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AUTO-ACTIVATION DE BLINDAGES ELECTROMAGNETIQUES OPTIQUEMENT TRANSPARENTS

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https://www.ietr.fr/

https://www.safran-group.com/fr/societes/safran-electronics-defense

Presentation Outline

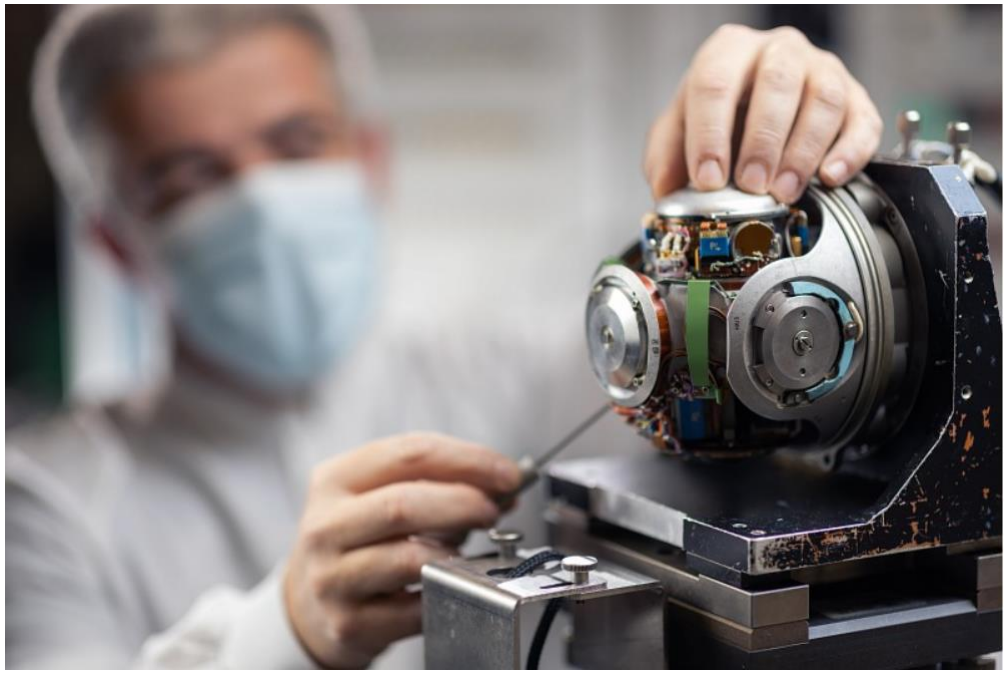
Introduction (EM protection of sensors)

Permanent shield

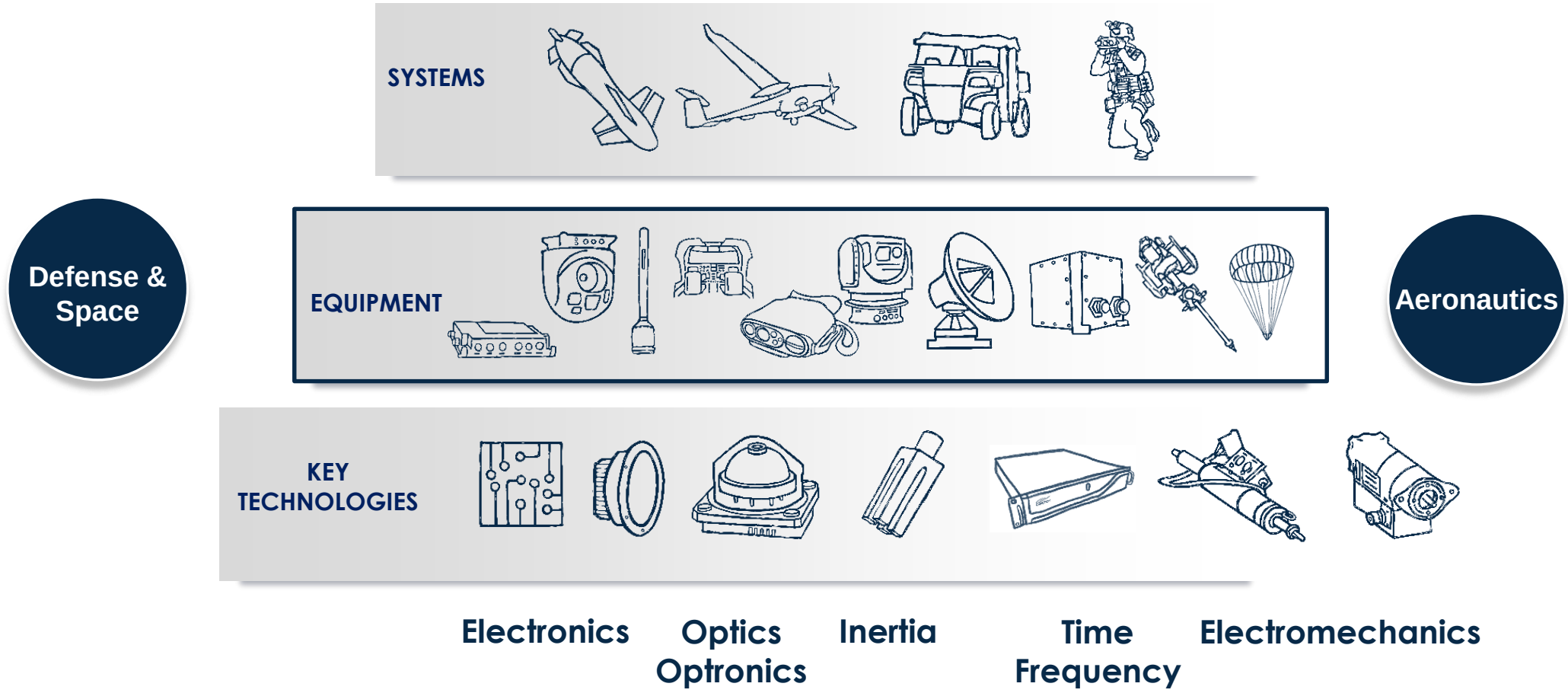
Dynamic shield

Auto-activated shield

Conclusion



Safran E&D : Observe, Decide & Guide

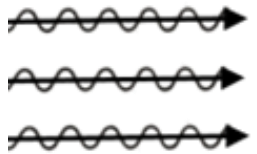


Introduction : RF & Optical sensors vs HIRF

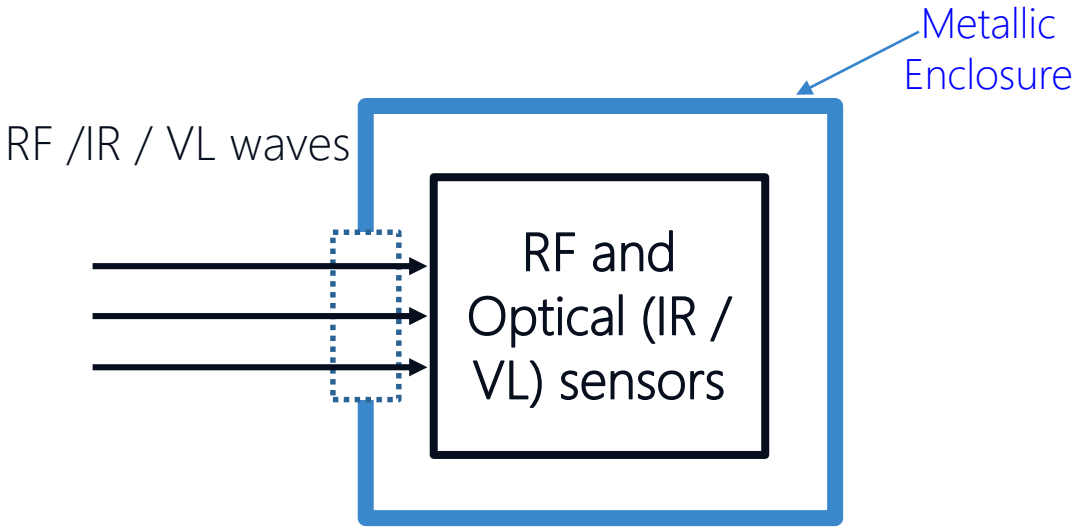
No source of HIRF:

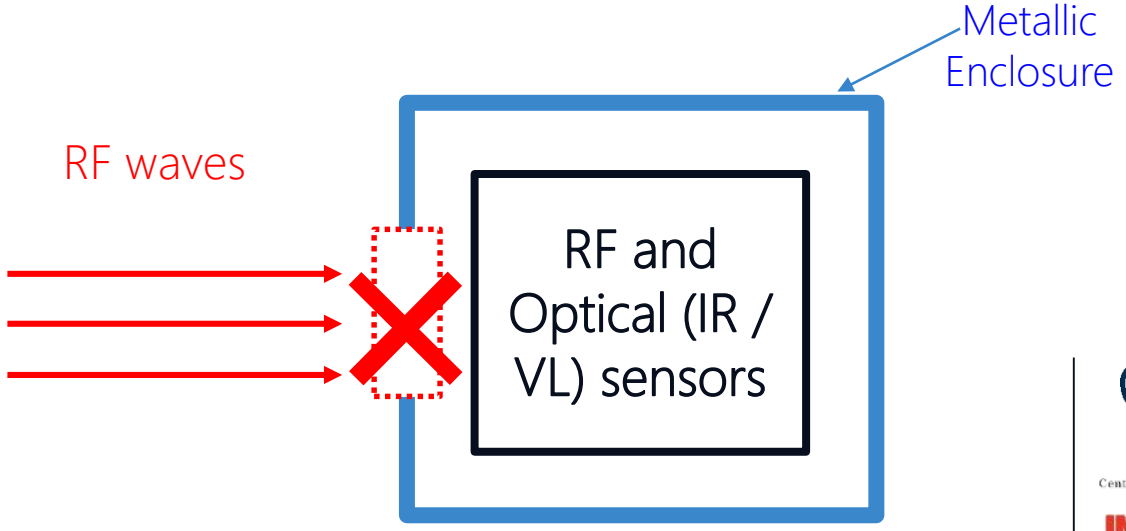
Low SE enclosure →
no sensor self-perturbation

Source of HIRF:



High SE enclosure →
no sensor external perturbation

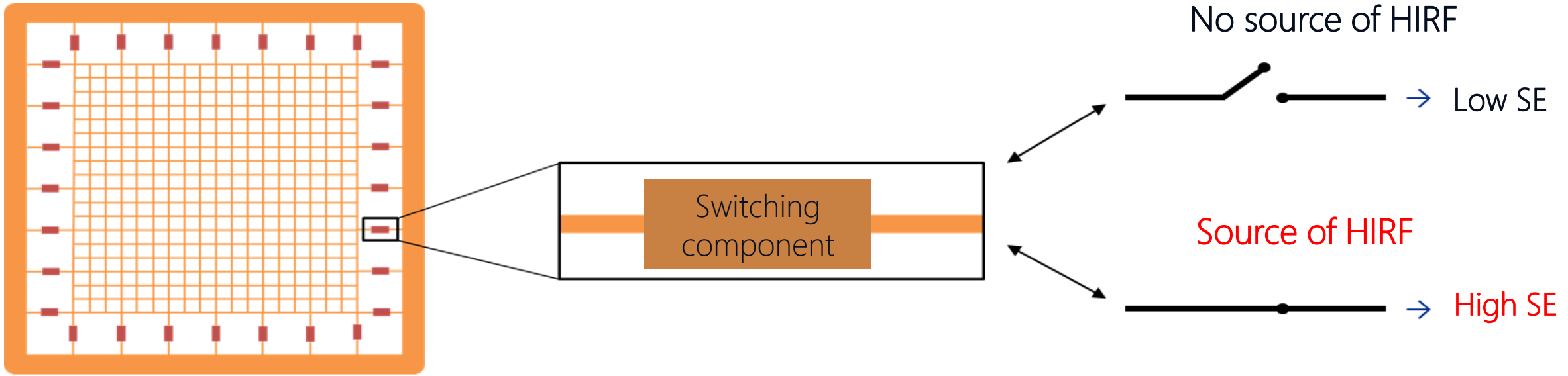




Auto-activated Electromagnetic Shield ?

Variable Shielding Effectiveness

Solution: Modification of the shield / support contact impedance



Goals :

- Frequency range : 2 - 34 GHz
- > 20 dB of SE variation
- > 80% of optical transparency
- Embedded solution
- Future integration into the SAFRAN E&D products portfolio

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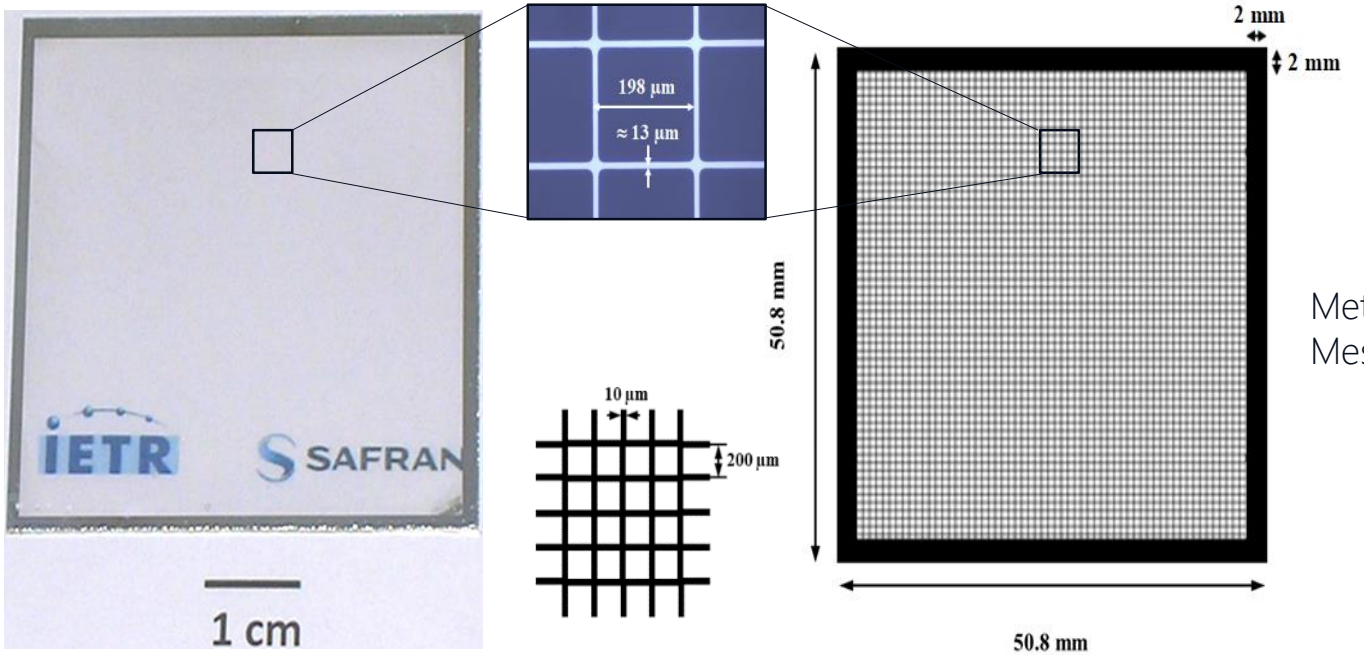
Permanent Shield

Permanent Shield (Concept)

Optically transparent shield

- A mesh-metal film : Ti/Ag (5nm/2µm) bilayer (optimal shielding in the frequency range of interest)



Metal strip width : $2a = 10\ \mu m$
Mesh pitch : $g = 200\ \mu m$

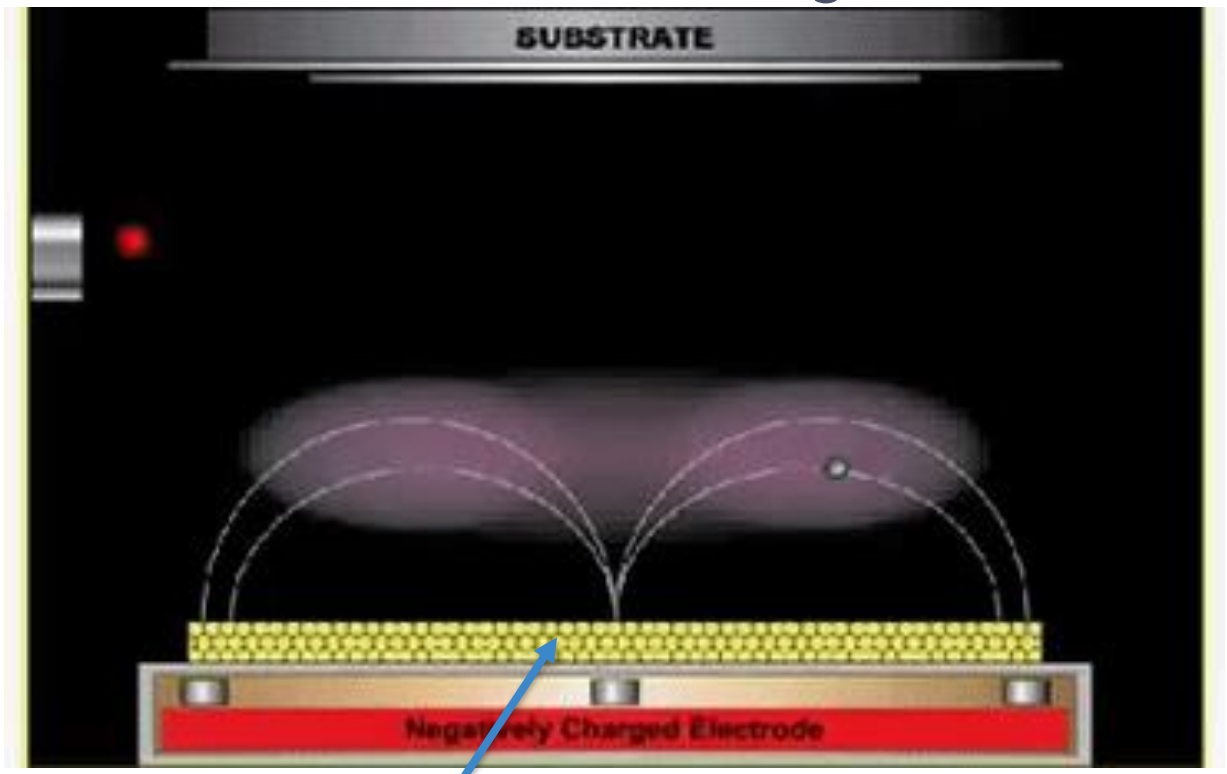
$$T = \left(\frac{g-2a}{g}\right)^2 \times T_{sub} = 83\%$$

