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# MOSFET probe for Intra Operative Radiotherapy

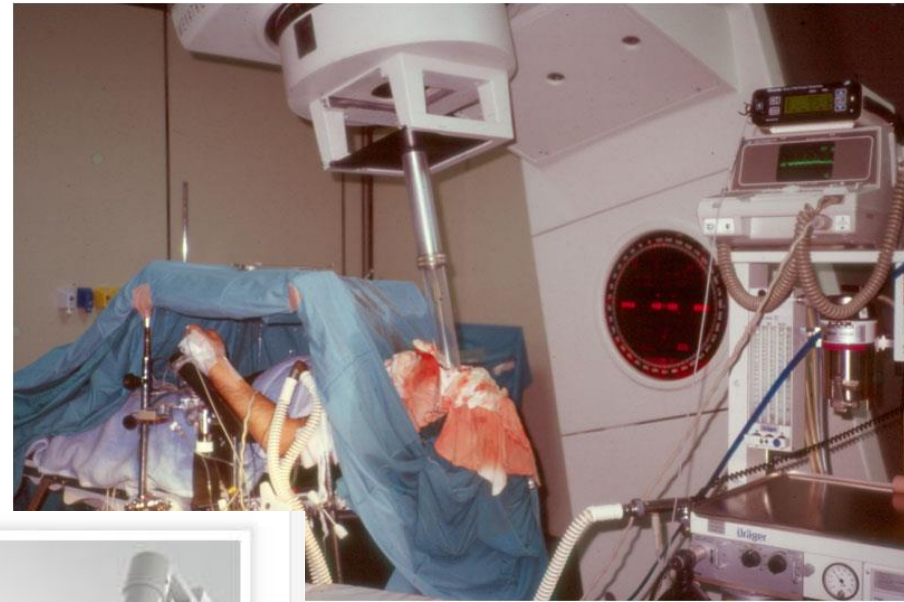
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## ■ Intra Operative Radiotherapy (IORT):

- Electron beams
- Only one irradiation session
- Wired sensors are required

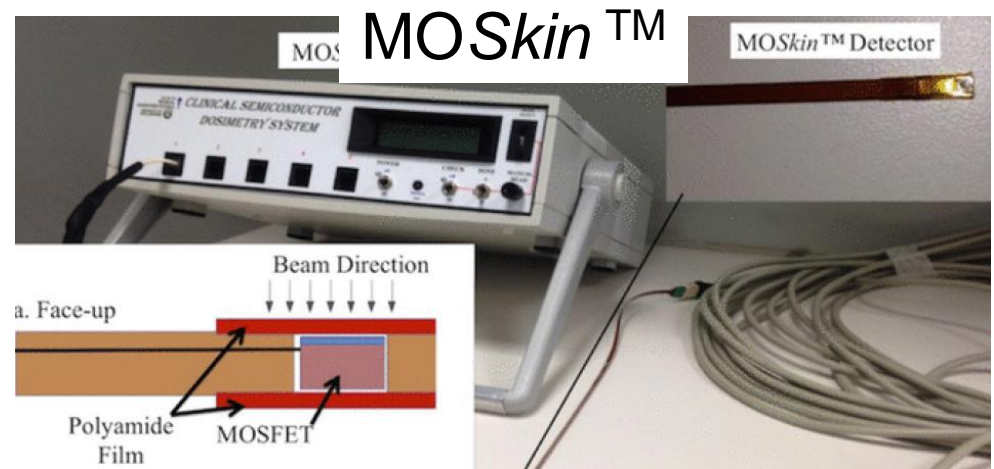


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# INTRODUCTION

- Dosimetry system based on wired MOSFETs

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- **Why MOSFETs?**
- Small size
- Immediate readout
- Easy calibration
- Reproducibility

