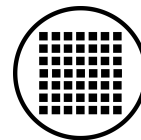




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CONICET

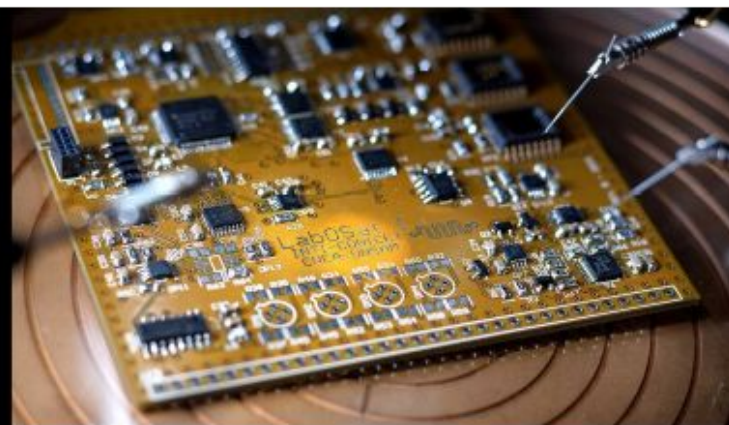
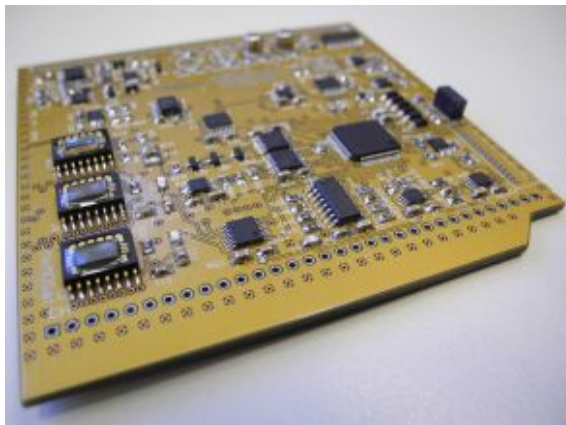


INTI



SATELLOGIC

LabOSat: plataforma de caracterización de dispositivos en órbita

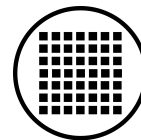


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CONICET

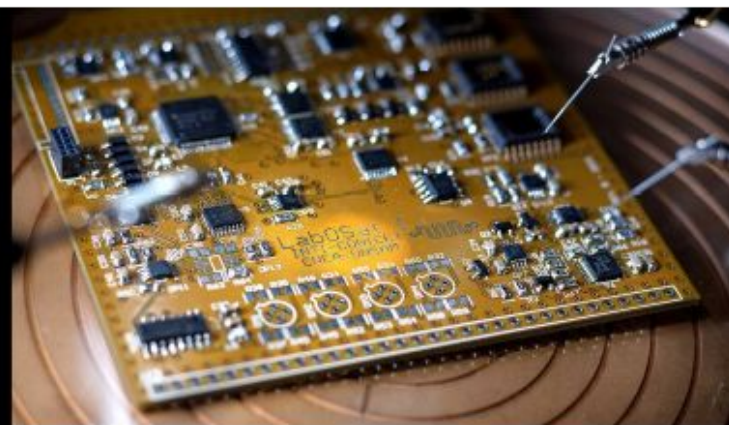
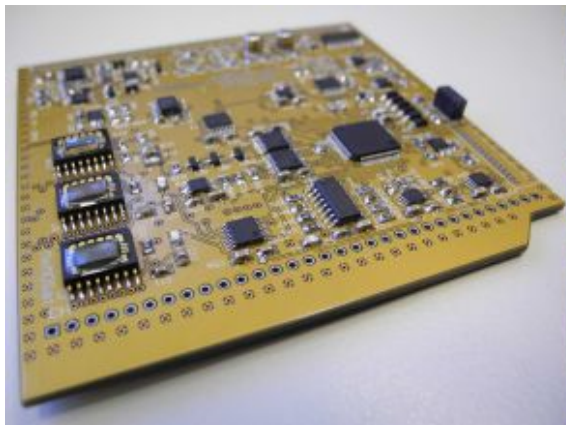


INTI



SATELLOGIC

LabOSat: plataforma de caracterización de dispositivos en órbita... y más



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ESCUELA
**CIENCIA Y
TECNOLOGÍA**



LabOSat
Laboratory On a Satellite



labosat.unsam.edu.ar

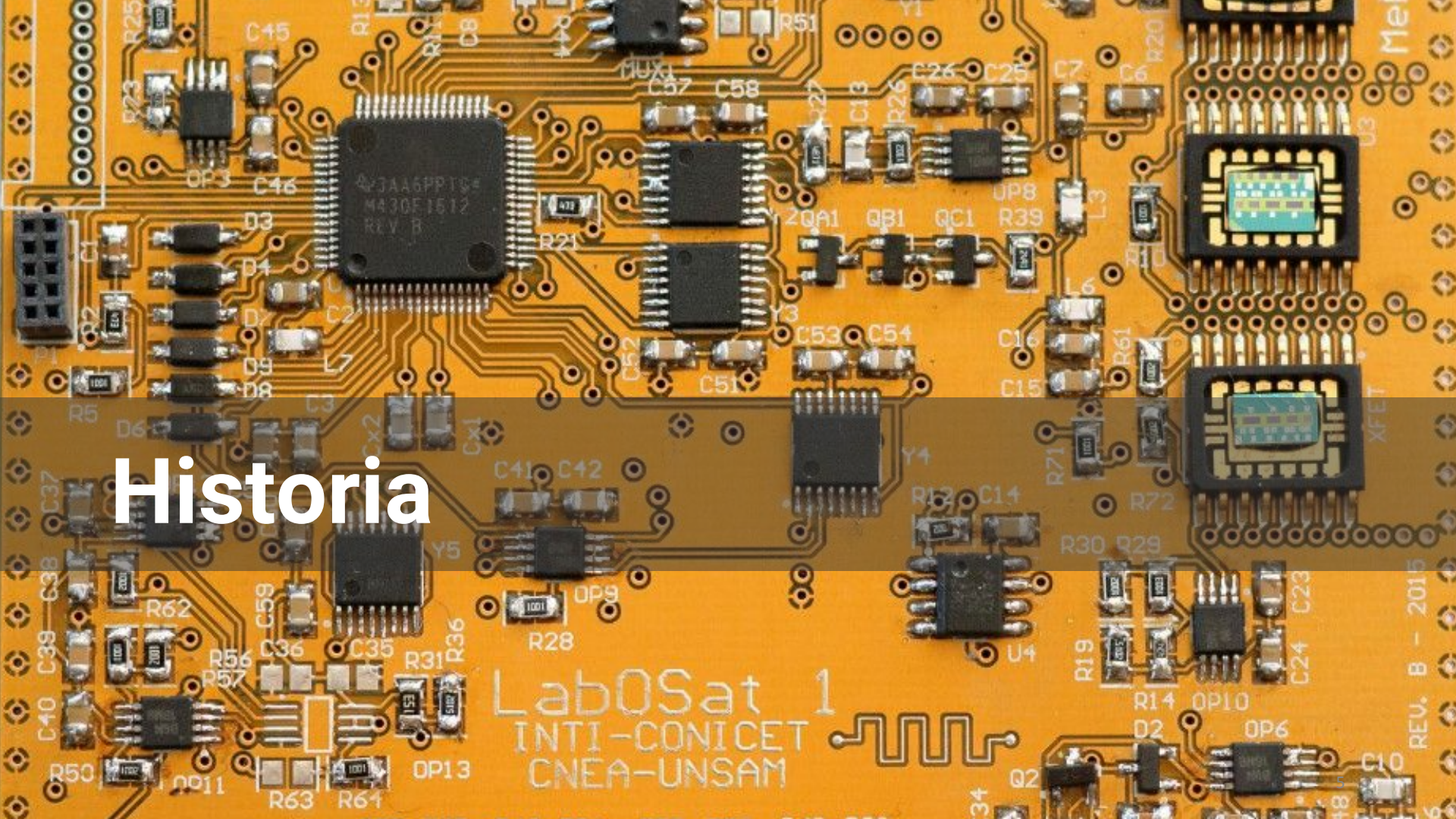
Plan de vuelo

1. Historia
2. Hardware y firmware
3. Plataforma de medición
4. Caracterización
5. Experimentos



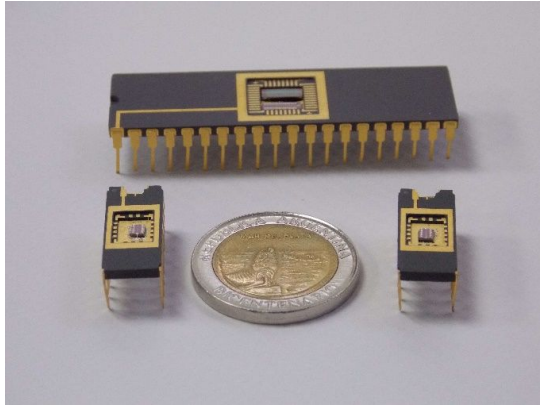
Historia

LabOSat 1
INTI-CONICET
CNEA-UNSAM



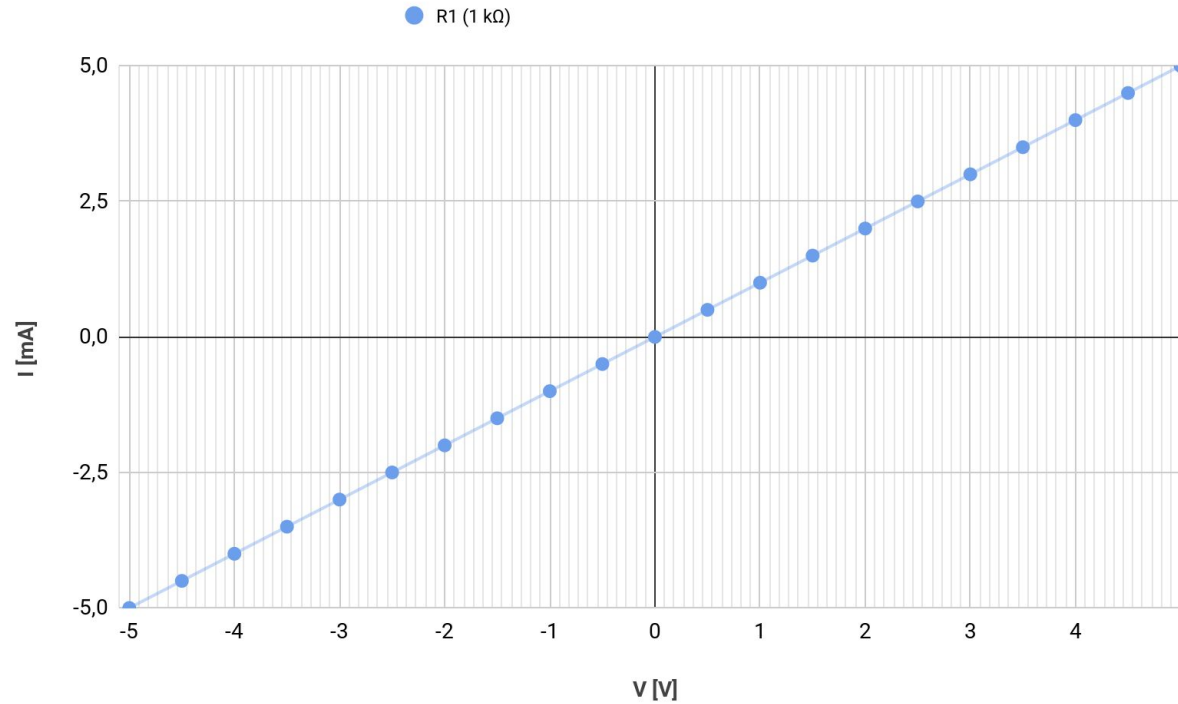
Historia: MeMO

- MeMO: mecanismos de memorias en óxidos
- Estudio RS (conmutación resistiva)
- Ciencia básica

