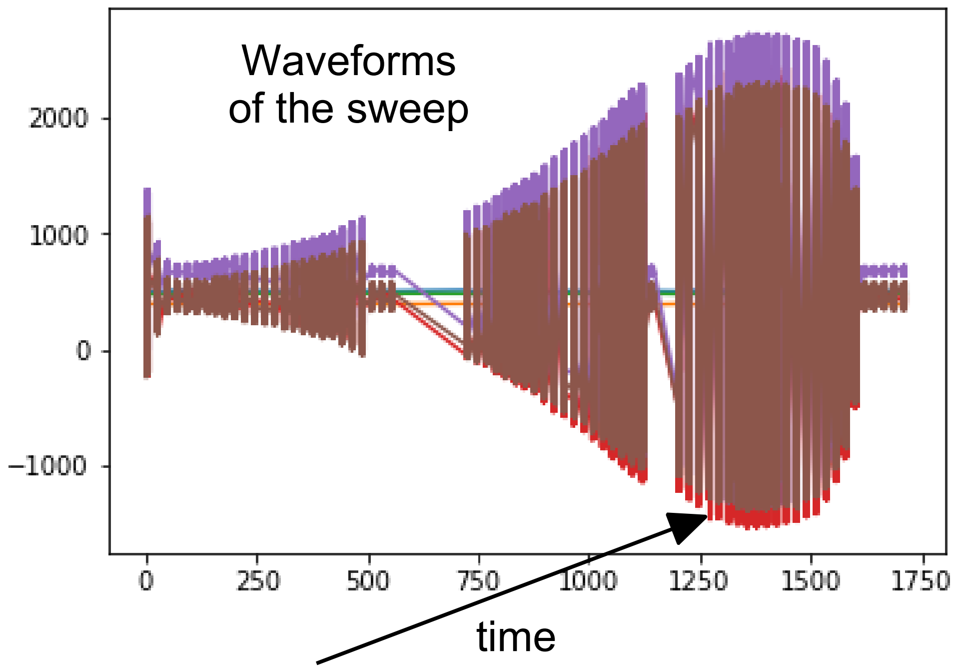
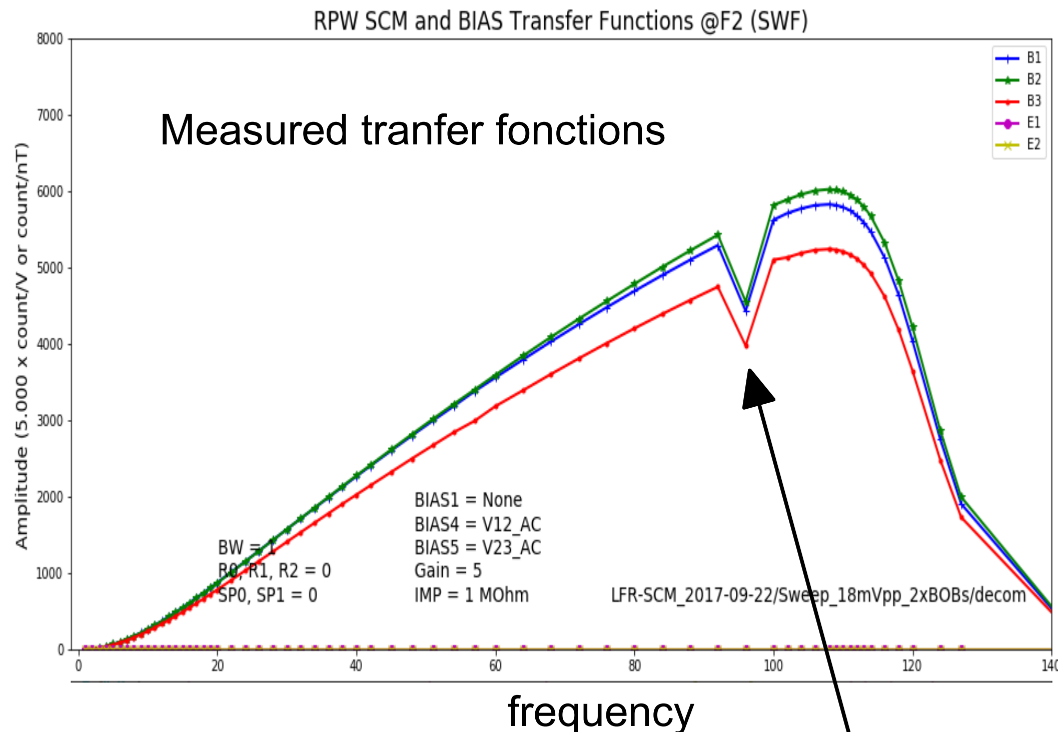
LFR status elements

- Snapshot synchronization anomaly **(*in principle* solved)**
- LFR spare model **(manufacturing is *ongoing*)**
- Background noise levels from the RPW thermal calibrations (SWF spectra [*noisy*] + **ASM spectra** [*less sensitive*])

Thomas Chust and the LFR team

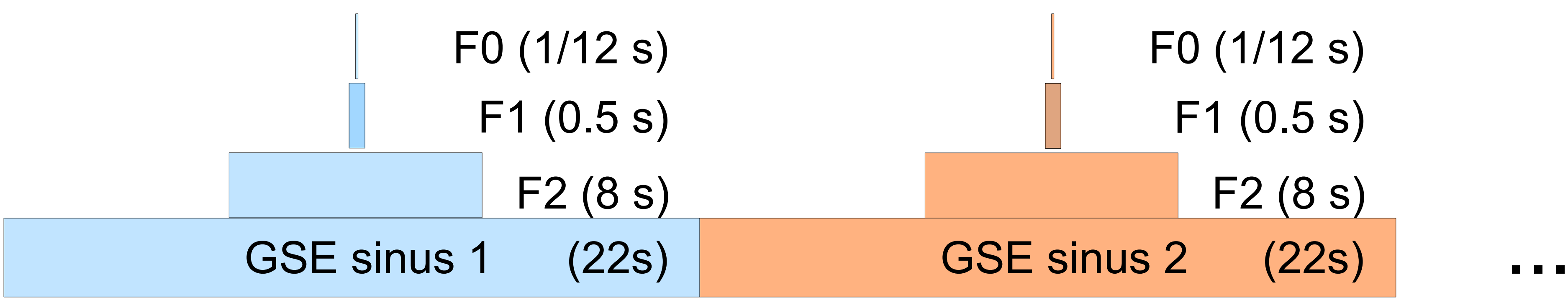
Anomaly observed during calibration sweeps (1)





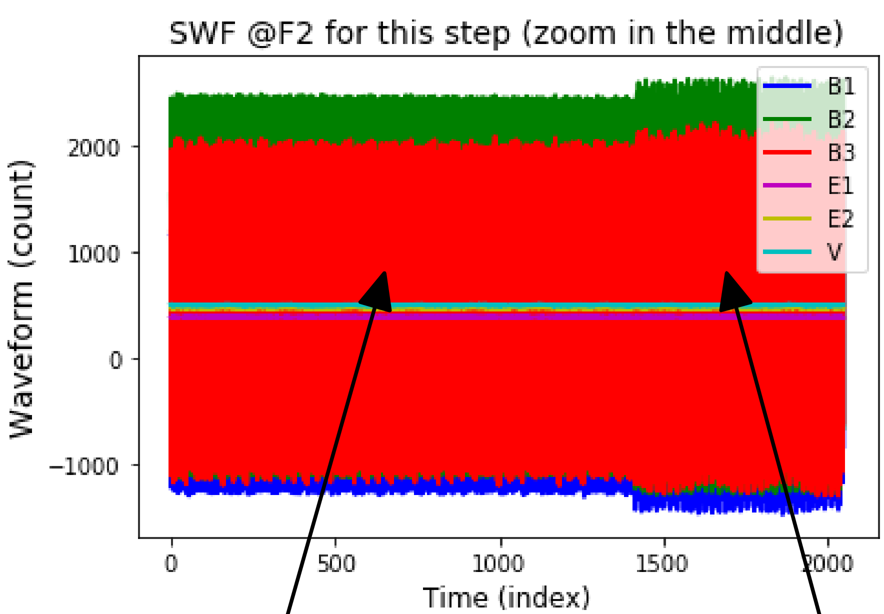
96Hz => 4th SWF_F2 of the third block

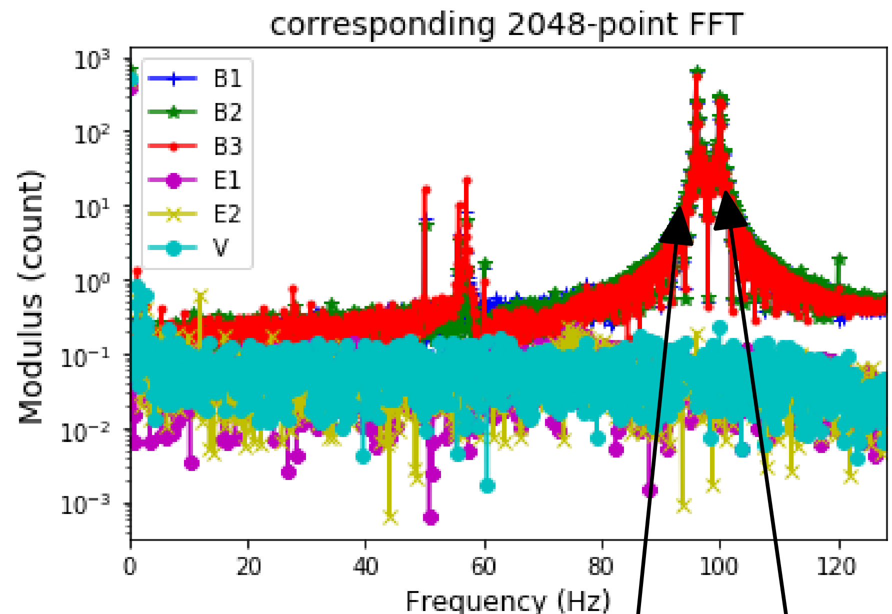
96Hz



Anomaly observed during calibration sweeps (2)

4th SWF_F2 of the third block:



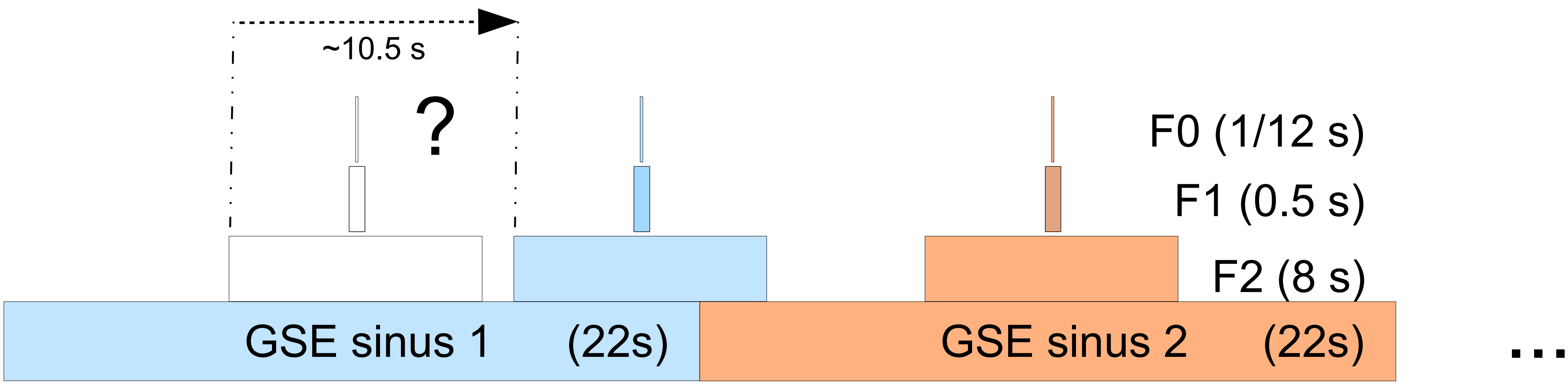


sinus @96Hz

sinus @100Hz

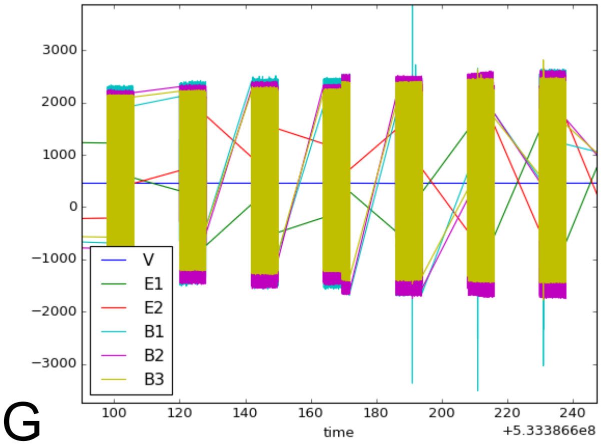
96Hz

100Hz



Snapshot synchronization anomaly (historical 1)

- First observed during calibration tests by Emmanuel G. on the waveforms (long time ago, seldom but regularly…)



- Confirmed and detected from the TF curve anomaly

- Daniel D. did deep investigation on the GSE arbitrary wave generator (implemented a pulse at the beginning of each 22s sinus of the original "multisin_block"); redo another investigation later with Alexis J. : NOTHING

- Alexis did also a deep investigation on LFR EQM (with signals allowing to *count* each second) but also NOTHING