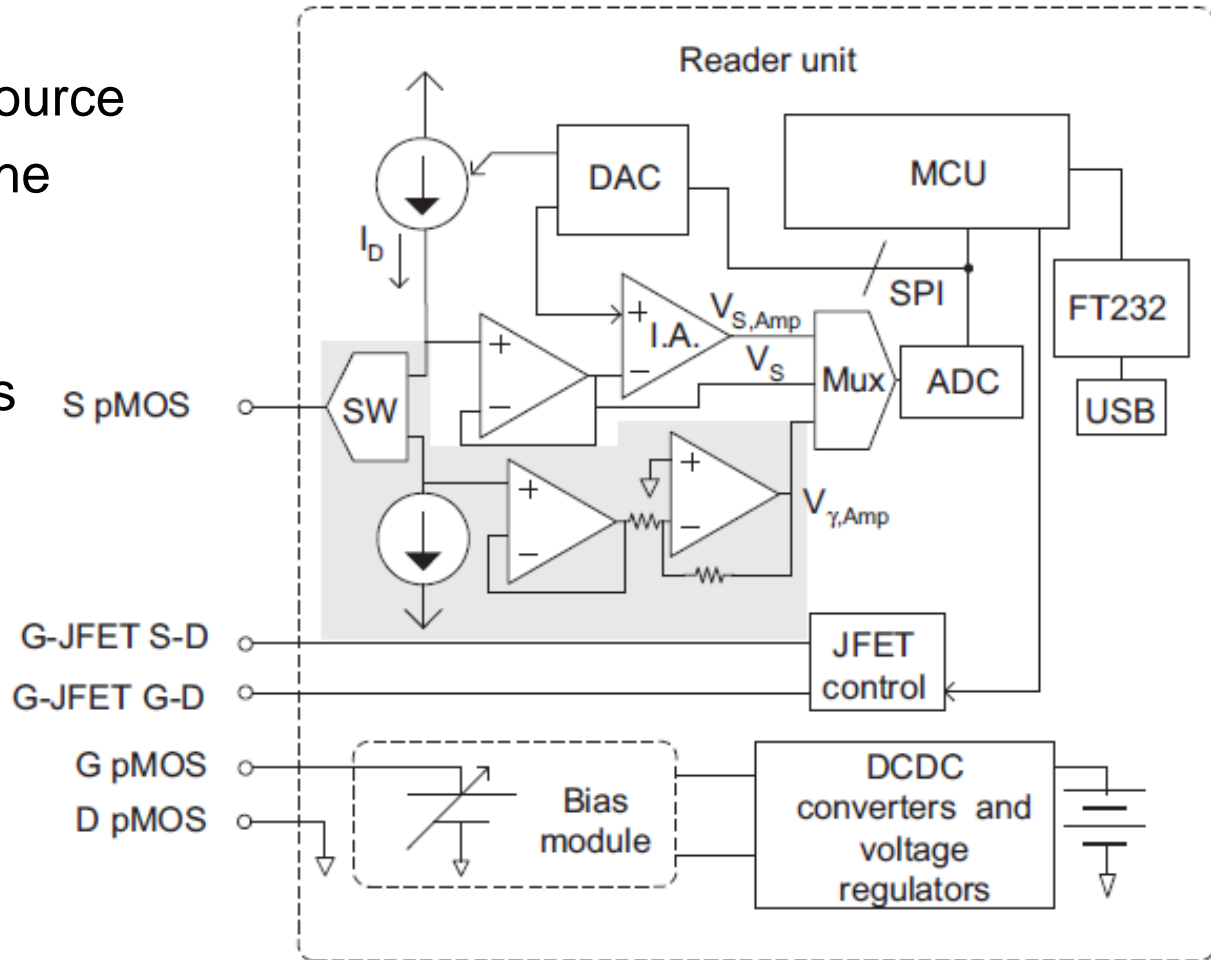
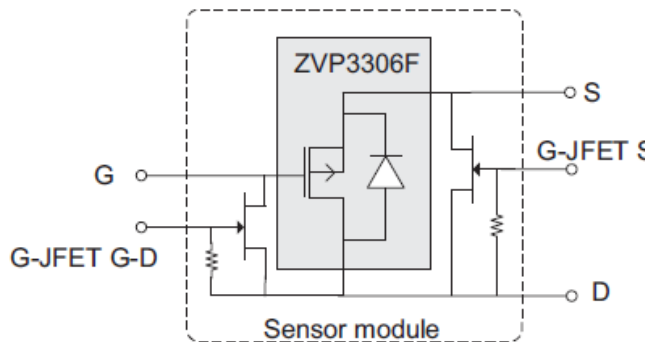
# Our goal

- **To measure dose as precise as possible using commercial low cost MOSFETs in electron beams treatments**
  - Stacked
  - Biased mode
  - Wired sensor

...

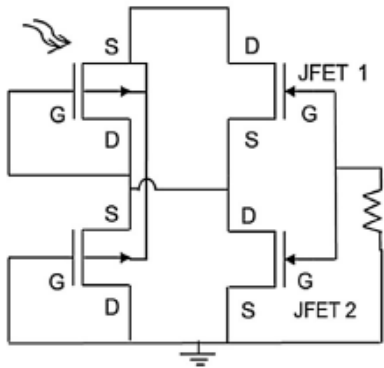
# State of art in our research group: Reader unit

- Programmable current source
- Sink current to activate the diode
- Zero DAC-I.A. Module
- Real-time measurements (every 5s)

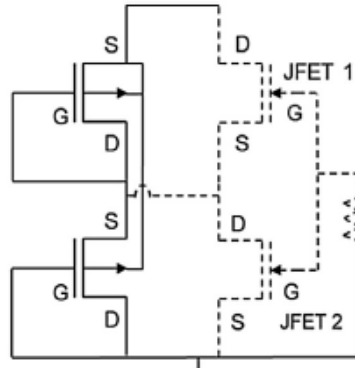


# State of art in our research group: Sensor modules

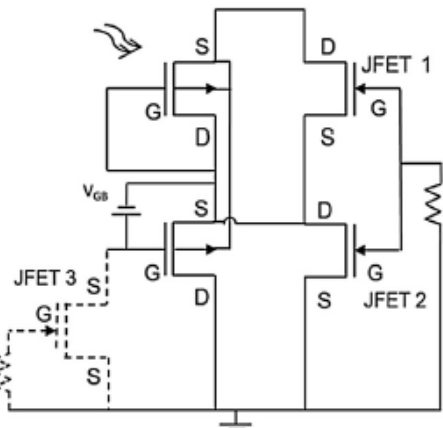
- Sensor modules based on commercial transistors and RADFETs from Tyndall:



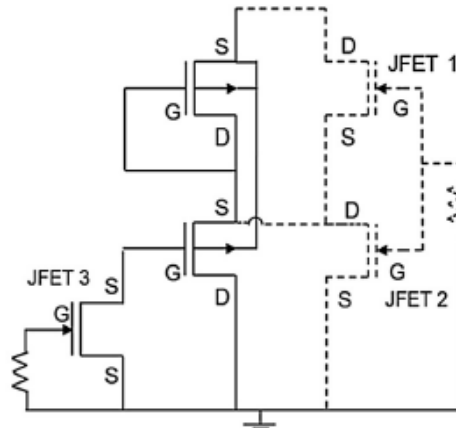
a)



