LFR status

- Spare model **(LFR PFM1 delivered)**
- Flight software update **(R3.2 delivered)**
- Ground segment software **(ongoing)**
- k-coefficients **(open questions)**

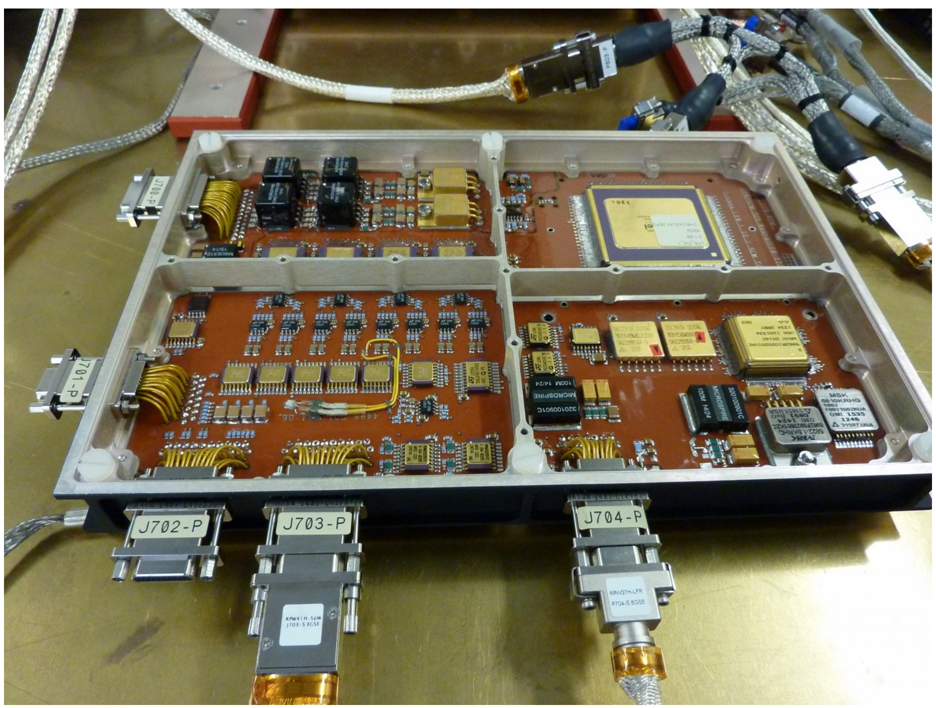
Thomas Chust and the LFR engineer team at LPP

(Alexis Jeandet, *Vincent Leray*, *Moufida Chariet*,

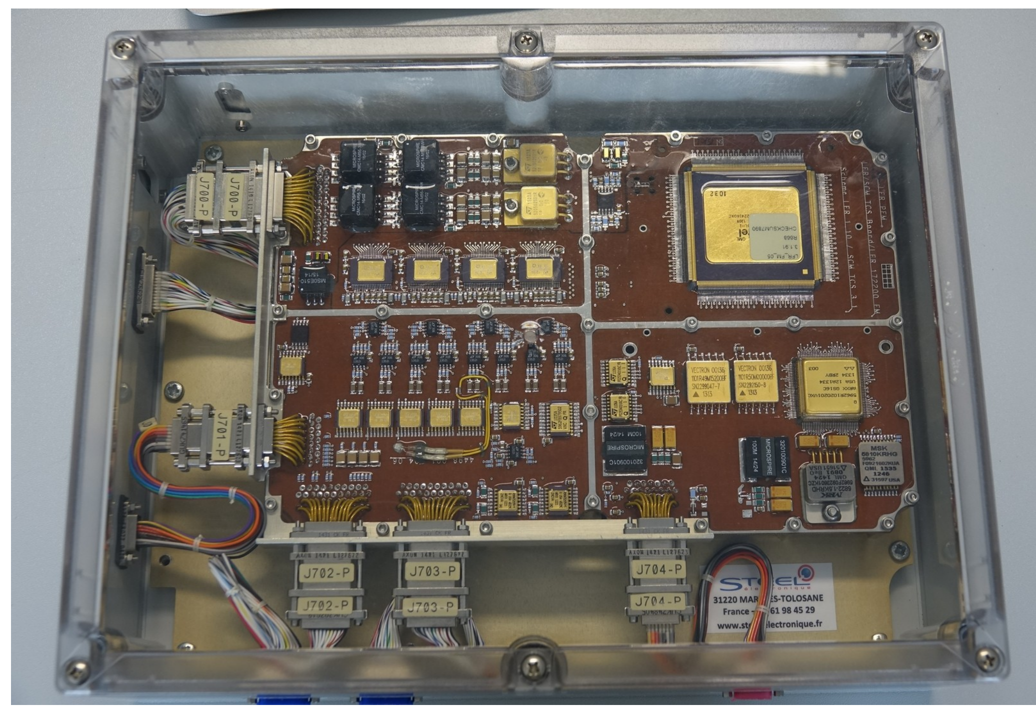
Bruno Katra, Véronique Bouzid, Rodrigue Piberne, *William Recart*)

LFR spare model

- PPBI of the LFR FPGA spare: ok (June 27, 2018)
- DRB of the LFR spare board (PFM1) at LESIA: ok (end of September 2018)
- Stored at LESIA in clean room
- PA datapack : will be closed soon (few minor updates)



