HEC Report

LHCC Referees Meeting 24.1.2000
HEC General Meeting 22.2.2000

- HEC Activities 1999/2000
- Radiation Hardness GaAs Chips
- Electronics Production
- Module Production

Horst Oberlack
MPI für Physik, München

HEC Activities 1999 (as projected in Jan.1999)

- Start series production of modules — Done
  Assembly of modules in 4 places — 3 Places
  (Dubna, Munich, Protvino, TRIUMF)
  1 module takes six weeks
- Finalize analysis of 1998 testbeam data — Done
- Write NIM papers (testbeam, electronics) — Progress
- Testbeam 1999 (June, August)
  - Upgrade #modules from 4 to 6 — Done
  - Install preshaper / shaper system towards final version — Done
  - Upgrade DAQ system towards ROD — Progress
  - Testbeam with first load of series modules — Done
- Start cold test of series modules — No (EST!)
- Finalize wheel assembly and insertion system — Progress
- Financial commitment for 2nd rear wheel by Canada
- INTAS proposal for measurement of joint performance of EMEC and HEC accepted

HEC Activities 2000

- Restart EST board productio n
- Restart series production of modules
  Assembly of modules in 4 places
  (Dubna, Munich, Protvino, TRIUMF)
  1 module takes four weeks
- Start cold test of series modules
- Testbeam with first loads of series modules
- Finalize wheel assembly and insertion system

- Warm electronics:
  - Preshaper: Review and prototyping
  - Trigger summing: Review and prototyping

- Joint performance of EMEC and HEC:
  - Prepare calorimeter set-up
  - Prepare joint electronics and DAQ system

EST Board Problem Overview

- 6 series modules (3 Front + 3 Rear) in testbeam 8/99. 120 gaps, 240 EST boards
- 5 HV problems observed during cold phase, all due to EST boards
- After warm up: All PAD boards ok,

  29 % 0f EST boards have HV problem

- Findings after disassembly of modules:
  - Tears at innermost and /or outermost tie rod holes, tears oriented towards outside
  - Partial penetration of HV guard zone
- Shrinkage w.r.t copper larger than foreseen in design (4.5 mm)

- Detailed investigation shows:
  - Two types of EST boards with shrinkage of 5.7 and 8.3 mm respectively
  - Shrinkage difference due to polyimid bought in Russia from two different companies. Companies different from module 0 ones.

EST Board Problem Solution

- Production of new sample EST boards at LPI (Dupont Kapton) and TRIUMF (GTS Kapton):

  ==> Shrinkage identical (4.7 mm)
- Procedere:
  - Improve layout of EST boards,

    more conservative etimate of tolerances
  - Apply punching rather than cutting technology
  - Restart EST production at LPI in January 2000, add TRIUMF production to make up for time lost.
  - Add to QC: Test of thermal shrinkage of boards at each production site.
  - Test boards from both sites in testbeam June 2000.
- Effect on schedule:
  - Delay of 6 months to finish modules for endcap C
  - Critical path:
    - Absorber production in Russia
    - Module assembly
    - Module cold test in HEC cryostat at CERN

Radiation Hardness of GaAs Chips Overview

- Expected radiation levels after 10 years of LHC operation at the hottest position of HEC amplifier boards: **neutrons 3 * 10^{13} n/cm^2 , photons 0.3 kGy**

- Previously irradiation facility and measuring set-up was developped at JINR Dubna utilizing the IBR-2 pulsed reactor
- Irradiation of GaAs chips of RD33 type and HEC prototypes showed
  - Irradiation with n up to 30 * 10^{13} n/cm^2 possible
  - Minor noise effects under photon irradiation up to 31 kGy
  - No dose rate dependence observed
  - Similar results for irradiation in cold or in warm
  - Similar results for irradiation with power on or off

- Result of PRR:
  - Use of GaAs preamplifiers probably uncritical from radiation point of view
  - Request for irradiation of larger statistics (20-30) of chips with final design

Radiation Hardness of GaAs Chips
Final Irradiation Measurements

- During 1999 irradiation of final chips:
  - 8 chips (64 preamps, 16 drivers) in cold, power on, high fluence with **110 * 10^{13} n/cm^2**
  - 8 chips in cold, power on, high dose rate with **55 kGy** (including 11 * 10^{13} n/cm^2)
  - 24 chips in warm, power off, low fluence with **90 * 10^{13} n/cm^2**

Radiation Hardness of GaAs Chips
Summary of Results

- Stable performance under neutron irradiation w.r.t. transfer function, rise time, linearity and noise
  up to **$50 * 10^{13}$ n/cm^2**

- No performance damage under Photon irradiation
  up to **55 kGy**

- Noise increases under irradiation both with neutrons and photons mixed with neutrons. Due to increase of parallel noise.
  - Effects observed with photons are compatible with interpretation as being due to underlying neutrons
  - Effects are small at the radiation levels expected for 10 years of LHC operation at the position of the amplifiers at the outer circumference of the HEC wheels of
    neutrons $3 * 10^{13}$ n/cm^2 , photons 0.3 kGy

Cold Electronics Status

- Signal cable harnesses in production in German industry (Front) and in electronics shop in IHEP Protvino (Rear).

  Finalized. 50 %
- HV harnesses as well as calibration and HV distribution boards in production in Kosice.

  Finalized. 30 %
- Amplifier electronics:
  - GaAs amplifier chips received: 100 %
  - Motherboards received: 100 %
  - Amplifier boards equipped: 30 %
  - QC tests see below
- Wheel cabling and interface to FT cabling being designed.