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Noise Performance of the HEC at SLHC
(very preliminary estimates)

Meeting at MPI on "HEC cold electronics"
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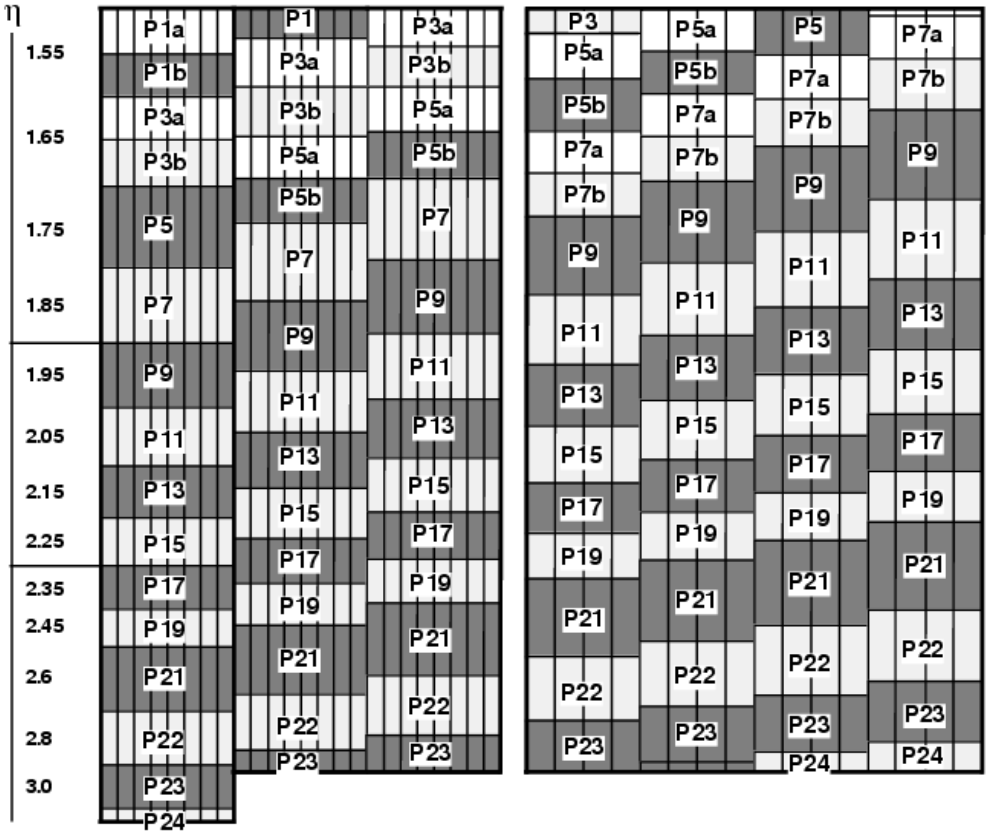
Introduction

- Two sources of noise in calorimeter channels:
  - electronics
  - pileup of minimum bias events, happened in the neighbouring bunch crossings
- Different behaviour of noise as a function of the peaking time:
  - electronic noise σ_{EL} decreasing
  - pileup noise σ_{PU} increasing
- Current design of HEC electronics is optimised for LHC luminosities:
  - low $L = 10^{33}$ cm^{-2}s^{-1}
  - high $L = 10^{34}$ cm^{-2}s^{-1}
- Super LHC luminosity ($L = 10^{35}$ cm^{-2}s^{-1}) requires new electronics
- This talk: first attempt to estimate total noise in HEC channels at SLHC
- Old programmes (used for HEC optimisation in 1997-1999) are applied for present calculations

