DIRAC2 2009 Testbeam Failure Analysis

R. Gaglione

Laboratoire d'Annecy-le-Vieux de Physique des Particules,
Université de Savoie, CNRS/IN2P3
FRANCE

January 5th, 2010

Outline

Reminder

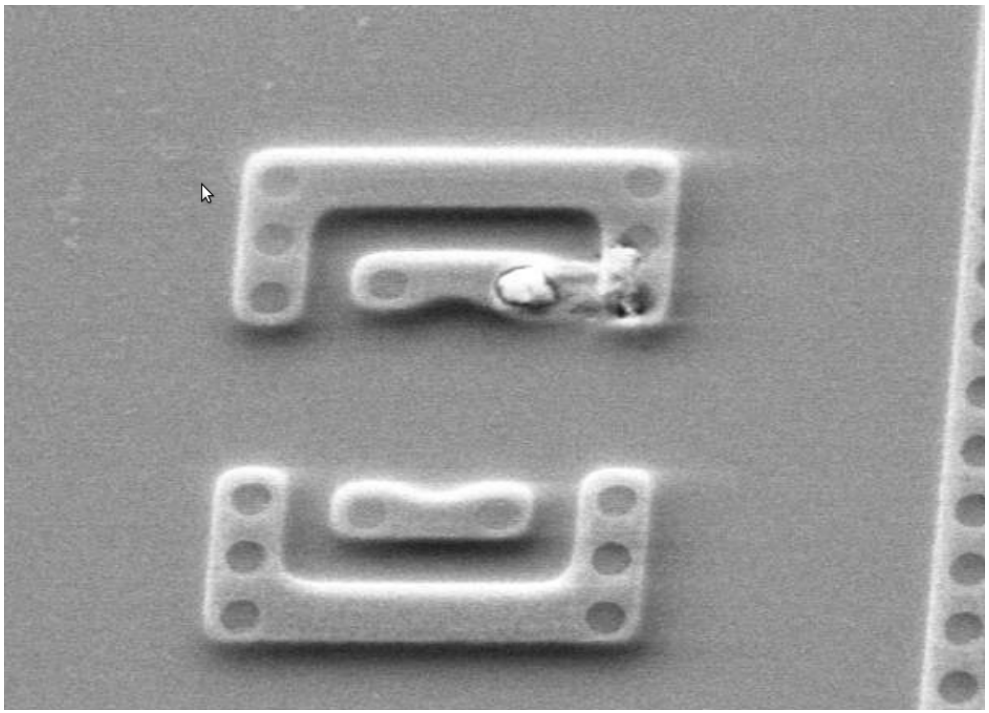
Please refer to the presentation of the November, 17th, 2009 for more details (link).

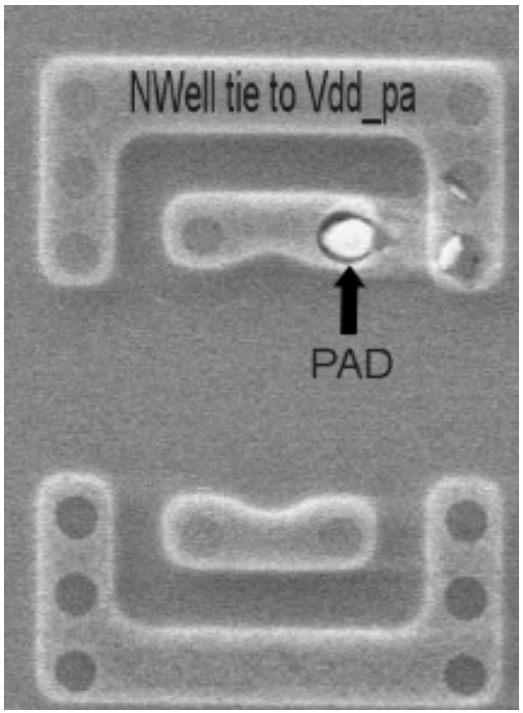
- No dead channel during detector burn-in;
- Analog channel destruction due to high spark rate in testbeam.

Chip analysis made by Serma technologies (Minatec/Grenoble).

