LumiCal & BeamCal

Readout Electronics

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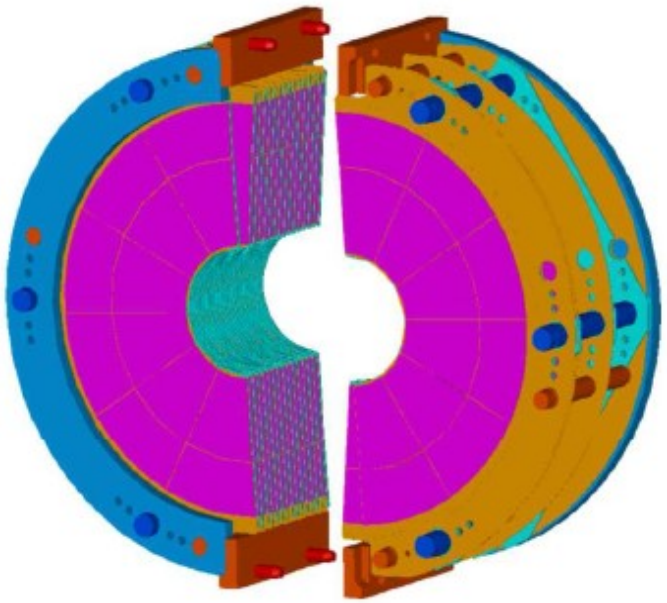
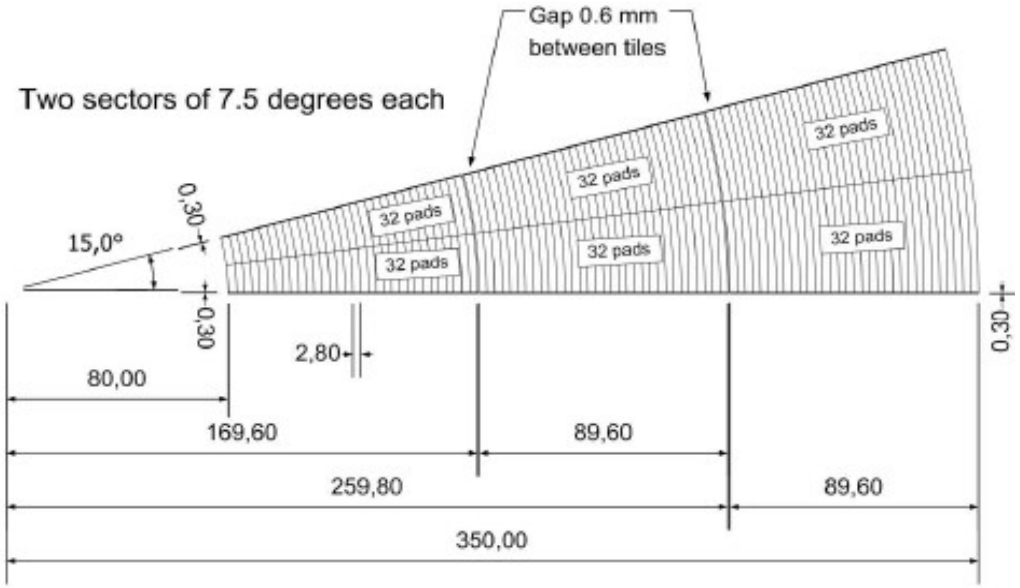
Outline

- Introduction
- Challanges for BeamCal and LumiCal electronics
- Readout architecture and operation
- Front-end design & simulations
- ADC design & simulations
- Specific BeamCal issues: fast feedback, radiation hardness
- Summary & milestones