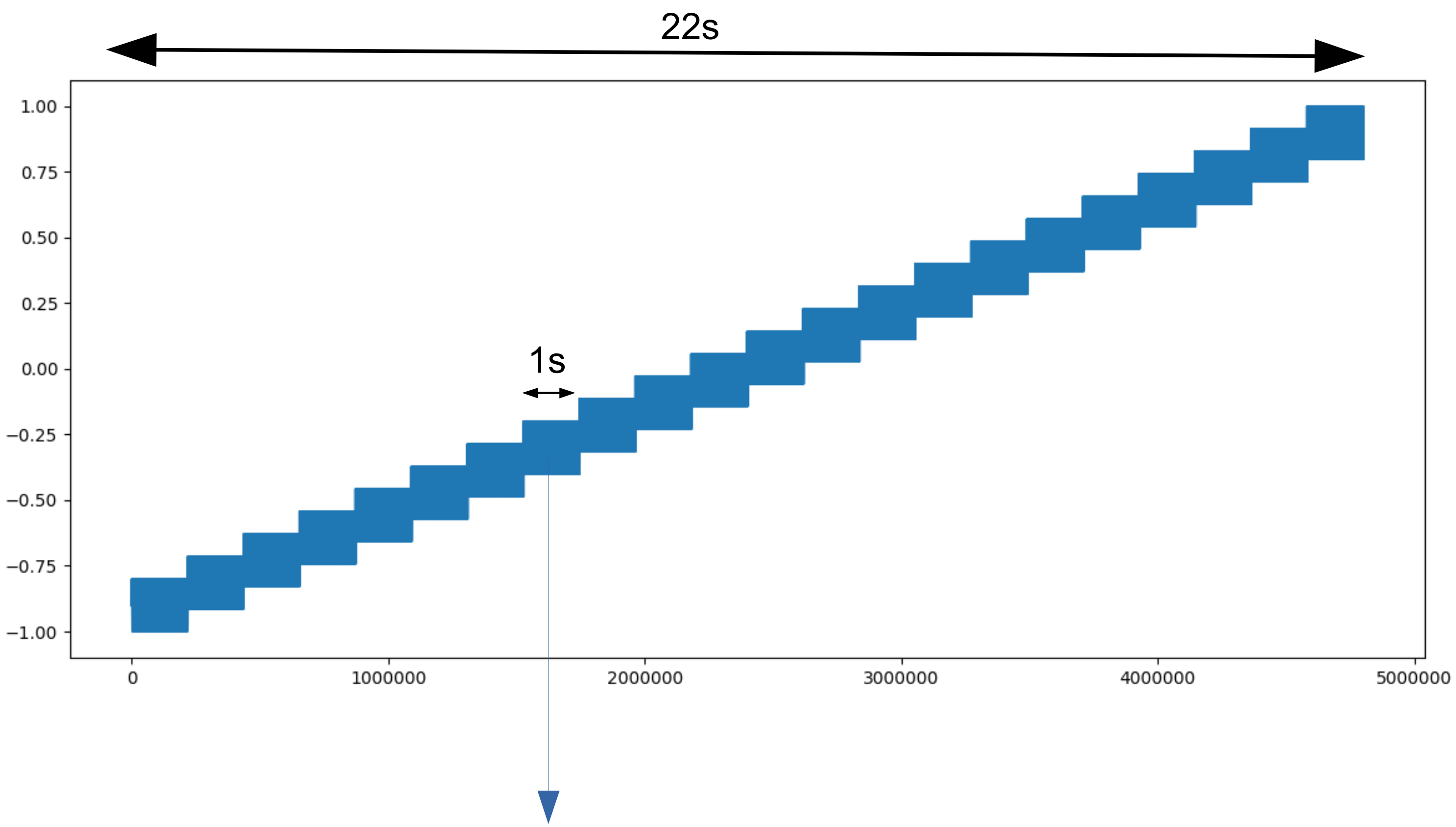
- Simone T. replays many times calibration sweeps in order to have statistics: the anomaly may occur in all of the 3 multisin blocks but always *exactly* in the same way : **at the 4th SWF_F2 of the considered block and with the same time shift**

- Alexis computed another "multisin_block" file in order to discriminate each sec.

- Simone replays many times again the calibration sweep with this file.

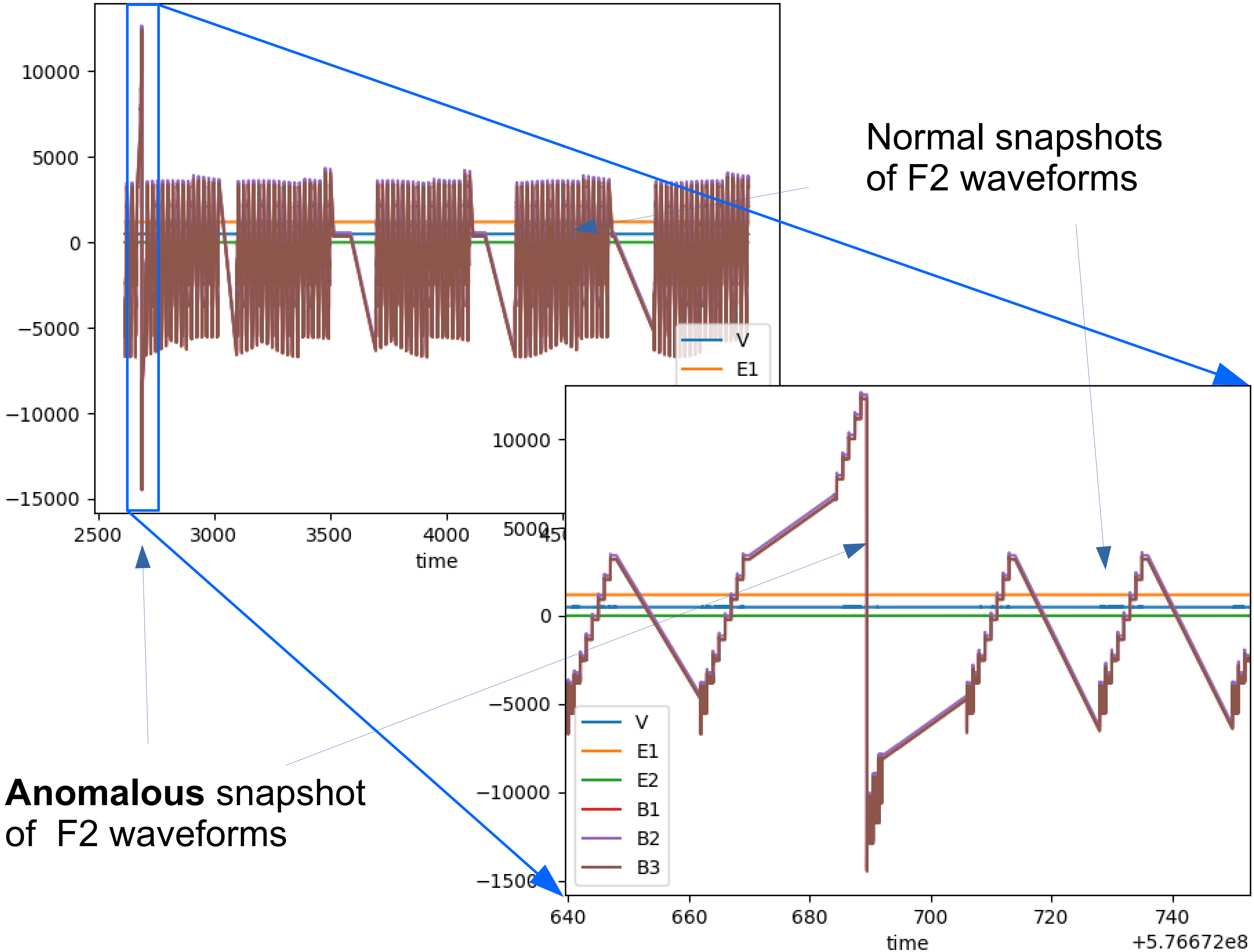
New test signals used for the "sweep"

Alexis' 22s pattern file (one second correspond to one level & one frequency):



Freq = (48 + i*12) Hz, i = 0, 1, …, 21

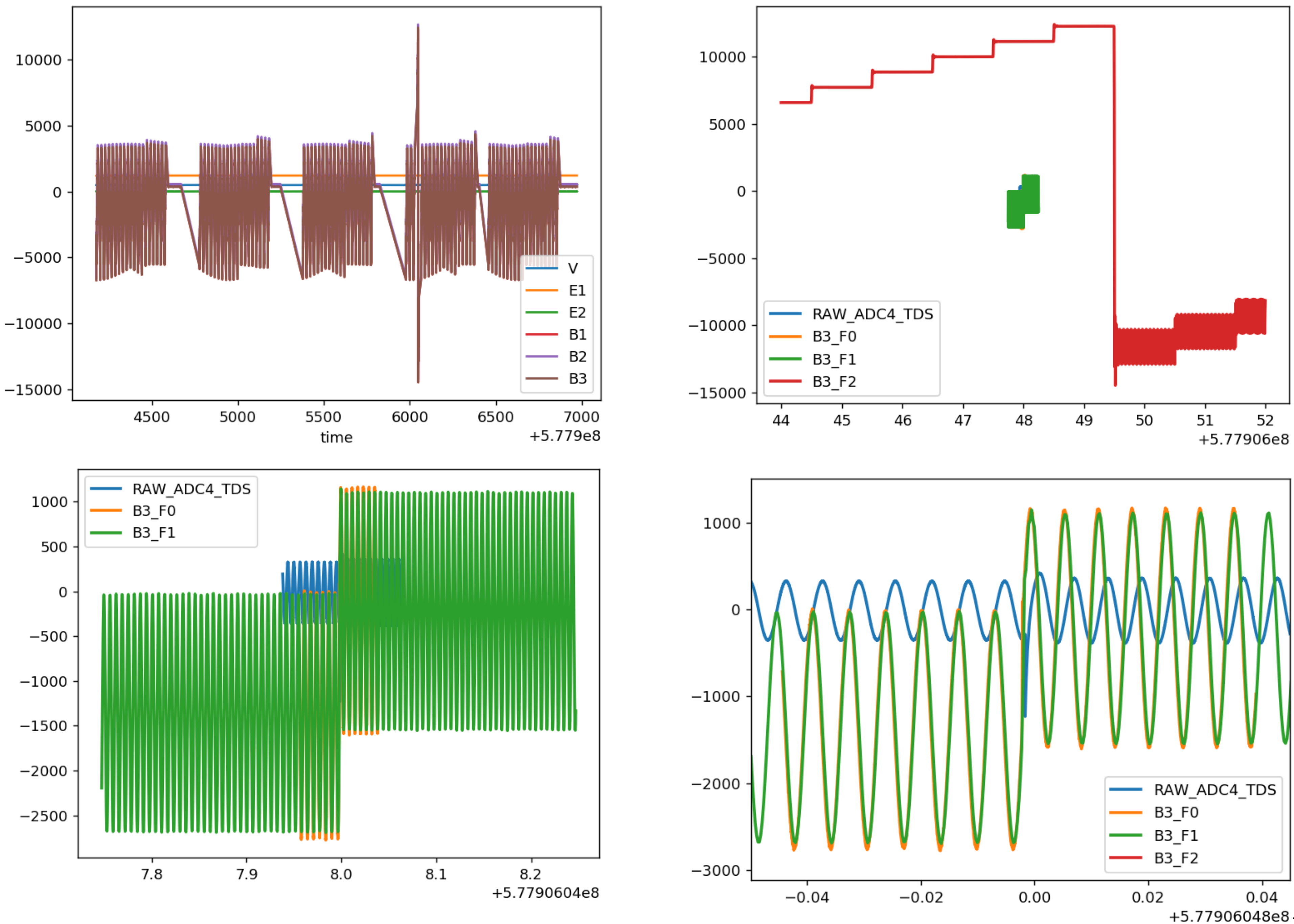
Anomaly observed with the new "sweep" file



Normal snapshots of F2 waveforms

Anomalous snapshot of F2 waveforms

LFR F2, F1, F0 snapshots (SWF) and TDS snapshots (RSWF)

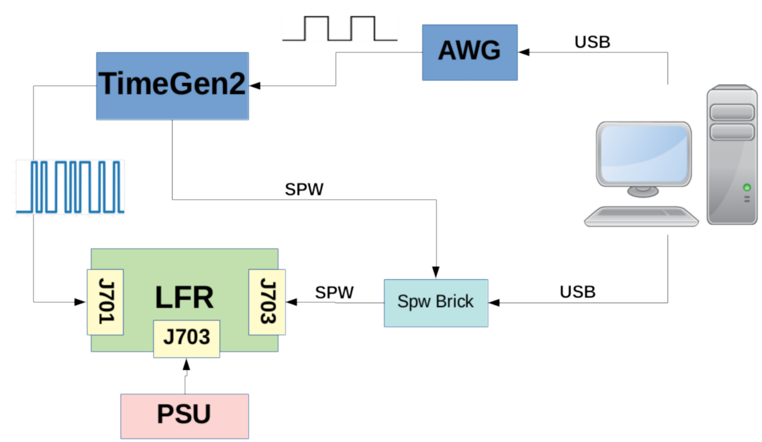


Snapshot synchronization anomaly (historical 2)

