

ARC Status & Microdischarge Studies

**Module Test Meeting
CMS Week
16th March 2004**

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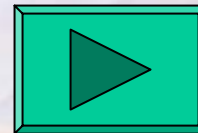
III. Physikalisches Institut B

RWTH Aachen

1. Status of **ARCS 7.1**
2. TEC Module 30200020015009
from TEC Ring 6 Pilot Run
Microdischarge Studies

Changes in ARCS 7.1:

1. Environment Settings are filled also when Fast Test is done first
2. All APV Modes are used to flag bad channel
3. Backplane Pulse Test implemented
 - See Talk last Tracker Week
4. Pipeline Gain Test
 - See Talk last Tracker Week
5. Changes in testsettings.xml
6. Changes in DB Parser





Microdischarge Studies

Short Retrospect



Last Tracker Week:

Lot of discussions on Sensors with high Leakage Current and Modules with CMN Problems

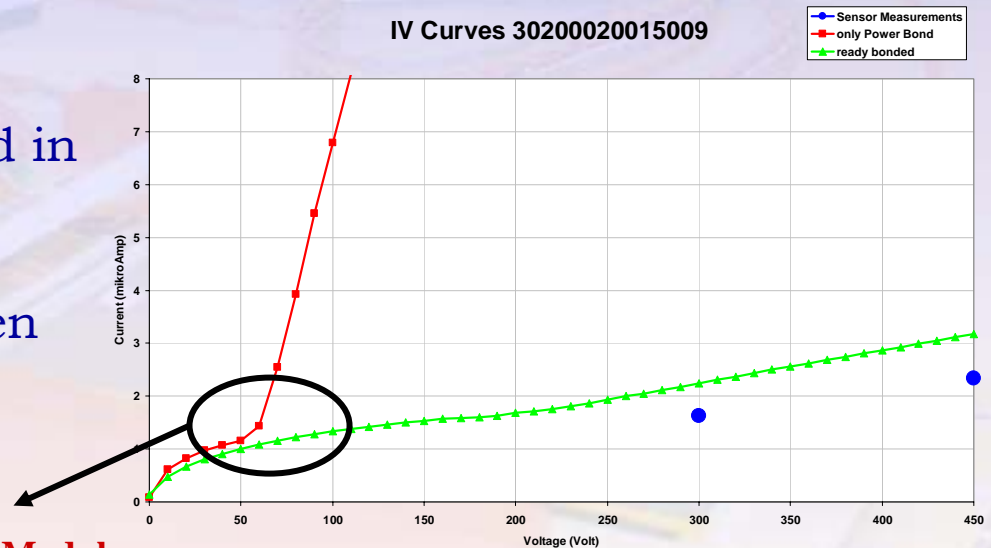
- Bad Treatment of Sensors is often reason for high Leakage Current
- High percentage of Modules built with Sensors showing higher Leakage Current in Reprobing Campaign suffered CMN Problems
- Even good and very good sensors of grade A/A+ develop Microdischarge Effect at a Rate of 5%
- Some Microdischarge Modules became even worse after some Time
- Even at low Relative Humidity (15-30%) the Leakage Current of some Modules rised until a certain level was reached
- Time Constant of this Effect reached from hours till days

TEC Community also had one Module showing Microdischarge Effect:

- In October 10 Ring 6 Modules were assembled in Brussels during TEC Pilot Run
- Modules arrived in Aachen on 15th October to be bonded and tested
 - One of the modules showed a much higher Leakage Current after Bias Bonding compared to Sensor QTC Data but seemed to have recovered after Strip Bonding

- Since then Module was used in Petal Integration Teststand in Lyon

Benjamin sent Module to Aachen to allow further investigations



Strong 2nd Kink is Indicator for high CMN Module

Questions:

Is the module mechanically damaged?

- Did bad Treatment cause the Effect or is it a feature of Sensor?

At which voltage does the Effect turn on?