PFM1 delivery @ LESIA – April 2016



PFM1 delivery @ LESIA – September 2018

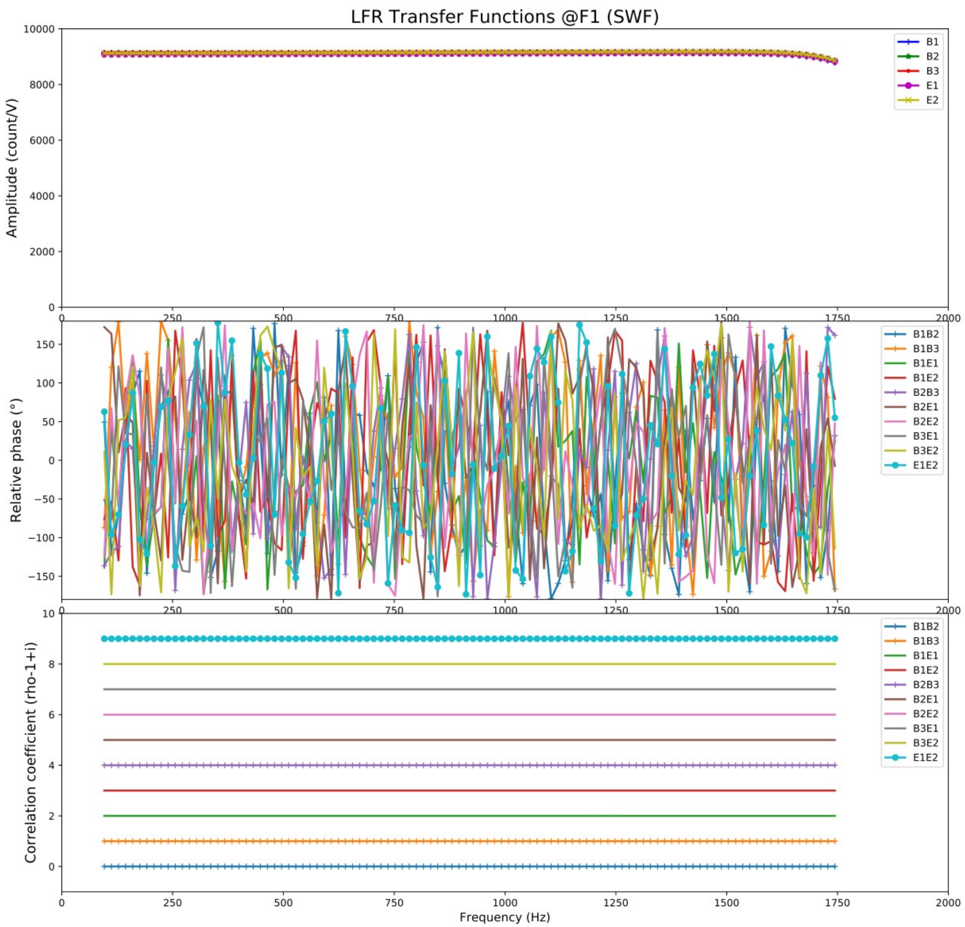
LFR FSW update

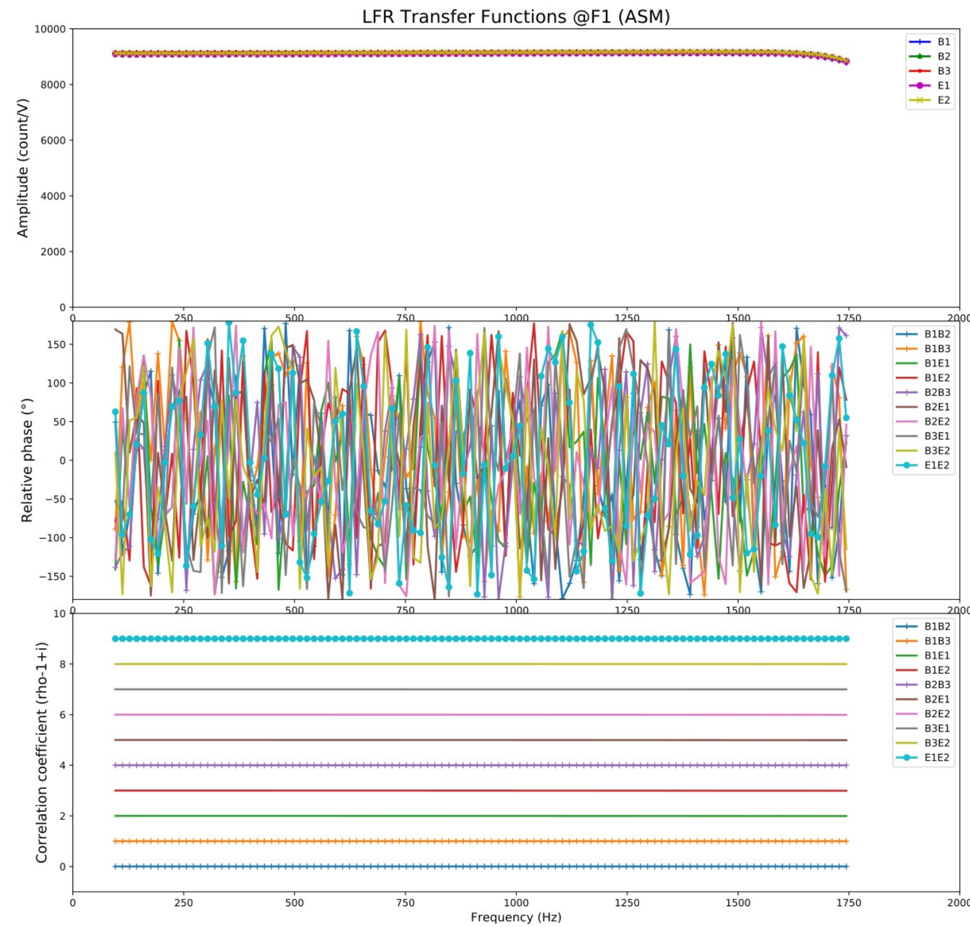
- Datapack **R3.2.0.24 LFR FSW** has been delivered (18 December, 2018)
- QR held begin of January 2019; a delta-QR scheduled for April 2019
- The main points in this update concern:

  - Modification of the SCM calibration signal (programmed by Alexis Jeandet and tested at LPP with Guillaume Jannet, during summer 2018)
  - LFR synchronization anomaly (due to a software error) has been corrected !
  - Scrubbing of LFR RAM (duty cycle has been increased from 40 min to 40 s)
  - Logiscope warnings

- In passage, consistency between SWF, ASM and BPs products have been checked again from Bruno’s CTC (the last time it was done, it was in 2015)

Consistency between SWF and ASM (1)





$$\mathbf{SM} = \begin{bmatrix} B_1B_1^* & B_1B_2^* & B_1B_3^* & B_1E_1^* & B_1E_2^* \\ cc & B_2B_2^* & B_2B_3^* & B_2E_1^* & B_2E_2^* \\ cc & cc & B_3B_3^* & B_3E_1^* & B_3E_2^* \\ cc & cc & cc & E_1E_1^* & E_1E_2^* \\ cc & cc & cc & cc & E_2E_2^* \end{bmatrix}$$

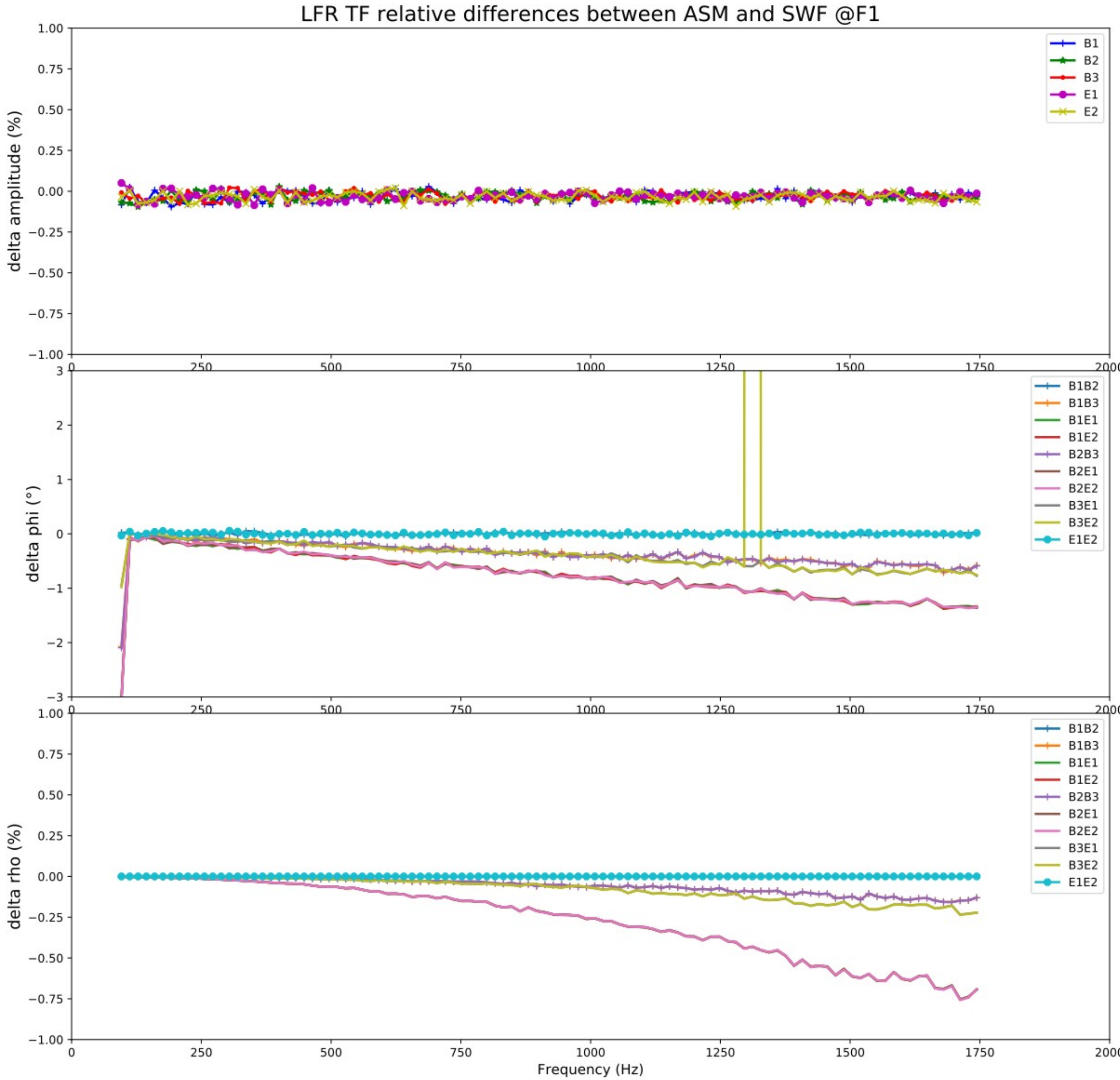
Results here @ F1 but similar results @ F0 and F1

