LumiCal & BeamCal readout and DAQ for the Very Forward Region

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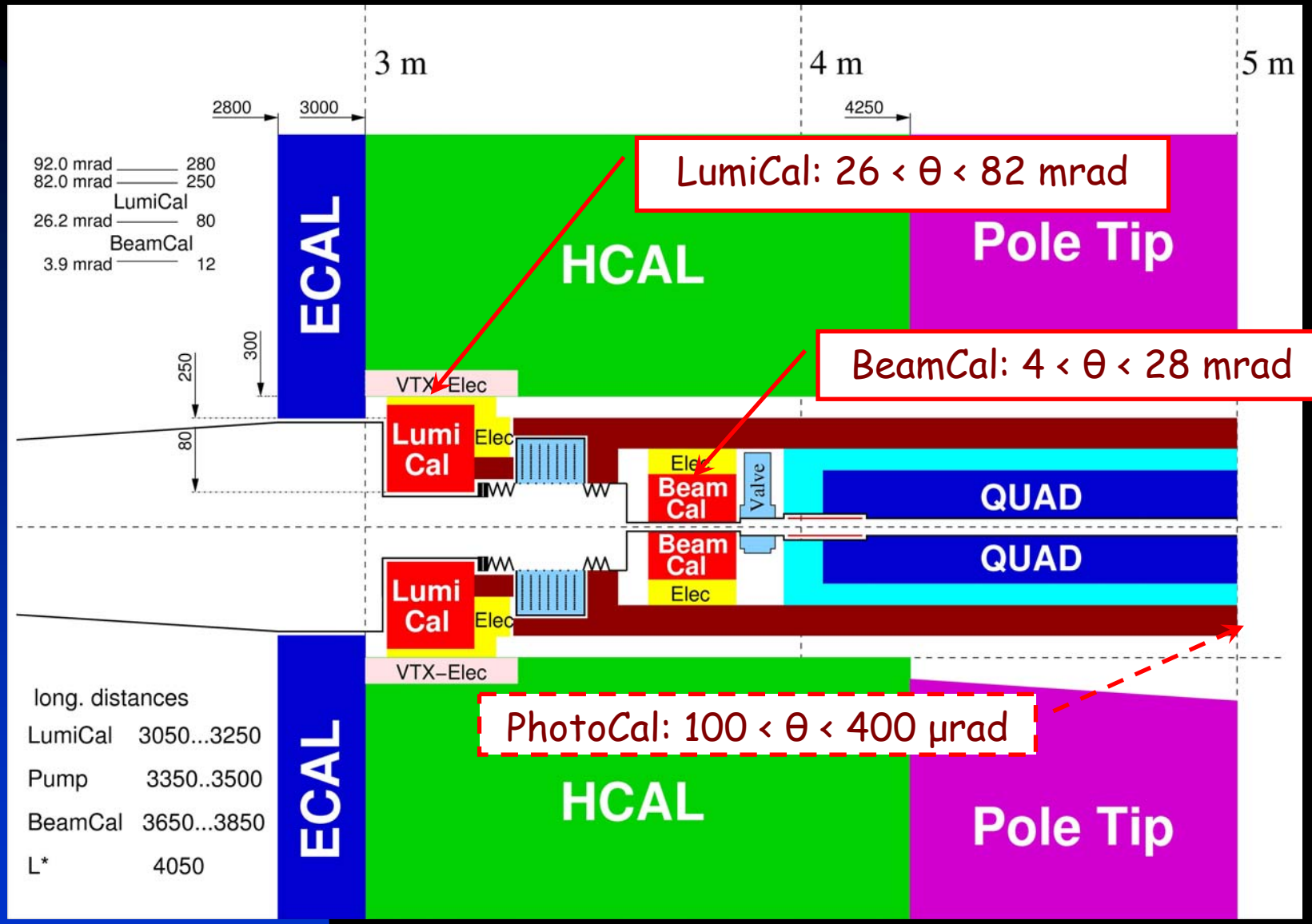
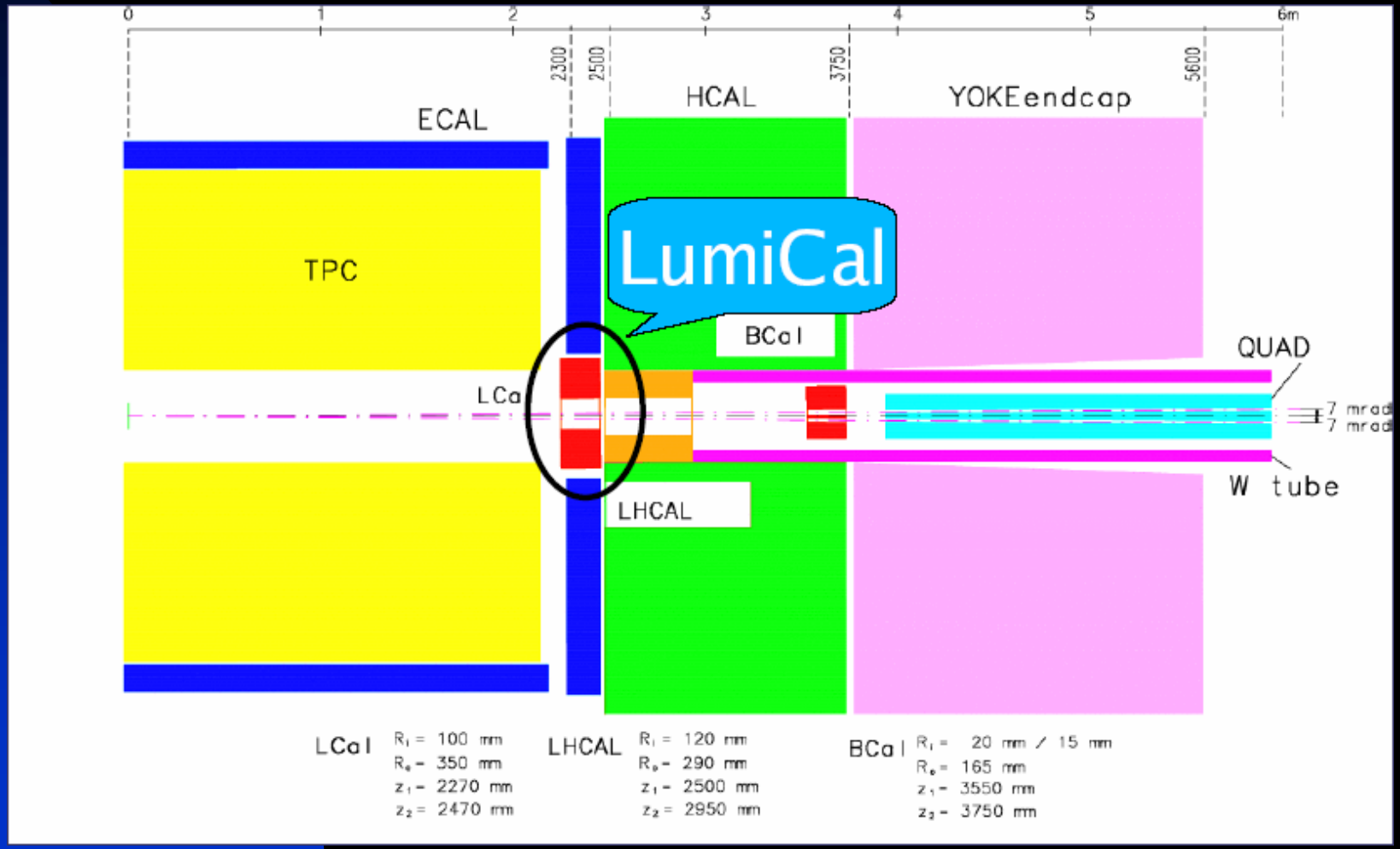
Instrumentation of Very Forward Region

