

# Status and Outlook for the B-TOF Detector

Sebastian Zimmermann  
On behalf of the Panda SciTil group

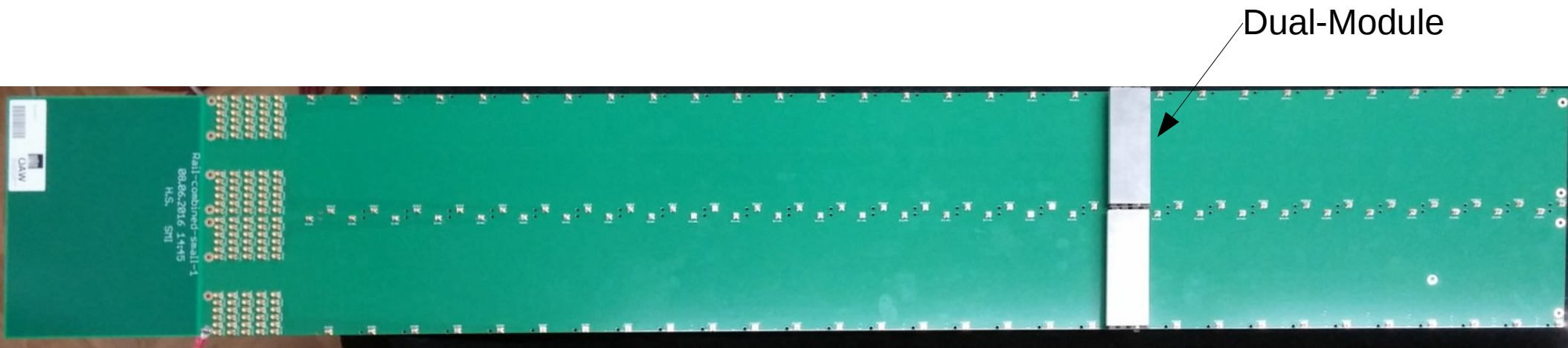
GSI, 9.6.2017

# Outline

- Current Railboard prototype overview
- Railboard update
- FEE/readout scheme
- Temperature sensor
- LED calibration system
- FEE update

