Sensors for **Wi**de band **M**agnetic field **M**easurement
SWiMM

ICI4

LPP (Laboratoire de Physique des Plasmas)
& L2E (Laboratoire d'Electronique et d'Electromagnétisme)
& DT INSU

TEAM ORGANIZATION

	Institute	Function
Patrick Robert	LPP	Scientists
Mathieu Berthommier		
Alexis Jeandet		Technical Manager & digital board design
Dominique Alison		Analog electronic board design
Christophe Coillot		Search-coil sensor design & ASIC design
Paul Leroy		ASIC design
Kaveh Moahamadabadi	LPP/SYSNAV	AMR magnetometer design
Nicolas Gesykens	DT-INSU (tbc)	Mechanical & Thermal design
Gérard Sou/Amine Rhouni	L2E	ASIC design

SWiMM OVERVIEW

Tri axis search coil magnetometer few Hz up to 15kHz

-Option 1 : 2 LF sensors ([Hz;15kHz) and 1 Dual band sensor identical to OHMIC mission ([Hz; 15kHz] (in fact 30kHz for Ohmic))

-Option 2 : 3 sensors identical to MMS ([1Hz;15kHz])

-Tri axis AMR magnetometer

-Option 2 : 4 AMR magnetometer on a square PCB (10cm*10cm) in gradiometer configuration for trajectory of the rocket recovery

-Option1: single AMR magnetometer (1nT resolution in 10Hz BW)

-Analog and digital electronic board

Tri axis search coil magnetometer few Hz up to 15kHz

SWiMM Heritage

CLUSTER and THEMIS Heritage

Bepicolombo & MMS are on going

ICI 4 search coil will be based on OHMIC performances

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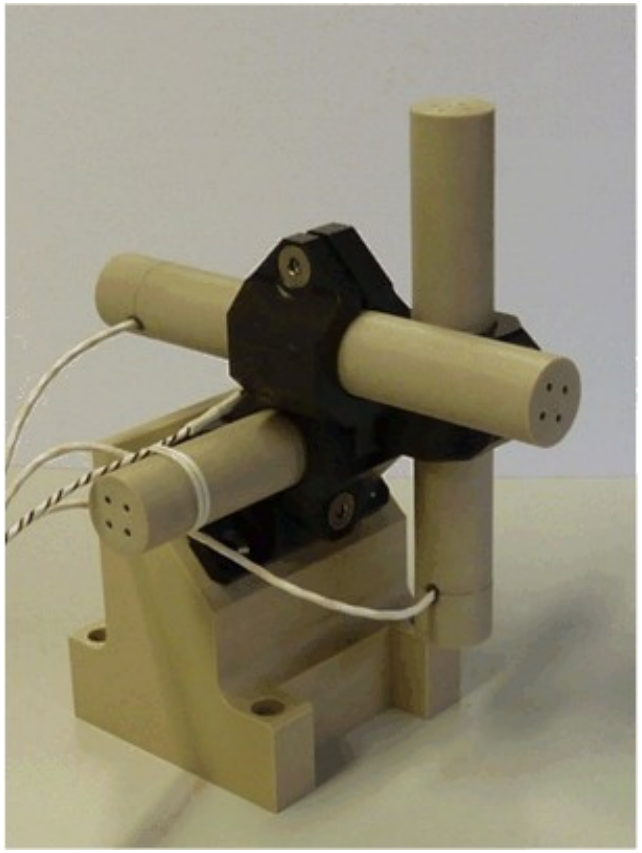
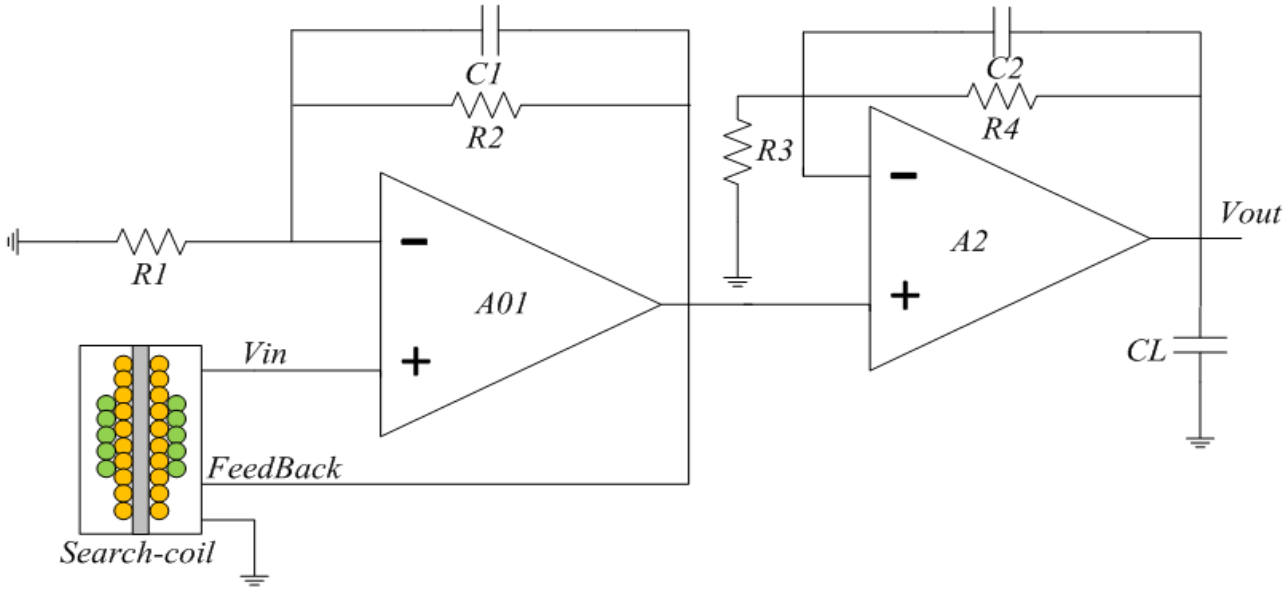