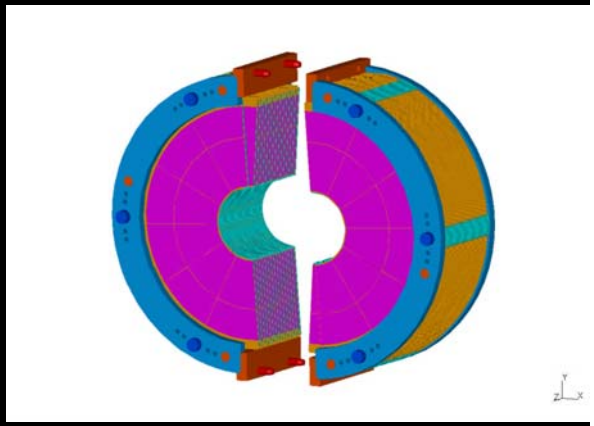


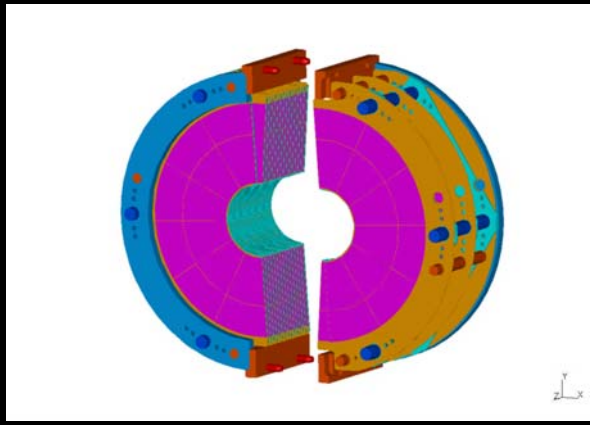
Instrumentation of Very Forward Region – new geometry



Mechanical design of LumiCal

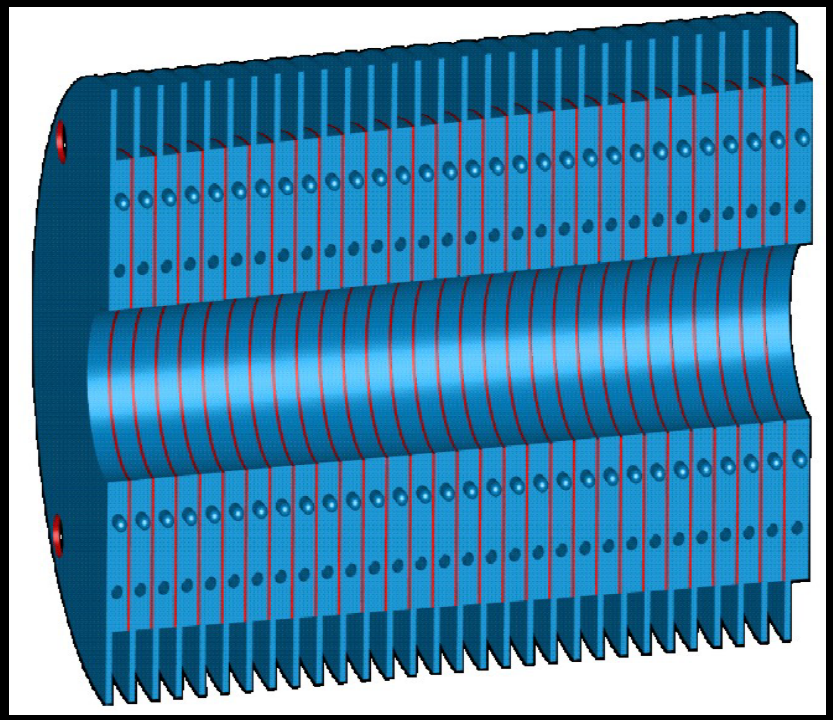
- Segmented silicon sensors interspersed into the tungsten half disks
- Two half barrels to allow for mounting on closed beam pipe
- The blue bolts support the heavy part of the detector, tungsten half disks
- The red bolts carry only the sensors
- Holes for precision survey the sensors position