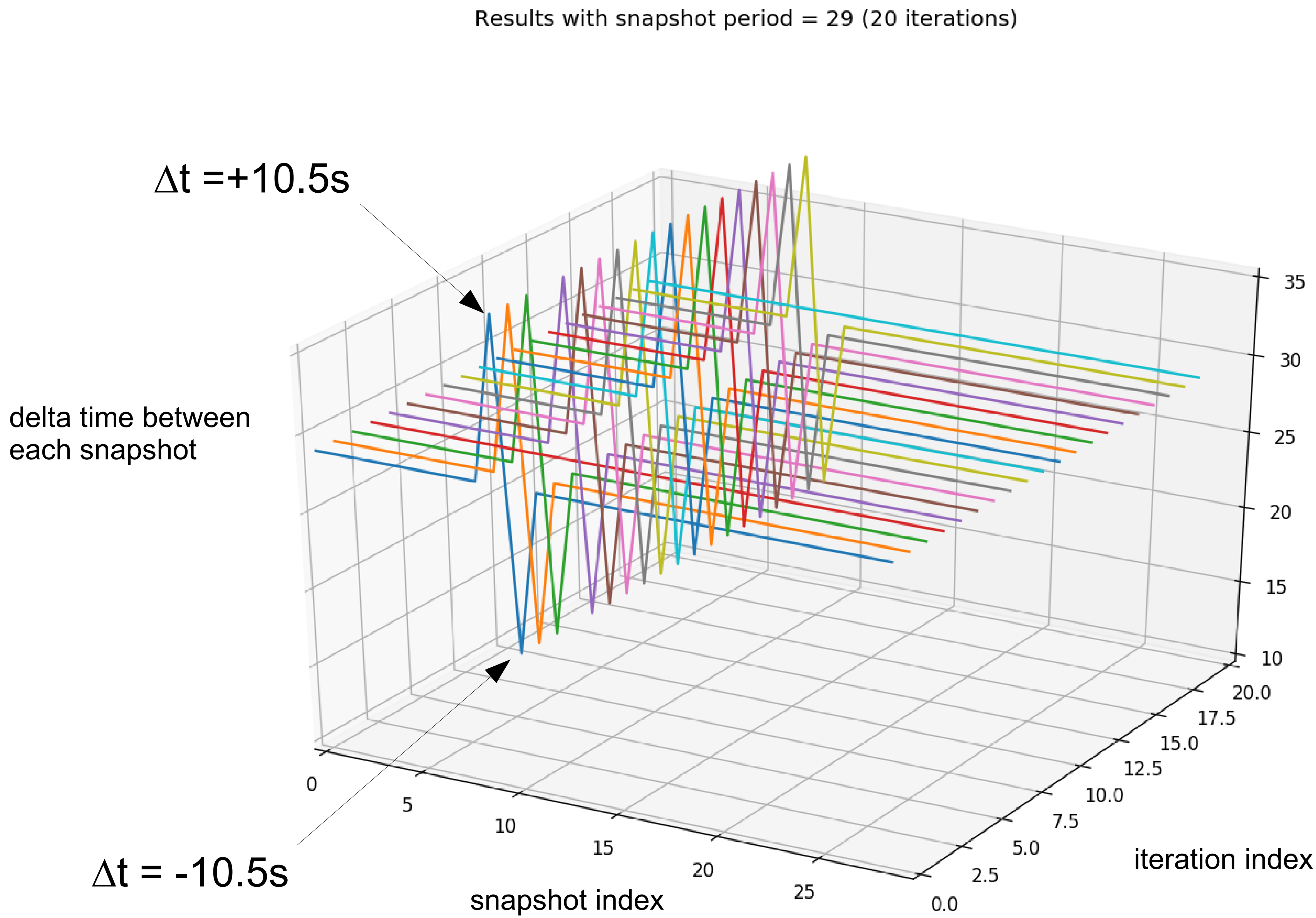
- From Simone’s measurements :
  - the LFR anomaly is present only on the F2 snapshot (F1 and F0 nominal)
  - the anomaly should stem from FSW and not from VHDL
  - the desynchronization occurs always on the same snapshot after start of the NORMAL mode, on the 4th SWF_F2
  - it happens always in the same way: exactly 10.5 s delay

- From Simone’s last measurements with TDS on:
  - TDS “see” the same things as LFR for F0 and F1 (except for the differences of gain, frequency bandwidth and phase)

- Alexis redid the tests he did before but with an *exact* 1Hz clock and found also plenty of synchronizations with the LFR EQM :
  - as for Simone’s tests, the anomalies have the same synchronization delay of 10.5 s,
  - and occur always on the same SWF_F2 after start of the NORMAL mode (for a given periodicity of the snapshots, tests having been done with different values, greater than 22s)

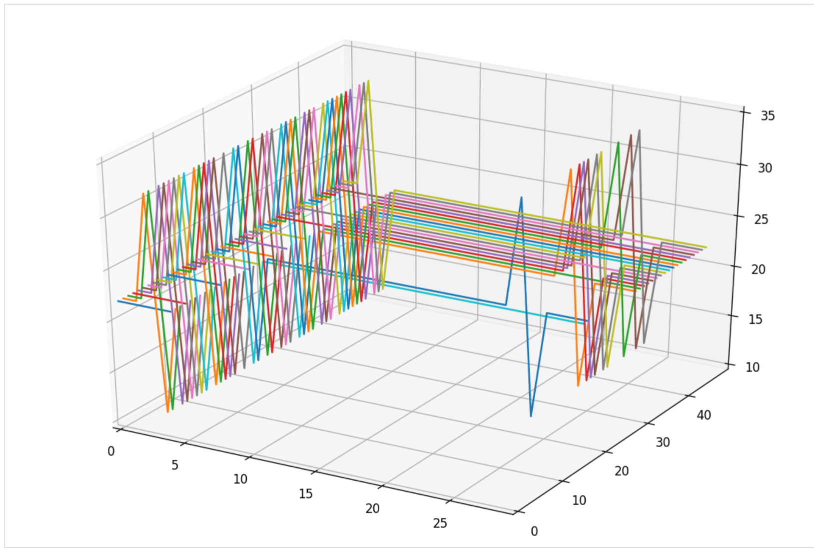


Alexis' desynchronization observations (1)

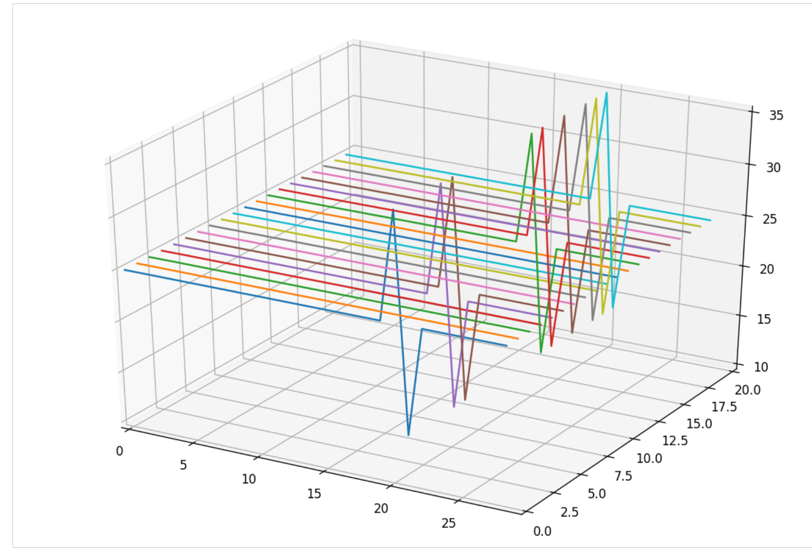


Alexis' desynchronization observations (2)

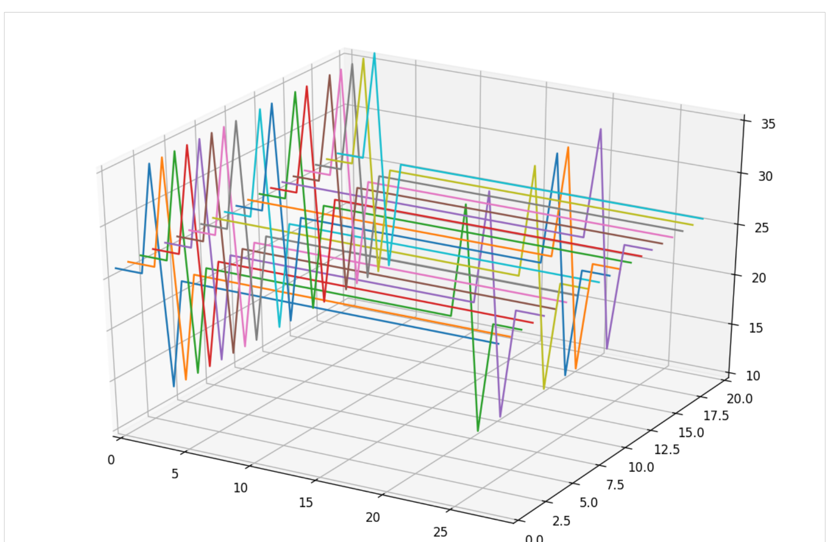
Results with snapshot period = 22 (49 iterations)



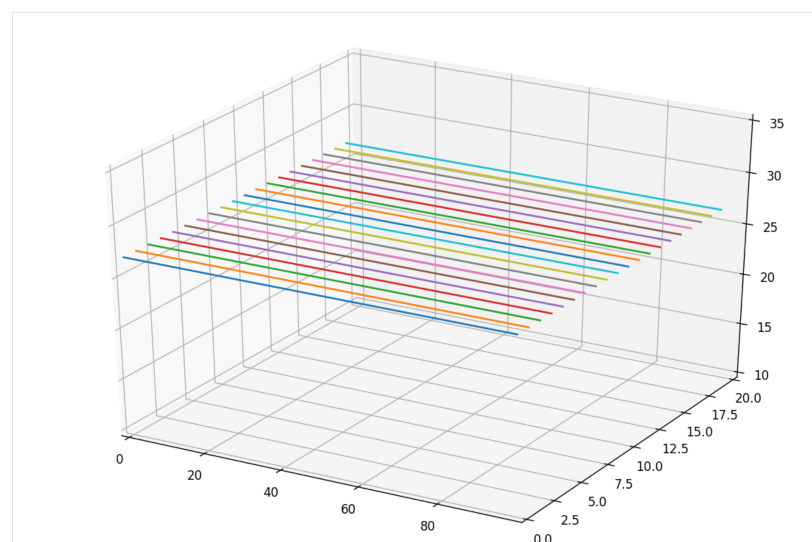
Results with snapshot period = 25 (20 iterations)



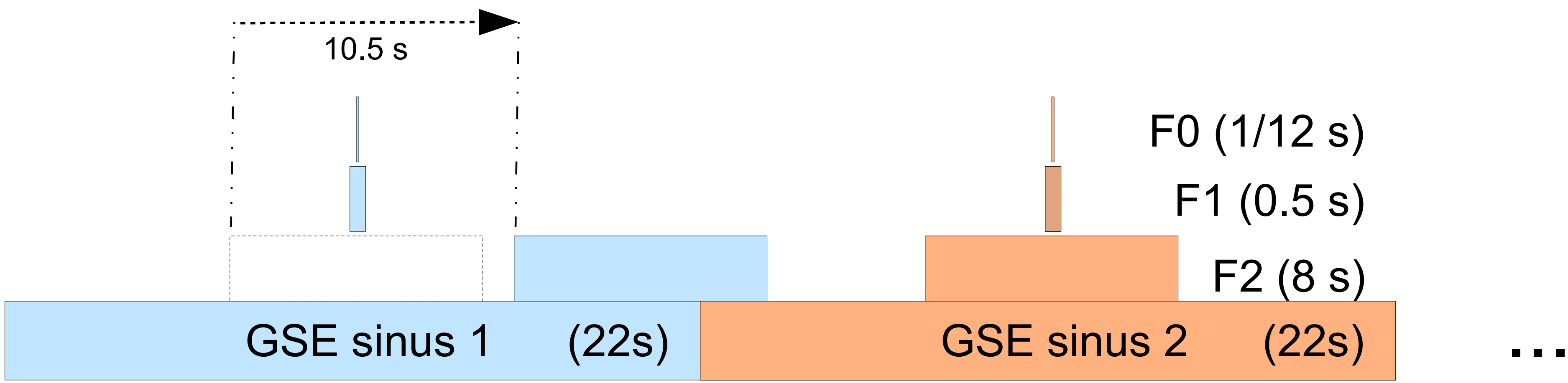
Results with snapshot period = 26 (20 iterations)



Results with snapshot period = 27 (20 iterations)



Snapshot synchronization anomaly (conclusion)



- 2688 / 256Hz = 10.5 s !
- 2688 is the size of the ring buffer used (and also of the snapshot) …
- **the anomaly occurs when the snapshot coincides with a buffer :** the correct time is recorded but the data of the next buffer is taken!