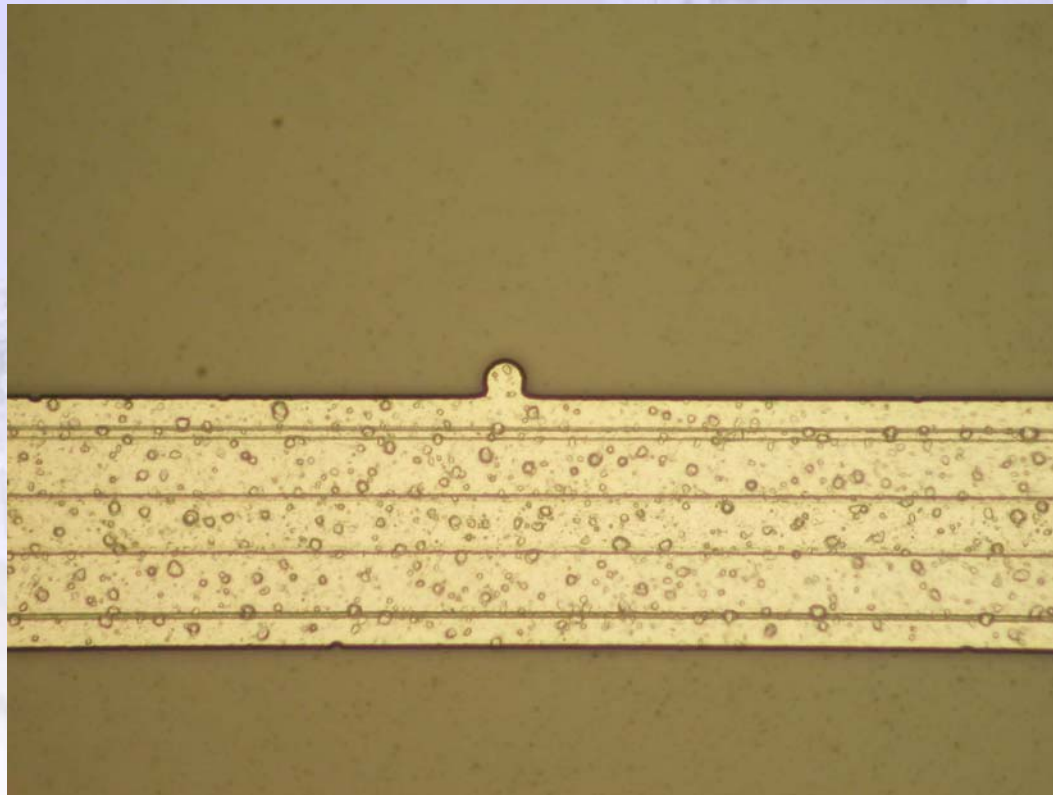
Is the module stable during operation?

- How does the leakage current evolve in time?

How does the module work in CMS Tracker environment?

Mechanical Damage:

Inspected the Module under Microscope but could not spot any damage apart from small Metal Overhang



At which Voltage does the Effect turn on?

First Measurements done at Room Temperature

Interesting:

- The turn on voltage changes with time
 - Could be a charge up or discharge Effect?
 - Or Temperature Effect?
- Strong change in Leakage Current is seen
 - If one ramps up to 450V in one go a current of few times $10\mu\text{A}$ is reached, but after some time drops down to $3,4\mu\text{A}$
- At low Leakage Current Effect is gone



If you wait long enough:

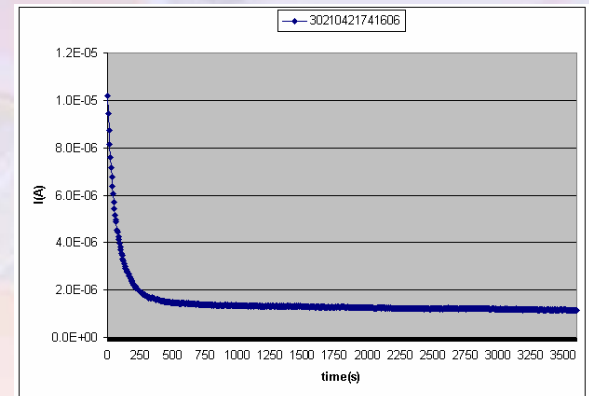
A very bad module becomes accepted without any problems

How long does it take until the Module recovers?

(It is not stable during operation at room temperature!)