3 sensors: 180mm length and 14mm diameter

SWiMM Sensors should be mounted on a boom (>50cm)

ASIC Low Noise Preamplifier

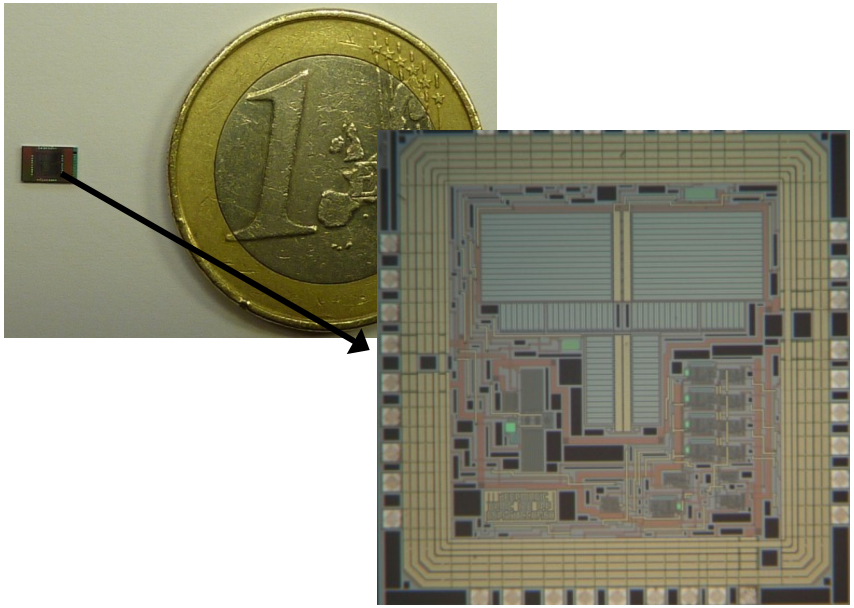


- 1 ASIC included: 2 stages amplifier & feedback manager & temperature compensated voltage regulator
- Low power consumption (I<2mA per channel)
- 1 PA per sensor : 1 PA for [Hz; 15kHz]