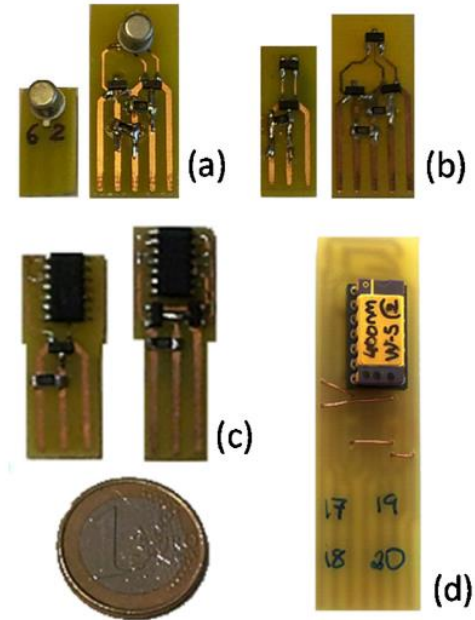
b)



c)

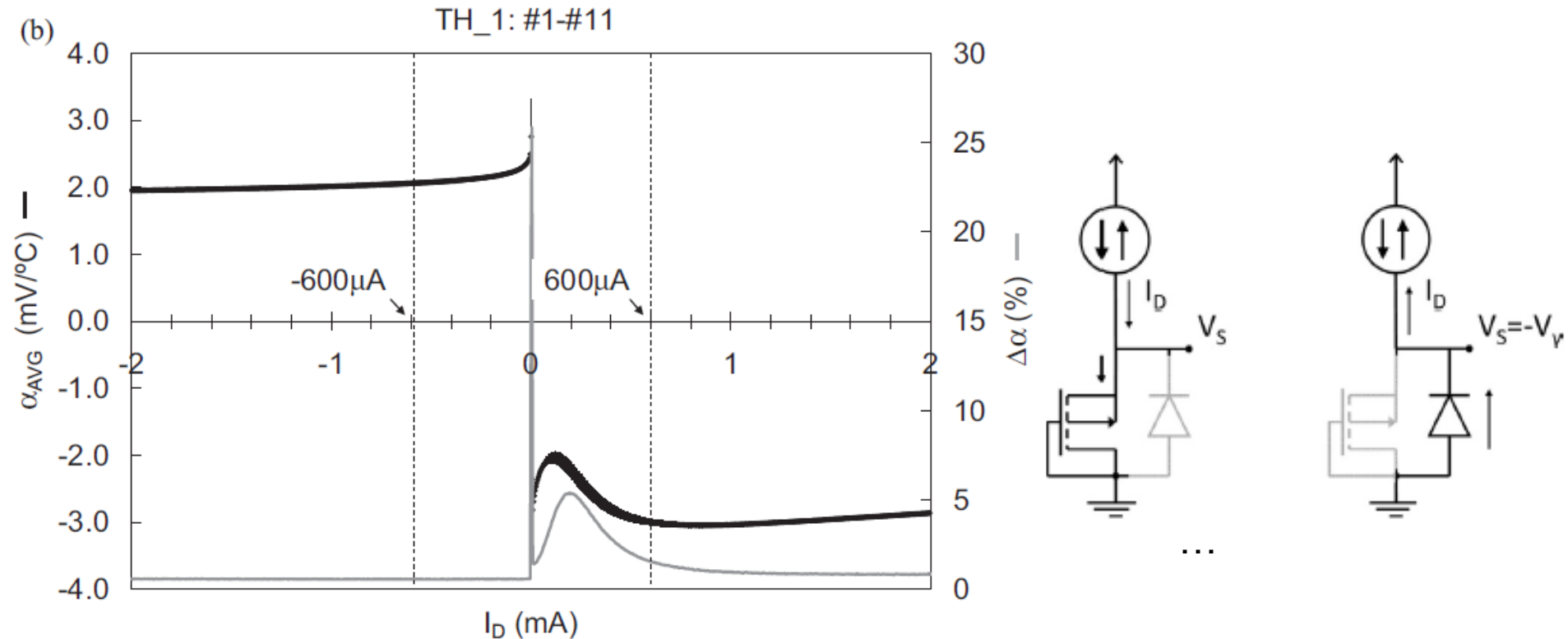


d)