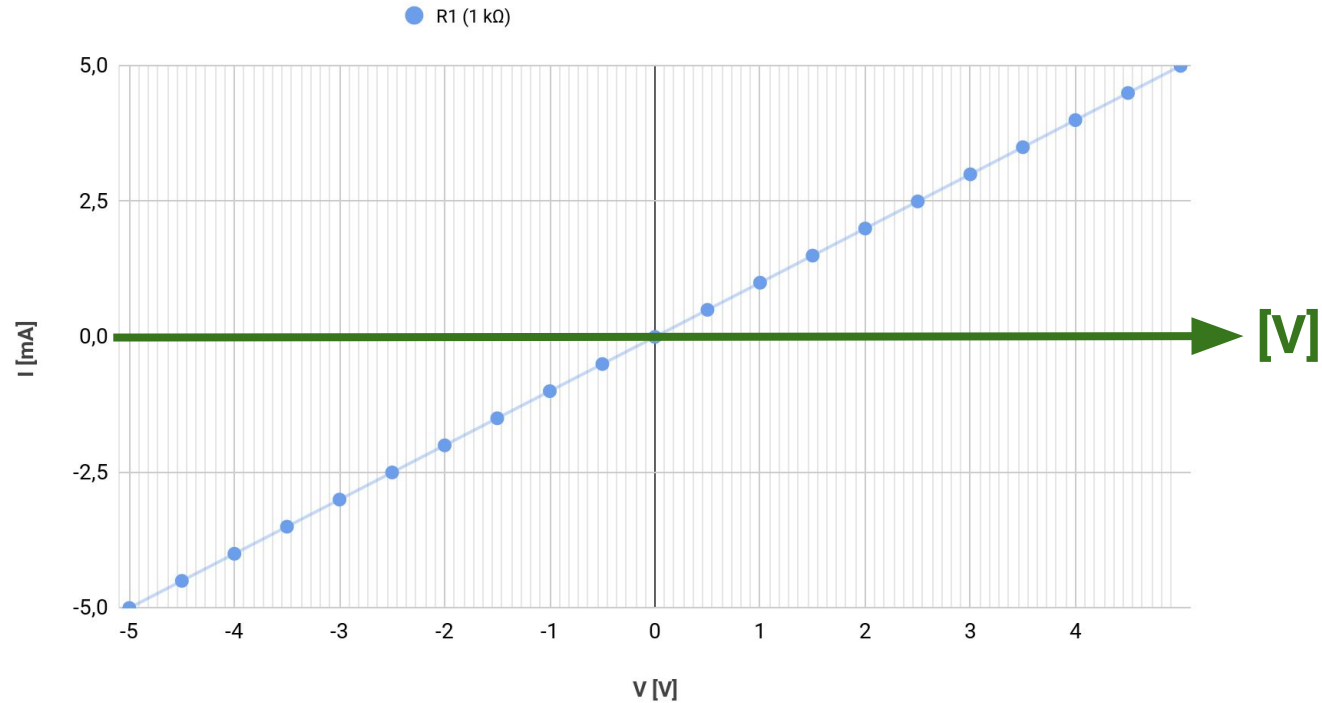


MeMO

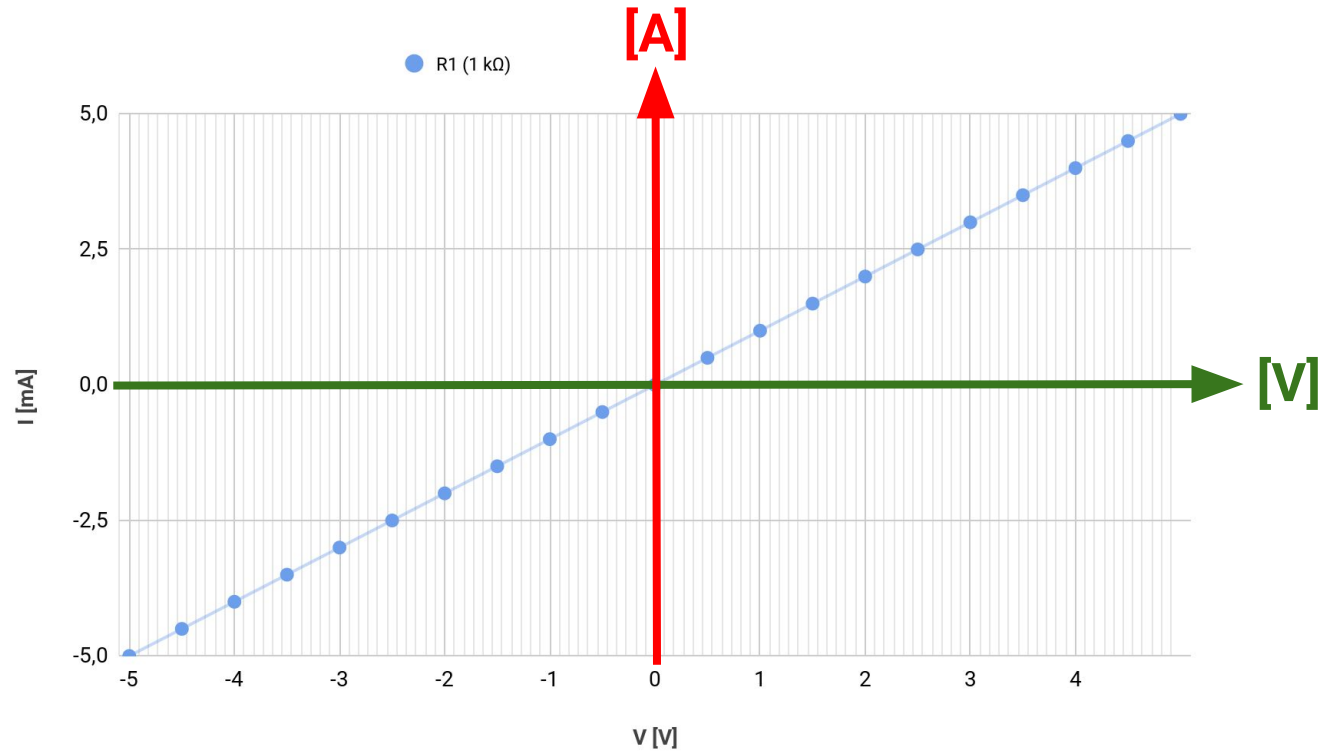
Conmutación resistiva



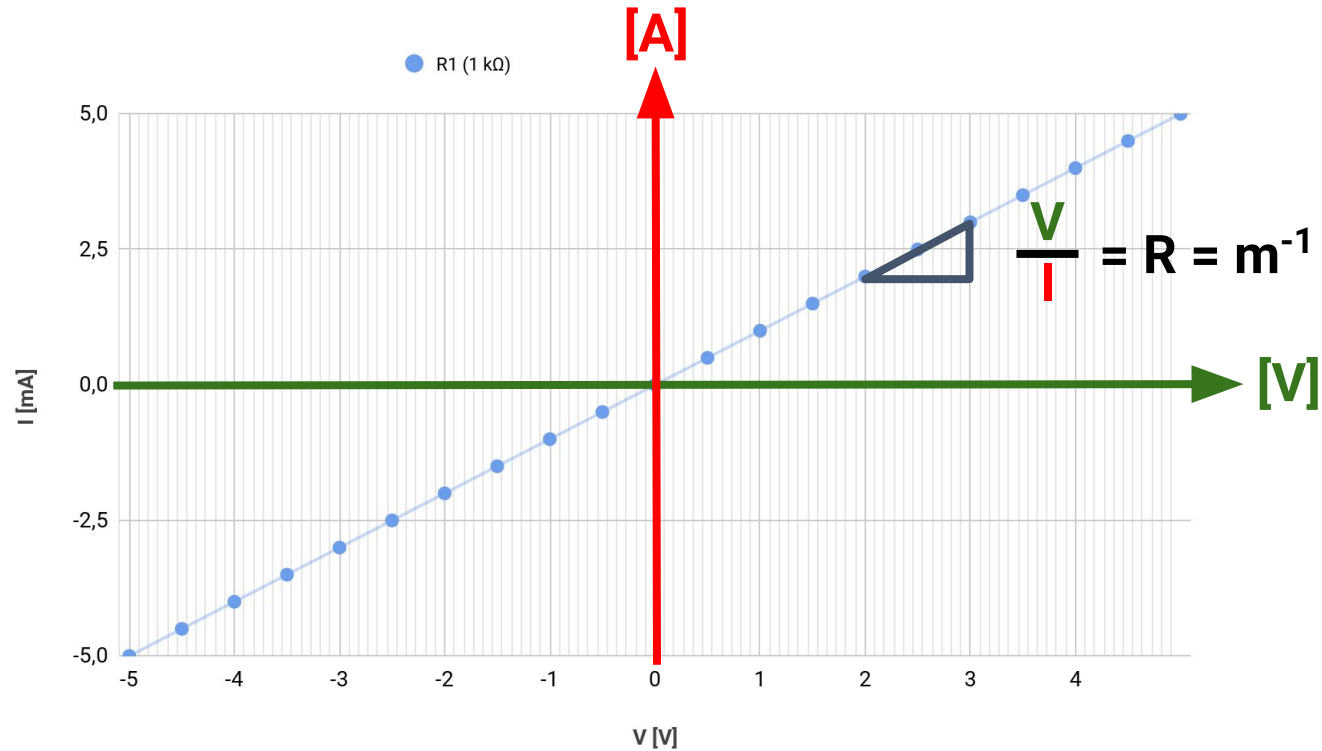
Conmutación resistiva



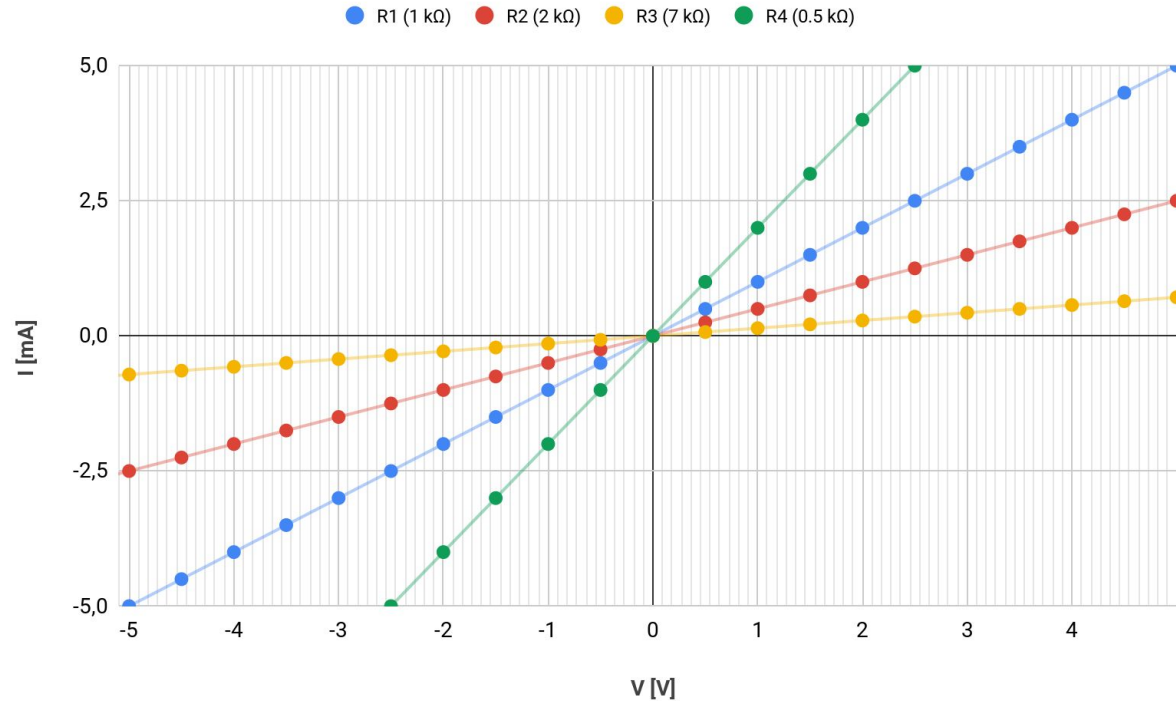
Conmutación resistiva



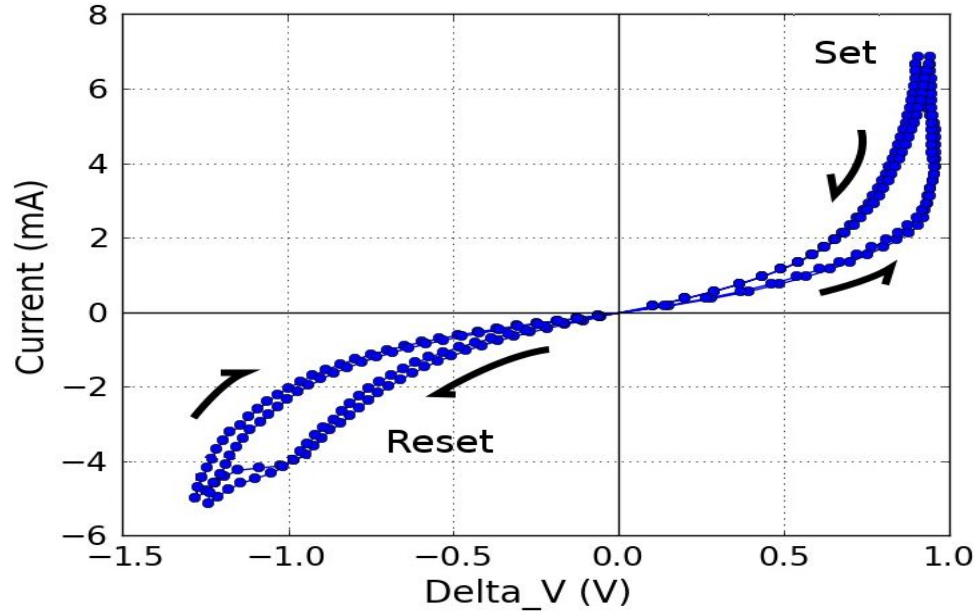
Conmutación resistiva



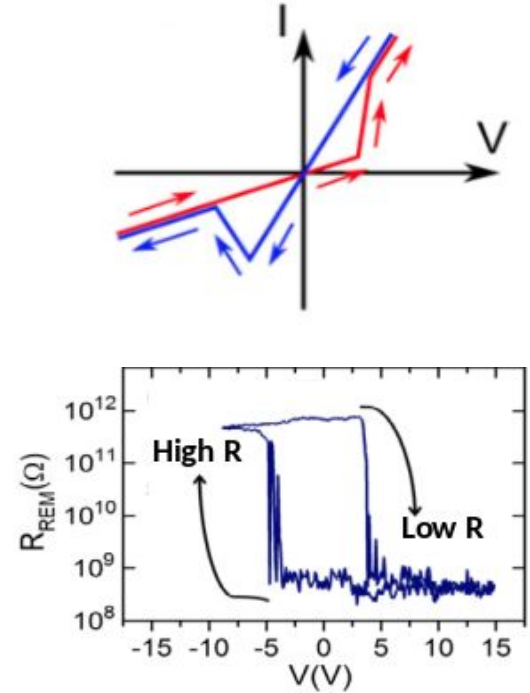
Conmutación resistiva



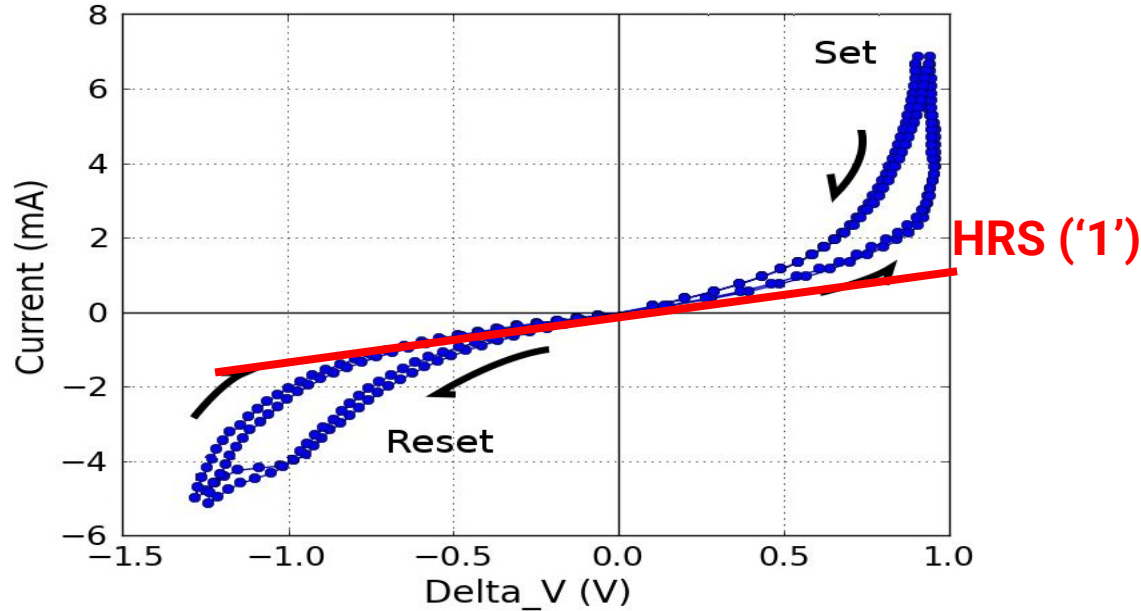
Conmutación resistiva



[Barella et al. 2016]

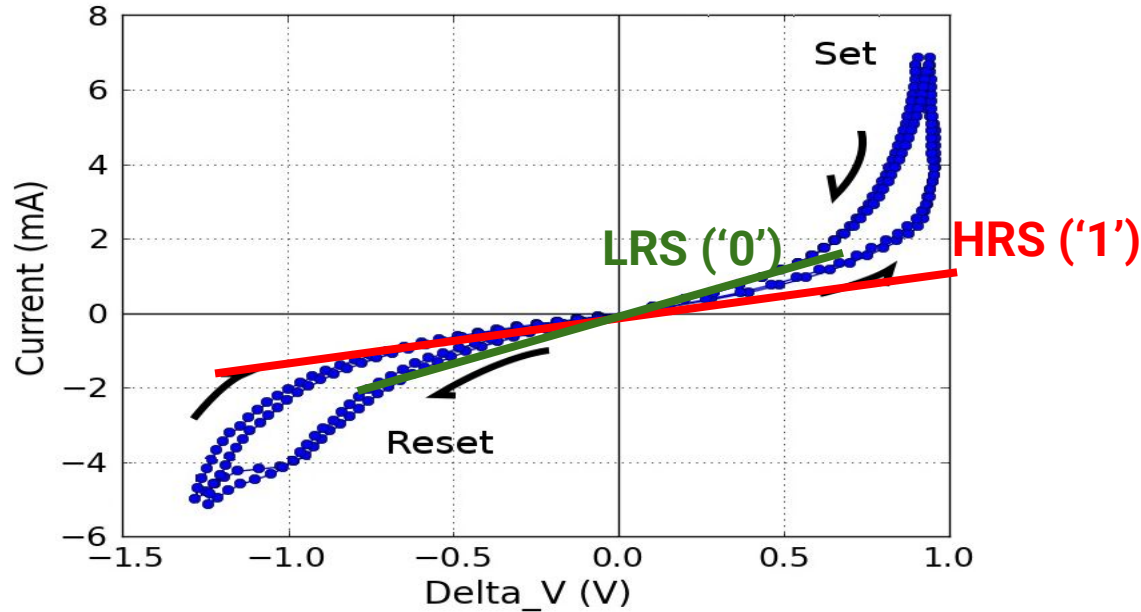


Conmutación resistiva



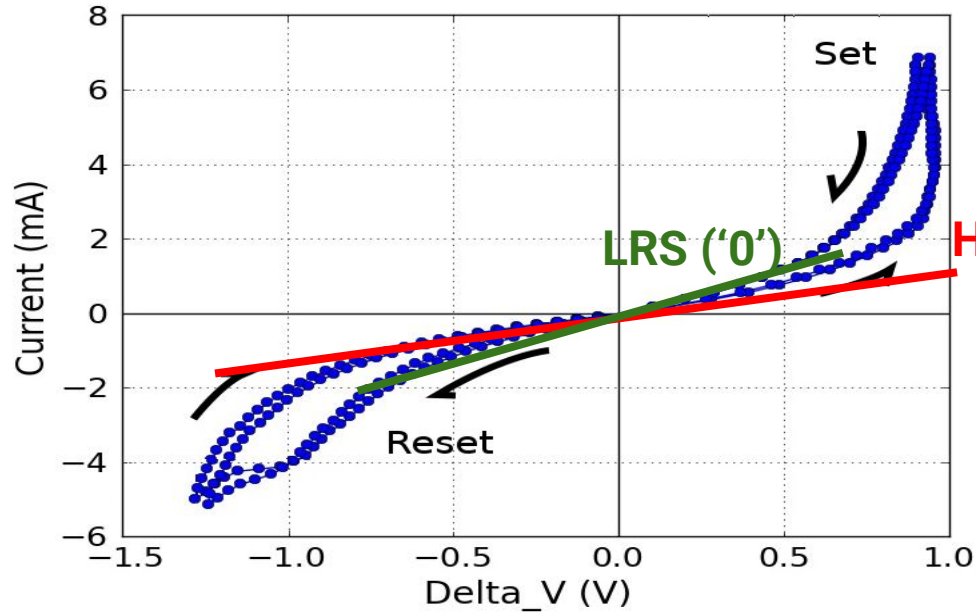
[Barella et al. 2016]

Conmutación resistiva



[Barella et al. 2016]

Conmutación resistiva



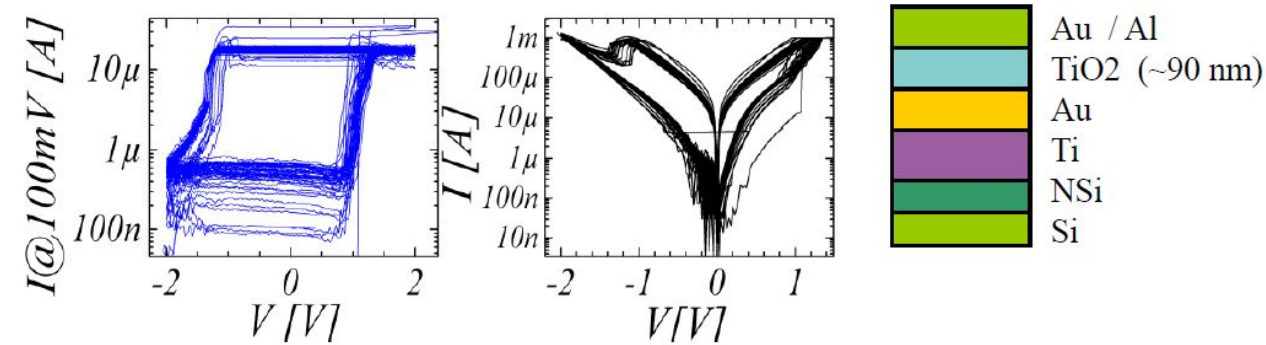
[Barella et al. 2016]