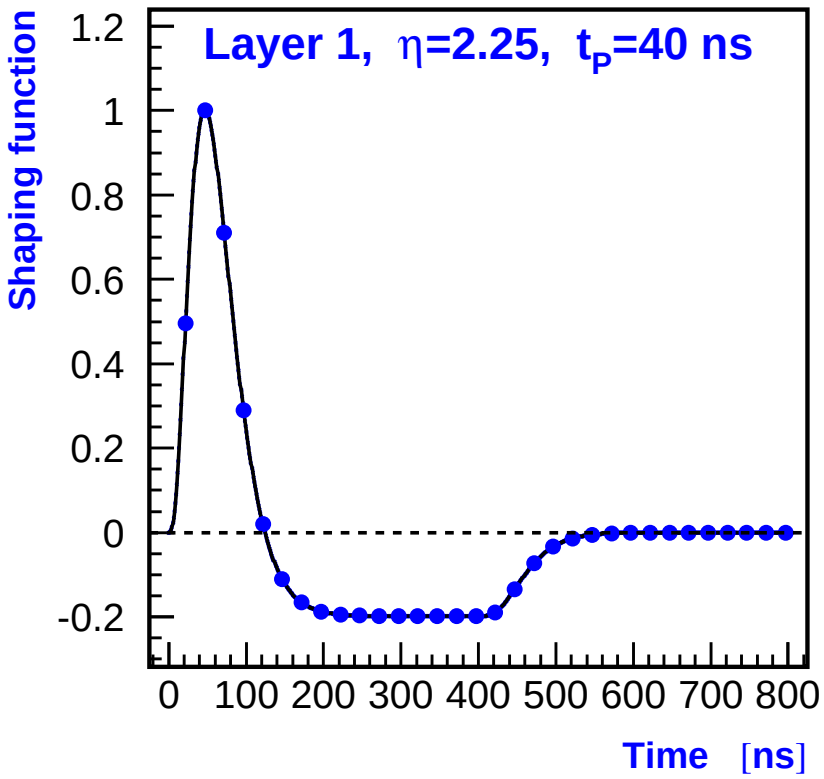
Channels in the HEC

- Hadronic end-cap calorimeter:
  - 2 front and 2 rear wheels
  - 32 modules in a wheel
- 5632 channels in total
- 51 different types of channels (azimuthal symmetry)
  - 14 pseudorapidity bins
  - 4 longitudinal layers
  - detector capacitance
  - cable length
  - number of preamplifiers



Shaping Functions

- FORTRAN-based programme from L. Kurchaninov and D. Salihagić
- Shaping function f_{SH}:
  - shaping time t_{SH}
  - detector capacitance C_D
- Peaking time t_P as a rise time of a shaping function from 5 to 100 %
- Set of shaping functions
  - 51 HEC channels
  - 19 values of the peaking time: from 20 to 110 ns