Y. Corredores, P. Besnier, X. Castel, J. Sol, C. Dupeyrat and P. Foutrel, IEEE Transactions on Electromagnetic Compatibility, vol. 59, no. 4, pp. 1070-1078, Aug. 2017

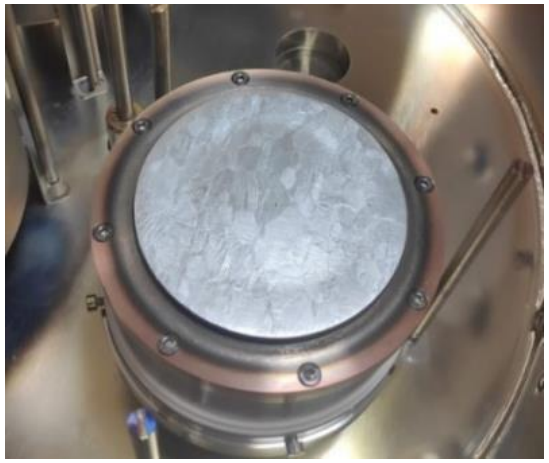
Permanent Shield (Fab.)

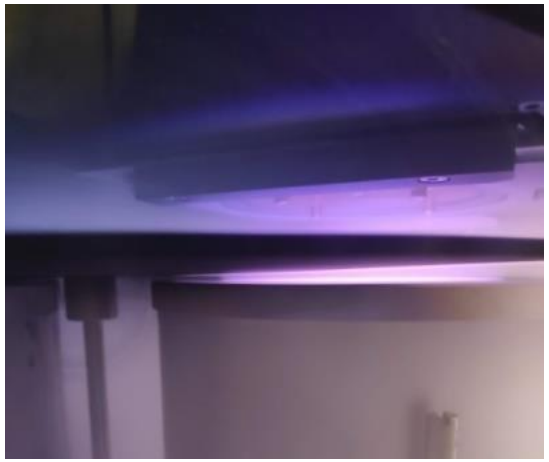
Thin layer deposition through RF sputtering (IETR)

Substrate: sodo-lime glass



Target: Ag



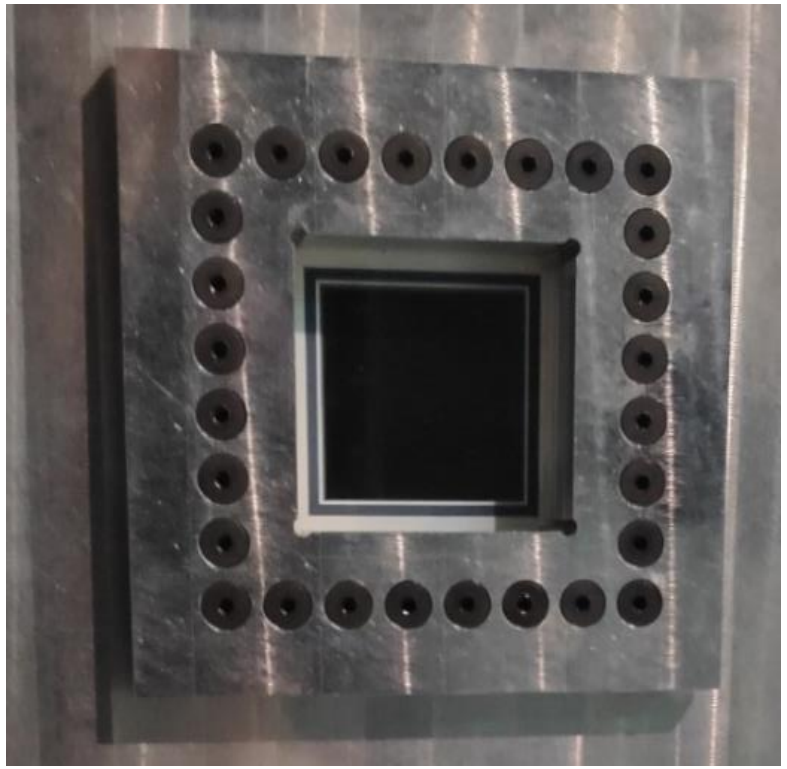


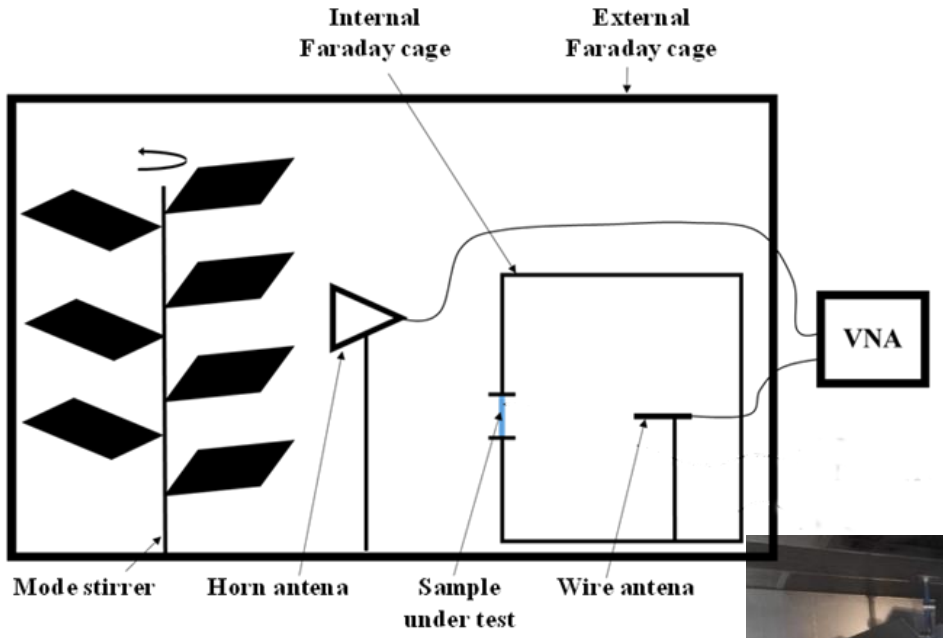
RF voltage difference → electrons interacting with Argon gas →sputtering: Deposition of Ag on the substrate

https://www.youtube.com/watch?v=Hf2kkqZhL7U

Permanent Shield (Meas.)