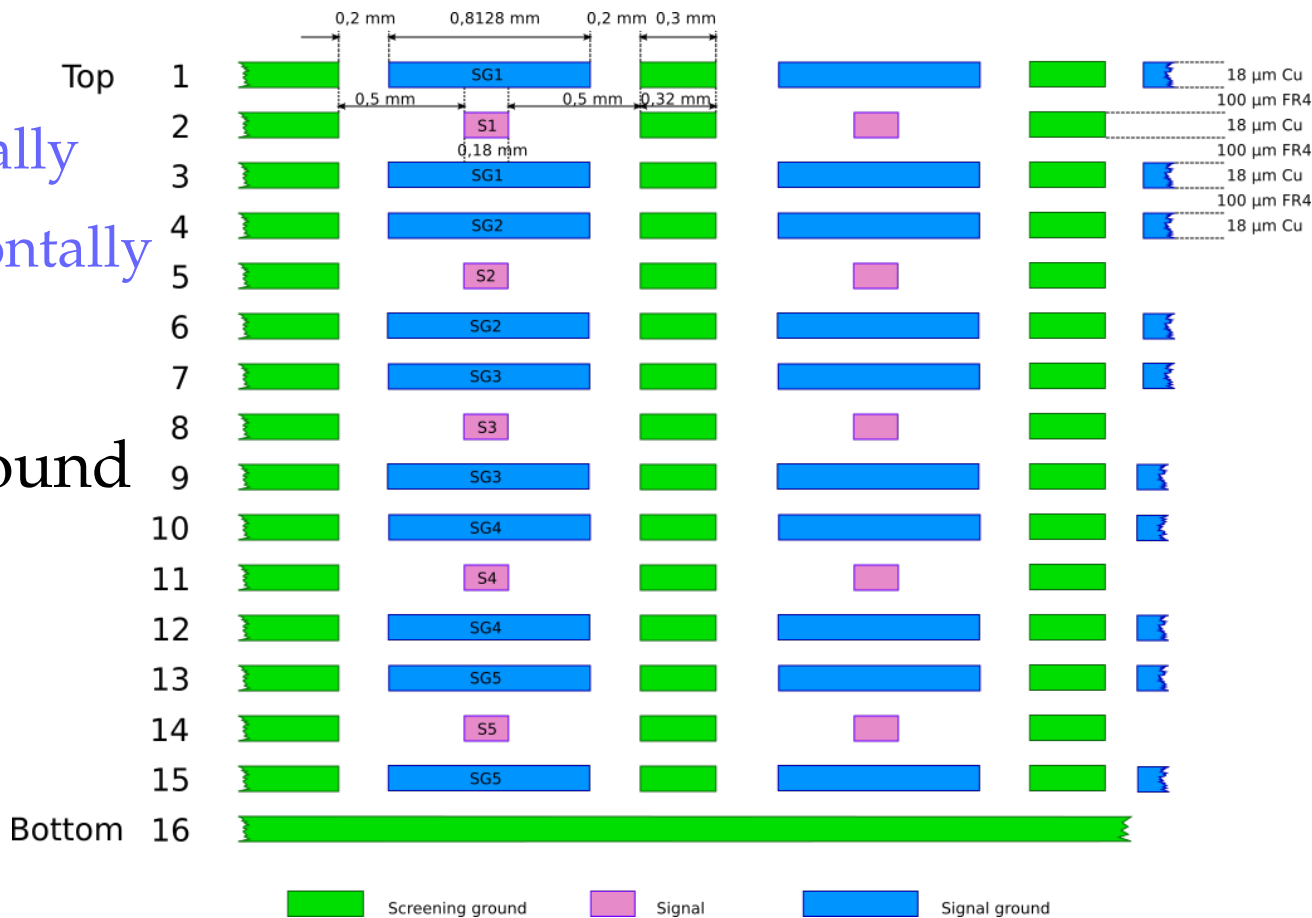
# Railboard Prototype

- This prototype is half the size of the envisioned supermodule
- Dimensions:
  - 110 cm x 17.5 cm x 2.5 mm
- Channels for 30 “dual-modules”
  - Each with dual readout of 4 connected SiPMs (hybrid or serial connection)

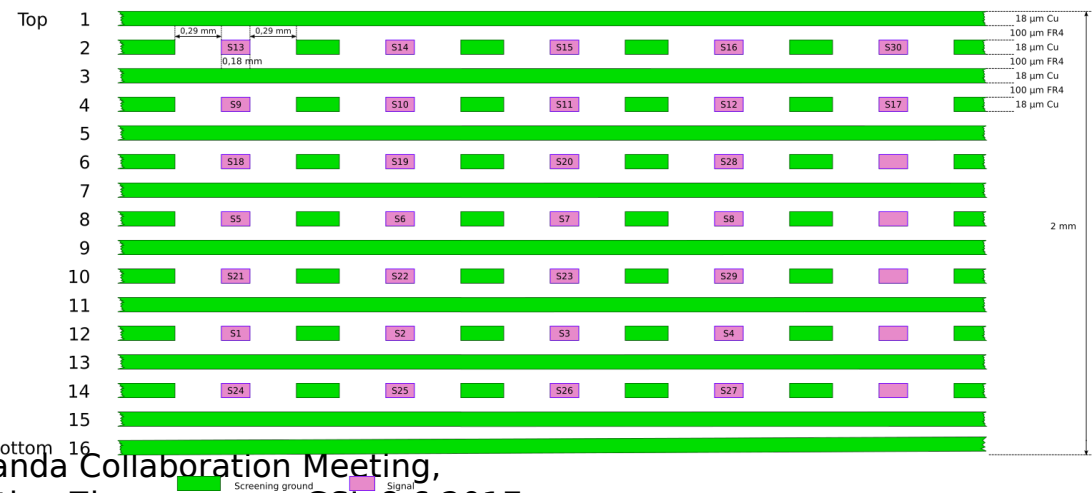
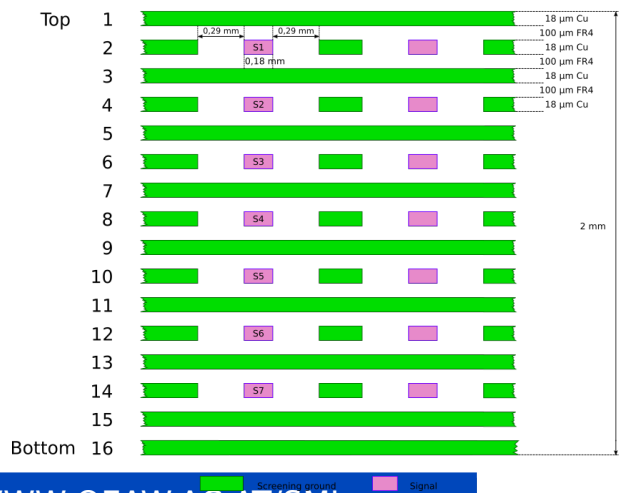
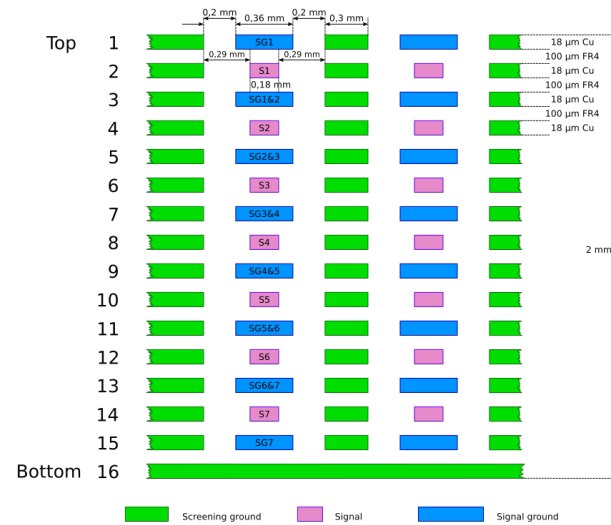
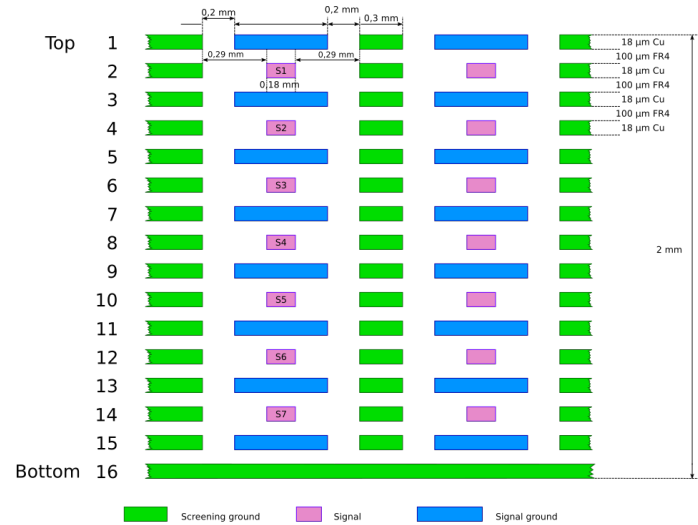