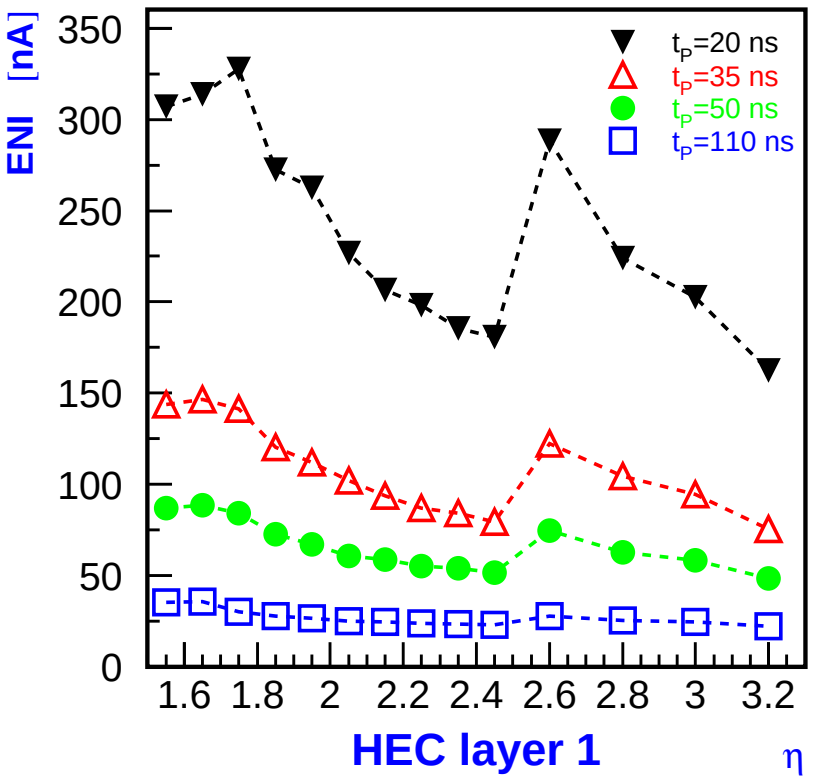


Electronic Noise

- Code from L. Kurchaninov
- Equivalent noise current (ENI)
  - shaping time t_{SH}
  - detector capacitance C_D
  - cable length
  - number of preamplifiers
- Electronic noise at the visible energy scale

