Radiométrie Hyperfréquence Spatiale

GDR Radiométrie Microonde pour l'Etude de l'Atmosphère -

06 octobre 2010

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Quelques bases

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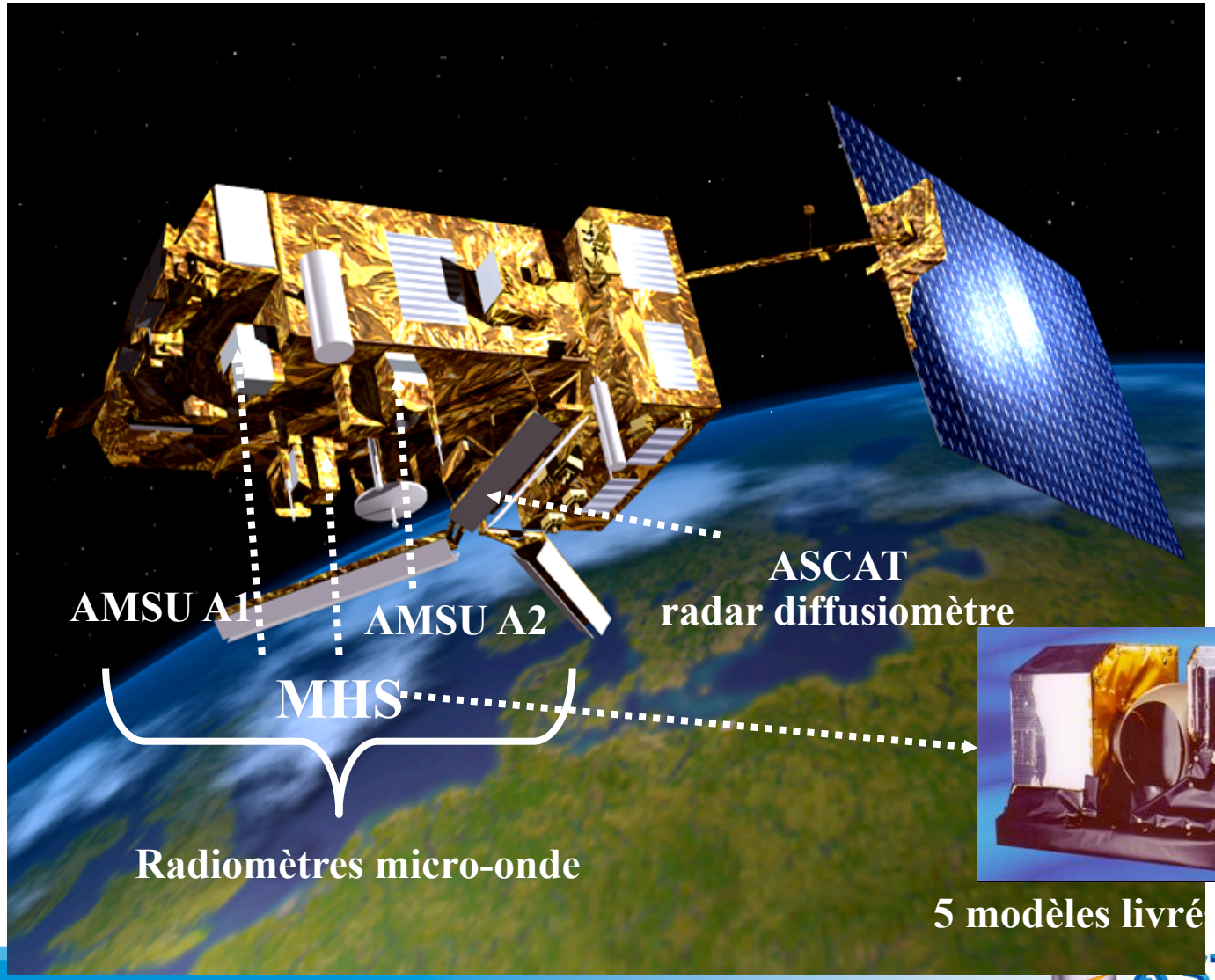
Radiomètres MHS et AMSU sur METOP et NOAA 18, NOAA 19: météo opérationnelle



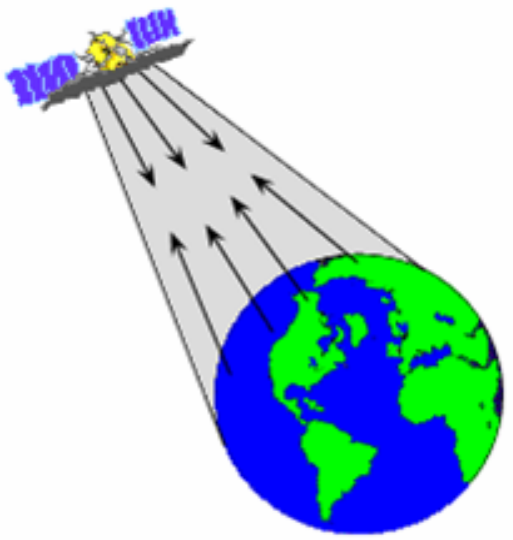
actualité

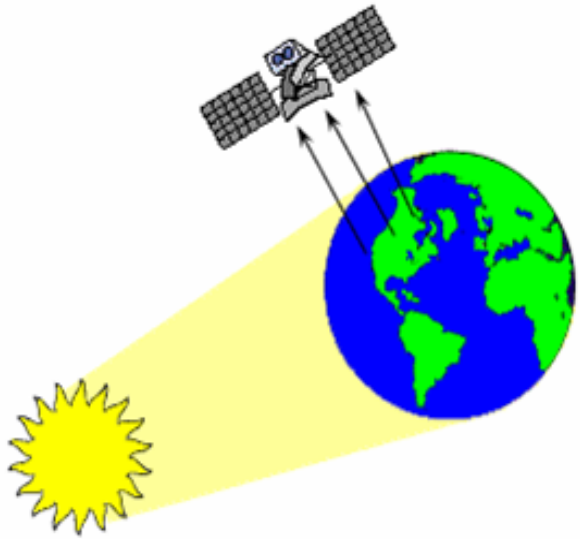
- Missions passées ou en cours :
  - météo : MSU, AMSU A&B, ESMR,SSMI/S, TMI, SMMR, MHS, MTS, MADRAS ...
  - astronomie : COBE, ODIN, PRONAOS, W-MAP, PLANCK, HERSCHELL
  - Océanographie (correction troposphérique des altimètre) : TMR, ATSR-M, JMR, BHR AltiKa
  - sondage au limbe : MLS, MAS, AMAS, ODIN, SMILE

- Misions à venir
  - PREMIER (steam R)
  - MWS, MWI, ICI (METOP SG)
  - GPM Br Fr, Boitata
  - Cloud Ice
  - Microwat

radiomètrie hyperfréquence

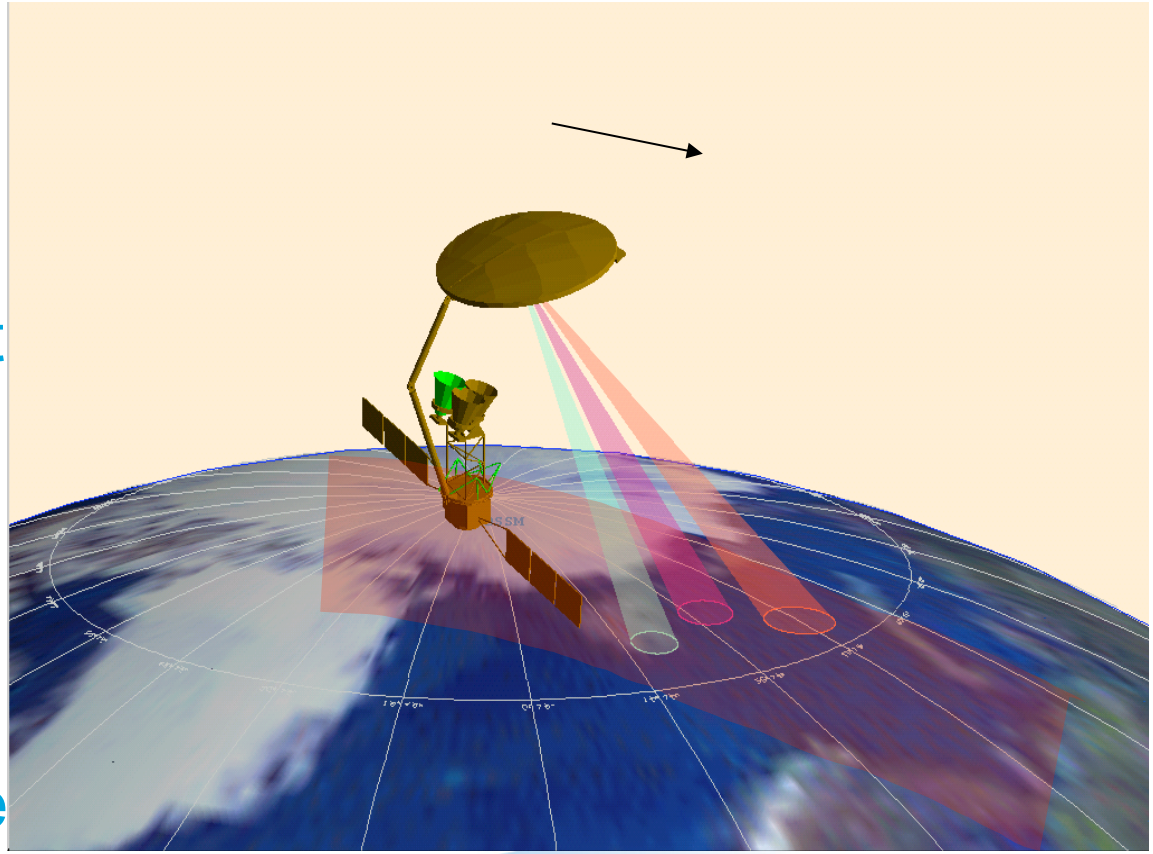
- Observation passive depuis l'espace d'un milieu naturel
  - mer, glace,sols nus ou avec végétatioplanètes, atmosphère, pluie
- Hyperfréquences: de 1 à 300GHz
- Hyperfréquences + : jusqu'à quelques THz





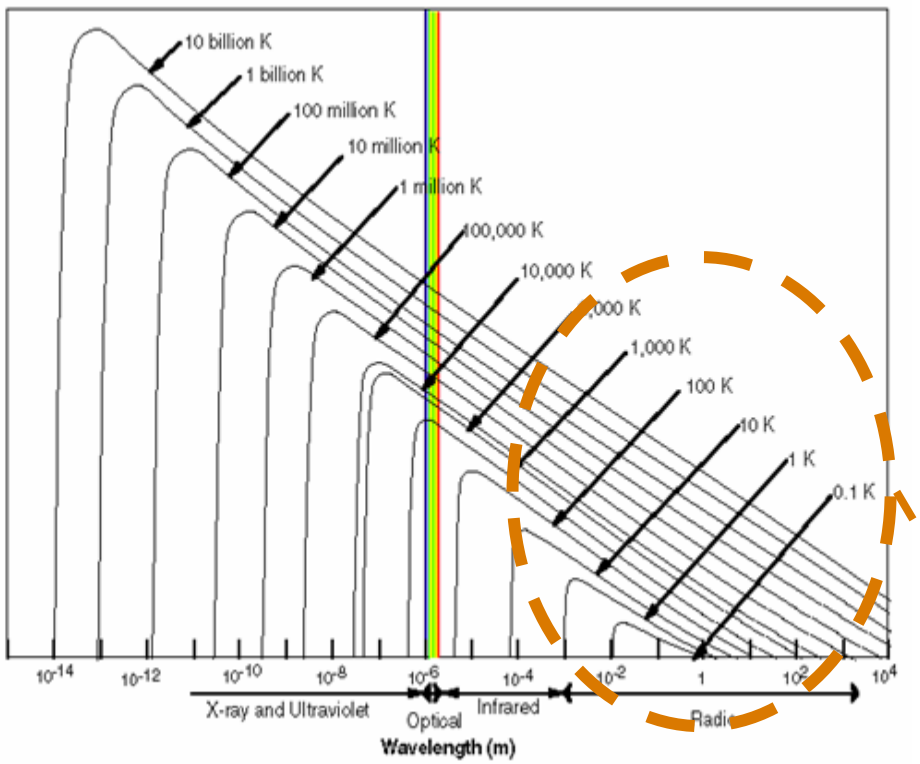
Principe radiométrie micro-onde

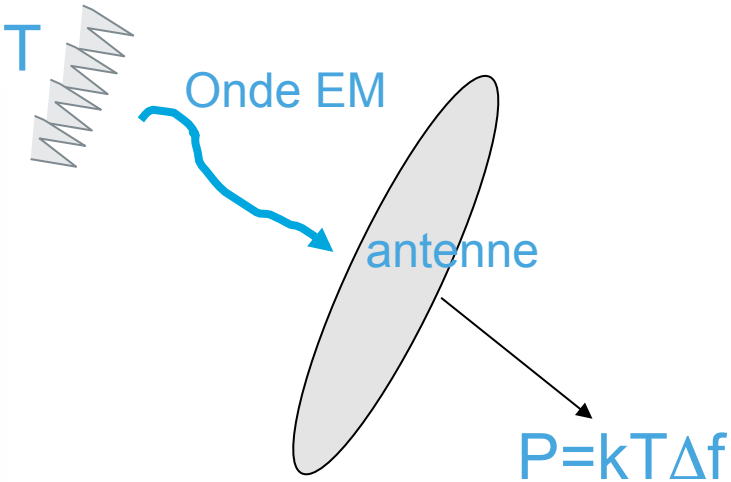
- Collection du flux naturellement émis par la scène
- L'antenne définit la résolution angulaire et la taille du pixel au sol
  - Météo: 1°, 30km
- La fauchée est atteinte par balayage, rotation mécanique de l' antenne