# Schematic of the Railboard

- 16 layers
  - 5 signal lines vertically
  - 6 signal lines horizontally
- Shielded by ground layers and signal ground

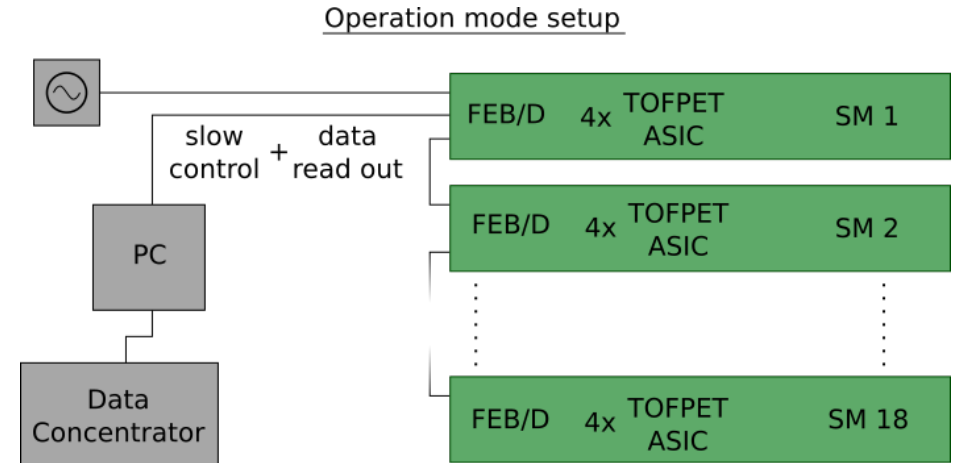


# Railboard v2 Schematic

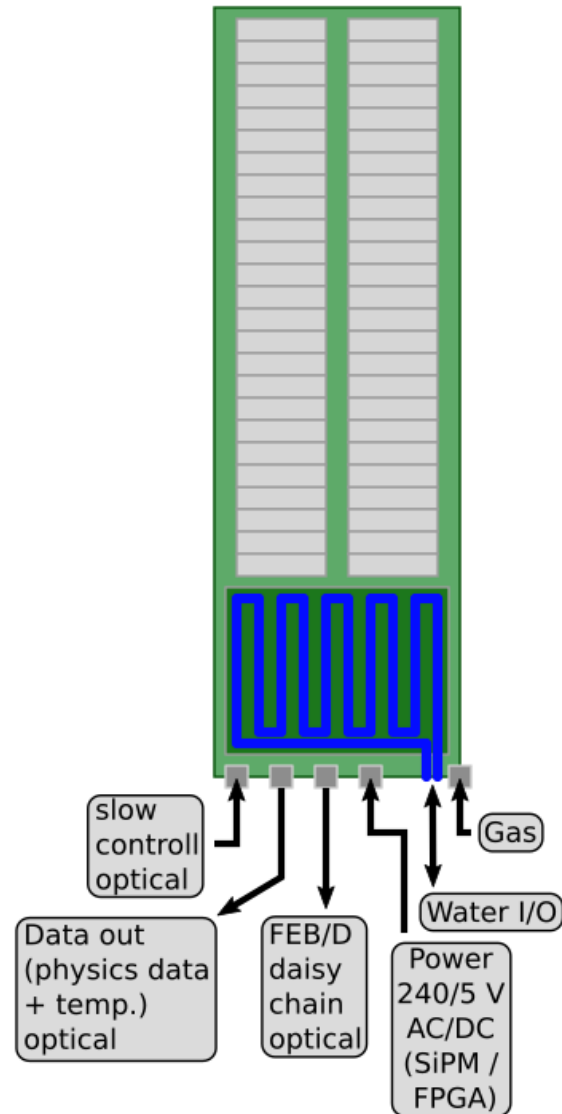


# Electronics Setup

- 2 FEB/A boards per Super Module (SM)
  - 4 ASICS per SM
- 1 FEB/D boards per SM
- Daisy chain of FEB/D possible
  - Using optical or HDMI cables
    - Optical cables can be used for data transfer
      - HDMI still distributes clock and synchronization signals
  - Data output through one Master-FEB/D
- Connection length between FEB/A and FEB/D can be up to 3 m (tested by PETsys)



# Super Module I/O



# LED calibration system

- Two possible approaches:
  - Every module can be has own LED controll independent of others
  - Alls LEDs are controlled over one line, not individually
    - Potentially controll every second tile
- Cost of approach one:
  - Doubles the necessary connection lines in the Railboard as every LED needs its own line
- Cost of approach two:
  - Single tiles can not be triggered separately



# Possible LED

- What is important?
  - SMT/SMD
  - Blue light
  - Thin enough to fit between Sensor board and scintillator

**OSRAM CHIPLED 0603 SMD LED 2,85 V blau, 0,17 LM rechteckige Linse, 2-Pin**

RS Best.-Nr. 697-3610  
 Hersteller OSRAM Opto Semiconductors  
 Herst. Teile-Nr. LB Q39G-N1P1-35-1






Abbildung stellvertretend für Produktreihe

**Informationen zur Produktgruppe**

**OSRAM-LEDs der Serie CHIPLED 0603**

Die OSRAM-Serie CHIPLED 0603 von Osram Opto Semiconductors ist Teil der CHIPLED-Familie. Die CHIPLED 0603 hat die kompakten Abmessungen des Standards 0402. Die CHIPLED 0603 ist ideal für Anwendungen, die keine Hochleistungs-LED erfordern, und kann für verschiedene Anwendungen verwendet werden. Diese Anwendungen umfassen Tasten-/LCD-Hintergrundbeleuchtung, Löscherät-Arrays, Anzeigen mit engem Abstand oder Anzeigeleuchten für externe Modems.

