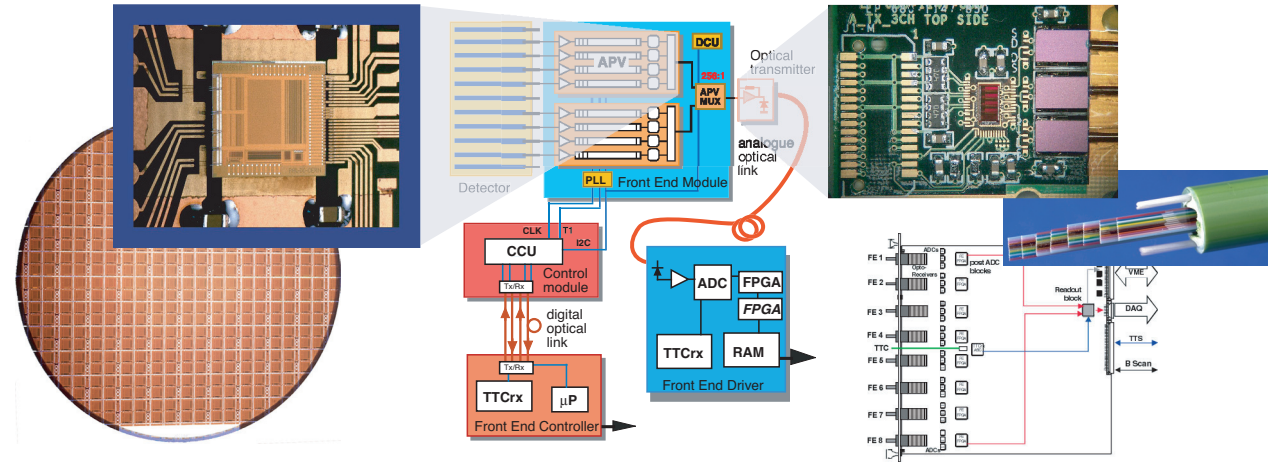
Tracker electronics

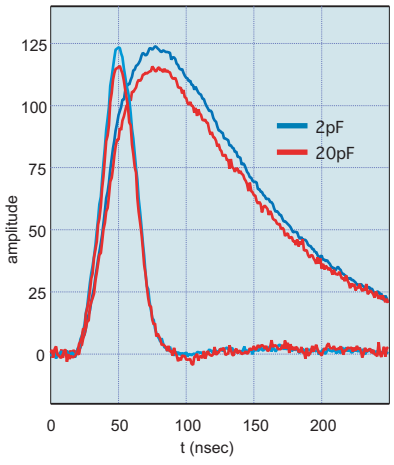


The system will provide analogue data from ~10 million channels of the microstrip tracker with minimal power and material. Electronic noise should be sufficiently low to ensure high efficiency and bunch crossing identification. Performance is ultimately limited by the speed and magnitude of detector signals and the radiation environment. Lifetime doses of 100kGy (10Mrad) and fluences of 2 x 10^{14} hadrons cm^{-2} are expected in the innermost layers

The target is an equivalent noise charge below 2000 electrons over the detector lifetime for front-end power consumption ~2mW/channel. Analogue data are preferred for good position resolution, from charge sharing between strips, and robustness, as common mode noise may be a challenge. The system minimises custom radiation hard electronics inside the tracker. Zero suppression of data outside the tracker allows possible upgrades through technology and cost evolution of commercial components

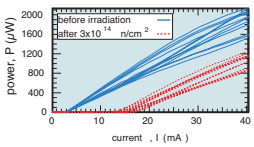
APV Front End circuit

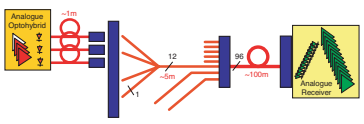
Each microstrip is read out by a charge sensitive amplifier whose output voltage is sampled at the LHC 40MHz rate. Samples are stored in an analogue pipeline for up to 4μs and, following a trigger, are processed by an analogue circuit using a weighted sum algorithm to measure signal amplitude and associate the bunch crossing with the hit. Pulse height data are multiplexed from pairs of front-end chips, sending differential signals over a short twisted pair cable to a laser where electrical signals are converted to infra-red pulses and transmitted over a 100m fibre optic cable to the counting room adjacent to the cavern

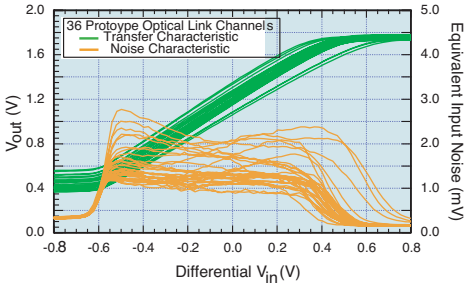


Optical link

The optical link employs edge-emitting semiconductor laser transmitters operating at the telecommunications wavelength of 1310 nm. The lasers are assembled with single mode fibre pigtails in a low mass package developed in collaboration with industry. All link components have been shown to be extremely radiation hard. A minimum current is required before laser action starts. Above threshold the light output power is extremely linear with drive current. After irradiation, an increase in threshold current is observed but the laser characteristic remains linear

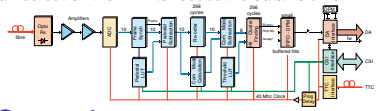






Front End Driver

Pulse height data are received by a photodiode-amplifier on the Front End Driver which digitises and processes the signals, including reordering and pedestal subtraction, and stores results in a local memory for the higher level data acquisition. In high luminosity conditions when CMS is operating at the maximum trigger rate, cluster finding will be carried out on the FED to reduce the data volume



Control system

The Front End Controller supervises control and monitoring of the front-end electronics and is the interface to the CMS Timing Trigger and Command system. Digital optical links, using the analogue link components, transmit triggers, clocks and control data. Internally, digital transitions are recovered by photodiode-amplifiers and distributed electrically by a Communication and Control Unit (CCU) to detector modules. Clocks are recovered by Phase Locked Loop (PLL) chips on each module for high reliability and minimum phase jitter. CCU modules can be configured as rings to match the tracker topology and reduce cost