Rayonnement du corps noir: simplification des équations

Loi de Planck

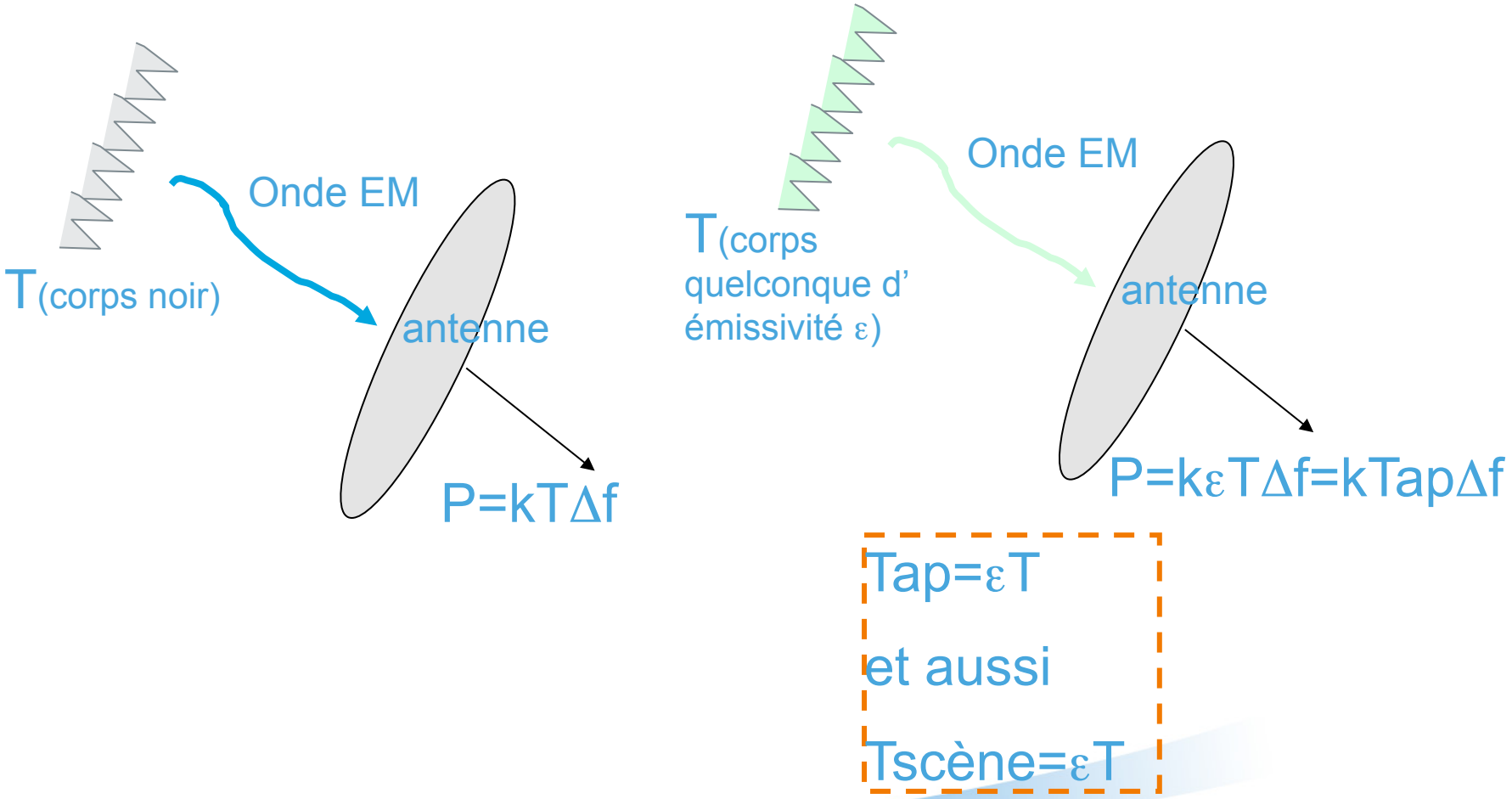




$$B_f(\theta,\phi) \approx \frac{2kT\varepsilon(\theta,\phi)}{\lambda^2}$$

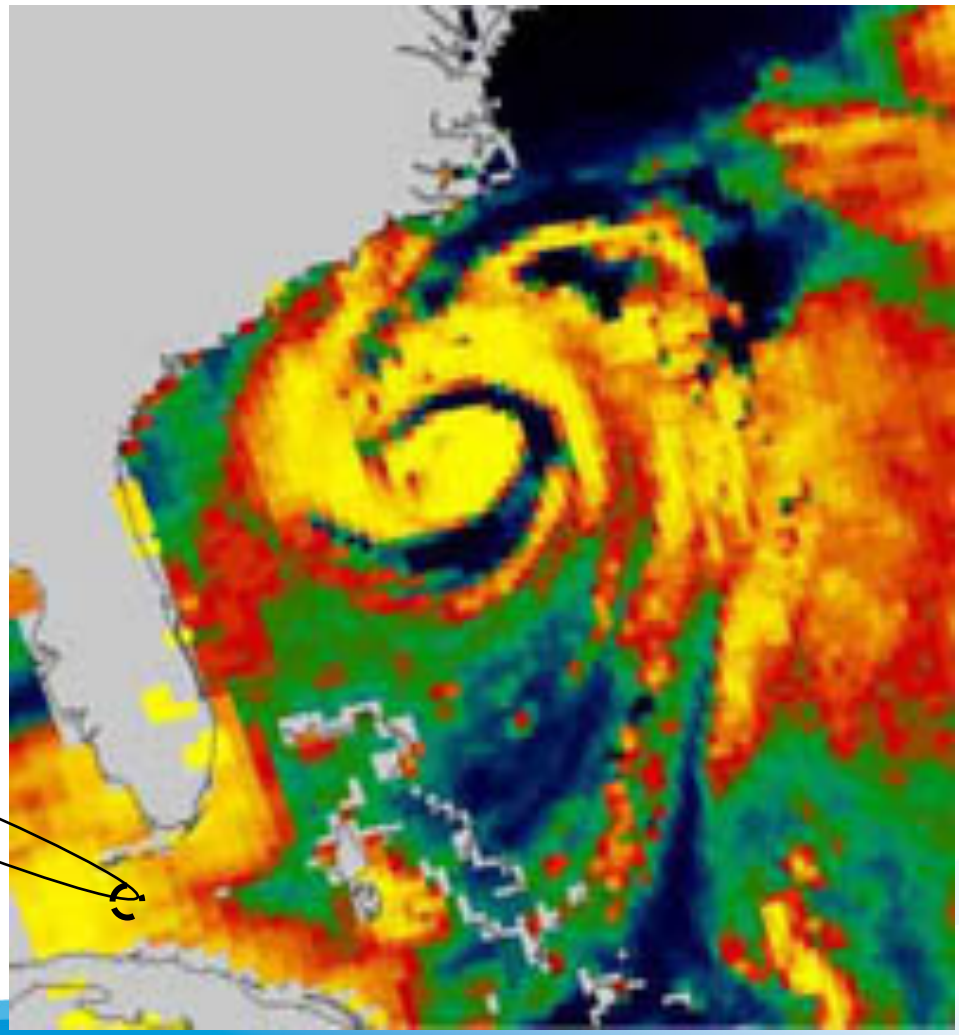
approximation de Rayleigh - Jeans pour $hf/kT < 1$

Température apparente



Au final on obtient des cartes en Tap (ou Tscène), par analogie au rayonnement du corps noir: Level 1B

$$P_r = kT_{scene}\Delta f$$



The Pixel size is ~30 Km

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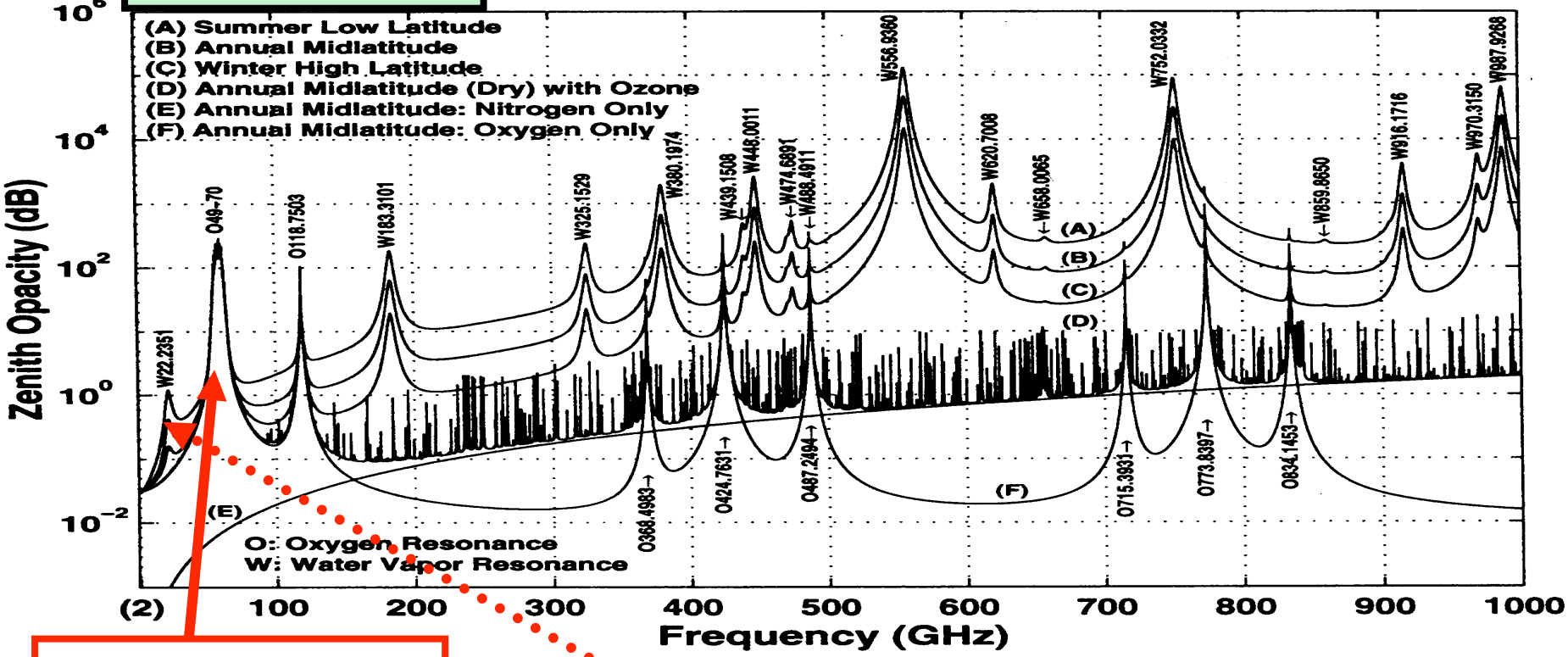
Atténuation atmosphère / missions

Précipitations
Madras, MWI

Nuages de glace: ICI, Boitata, Cloud Ice

Météo LEO : Amsu
MHS, MWS

Chimie aux limbes: Steam-r



Radars
Calibration , Altika

SST: MICROWAT

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Etalonnage

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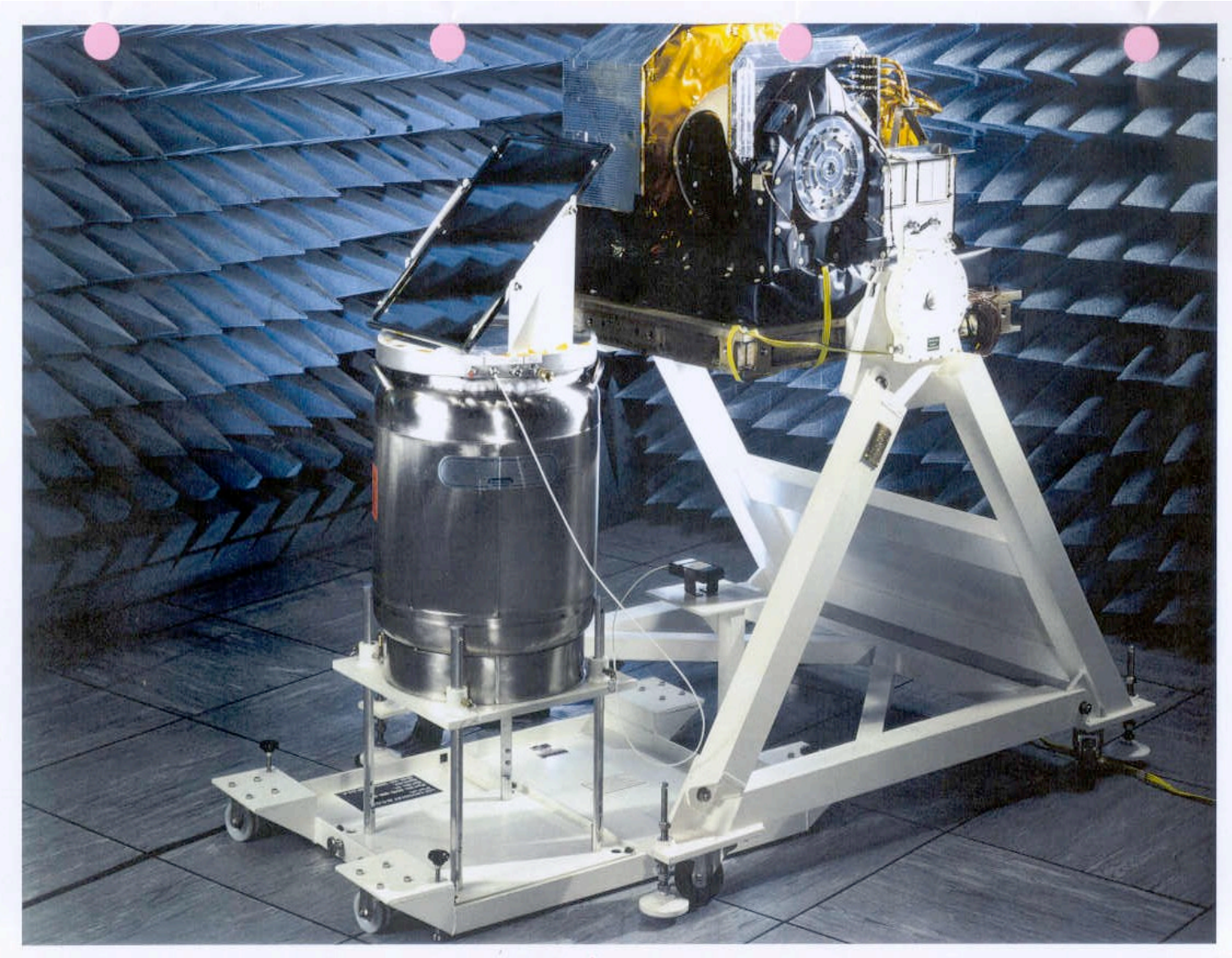
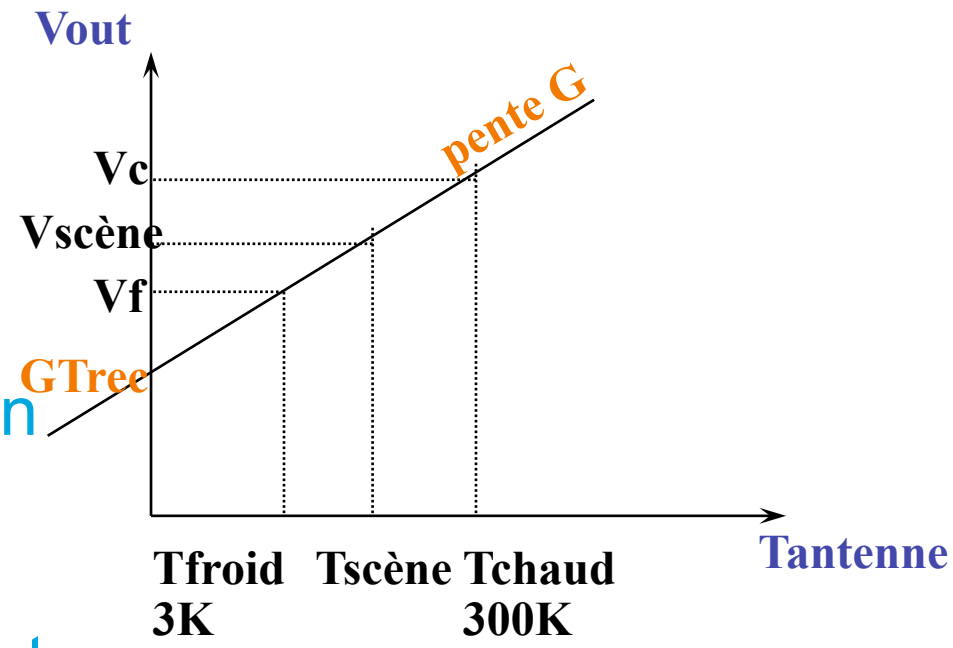
Test sur Etalon Froid d'un radiomètre Complet