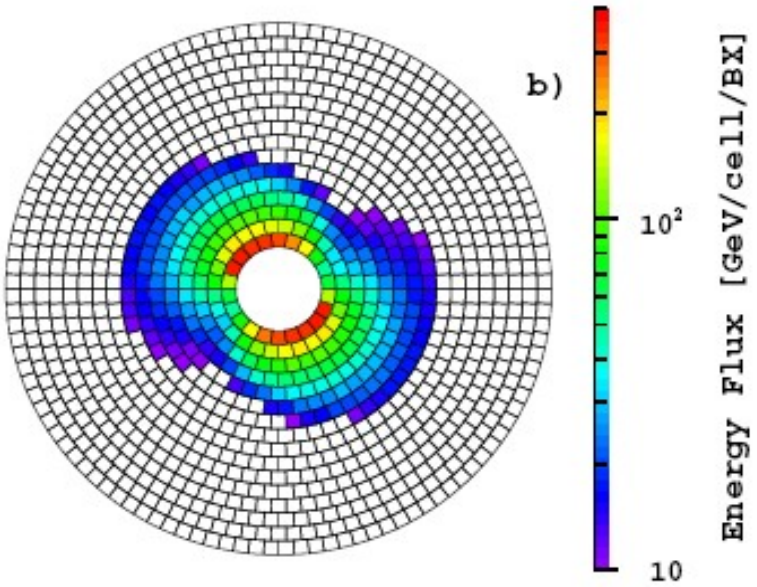
LumiCal architecture





- LumiCal ⇔ 30-40 discs of silicon detectors
- Disc ⇔ 48(?) azimuthal (7.5°) sectors
- Sector ⇔ $R_{in\text{-}out}$ = 8-35 cm, built of ~100 radial pads
- Channel number estimation 2*35*48*100~340000

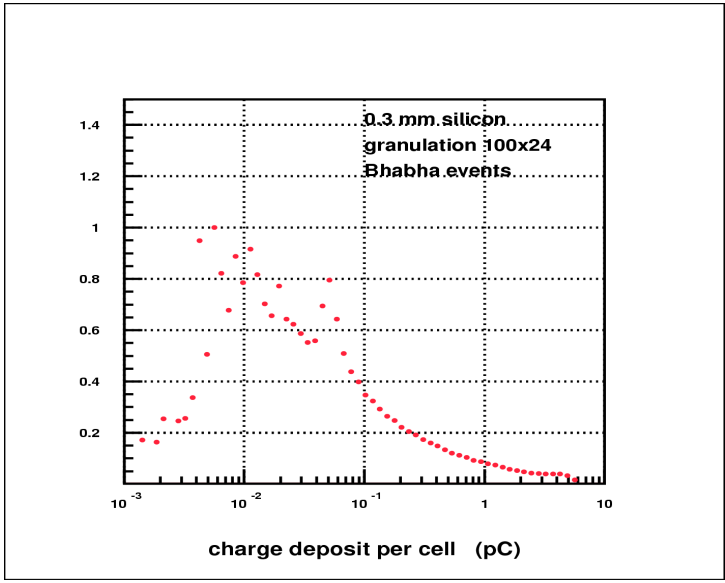
BeamCal architecture



- BeamCal ⇔ 30 discs of semiconductor(?) detectors
- Disc ⇔ $R_{in\text{-}out}$ = 1.5-16.5 cm, built of equal size pads
- Channel number estimation 2*30*?~?

Detector specifications

- Signal: from 2 fC (muons in test mode) up to more than 10 pC (physics mode)
- Occupancy: up to ~20% (beam-strahlung), below 1% (bhabha)
- Sensors: DC-coupled 300 µm thick Si pads. (C_{det} 10-100 pF plus fanout ~1pF/cm ?, leakage current ?)
- Inter bunch time ~ 300 ns
- Low average power dissipation