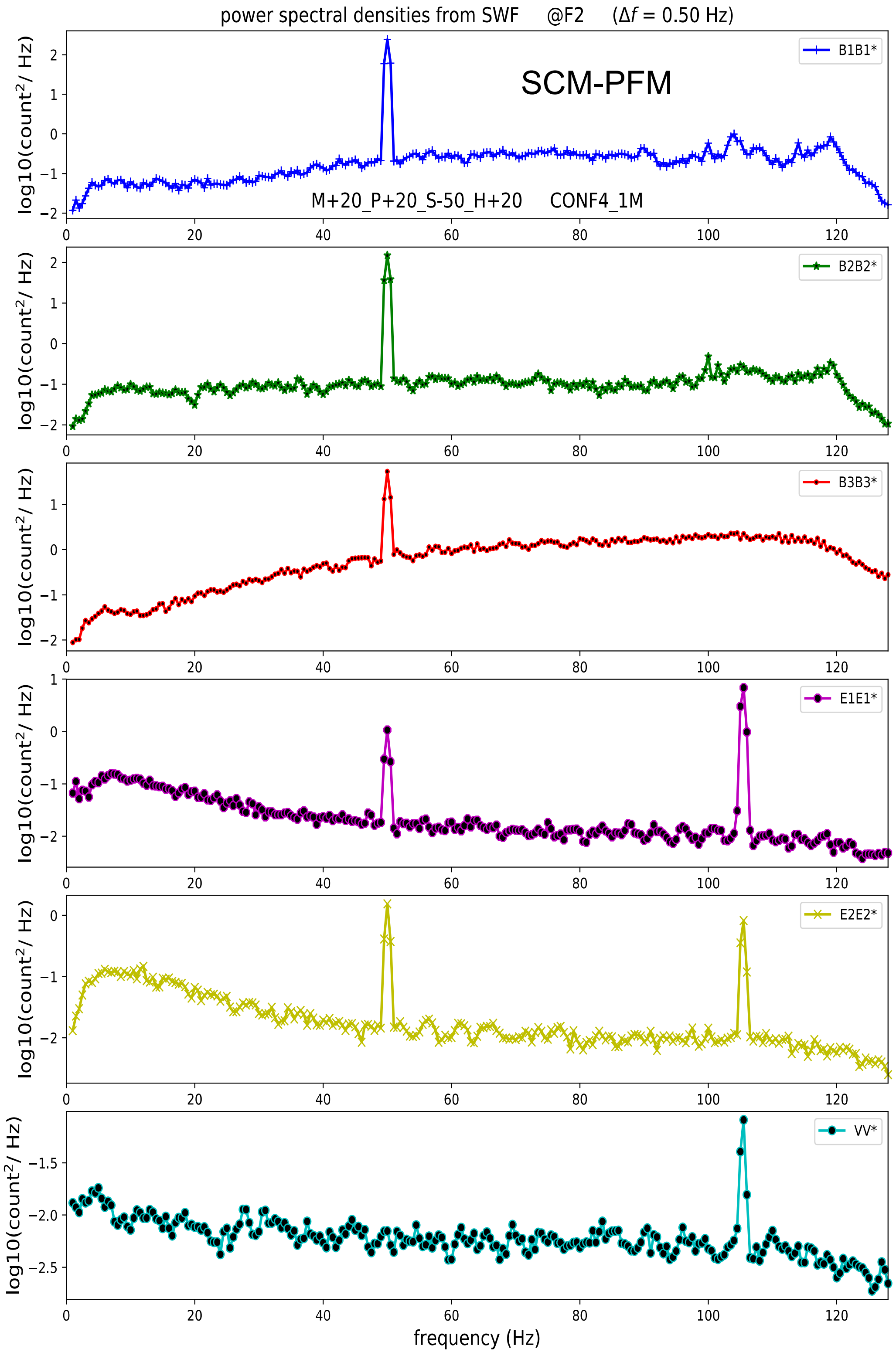
```
    if ( (nbSamplesPart1_asLong >= NB_SAMPLES_PER_SNAPSHOT) | (nbSamplesPart1_asLong < 0) )
    {
        nbSamplesPart1_asLong = 0;
    }
    // copy the part 1 of the snapshot in the extracted buffer
    for ( i = 0; i < (nbSamplesPart1_asLong * NB_WORDS_SWF_BLK); i++ )
    {
        swf_extracted[i] =
                ((int*) ring_node_to_send->buffer_address)[ i + (sampleOffset_asLong * NB_WORDS_SWF_BLK) ];
    }
    // copy the part 2 of the snapshot in the extracted buffer
    ring_node_to_send = ring_node_to_send->next;
    for ( i = (nbSamplesPart1_asLong * NB_WORDS_SWF_BLK); i < (NB_SAMPLES_PER_SNAPSHOT * NB_WORDS_SWF_BLK); i++ )
    {
        swf_extracted[i] =
                ((int*) ring_node_to_send->buffer_address)[ (i-(nbSamplesPart1_asLong * NB_WORDS_SWF_BLK)) ];
    }
```

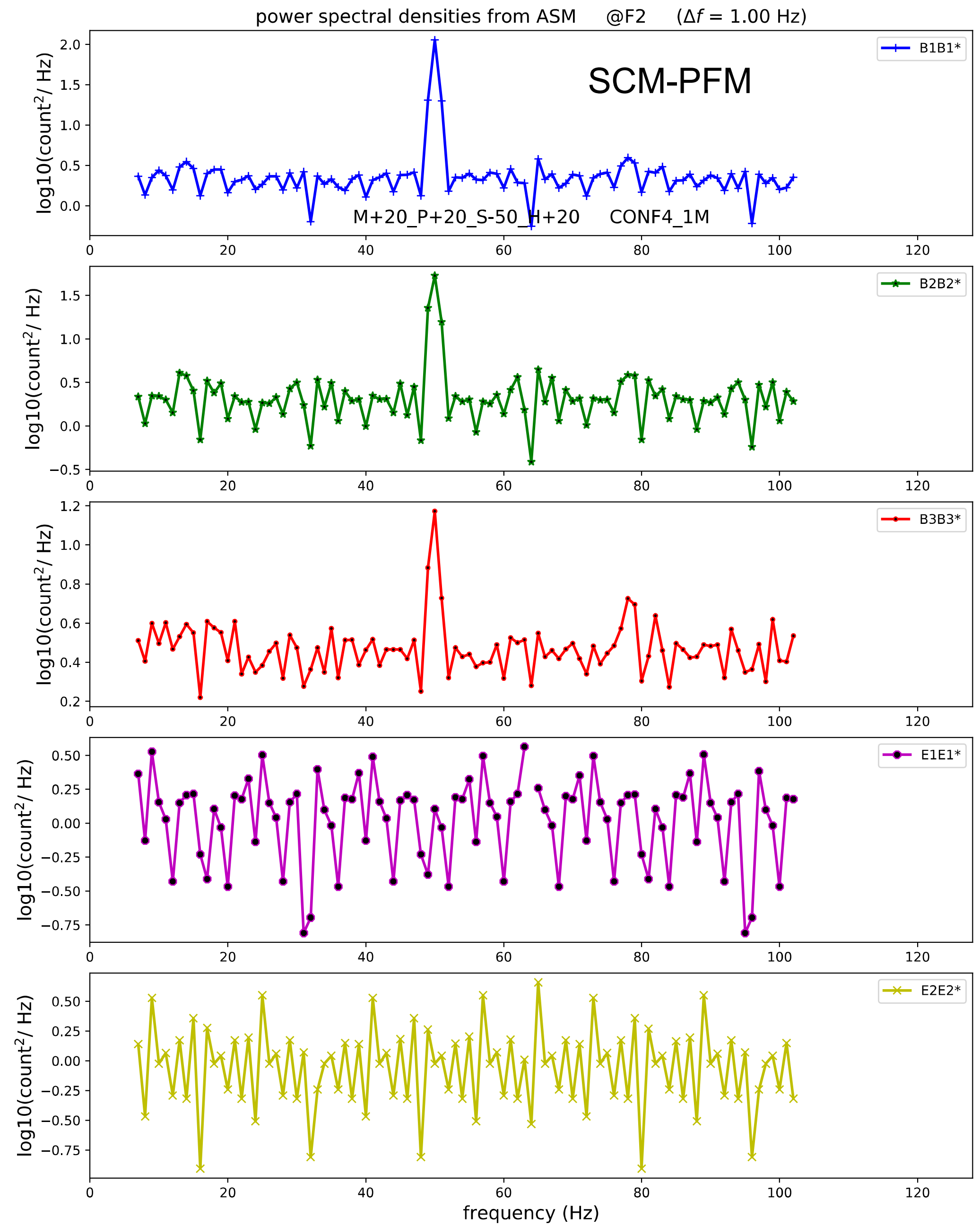
LFR PFM1 (the actual spare model)

- Manufacturing of the LFR spare model was pending up to now ...
- Noise anomaly from LFR ADCs/clock signal observed below -20° has been considered acceptable since the MEB working temperature range will be well above (decision from last team meeting, Nov. 2017, Paris)
- Boot anomaly of LFR (within MEB) when reaching temperatures higher than 50° has been solved: it was caused by a too short timing of the DPU booting sequence ...
- LFR synchronization anomaly is not linked to hardware but to the FSW
- LFR PFM1 board activities have thus restarted !
- The FPGA has been successfully programmed by HIREX (week 22)
- Things are ongoing …
- Optimally, DRB with LESIA in Sept. 2018, with LFR PFM1 board acceptance

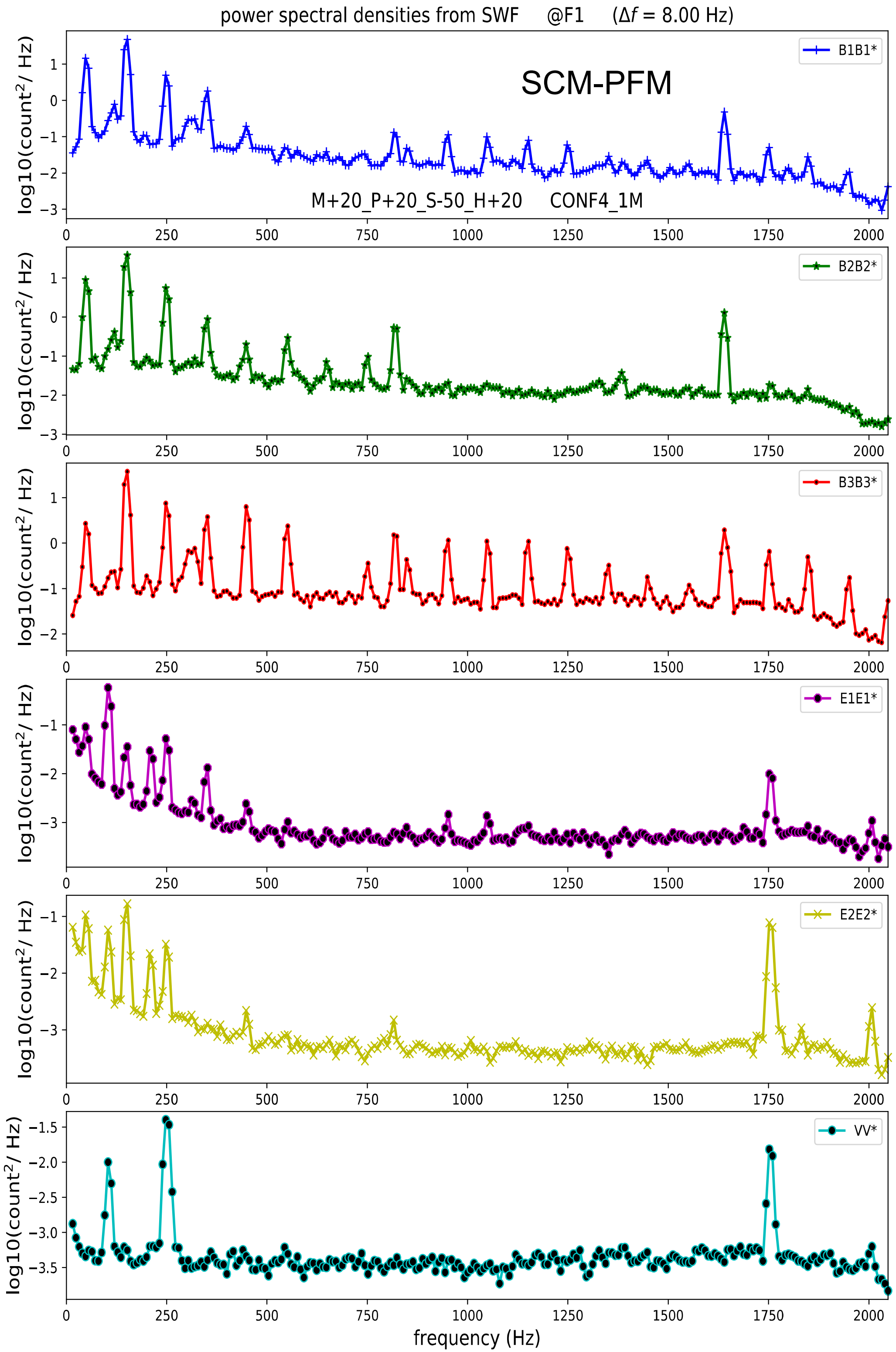
SWF & ASM output noise spectra with SCM-PFM