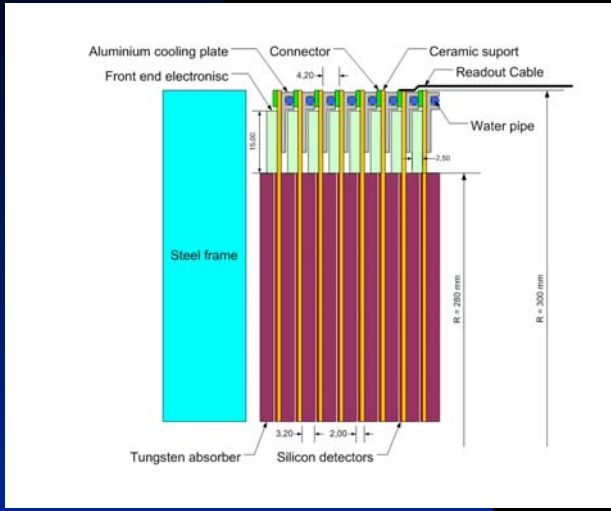


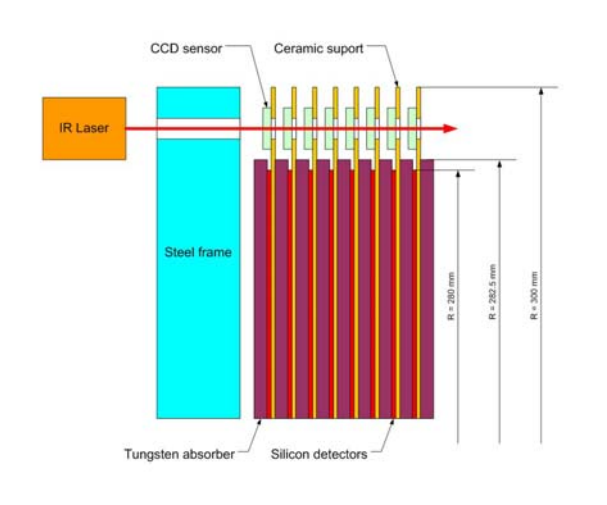
Mechanical design of BeamCal

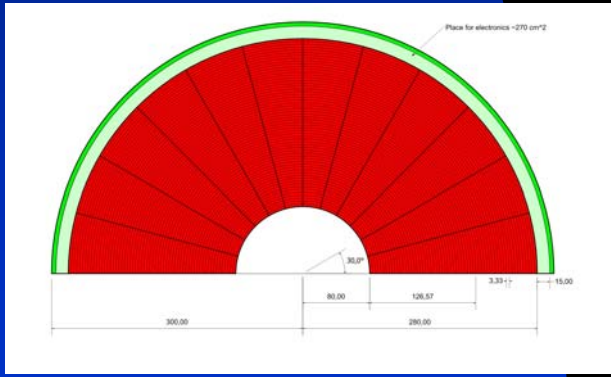
- Diamond-Tungsten Sandwich Calorimeter
- Two half-barrels placed just outside the beam
- Thickness of the tungsten absorber disks is one radiation length
- Space for the sensors is ~0.5 mm

