

LMU München - Excellence Cluster Universe

# First Measurements on Output Impedance

Stefan Rummel, Stefan Petrovics, Felix Mueller





#### Overview



- Output impedance
- Measurement
  - Method
  - Comparison with simulation
  - Tests
    - Decoupling
    - Long cables
    - PP & hierarchical decoupling
- Outlook and interpretation



## Output impedance



- Measuring deviation from ideal voltage source
- Modulating current with well defined frequency







- Setup with long lines, sense wires and regulator
- Both current and voltage are measured simultaneously
- Filtering and amplitude extraction done on PC level



#### Measurement & Simulation



- Simulation with regulator
- Cable modeled as inductor (no distributed parasitics)
- Good agreement







- Potential LC resonance L-Kapton C-PP
- Flex simulated with 30cm Cat4 TWP





- Hierarchical decoupling Flex replaced with 30cm Cat4 TWP
- Regulator still stable
- Structural change  $\rightarrow$  addition peak ~1MHz , LC-resonance short wire decoupling



### Hierarchical decoupling & long cables





- Capacitance @ detector 470nF
- Varying C on PP from 0uF-1uF-10uF-22uF
- $\rightarrow$ Output impedance improves for almost all frequencies



### Hierarchical decoupling & long cables





- 100nF @ load
- Varying C on PP from 0uF-1uF-10uF-22uF
- $\rightarrow$ Output impedance improves for almost all frequencies



Outlook - Interpretation



- Understanding of the behavior of the output-impedance
- Ability of systematic investigations
- Measurements are with PP/Kapton replacement
  - $\rightarrow$  Verify power distribution chain with Kapton prototypes
- Decoupling @ PP improves output impedance at almost all frequencies
- Typical frequencies for DEPFET
  - Static voltages 100Hz 10mOhm, DC Measurements .5mOhm
  - Steering voltages draw current at 10MHz + harmonics
  - Digital circuitry @ clock frequency
  - $\rightarrow$  Falls into regions with low output impedance

 $\rightarrow$  Can serve as input for a realistic system simulation ( Christians Koffmane's work) including power distribution



LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Ł

Backup





- Found Wiener-MPOD in the cellar (dedicated "slow" mode for sensing, actually not used here)
- HMP4040 with sensing





### Noise level of Setup





## Noise floor of setup

- Noise Measurement without stimulus applied
- Only above 30MHz noise contribution to signal, rest factor 10-100 below signal