Challanges of LumiCal front-end

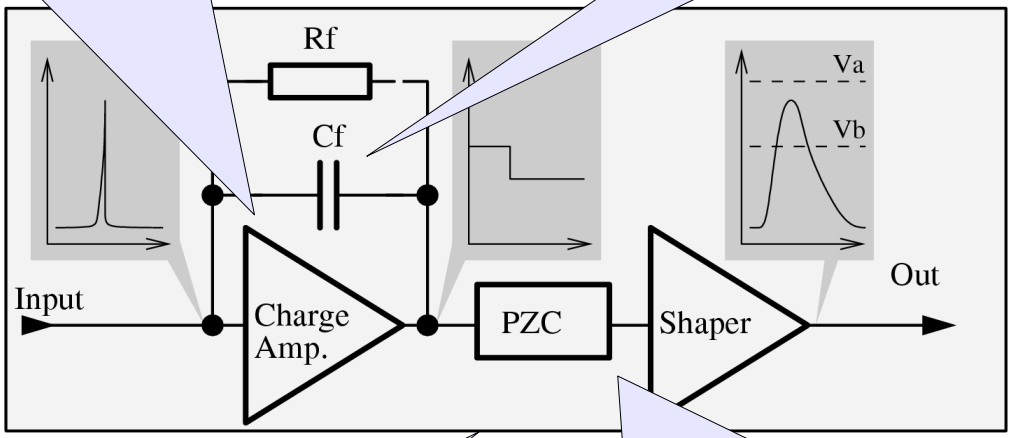
Large C_{det} range 10-100 pF

Test mode S/N~10 for MIP

Charge sensitive amplifier

Q_{max} ~ 10 pC

Cf ~ 10 pF



Test & Physics mode

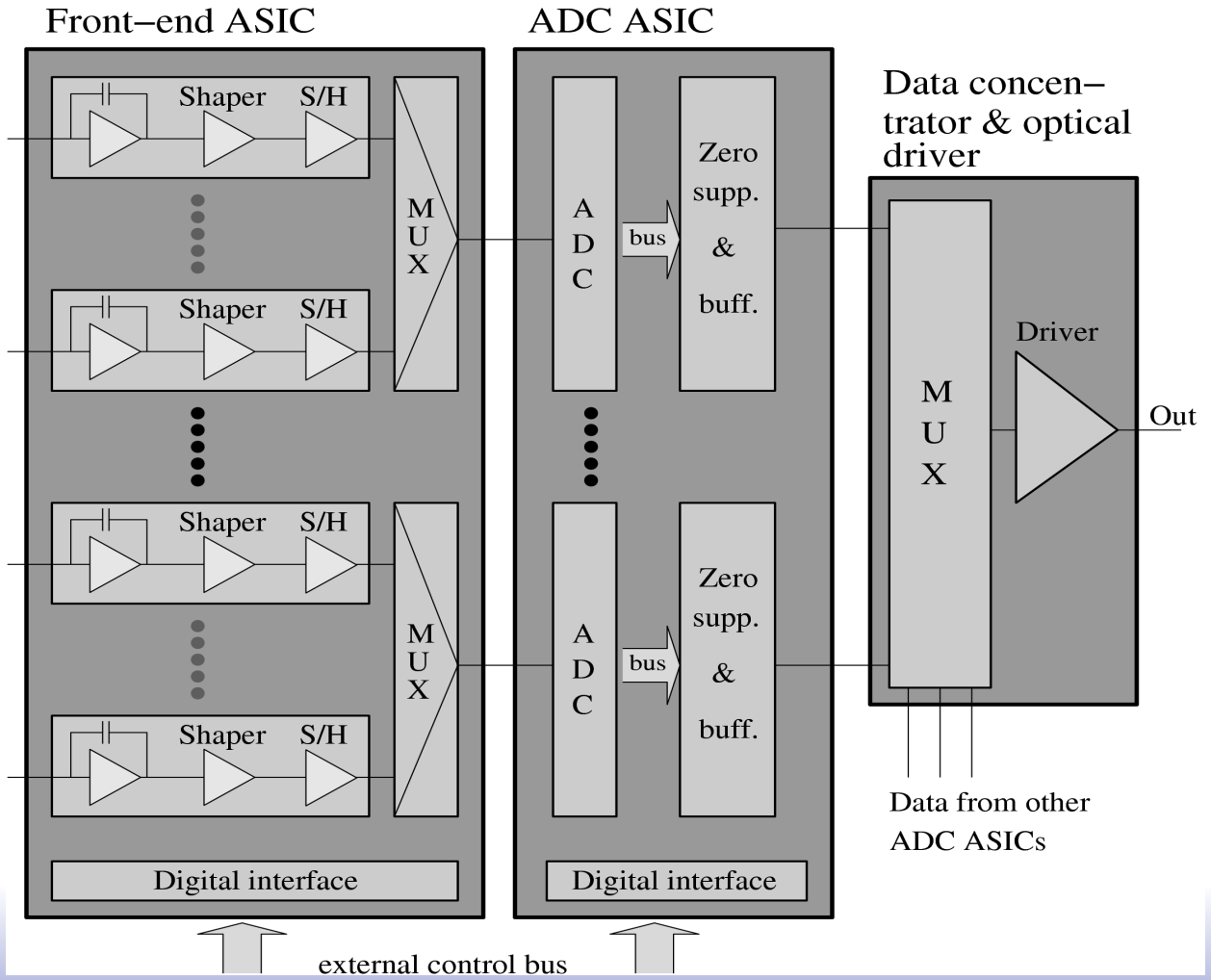
Variable gain

Δt≃300 ns, high occupancy

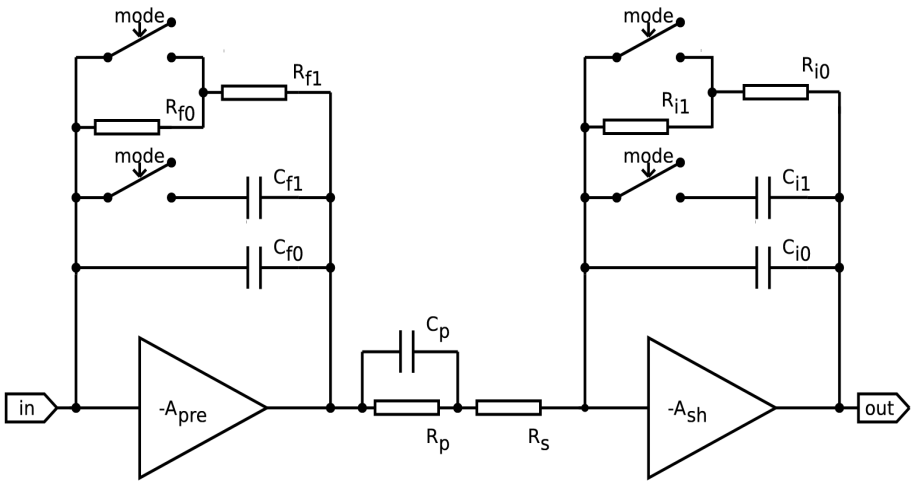
PZC +Shaper T_{peak} ~ 60ns

LumiCal readout architecture