Consistency between SWF and ASM (2)

$$ASM_{ii} \equiv FFT^2 = \left(\frac{A}{2}\right)^2$$

$$\rho \exp(I\phi) = \frac{ASM_{ij}}{\sqrt{ASM_{ii}\ ASM_{jj}}}$$

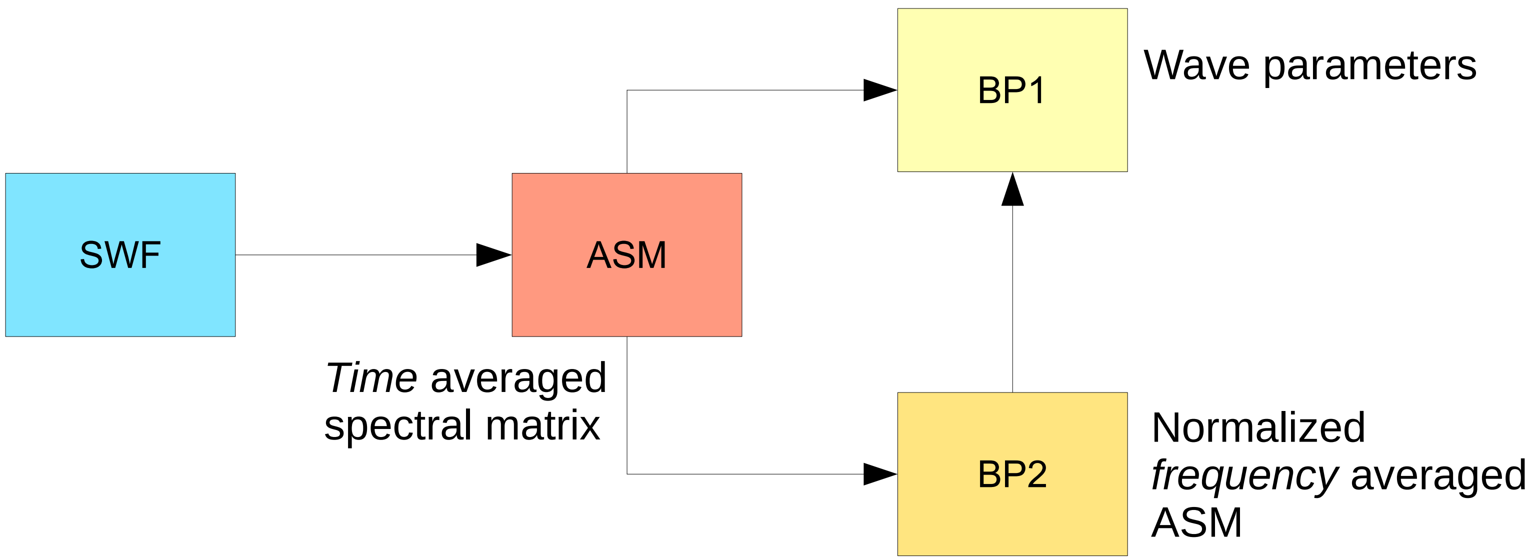
$$\mathbf{ASM} = \begin{bmatrix} 0 & 0 & 1 & 2 & 3 \\ cc & 1 & 4 & 5 & 6 \\ cc & cc & 2 & 7 & 8 \\ cc & cc & cc & 3 & 9 \\ cc & cc & cc & cc & 4 \end{bmatrix}$$



Consistency between ASM, BP2 & BP1

Still from Bruno’s test @ F0, F1 and F2 (CTC-510, CTC-511 et CTC-512):

- ✔ BP2 computed from ASM: **comparison with BP2** => ok
- ✔ BP1 computed from ASM: **comparison with BP1** => ok
- ✔ BP1 computed from BP2: **comparison with BP1** => ok



Current set of Basic Parameters

"Instantaneous" 5 x 5 spectral matrix (256 FFT points)

$$\mathbf{SM}\left(\omega_j^{(m)}\right)=\begin{bmatrix} B_1B_1^* & B_1B_2^* & B_1B_3^* & B_1E_1^* & B_1E_2^* \\ cc & B_2B_2^* & B_2B_3^* & B_2E_1^* & B_2E_2^* \\ cc & cc & B_3B_3^* & B_3E_1^* & B_3E_2^* \\ cc & cc & cc & E_1E_1^* & E_1E_2^* \\ cc & cc & cc & cc & E_2E_2^* \end{bmatrix}$$

Time Averaged Spectral Matrix (ASM)

$$\mathbf{ASM}\left(\omega_j^{(m)}\right)=\frac{1}{N_{SM}^{(m)}}\sum_{k=1}^{N_{SM}^{(m)}}\mathbf{SM}_k\left(\omega_j^{(m)}\right)=\left\langle\mathbf{SM}\right\rangle_{time}$$

***Frequency* average ...**

$$\mathbf{S}\left(\omega_j^{(m)}\right)=\left\langle\mathbf{ASM}\right\rangle_{frequency}$$

... before computations of the BPs (i.e. wave parameters)

Mono-**k** assumption :

	BP1 set 1:	Power spectrum of the magnetic field (***B***)
	BP1 set 2:	Power spectrum of the electric field (***E***)
(Means, JGR, 1972) {	**BP1** set 3:	Wave normal vector (from ***B***)
	BP1 set 4:	Wave ellipticity estimator (from ***B***)
(Samson & Olson, GJRA, 1980) {	**BP1** set 5:	Wave planarity estimator (from ***B***)
	BP1 set 6:	X_{SO}(radial)-component of the Poynting vector
$\mathbf{n}\times\mathbf{E}=\frac{\omega}{k}\mathbf{B}$ →	**BP1** set 7:	Phase velocity estimator
	BP2 set 1:	Autocorrelations
$\frac{S_{ij}}{\sqrt{S_{ii}S_{jj}}}$ →	**BP2** set 2:	Normalized cross correlations

LFR ground segment software (1)

Official delivery of first full processing pipeline (lfr-calbut v0.4) to the ROC was done in December 2018: WF + ASM.

Calibration tables (RCT)

- Produced calibration tables for BIAS, SCM (and VHF).

Waveforms products (CWF, SWF)

- L1 to L1R pipeline is operational. It produces :

- CWF in SBM1, SBM2 and SURV mode.
- SWF in SURV mode.

