +30°C

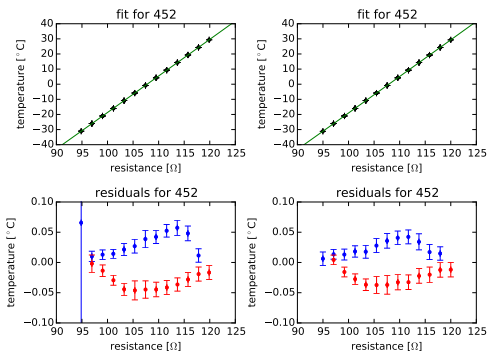
t 1 h
 ΔT 1°C
 $T_{\min}$ -30°C
 $T_{\max}$ +30°C

Hysteresis Studies



t	1 h	1 h	1 h
ΔT	5°C	5°C	5°C
$T_{\min}$	-35°C	-30°C	-25°C
$T_{\max}$	+35°C	+30°C	+25°C

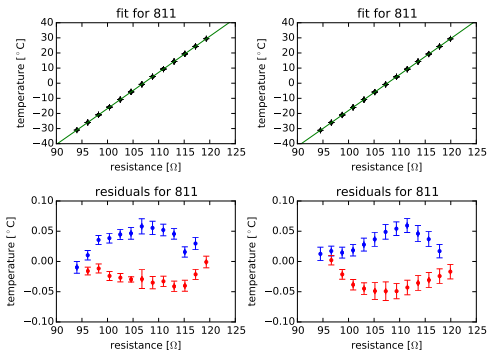
Hysteresis Studies



baked once

baked twice

Hysteresis Studies



baked once

baked twice

Status of THMP Production

- Need:
 - 10 THMPs designated for forward endcap
(74 T -PBBs, 6 p -PBBs)
 - 2 THMPs designated for barrel test slice
(12 T -PBBs, 4 p -PBBs)
- Status:
 - 15 fully equipped and tested THMP-mainboards
12 of them already mounted in cases
 - 92 fully equipped and tested temperature sensor PBBs
 - 25 fully equipped and tested pressure/humidity sensor PBBs
 - 2 THMPs with 6 resp. 8 T -PBB calibrated
→ 8 · 24 h measurements (T dependent!)

Summary and Outlook

- ✓ Almost all produced temperature sensors calibrated
- ! Further study hysteresis effect:
 - Measurement with small variations around -25°C (mimic detector operation scenario)
- ✓ THMP hardware is ready!
- ✓ 2 THMPs already calibrated

Questions? Comments?