Main Parameters of MIMOSA-22+

Input to discussion

Marc Winter (IPHC-Strasbourg)

on behalf of IPHC and IRFU/Saclay

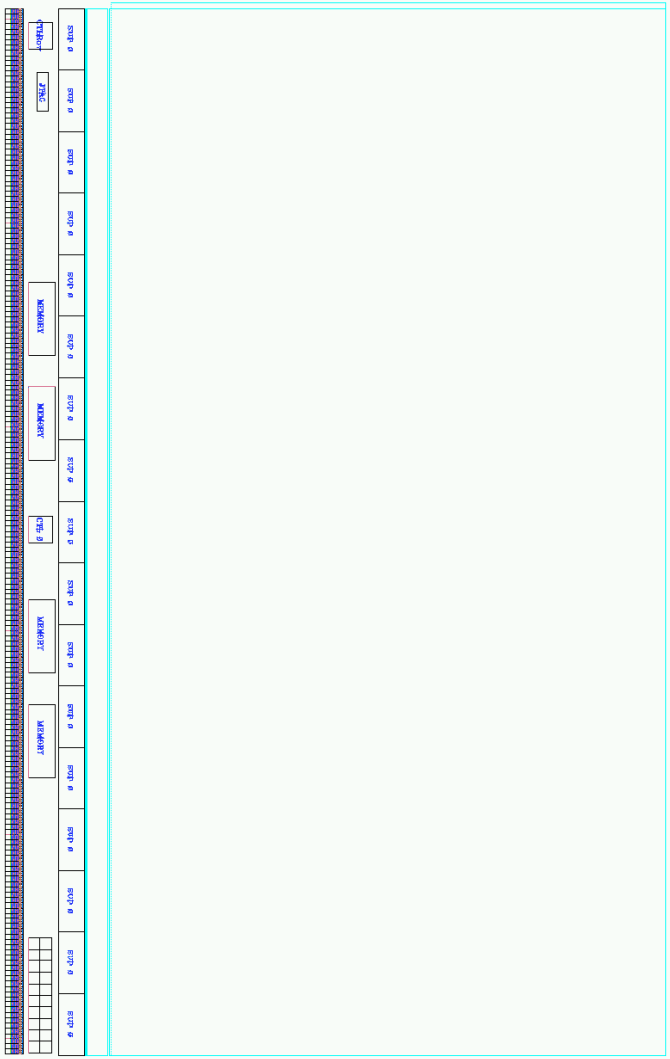
OUTLINE

- *Introductory remarks (reminder)*
- *Limitations of present design*
- *Possible improvements :*
  - ⁂ *dimensions*
  - ⁂ *data throughput*
  - ⁂ *SNR ⟼ det.eff.*
  - ⁂ *radiation tolerance*
- *Consequences on design finalisation and chip delivery*
- *Summary*

Main Parameters of the Present MIMOSA-22+ Design

Autumn 2008 : fabrication of MIMOSA-22+ = Final Sensor

- MIMOSA-22 (binary outputs) complemented with $\emptyset$ (SUZE-01)
- 1 or 2 sub-arrays (best pixel architectures of MIMOSA-22) ?
- Active surface : 1088 columns of 544/576 pixels (20.0 x 10/10.5 mm^2)
- Pixel pitch : 18.4 $\mu m \rightarrowtail \sim$ 0.6 million pixels
  $\hookrightarrow \sigma_{sp} \sim$ 3.5 μm
- Integration time $\sim$ 100 $\mu s \rightarrowtail \sim 10^4$ frames / second
- $\emptyset$ based on 17 groups of 64 columns
  and assuming $\leq$ 9 "clusters" per row
- Chip dimensions : $\sim$ 20 x 12 mm^2
- Data throughput: 1 output at 100 Mbits/s
- Engineering run : 6 wafers of $\sim$ 50 chips ($\sim$ 120 keuros)



▷▷▷ Question : are these reasons to revisit these parameters ?