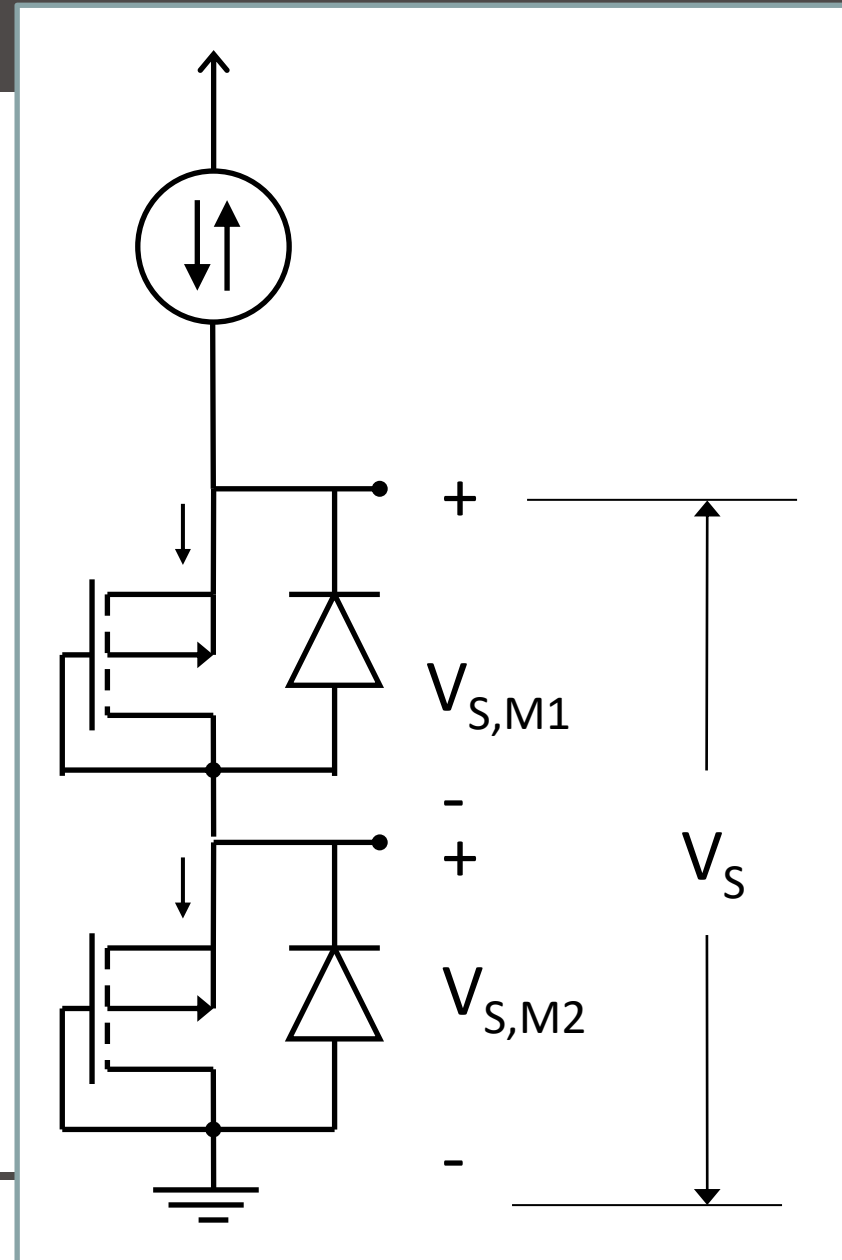


# State of art in our research group: Thermal compensation DMOS

- Inverting the current source the bulk source diode is activated



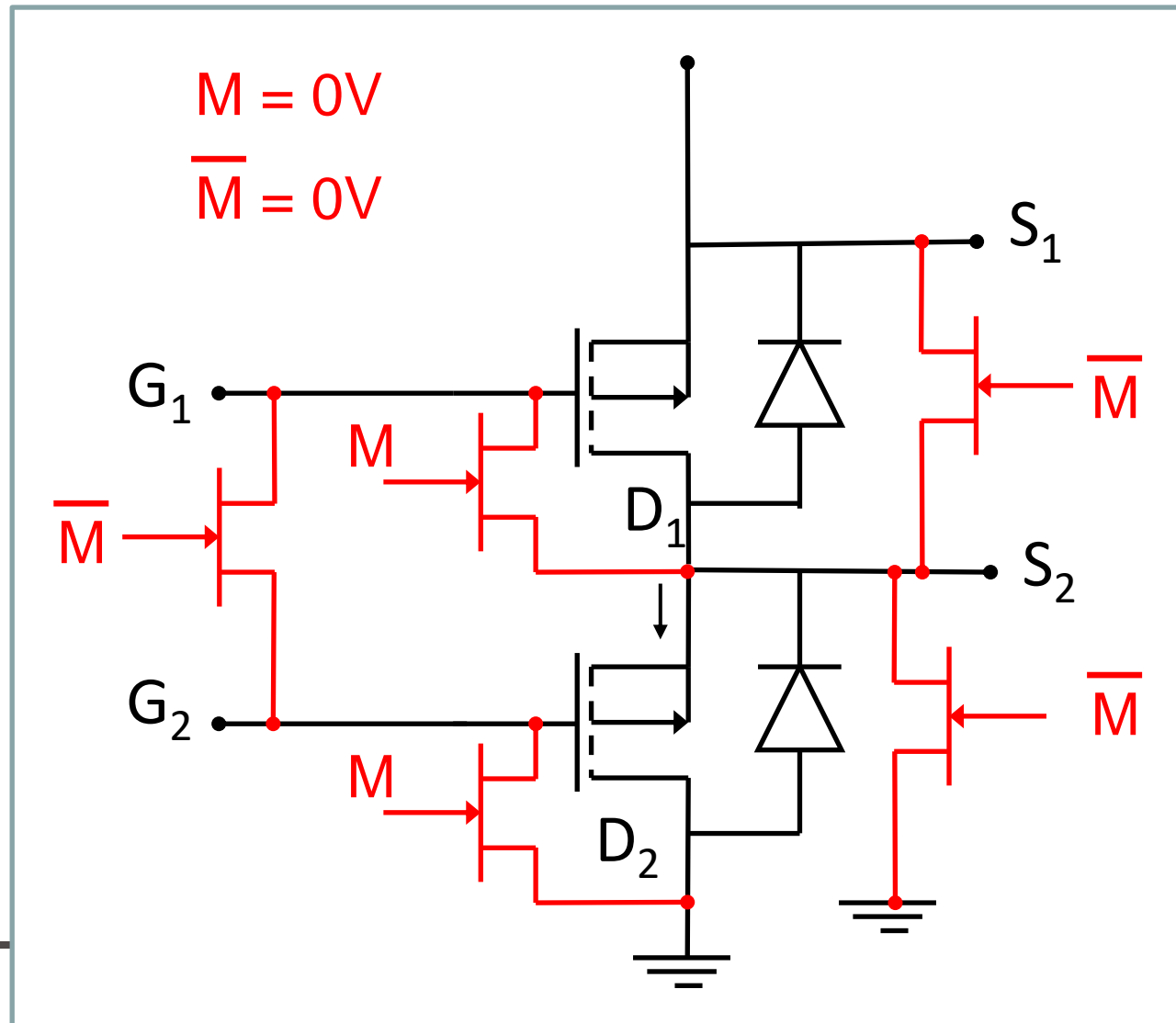
- Two biased and stacked commercial DMOS transistor
- Wired sensors (1.80 m length)
- Dimensions: under 5 mm
- Measurements every 5 s
- Electron beams
- **Four sensor states**
  - Storage
  - Read out
  - Temperature measurements
  - Sensing