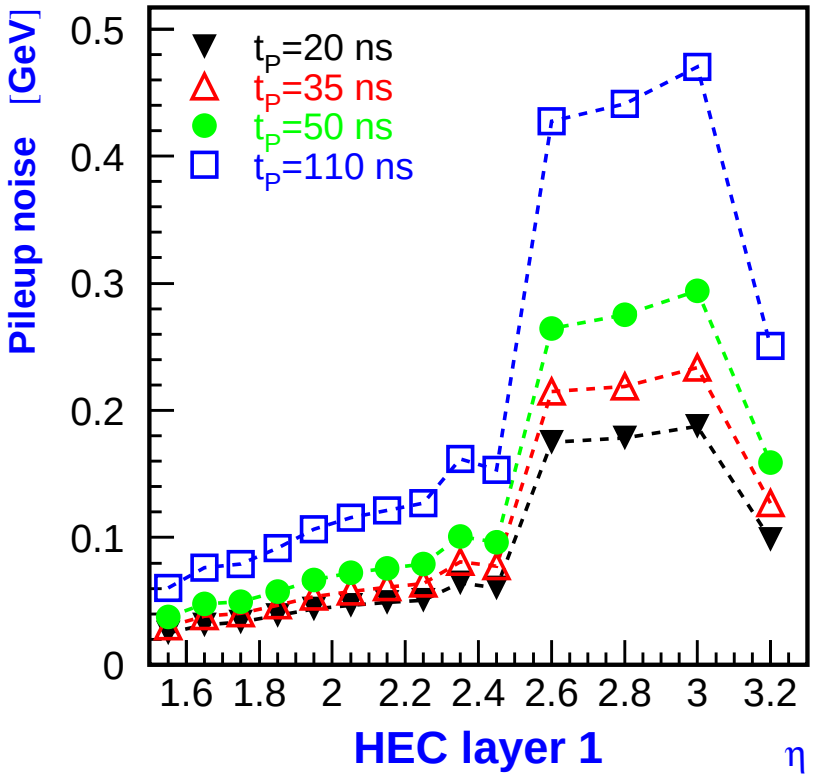
$$\sigma_{EL} = ENI/C_0,$$

where $C_0 = 7135$ nA/GeV

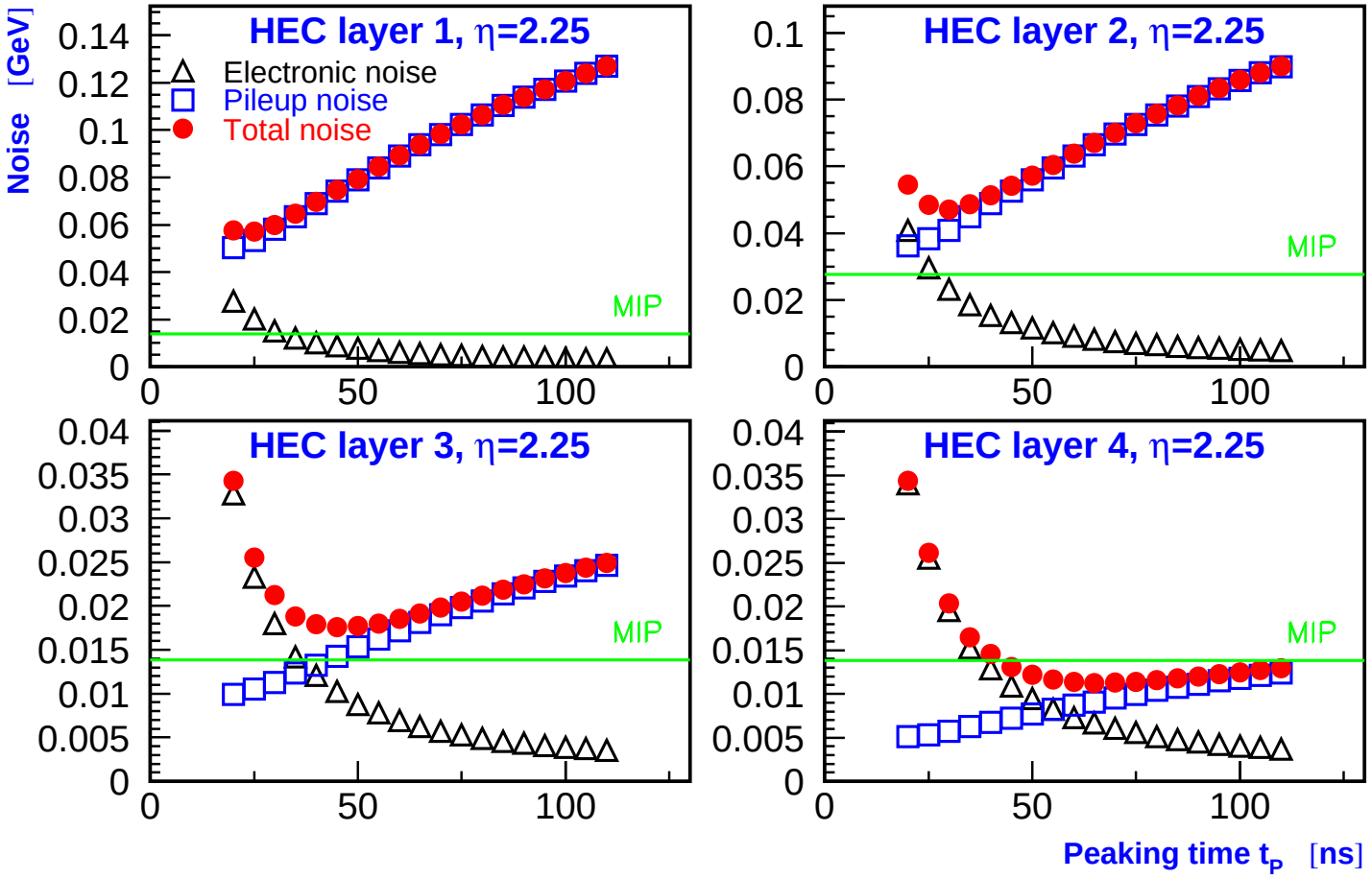


Pileup Noise

- 2871 minimum bias events, fully simulated with the version 96_12 (calorimeter TDRs)
- Pileup of N_{MB} in average (Poisson distributed) minimum bias events per bunch crossing ($N_{MB} = 230$ at SLHC)
- R.M.S. of distribution of visible energy in one channel in one bunch crossing σ_{BX} — pileup noise for the infinitely fast detector (t_P=0)
- "Shaping integral": $S_{int} = \sqrt{\sum_{25ns} f_{SH}^2}$
- Pileup noise — result of convolution with a shaping function: $\sigma_{PU} = \sigma_{BX} \times S_{int}$