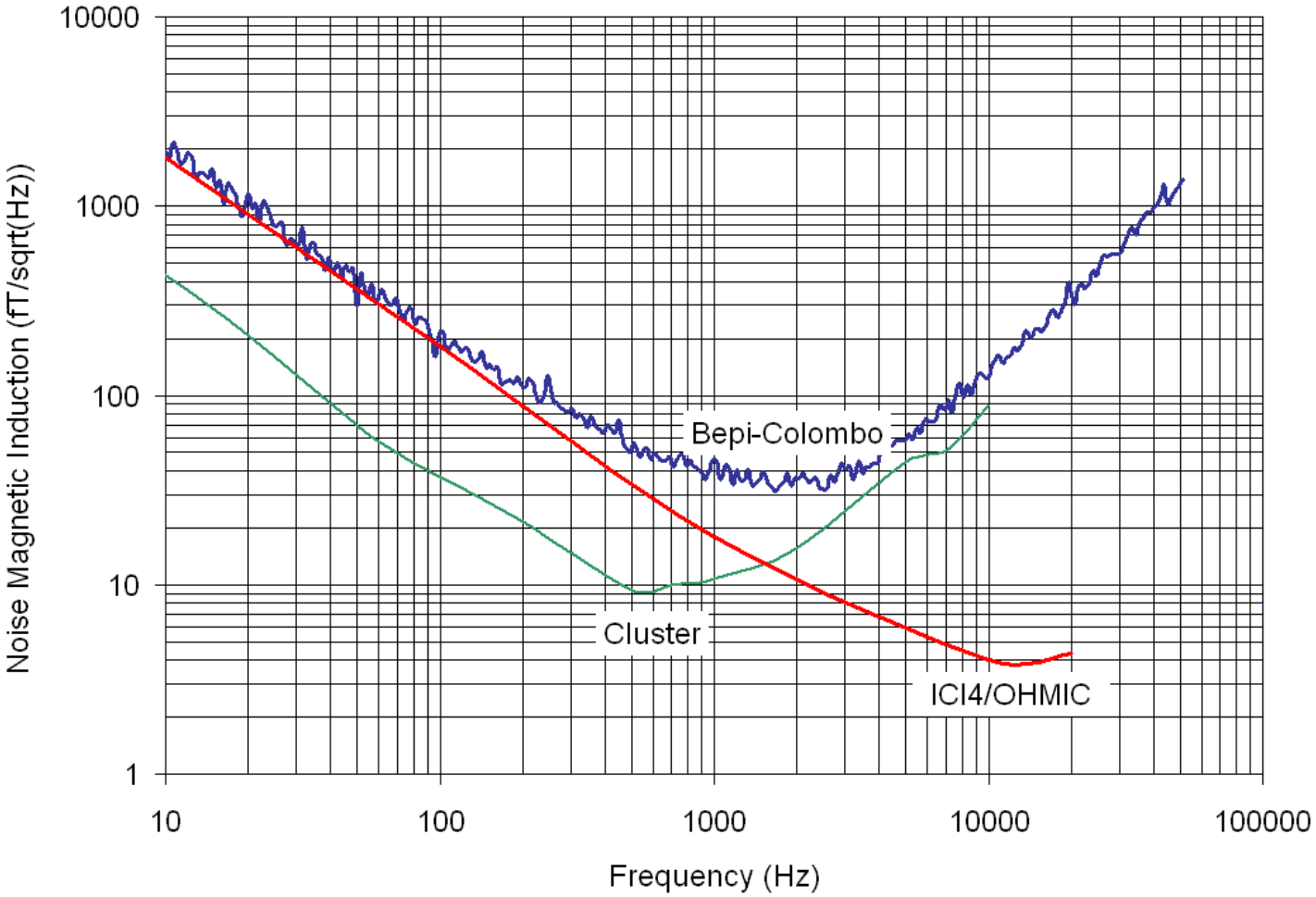
→ **design of ASIC in CMOS 0.35µm technology**

ASIC low noise preamplifier

- Frequency bandwidth : 100mHz-50kHz
- Input noise: 4 nV/√Hz @ 10 Hz
- Gain: 83 dB
- Power consumption: 12mW
- Chip 2.2*2.3mm
- Temperature operating range: -70°C; +80°C



SWiMM magnetic noise objective



Noise Equivalent magnetic Induction objective:

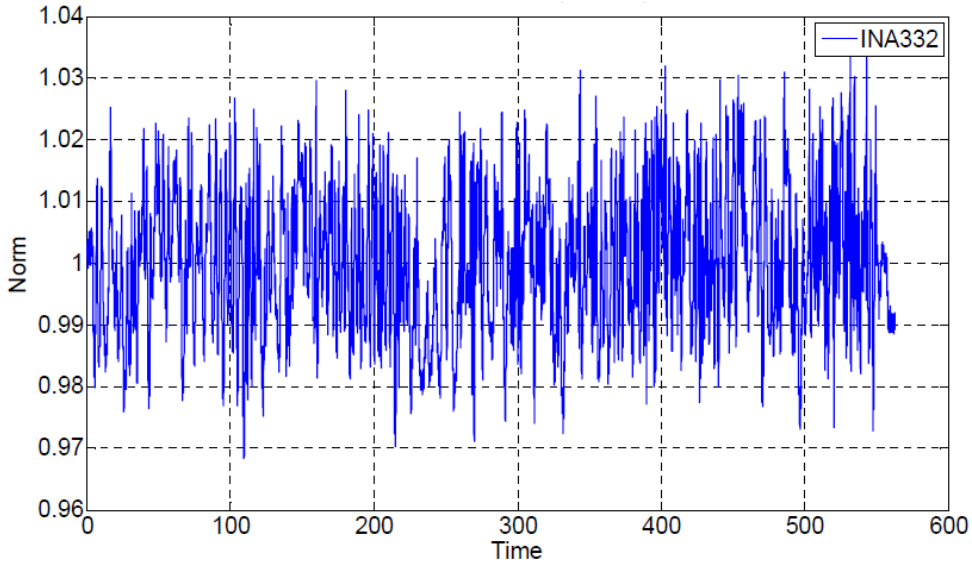
1.8pT/sqrt(Hz) @ 10Hz **18fT/sqrt(Hz)** @ 1kHz **4fT/sqrt(Hz)** @ 10kHz