- Front-end ASIC will contain 32-64 channels
- An ADC will serve ~8(?) front-end channels
- First prototypes in AMS 0.35 µm

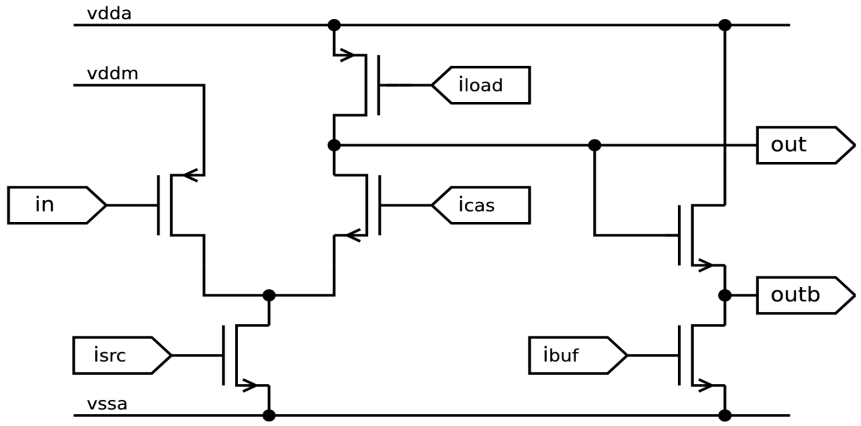


Front-end electronics architecture

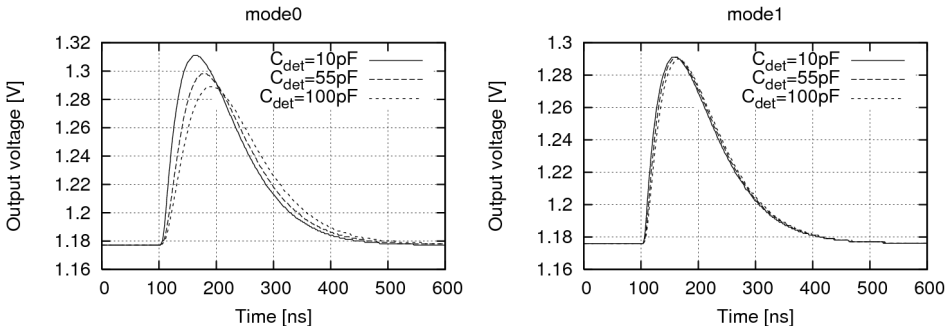


- Preamplifier: I_{pre}~2.5mA, PMOS input, Cf~10pF (physics), Cf~0.5pF (test)
- Shaper: 1st order, T_{peak}~60ns, variable gain, I_{sh}~0.5mA