# Sensor states: Storage

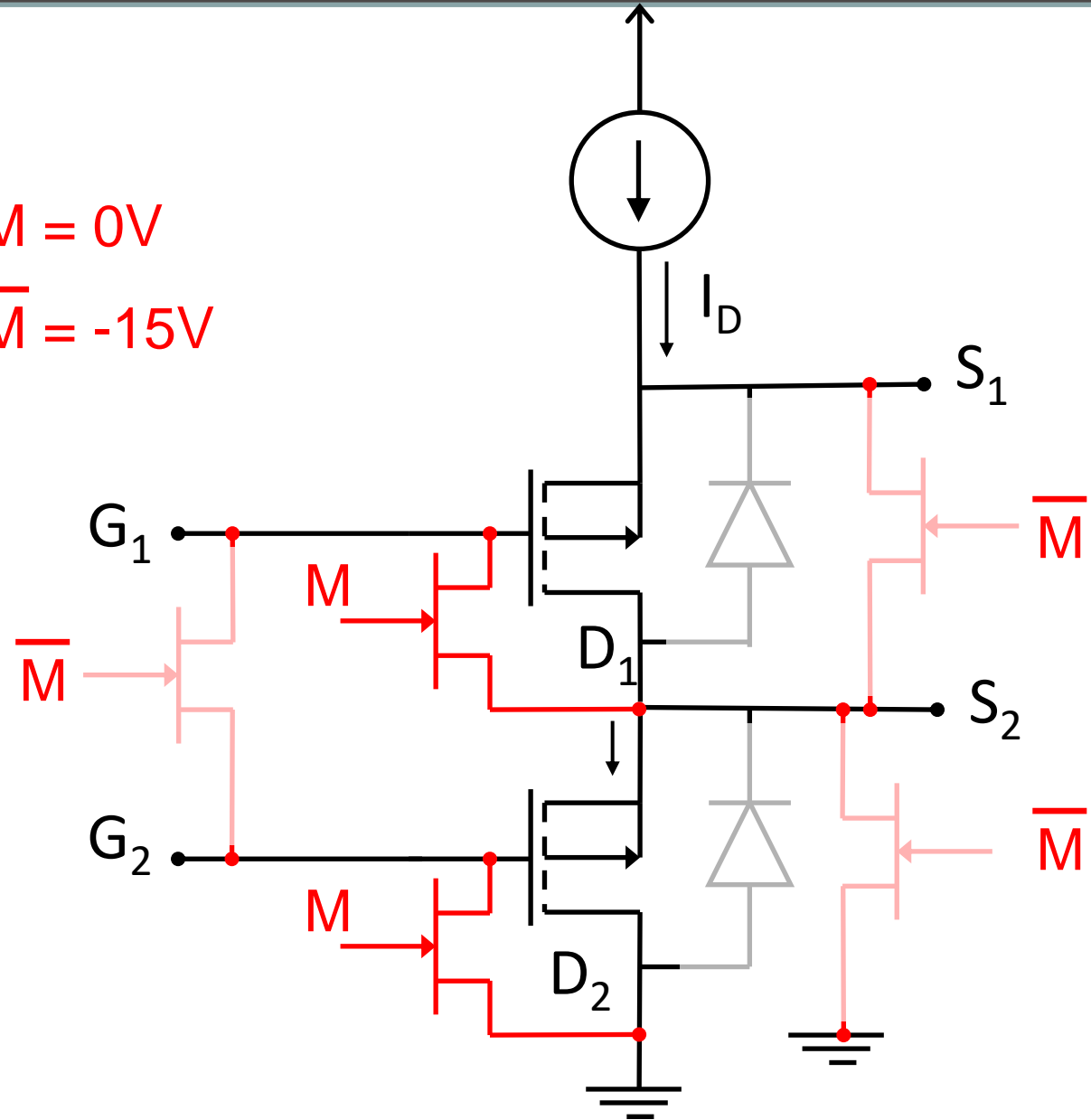
- All jFETs are ON
- All terminals are connected