Merkmale der LEDs der Serie CHIPLED 0603:  
 Abmessungen: 1,6 x 0,8 mm  
 Gehäuse nach Industriestandard 0603  
 Flache Pakete (0,3 mm) verfügbar  
 Auswahl von Farben

**€ 0,134**  
 Preis pro 1 Stück (in Packung zu 10)

Stück	Pro Stück	Pro Packung*
10 - 40	€ 0,134	€ 1,34
50 +	€ 0,12	€ 1,20

Menge  Stück

Verfügbarkeit prüfen


\*Bitte VPE beachten

Verpackungsoptionen:  Standardverpackung  Produktionsverpackung

**Datenblätter und Anleitungen**

- RoHS Status: kompatibel (Erklärung anzeigen)
- Datasheet
- LED Designation System
- Build or Request PCB Symbol & Footprint

**Zubehör**

 RS Pro Löldrath kolophoniumhaltig Sn96,5 Ag3 Cu0,5, Ø 0,7mm, Schmelzpunkt +217 → +219°C, 250g  
**€ 30,78**  
 Schnellansicht

**280 Lieferbar am folgenden Werktag (Mo-Fr) bei Bestelleingang werktags bis 19 Uhr.**

**130 weitere lieferbar am folgenden Werktag (Mo-Fr) bei Bestelleingang werktags bis 19 Uhr.**

# Temperature Sensor

## Best solution ignoring cost:

- Using 1-Wire® (one ground and one signal line) + passive power supply
- 64 bit EEPROM addressing
- DS18B20Z+/U+
  - Accuracy: +/- 2°C
  - 2.51 € per sensor
  - In SOIC-8 (5x4mm) or MSOP-8 (3.1<sup>2</sup>) Case
- DS18S20Z (not recommended by maxim integrated <https://www.maximintegrated.com/en/app-notes/index.mvp/id/4377>)
  - Accuracy: +/- 0.5°C
  - 2.90 € per sensor
  - In SOIC-8 Case

**Mouser Part No:** 700-DS18B20U  
**Manufacturer Part No:** DS18B20U+  
**Manufacturer:** Maxim Integrated  
**Description:** Board Mount Temperature Sensors Prgmble Resolution 1-Wire Parasite Pwr

Learn more about Maxim Integrated DS18B20U+  
[DS18B20U+ Datasheet](#)

Images are for reference only  
 See Product Specifications

Specifications	Alternative Packaging	Features	Documents (2)	My Notes
<b>Product Category:</b>	Board Mount Temperature Sensors			<input checked="" type="checkbox"/>
<b>Manufacturer:</b>	Maxim Integrated			<input type="checkbox"/>
<b>RoHS:</b>	<a href="#">Details</a>			<input type="checkbox"/>
<b>Output Type:</b>	Digital			<input type="checkbox"/>
<b>Configuration:</b>	Local			<input type="checkbox"/>
<b>Accuracy:</b>	+/- 2 C			<input type="checkbox"/>
<b>Maximum Operating Temperature:</b>	+ 125 C			<input type="checkbox"/>
<b>Minimum Operating Temperature:</b>	- 55 C			<input type="checkbox"/>
<b>Interface Type:</b>	1-Wire			<input type="checkbox"/>
<b>Resolution:</b>	12 bit			<input type="checkbox"/>
<b>Supply Voltage - Max:</b>	5.5 VDC			<input type="checkbox"/>
<b>Supply Voltage - Min:</b>	3 VDC			<input type="checkbox"/>
<b>Shutdown:</b>	No Shutdown			<input type="checkbox"/>
<b>Temperature Threshold:</b>	Programmable			<input type="checkbox"/>
<b>Mounting Style:</b>	SMD/SMT			<input type="checkbox"/>
<b>Package/Case:</b>	MSOP-8			<input type="checkbox"/>
<b>Product:</b>	Sensor			<input type="checkbox"/>
<b>Packaging:</b>	Tube			<input type="checkbox"/>
<b>Brand:</b>	Maxim Integrated			<input type="checkbox"/>
<b>Operating Supply Current:</b>	1.5 mA			<input type="checkbox"/>
<b>Series:</b>	<a href="#">DS18B20</a>			<input type="checkbox"/>
<b>Factory Pack Quantity:</b>	50			<input type="checkbox"/>
<b>Part # Aliases:</b>	90-18B20+U00			<input type="checkbox"/>

**Real Time Availability**

**Stock:** 9.270 Can Dispatch Immediately

**On Order:** 0

**Factory Lead Time:** 9 Weeks

**Enter Quantity:**

Minimum: 1 Multiples: 1

**Pricing (EUR)**

1: € 2,51

To add to a project, please Log In.