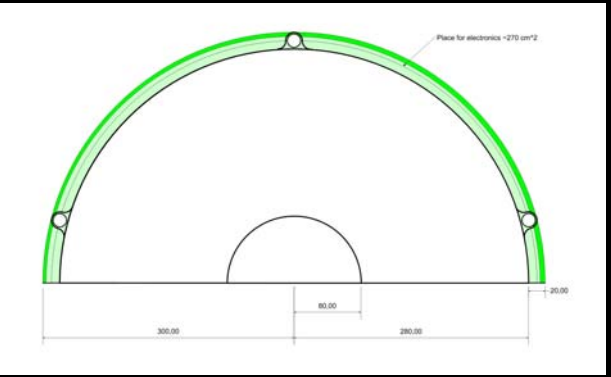


Space for electronics





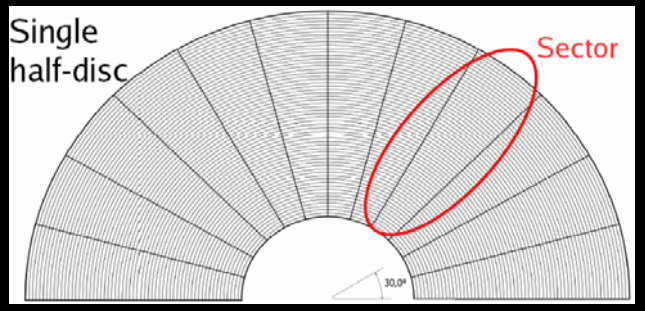




- There is a limited space for the FE electronics for the 300 mm outer radius of LumiCal
- Bolts for tungsten & sensors support takes additional space
- Si sensors online positioning needs place also

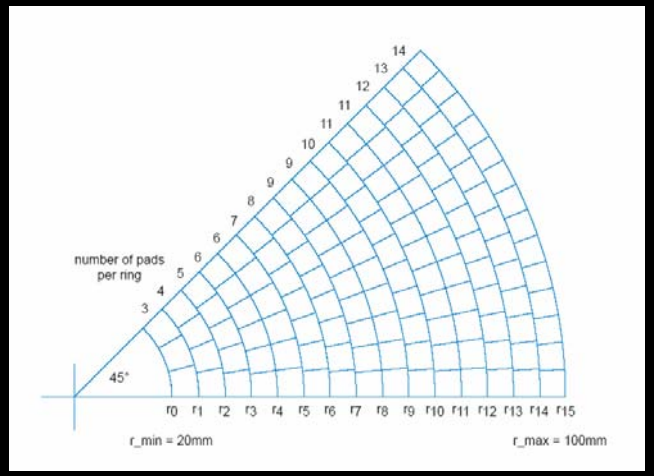
Pads Design

- 30 discs of silicon detectors
- Disc = 24 azimuthal sectors of~100 radial pads
- Total number of channels for one LumiCal = 72000



LumiCal

- 30 discs of diamond sensors
- Disc = 8 azimuthal sectors of 128 pads
- Total number of channels for one BeamCal = 30720



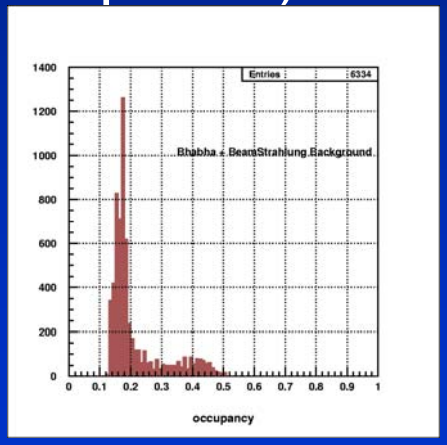
BeamCal

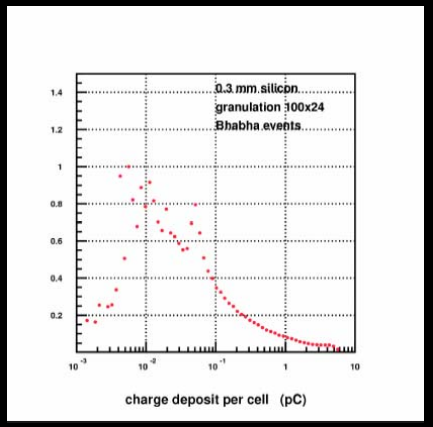
Raw luminosity measurement and Machine Detector Interface