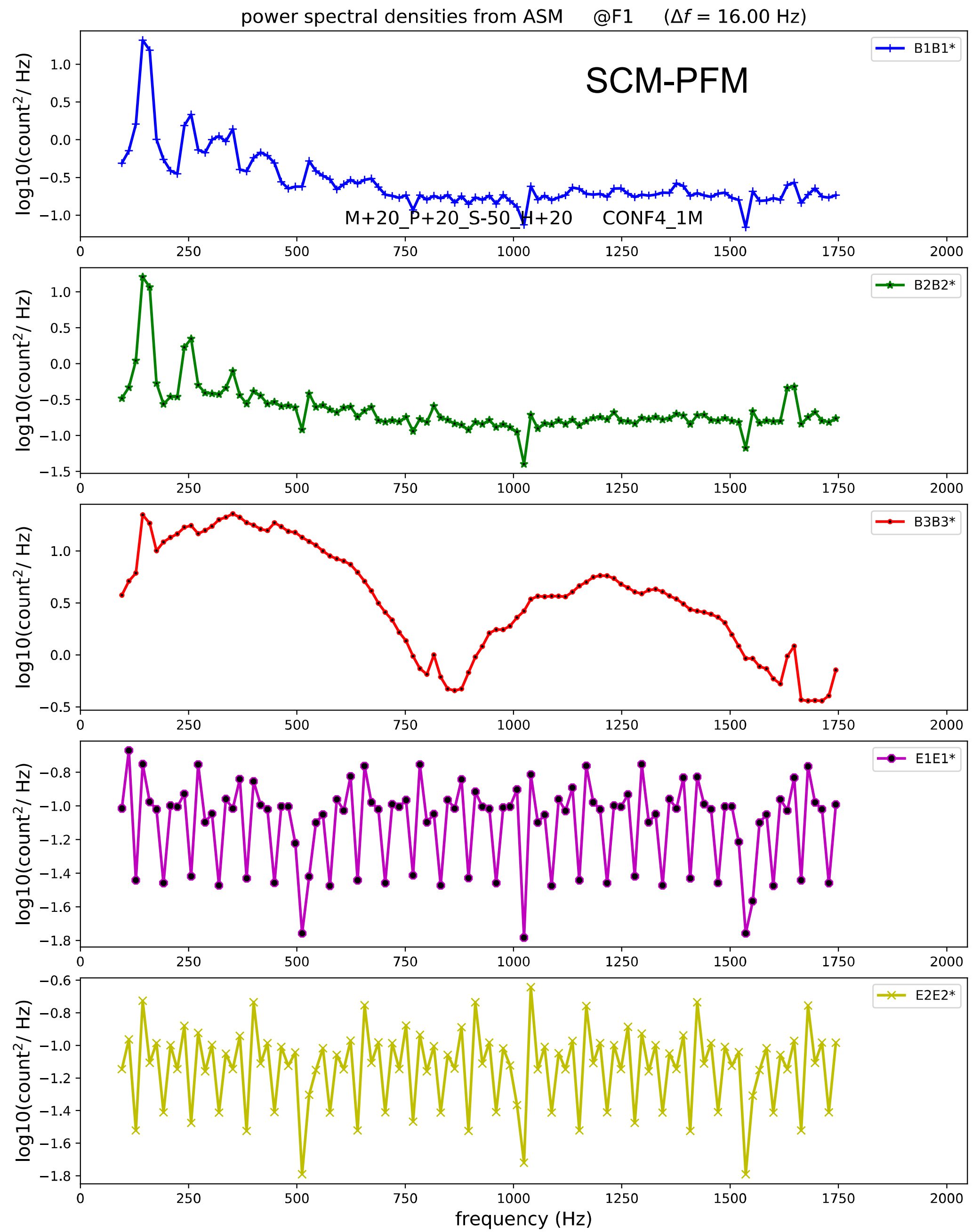
MEB +20°



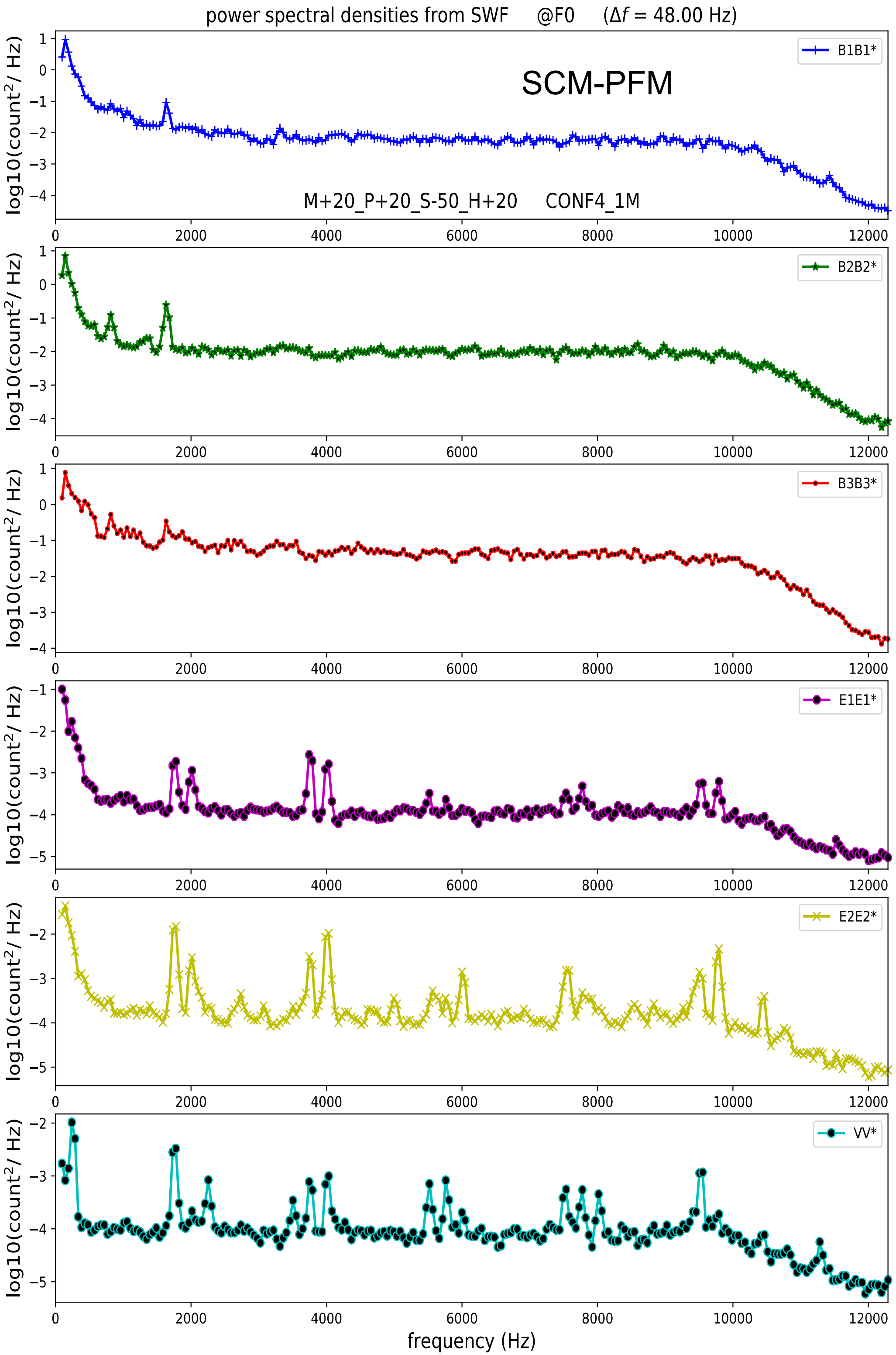


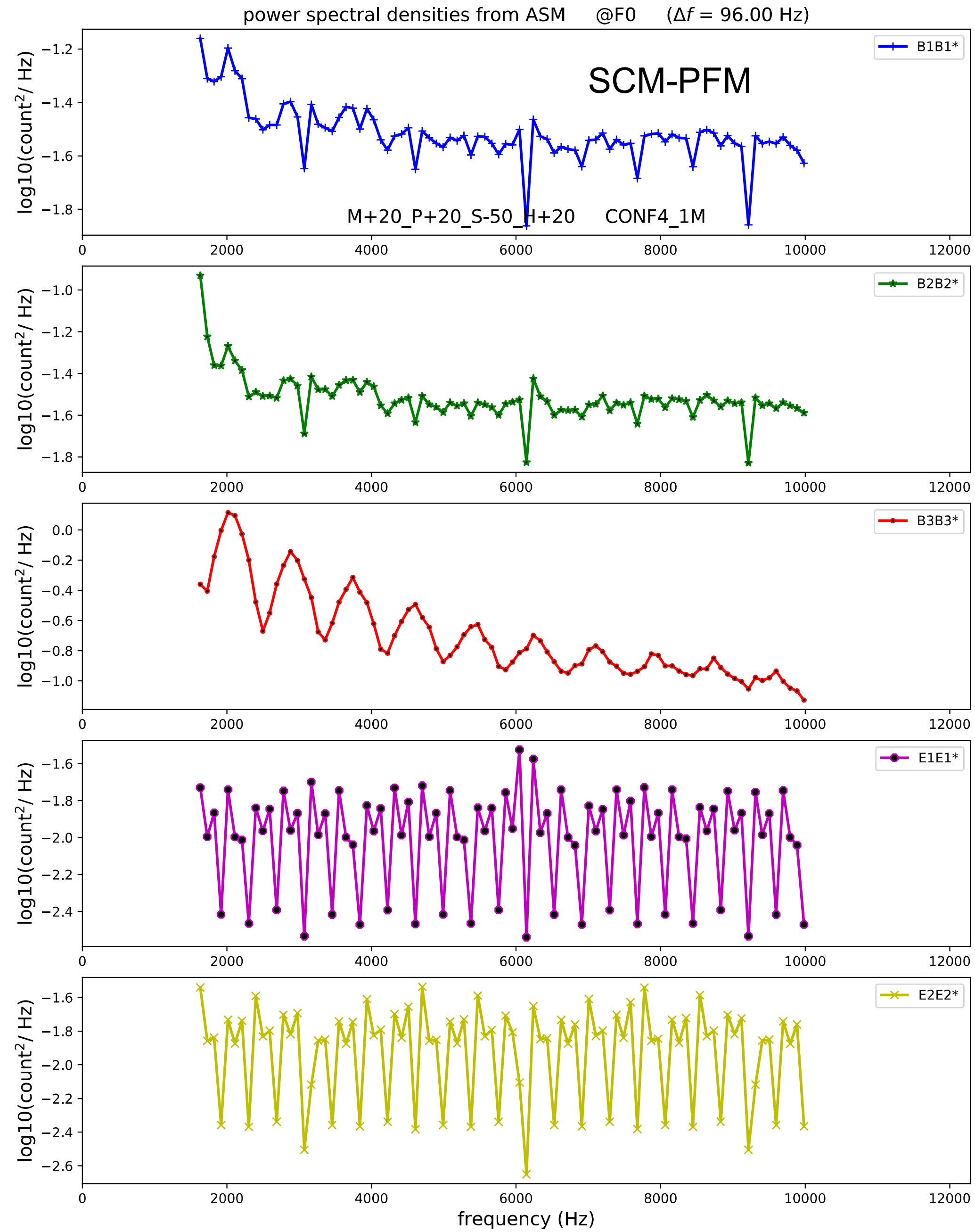
SWF & ASM output noise spectra @F2





SWF & ASM
output noise spectra @F1



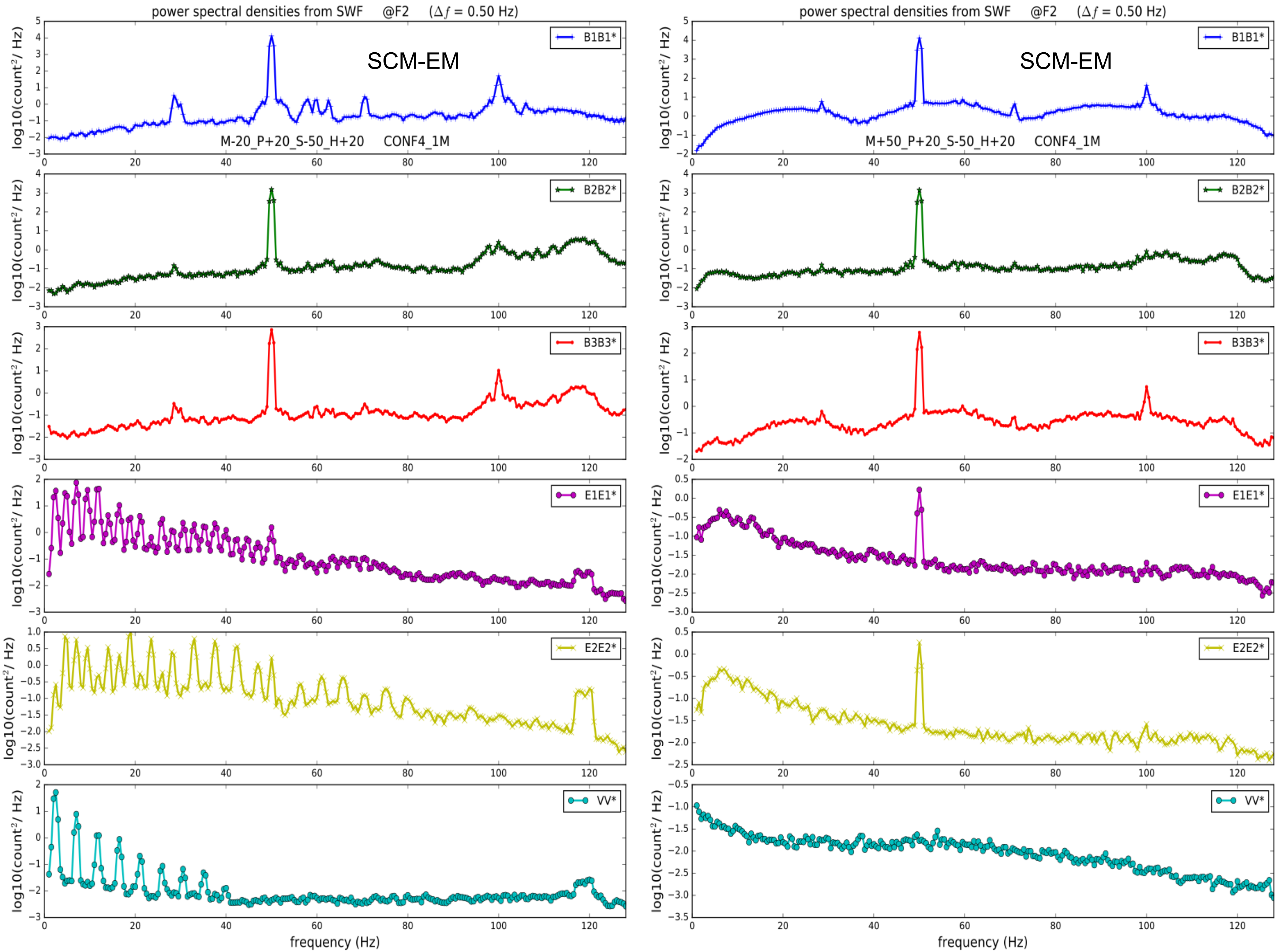


SWF & ASM output noise spectra @F0

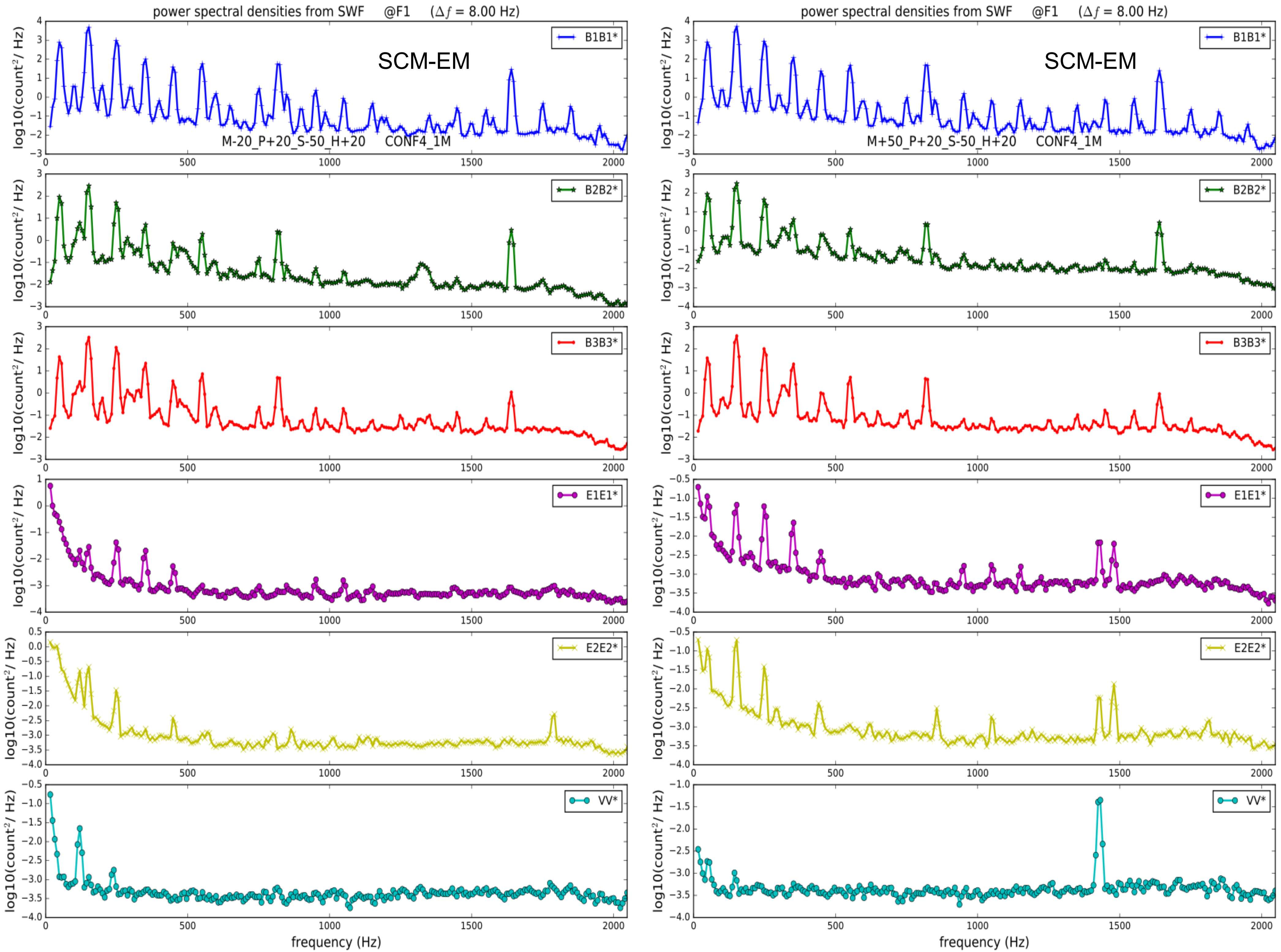
SWF output noise spectra with SCM-EM

MEB [-20°, +50°]

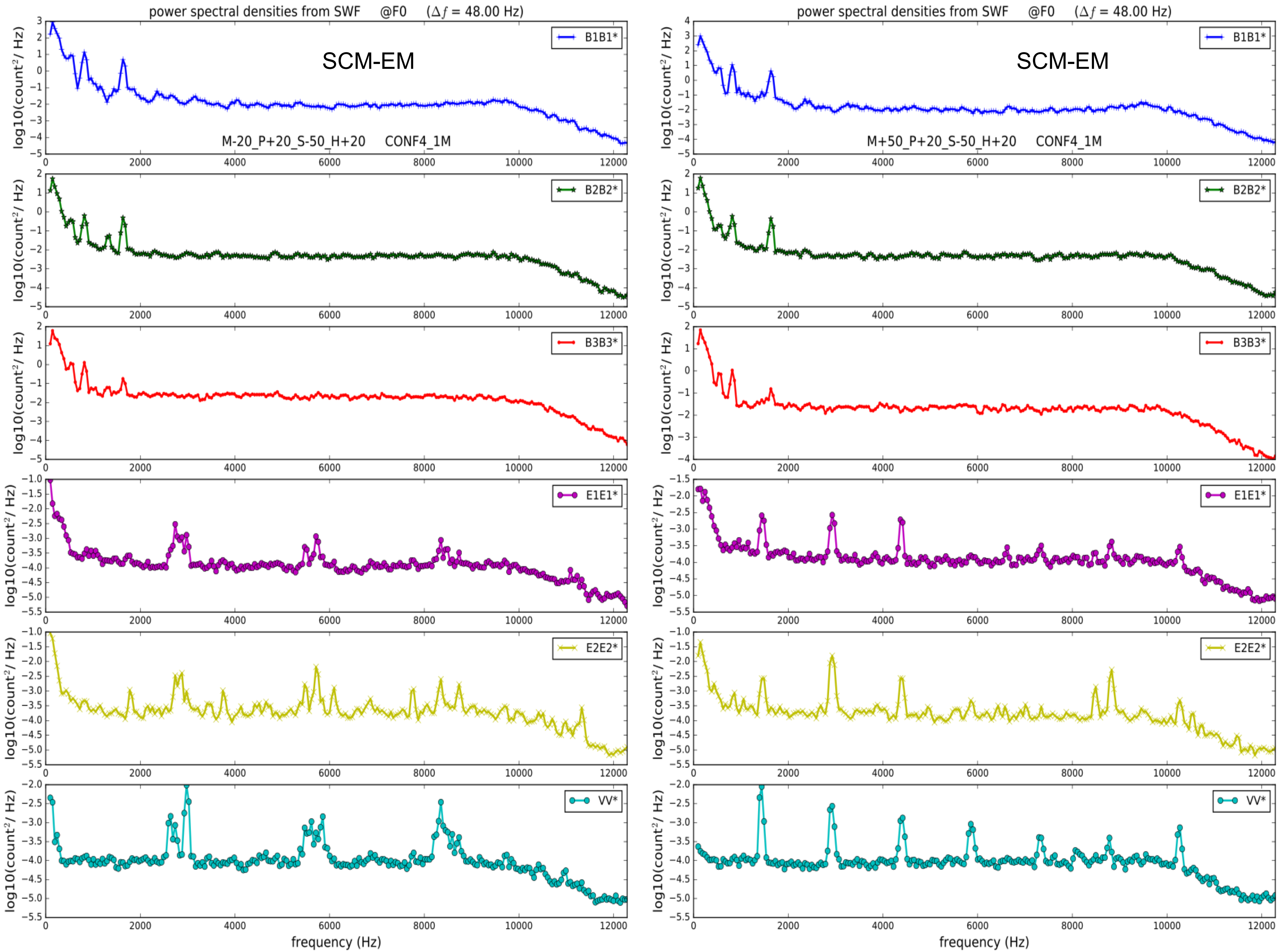
(already shown during the Stockholm's RPW team meeting, June 2017)



power spectral densities from SWF @F2 (Δf = 0.50 Hz)
SCM-EM
M-20_P+20_S-50_H+20 CONF4_1M
M+50_P+20_S-50_H+20 CONF4_1M
B1B1*
B2B2*
B3B3*