RRAM
resistive
random-access
memory

Historia: MeMO

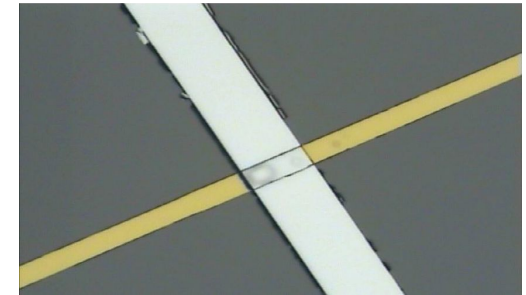
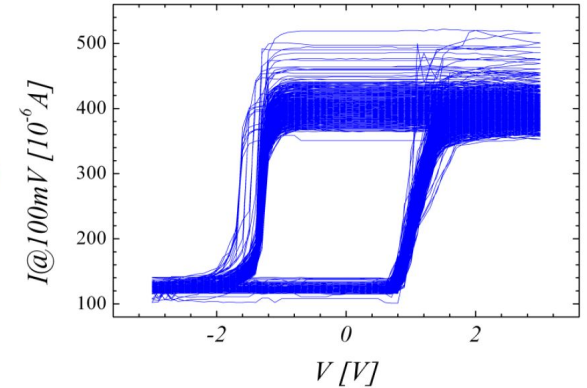
Dispositivos NVM/RRAM con óxidos de TiO_2



“A compact model for binary oxides-based memristive interfaces”,
 N.Ghenzi et al., J. Phys. D: Appl. Phys. (2013)

“Role of I compliance”, Ghenzi et al. APL (2014)

“Role of Oxygen Vacancies”, Ghenzi et al. APL(2015)

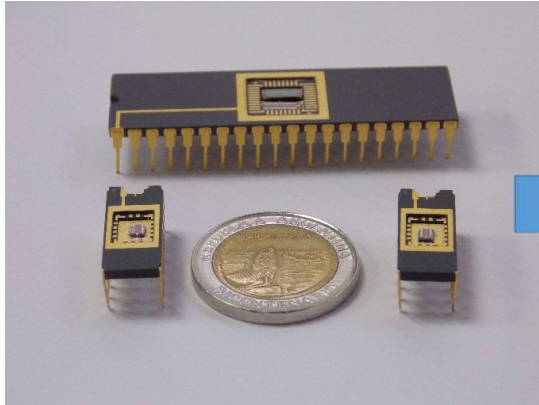


10 μm x 30 μm

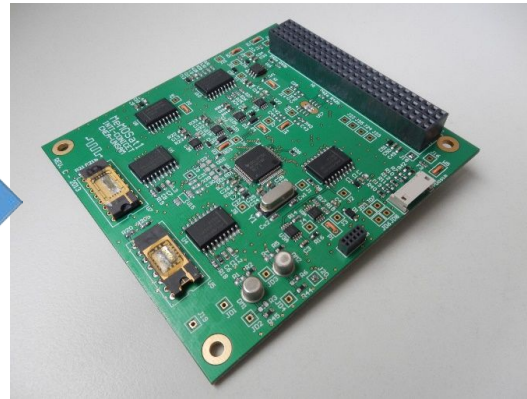
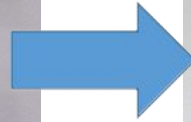
Historia: MeMOSat-01

- “Estándar” CubeSat
- Diseñado para ensayar dispositivos RS
- Operando en BugSat-01 (Tita) desde Junio de 2014

SATELL^{OGIC}



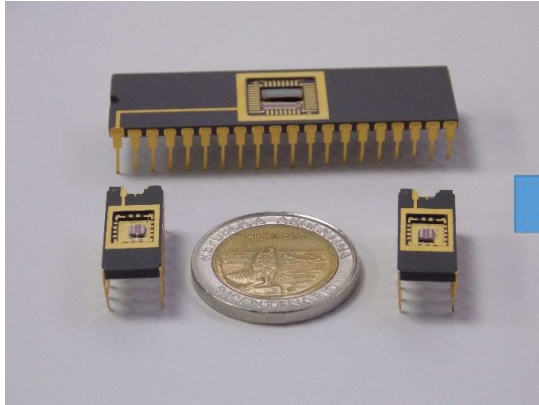
MeMO



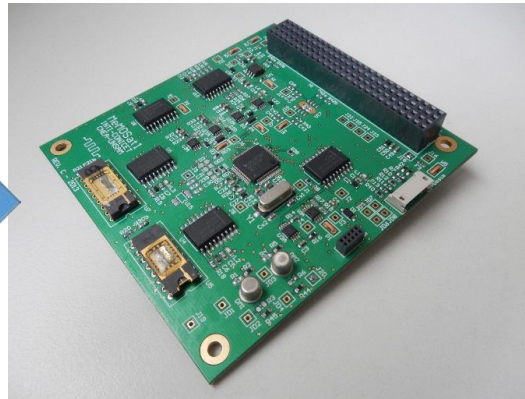
MeMOSat

Historia: MeMOSat-01

- 100 g, 10 x 10 cm
- 200 B/día, 10 min/día
- 9 V, 100 mW, 10G



MeMO

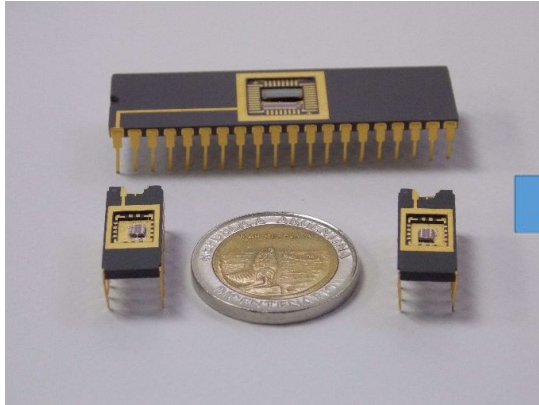


MeMOSat

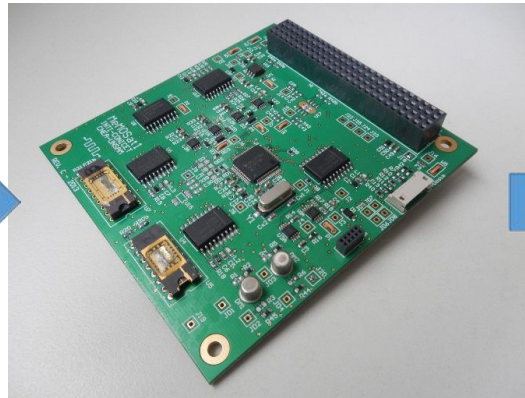
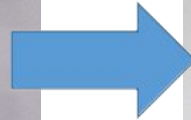
Historia: LabOSat-01

- LabOSat: acrónimo de “*Laboratory On a Satellite*”
- Diseñado para ensayar dispositivos RS... **y más**
- Operando en ÑuSats desde Septiembre de 2016

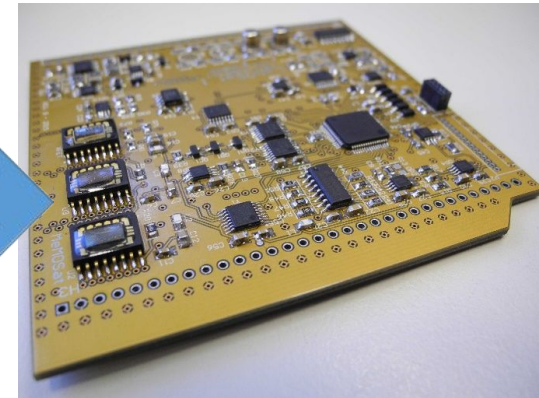
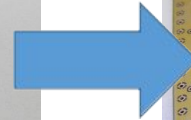
SATELL^oGIC[®]



MeMO

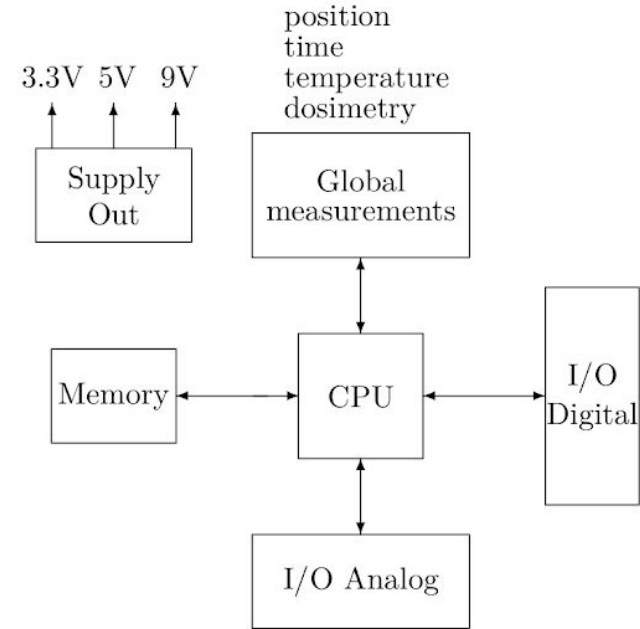
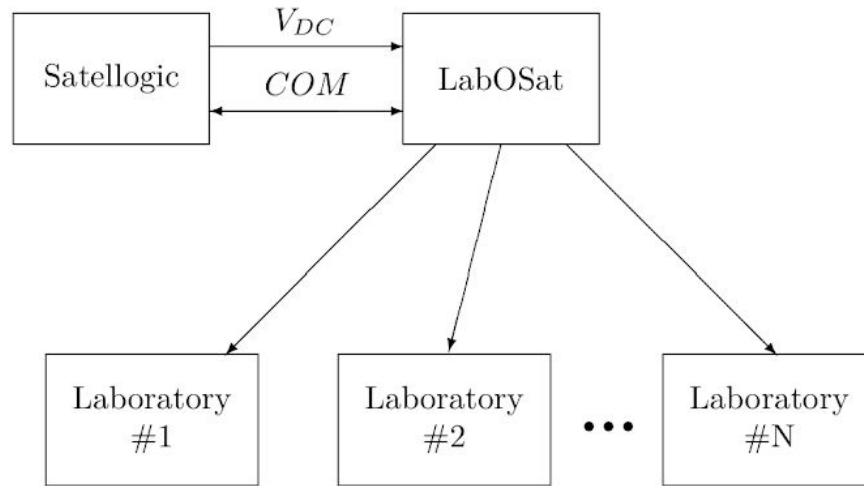


MeMOSat



LabOSat

Historia: LabOSat-01



*Propuesta de diseño LabOSat-01, 7 de febrero de 2015

Historia: LabOSat-01

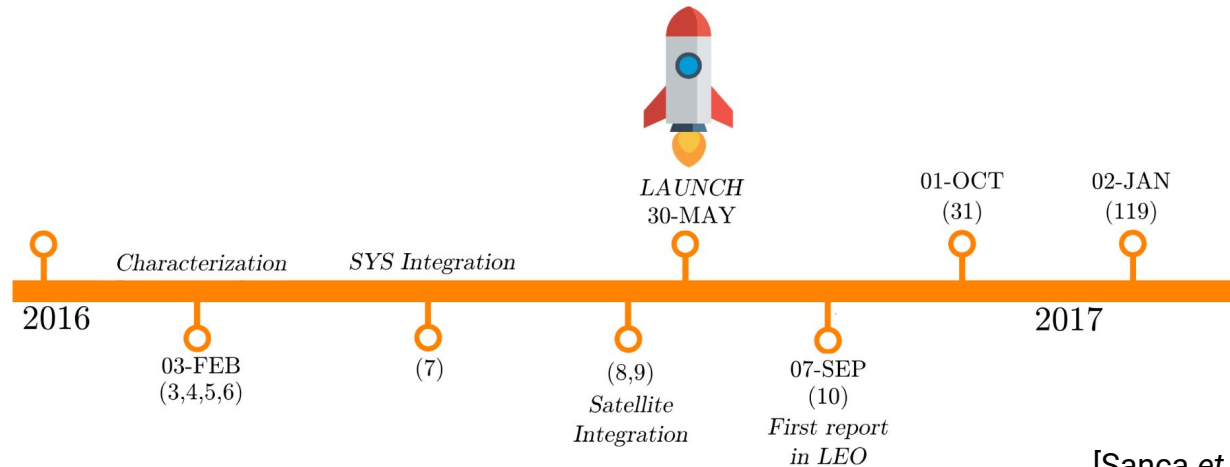
Mejoras propuestas a partir de MeMOSat-01:

- Limitaciones en tensión y corriente
- Protecciones (ruido, tensión, corriente, etc.)
- Disponer de fuentes de corriente
- Aumentar los rangos de excitación y lectura
- Diseñar redundancias
- Diseñar un algoritmo de auto-comprobación*
- Capacidad para medir resistencia y continuidad

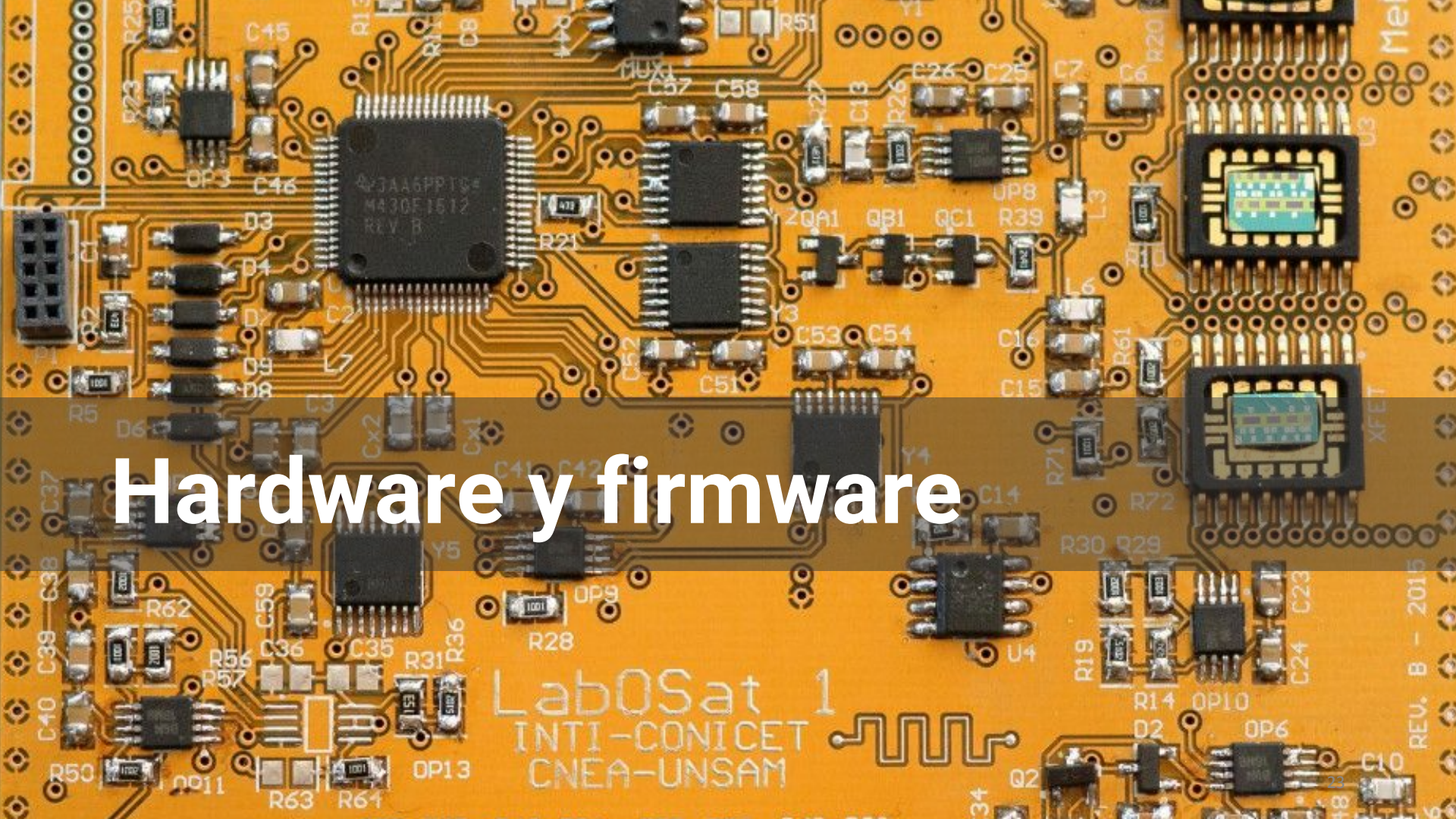
*Propuesta de diseño LabOSat-01, 7 de febrero de 2015

Historia: LabOSat-01

- Carga útil de instrumentación
- Órbita LEO
- Satélites ÑuSat 



[Sanca et al. 2017]