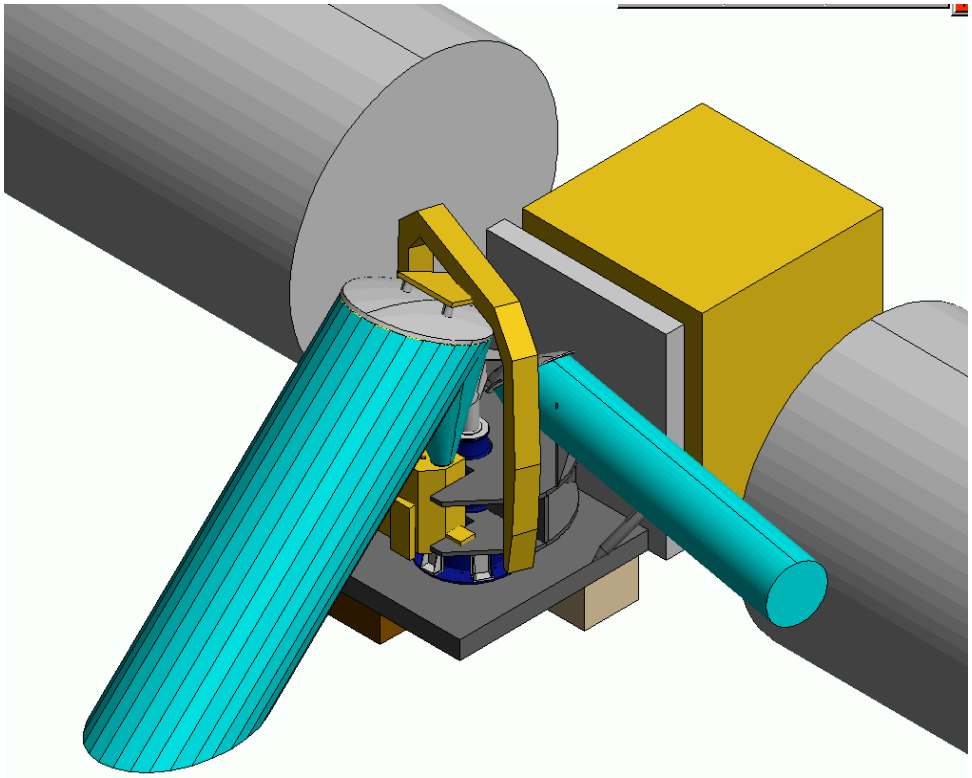


Calibration sur source chaude et froide

- On présente alternativement une source chaude, une source froide (le ciel souvent) et la scène à l'antenne du radiomètre.
- Si son gain est linéaire en puissance (fortement recommandé mais pas évident à réaliser) on peut interpoler et déduire Tscène



Champs de vue tenant compte de la rotation des panneaux solaires



Antennes

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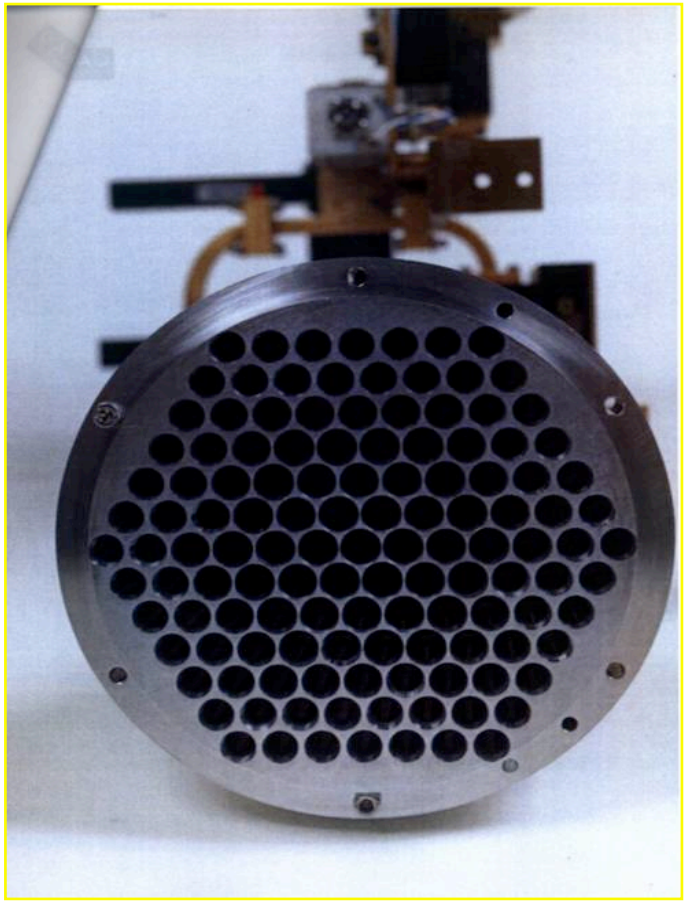
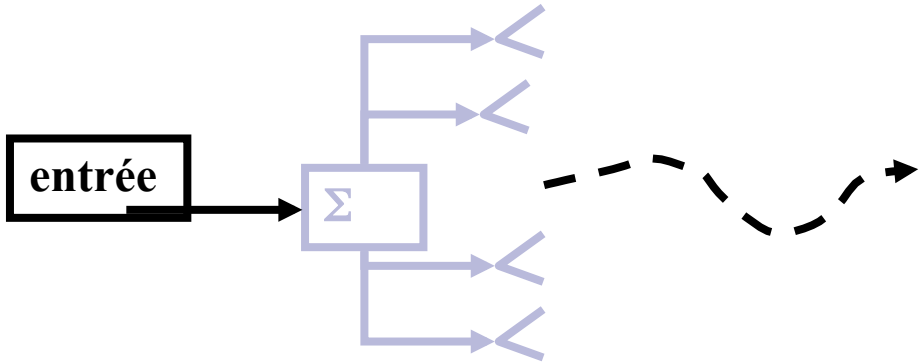
Sources primaires: ouverture < 10λ de diamètre