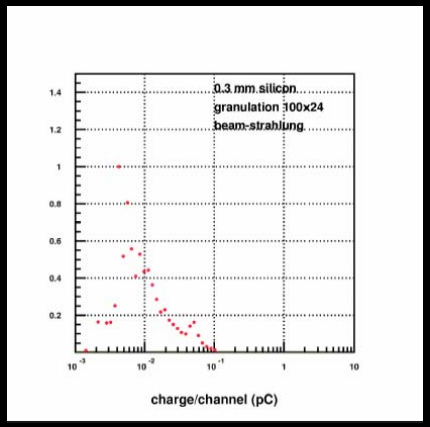
- LumiCal should provide raw luminosity after a few trains – readout can be done in time slots between trains
- Precision luminosity can be calculated later (in order of a few hundred seconds)
- BeamCal should provide beam diagnostics information (σ_x, σ_y, σ_z and $\Delta\sigma_x$, $\Delta\sigma_y$, $\Delta\sigma_z$, x_{offset}, y_{offset} and Δx_{offset}, Δy_{offset}, Bunch rotation, N particles/bunch) after a few bunches – readout should be done simultaneously with bunches every ~300 ns (~150 ns)
- Beamstrahlung Pair Analysis needs fast algorithm

Front-end specifications (LumiCal)

- Signal: from 0.4 fC (muons in test mode) up to 6 pC (normal mode)
- Occupancy: up to 20% (beam-strahlung), below 1% (Bhabha)
- Input capacitance range: 20-120 pF (plus fanout ~1 pF/cm)

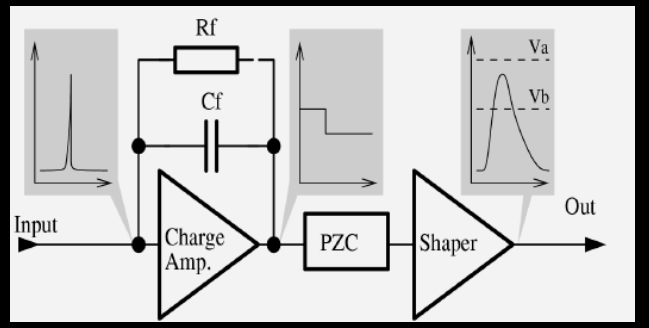


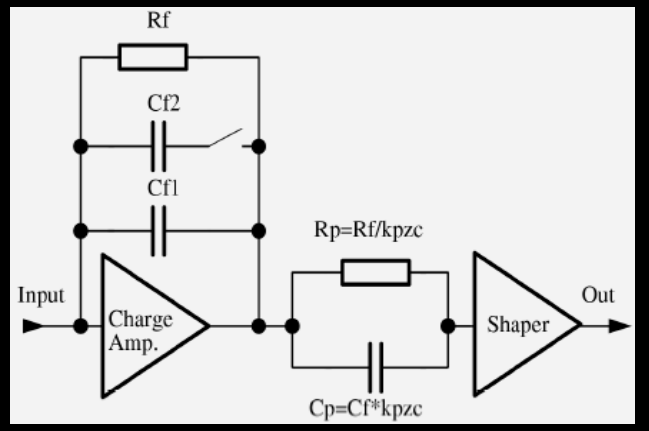




Front-end implications

- Signal range (4 fC to 6 pC) – variable gain preamp
- Large pads capacitance range (20-120 pF) – charge sensitive preamp
- Shaper with 50-70 ns peaking time to avoid pileup





Readout solution

- Derandomizing buffer – pro & contra
- ADC on chip or external?
- Data stored in local memory or sent immediately?

Derandomization buffer

- Advantages:

1. Low frequency ADC per channel or high freq. ADC multiplexed to a group of channels
2. Lower averaged power per channel

- Disadvantages:

1. More complicated design (more manpower)
2. Possible buffer overflow

ADC on chip or external (commercial)?