- Did not touch the Module for one day
- Redid Measurement not exceeding $10\mu\text{A}$
Leakage Current (“DEPP Range 1“):
 - Microdischarge Effect vanished after roughly 60min

In agreement with Guido Tonellis
Observations presented last Tracker week:
“Surprisingly 9/11 ‘rejected’ sensors reach an asymptotic current value inside specs : became ‘accepted’ but with longer time constant”



From Guidos Talk

How does the Module work in CMS Environment?

- The relative Humidity stayed below 30% during the whole time
 - Put the Module in our Cold Box and cooled down to -25°C (Temperature of cooling liquid)
 - Ramped up to 450V and Monitored Leakage Current
 - Microdischarge Effect startet at about 80V
 - Effect did not vanish after one hour
 - Leakage Current increased within 4 hours from $42\mu\text{A}$ to $100\mu\text{A}$ (current limit)! Later Voltage steadily drops down to 308V after 15.5h
 - Redid test @150V and Monitored Leakage Current
 - Leakage Current started @ $24\mu\text{A}$
 - After 21h dropped down to $19\mu\text{A}$
- ➔ Module can not be operated stable @450V but perhaps at 150V
Measurements are very time consuming

Other Observations:

- Microdischarge Effect is strongly correlated with increase in Leakage Current – 2nd kink
- Module did not show worse Behaviour compared to October
 - No additional leaky Strips
- Turn on Voltage at 10°C is 85V
 - Depletion Voltage of Sensors >185V @22°C

Summary:

TEC Ring 6 Module was tested at room Temperature and at low Temperature

- No mechanical Damage found on leaky Strip
 - Same observation was made by US
- TEC Ring 6 Module shows strong Dependency between Leakage Current and Time at Room Temperature
 - Consistent with reports last Tracker Week from Italian Group
 - Microdischarge Effect is not stable at Room Temperature
- In CMS Environment
 - Increase of Leakage Current @-25°C
 - Never switch off the Tracker
 - Slow decrease of Leakage Current @-10°C
 - Module may recover after some time
- Microdischarge Effect is strongly correlated with increase in Leakage Current – 2nd kink
 - Reported from US Group last Tracker Week

Conclusions:

- The only conclusion is that we have to be careful when doing tests
 - The unstable behaviour of a module on longer timescales can cause faults to be easily undetected
 - Longterm Scenarios with a duration of a few weeks are worth to be done
 - Tests done at conditions of the CMS Tracker environment are very important to assure that modules can be used in detector
 - More Tests have to be done to understand Microdischarge Effect and it's implications
 - Influence of Humidity
 - Effects on APV

Added <TestObjectProperties>

Extract:

```
<TestObjectProperties name="IB_1"
  NumberOfAPVs="6"    NumberOfSensors="1"
  channelOrder="normal" Type="Module" />
<TestObjectProperties name="OB_2"
  NumberOfAPVs="4"    NumberOfSensors="2"
  channelOrder="normal" Type="Module" />
<TestObjectProperties name="W1_TEC"
  NumberOfAPVs="6"    NumberOfSensors="1"
  channelOrder="reverse" Type="Module" />
<TestObjectProperties name="W2_TEC"
  NumberOfAPVs="6"    NumberOfSensors="1"
  channelOrder="reverse" Type="Module" />
<TestObjectProperties name="W7_TEC"
  NumberOfAPVs="4"    NumberOfSensors="2"
  channelOrder="normal" Type="Module" />
<TestObjectProperties name="W1_TID"
  NumberOfAPVs="6"    NumberOfSensors="1"
  channelOrder="reverse" Type="Module" />
```

- The Tag indicates Properties of the Test Object
- Very useful for Fast Test
 - Number of Sensors for DCU Test
 - Number of I2C Devices
- Allows to adjust Output of bad Channel
 - Great help for Bonding Technicians
 - No Changes for Root File

Almost all Tags are filled in XML File:

Channel Flagging:

<chflag> filled correctly with #channel #flag

Ileak in nA

Ipinhole in nA

.....

Still not filled:

Status Flags:

to fill these correctly some
tests still have to be implemented

New Version will be released this week if download to
DB works ok!