U+: <http://www.mouser.at/ProductDetail/Maxim-Integrated/DS18B20U+/?qs=sGAEpiMZZMusbZ2pNxAMx1kxvzJ5QdJzjtSgPeFhoSI%3d>

Z+: <http://www.mouser.at/ProductDetail/Maxim-Integrated/DS18B20Z+/?qs=sGAEpiMZZMucentShoSnu2ltHlyJVLbxDHdUM%2blgs%3d>

S: <http://www.mouser.at/ProductDetail/Maxim-Integrated/DS18S20Z+/?qs=sGAEpiMZZMucentShoSnu2ltHlyJVLbxDHdUM%2blgs%3d>

Sebastian Zimmermann, GSI, 8.6.2017

# Temperature Sensor

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- 64 bit EEPROM addressing
- DS18B20Z+/U+
  - Accuracy: +/- 2°C
  - 2.51 € per sensor
  - In SOIC-8 (5x4mm) or MSOP-8 (3.1<sup>2</sup>) Case
- DS18S20Z (not recommended by maxim integrated <https://www.maximintegrated.com/en/app-notes/index.mvp/id/4377>)
  - Accuracy: +/- 0.5°C
  - 2.90 € per sensor
  - In SOIC-8 Case

**Mouser Part No:** 700-DS18B20U  
**Manufacturer Part No:** DS18B20U+  
**Manufacturer:** Maxim Integrated  
**Description:** Board Mount Temperature Sensors Prgmble Resolution 1-Wire Parasite Pwr

[Learn more about Maxim Integrated DS18B20U+](#)  
[DS18B20U+ Datasheet](#)

Images are for reference only  
 See Product Specifications

**Specifications** | Alternative Packaging | Features | Documents (2) | My Notes

<b>Product Category:</b>	Board Mount Temperature Sensors	<input checked="" type="checkbox"/>
<b>Manufacturer:</b>	Maxim Integrated	<input type="checkbox"/>
<b>RoHS:</b>	<a href="#">Details</a>	<input type="checkbox"/>
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<b>Temperature Threshold:</b>	Programmable	<input type="checkbox"/>
<b>Mounting Style:</b>	SMD/SMT	<input type="checkbox"/>
<b>Package/Case:</b>	MSOP-8	<input type="checkbox"/>
<b>Product:</b>	Sensor	<input type="checkbox"/>
<b>Packaging:</b>	Tube	<input type="checkbox"/>
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<b>Operating Supply Current:</b>	1.5 mA	<input type="checkbox"/>
<b>Series:</b>	<a href="#">DS18B20</a>	<input type="checkbox"/>
<b>Factory Pack Quantity:</b>	50	<input type="checkbox"/>
<b>Part # Aliases:</b>	90-18B20+U00	<input type="checkbox"/>

**Real Time Availability**

**Stock:** 9.270 Can Dispatch Immediately

**On Order:** 0

**Factory Lead Time:** 9 Weeks

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**Enter Quantity:**

Minimum: 1 Multiples: 1

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**Pricing (EUR)**

1: € 2,51

To add to a project, please Log In.

U+: <http://www.mouser.at/ProductDetail/Maxim-Integrated/DS18B20U+/?qs=sGAEpiMZZMusbZ2pNxAMx1kxvzJ5QdJzjtSgPeFhoSI%3d>  
 Z+: <http://www.mouser.at/ProductDetail/Maxim-Integrated/DS18B20Z+/?qs=sGAEpiMZZMucentShoSnu2ltHlyJVLbxDHdUM%2blgs%3d>  
 S : <http://www.mouser.at/ProductDetail/Maxim-Integrated/DS18S20Z+/?qs=sGAEpiMZZMucentShoSnu2ltHlyJVLbxDHdUM%2blgs%3d>

Panda Collaboration Meeting  
 Sebastian Zimmermann, GSI, 8.6.2017

# Other options

- I wire compatible
  - Not sure if possible to run with parasitic power  
→ 3 connection (GND, Signal, supply)
- Multidrop of up to 8 (not enough)

**Mouser Part No:** 700-MAX6575LZUTT  
**Manufacturer Part No:** MAX6575LZUT+T  
**Manufacturer:** Maxim Integrated  
**Description:** Board Mount Temperature Sensors Temperature Sensor w/Multidrop Int

**Real Time Availability**  
**Stock:** 4.451 Can Dispatch Immediately  
**On Order:** 0  
**Factory Lead Time:** 6 Weeks

**Enter Quantity:**  
  Minimum: 1  
 Multiples: 1

**Pricing (EUR)**

Quantity	Price (EUR)
1	€ 1,84
10	€ 1,74
25	€ 1,39
50	€ 1,32
100	€ 1,22
250	€ 1,15
500	€ 1,11

**Specifications**


Specification	Value
Product Category:	Board Mount Temperature Sensors
Manufacturer:	Maxim Integrated
RoHS:	RoHS Details
Output Type:	Digital
Accuracy:	+/- 0.8 C
Maximum Operating Temperature:	+ 125 C
Minimum Operating Temperature:	- 40 C
Interface Type:	1-Wire
Supply Voltage - Max:	5.5 VDC
Supply Voltage - Min:	2.7 VDC
Mounting Style:	SMD/SMT
Package/Case:	SOT-23-6
Product:	Temperature Sensor
Packaging:	Reel
Brand:	Maxim Integrated
Operating Supply Current:	150 uA
Output Current:	20 mA
Series:	MAX6575L
Factory Pack Quantity:	2500
Part # Aliases:	MAX6575

**Full Reel and Broken Reel Options**

- Reel and Cut Tape
- Reel and MouseReel™  
 Reel Service Fee € 5,50  
 MouseReel™ price is calculated in the basket. All MouseReel™ orders are non-returnable.