E1E1*
E2E2*
VV*
log10(count²/ Hz)
frequency (Hz)



power spectral densities from SWF @F1 (Δf = 8.00 Hz)
SCM-EM
M-20_P+20_S-50_H+20 CONF4_1M
M+50_P+20_S-50_H+20 CONF4_1M
B1B1*
B2B2*
B3B3*
E1E1*
E2E2*
VV*
log10(count²/ Hz)
frequency (Hz)

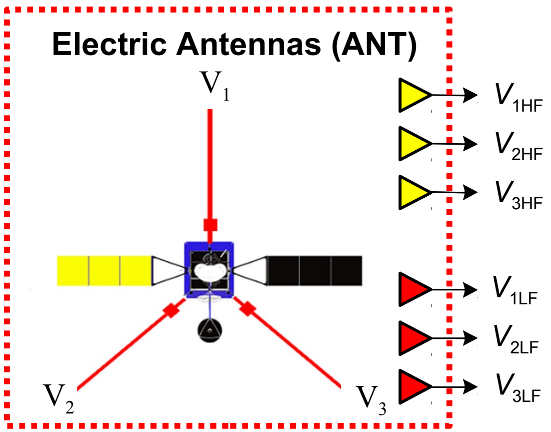


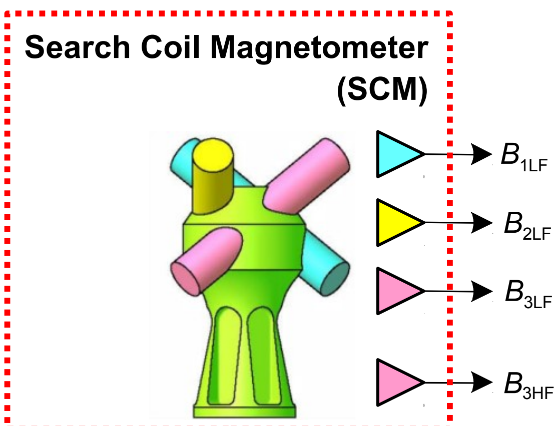
power spectral densities from SWF @F0 (Δf = 48.00 Hz)
SCM-EM
M-20_P+20_S-50_H+20 CONF4_1M
B1B1*
B2B2*
B3B3*
E1E1*
E2E2*
VV*
log10(count^2/ Hz)
frequency (Hz)
power spectral densities from SWF @F0 (Δf = 48.00 Hz)
SCM-EM
M+50_P+20_S-50_H+20 CONF4_1M
B1B1*
B2B2*
B3B3*
E1E1*
E2E2*
VV*
log10(count^2/ Hz)
frequency (Hz)