- Both Preamplifier and Shaper designed as folded cascode plus source follower

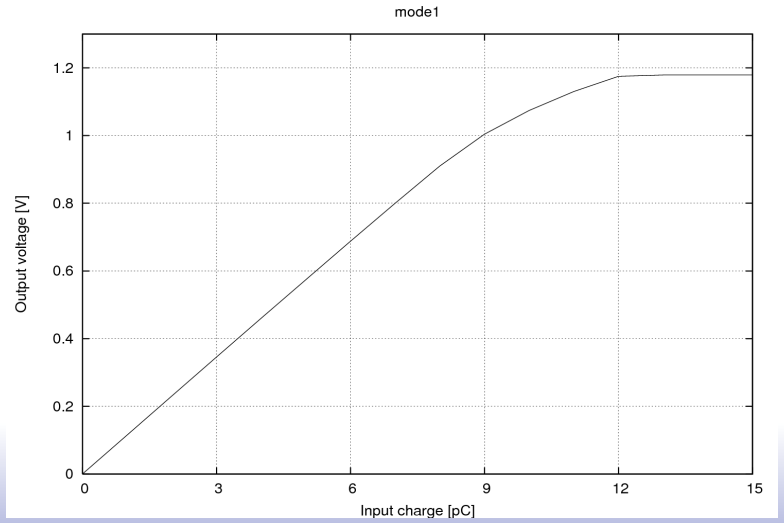


Front-end simulations

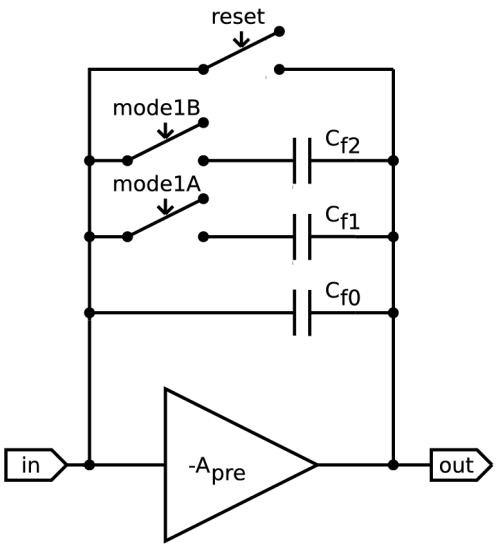


- Front-end response in test (mode0) and physics (mode1) mode for different C_{det}

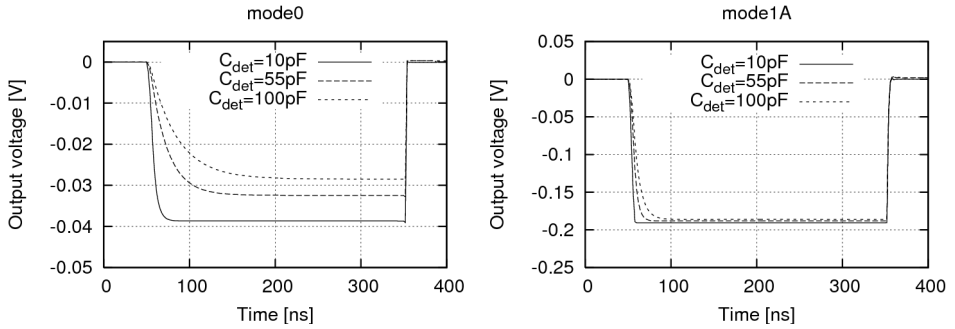
- Output amplitude versus injected charge in physics mode