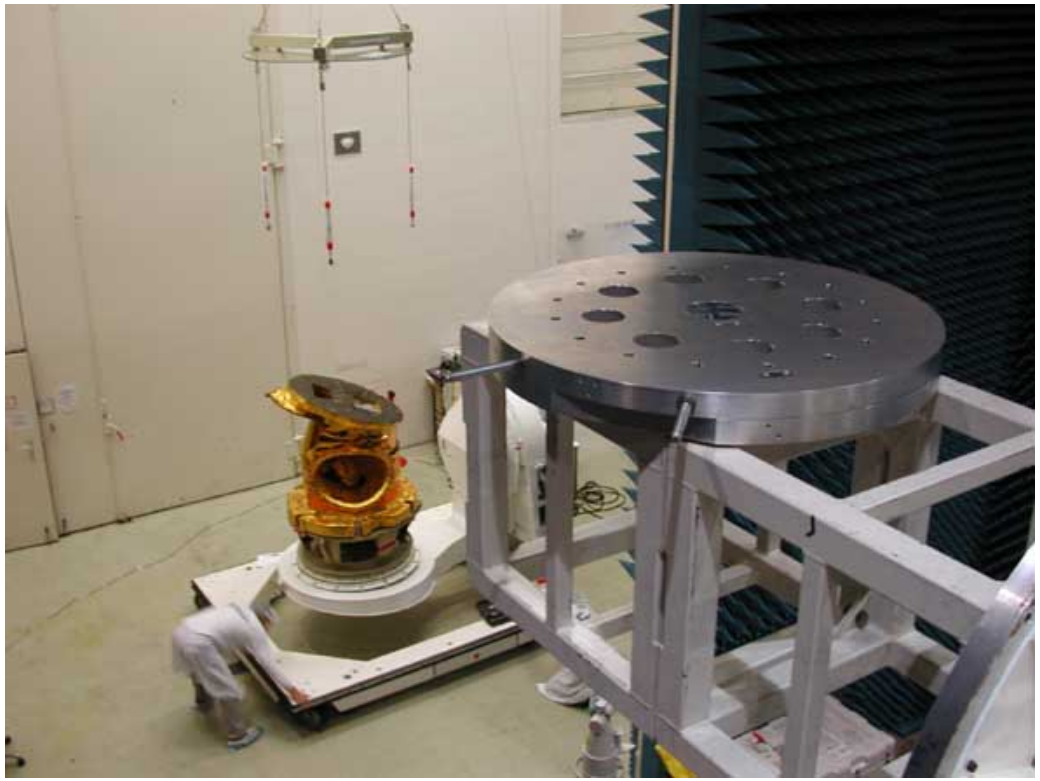
Antenna réseau: 20λ

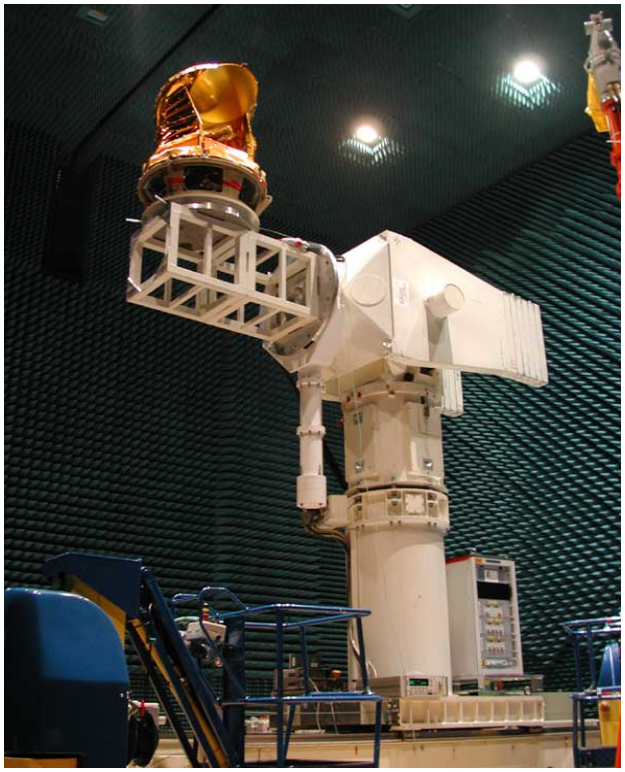




Antennes à réflecteur: 150λ

caractérisation de MADRAS





Herschel, le plus grand miroir spatial du monde

Φ 3.5m

De 400 GHz à 5THz

Récepteurs

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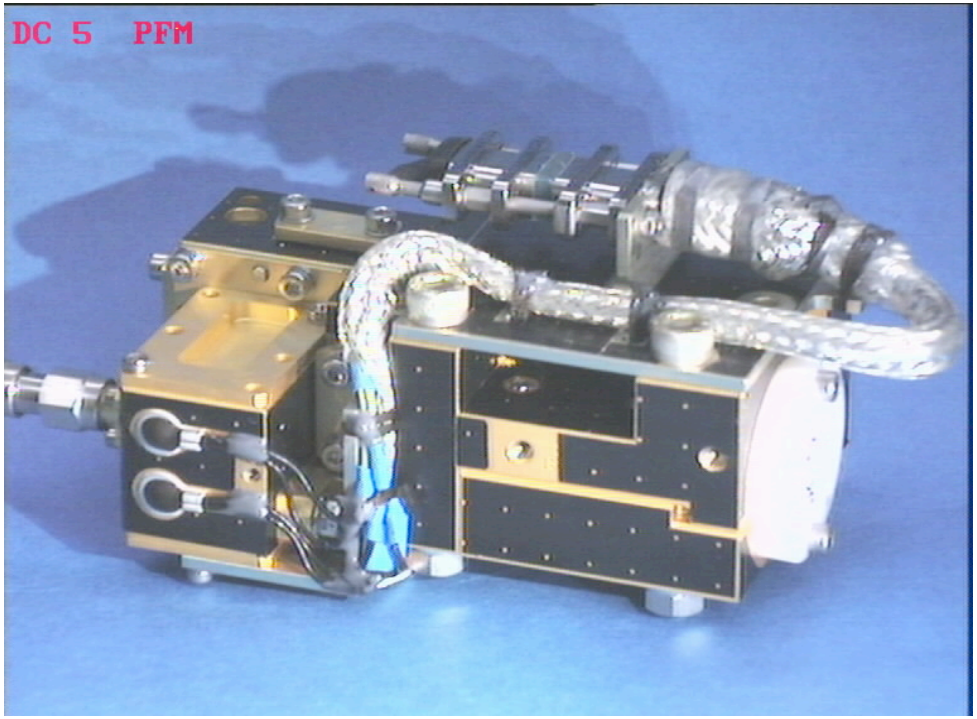
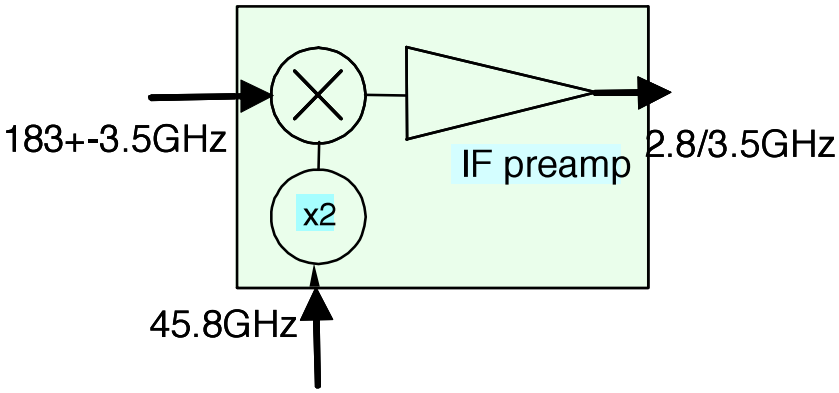
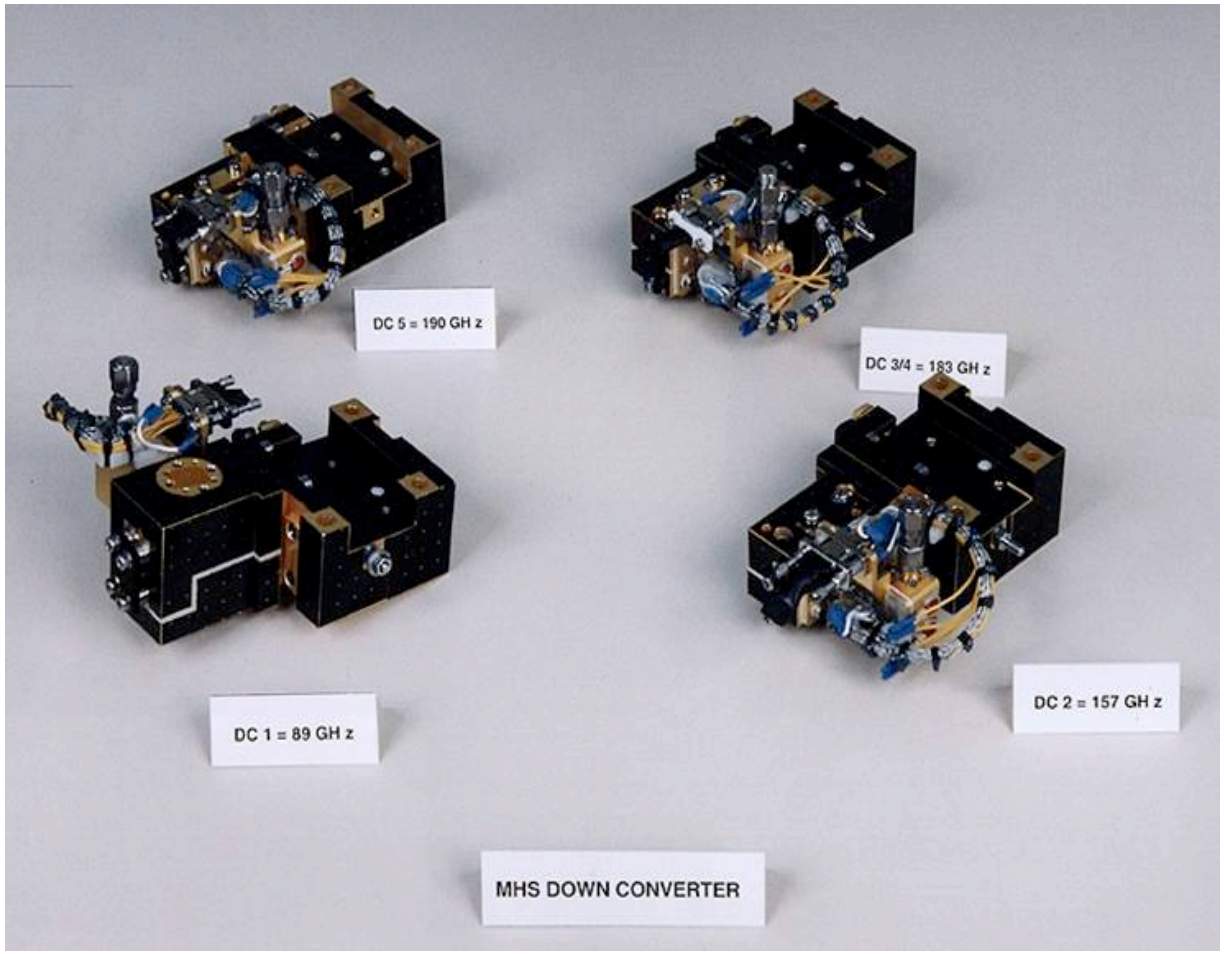
Millimeter wave down Converters @ 89/157/183 GHz

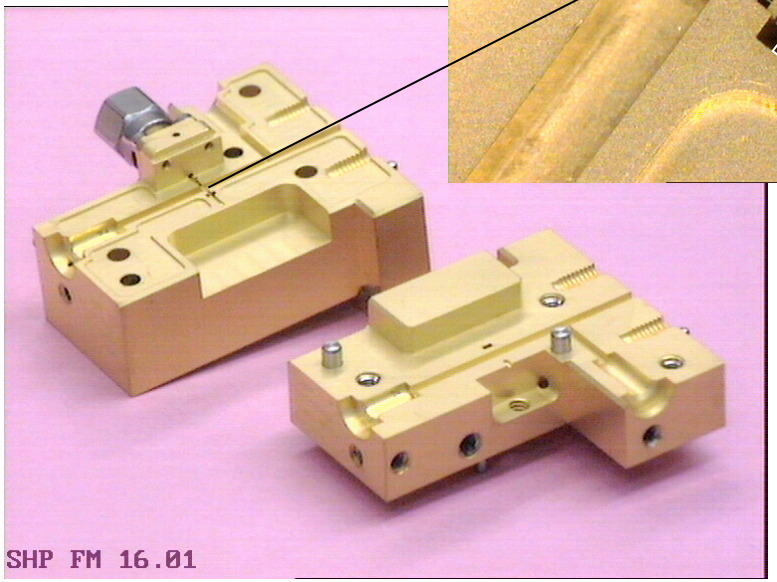


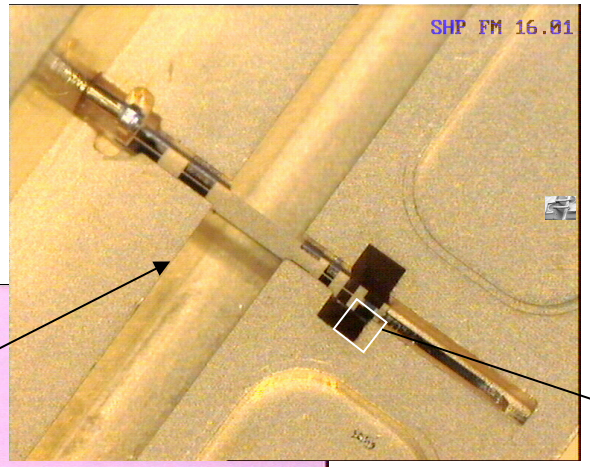


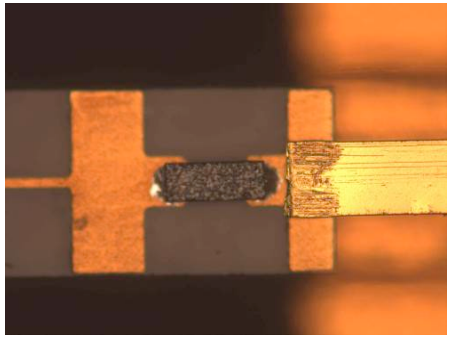
Down Converters MHS



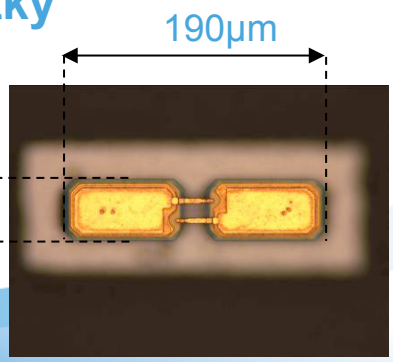
157 to 190GHz Mixer

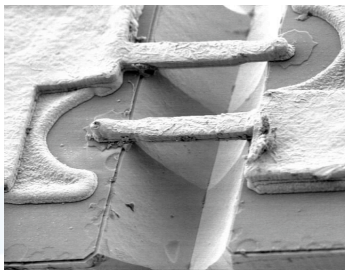






Schottky Diode





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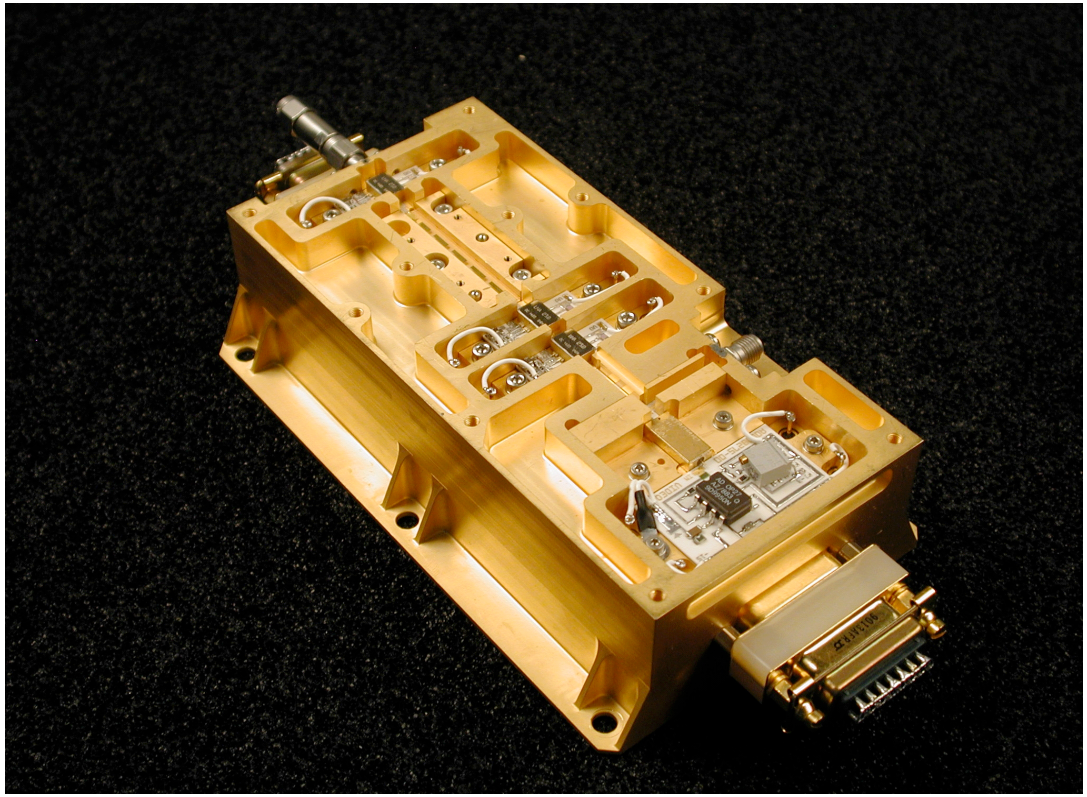
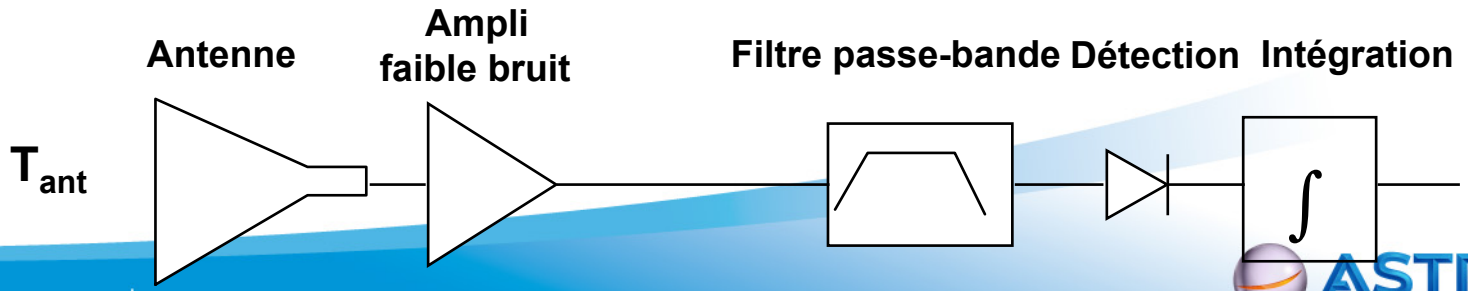
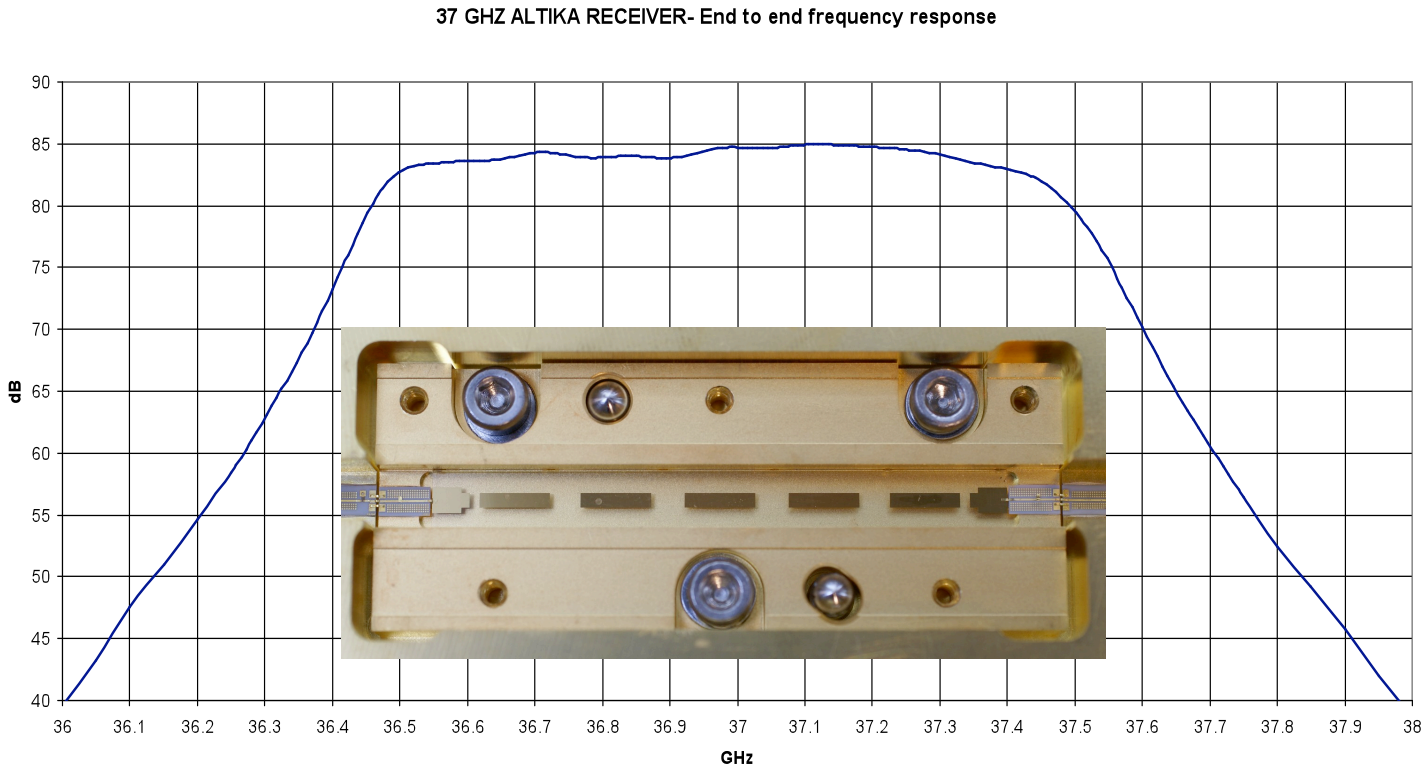
Compact, direct detection receivers inherited from MADRAS