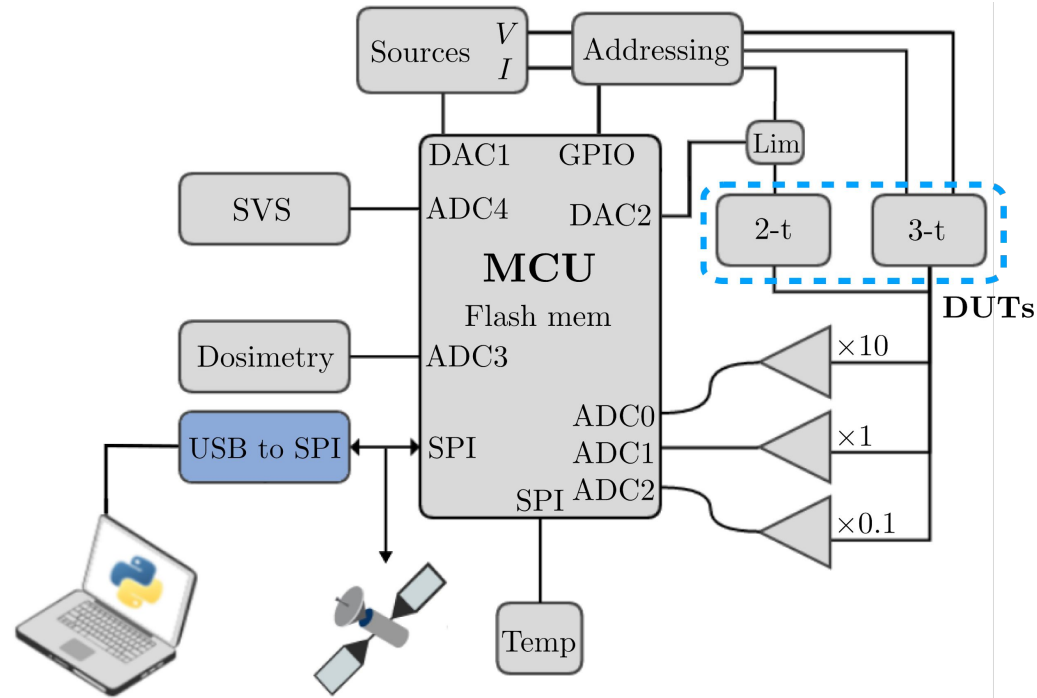


Hardware y firmware

LabOSat 1
INTI-CONICET
CNEA-UNSAM

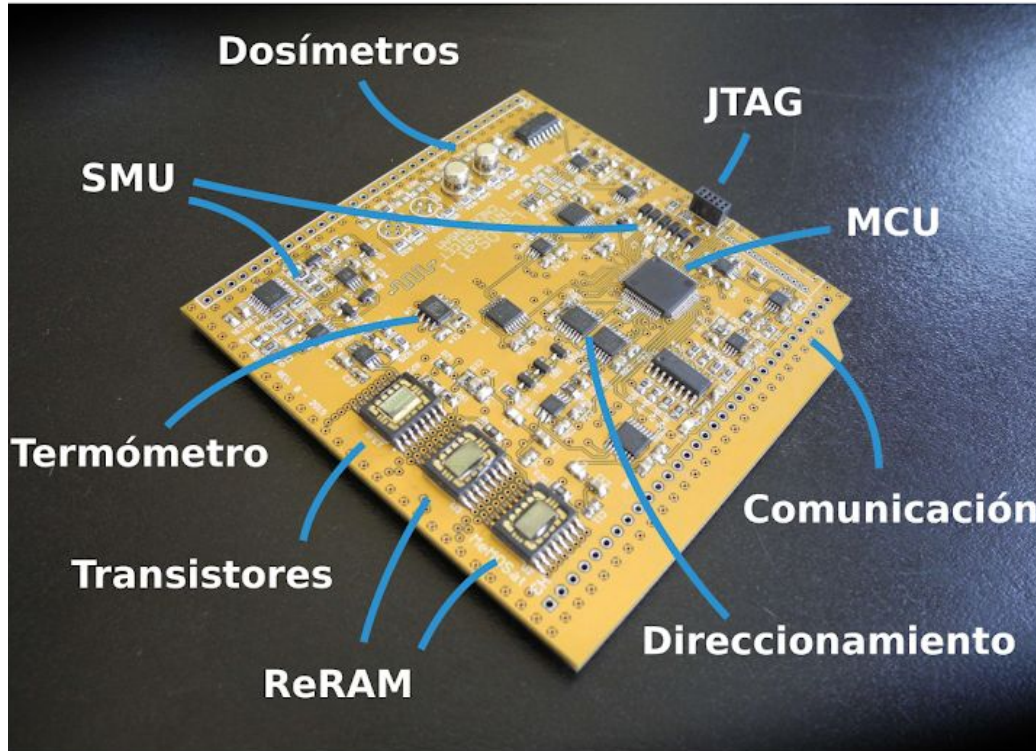
REV. B - 2015

Hardware

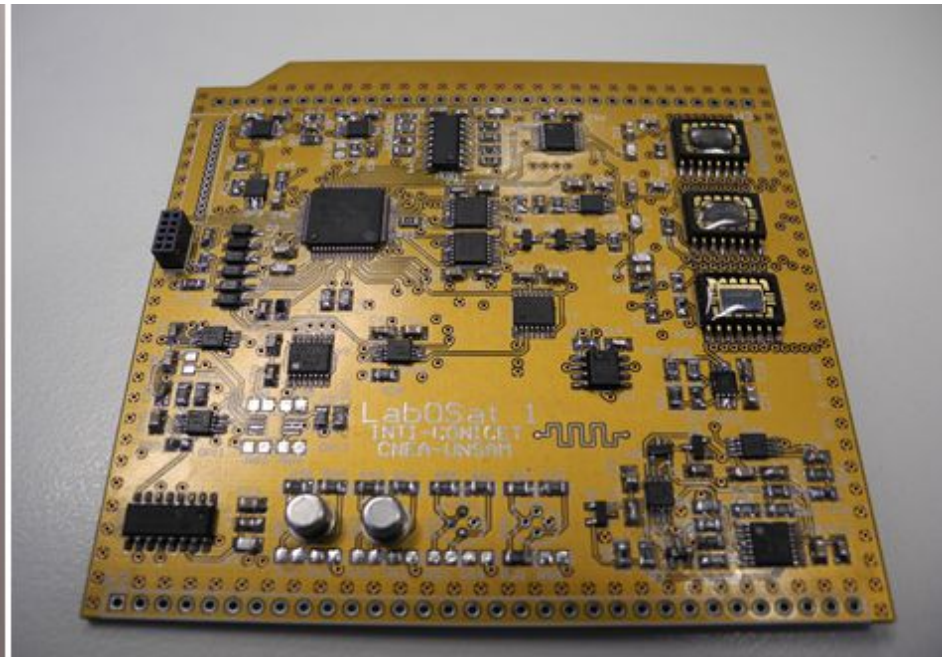
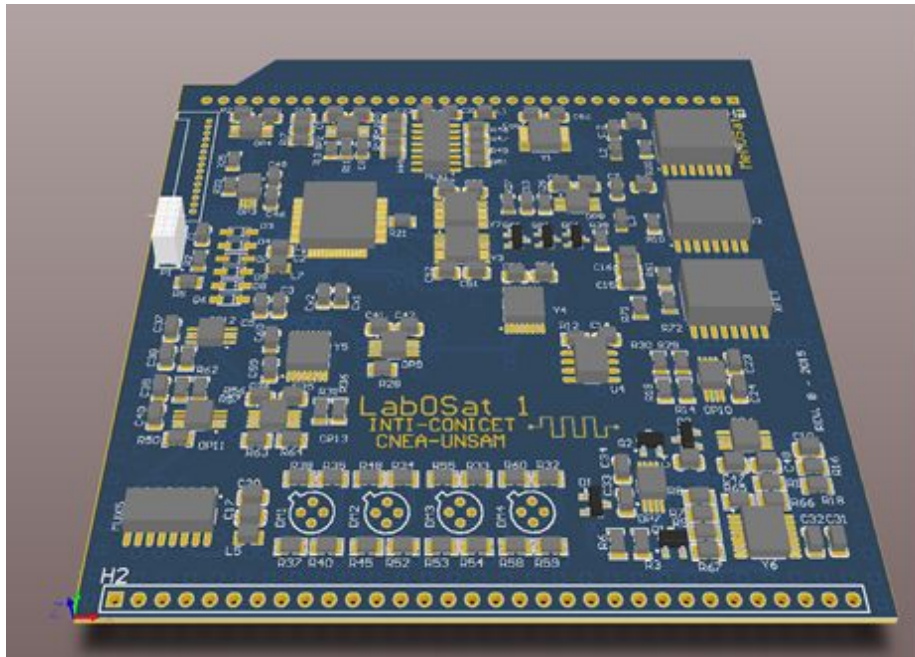


[Barella et al. 2018]

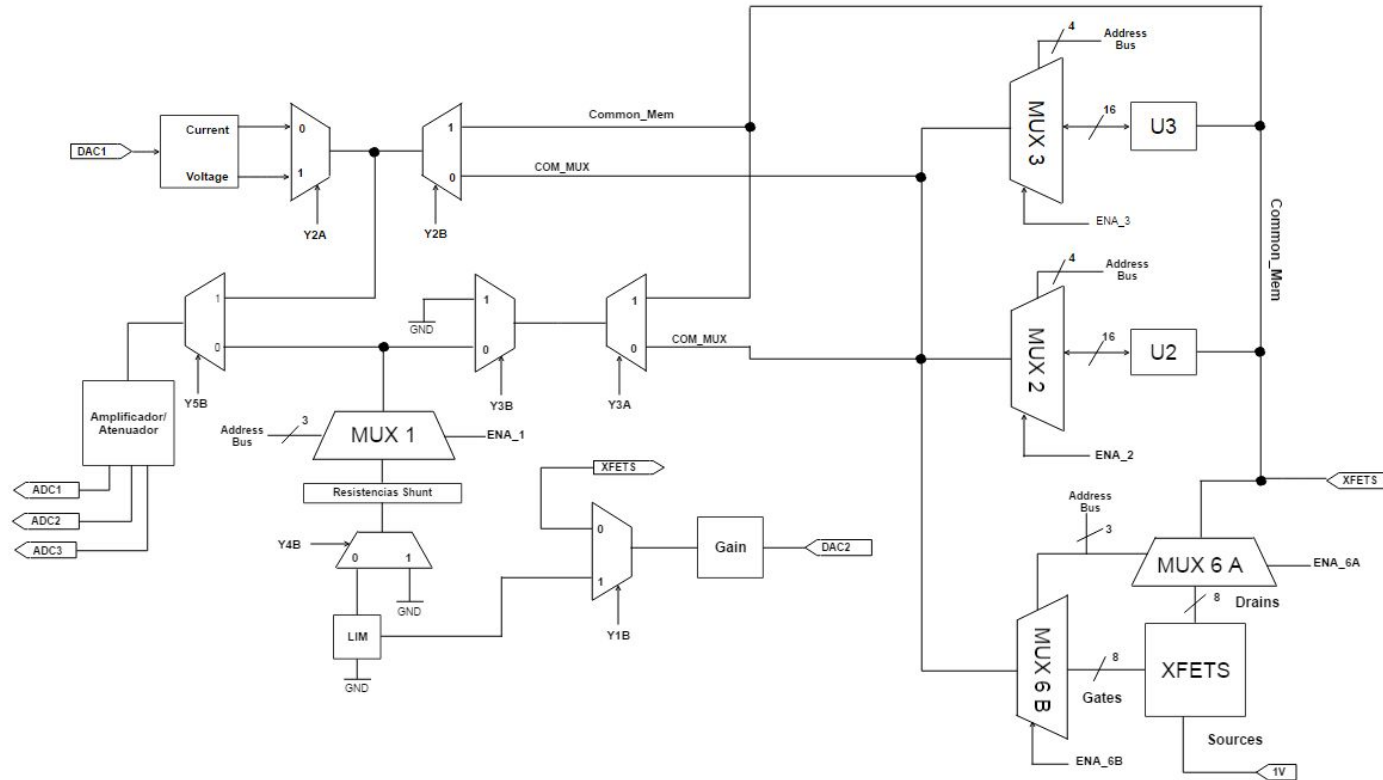
Hardware



Hardware



Hardware



Firmware

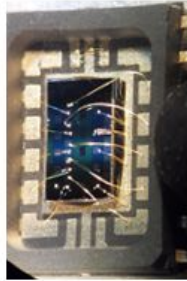
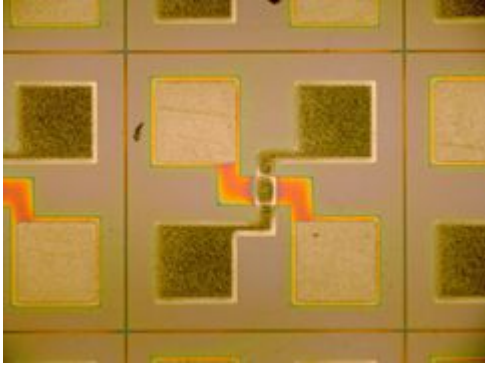
- Lenguaje C
- Conjunto de instrucciones
- Ruptura modo IDLE: comunicación por SPI

Firmware: solicitud stdTest

```
if pasó un día then
    <ejecutar Test Estándar>
else
    <no ejecutar Test Estándar>
end if
```

Firmware: ejecución stdTest

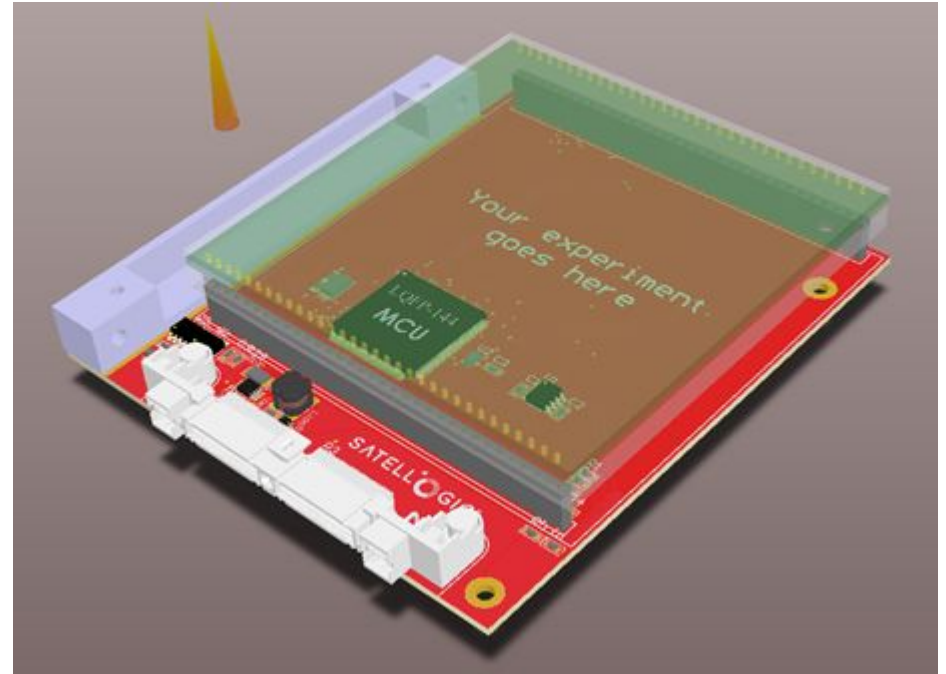
```
obtener fecha del anfitrión
lectura dosimetría,  $VDD^{start}$ ,  $T^{start}$ 
for cada 2-t DUT en banco 1 do
    <programmed test>
end for
lectura  $VDD^{med}$ ,  $T^{med}$ 
for cada 2-t DUT en banco 2 do
    <programmed test>
end for
for cada 3-t DUT do
    <curva característica> <curva de modulación>
end for
lectura  $VDD^{end}$ ,  $T^{end}$ 
calcular CRC-16 del firmware y de los datos generados
calcular número de ejecución
comprobar errores
```