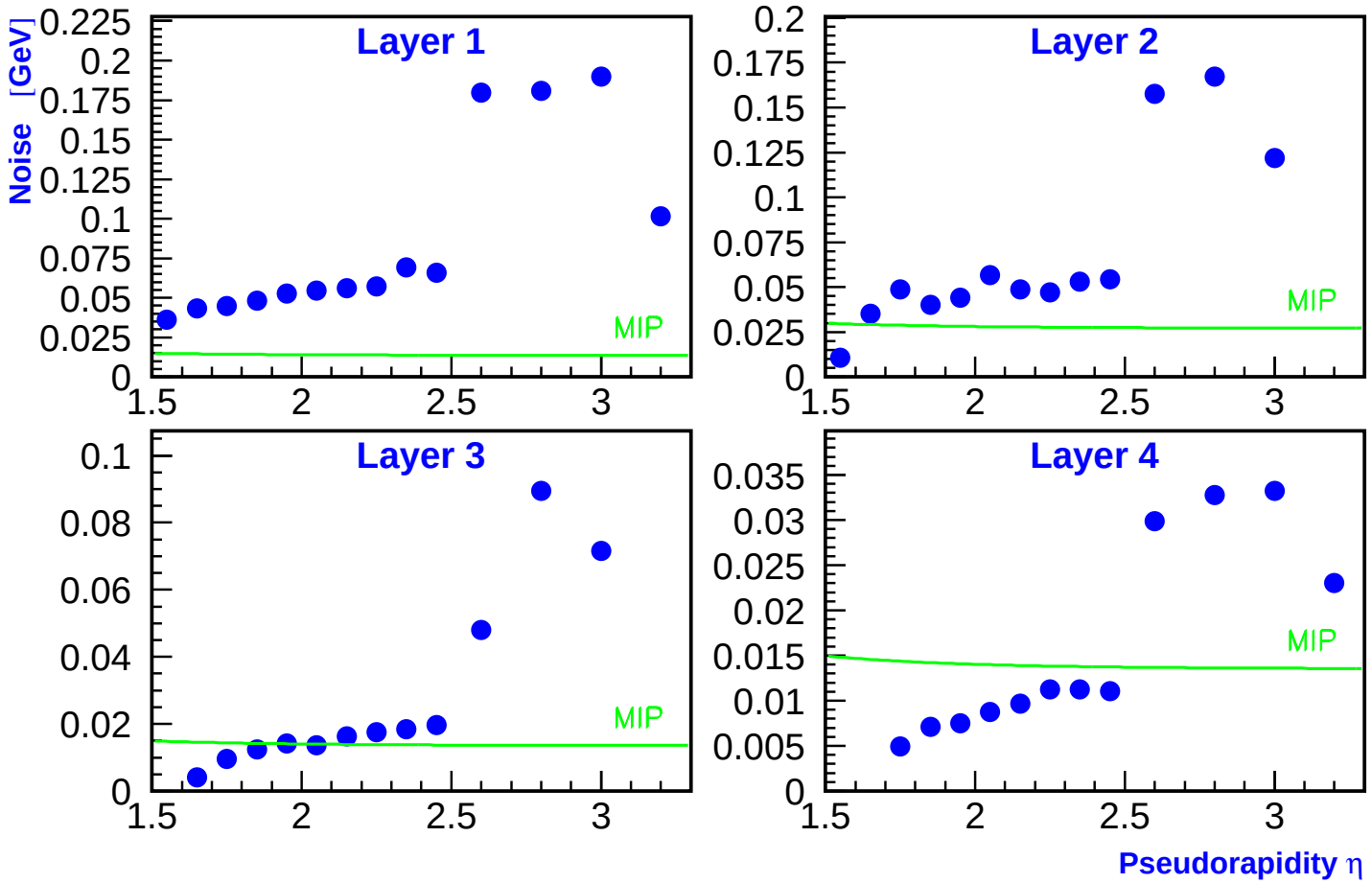
Noise versus Peaking Time



Total noise $\sigma_{TOT} = \sqrt{\sigma_{EL}^2 + \sigma_{PU}^2}$

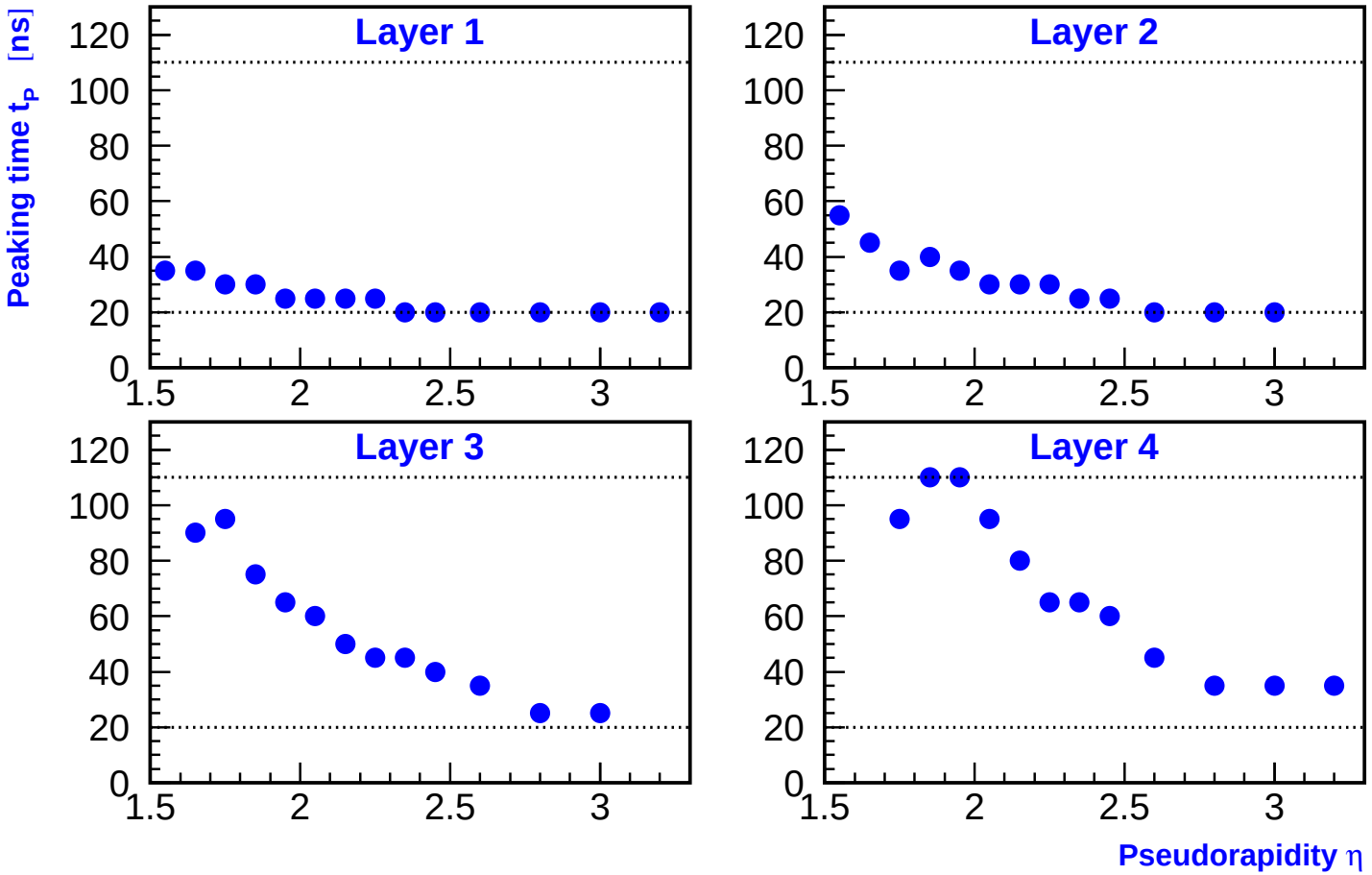
Noise versus Peaking time

Minimal total noise



Noise versus Peaking time

Peaking time corresponding to minimal total noise



Next Steps?

1. Old model of HEC electronics chain ⇒
   Complete model (L. Kurchaninov, ATLAS HEC Note-109, 2001)
   - calculations with MCAD under Windows
   - different peaking times
   - other types of preamplifiers, shapers, etc.

2. Measurements in one time sampling ⇒
   Measurements in five time samplings and optimal weighting
   - other schemes (not five samplings, not every sampling, etc.)

3. Old simulations of minimum bias events ⇒
   Latest simulations
   - another structure of HEC channels (longitudinal segmentation, transverse granularity) ?