- The direct detection scheme is attractive moderate channel bandwidths (> 2%).
- It is also base lined for MWIS at 89 GHz
- It could also be envisaged at 150GHz but a conservative heterodyne scheme is presented here





Stable channel definition



Frequency performances mainly offered by the planar filter on fused silica, providing high temperature stability

- 3dB bandwidth: 200MHz@18.7GHz, 400MHz@23.8GHz, 1000MHz@36.5 and 37GHz

Madras sur Megha Tropiques

Mission Megha-Tropiques

- Climatologie: Etude des échanges d'énergie dans la zone intertropicale. Mission Franco-indienne (ISRO-CNES).

- L'originalité de la mission réside dans son orbite faiblement inclinée permettant à la fois une couverture globale et une revisite intensive de la zone intertropicale.

- Tir 2011 - durée de vie 3 ans.

MHS

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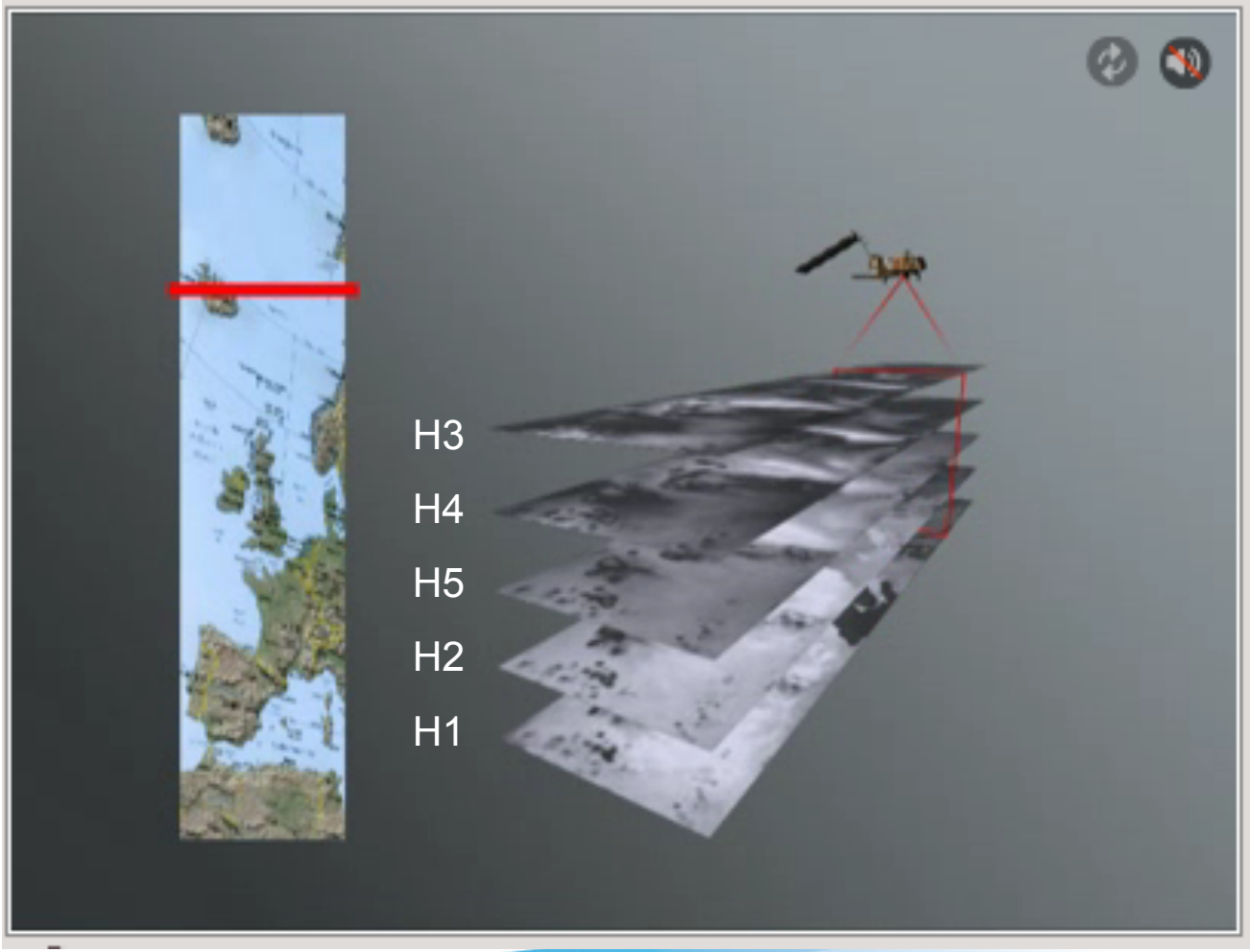
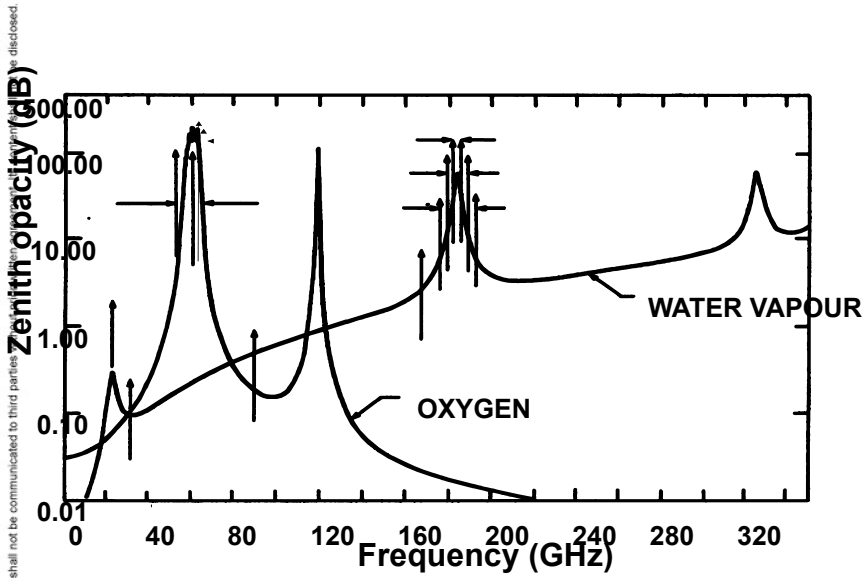
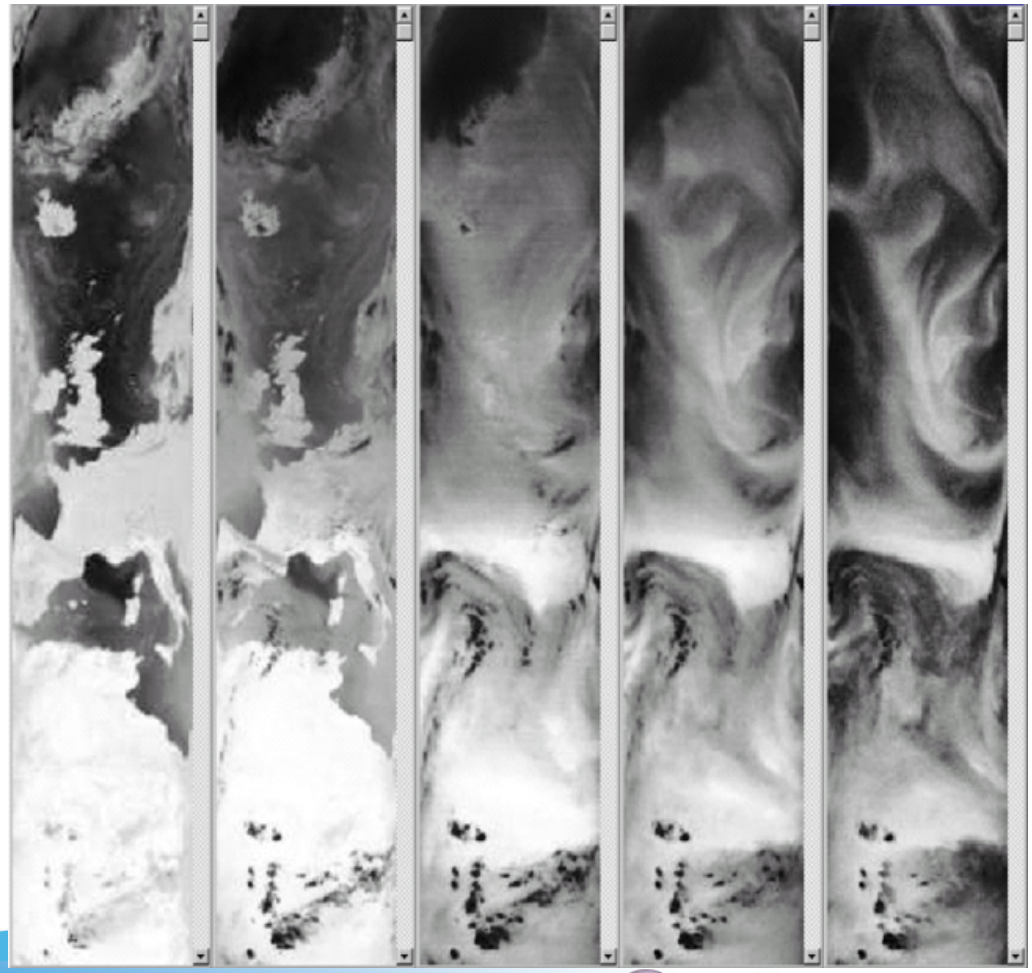
Profil en vapeur d’ eau produit par MHS