Hosting



SATELLOGIC

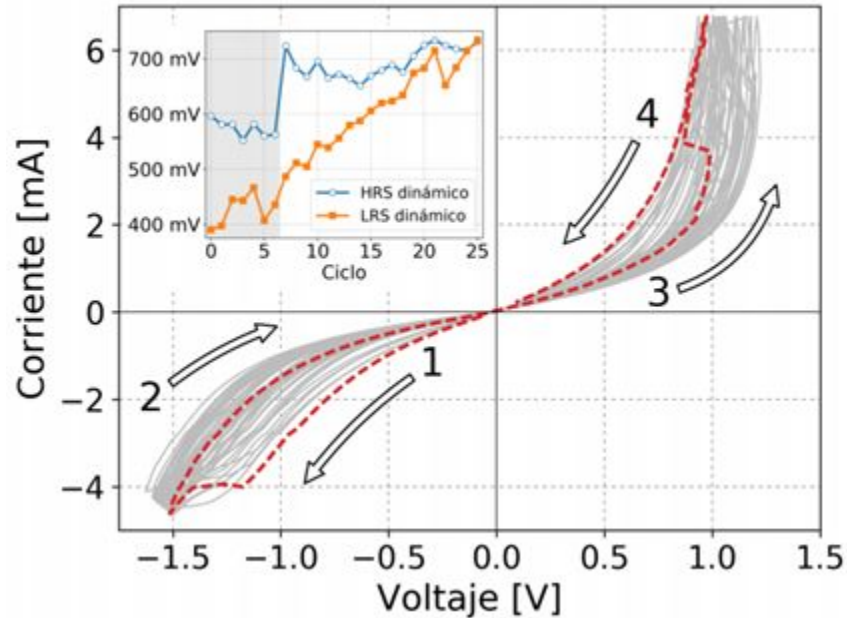


Plataforma de medición

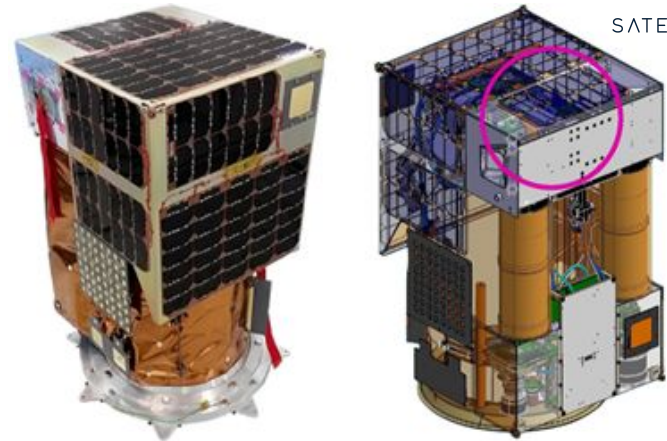
LabOSat 1
INTI-CONICET
CNEA-UNSAM



Plataforma de medición

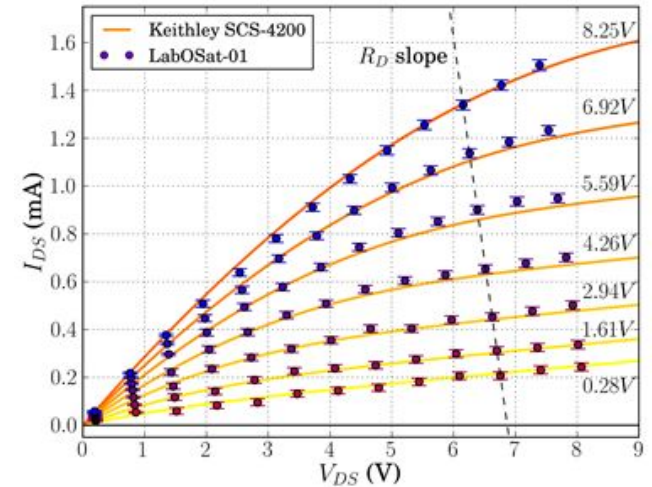
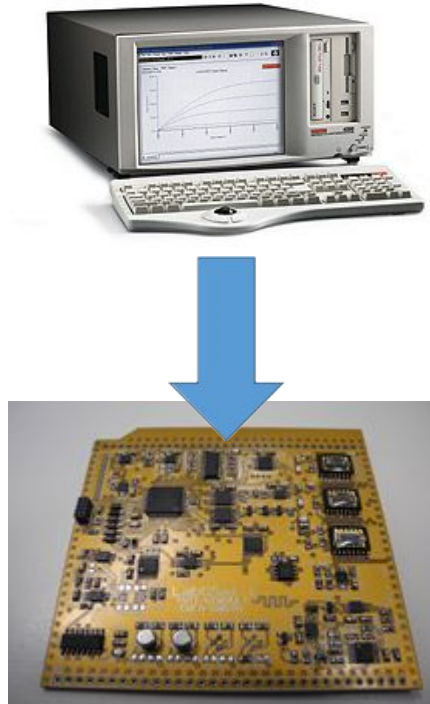
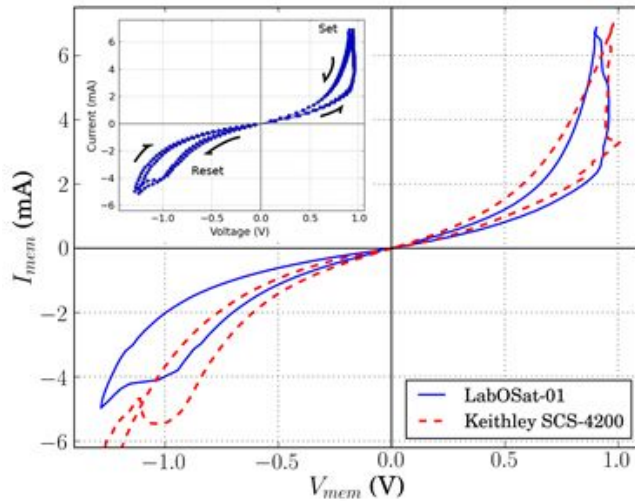


Celda *cross-point* TiO_2 en LEO
[M. Barella *et al.* 2018]



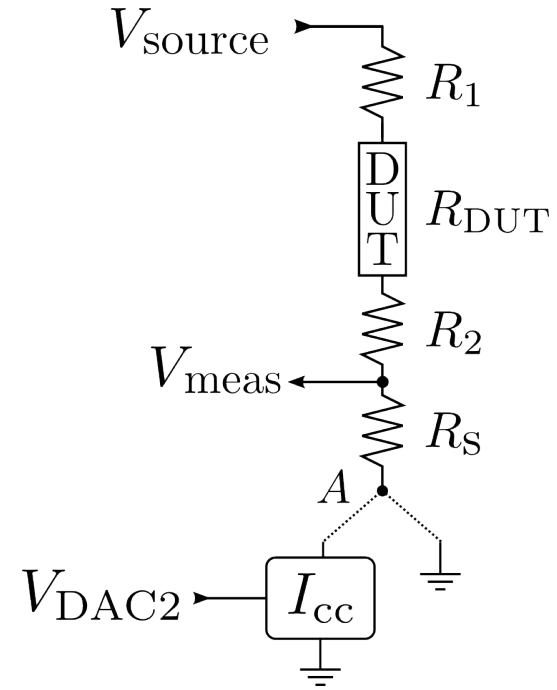
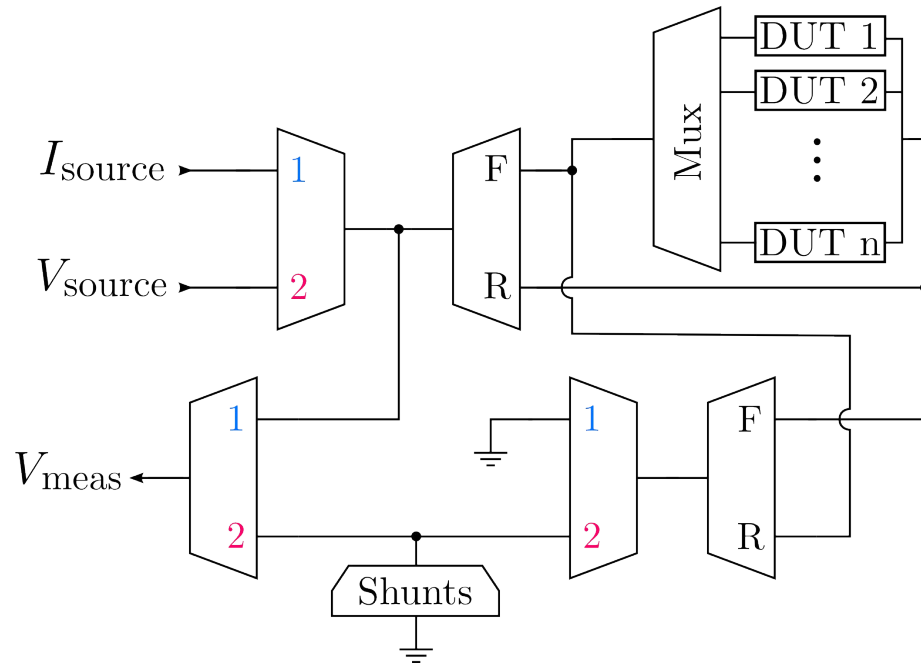
SATELLOGIC

LabOSat como SMU

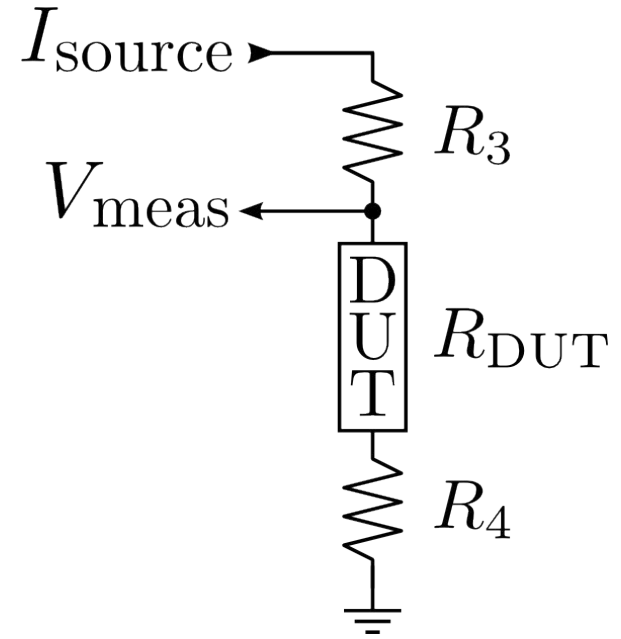
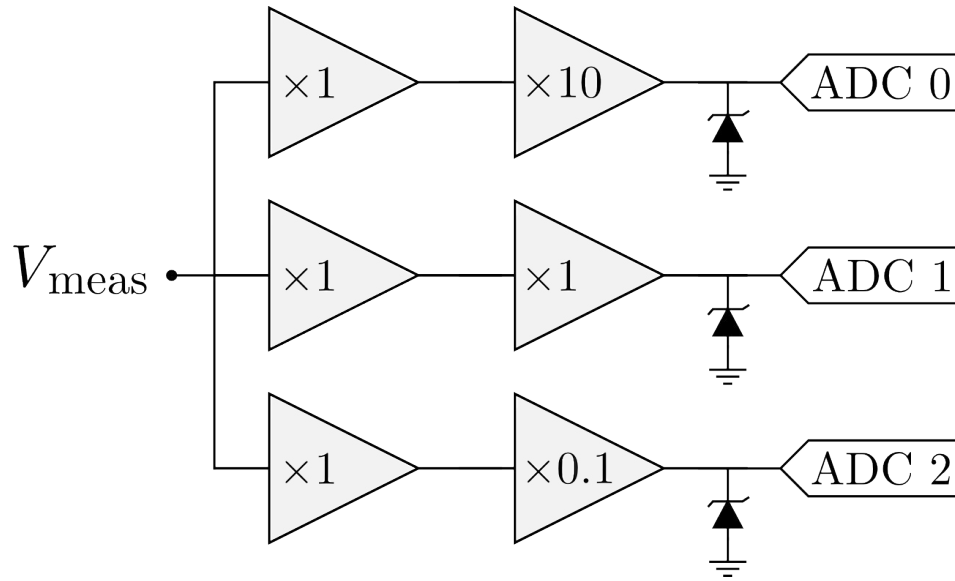


[Barella *et al.* 2016]

LabOSat como SMU

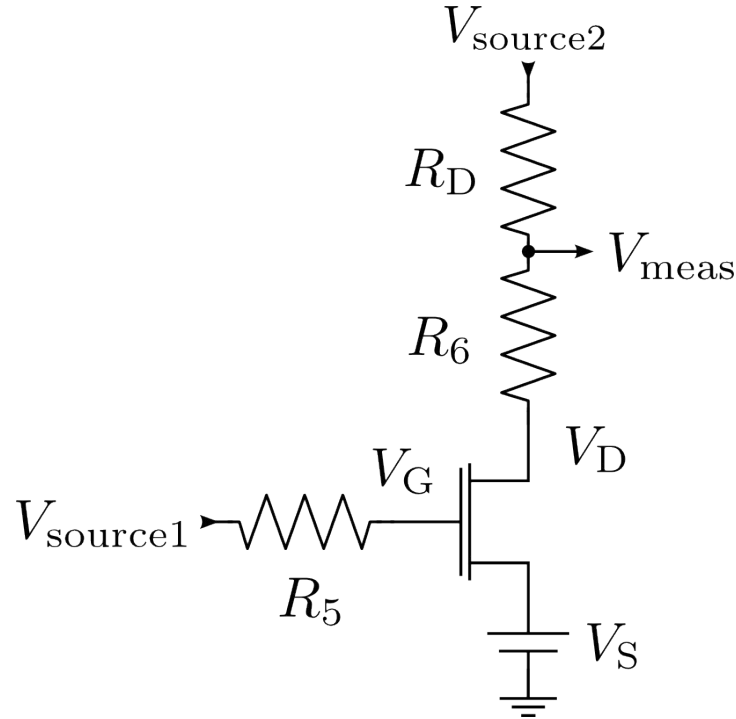


LabOSat como SMU

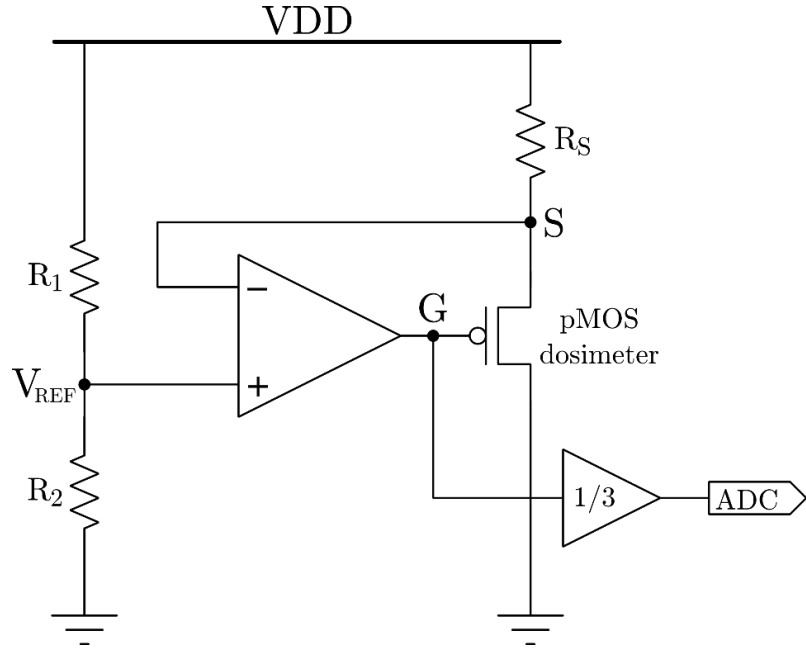
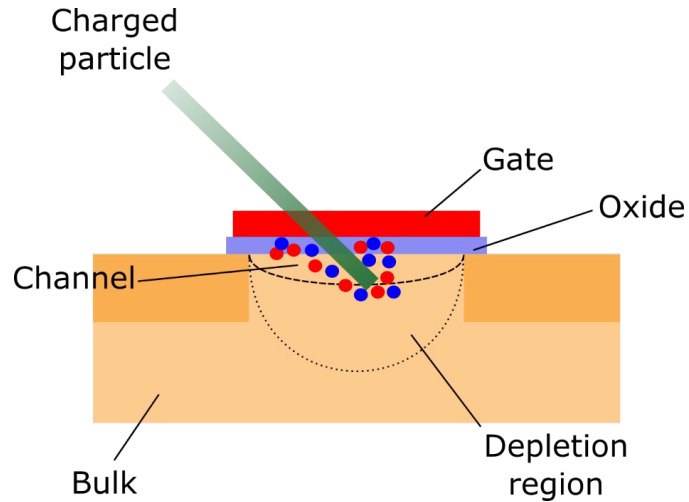


LabOSat como SMU

Dispositivos 3T



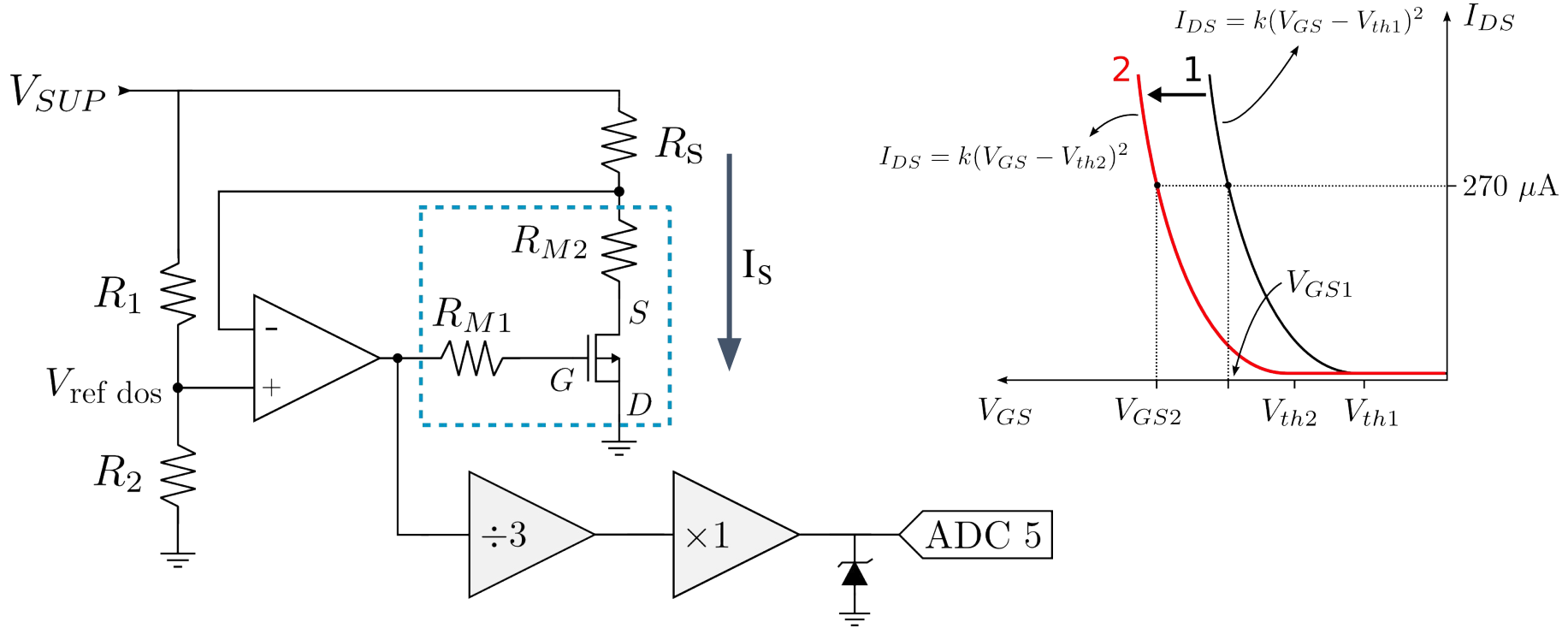
Dosimetría



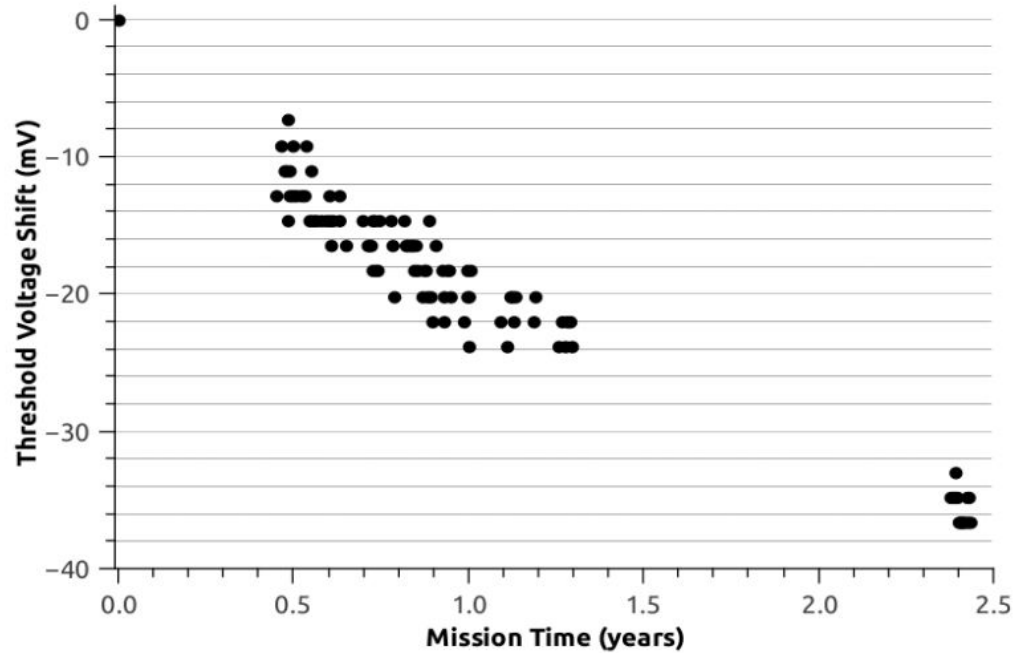
[Sanca et al. 2017]