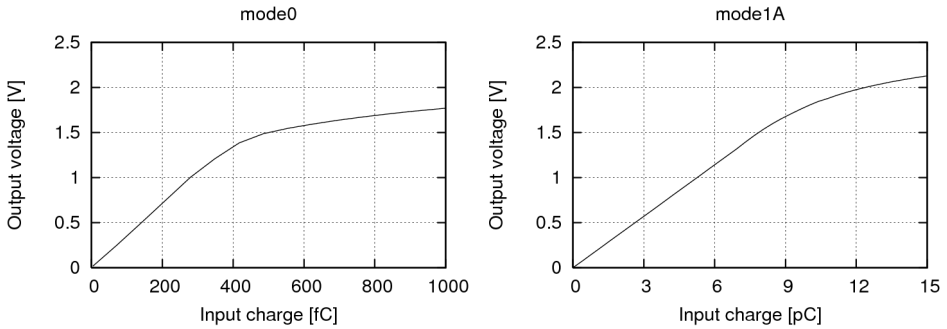
Alternative front-end
Switched-Reset configuration

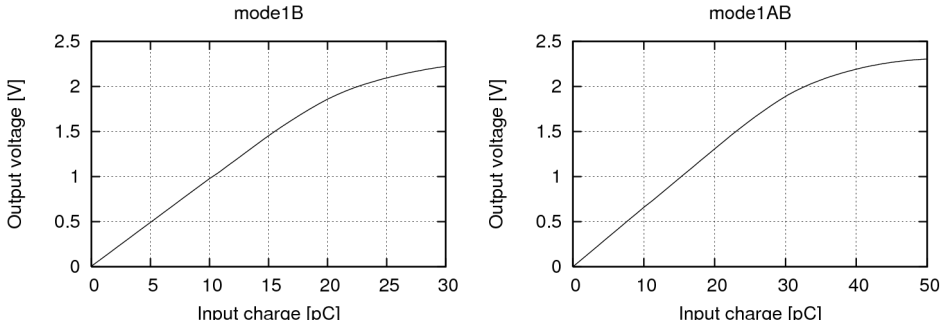


Switched-Reset configuration



Response in test (mode0) and physics (mode1) mode

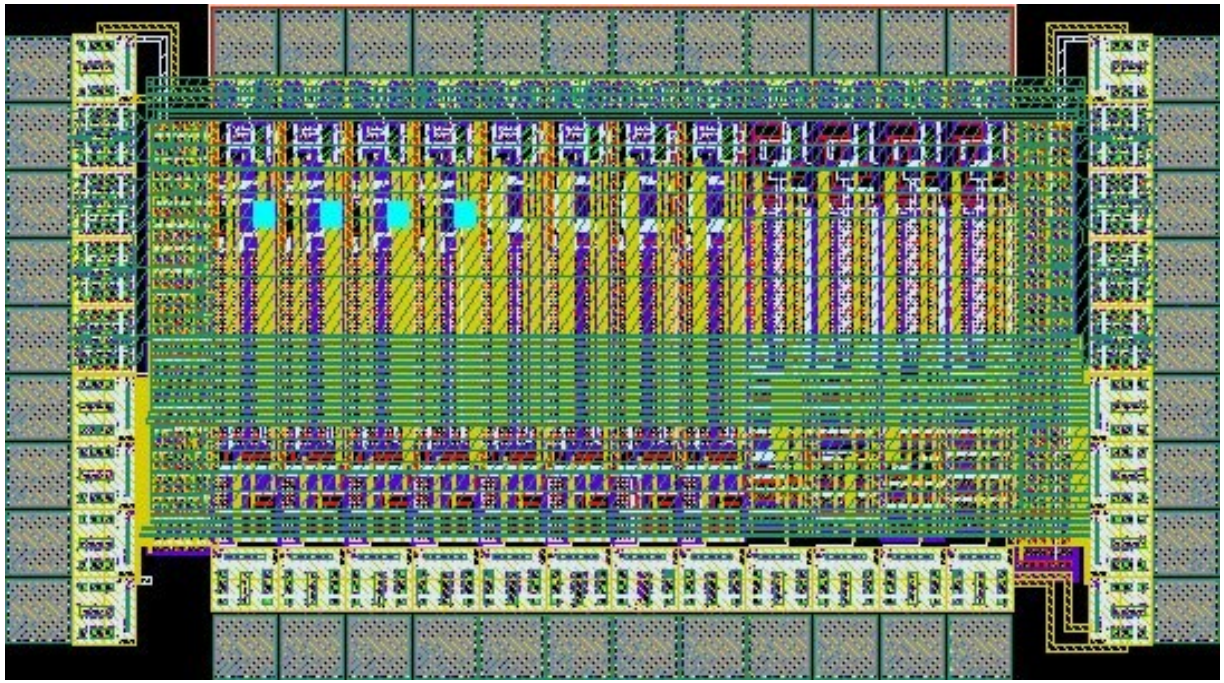