Tri axis AMR magnetometer

Based on Honeywell AMR sensors

4 tri axis AMR magnetometer:

- Gradiometer configuration=> recovery of rocket trajectory
- available in compact size (3cm*3cm) => PhD student Kaveh
- Gradiometer board: 10cm*10cm



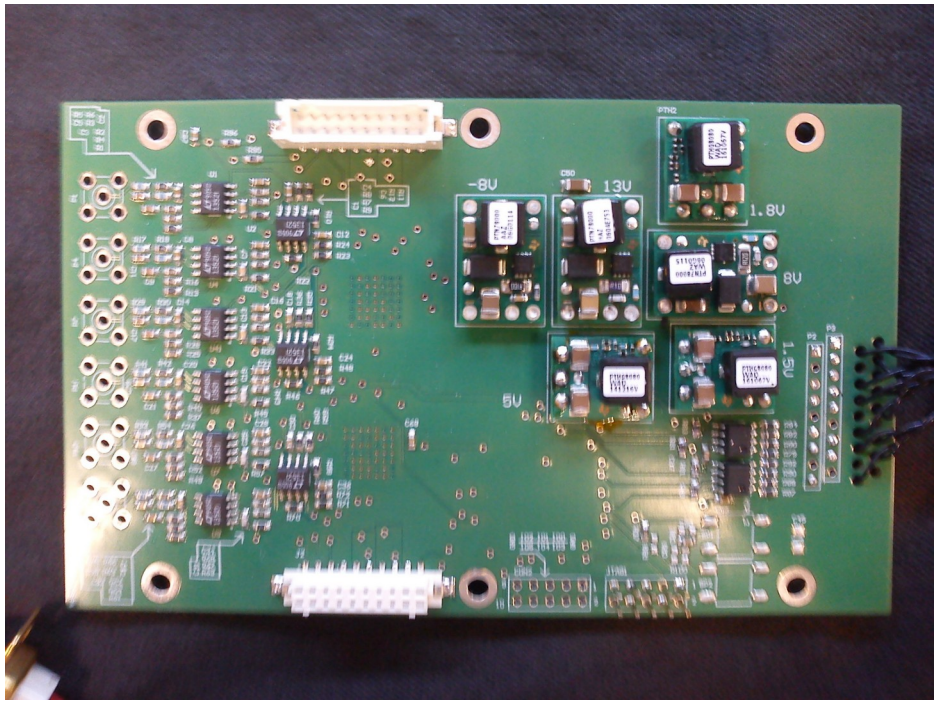
Tri axis measurement : norm of Earth Bfield