Dosimetría



Dosimetría



[Lipotevzky et al. 2017]

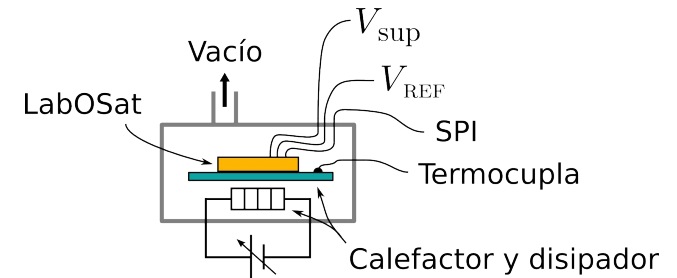
Caracterización

LabOSat 1
INTI-CONICET
CNEA-UNSAM

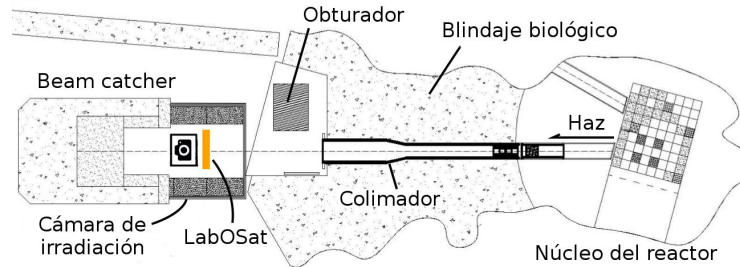
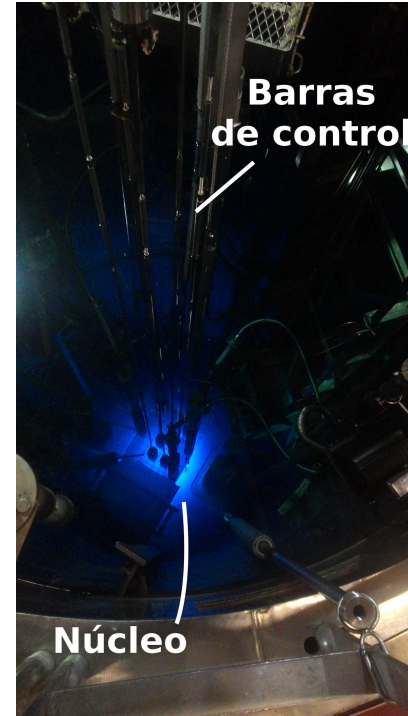
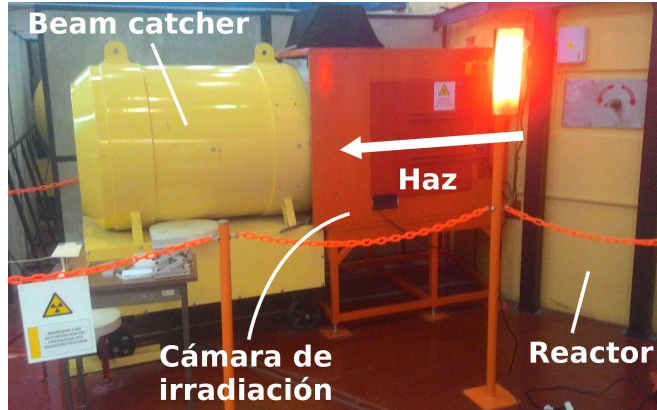
REV. B - 2015

Tests on LabOSat

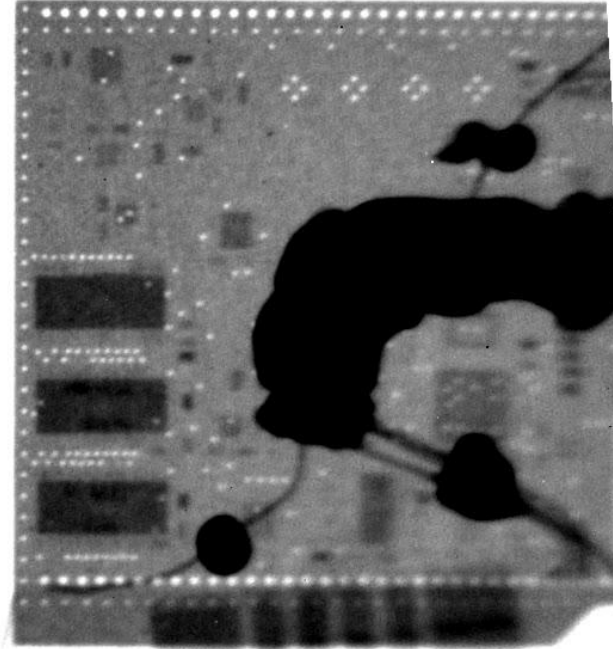
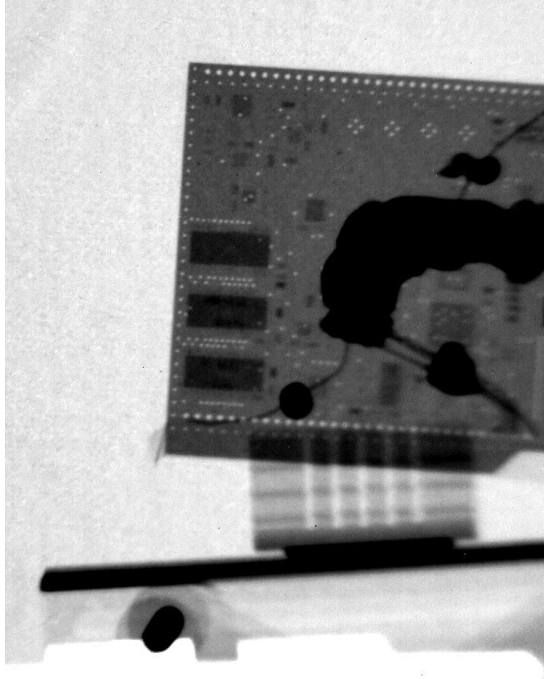
- **RA6**, Bariloche, neutrones
 - 2 h (baja dosis)
 - 5 h (7.24×10^{12} n/cm²)
- **Tandar**, Buenos Aires, protones
 - 10 MeV (6.81×10^{10} p⁺/cm², 20 s)
- **Satellogic** – LEO ~500 km
- **Shaker**
- **Temperatura**
 - ensayo A: 7 días a **100°C** (168 h)
 - ensayo B: 0 a **-50°C**
 - ensayo C: shock térmico a **150°C**



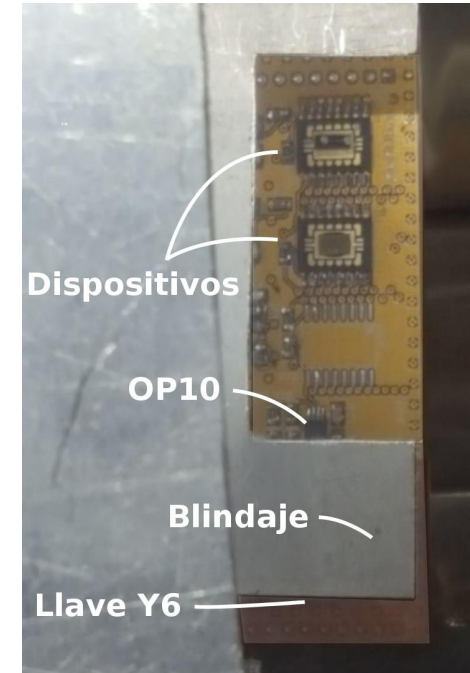
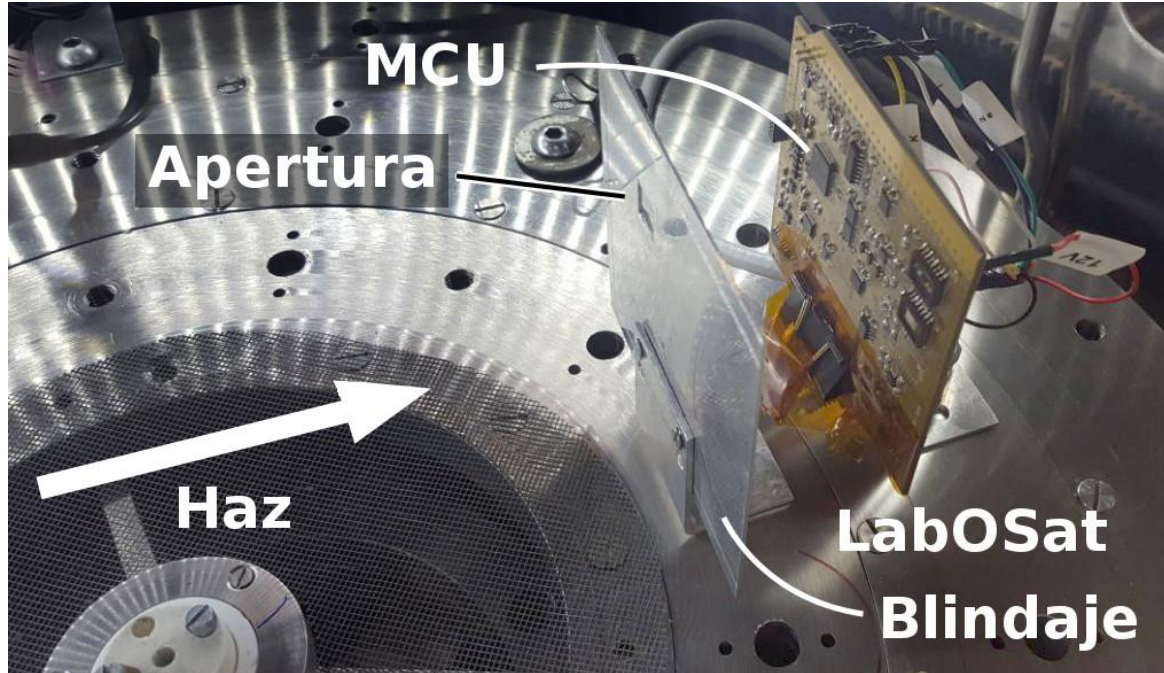
Caracterización bajo haz de neutrones



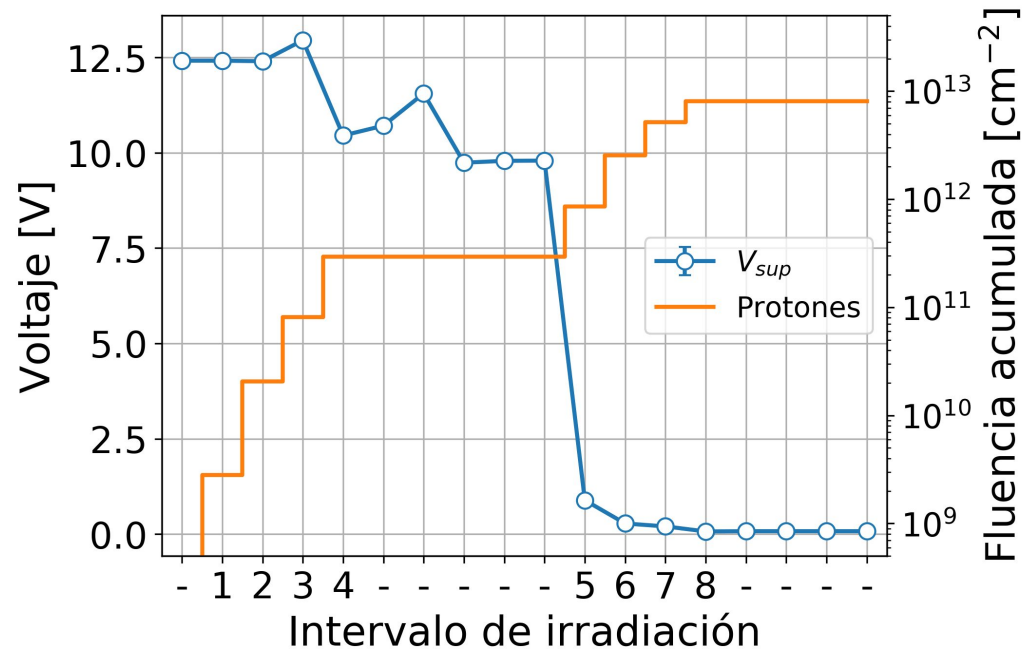
Neutrografía



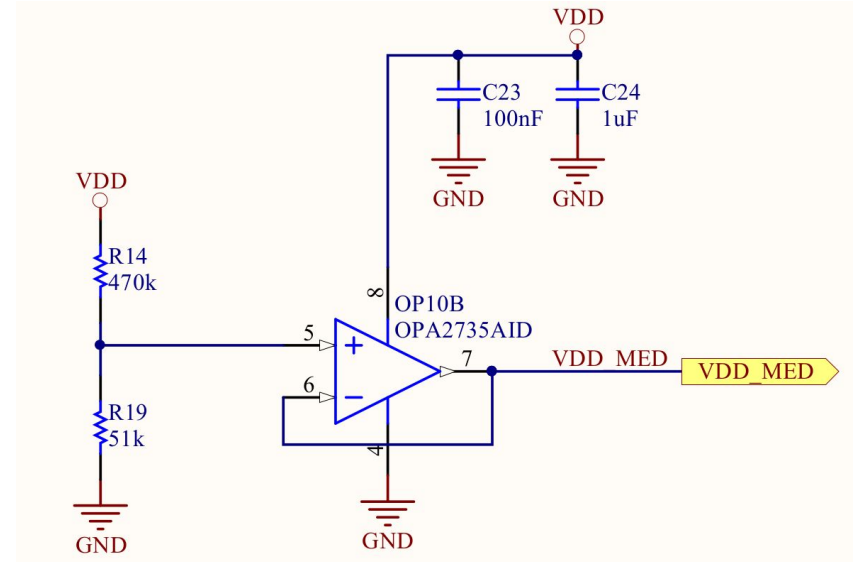
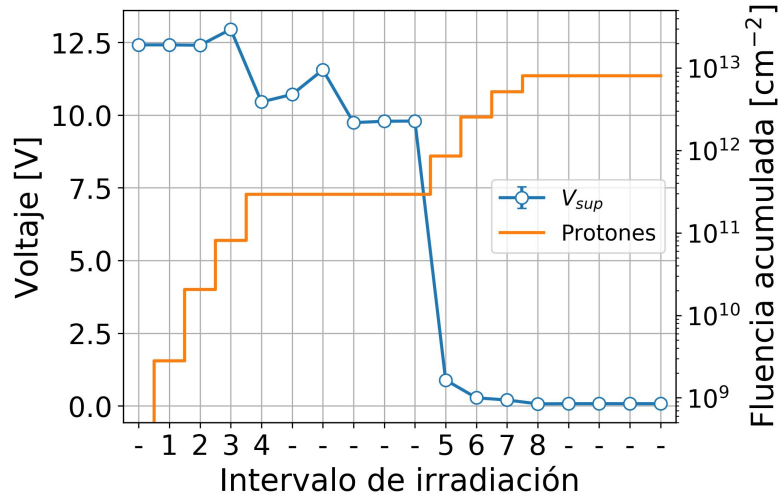
Caracterización bajo haz de p^+