- Output amplitude versus Q_{in} for different gain setting

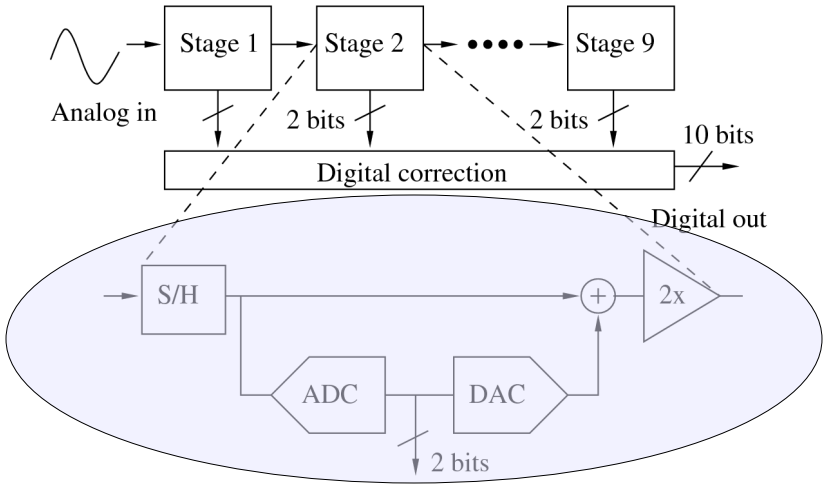
Layout of LumiCal front-end ASIC

Prototype ASIC contains 8 channels with continuous shaping and 4 channels with switched-reset