L' Europe vue par MHS





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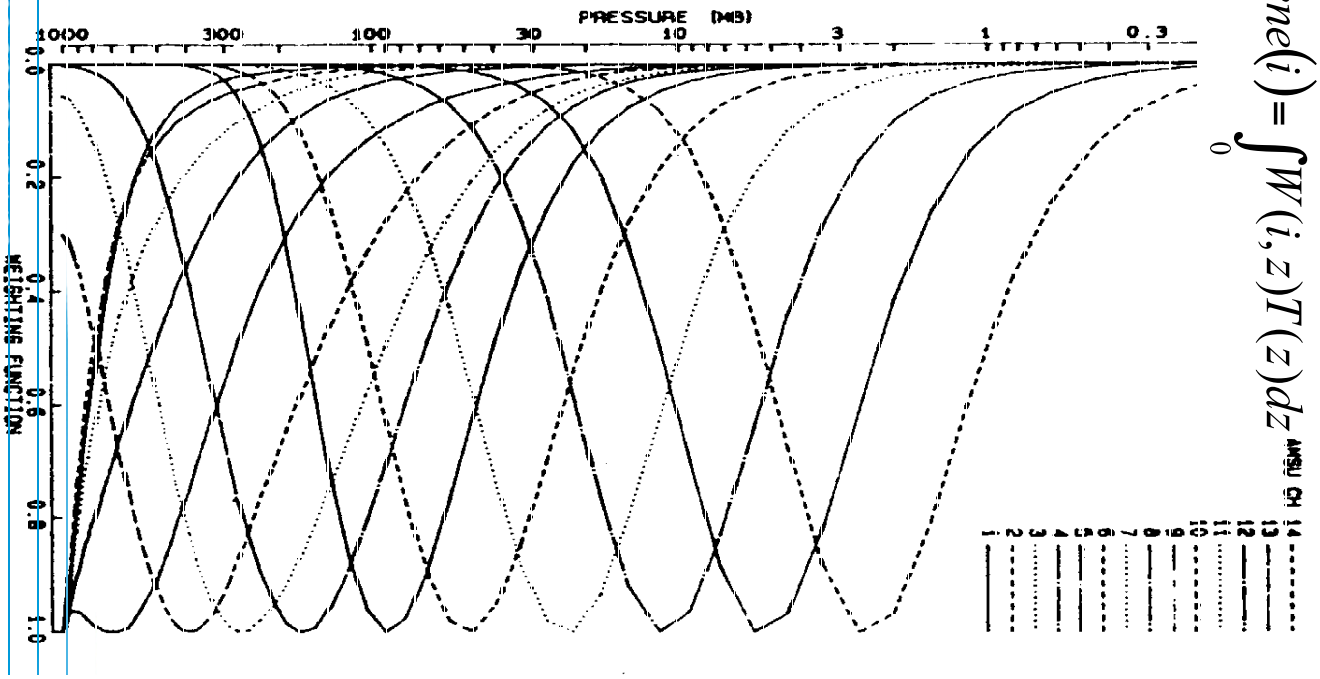
$$T_{scène}(i) = \int_0^{\infty} W(i,z)T(z)dz$$



EUMETSAT

AMSU-A

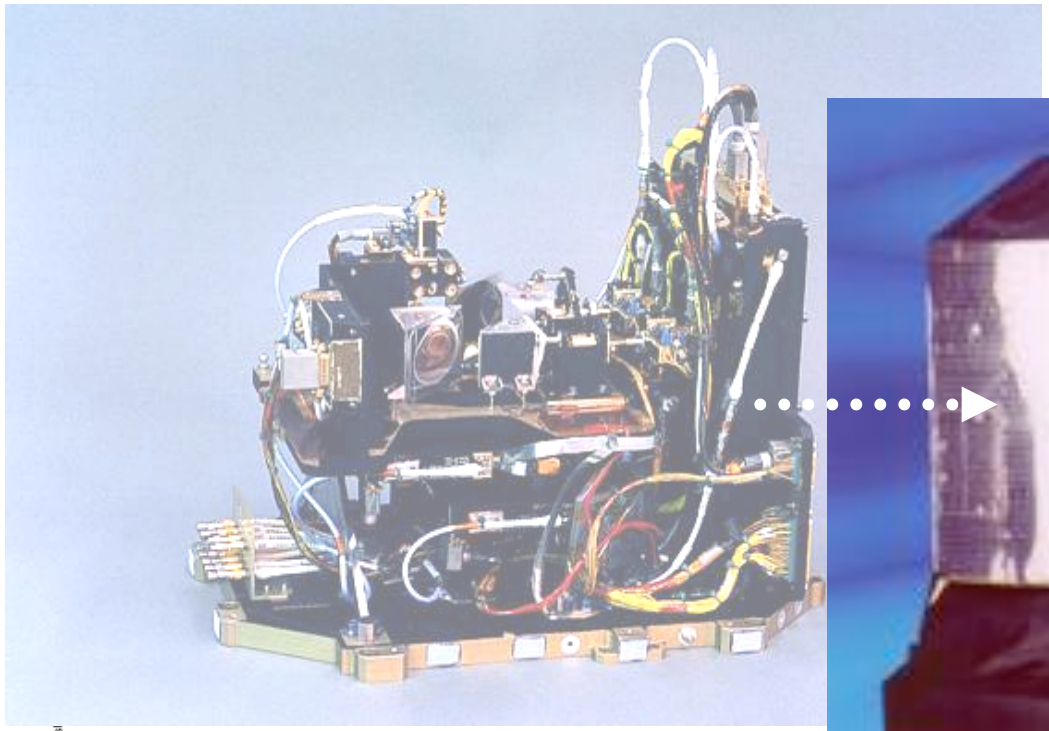
AMSA_xxx_00_M02_20061024164507Z_20061024182356Z_N_O_20061024182047Z

FIRST LEVEL 0 DATA PRODUCT FROM AMSU-A INSTRUMENT ON METOP-A

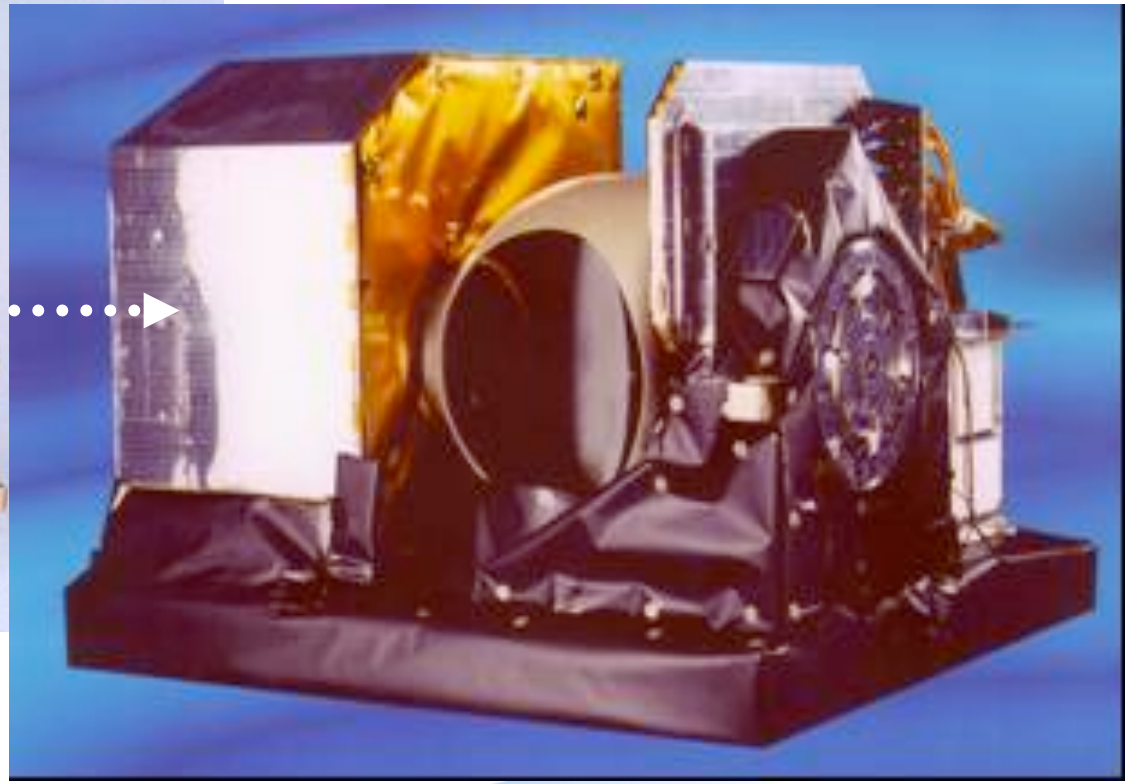
Microwave humidity Sounder: l'instrument complet

- réflecteur rotatif
- mécanisme
- écrans thermiques
- récepteur

Microwave Humidity Sounder: five models, one in flight, A-EU prime



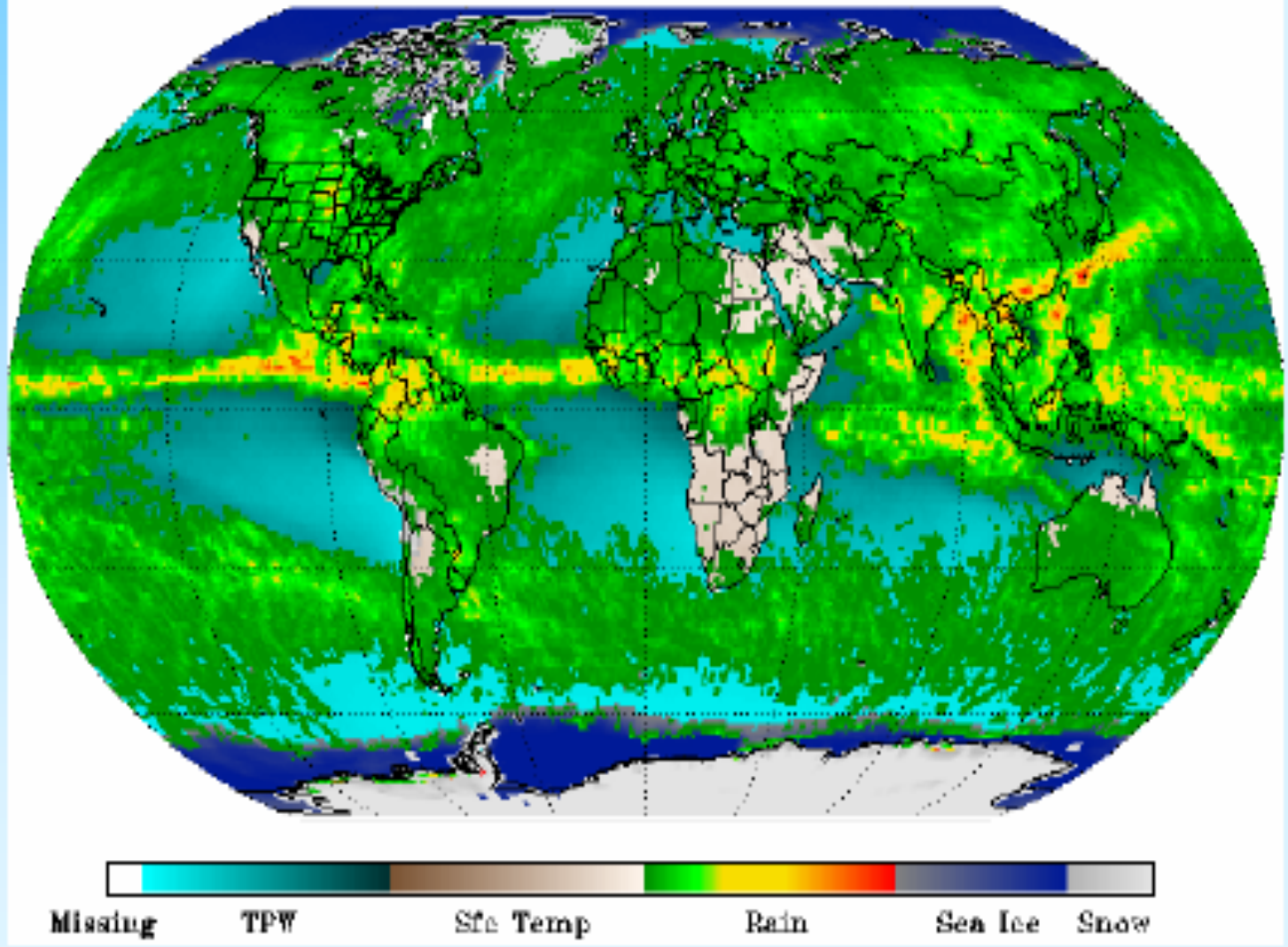
Récepteur: Astrium France



Instrument: Astrium UK

Microwave Products from N18 Operational Sensors: AMSU / MHS

January 2006



Les radiomètres à synthèse d ’ouverture

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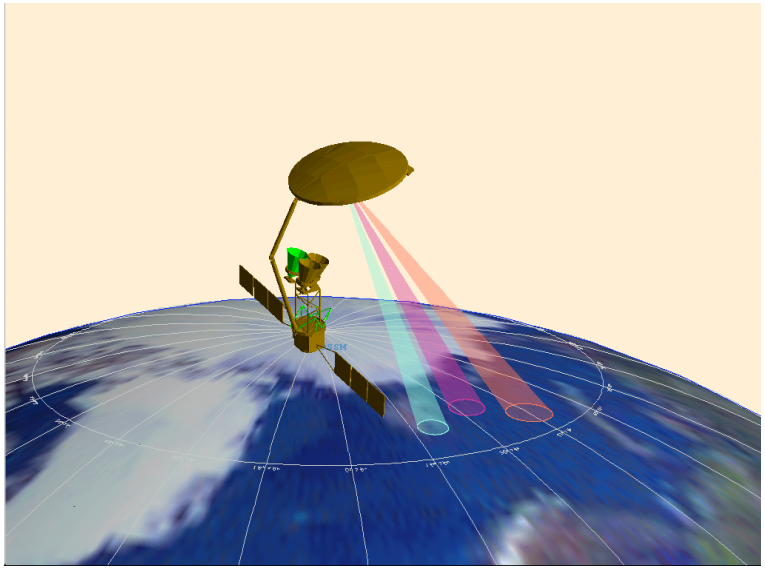
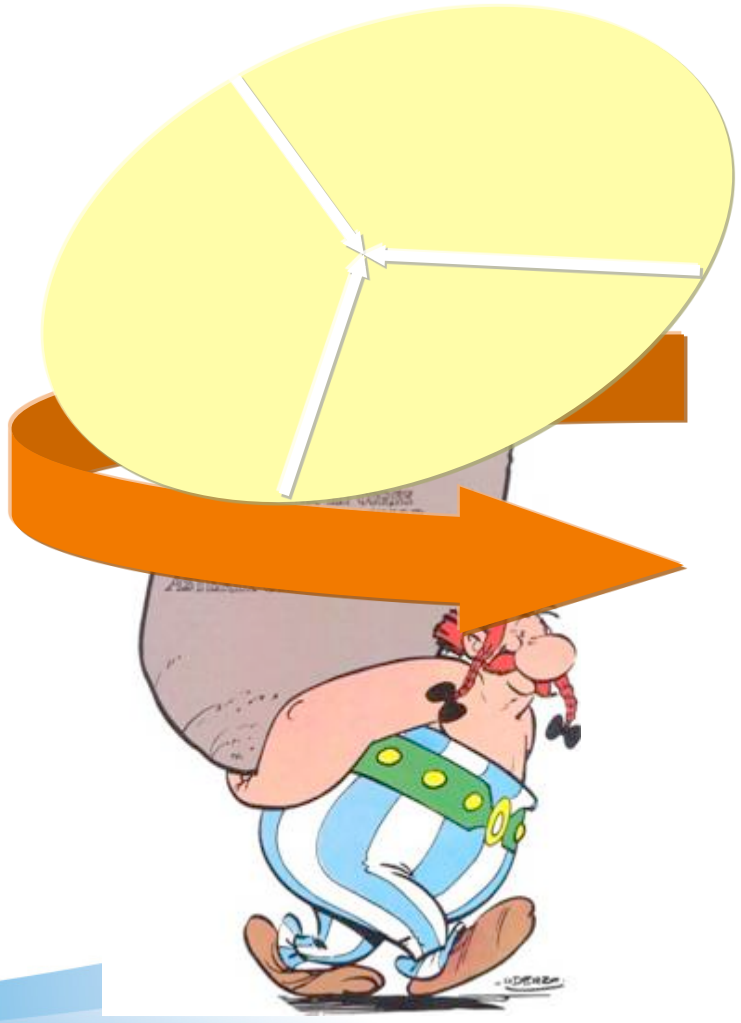
Le limites du balayage mécanique: rotation d’ une grande masse