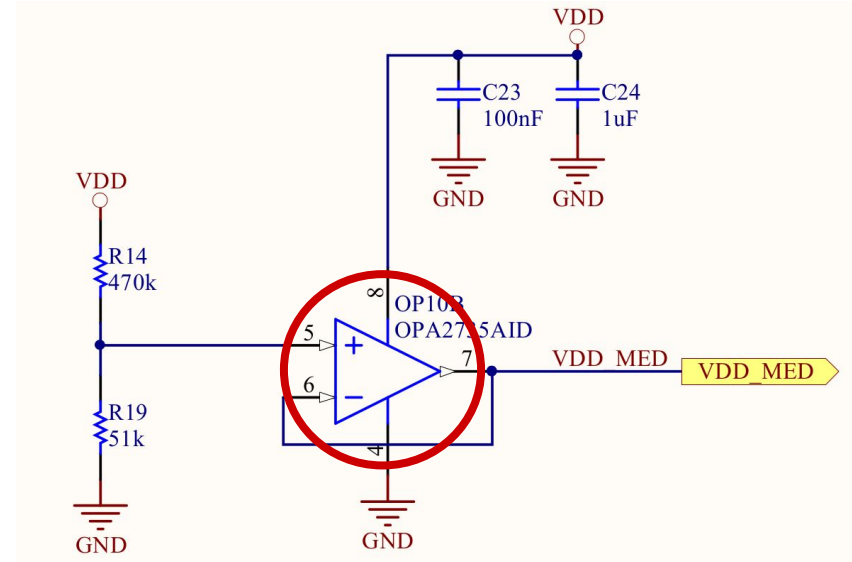
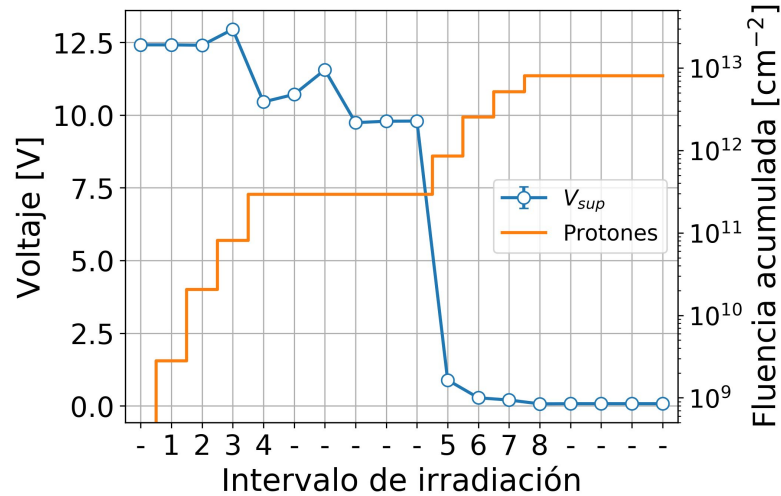
Caracterización bajo haz de p^+



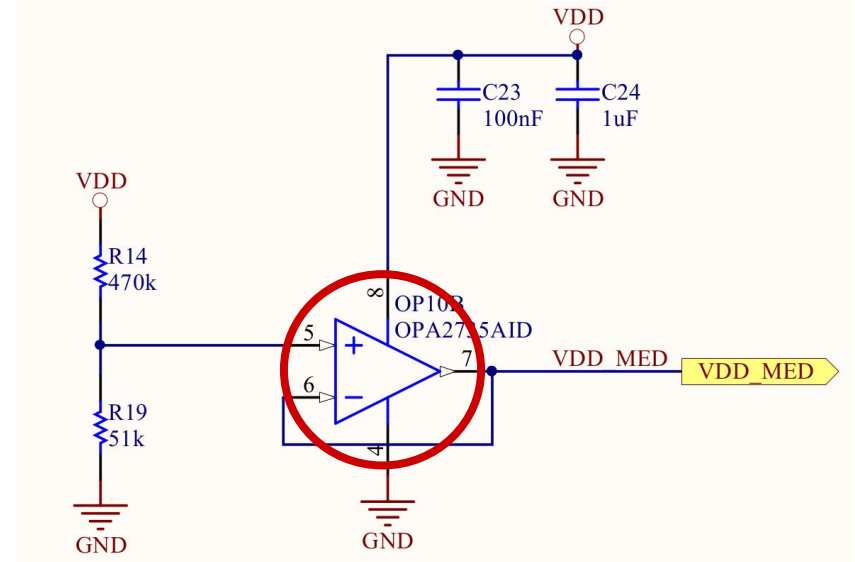
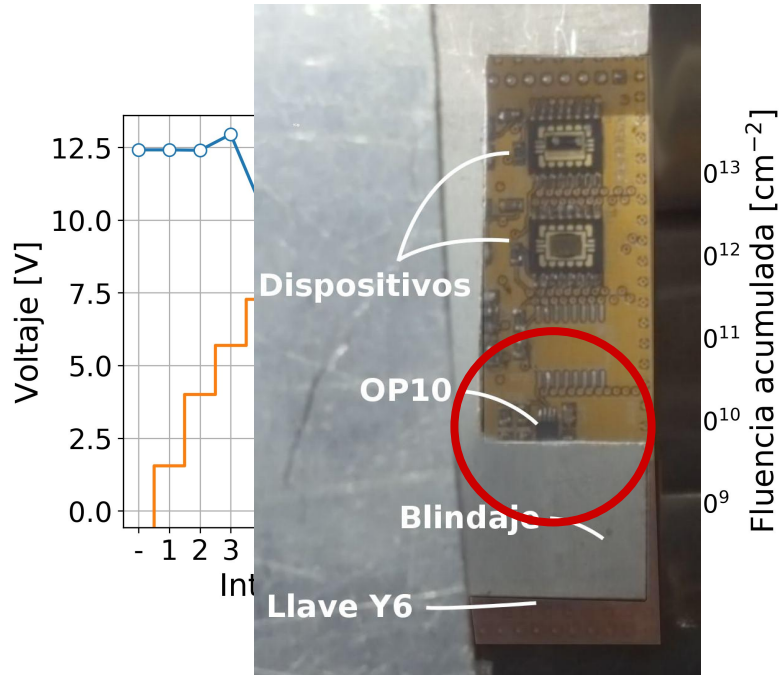
Caracterización bajo haz de p⁺



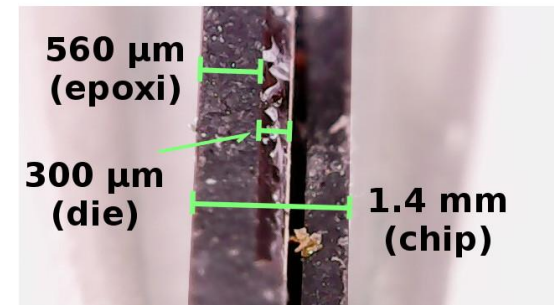
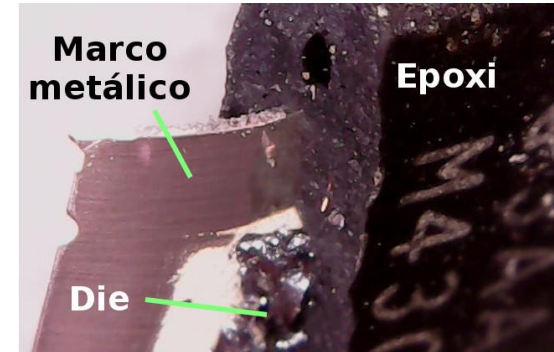
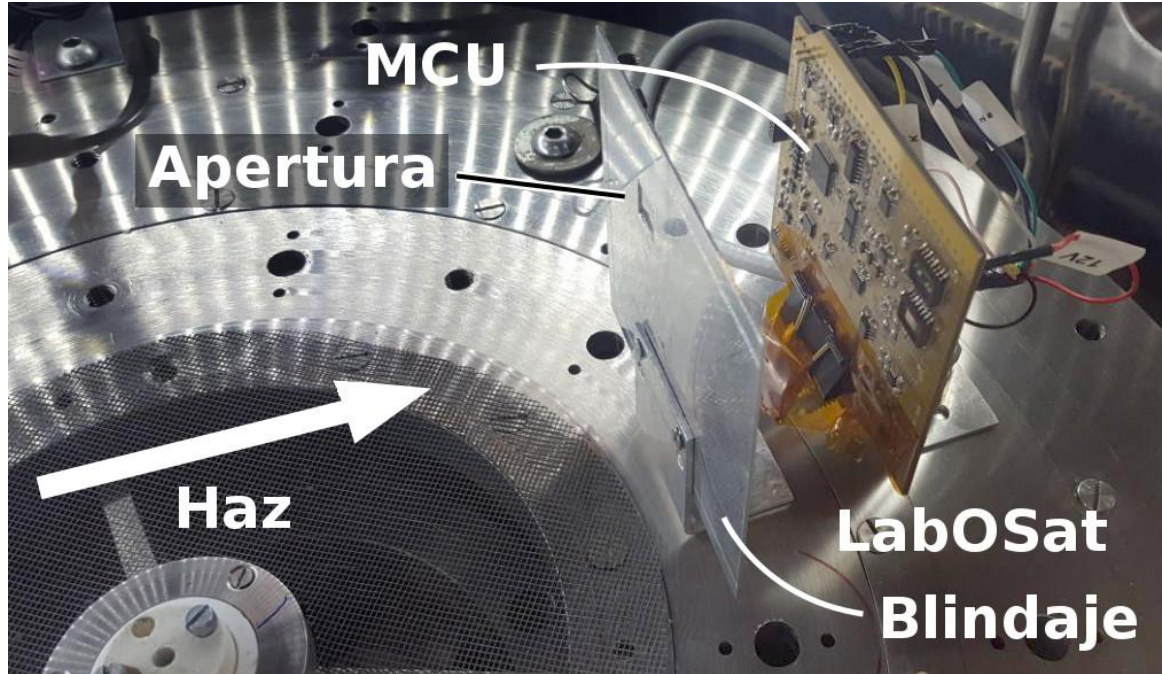
Caracterización bajo haz de p⁺



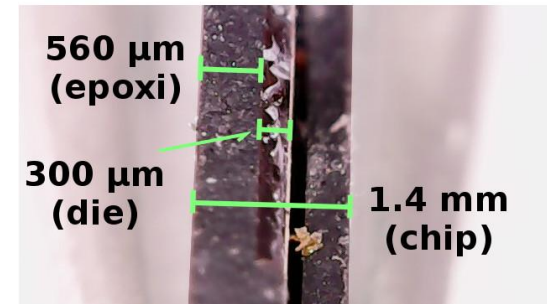
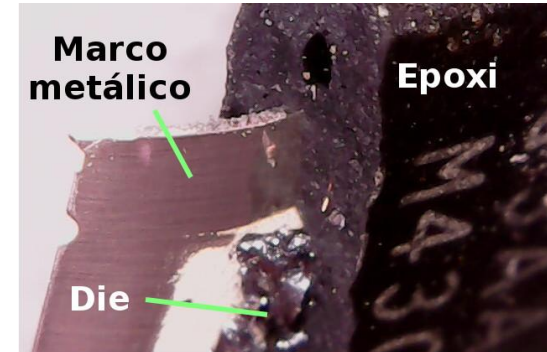
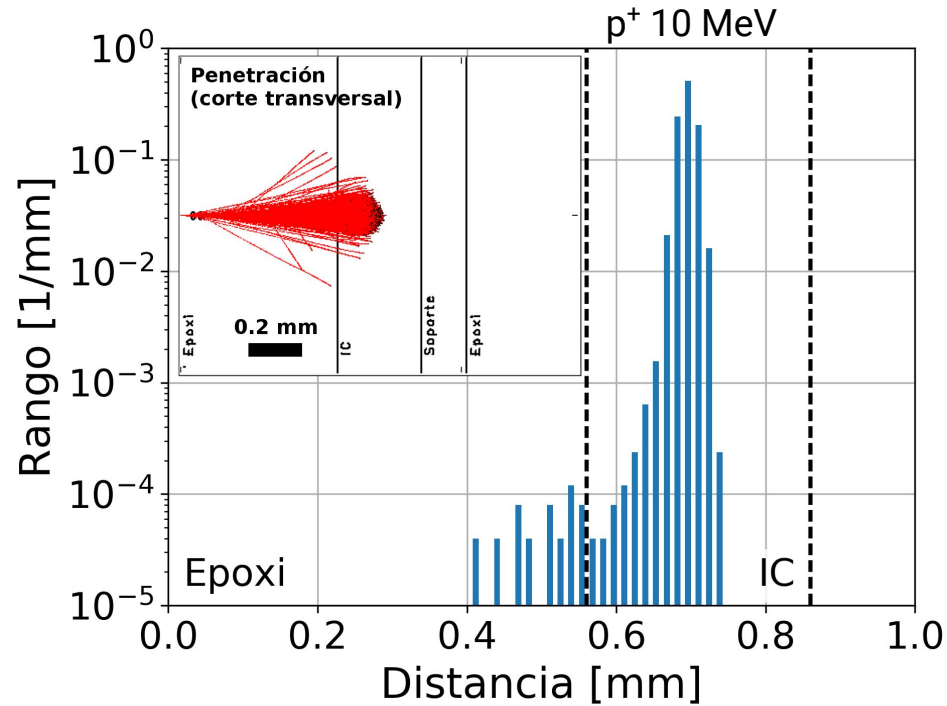
Caracterización bajo haz de p⁺



Caracterización bajo haz de p^+



Caracterización bajo haz de p^+



Experimentos

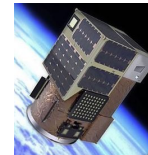
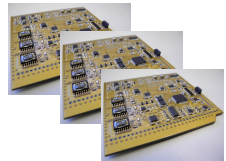
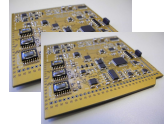
LabOSat 1
INTI-CONICET
CNEA-UNSAM

REV. B - 2015

Misiones

- Junio 2014:
 - MeMOSat-01 en Tita @ 620 km: HfO_2 memristors
- Mayo 2016:
 - LabOSat-01 en Fresco @ ~ 500 km
 - LabOSat-01 en Batata @ ~ 500 km
- Junio 2017
 - LabOSat-01 en MilaneSat @ 500 km
- Febrero 2018
 - LabOSat-01 (x3) en Ada y Maryam

} LCMO, TiO_2 memristors
ZnO TFT



Carga útil @ LabOSat

- Dosímetros:
- TiO_2 *memristors single*:
- TiO_2 *memristors Xbar*:
- $\text{La}_{0.66}\text{Ca}_{0.33}\text{MnO}_3$
- HfO *memristors*:
- YBCO *memristors*:
- ZnO *transistors*:

FI.UBA

INL - MeMOSat

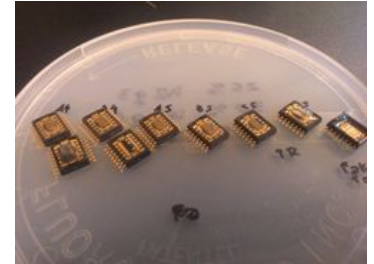
MeMOSat

MeMOSat

CIC_nanoGUNE - MeMOSat

Turku - DF.UBA

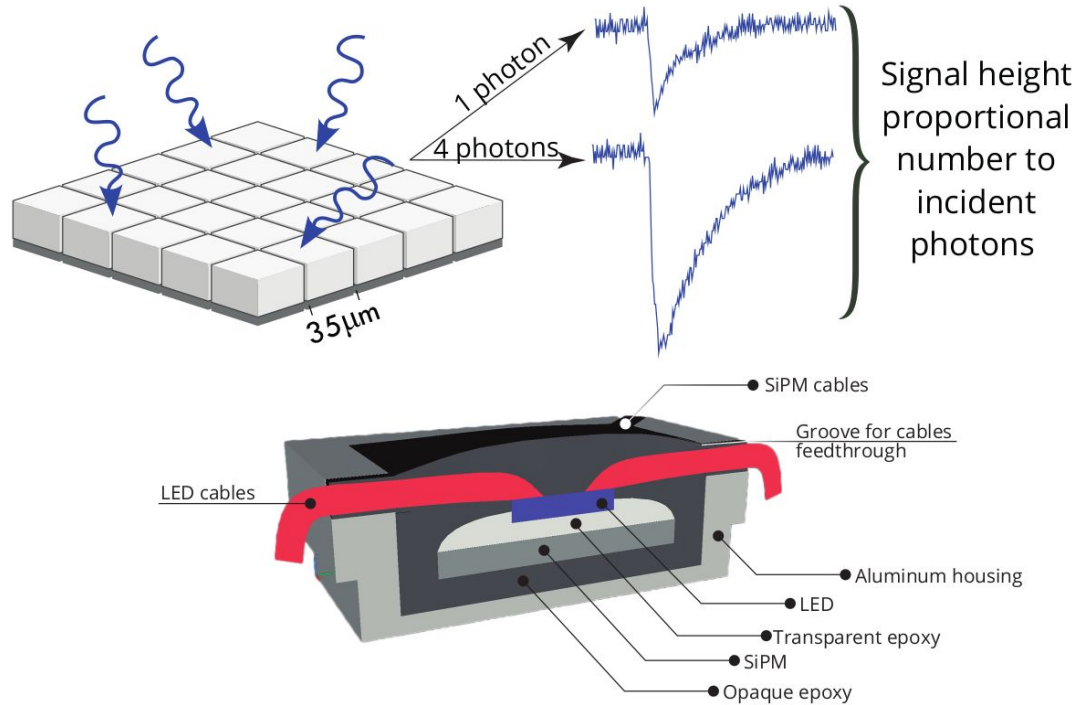
CIC_nanoGUNE



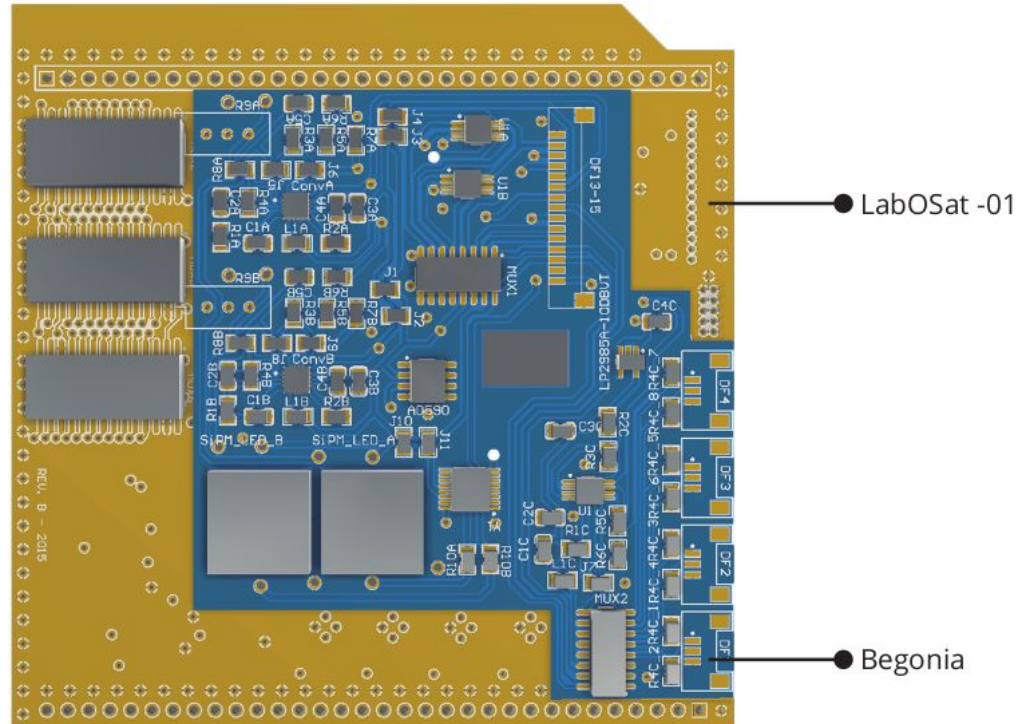
Futura carga útil @ LabOSat: SiPM

- Nuevo fotosensor rápido sensible a fotones individuales
 - Tecnología de estado sólido
 - Liviano
 - Volumen bajo
 - Mayor robustez mecánica que los Tubo Fotomultiplicador
 - Insensible a los campos magnéticos
- Habilitar la tecnología de SiPM para aplicaciones espaciales
 - A bordo de satélites de Satellogic
- Futuras aplicaciones de los SiPM en órbita:
 - Fotoquímica, biofotónica, física