<http://www.mouser.at/ProductDetail/Maxim-Integrated/MAX6575LZUT+T/?qs=sGAEpiMZZMucentlShoSnu2ltHlyJVLbF7teo2UTsAo%3d>

- 1-wire
- Daisy chain 32 sensors
- No passive power



**Mouser Part No:** 595-TMP107BIDR  
**Manufacturer Part No:** TMP107BIDR  
**Manufacturer:** Texas Instruments  
**Description:** Board Mount Temperature Sensors 70.4°C Temperature Sensor with Daisy-Chain UART, EEPROM, and Alert Function 8-SOIC -55 to 125  
**Lifecycle:** New Product: New from this manufacturer.  
[TMP107BIDR Datasheet](#)

Images are for reference only  
See Product Specifications

[Add to Compare List](#) [Share](#) [f](#) [G+](#) 0

**Real Time Availability**

**Stock:** 1 043 Can Dispatch Immediately  
**On Order:** 0  
**Factory Lead Time:** 8 Weeks

**Enter Quantity:**  
  Minimum: 1  
 Multiples: 1

**Select Packaging Option Below**

**Pricing (EUR)**

Cut Tape

1:	3,14 €
10:	2,82 €
25:	2,72 €
100:	2,31 €
250:	2,20 €
500:	1,97 €
1 000:	1,55 €

MouseReel™ Reel Service Fee 5,50 € Price will be calculated in basket.

Full Reels of 2500

To purchase full reel, order in multiples of 2500:

2 500: 1,55 €

**Full Reel and Broken Reel Options**

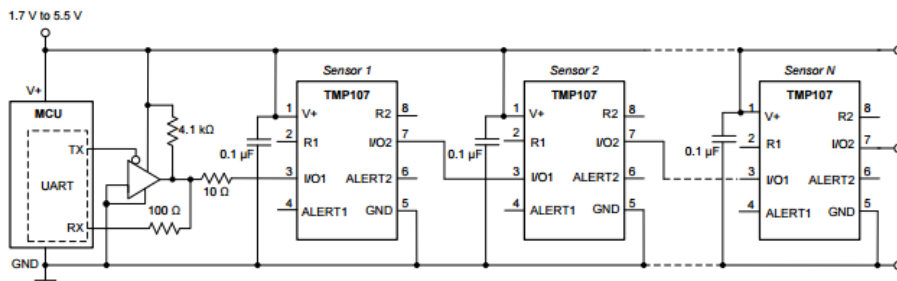
Reel and Cut Tape

Reel and MouseReel™  
 Reel Service Fee 5,50 €

MouseReel™ price is calculated in the basket. All MouseReel™ orders are non-returnable.

To add to a project, please [Log In](#).

Specifications	Alternative Packaging	Features	Documents (2)	My Notes
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<b>RoHS:</b>	Details			
<b>Output Type:</b>	Digital			<input type="checkbox"/>
<b>Configuration:</b>	Local			<input type="checkbox"/>
<b>Accuracy:</b>	0.4 C			<input type="checkbox"/>
<b>Maximum Operating Temperature:</b>	+ 125 C			<input type="checkbox"/>
<b>Minimum Operating Temperature:</b>	- 55 C			<input type="checkbox"/>
<b>Interface Type:</b>	1-Wire, UART			<input type="checkbox"/>
<b>Resolution:</b>	14 bit			<input type="checkbox"/>
<b>Supply Voltage - Max:</b>	5.5 VDC			<input type="checkbox"/>
<b>Supply Voltage - Min:</b>	1.7 VDC			<input type="checkbox"/>
<b>Shutdown:</b>	Shutdown			<input type="checkbox"/>
<b>Mounting Style:</b>	SMD/SMT			<input type="checkbox"/>
<b>Package/Case:</b>	SOIC-8			<input type="checkbox"/>
<b>Product:</b>	Digital Temperature Sensor			<input type="checkbox"/>
<b>Packaging:</b>	Reel			<input type="checkbox"/>
<b>Brand:</b>	Texas Instruments			
<b>Operating Supply Current:</b>	300 uA			
<b>Resistance:</b>	100 kOhms			
<b>Series:</b>	TMP107			
<b>Factory Pack Quantity:</b>	2500			



All figures shown as TMP107 represent TMP107-Q1 as well.

# Evaluation Kit for temp sensor

- Dallas Semiconductor  
DS1701K e-kit

– For readout of DS

<http://media.digikey.com/pdf/data%20sheets/dallas%20semiconductor%20pdfs/ds1701k.pdf>