	External (commercial)	Internal (custom)
Need to be design	No	Yes
Space on PCB	a lot	No
Control	complicated	easier
Price & power	comparable	

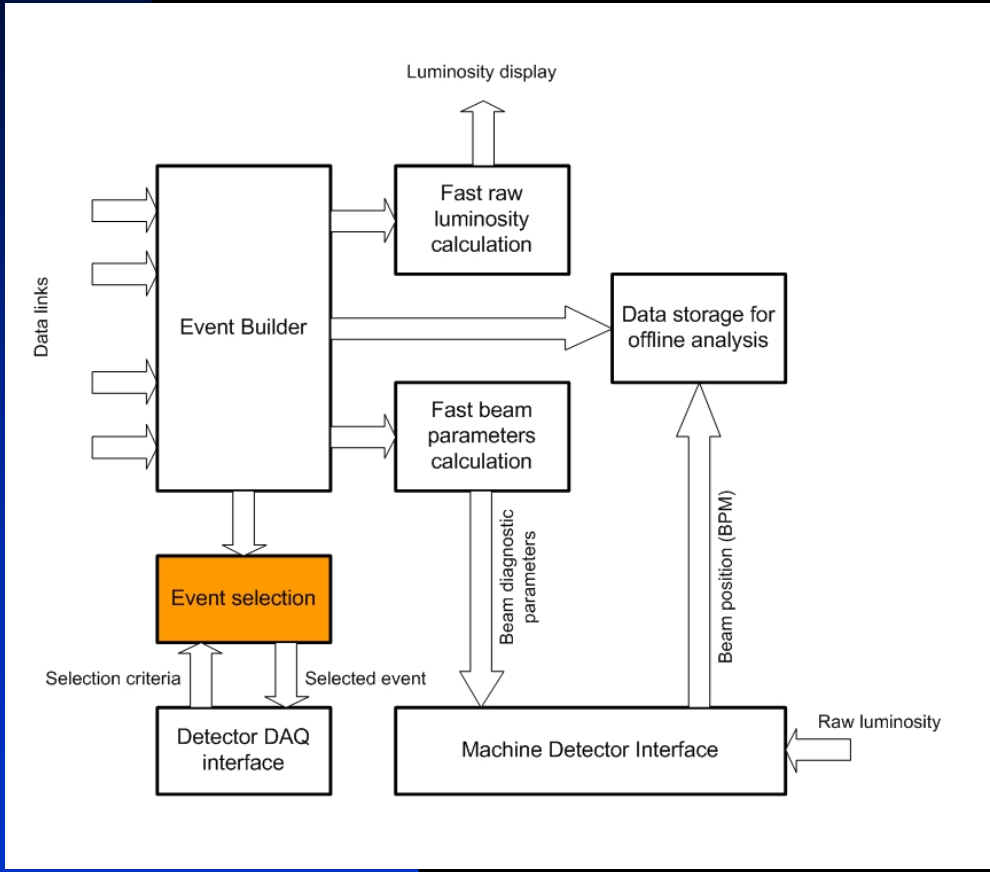
Data transmission

	Test mode	Bhabha
Occupancy	5.5%	<0.2%
Direct transmission*	7.88 Gb/s	5.22 Gb/s
InterTrain transmission*	23.6 Mb/s	15.62 Mb/s
Data per Train*	7.1 Mb	4.7 Mb

*Calculations done for half-disc unit

- We should watch commercial solutions
- For beam diagnostics (BeamCal) it is essential to have direct data transmission

Possible DAQ solution for Very Forward Region



- Event builder – glue events with the same bunch number stamp into one record
- Fast raw luminosity calculation – low precision luminosity data every ~10 s
- Event selection – should be discussed due to the Detector DAQ philosophy
- Beam Position Monitors data essential for the event reconstruction

Conclusions

- Work on readout chip started, we foresee the first prototype (preamp, shaper) mid 2007
- Digital data transmission over the break between trains possible only for LumiCal
- The BeamCal should be read out simultaneously with bunches

DAQ for the Forward Calorimeters has to read out each bunch crossing and the readout philosophy is different to the rest of Detector DAQ