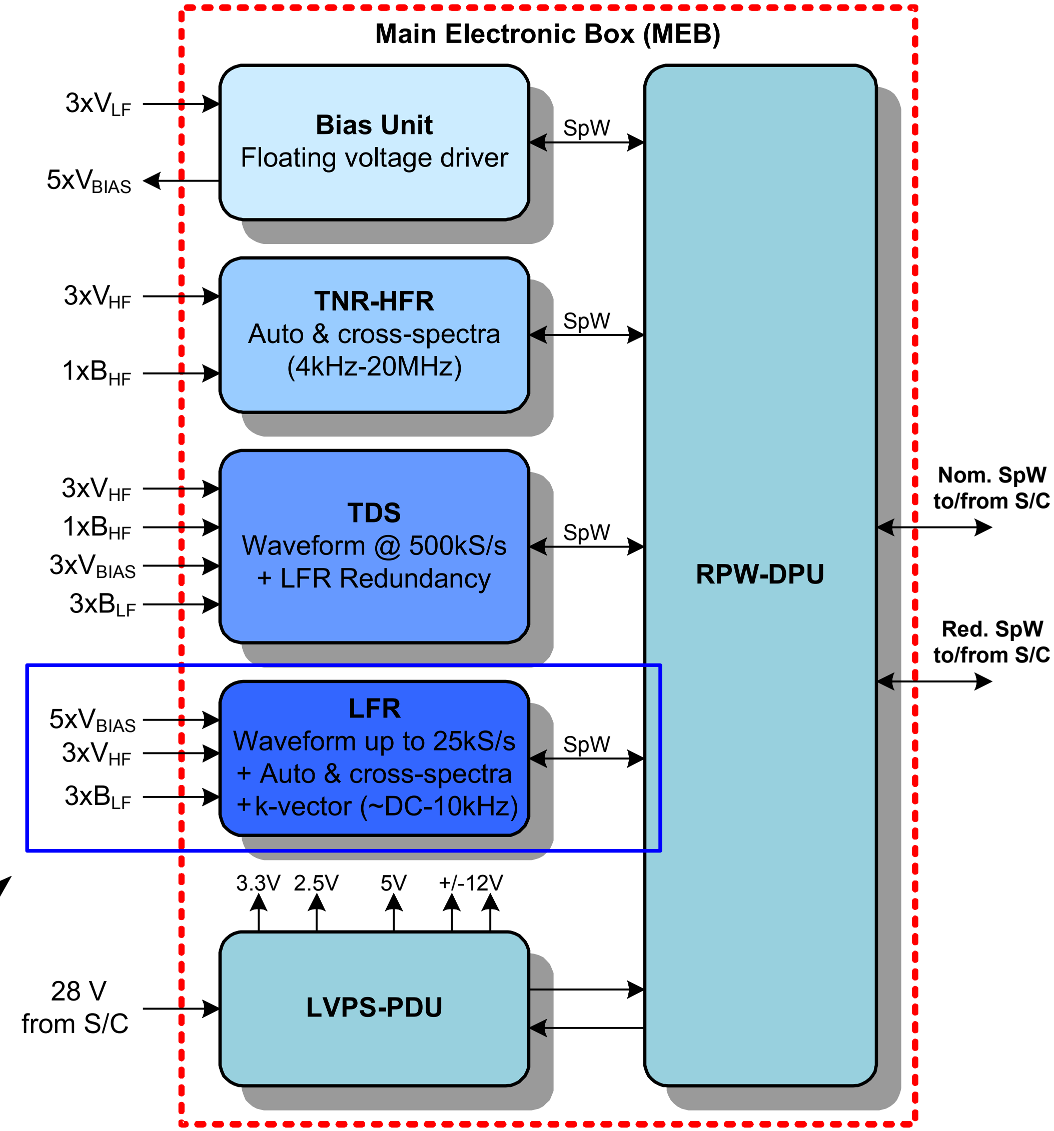
Additional slides

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***

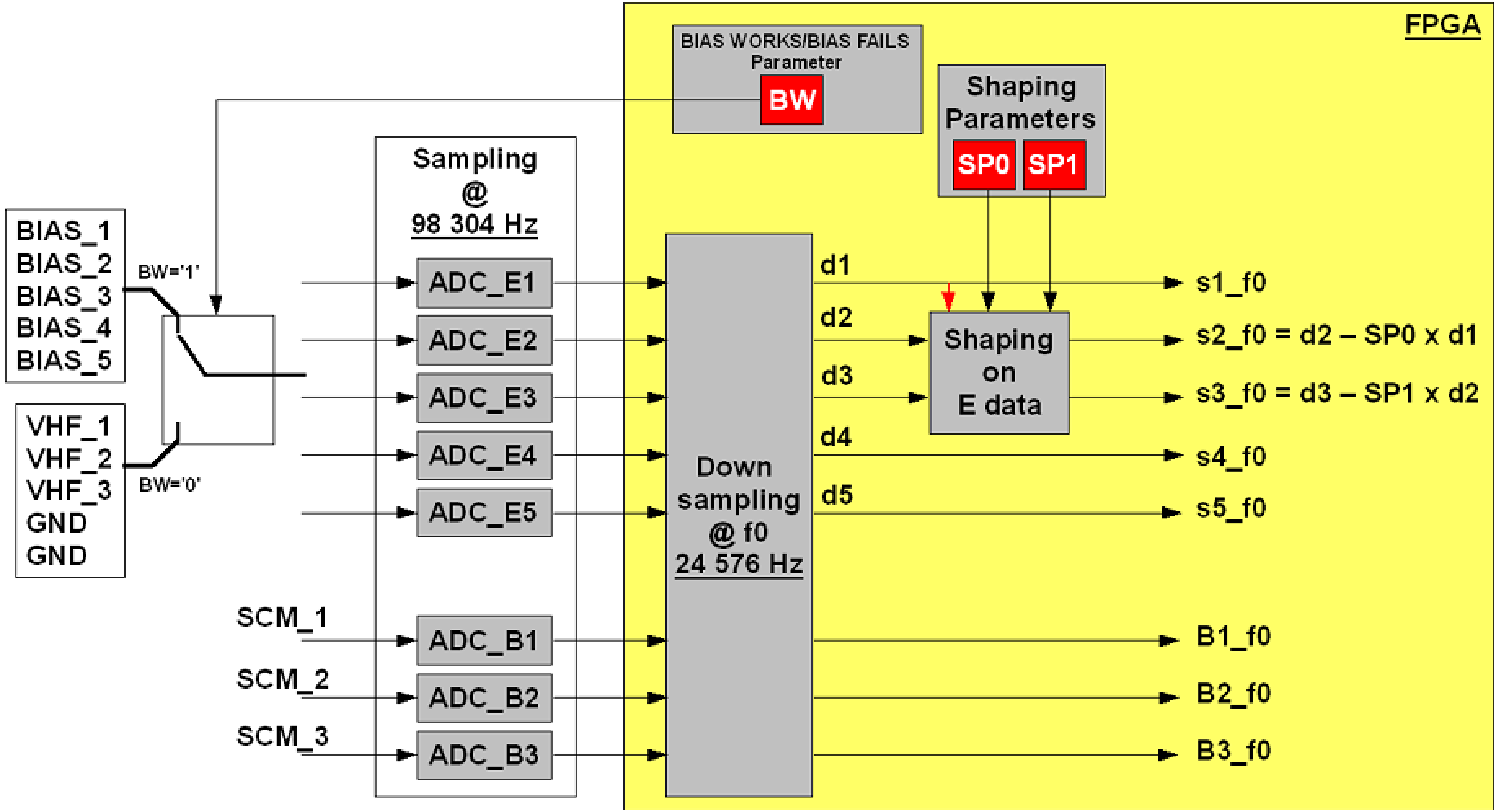




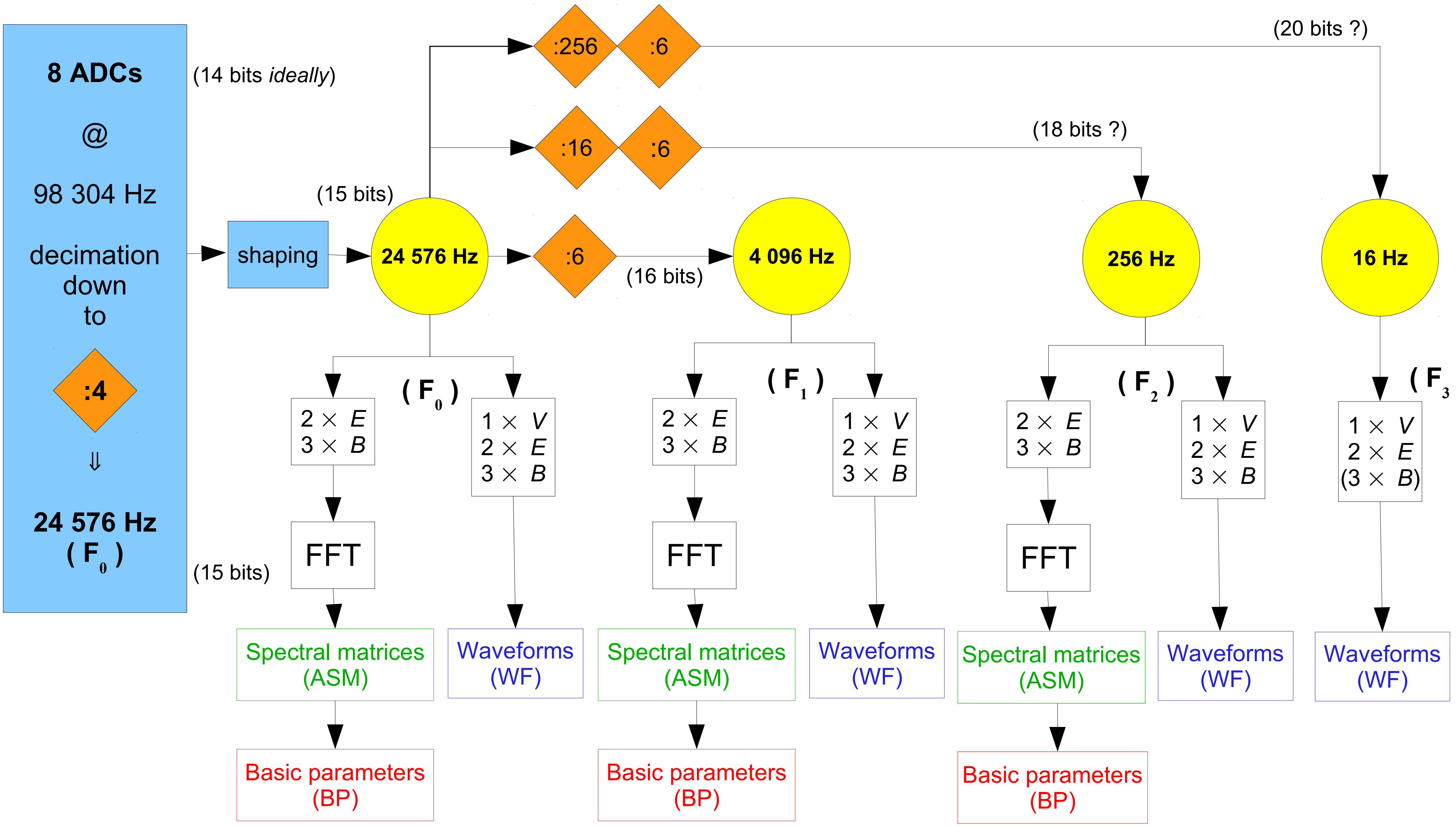


Low Frequency Receiver

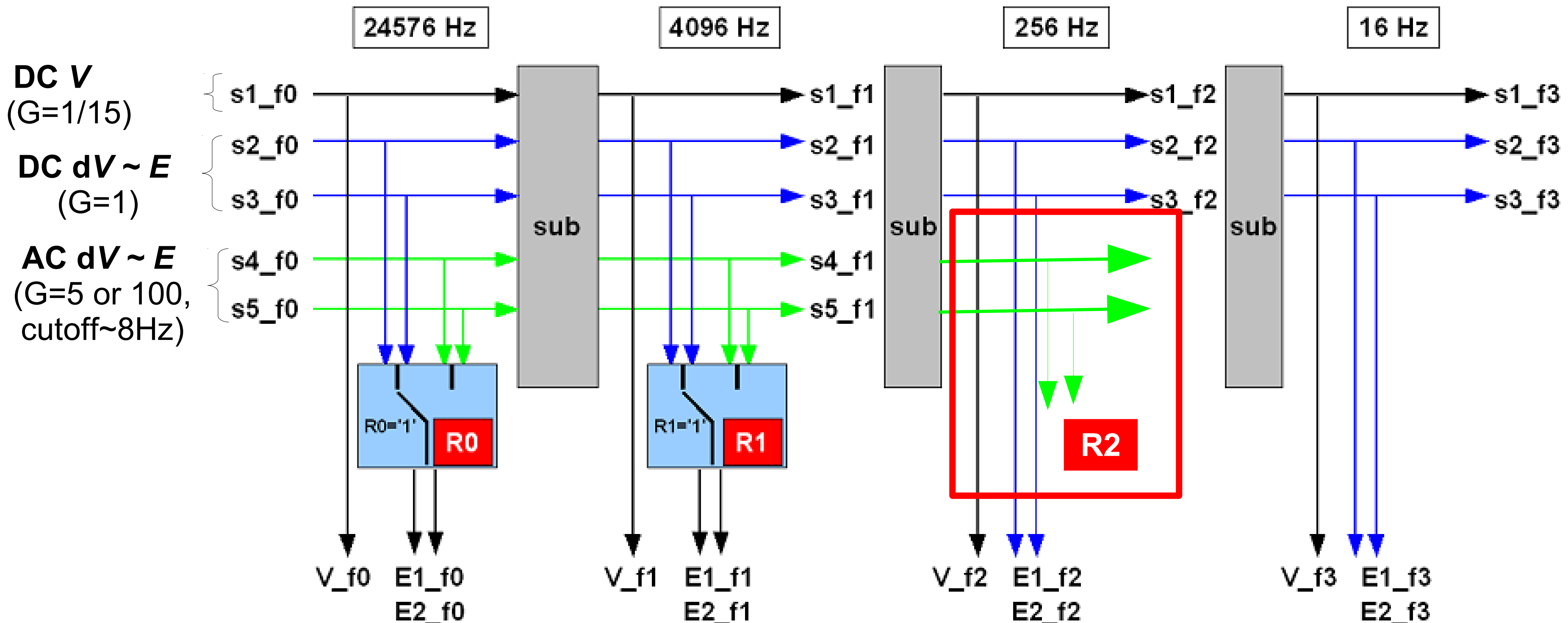
LFR 11 analogue inputs



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**

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)

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

***Frequency* average ...**

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

... 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 Spectral Frequencies

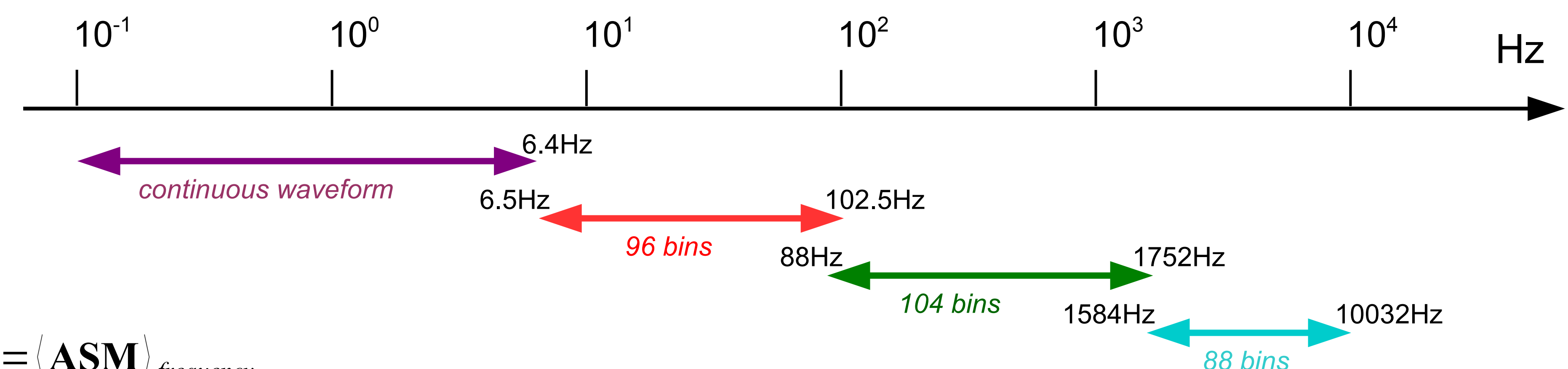
(1) Depending on the frequency channel, **selection** of 96, 104 or 88 consecutive **frequency bins** among 128 (N_{FFT} = 256) of the *time* averaged spectral matrices.