Shielding Effectiveness Measurement



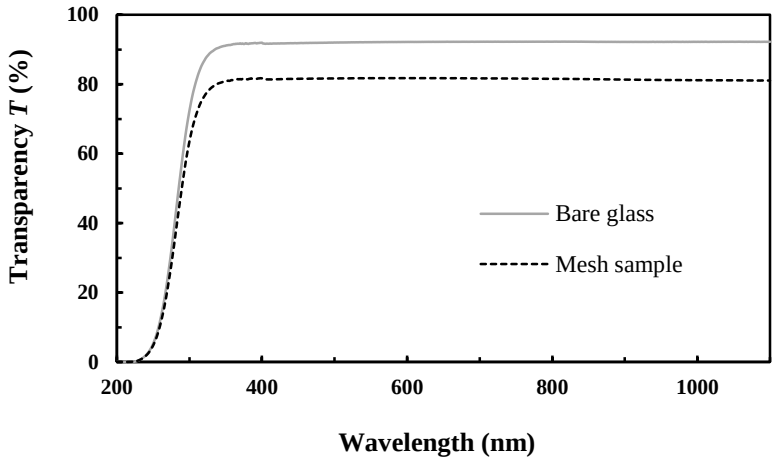


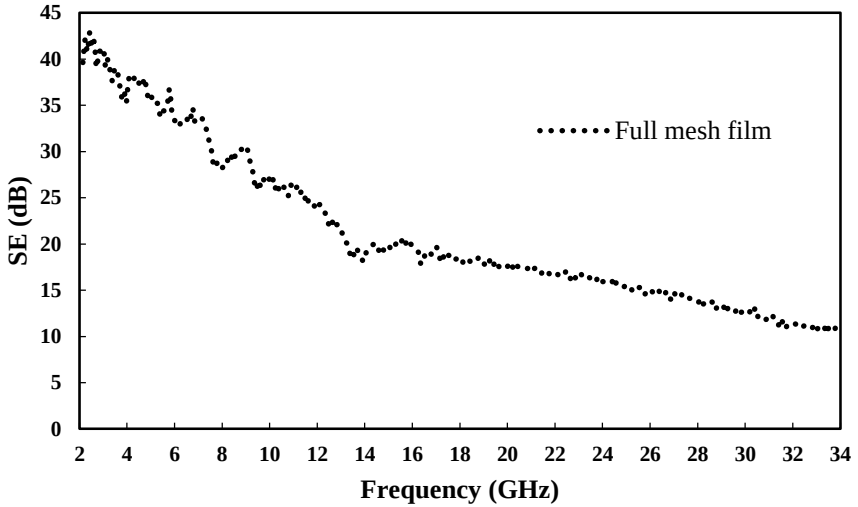
C. L. Holloway, D. A. Hill, J. Ladbury, G. Koepke, et R. Garzia, « Shielding effectiveness measurements of materials using nested reverberation chambers », *IEEE Trans. Electromagn. Compat.*, vol. 45, nº 2, p. 350-356, May 2003.

Permanent Shield (Results)

Optically transparent shield

- A mesh-metal film : Ti/Ag (5nm/2µm) bilayer (optimal shielding in the frequency range of interest)





$$T = \left(\frac{g-2a}{g}\right)^2 \times T_{sub} = 83\%$$

Metal strip width : $2a = 10\ \mu m$
Mesh pitch : $g = 200\ \mu m$

→ Not reconfigurable: Mesh parameters are fixed. Dynamic variation of SE non-available.

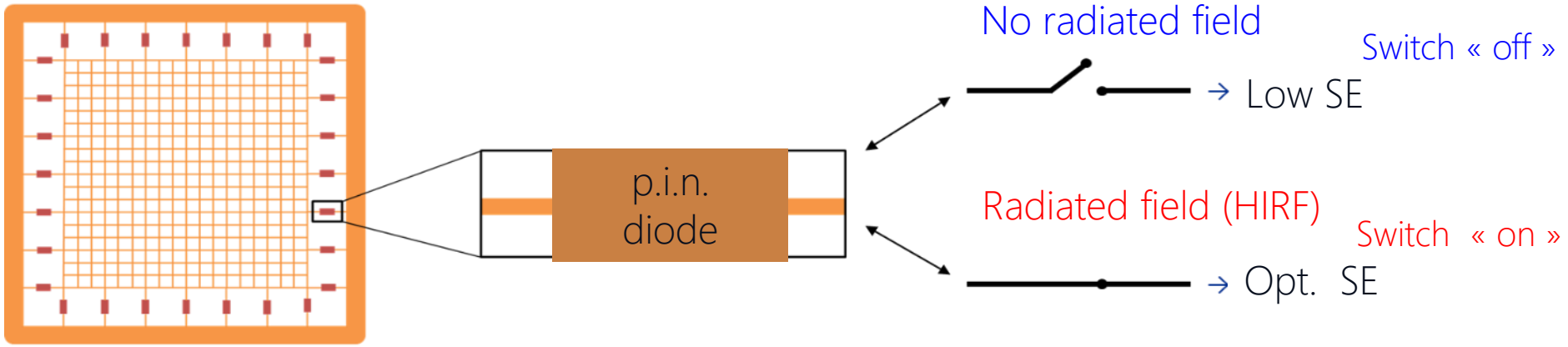
Y. Corredores, P. Besnier, X. Castel, J. Sol, C. Dupeyrat and P. Foutrel, IEEE Transactions on Electromagnetic Compatibility, vol. 59, no. 4, pp. 1070-1078, Aug. 2017

2

Dynamic Shield

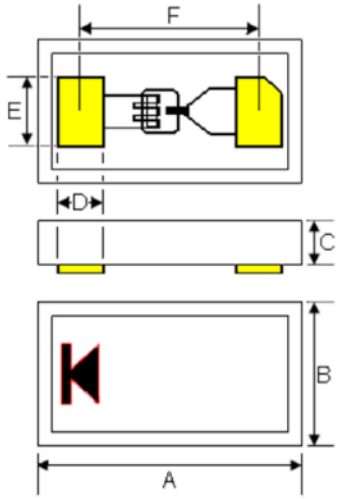
Surface Mounted Switching Devices

Active shield made of switchable p-i-n Diodes

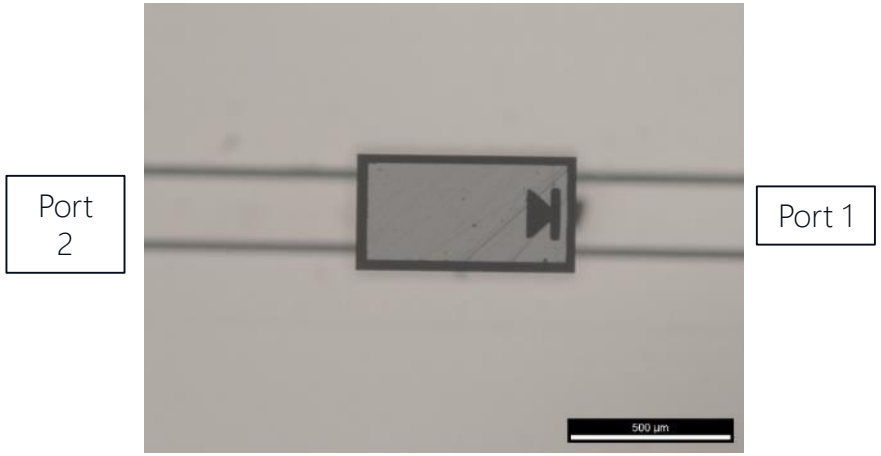


Surface Mounted Switching Devices

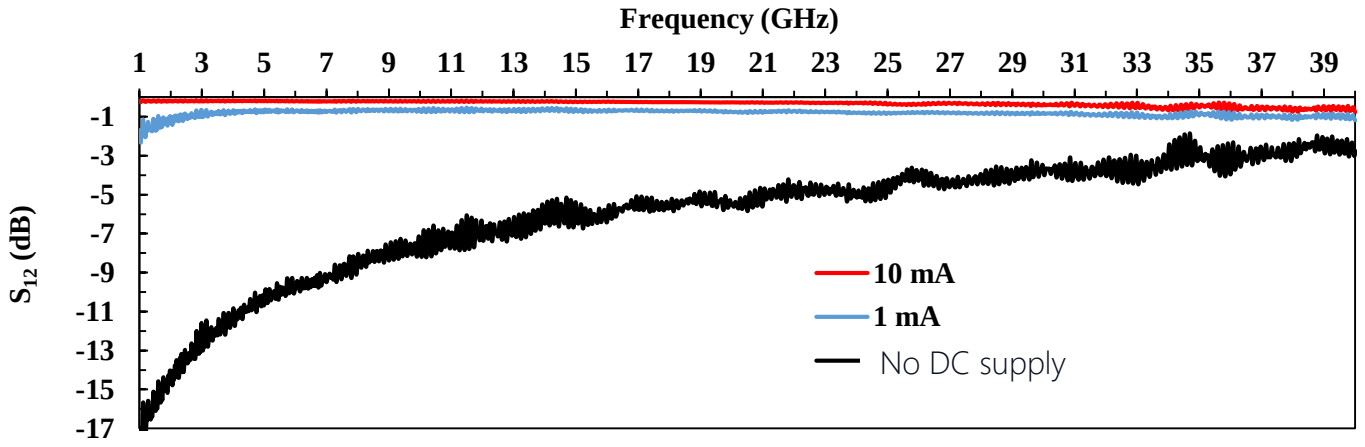
Component : p-i-n diode (MACOM: MA4AGFCP910)