temperature sensors such as  
DS18B20

## Features:

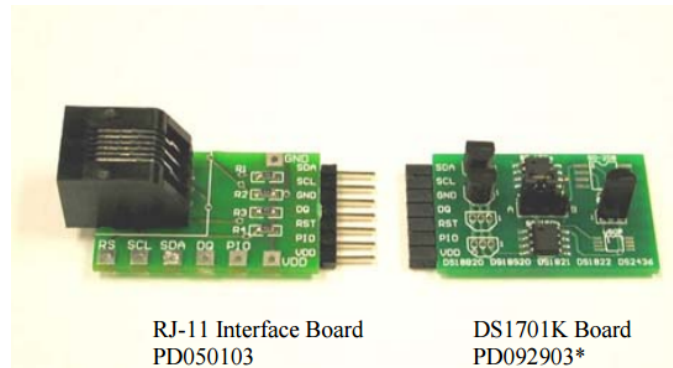
- Full-Featured Evaluation Kit for the DS1701K with Temperature Sensor reading.
- Compatible with *Windows™ 95*, *Windows™ 98*, and *Windows™ NT* Operating Systems.
- Complete read/write access to all registers within the DS1701K devices and temperature reading for the DS1820, DS18B20, DS18S20, DS1821 and DS1822 devices.
- Measures temperatures from the full range of the devices -55°C to +125°C. Fahrenheit equivalent is -67°F to +257°F.
- Celsius and Fahrenheit temperature readings.

## Kit Contents:

1. Programming Software CD ROM containing DS1701K.exe Installer.
2. 87-1701K-000 Demo board.
3. DS1701K Demo Kit documentation on CD ROM.
4. DS1820, DS18B20, DS18S20, DS1821 and the DS1822 Demo Devices.
5. DS9123 *Universal Brick™* serial port device and cable.

*To use the kit, you will also need:*

1. An available Serial Port to connect the DS9123 *Universal Brick™* modular data cable.
2. A +3 to +5 volt regulated power supply with banana jack leads.



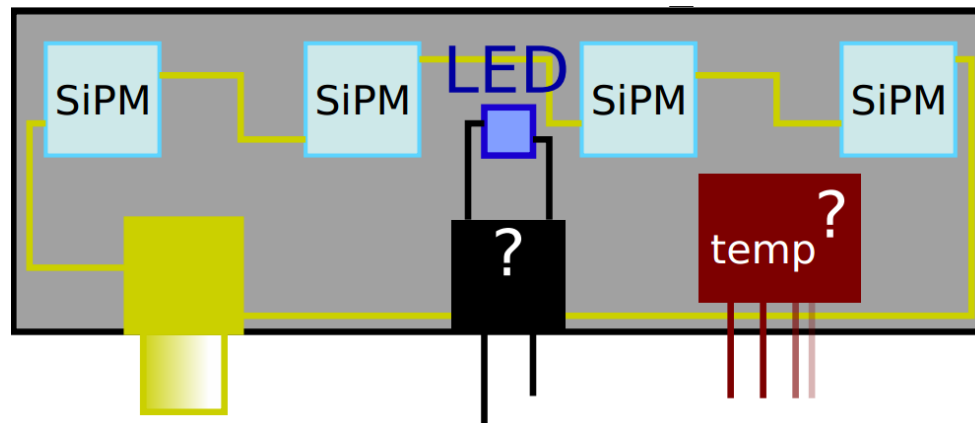
RJ-11 Interface Board  
PD050103

DS1701K Board  
PD092903\*

Sebastian Zimmermann, GSI, 8.6.2017

# Sensor Board

- The sensor board should host the
  - SiPMs
  - Connection circuit
  - LED
  - LED illumination circuit?
  - Temperature sensor?
- Every separate circuit needs to be connected to the railboard
  - New connector for everyone?
  - Coax necessary for SiPM signal



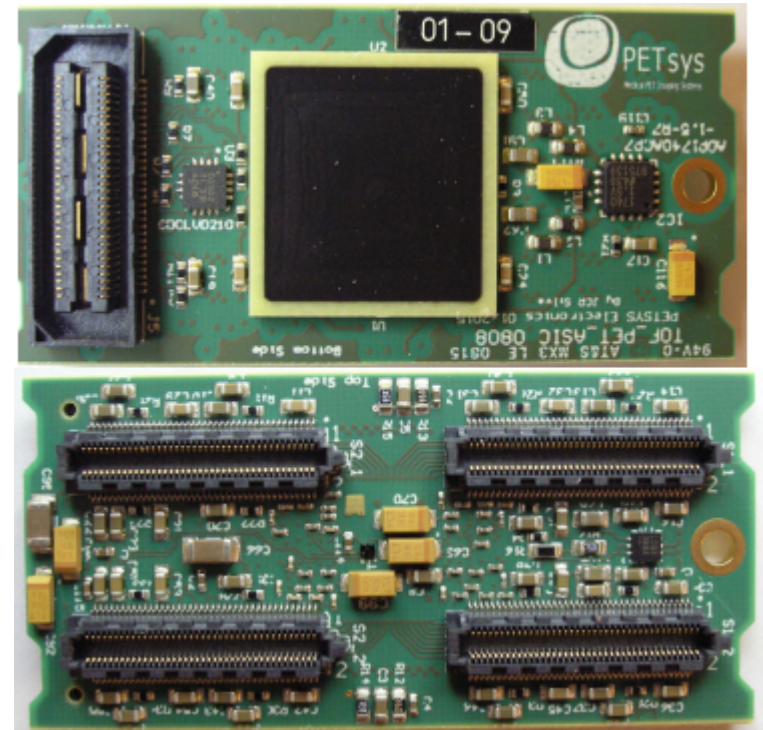
# TOFPET ASICv2

- Order placed for one FEB/Dv2 board (5376 €) + upgrade of existing e-kit (two TOFPET ASICv2) (2496 €)
- DAQ (16 k€) board not a necessity. It increases data transmission
  - Alternative is Ethernet readout limited to 1Gbit/s
    - Event has 66 bit + little overhead
    - max rate for FEB/D with 8 FEB/A:      15 kcps (k counts per second) /ch
      - For 2 ASICS                              60 kcps/ch
    - With DAQ board:                              75 kcps/ch
  - Ordering DAQ board later is possible
    - New mezzanine will however be necessary: ~1.500 € extra
- New board development can be done by us or them
  - If they do it we need to pay development cost
  - If we do it probably good idea to have consultant contract