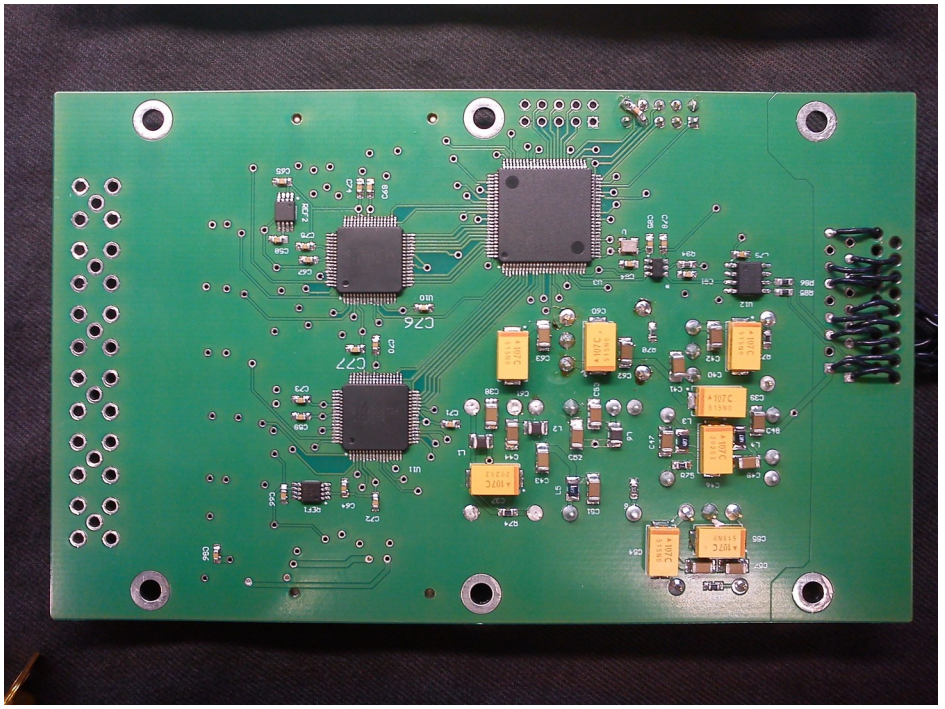
Operating under 0/+5V

Power consumption <500mW per magnetometer

On board processing (linearity improvement)

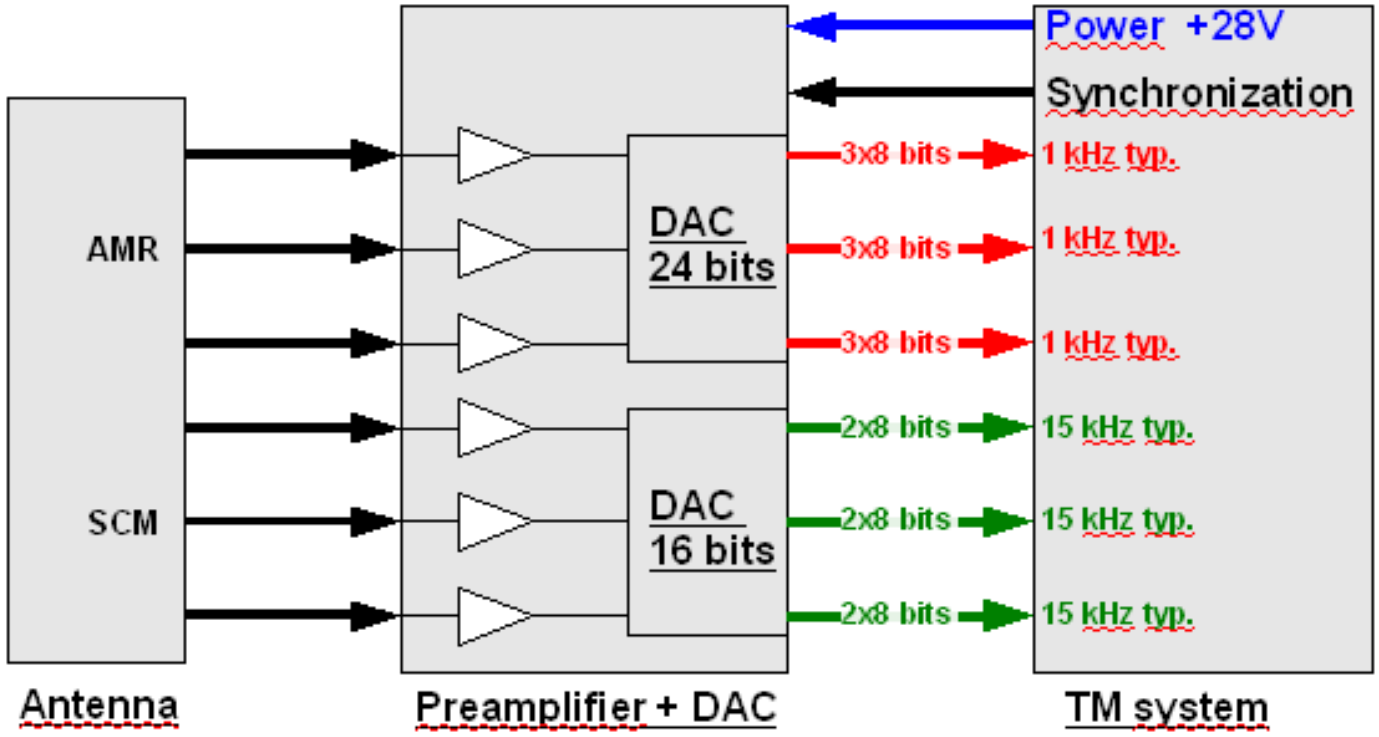
Analog and digital electronic board


-8V
13V
1.8V
8V
1.5V
5V



SWiMM Electrical/Mechanical interfaces

Electrical interfaces :