DIM	MM	
	MIN.	MAX.
A	0.6604	0.6858
B	0.3429	0.3683
C	0.1651	0.1905
D	0.1092	0.1346
E	0.1727	0.1854
F	0.4623	0.4877

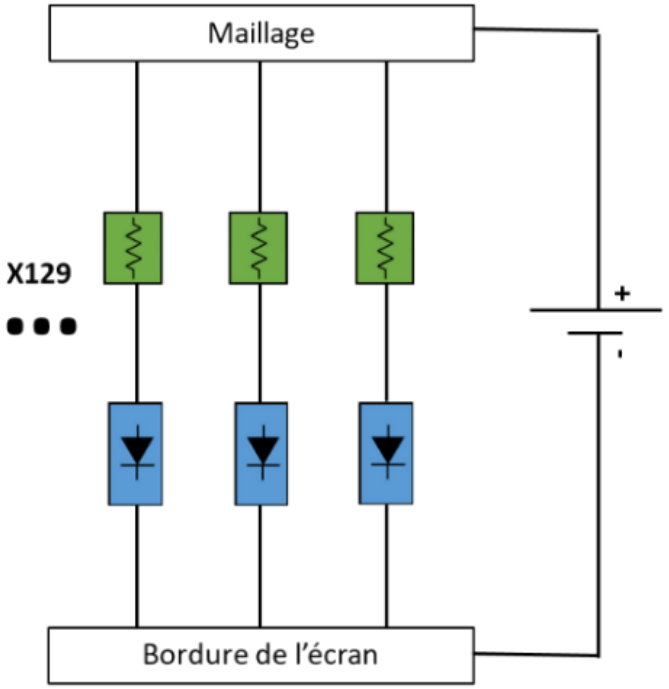


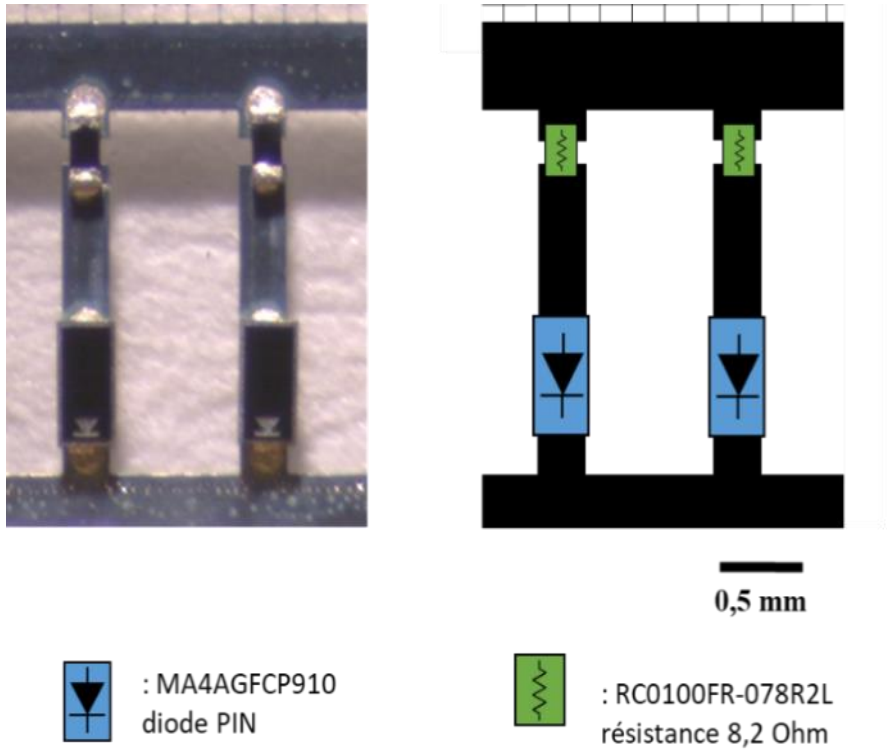
S_{12}: No supply (switch off), 1 mA / 10 mA supply (switch on)