LFR ground segment software (2)

Spectral products (Averaged Spectral Matrices)

➢ L1 to L2

The calibration of ASM is implemented in lfr-calbut. It was tested using a comparison with another calibration method (Rodrigue's versus Thomas' algorithm).

It produces:

- ASM in SURV mode.

LFR ground segment software (3)

Spectral products (Basic parameters)

➢ L1 to L2

The calibration of BP1 and BP2 was developed but still needs some validation.

Furthermore, this calibration currently used the old L1 format, which will be changed when LESIA will integrate the « translation » of raw BP1 in the L1.

It produces:

- BP1 and BP2 in SBM1, SBM2 and SURV mode.

LFR ground segment software (4)

Question concerning CALBUT integration in ROC pipeline

- L1 to L2 (i.e. spectral products)

- It seems necessary:

(1) to create a dico (or file) which centralize the **history of the calibration tables to be applied**;

(2) to define the procedure for analyzing this dico with respect to input parameters and giving as output the calibration table to be applied.

Then, application of this procedure can be done either at the pipeline level or at the CALBUT level.

We are OK to perform it within CALBUT.

On the other side, the **elaboration and the update of this dico** should be done at the pipeline level with inputs from each sensor team.

LFR k-coefficient setting

- These coefficients if correctly set would allow to correlate on-board the electric and magnetic signals for an estimate of :
  1) the (radial) **X-component of the Poynting flux**;
  2) the **phase velocit**y of plane waves .

- The setting of k-coefficients should mainly consist of updating the **ANT/BIAS and SCM geometric parameters** and the **relative phase of their frequency response**

- This operation that aims at adjusting to the best the LFR k-coefficients will necessitate some interactions with the ANT, BIAS and SCM teams.

QUESTIONS:

- How much update ? Every weeks? Every months ?

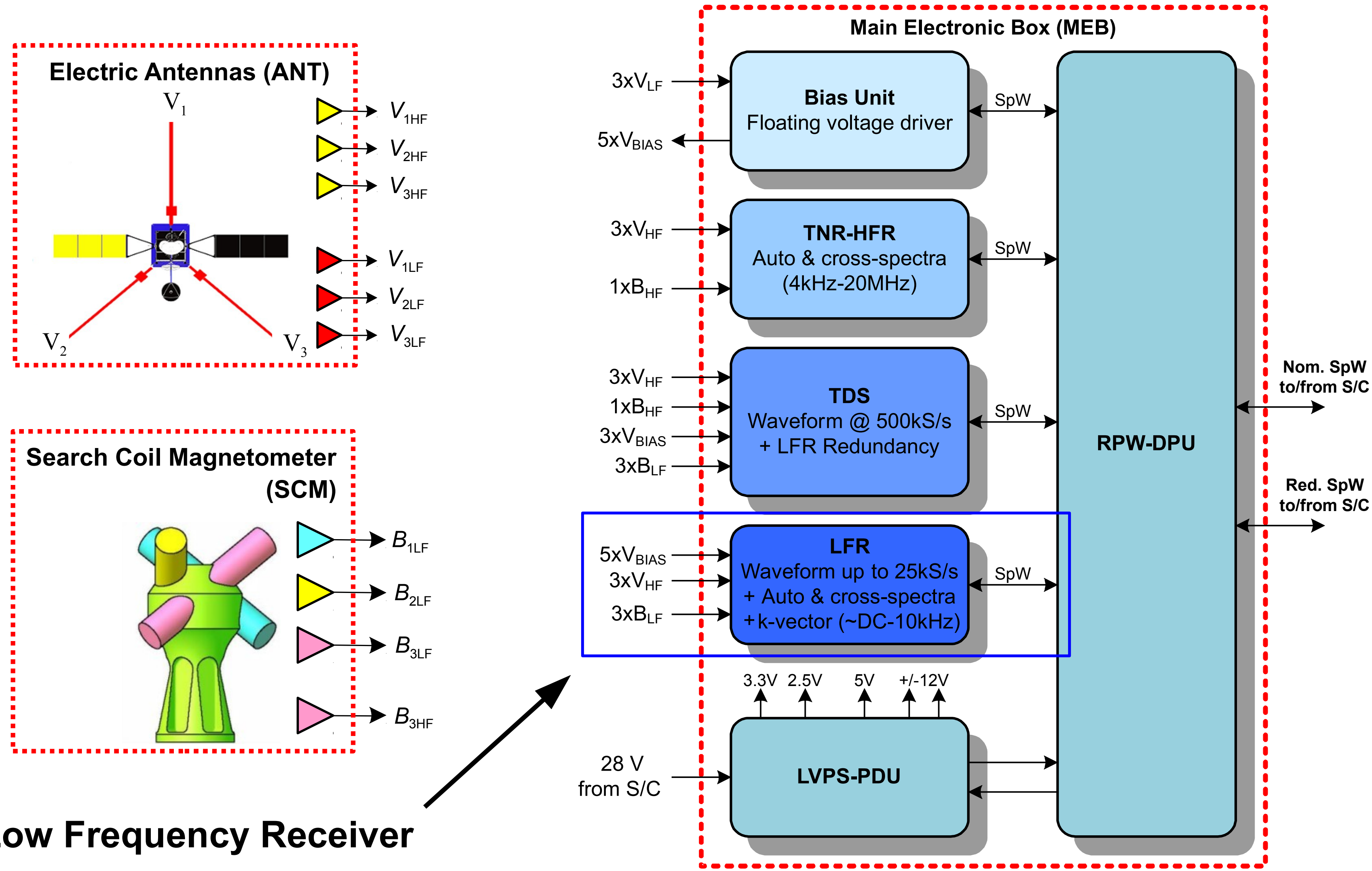
- **Where are stored the corresponding data ? Important for calibration …**

- Splinter on Friday afternoon ?