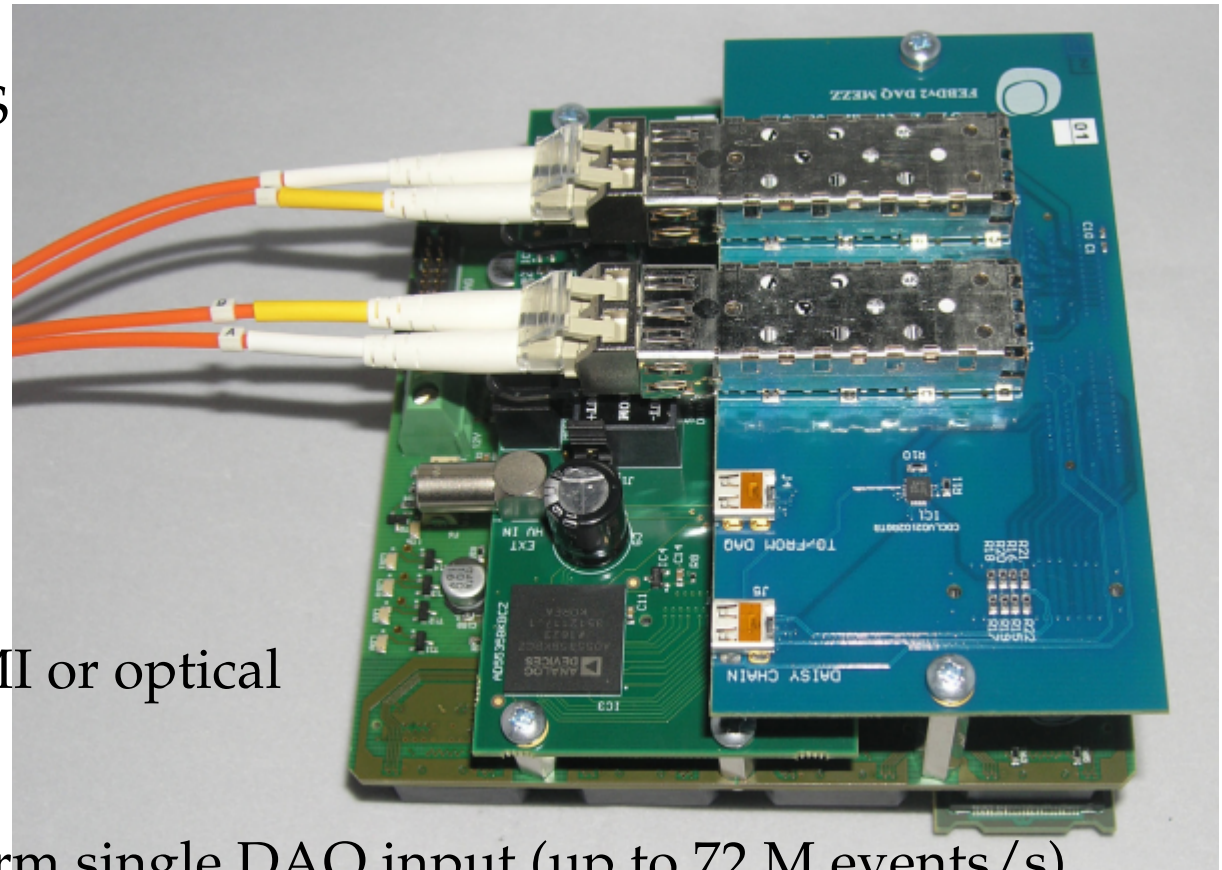
# FEB/A

- Houses two TOFPET ASICS
  - Readout of 128 channels
- 52.0 x 25.4 mm<sup>2</sup>
- Onboard temperature sensor
- Input connector:  
Samtec SS4-40-1.00-L-D-P-TR
- Connector to FEB/D:
  - CLK\_IN: Nominal operation mode uses a 160 MHz clock
  - SPI interface: 10 MHz configuration interface writes and reads the configuration
  - SYNC\_RST: dual purpose reset (full and partial reset)
  - BIAS V: 8 bias voltages lines
  - TX\_OUT (0-3): 2 LVDS data links
  - TEMP: temperature sensor
  - Supply voltages: 1.5 V (analog), 1.2 V (digital), 2.5 V (I/O).



# FEB/D Board

- Kintex 7 FPGA
- Handles 16 TOFPET ASICS
  - 8 FEB/A boards
  - Connect board to board or flexible flat cable
- Receives configuration, clock & sync signals from DAQ board
- Connects to DAQ via HDMI or optical
- 104.5x104.5 mm<sup>2</sup>
- Can be daisy-chained to form single DAQ input (up to 72 M events/s)
- Supplies bias voltage to SiPMs
  - 64 bias voltages, 5 - 100 V



# Outlook

- Understand TOFPET behaviour and controll
- Setup readout with TOFPET ASICv2
- Design LED calibration system
- Test new Railboard design
  - Attenuation
  - Crosstalk

Thank you for your attention