Surface Mounted Switching Devices

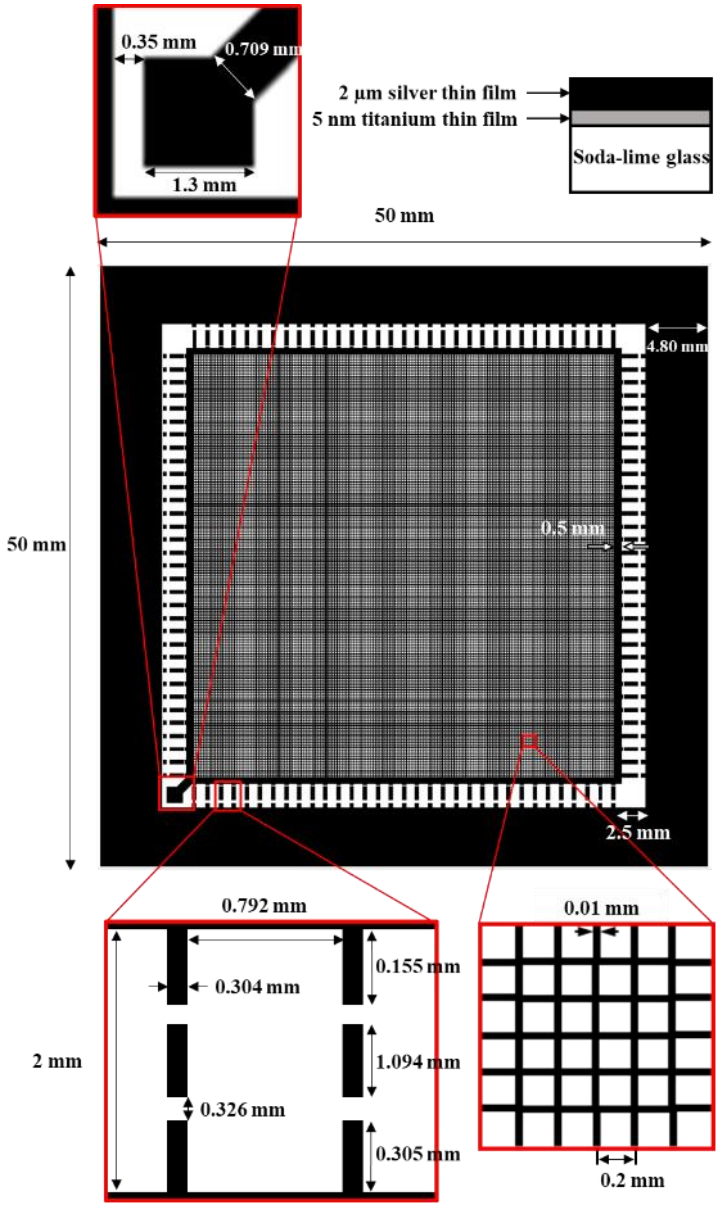
Bias circuit

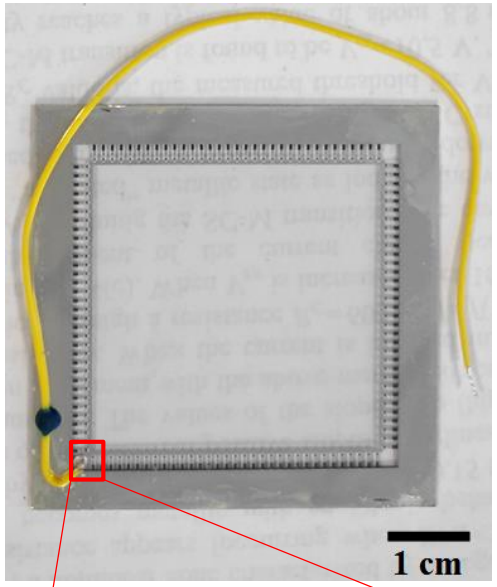


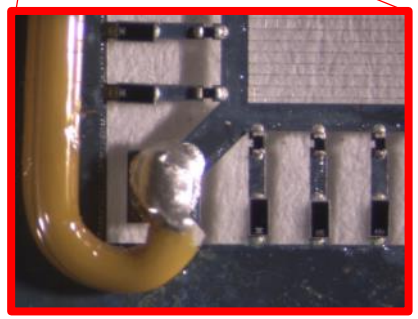


Surface Mounted Switching Devices

Fabrication



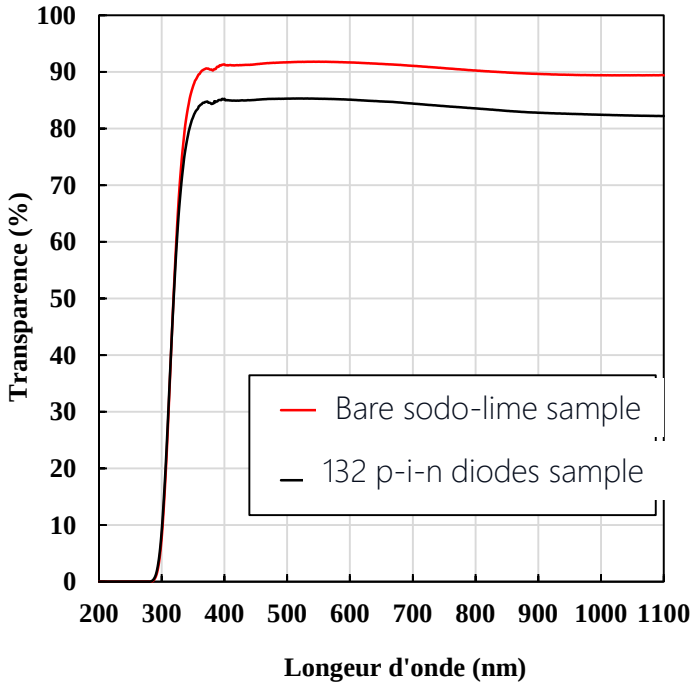


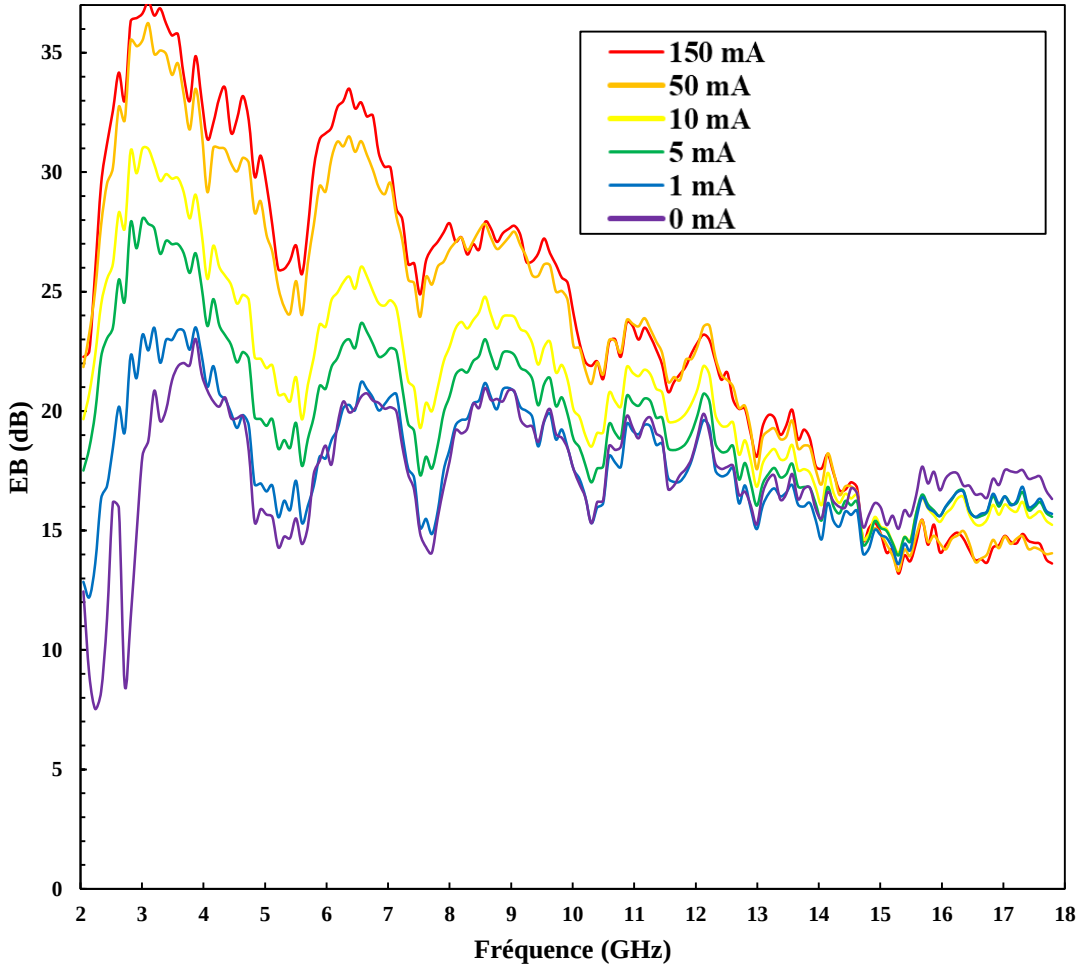


Mounting by SAFRAN E&D, Valence, France

Surface Mounted Switching Devices

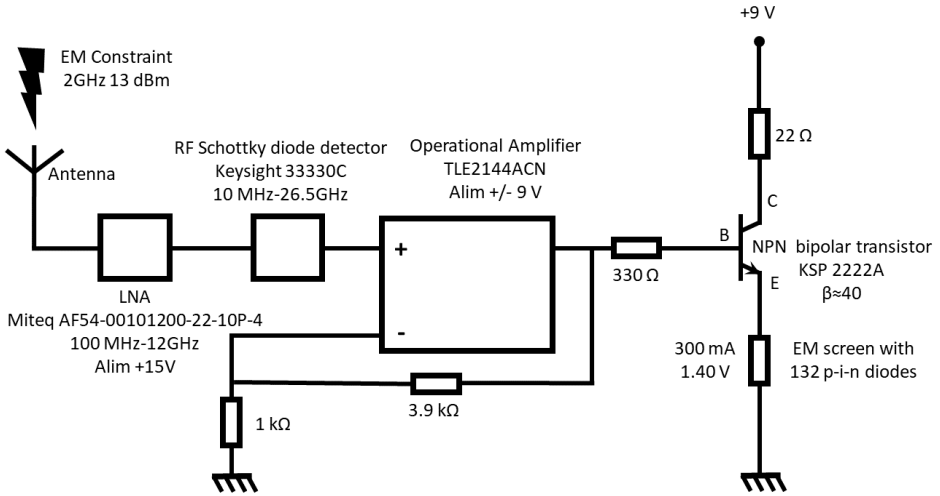