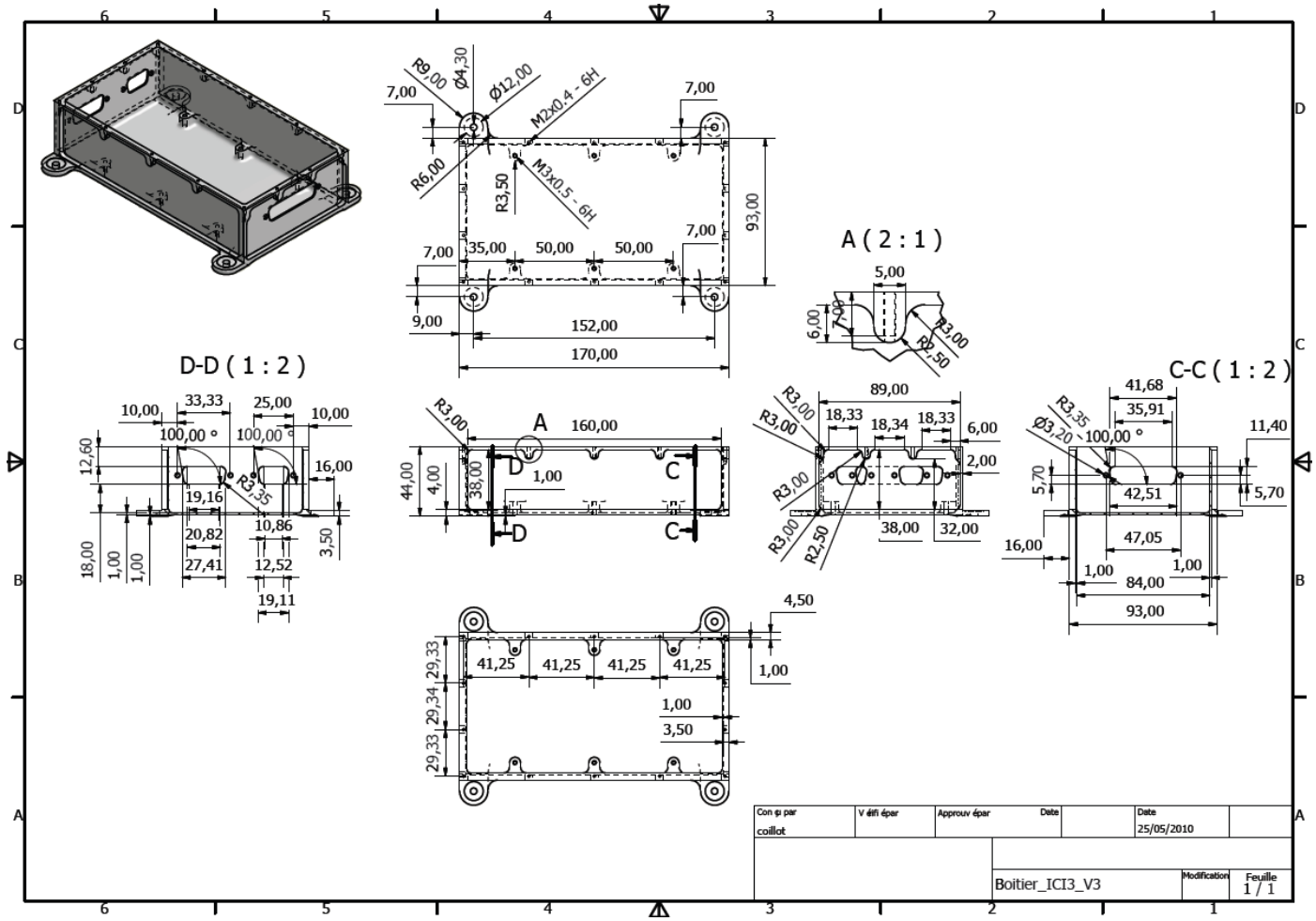


- **Divided in 3 words of 8 bits for DC and 2 words of 8 bits for AC**
- **NEMI of DC and AC magnetic field is reached**

Mechanical interface

Search coil Preamplifier board + AMR gradiometer board + digital board will be mounted inside a single aluminium housing (heritage ICI3).

