

## MALTA monolithic Pixel sensors in Tower 180 nm technology

Heinz Pernegger / CERN EP Department Heinz.pernegger@cern.ch

On behalf of H. Pernegger, P. Allport, I. Asensi Tortajada, D.V. Berlea, D. Bortoletto, C. Buttar, F. Dachs, V. Dao, H. Denizli, D. Dobrijevic, L. Flores Sanz de Acedo, A. Gabrielli, L. Gonella, V. Gonzalez, G. Gustavino, M. LeBlanc, K. Oyulmaz, F. Piro, P. Riedler, H. Sandaker, C. Solans, W. Snoeys, T. Suligoj, M. van Rijnbach, A. Sharma, M. Vazque Nunez, J. Weick, S. Worm, A. Zoubir

## MALTA = Radiation hard small pixel CMOS sensor for tracking

**Developed for application** as tracking sensors at HL-LHC with pecifications suitable for pp-experiments:

- NIEL radiation hardness 2  $x10^{15}n_{eq}/cm^2$
- TID radiation hardness >100Mrad
- pixel size <50x50μm<sup>2</sup>

## MALTA sensor parameters and performance

- Pixel Pitch pixel size 36.4x36.4µm<sup>2</sup>
- Matrix size 512 x 512 pixel (MALTA1) and 512 x 224 pixel (MALTA2)
- Asynchronous readout architecture to stream all hit data to output (trigger-less operation)
- Sensors data daisy-chain for sensors-to-sensor data transmission
- sensor thickness optimised to application 50µm to 300µm

TJ180nm CIS Process towards radiation hardness

- Radiation hard MALTA sensor implemented in high volume industrial 180nm CMOS process
- Implant design optimised for high charge collection speed, fast signal response and radiation hardness
- Produced on Epitaxial and Czochralski high-resistivity substrates



Block diagram of MALTA3

- 40 MHz bunch tagging
- Sensor size ~ 20x20mm<sup>2</sup>
- Target ENC noise ~ 10 e-
- Minimal Threshold ~ 100 e-
- full efficiency (>98%) 2 x10<sup>15</sup>n<sub>eg</sub>/cm<sup>2</sup>
- time-resolution <2ns</li>
- minimal threshold after irradiation 120 e-



- Threshold dispersion typically 10% of threshold
- values doubles with neutron irradiation to 3 x10<sup>15</sup>n<sub>ed</sub>/cm<sup>2</sup>







- Modular 24-column block design to scale to desired sensors matrix size