# Sensor states: Read out

$$M = 0V$$

$$\overline{M} = -15V$$

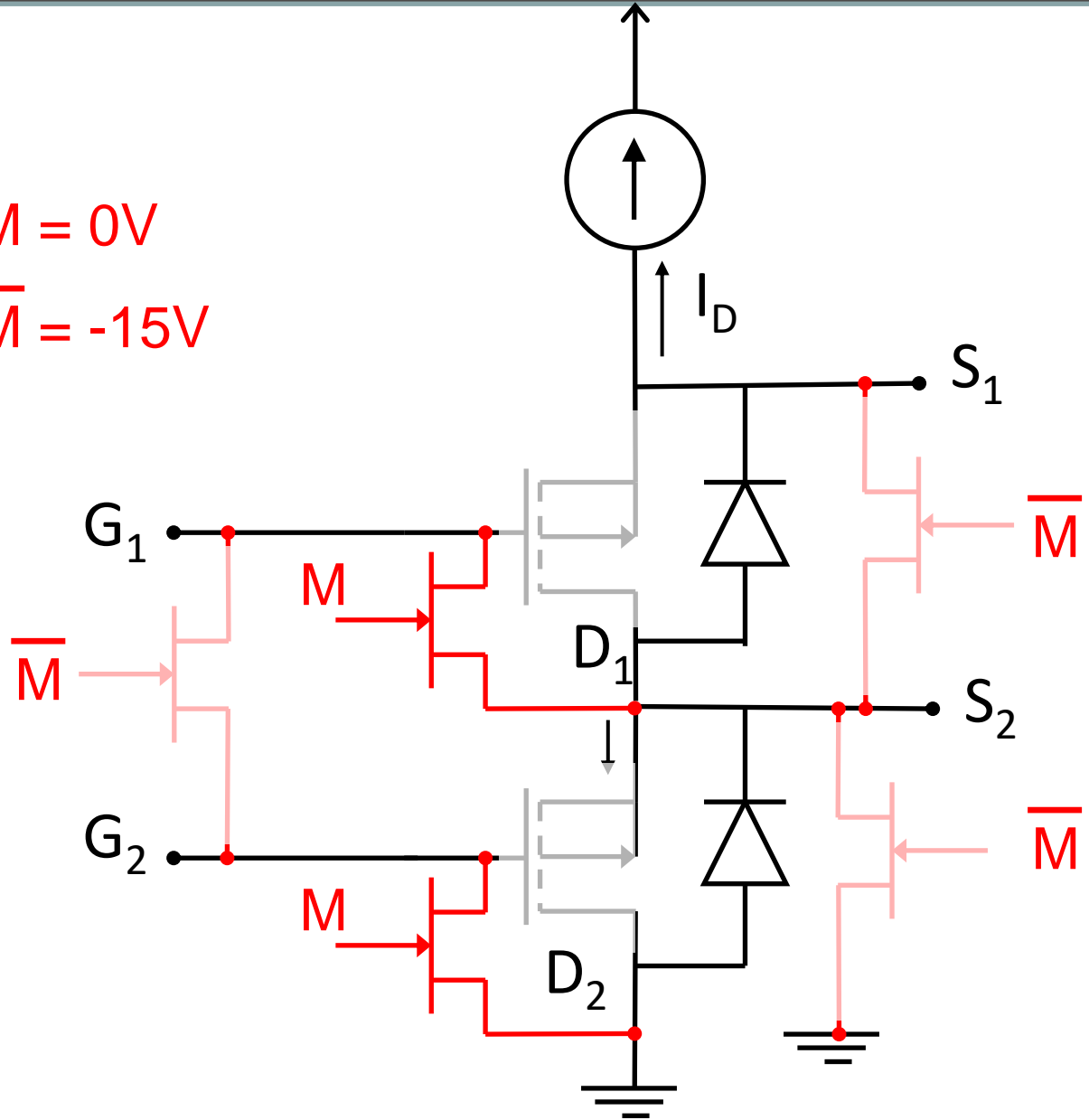


- Current is forward
- G-D jFETs are ON
- DMOS is saturation regime

# Sensor states: T measuring

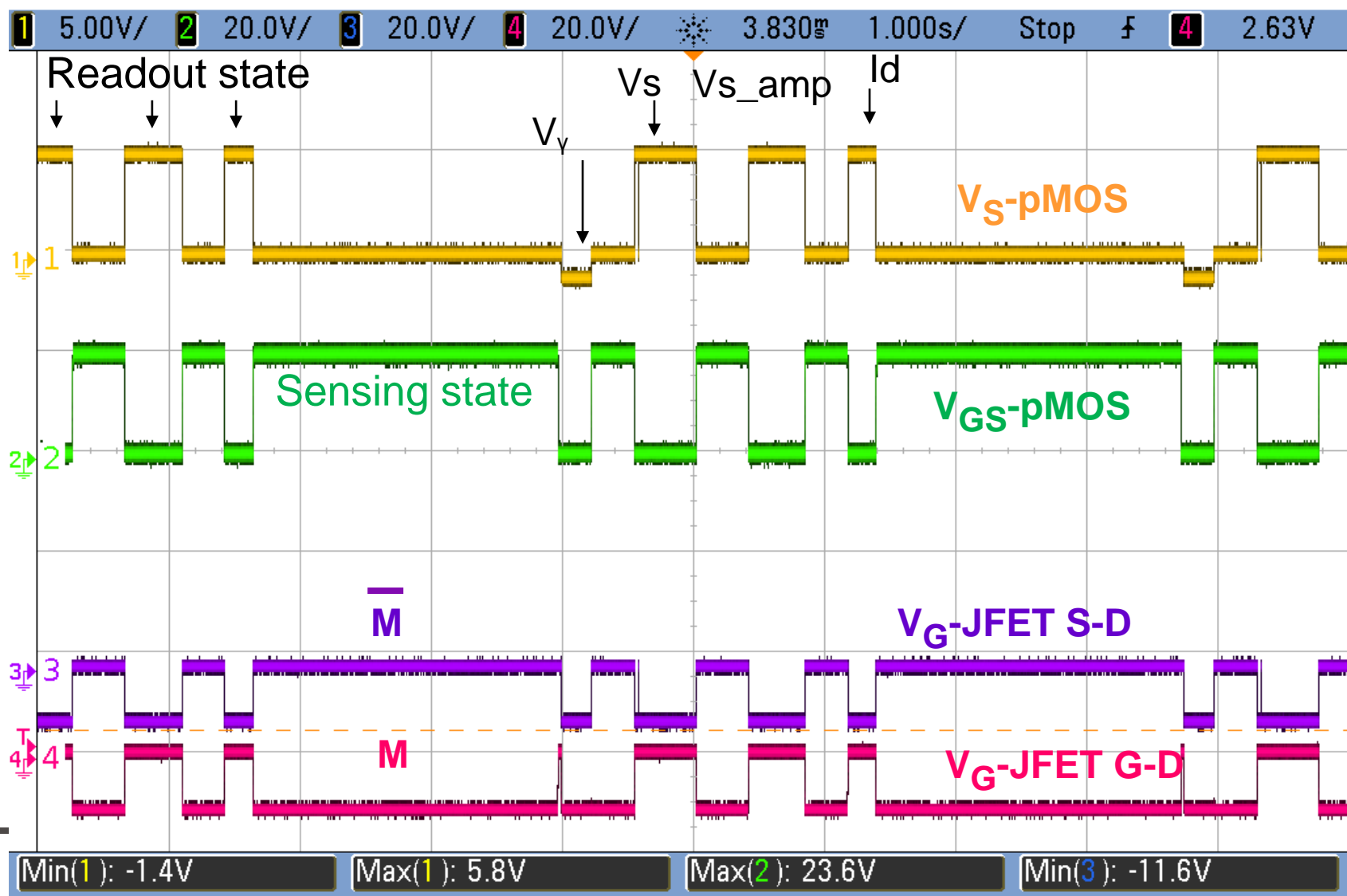
$M = 0V$   
 $\overline{M} = -15V$

- Current is reversed
- G-D jFETs are ON
- Diode is activated



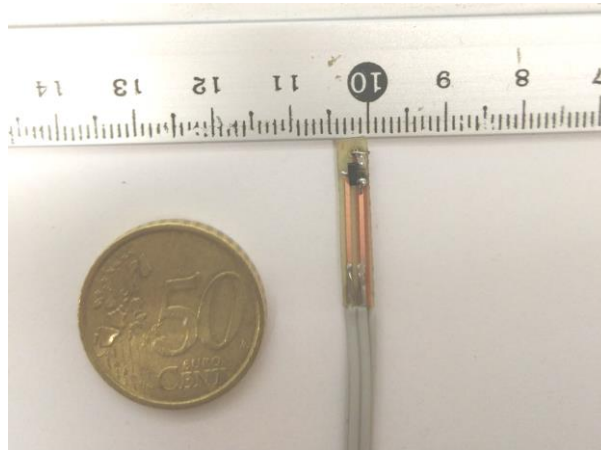