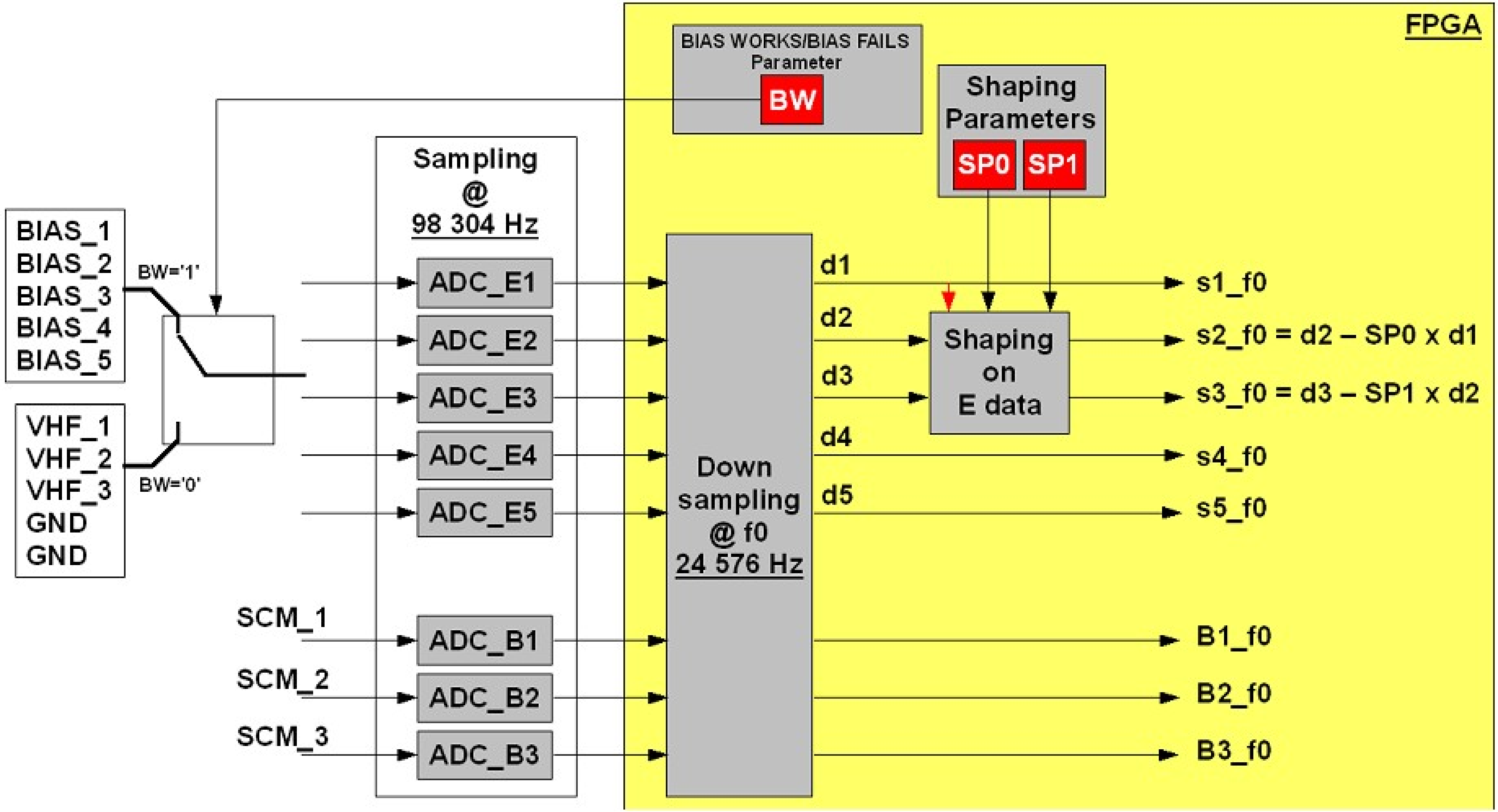
Additional slides

RPW Instrument Overview

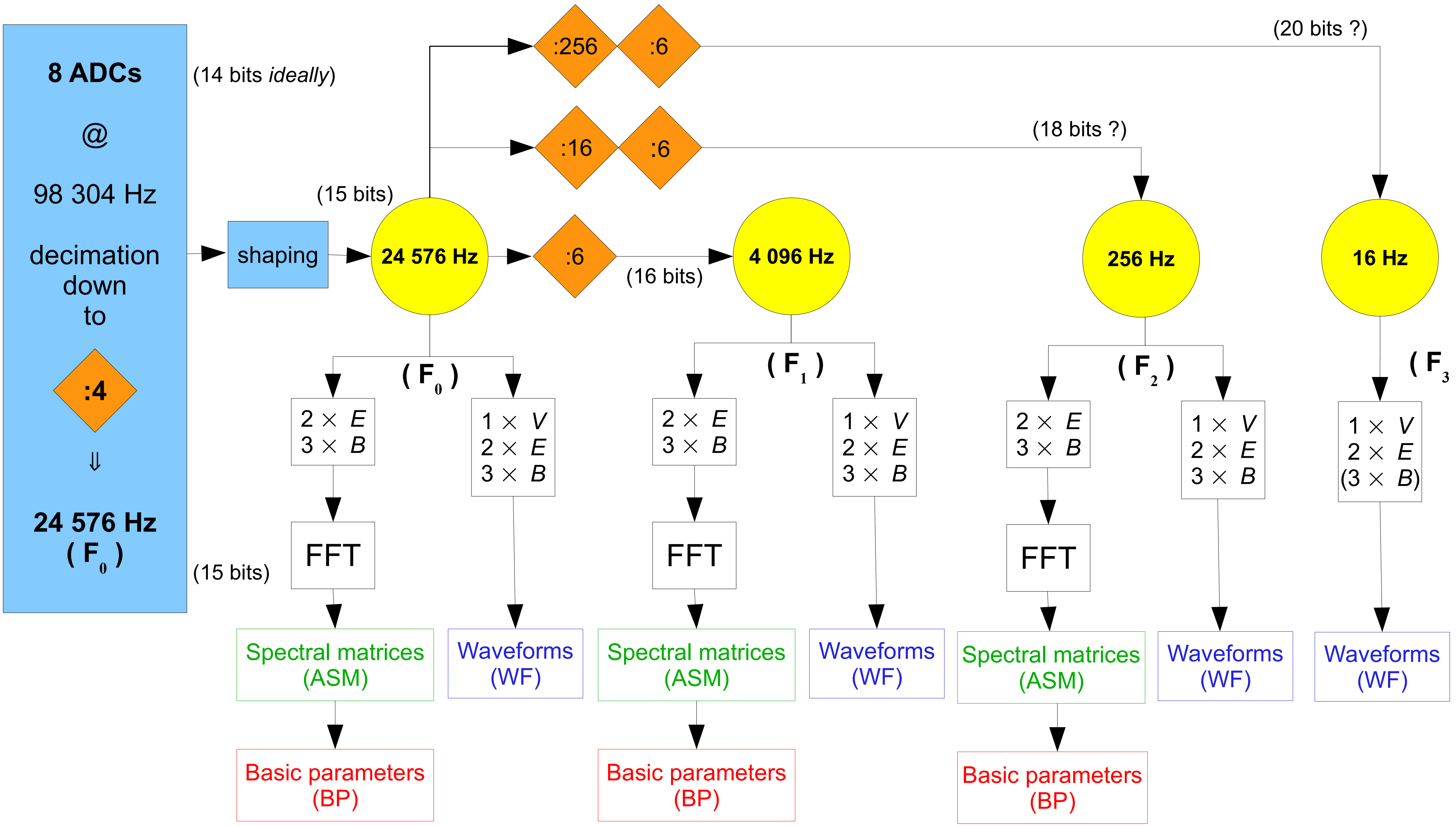
*Will allow the characterization of the electric and magnetic fields associated to the dynamics of the near-Sun heliosphere **from near DC up to 20 MHz***