SEM photography

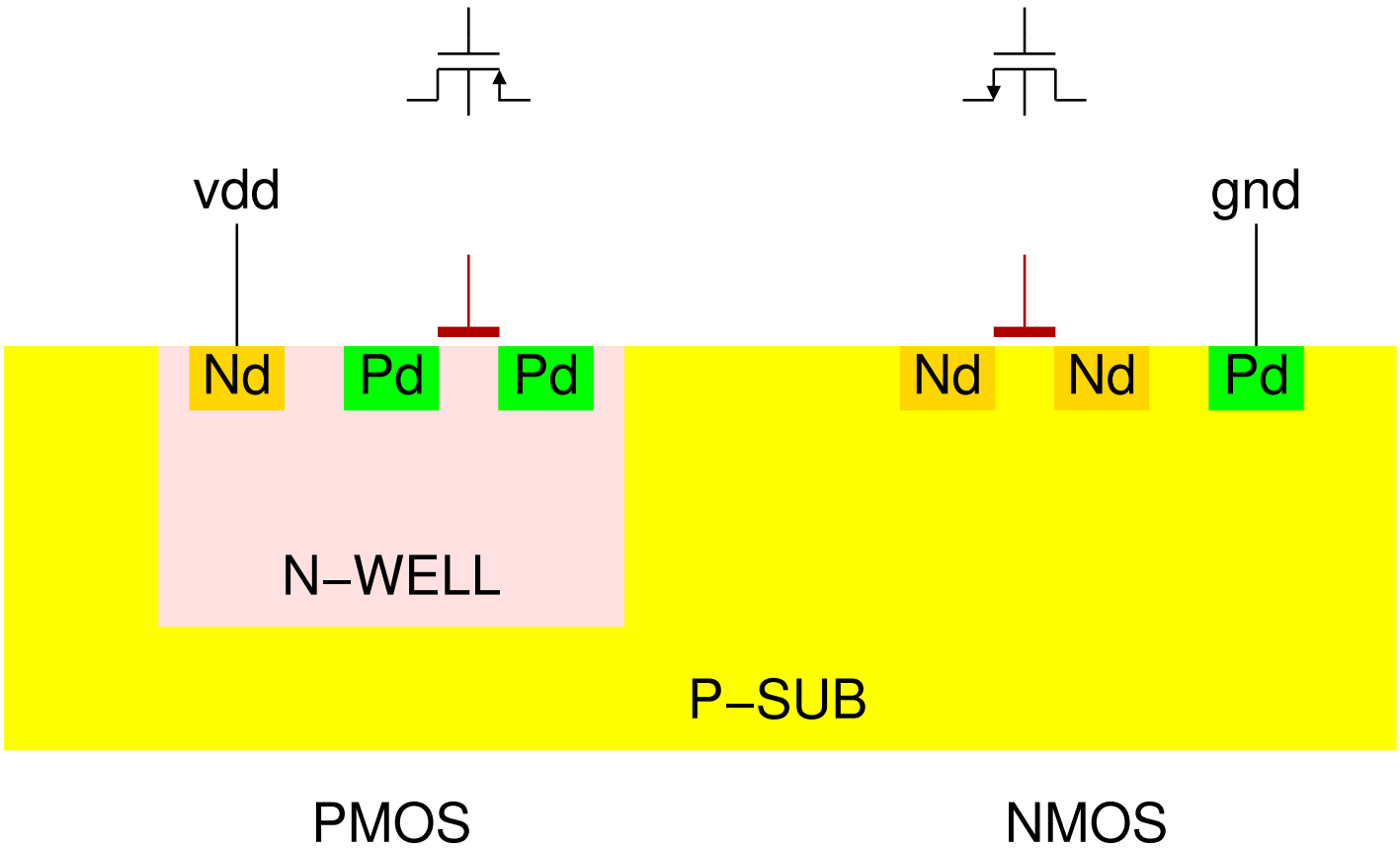
SERMA confirm that there is nothing to be seen with optical microscopy. . .
Scanning Electron Microscopy shows defect between P and N diffusion into an N-Well, for all dead channels:





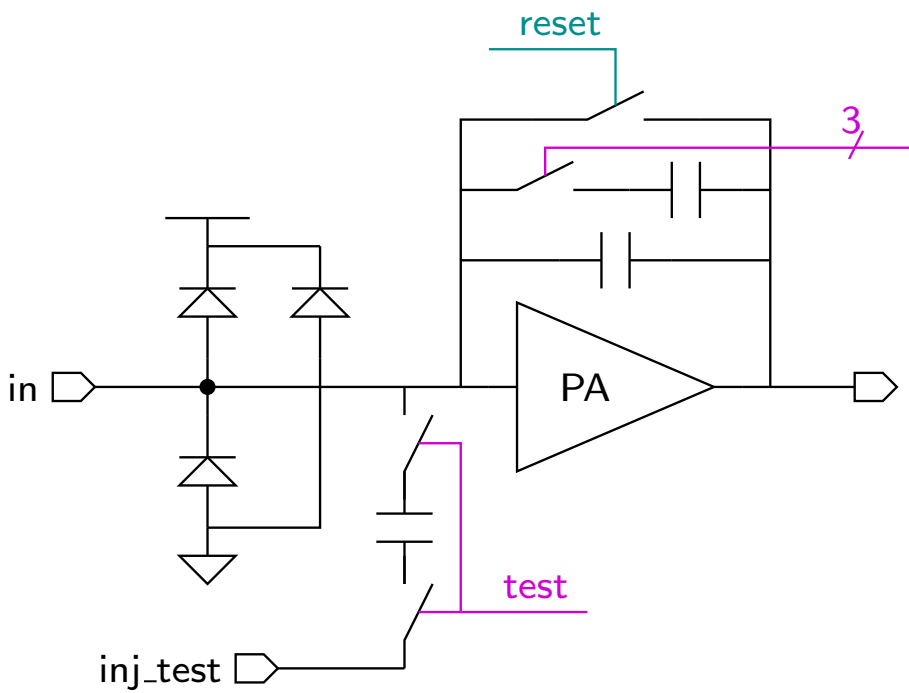
The MOS structure

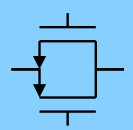
Simplified cut of the AMS MOS technology:



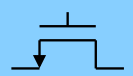
Schematics

The damaged structure is the reset switch of the charge preamplifier!





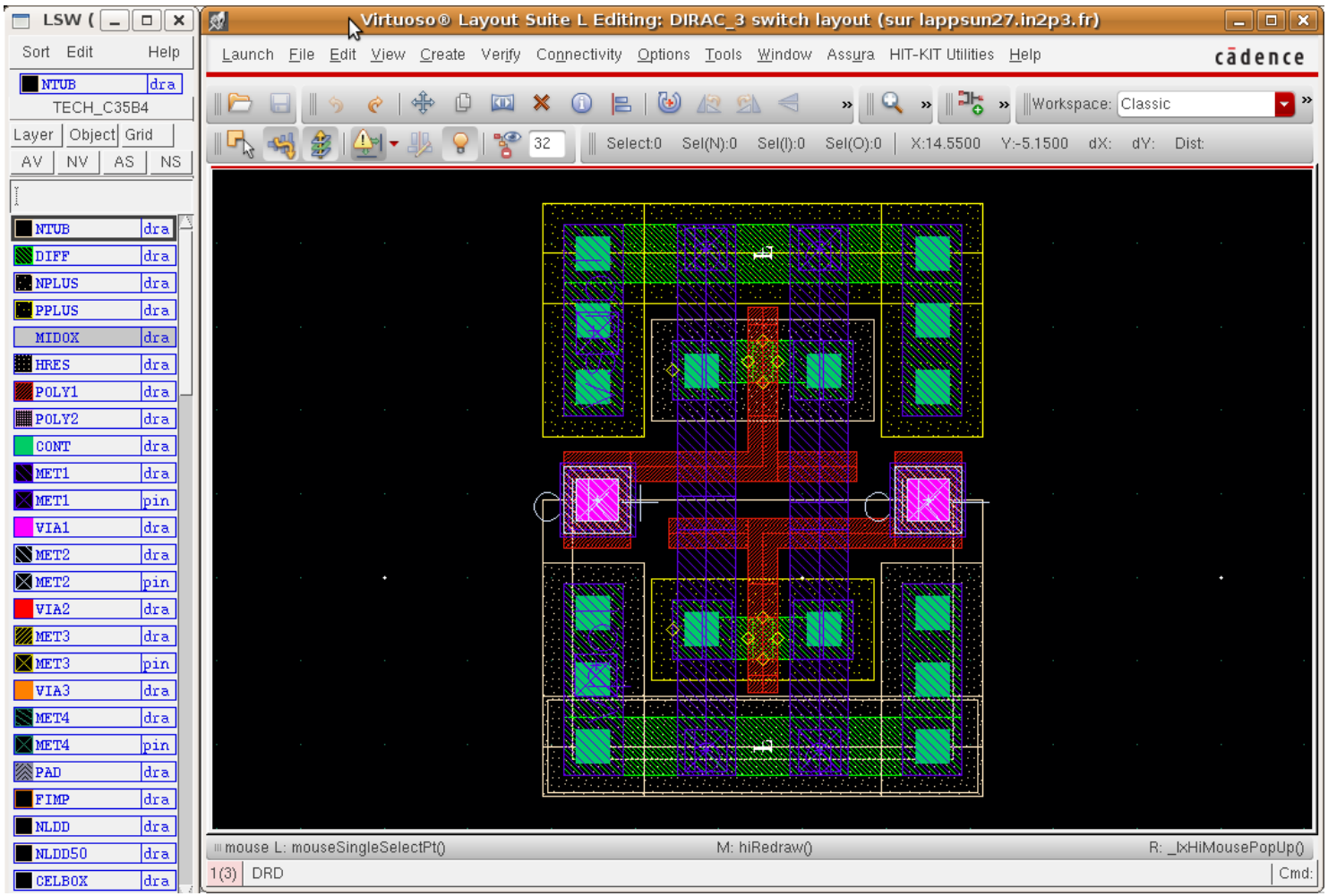
reset switch
is made of
complementary MOS