Size will be:



SWiMM Budget Telemetry:

	Option 1 for search coil Option 1 for AMR
B “AC” (Search coil)	3*16 bits 1*12bits
Frequency Range (TBC)	3*1Hz-15kHz tbc 1*1Hz-100kHz
B “DC” (AMR)	3*24 bits
Frequency Range	DC-1kHz
Total Digital TM	1992kb/s

=> Synchronization with E field

SWiMM Budget Mass/Power consumption:

	Mass	Power consumption (mW)
Search Coils Sensors	3*45 gr	N.A.
Mechanical structure	200 gr	N.A.
Search coils Electronic analog+digital	350gr	2W (+/-25%)
AMR sensor+electronic	150gr	4*500mW

Mass of tri-axis sensor will be ligther than for ICI 3 <400gr

SWiMM Funding:

25kE have been allocated by CNES to manufacture the instrument (including boom funding…).

Funding for mission will be asked to CNES (25kE => 1 technical meeting for 3 pers+2 integrations for 2 persons+1 launch mission for 2 persons)

CONCLUSION & Open points

Open points

-Electronic board for ICI4 could be at cubeSat format => TBC.

-Rocket trajectory computation through gradiometer ?

-Voltage supply: 28V ?

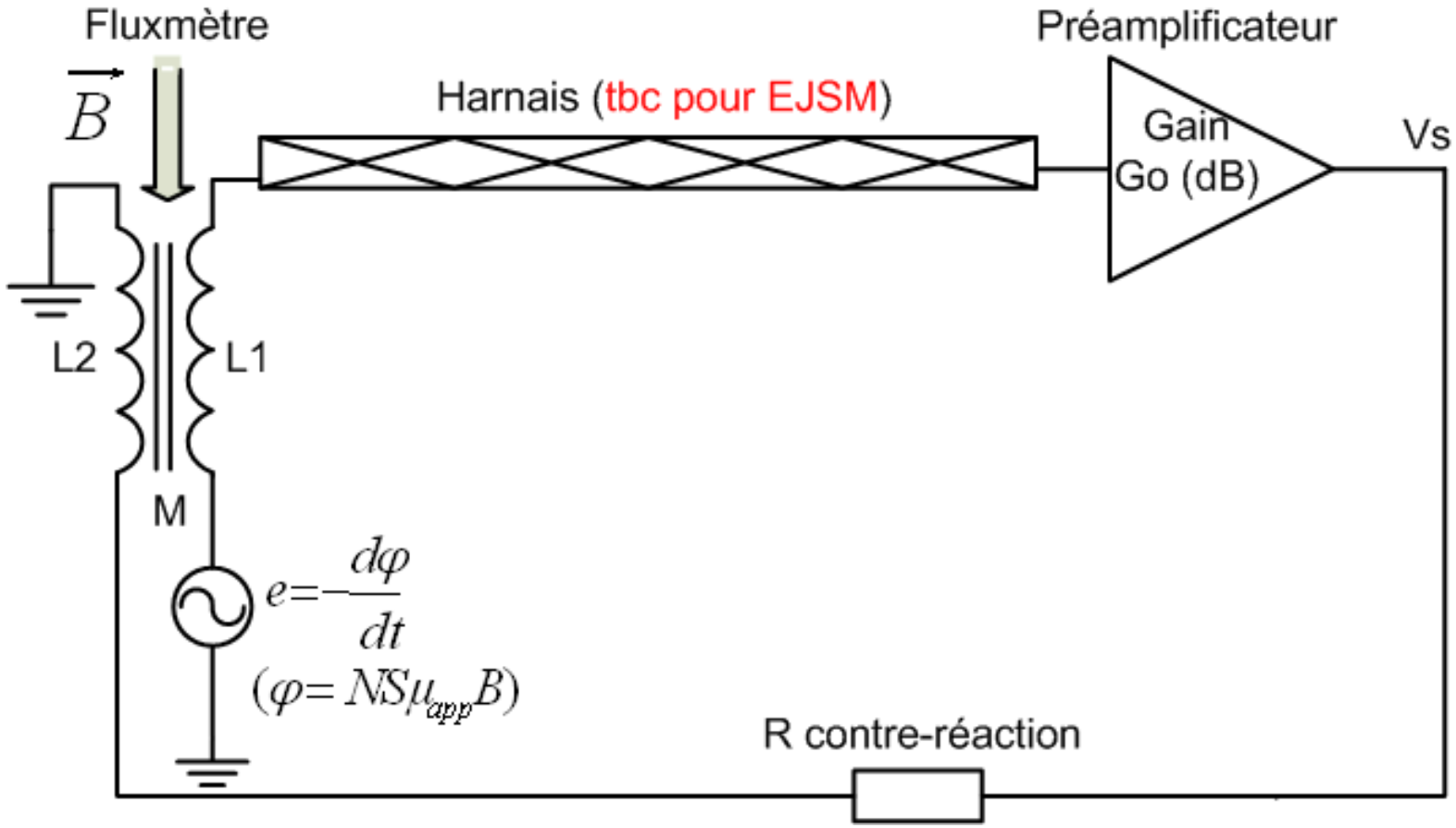
- Spin frequency ? Maximum angle between magnetic field line and rocket ?