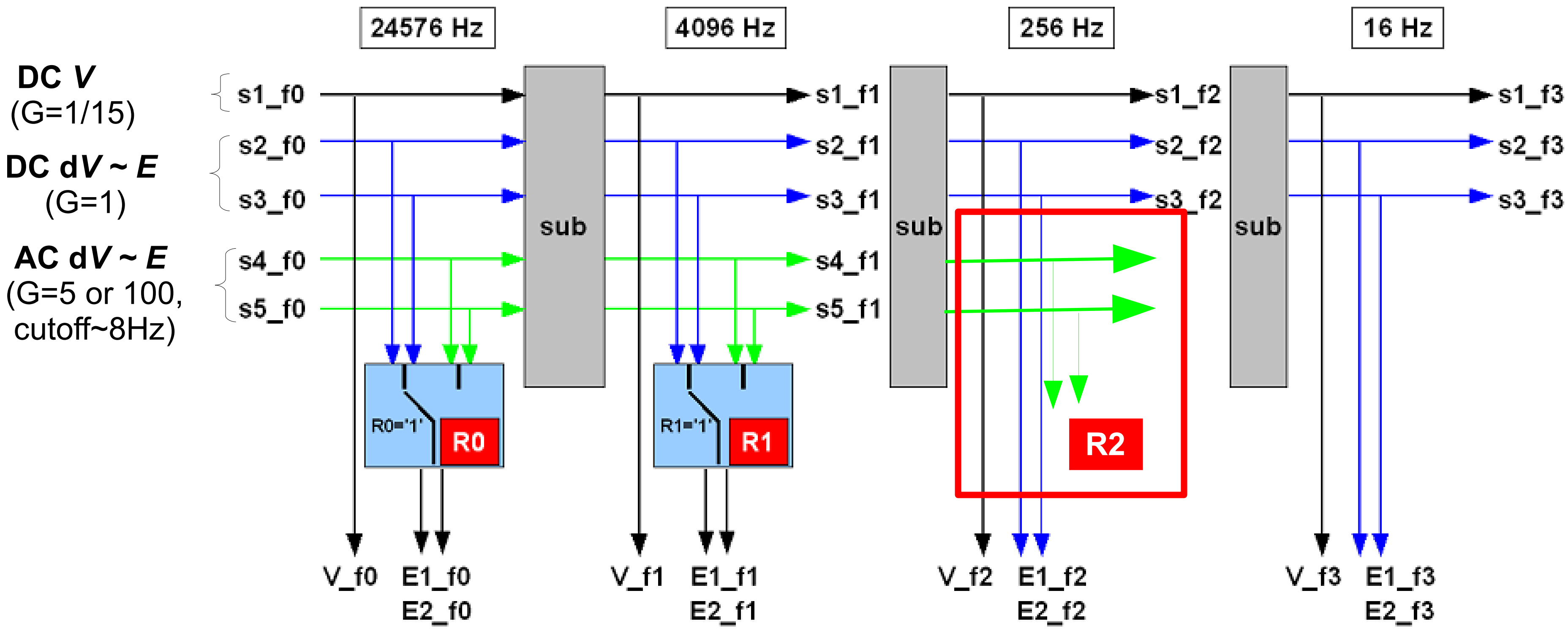
LFR 11 analogue inputs



LFR Decimation and Processing Strategy



BIAS 5 analog inputs and the R-parameters



BIAS configuration

BIAS_WORKS								
BIAS_1	**BIAS_2**	**BIAS_3**	**BIAS_4**	**BIAS_5**				
V1_DC	V12_DC	V23_DC	V12_AC	V23_AC	**standard**	SCM_1	SCM_2	SCM_3
V2_DC	V3_DC	V23_DC	V12_AC	V23_AC	**probe 1 fails**	SCM_1	SCM_2	SCM_3
V1_DC	V3_DC	V13_DC	V13_AC	V23_AC	**probe 2 fails**	SCM_1	SCM_2	SCM_3
V1_DC	V2_DC	V12_DC	V12_AC	V23_AC	**probe 3 fails**	SCM_1	SCM_2	SCM_3
V1_DC	V2_DC	V3_DC	V12_AC	V23_AC	**offsets saturate V12**	SCM_1	SCM_2	SCM_3
BIAS_FAILS								
VHF_1	VHF_2	VHF_3	GND	GND		SCM_1	SCM_2	SCM_3
↓	↓	↓	↓	↓		↓	↓	↓
ADC_ E1	**ADC_E2**	**ADC_E3**	**ADC_E4**	**ADC_E5**		**ADC_B1**	**ADC_B2**	**ADC_B3**

LFR Spectral Frequencies

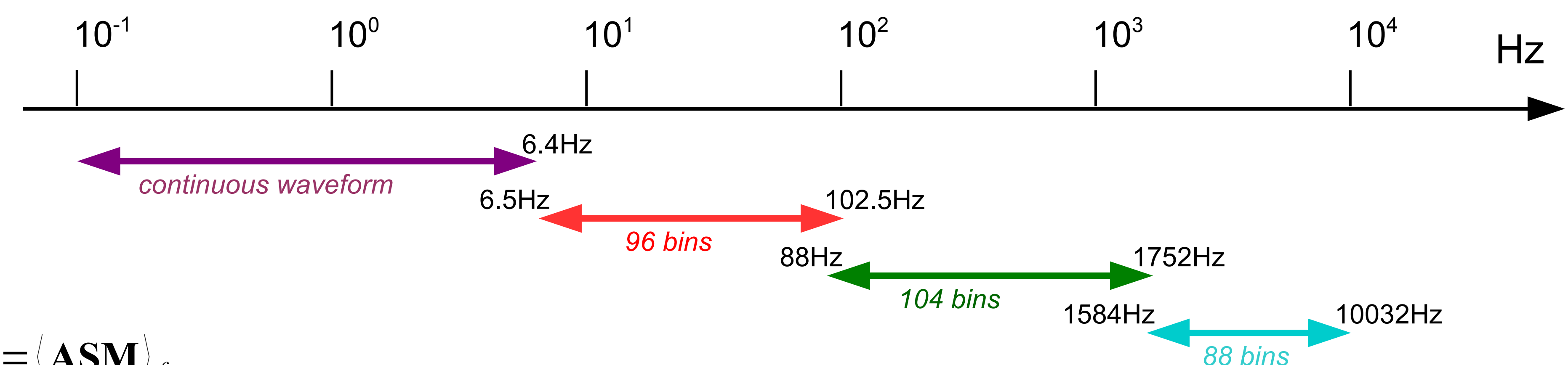
(1) Depending on the frequency channel, **selection** of 96, 104 or 88 consecutive **frequency bins** among 128 (N_{FFT} = 256) of the *time* averaged spectral matrices.

(2) Then, the ASMs are averaged over packets of N_{freq} (8 or 4) consecutive bins :

$$\Delta f^{(m)} = \frac{f_m}{N_{FFT}} \times N_{freq}$$

$$N_{freq} = 8$$

f_3 = 16 Hz	=>	waveform	[DC, 8Hz]		f_3 / 2.5 = 6.4 Hz
f_2 = 256 Hz	=>	12 frequencies	[6.5Hz, 102.5Hz]	$\Delta f^{(2)}$ = 8 Hz	f_2 / 2.5 = 102.4 Hz
f_1 = 4096 Hz	=>	13 frequencies	[88Hz, 1752Hz]	$\Delta f^{(1)}$ = 128 Hz	f_1 / 2.5 = 1638.4 Hz
f_0 = 24576 Hz	=>	11 frequencies	[1584Hz, 10032Hz]	$\Delta f^{(0)}$ = 768 Hz	f_0 / 2.5 = 9830.4 Hz

