ITS Upgrade - WG4 Strip Upgrade

Outline

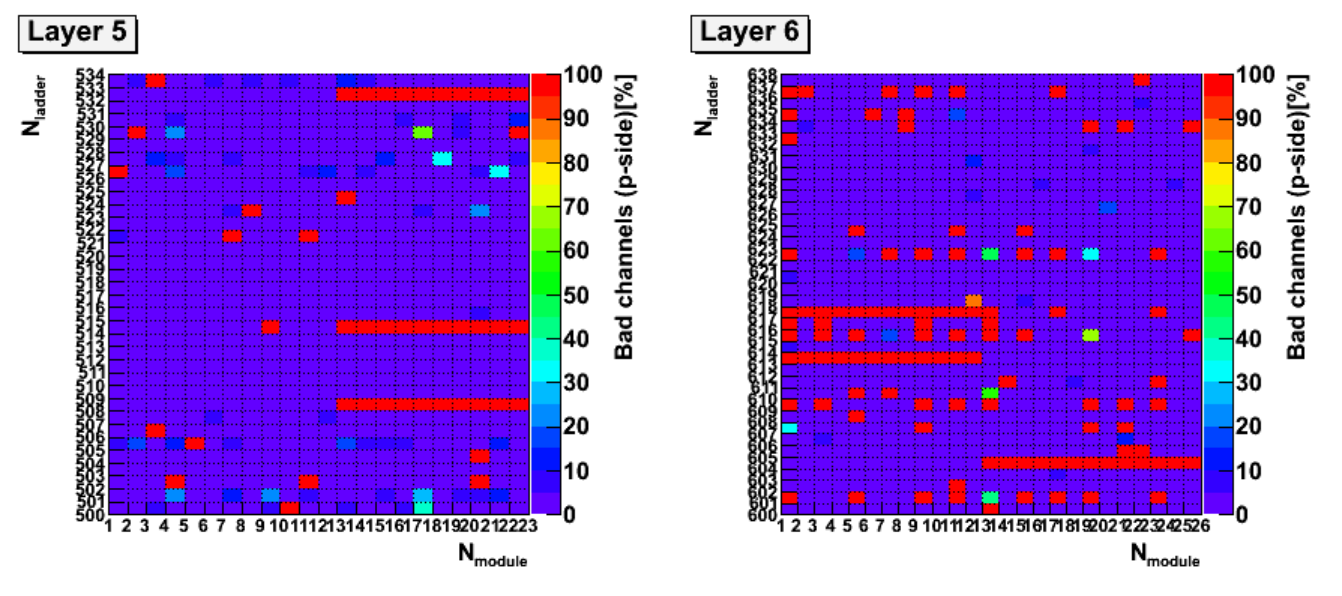
- The present SSD
  - General description
  - Status & Performance
  - Possible improvements
- The strip upgrade
  - Layout options
  - Services
  - Performance goals

The present SSD – *A starting point*

- The SSD detector
  - overall dimensions: L x d ~ 1m x 1m A = (2.2 + 2.8) m^2
    - Layer 5: radius = 38 cm ±z = 43.1 cm
    - Layer 6: radius = 43 cm ±z = 48.9 cm
  - acceptance coverage: $|\eta| < 0.9$
  - #ladders (PS/DCS/DataTransfer unit): 144 (68+76)
  - #modules (readout unit): 1698 (748+950)
  - #FEchips (FE config unit): ~20k (12 chips/module)
  - #channels (signal treatment unit): ~2.6 millions
- The sensor
  - layout: doublesided – 768 strip/side – 95 µm pitch – 35mrad stereo angle
  - sensor area ~ 0.0028 m^2
  - achieved spatial resolution: 20 µm (rphi) – 800 µm (z)
- The front-end chip and electronics
  - HAL25 mixed analogue digital ASIC designed; 0.25µ CMOS process
  - 128 channels with preamplifier, shaper, storage capacitor
  - ± 14 MIPs input dynamic range with good linearity
  - 1.4 – 2.2 µs adjustable peaking time
  - signal sampled by external Hold and read-out through analogue multiplexer
  - serialized samples are then AC decoupled to multplx/buffer and driven to ADC

SSD status in 2010

- **Overall efficiency** **~ 90.3%**
  - Active modules: 1557/1698 ~ 91.7%
  - Active channels in active modules: ~ 98.5%
  - Not operable half-ladders: 6/144
    - single channels off: high noise, zero gain
    - modules/ladders off: electrical/configuration problems



- **Very good stability in *Run 2010***
  - Max variation in active channels ~ 0.5%
  - Presence in Physics Runs ~ 100%
  - Good integration with central procedures
  - Crucial role in tracking and PID

Present SSD - *Possible improvements*

New possible requirements from the upgrade studies concerning:

- Acquisition rate
  - Limited at ~3700Hz at present, due to a total dead time = 265 μs
  - Sources of dead time:
    - 12x FEchip serial read-out time: ~ 160 μs +
    - endcap electronics ”calm down” time ~ 105 μs = 265 μs
- dE/dx capabilities
  - nominal FEchip dynamic range: +/- 14 MIPs within 5% linearity
  - confirmed by proton data analysis up to ~10 MIPs particles
  - studies ongoing for highly ionizing particles/light nuclei
  - possible asymmetric P/N charge collection (*under investigation*)
- Signal optimization
  - Intrinsic noise suppression: better control of env. conditions
  - Common Mode noise suppression:
    - better grounding of power lines
    - new algorithm implementation in the FEROM firmware

The strip upgrade - *Layout*

- Layout options (scenarios to be tuned according to the prompt WG2 outputs)
  - Replacement of present SDD with SSD-like modules
    - replace present **SDD Inner** layer: ~150 new modules
    - replace present **SDD Outer** layer: ~320 new modules
      - ~500 SSD modules: to be scaled with the rapidity coverage, radius, no. of layers
        - new sensor production
        - same FEchips (6000xHAL25) possibly available
        - new production of microcables, front-end electronics
        - new design for services and supports
  - Complete **re-design** of the detector to fit the new physics performance requirements and the new position of the detector (occupancy, radiation, …)
- Supports & Services (see WG5)
  - Integration with present SSD layers *(if kept)*
  - Integration with the rest of ITS upgrade
  - New cooling system, ...

The strip upgrade – *Performance goals*

- Performance goals (to be tuned according to WG1/2 outputs):
  - Acquisition **rate**: extend beyond 3700Hz *(up to ?)*
    - with present chip HAL25: different signal serialization
    - new endcap/bus
    - new chip
    - new read-out modules
  - **dE/dx**: extension of the dynamic range by redesign of electronics
  - Maximum **occupancy** handled: depending on radius, LHC beam energy
    - new sensor design decreasing strip pitch/lenght
    - new micro-connection design (pitch, geometrical tolerance)
    - new power consumption, cooling requirements
  - **Material budget**
  - **Radiation** tolerance of sensor and electronics

Summary

- The strip upgrade studies should move toward different scenarios following the first WR1/2 outputs
- The present SSD is a good starting point for first discussions and plans on
  - geometry layouts
  - required performance
  - possible improvements of the present components
- New solutions and designs should be investigated for
  - front-end chip
  - sensor
  - off-detector electronics
  - services