Experimental results



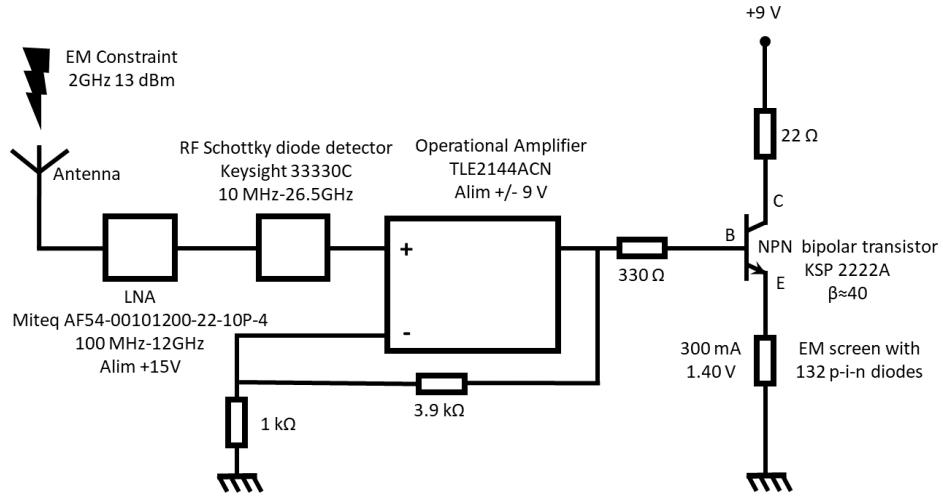


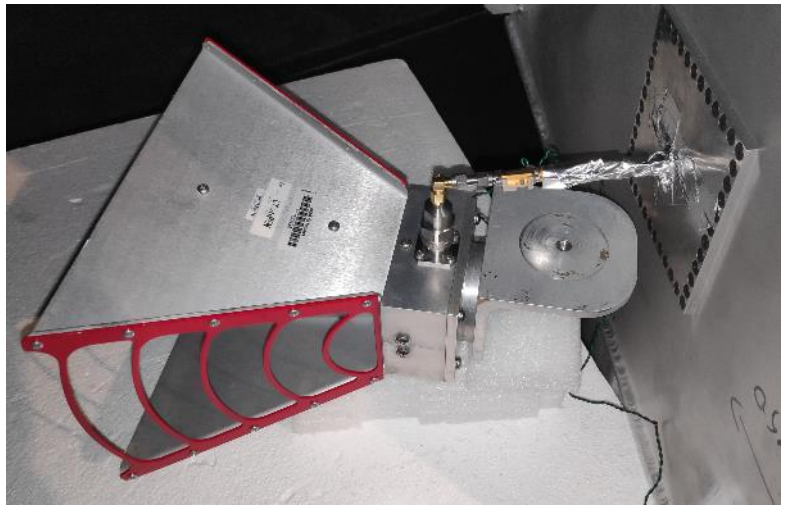
3

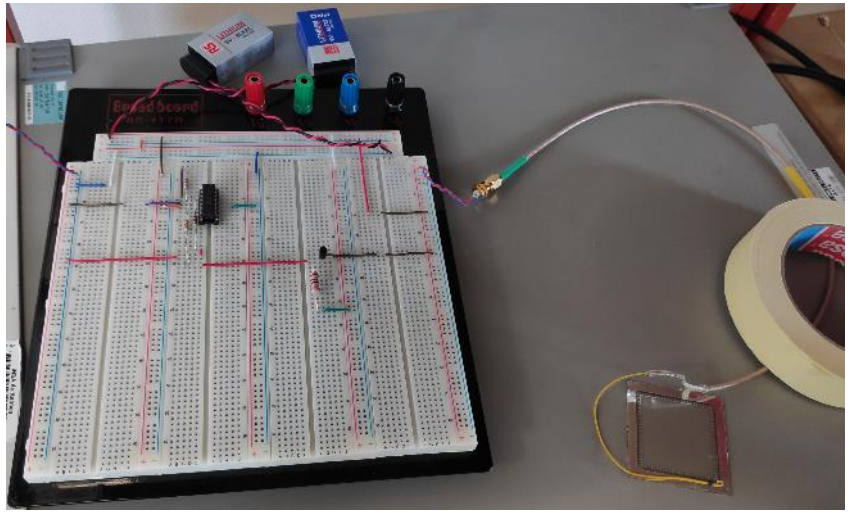
Auto-Activated Shield



Auto-activated Shield

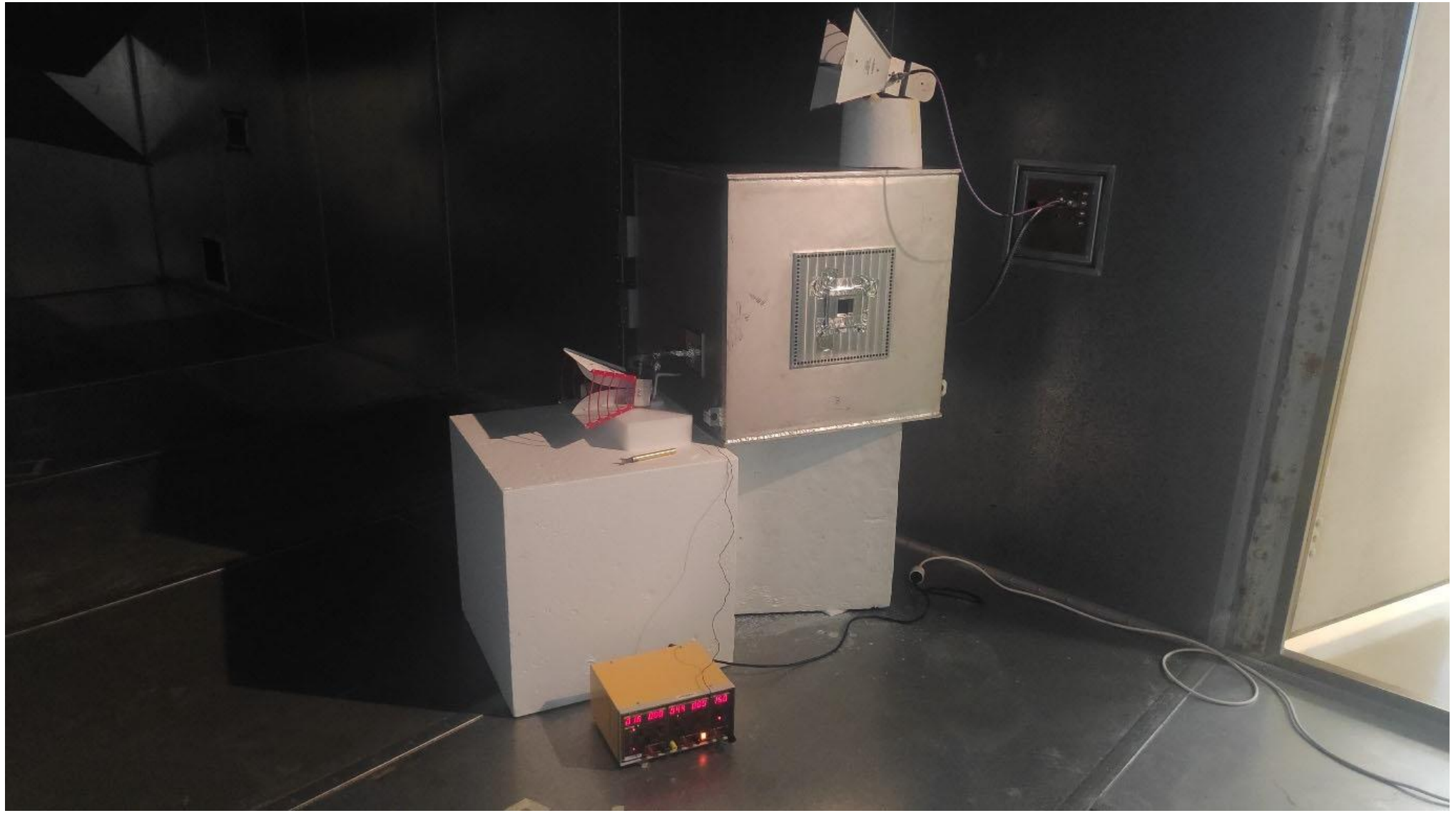






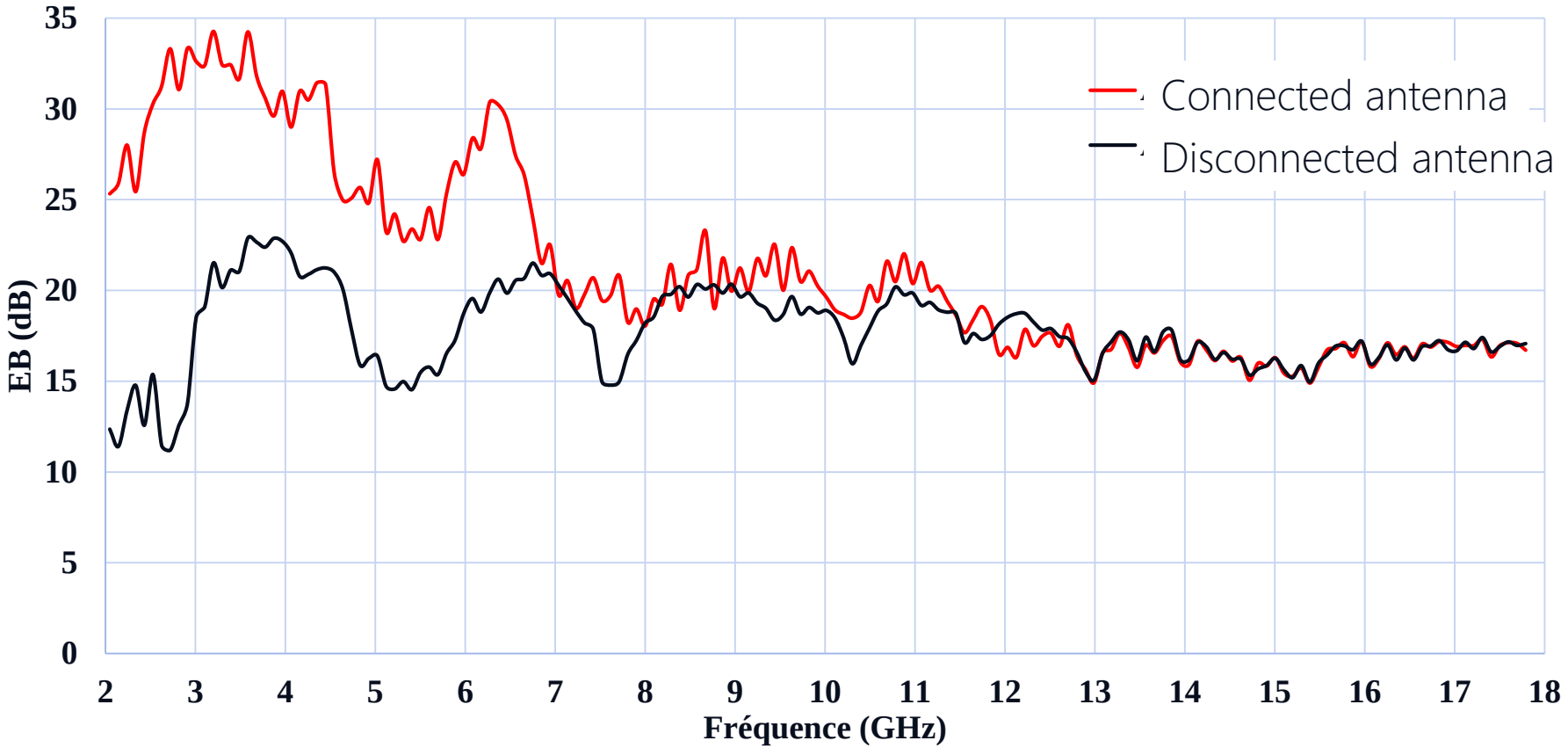
- Auto-activation : sensing (antenna), rectifying (Schottky diode), amplifyng
- Provide the bias current for the p.i.n. diodes upon presence of the HIRF