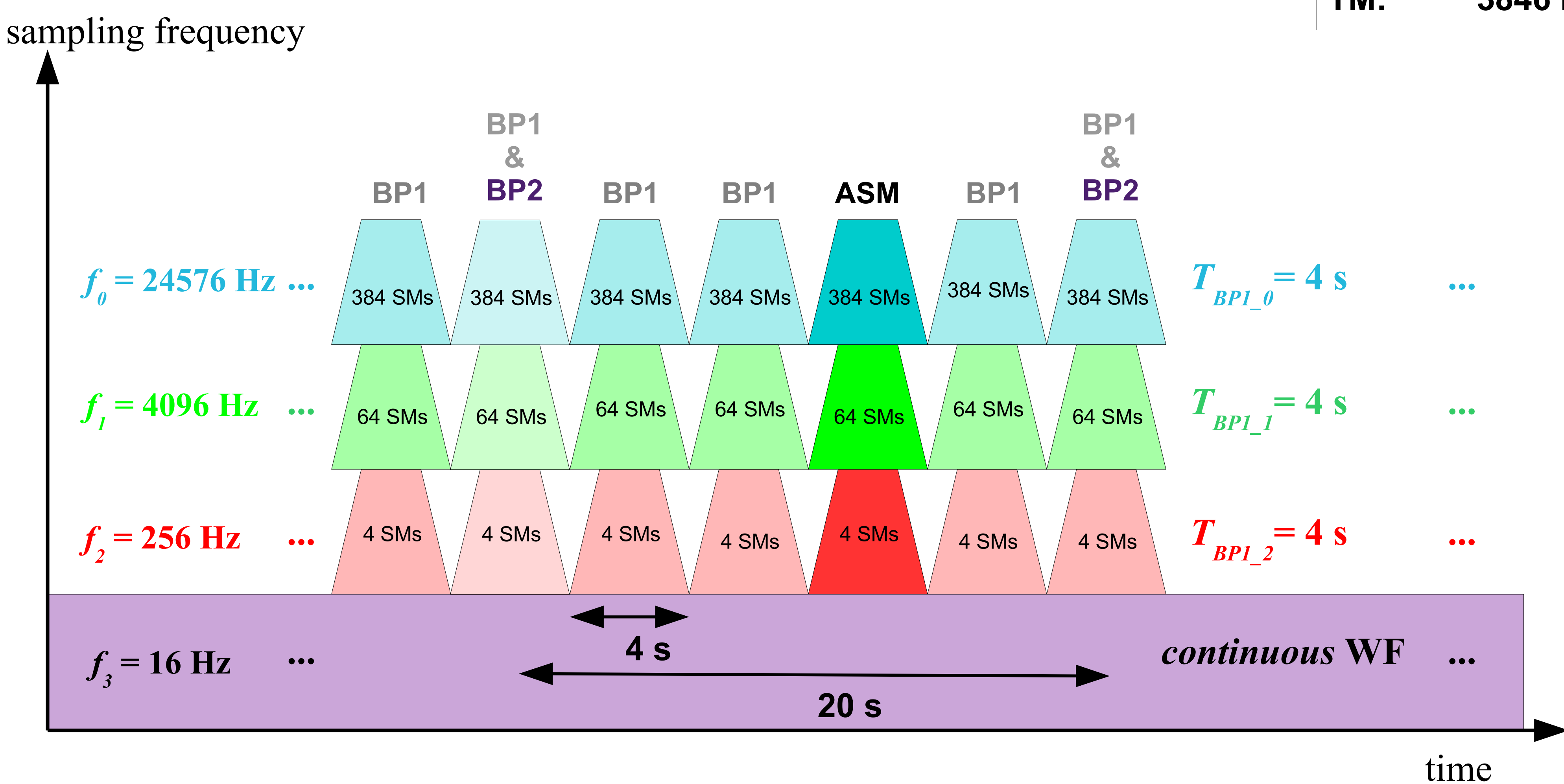


$$\mathbf{S} = \langle \mathbf{ASM} \rangle_{frequency}$$

LFR Normal Mode (1)

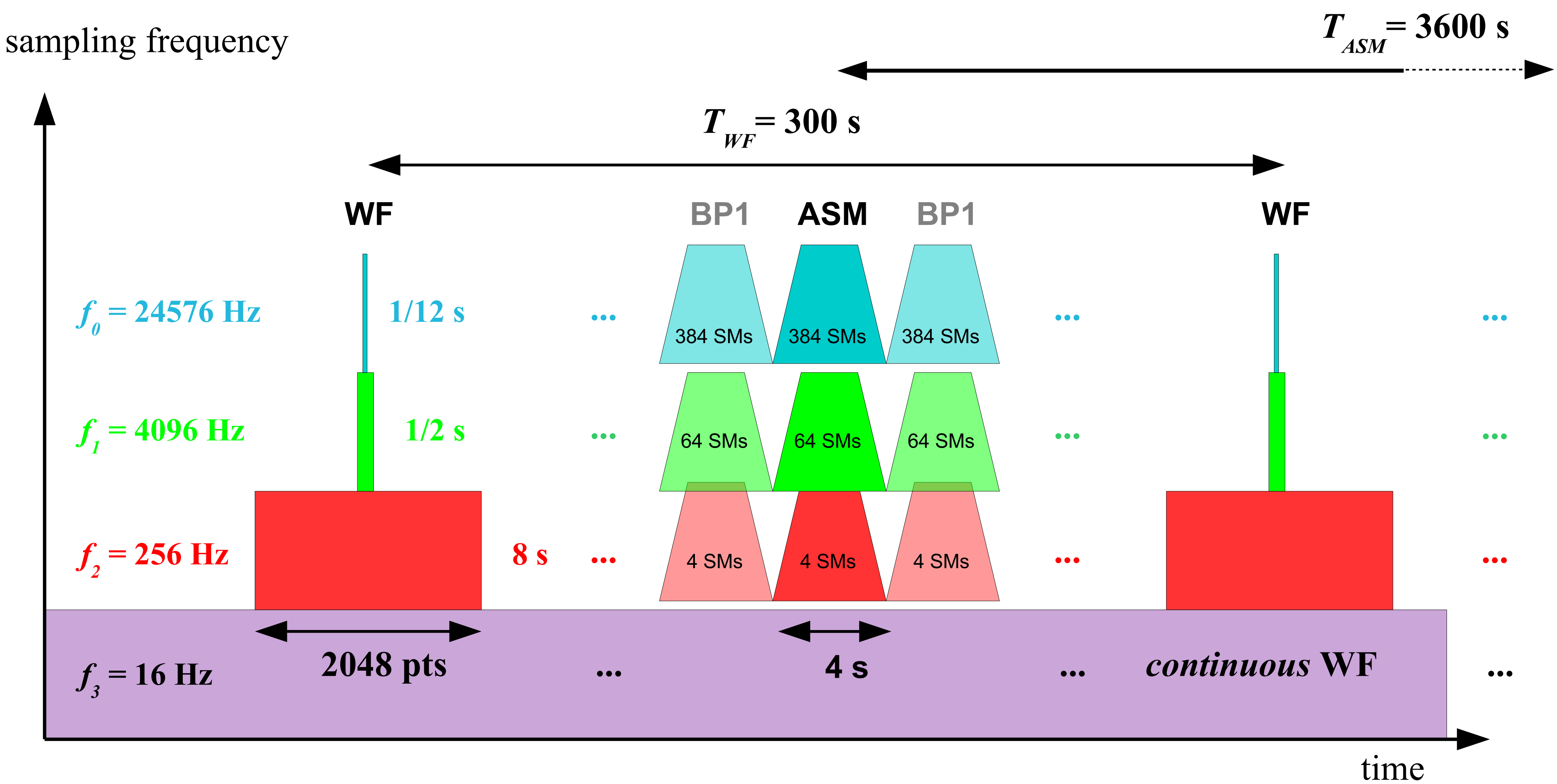
BP:	1080 bps
WF:	2734 bps
ASM:	32 bps
TM:	3846 bps