Futura carga útil @ LabOSat: SiPM



SiPM @ LabOSat: Placa Begonia



Futura carga útil @ LabOSat: transistores SOI

- Transistores en tecnología SOI (*silicon-on-insulator*)
- Caracterizados como dosímetros
- Prueba de concepto
 - Primera misión: curvas IV
- Colaboración con CNEA.CAB



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¡Muchas gracias!

¿Preguntas?

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gsanca@unsam.edu.ar

Referencias

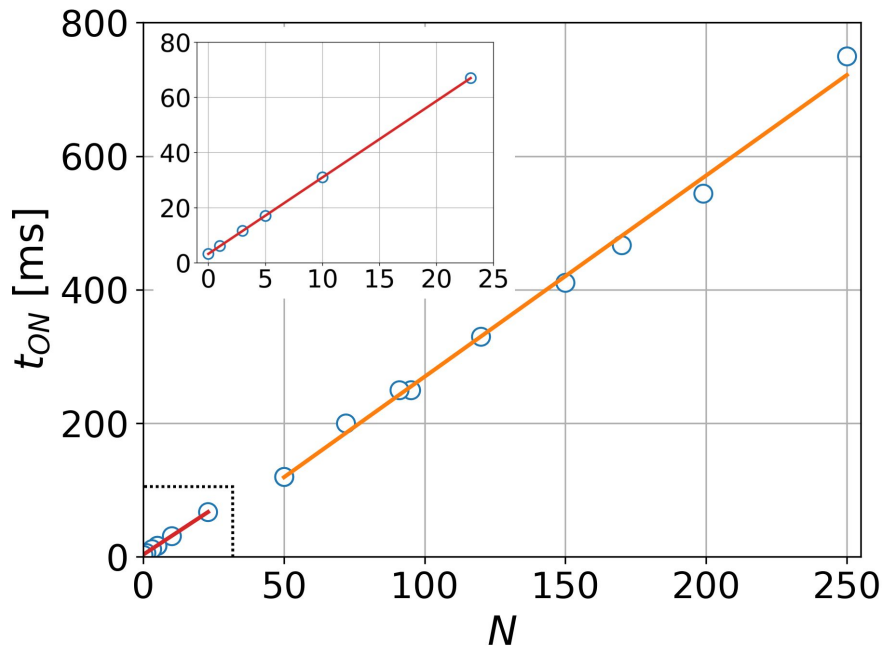
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- M. Barella. "Dispositivos de memoria basados en TiO_2 : fabricación y caracterización en ambientes hostiles mediante un controlador dedicado", PhD Thesis, Universidad de Buenos Aires, 2018.

Extra slides

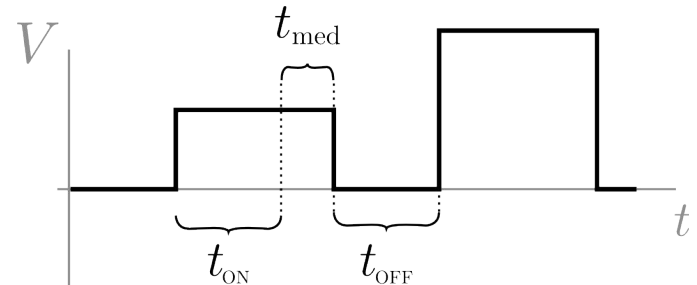
LabOSat 1
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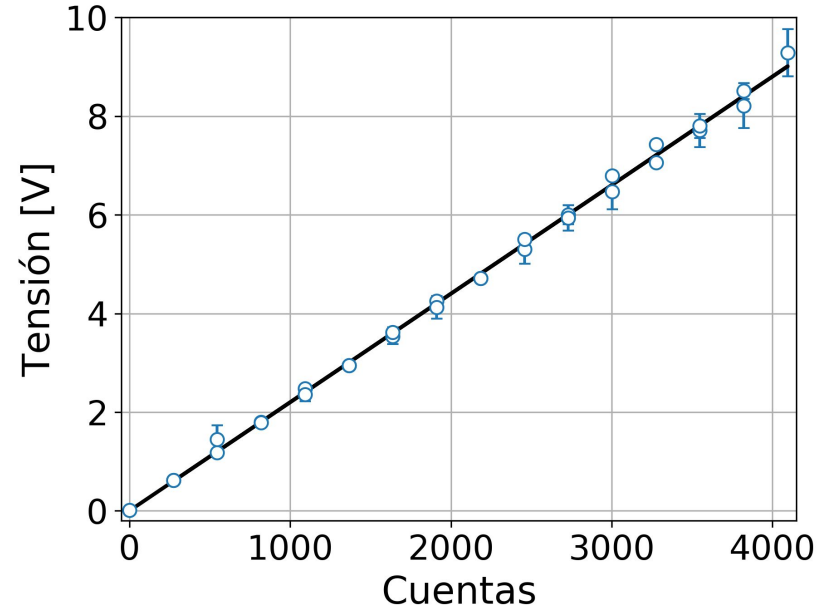
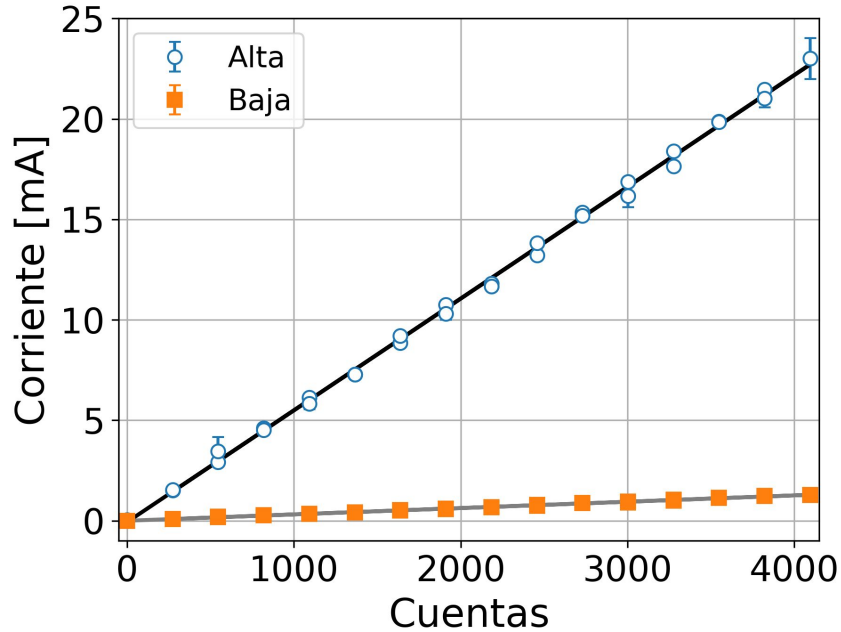
Calibración temporal



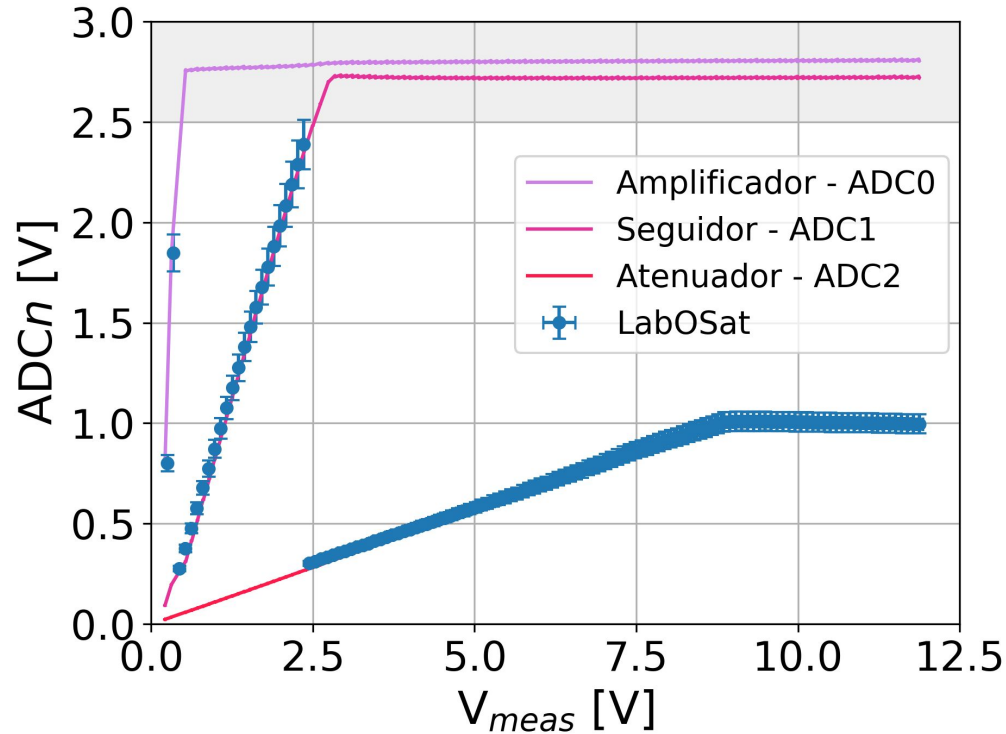
N de med.	Duración de la med. (t_{med})	Duración del pulso (t_{ON})
4	806 ± 1 us	3.69 ± 0.01 ms
8	1.62 ± 0.03 ms	4.49 ± 0.01 ms
16	3.21 ± 0.01 ms	6.10 ± 0.01 ms
16	-	$t_{OFF} = 250 \pm 1$ ms



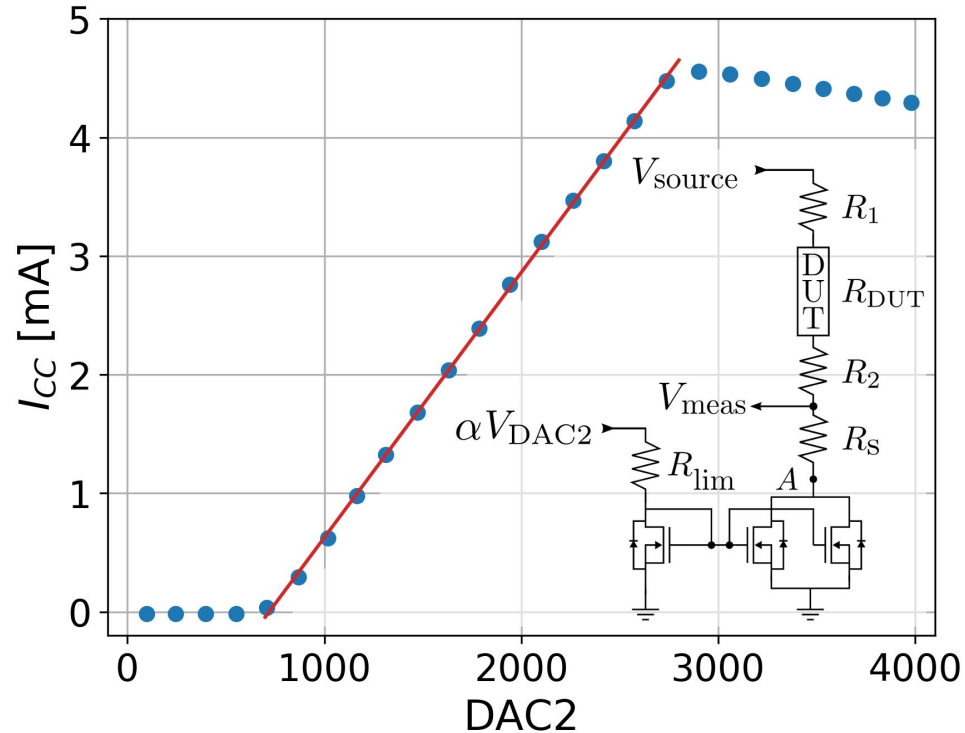
Linealidad de la SMU



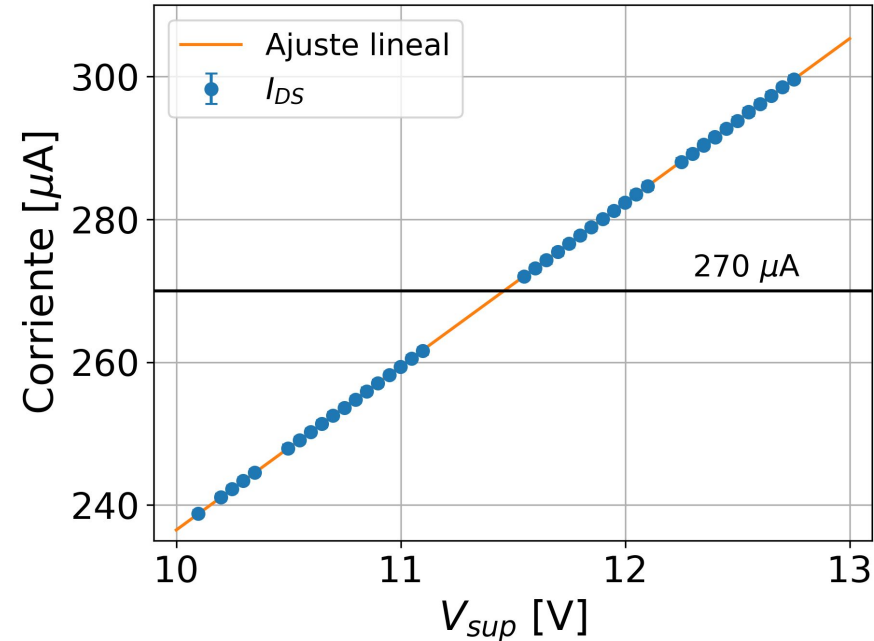
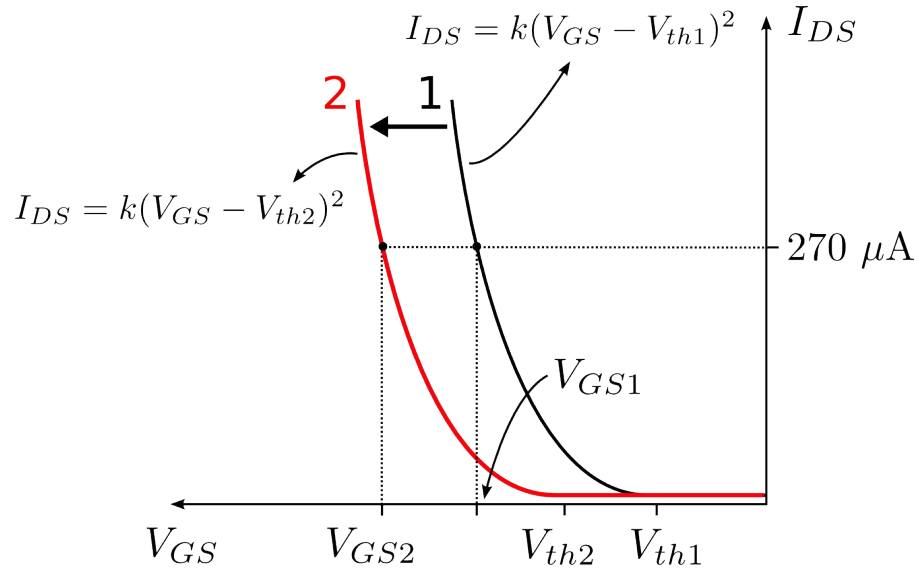
Linealidad de la SMU



Limitador de corriente



Caracterización del módulo de dosimetría



Caracterización del módulo de dosimetría