# Measurement chronogram



# Sensor manufacturing

- Thickness Printed Circuit Board has been reduced down 0.8 mm.
- Wired sensors (1.80 m length)
- pMOS transistors in both PCB sides
- jFET included in the reader unit connector
- Diameter of the sensor under 5 mm



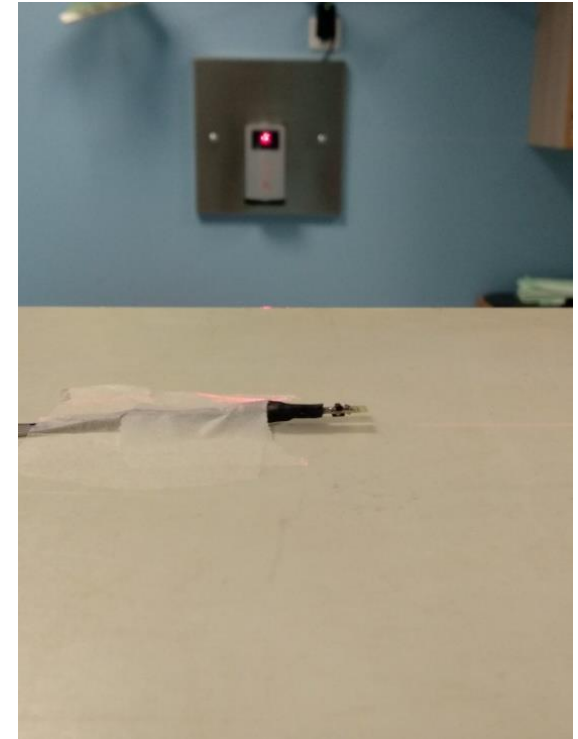
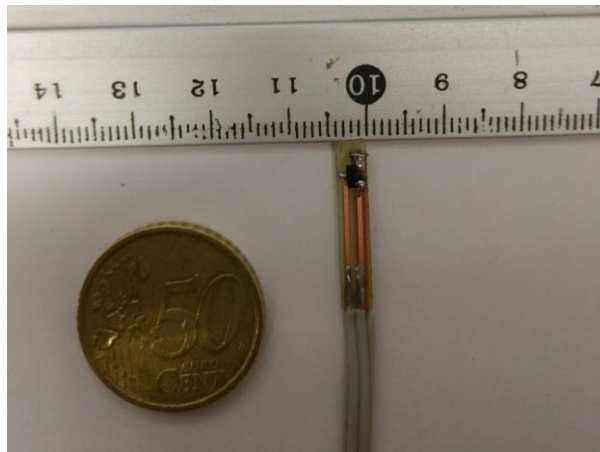
# Experimental setup