Auto-activated Shield



Auto-activated Shield

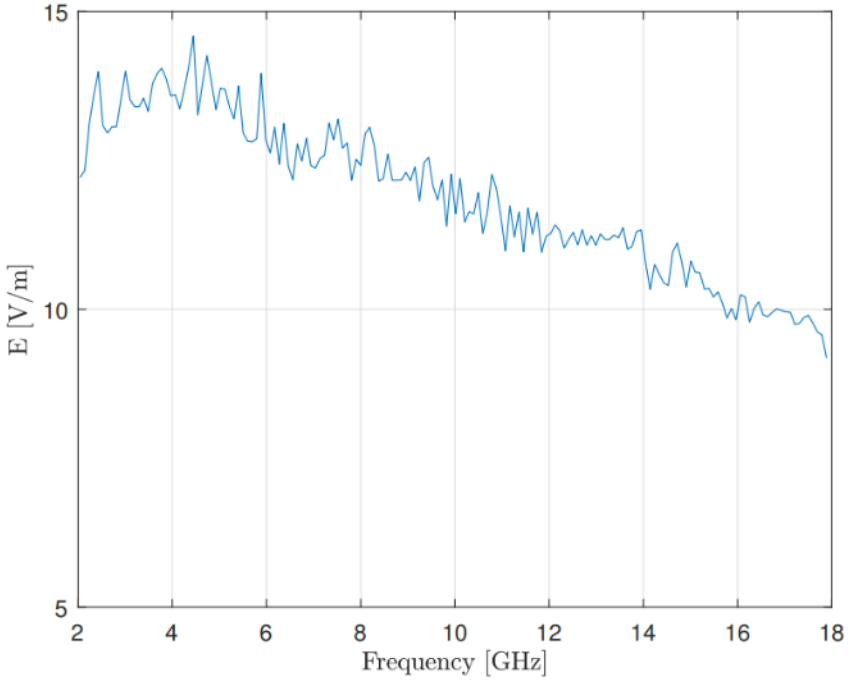
Results



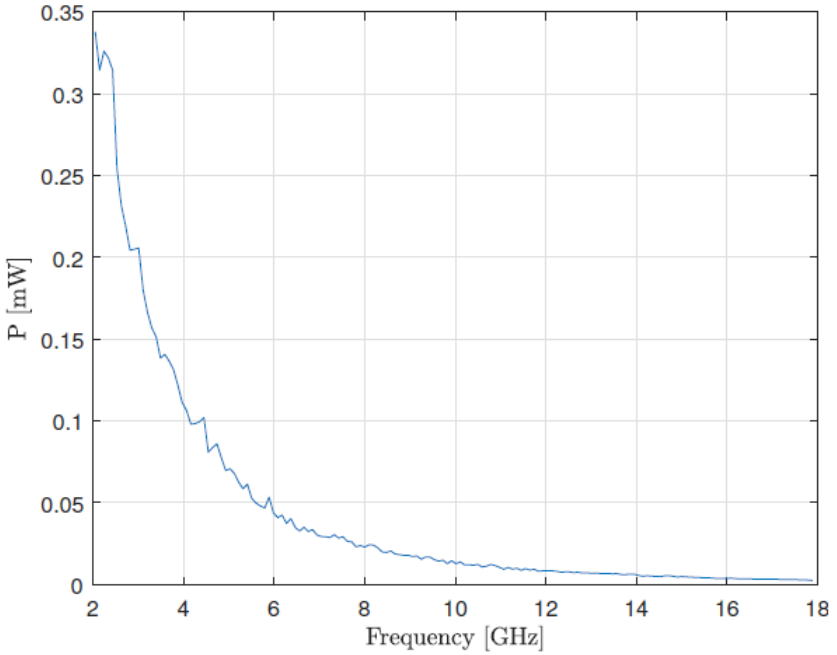
- Excitation : 16 dBm (VNA output)→ Average Electric field strength ~ 10 to 15 V/m
- SE variation is absent beyond 10 GHz due to the effective area of the receiving antenna

Auto-activated Shield

E-Field strength in the RC and power received at the input of the detection circuit



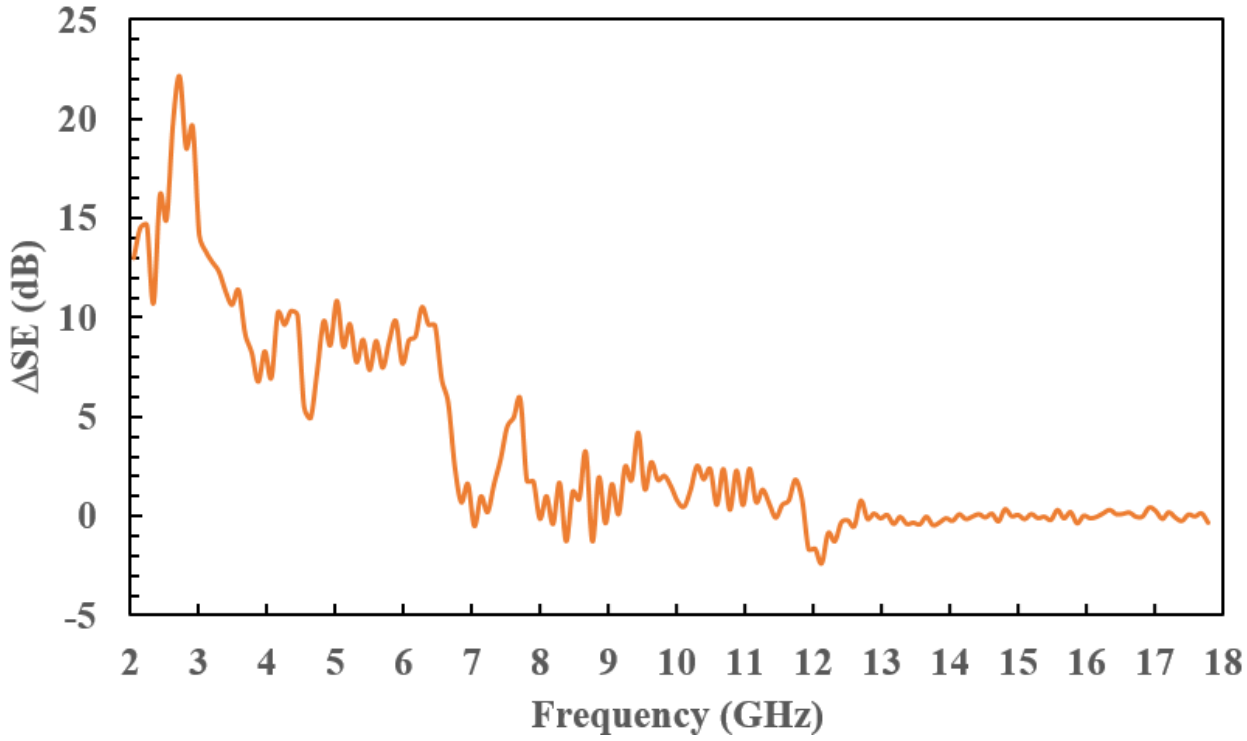
Estimated average E-field in the RC (based on Q-factor measurement)



Average received power at the antenna port of the detection circuit

Auto-activated Shield

Relative variation of SE with the proposed auto-activated shield



Conclusion

A solution to protect electronics from radiated fieds (HIRF) upon detection of the interference

- A mesh-metal film deposited on a glass substrate for optical transparency and protection against EM field
- An array of p-i-n diodes controlling the contact impedance of the shield
- A detector circuit for switching diodes on and off in presence or absence of external interference (HIRF)

Advantages

- Fast switching solution
- Thin film deposition and p-i-n diodes reporting are standard industrial processes
- Possible adjustement of the detector circuit (here designed for proof-of-concept only)

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Merci de votre attention