Dimensions:

- *imposed by reticle dimensions*
- *reticle dimensions have somme flexibility : 22 x 22 mm^2 $\longmapsto$ 26 x 17 mm^2*

SNR :

- *reflects sensing diode parameters (e.g. dimensions) and in-pixel amplification*
- *degrades after exposure to intense radiation $\longmapsto$ concern ???*
- *not yet fully optimised : SNR $\sim$ 18–19 expected*
  - $\Rrightarrow$ *worth increasing safety margin w.r.t. "critical" regime (SNR $\lesssim$ 12–13)*
- *Room for optimisation already investigated*

What is preventing from improving these parameters before submitting MIMOSA-22+ ?

- *Time line imposed by EU ?*
- *Pressure from telescope users ? $\longmapsto$ use demonstrator meanwhile*
- *Money for additionnal prototyping ?*
- *JRA-2 and -3 projects being ahead of JRA-1 ?*

$\triangleright\triangleright\triangleright$ **Why considering extending EUDET by one year ?**

Extension of Active Area

- **Realistic goal:** *extend sensor dimension beyond ILC VD ladder width (20 mm ?)*

- **Proposed dimensions:** *1280 columns of 576 pixels $\longmapsto$ 23.5 x 10.5 mm^2 (740,000 pixels)*

- **Consequences:**

  - *number of groups of 64 columns moves from 17 to 20 $\Rightarrow$ adapt the zero suppression design*
  - *25 % increase of number of pixels $\Rightarrow$ Nb(pixels) with noise fluctuation above discri. threshold* $\nearrow$
  - *25 % increase of Nb (hit pixels)*

  $\Rightarrow$ **Increase zero suppression and data throughput capacity**

- **Practical aspects:**

  - *no additional prototyping needed $\Rightarrow$ no budget overhead*
  - *extend zero suppression capacity to 10 ”clusters” per row*
  - *2 outputs at 75 Mbits/s per chip $\Rightarrow$ consequence for DAQ boards ?*
  - *design effort costs a minimum of 2 months delay in submission date $\longmapsto$ early 2009.*

- **Motivations :**
  - ✳ *improve CVC gain : reduce sensing diode dimensions & optimise amplification*
  - ✳ *reduce vulnerability to ionising radiation ⟼ optimise T gate voltage to reduce I_{leak} effects*

- **Practical aspects:**
  - ✳ *send prototype for fabrication by end of June or July (15–20 keuros)*
  - ✳ *complete prototype tests by end of Octobre*

  ⇛ **costs 1 month delay in submission date ⟼ end of Novembre 2008**

  (*in parallel with design modifications for surface extension)*

- **Use of telescope at DESY:** *few 10^3 e^-/s*
  - ⁜ *10^4 frames/s ⇛ < 1 hit/frame in average*
  - ⁜ *intensive use ($2 \cdot 10^7$ s/yr) ⇛ up to 10^{11} e^- (few GeV)/yr*
    - ↪ *yearly radiation dose ∼ 3.5 kRad & 10^{10} n_{eq}/cm^2*

- **Use of telescope (copies ?) at hadron colliders:** *10^4–10^5 $\pi, \mu, \ldots$/s*
  - ⁜ **10^4 frames/s ⇛ up to several tens of hits/frame in average**
  - ⁜ **intensive use ($1 \cdot 10^7$ s/yr) ⇛ up to several 10^{12} $\pi, \mu, \ldots$/yr**
    - ↪ **yearly radiation dose: O(100 kRad) & O(10^{12}) n_{eq}/cm^2**

⇛ **Should the pixel design be tolerant to (ionising) radiation ?**

↪ **cost in noise before irradiation : 1 e^- ENC ⇾ SNR ? (beam tests)**

◇ **Special care for cooling ?**

- **MIMOSA-22+ benefits from delaying the fabrication to early 2009:**
  - *extend the dimensions: 23.5 mm width, surface + 25 %*
  - *improve SNR and tolerance to ionising radiation*

- **Cost overhead (15–20 keuros) affordable by proponents**

- **Decision deadlines:**
  - *sensor dimensions : early June !!!*
  - *pixel architecture : June – Septembre*

⇒ **Phone meeting next week ?**

(connexion to DevDet proposal evolution ?)