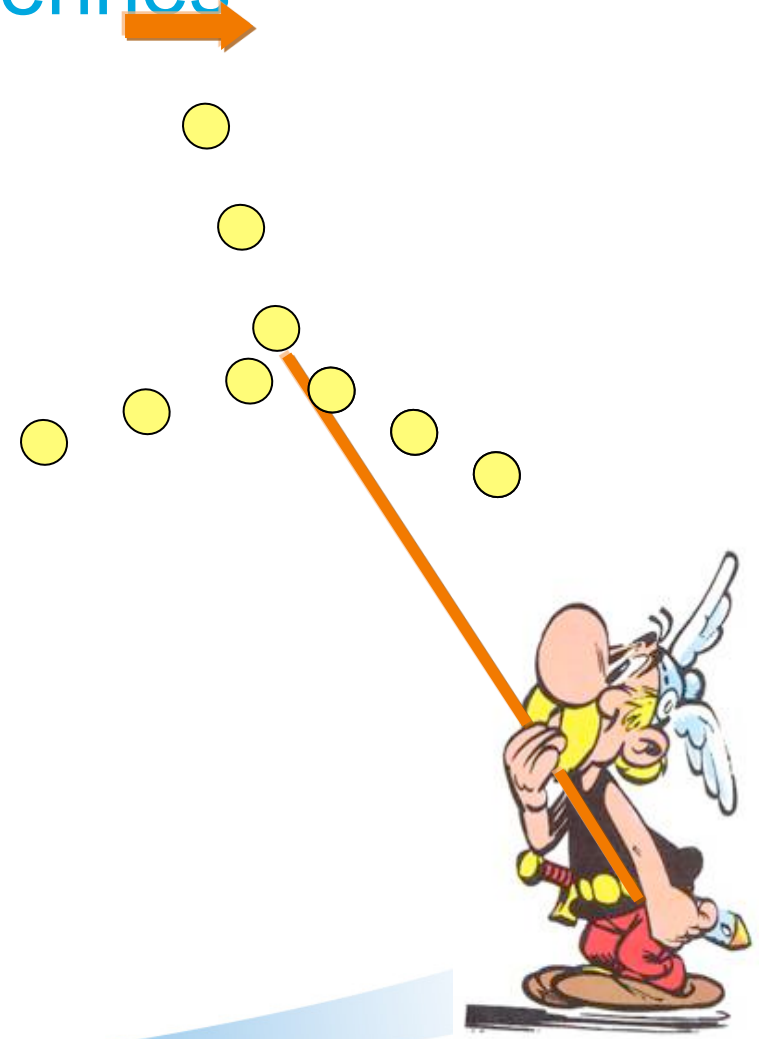


Projet de Satellite HYDROS



Radiomètres à grandes antennes interférométrie

MIRAS sur SMOS



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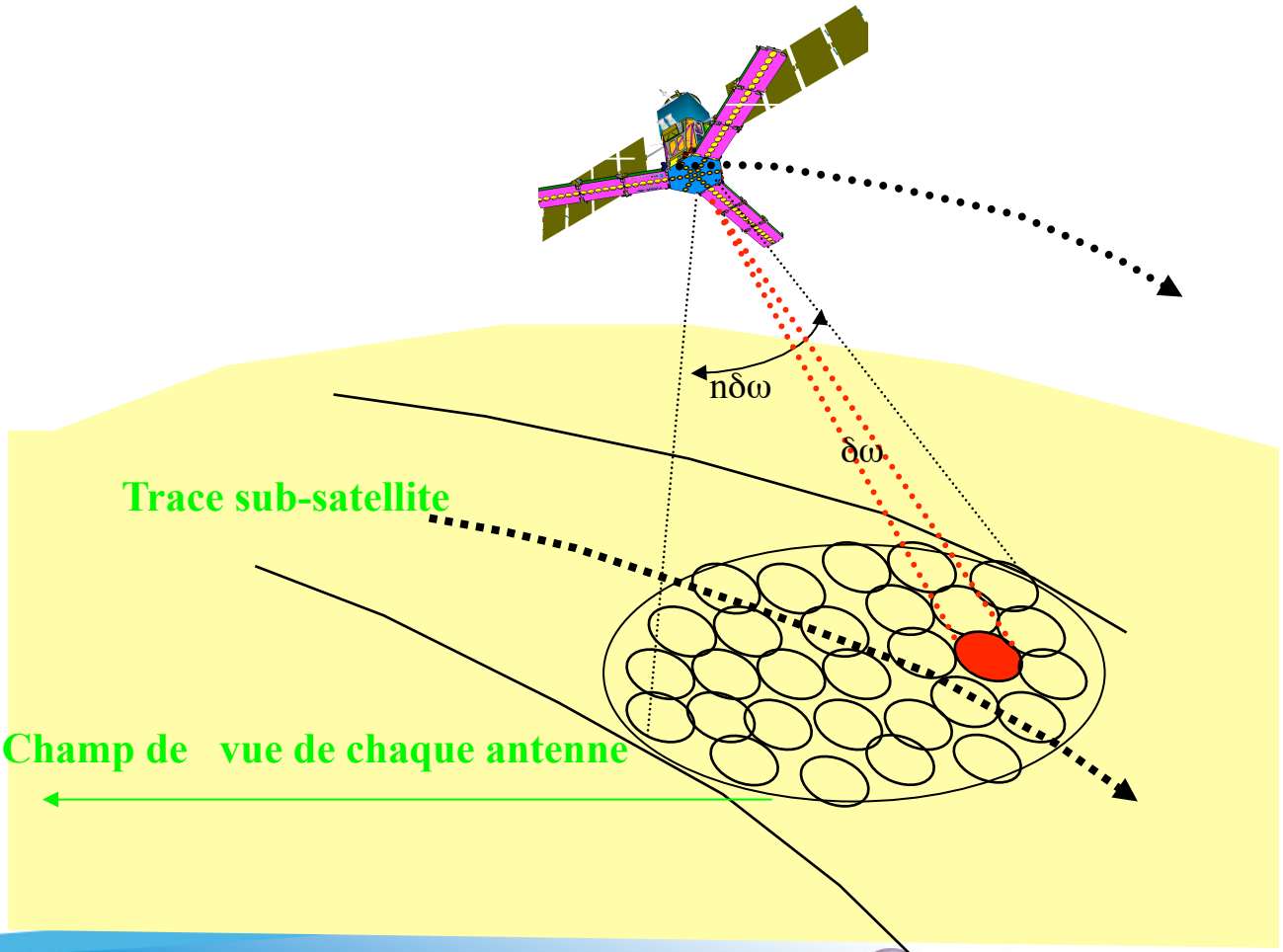
Champ de vue de l'interféromètre

- L 'antenne est immobile
- le champ de vue hors trace est large
- le déploiement est facilité



Perspectives

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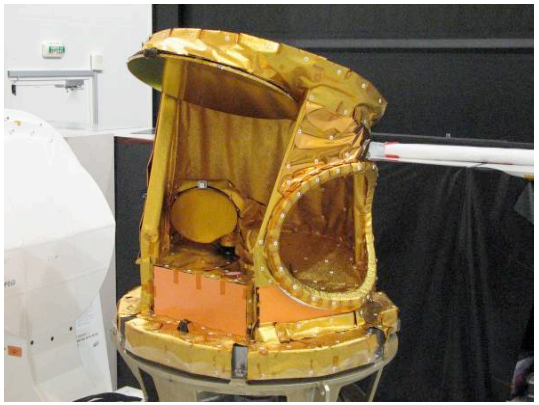
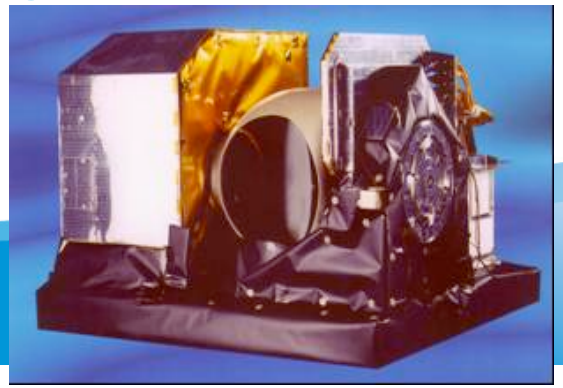
Operational meteorology and climate needs

	Today	Tomorrow
Precipitation , Ice Clouds	Madras: 18 to 150GHz 	Micro Wave Imager Ice Cloud Imager (METOP SG) Boitata (GMM Br Fr) Cloud Ice (EE8) Up to 665 GHz
Atmosphere sounding	Microwave Humidity Sounder and AMSU : 23 to 191 GHz 	Micro Wave Sounder On METOP SG Up to 230 GHz

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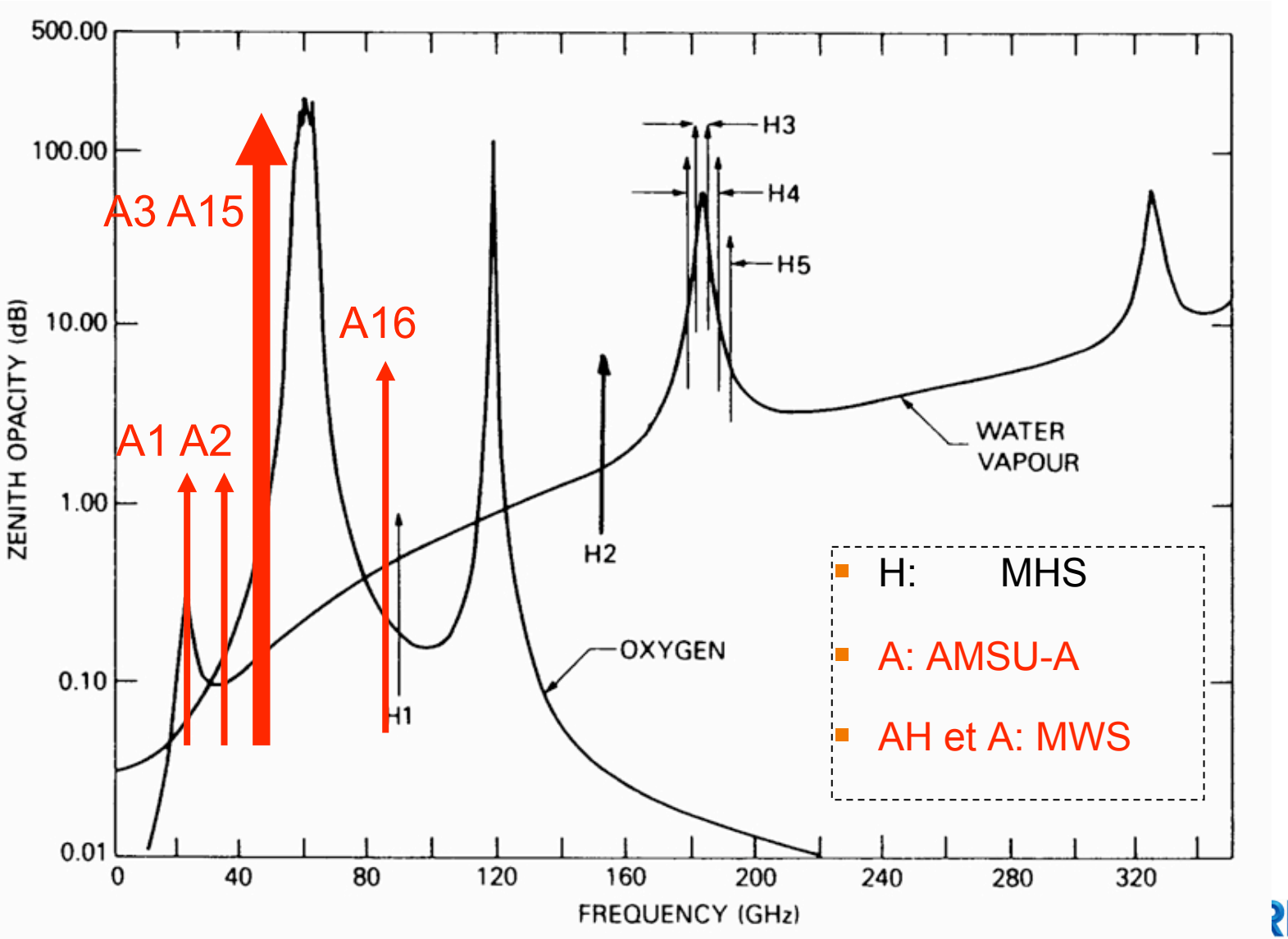
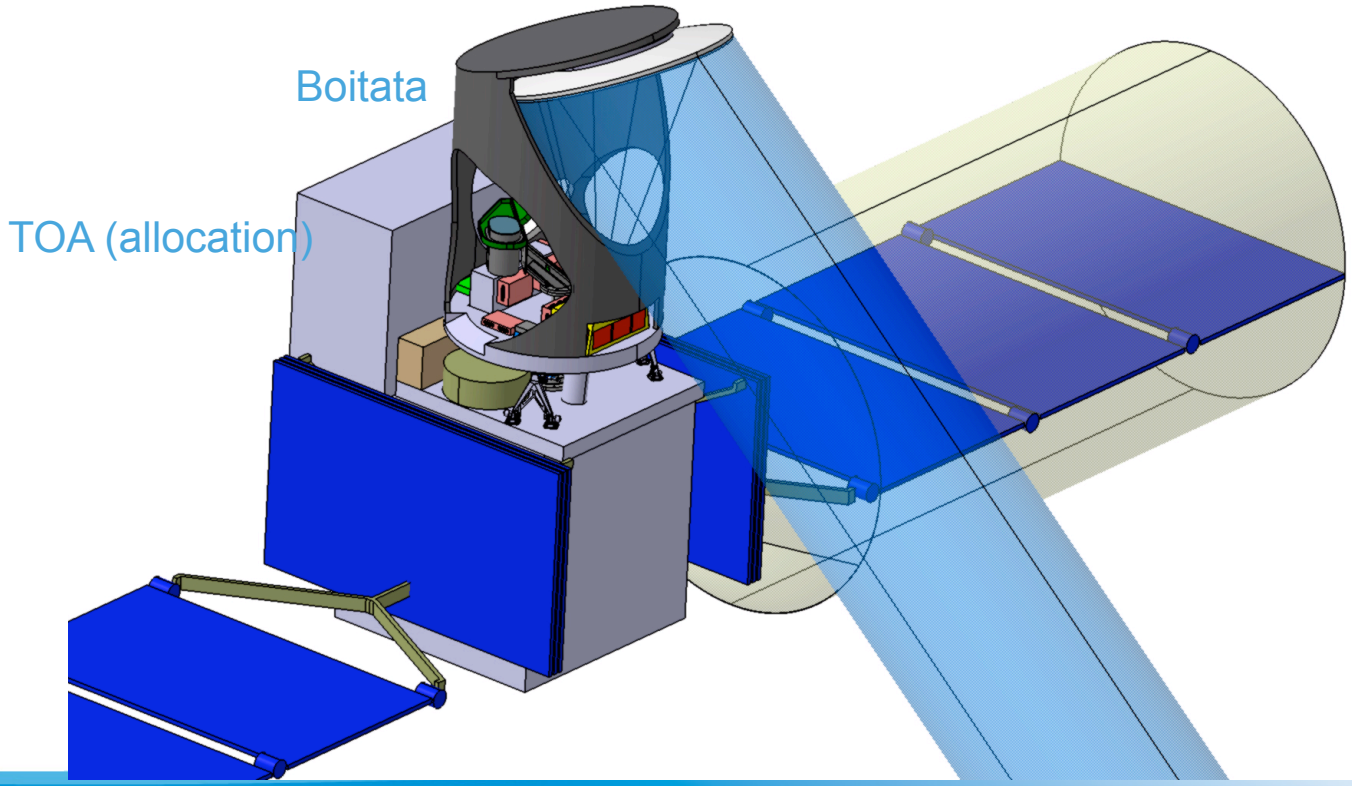
Les canaux du sondage en atmosphérique



