The TEC Cable Problem - Status and Plans

*Tracker QA Meeting, August 8\textsuperscript{th}, 2006*

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Outline

- General status of TEC+ and TEC−
- The TEC cable problem
- Technical solution
- Status
- Further planning and schedule implications
TEC Integration Status

TEC+:  
- 6 ½ sectors inserted  
- 4 sectors tested  
- 3 sectors qualified (except for cable repair)  
- cables of 1 sector repaired

TEC−:  
- 4 sectors inserted  
- 2 sectors tested  
- cables of 0 sectors repaired
During the test of sector 7 (4\textsuperscript{th} sector tested), unreliabilities observed in LV connections (~ beginning of July)

Symptom: very low or very high noise on one power group

Module 1 - 5

Ring 3 - 7

LV group 2 - bad

LV group 3 - ok
The TEC Cable Problem

- In total, problem seen on ~ 11 power groups
- Problem can be removed (temporarily) by:
  - unplugging and replugging the Molex connector
  - wiggling at the cable near the Molex connector
- Finally traced back to **bad crimp contacts** (July, 6th)

- Many connectors opened and visually inspected
  - only few cases with insulation below complete crimp contact
  - but many “non-standard” crimp contacts
  - only wires with thin diameter affected (AWG28 and AWG30)
The TEC Cable Problem

ANATOMY OF A TERMINAL

Illustration A.
The TEC Cable Problem

Wire Inserted Too Far

Wire Conductor Extends Into Transition Section of Terminal and Insulation is Into Crimp Section

Wire Protrudes Out of Crimp Section by One Wire Diameter Min. and Both Insulation and Conductor Are Visible.

Solution: Strip Length Too Long or Wire Inserted Too Far Into Crimp Section Before Crimping. Check Wire Stop Location on Press.

Figure VII

Katja Klein

TEC cable problem
The TEC Cable Problem

• Company (Adapt) immediately contacted

• Visit from two Adapt people to inspect problem (July, 11\textsuperscript{th})

• Adapt admits mistake:
  - insulation removed automatically with “stripper-crimper”
  - machine cannot handle insulation material (teflon) for thin wires properly, insulation process and location of conductor crimp with respect to insulation basically undefined
  - no optical control
  - cables passed all electrical tests (not completely understood)

• Company declares whole production as unreliable
Technical Solution

Several options for repair discussed and tested with Adapt (July 21st):

- Removal of cables from TEC → only possible if petals are disassembled → no option
- Inspect optically all wires, repair only bad ones → no reliable criteria without removing complete shrinkage tube
- Cut connector and crimp new contact directly onto cable → too difficult in-situ
- **Produce pig-tails with crimps at Adapt and**
  - solder them to MS cables using a tin bath → solid technology, but handling difficult and risky
  - crimp them to MS cables with a splice crimp → ok if crimp is not too bulky
Technical Solution

Decision to repair ALL connectors (LV, HV, control) in following way:

- Pigtauls as delivered by Adapt: stripped, crimped and inserted into connector

- Crimps of type Tyco D-609-03

- Cables after Y-type crimping

- Repaired cables with shrinkage tube
Status

• On August 4th, three people from Adapt repaired sector 7

• Good experience with solution chosen

• Time needed to crimp & add shrinkage tube:
  - 1 connector: 20 minutes
  - 1 complete sector: 11 hours for 3 people

• With stripping: 2 days per sector

• Estimate for electrical test: half a day

⇒ Repair of one sector: 2-3 days
Quality Assurance & Control

- Usage of thick wires only (AWG24 = 0.25mm²)
- Optical inspection with digital camera by Adapt
- Electrical test of cables with Horizon 1500 wiring analyzer
  - tests connectivity, shorts and resistance
  - learns connections from good prototype cable
  - measures resistance with $\delta R = 2.5\% \pm 20\text{m}\Omega$ and compares with a programmed value
Plan for TEC+:

W32:  - electrical and mechanical tests of repaired cables
       - readout test of sector 7
       ⇒ qualification of technology

W33:  repair of two sectors (petals already inserted)

W34/35: readout test of these two sectors

W36:   petal insertion for last two sectors

W37/38: repair of remaining 5 sectors

W39/40: readout test of last two sectors

Readout test of 3 already qualified sectors at CERN (!)

Plan for TEC−:

W37 → ?: repair of all cables

Boundary conditions:
- currently, crimps for only one more sector in hands
- crimps for one additional sector expected this week
- delivery date for remaining 25000 crimps: 6th of September
TEC+ Integration Schedule

• TEC+ integration completed: October, 17th
• TEC+ arrival at CERN: October, 24th
• Cold test of full TEC: 28 days
• TEC+ ready for insertion into tracker support tube: December, 26th
• Tracker ready for TEC+ insertion: December, 19th
  (Jeff Spalding, July tracker days):

⇒ On paper, 1 month delay due to cable problem
Summary

- Serious problem observed on both TECs: flaky contacts in cables
- Technical solution has been identified and tested, still to be qualified
- Company is very cooperative: takes over all costs and will send 1-2 people for repair work both in Aachen and at CERN
- TEC+ schedule slips by about 1 month: TEC+ at CERN end of October