static switches
are made of
N-type MOS only

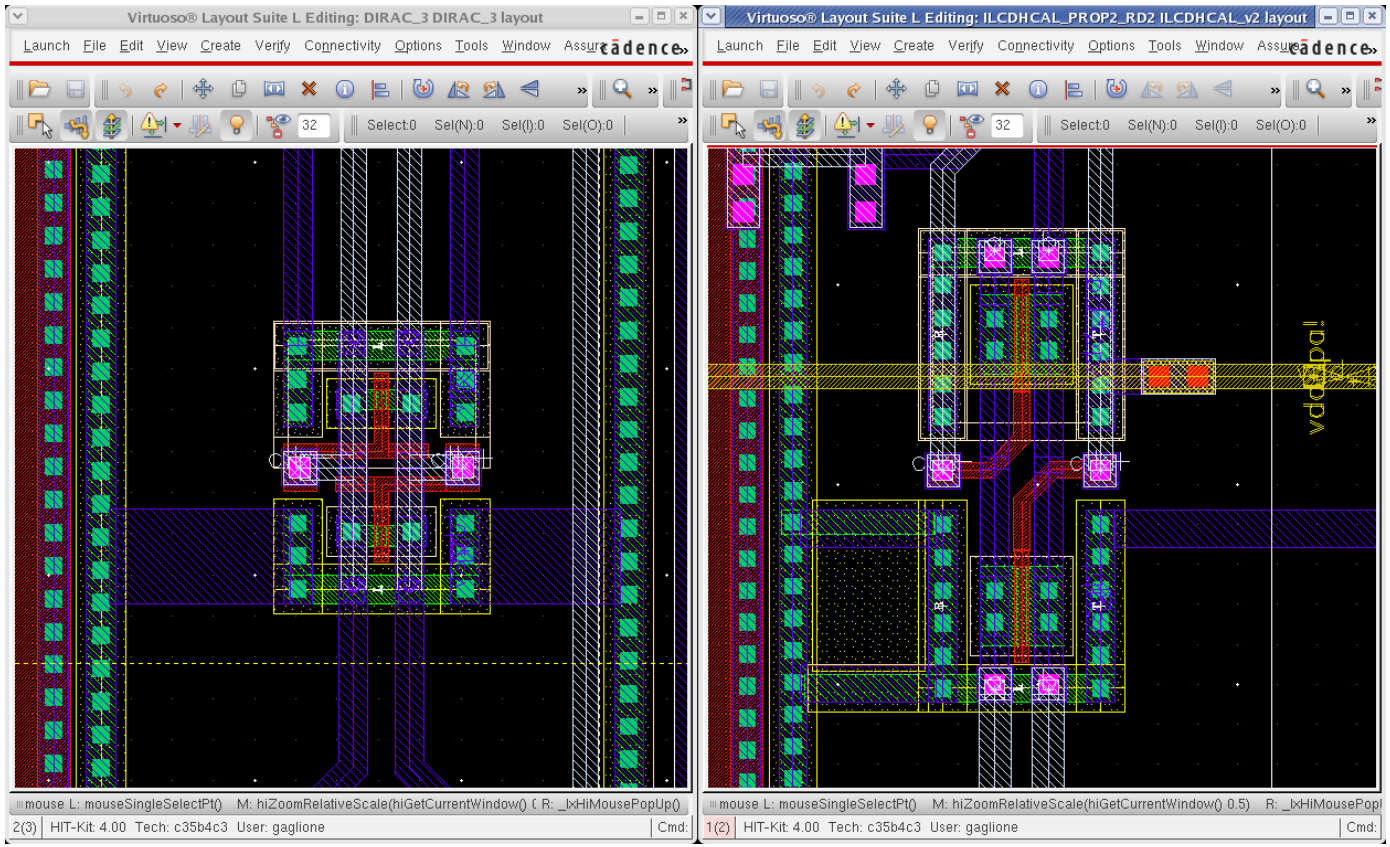
Layout view

The complementary switch:



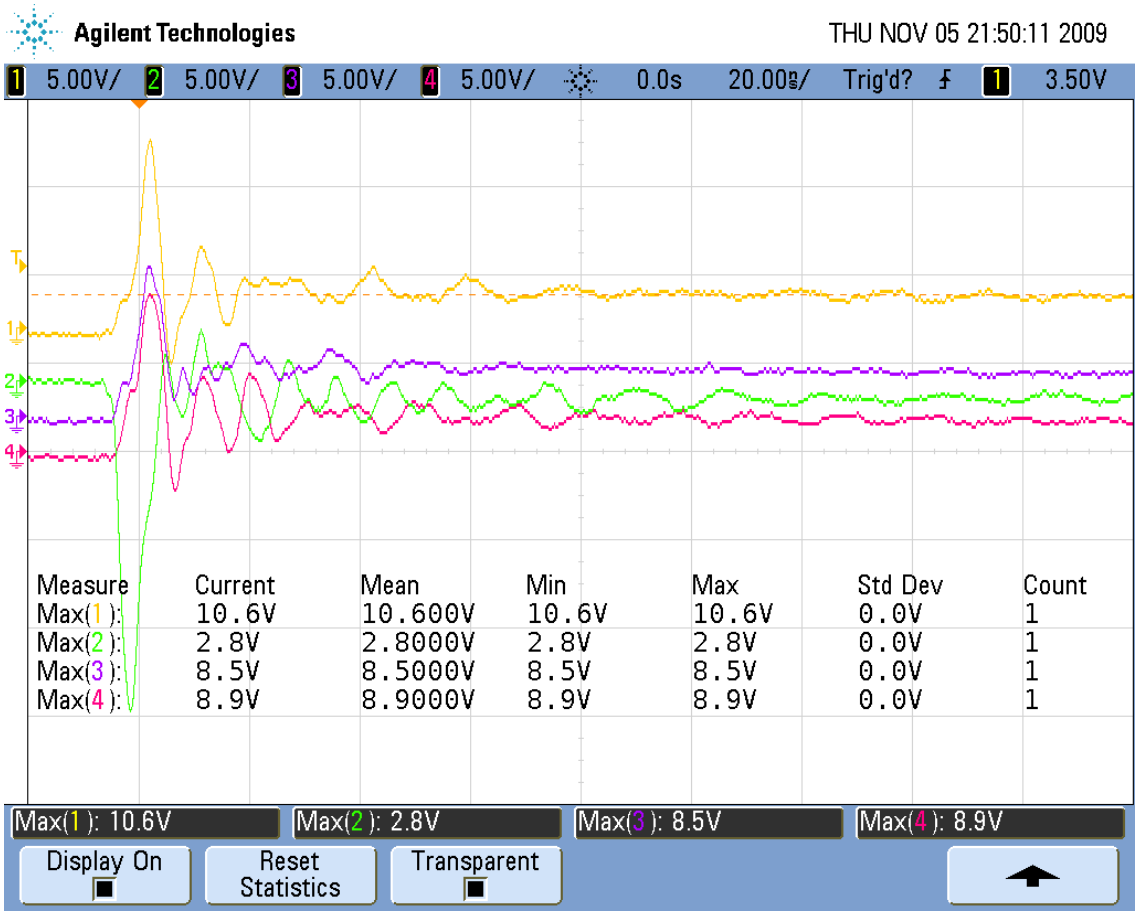
DIRAC 1 *vs.* DIRAC 2

Structure has been optimized on DIRAC 2 to reduce injected noise, improve matching and reduce area.



What happened?

The PN junction diodes between input and N-Well start to conduct due to an input voltage $>$ vdd+0.6 V. This can happen only with a positive voltage on input pin (V_{mesh} is negative)!



Protection R&D

Status:

- Spark testboard has been submitted to Rui before holidays;
- Lot of diodes from different manufacturers have been received to perform reverse-engineering;
- We have 2 embedded capacitors (from Rui) to be characterized.

Conclusions

We learn that:

- Every single detail on the pad path is important!
- We know how to correct the problem (increase distance, add serial resistor);
- External protection are at the limit $\longrightarrow$ must be improved for large scale detectors!

To do

8×8 prototypes:

- Precisely measure pad capacitance on a dead prototype;
- Precisely measure mesh capacitance on a dead prototype;
- Characterise embedded capacitors;
- Rebuild 4 ASU for cosmic bench;
- Perform precise timing measurement on anode (receive a high bandwidth, low-noise amplifier).

Other duties

- Finish testbeam efficiency analysis (hard to do because of old version of Labview);
- Design and submit to review the new preamplifier (HardrocX?, DiracX?, MAMMA?, CLIC?).