Basic Parameters



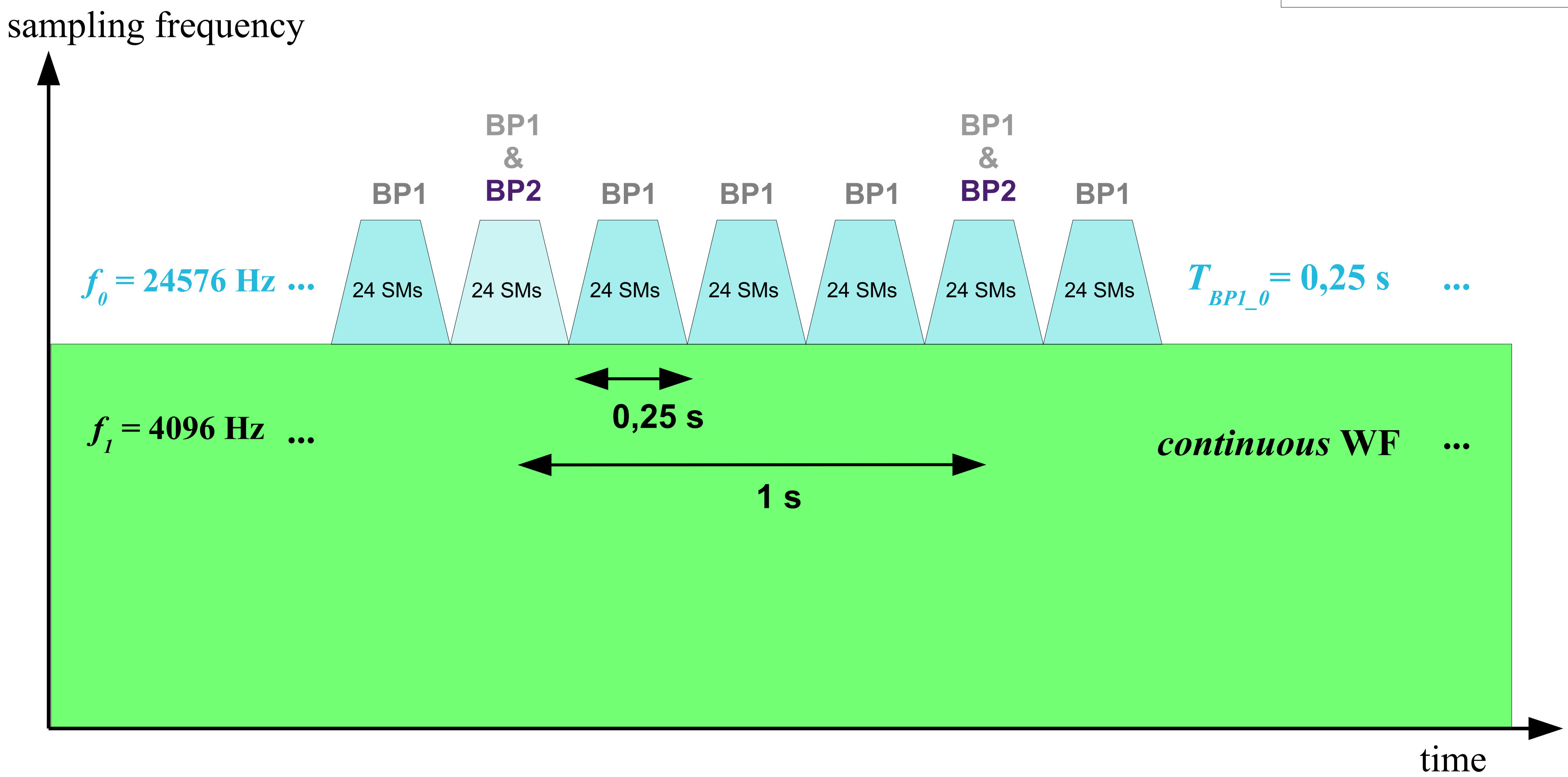
LFR Normal Mode (2)

WaveForms & Averaged Spectral Matrices



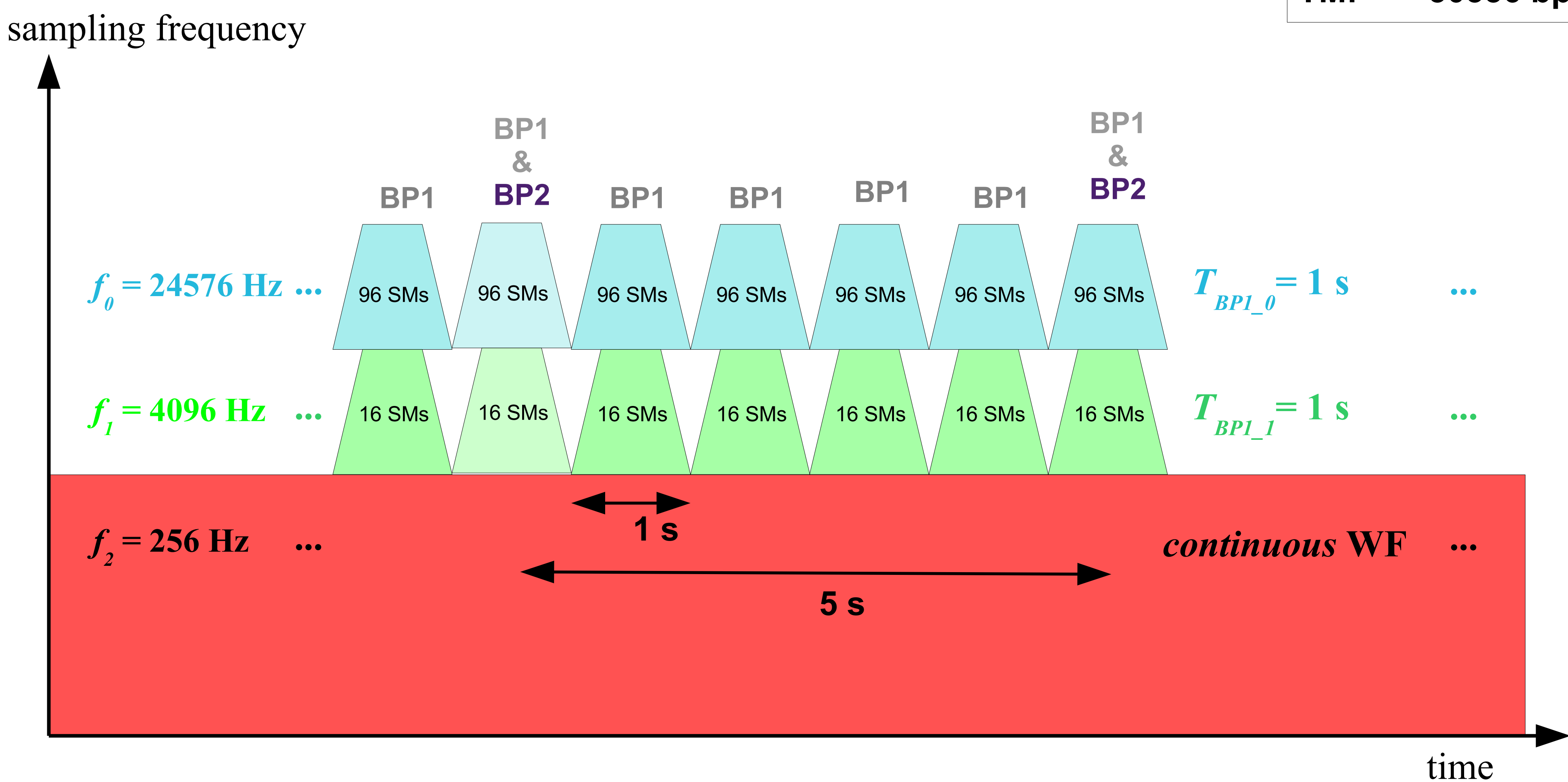
LFR Selected Burst Mode 1

BP:	12672 bps
WF:	393216 bps
ASM:	0 bps
TM:	405888 bps



LFR Selected Burst Mode 2

BP:	5760 bps
WF:	24576 bps
ASM:	0 bps
TM:	30336 bps



LFR block diagram