- Boom cost ?

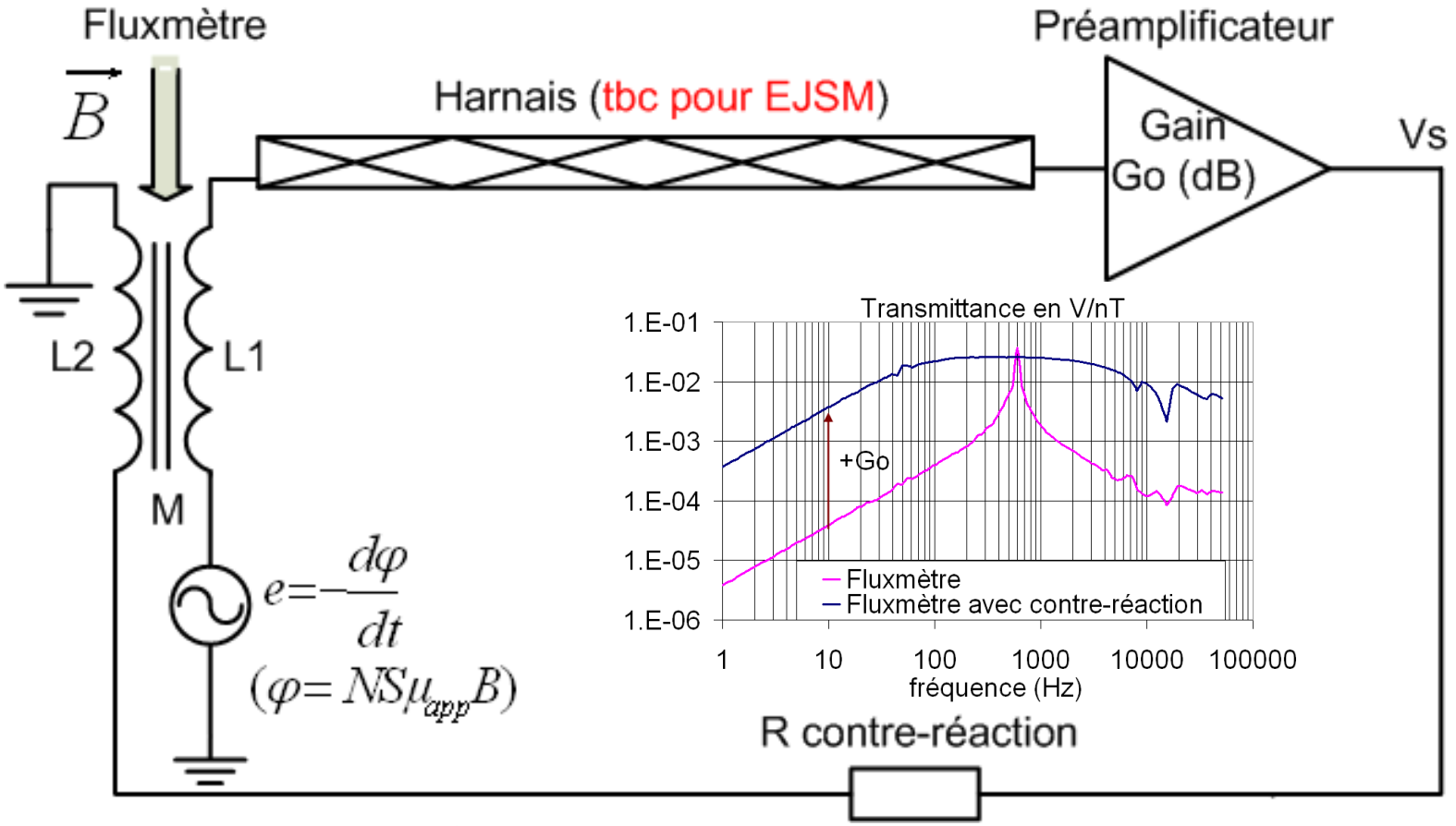
- **Temperature & voltage supply monitoring ?**

- Telemetry : <15kHz ?

Capteur magnétique de type fluxmètre: principe & design : utilisation d'une contre-réaction de flux



Capteur magnétique de type fluxmètre: principe & design : utilisation d'une contre-réaction de flux



- Suppression de la résonance
- Transmittance en champ magnétique **plate sur 2 décades**
- La bande de fréquence 100mHz à qq. kHz