- Electron beams (LINAC: Siemens Artiste):
  - With and without applicator
  - Solid water under the sensor modules
  - Electrons of 12 MV, field 10x10 cm<sup>2</sup>



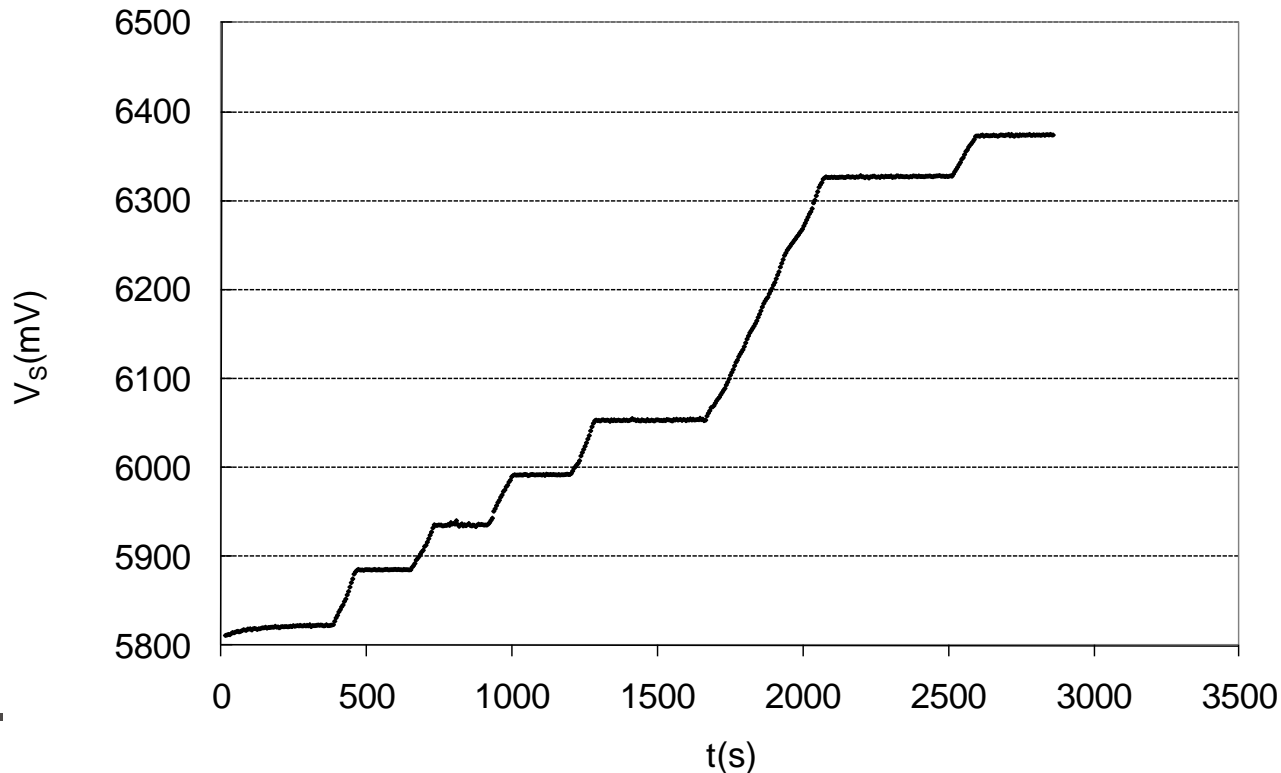
# Experimental setup

- Sensor at the iso-center of the source
- Gantry at  $0^\circ$  for sensitivities studies
- Reader unit shield with metal housing to reduce the absorbed dose





- **With applicator field 15x15 cm<sup>2</sup>**
  - Sensitivities:  $(14.4 \pm 1.3)$  mV/Gy and  $(13.8 \pm 1.1)$  mV/Gy



- **Without applicator field 10x10 cm<sup>2</sup>**
  - Two main dispersion between sensitivities: from 8 to 13 mV/Gy.
  - A deeper study is required:
    - Build up?
    -

# CONCLUSIONS

- A prototype of a real time dosimetry system based on commercial transistors have been developed, suitable for in-vivo dosimetry.
- A higher number of transistors of ZVP3306 must be studied in order to have a better statistical uncertainties.
- The rise of the  $V_S$  of lateral transistors must be studied in depth, however it was not observed for DMOS.

- Include the biasing module into the reader unit.
- Study the  $V_S$  drift due to external polarization (two currents, pulsed,...).
- Thermal correction of DMOS using the diode is being studied.
- Study the response of a wider group of ZVP3396 with photons and electron beams.
- Study the response of RADFETs.
- To test the bluetooth link inside the bunker
- ...

# Acknowledgements

- University Hospital San Cecilio (Granada, Spain).
- For funding this work: Ministerio de Ciencia e Innovacion and the Junta de Andalucía and CEI-BioTIC-UGR.
- And partially supported by European Regional Development Funds (ERDF)

see you in Granada

**It's  
here!**

**Thank you**  
for your attention

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