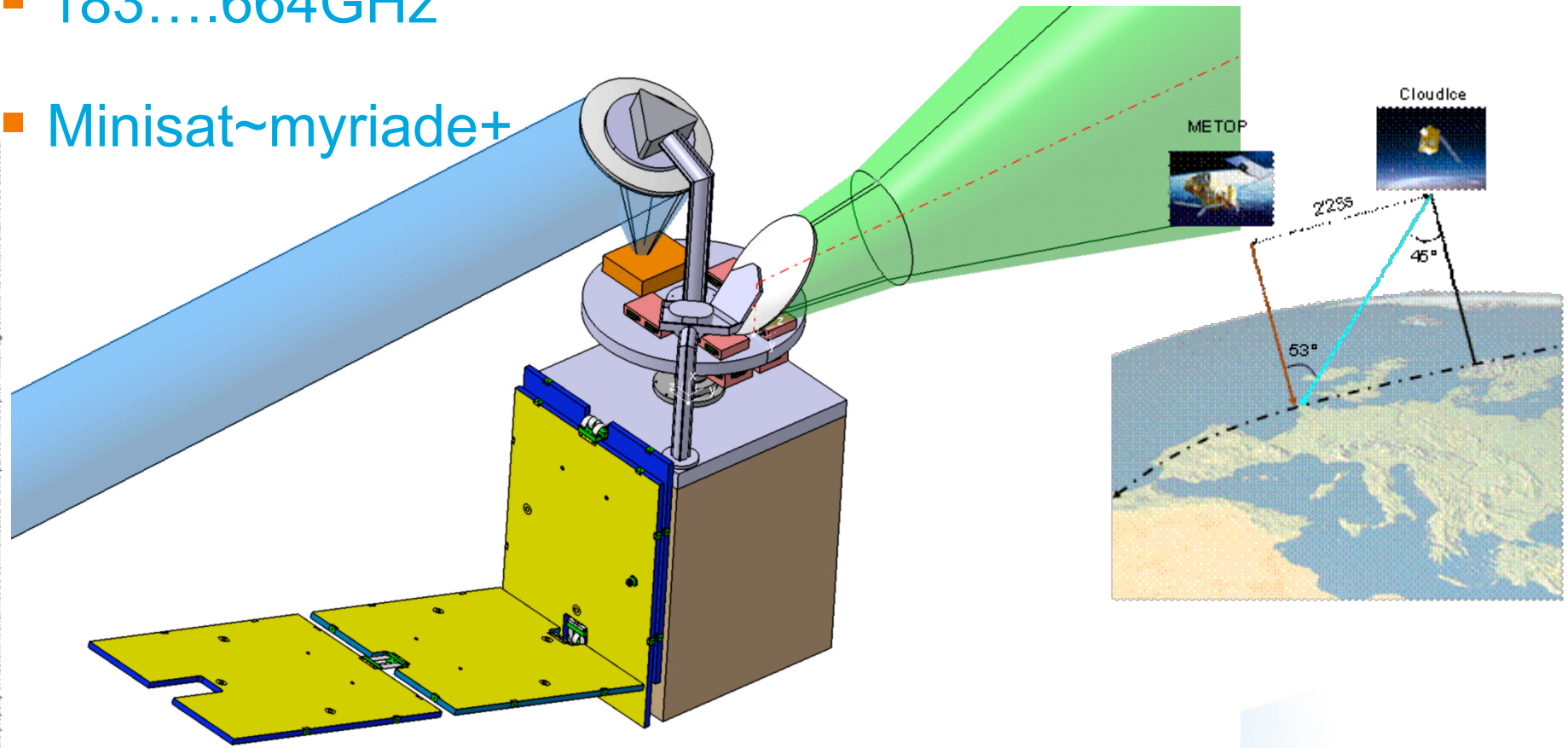
GPM Br Fr

- Brazilian platform (700 km orbit, 26° inclination)
- 18.7…….664GHz
- Energy and water budgets in the tropical atmosphere
- cloud-ice microphysics.
- Succesor of MADRAS/SAPHIR with submmW capability



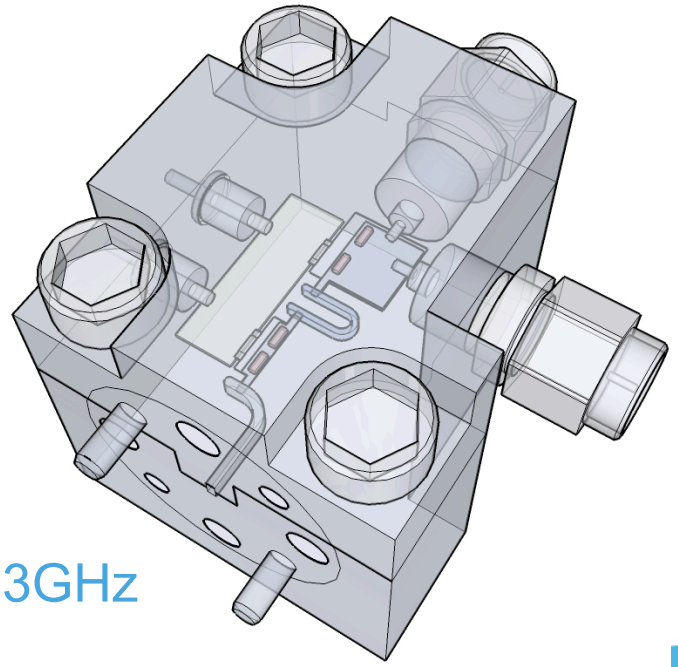
Cloud Ice proposition ESA Explorer 8

- 183….664GHz
- Minisat~myriade+



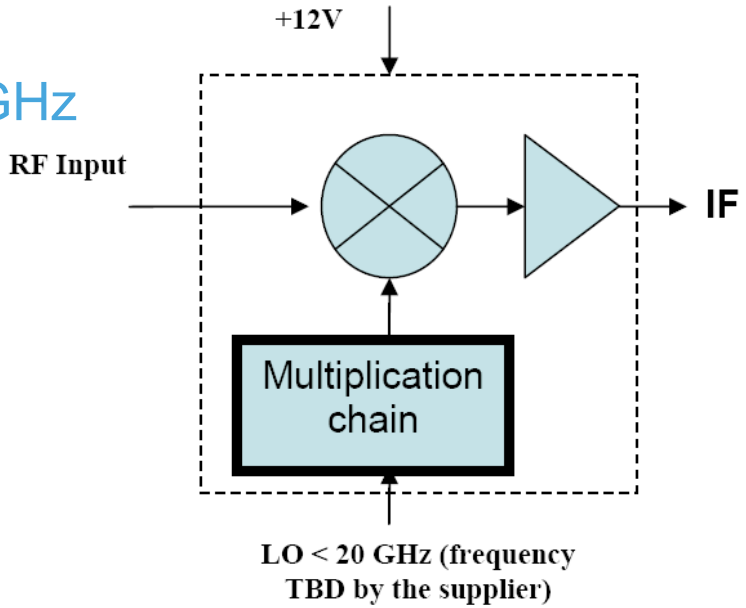
R&D en Cours

- Récepteur 183 GHz MMIC:
- Canal 480 GHz



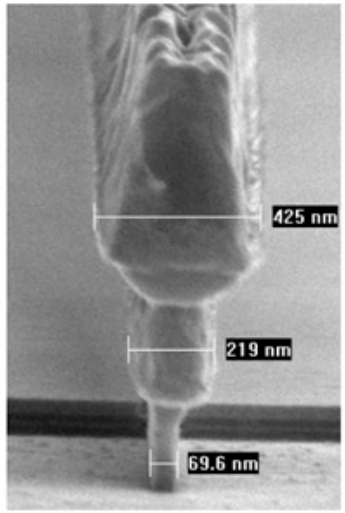
183GHz

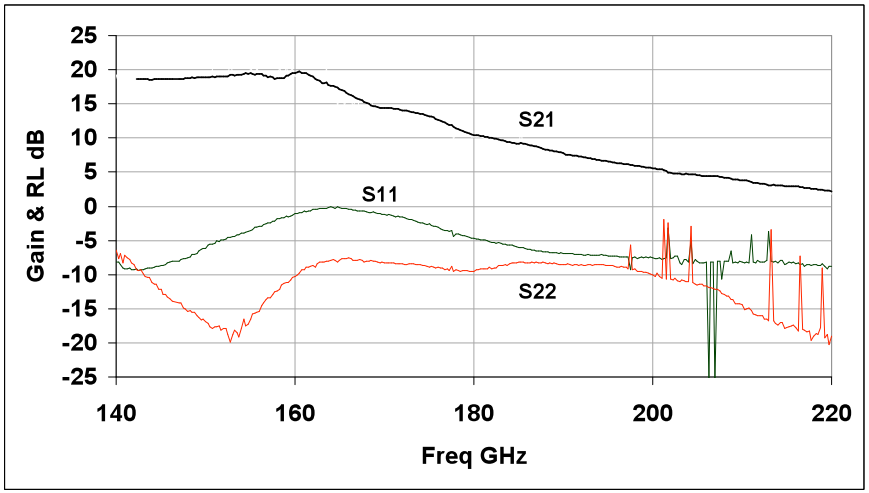
480GHz

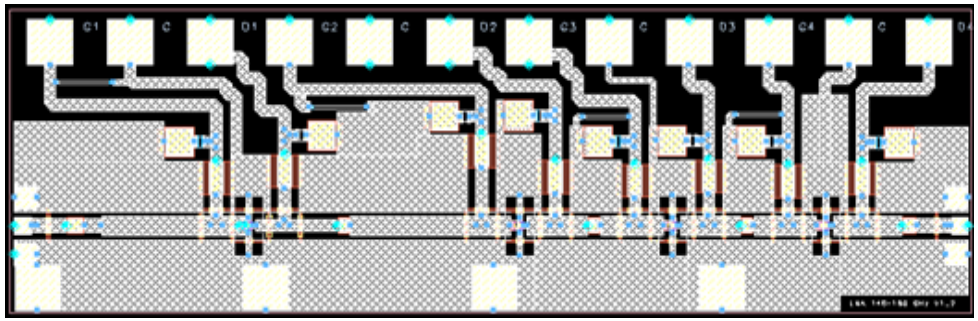


suite MHS: LNA 150 GHz

- MMIC LNA use M-HEMT 70nm transistor from OMMIC D007IH foundry.







(*) ESA/ASTRIUM R&T: « MMIC Technology for Future Atmospheric sounders » contract 16264/02/NL/MM