Pad Pitch 100 µm

ADC architecture

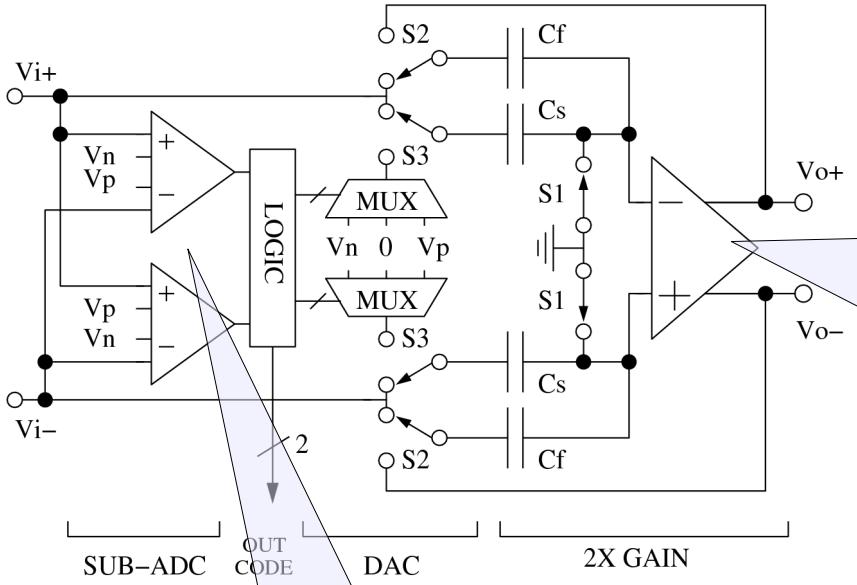


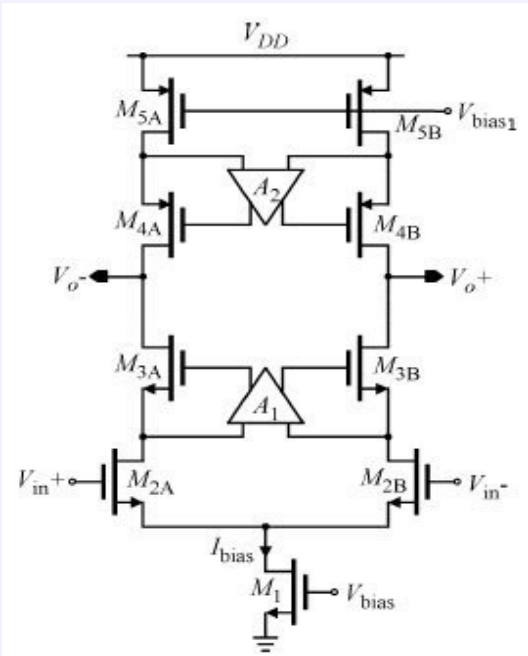
- 10 bit pipeline ADC
- 1.5 bit stage
- Fully differential architecture

Pipeline advantages

- High throughput
- Robustness
- Power efficient
- Reasonable area

1.5 bit stage architecture

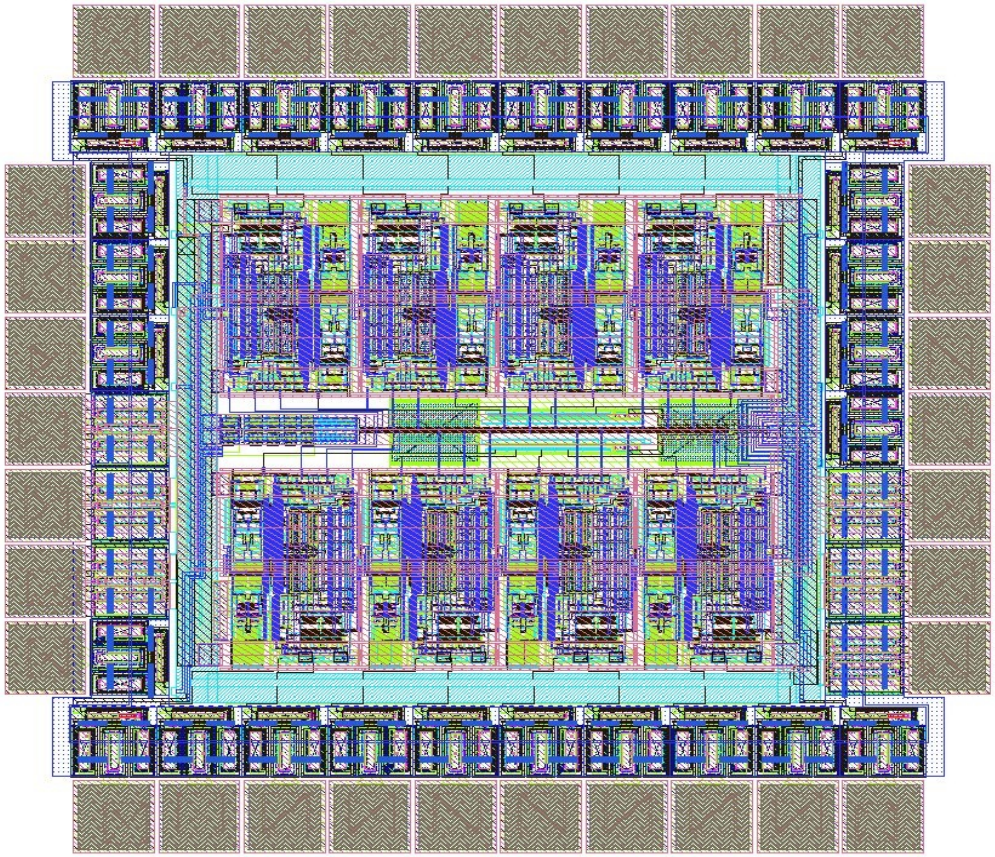




Dynamic latch comparators

Layout of ADC blocks

Prototype ASIC contains 8 pipeline stages



Pad Pitch 100 µm

Summary & milestones

- Now - first prototypes of the front-end and ADC functional blocks are being submitted
- ~December 2007 - tests of prototypes completed, design of ADC, S/H
- ~March 2008 - submission of ADC prototypes and front-end prototypes including S/H
- ~October 2008 - tests of ADC and front-end completed, design of supporting circuitry (biasing, DACS,...)
- ~December 2008 - submission of complete front-end and ADC prototypes
- ~June 2009 - tests of prototypes completed