(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

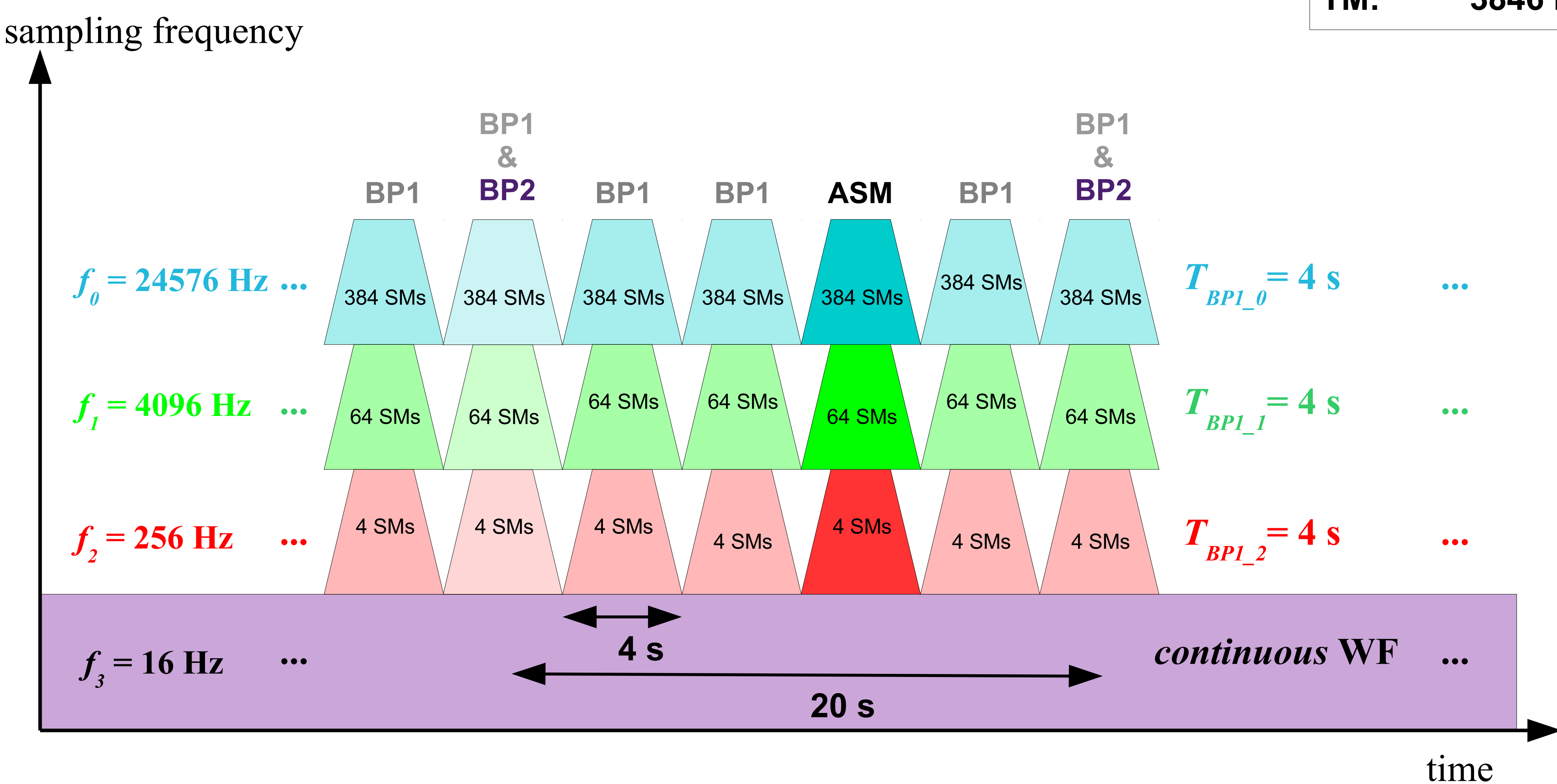


$$\mathbf{S} = \langle \mathbf{ASM} \rangle_{frequency}$$

LFR Normal Mode (1)

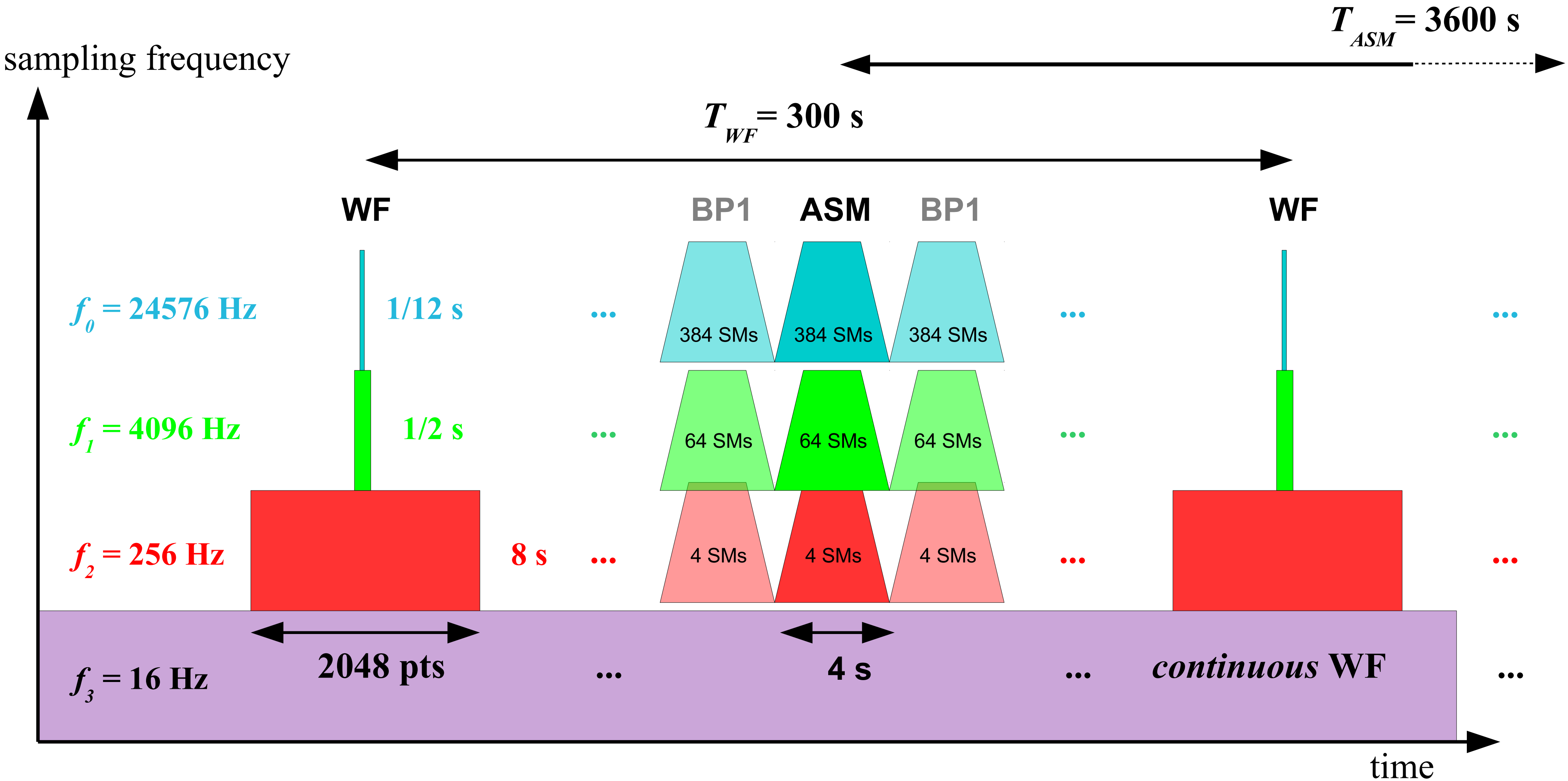
BP:	1080 bps
WF:	2734 bps
ASM:	32 bps
TM:	3846 bps

Basic Parameters



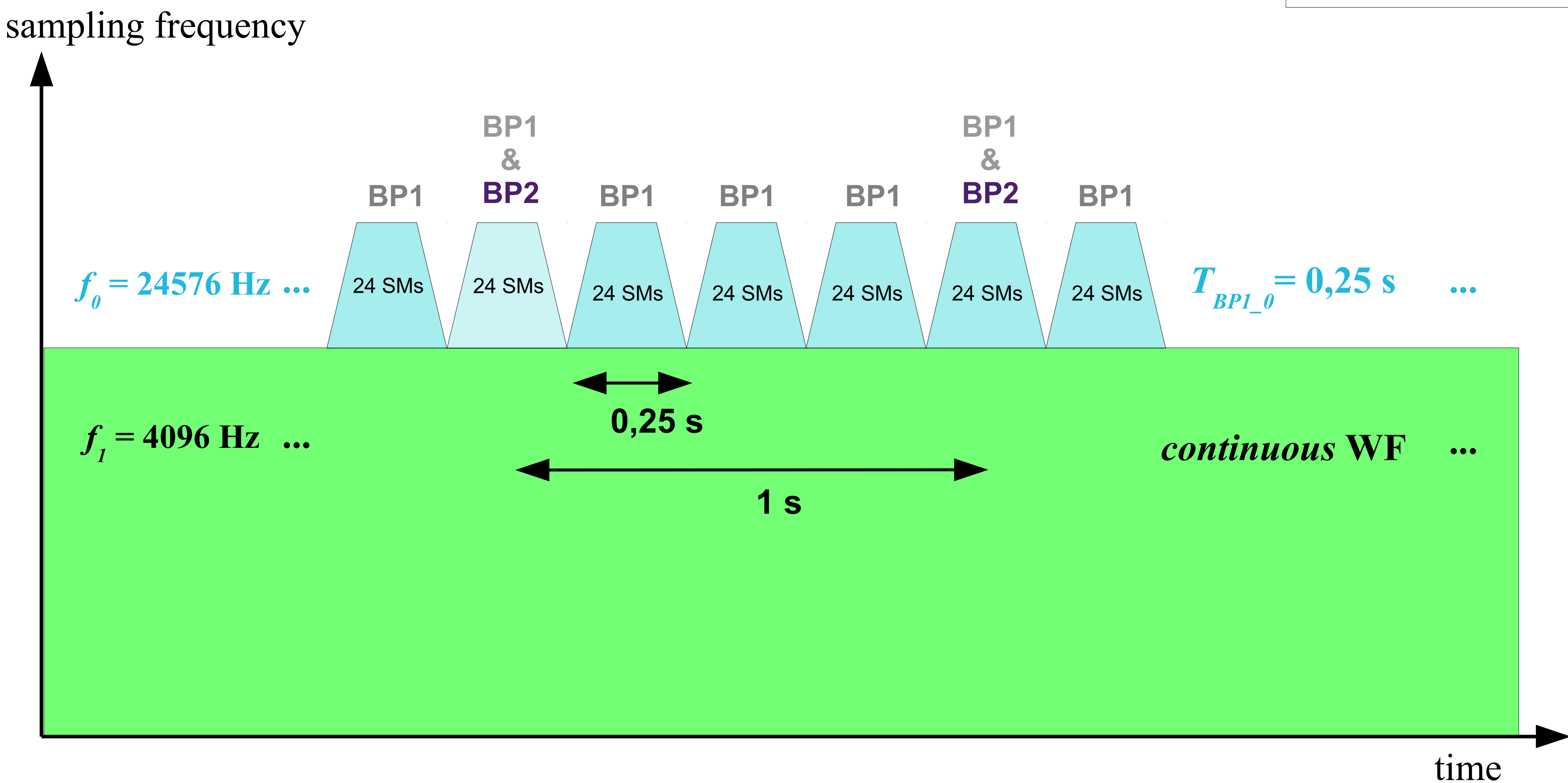
LFR Normal Mode (2)

WaveForms & Averaged Spectral Matrices



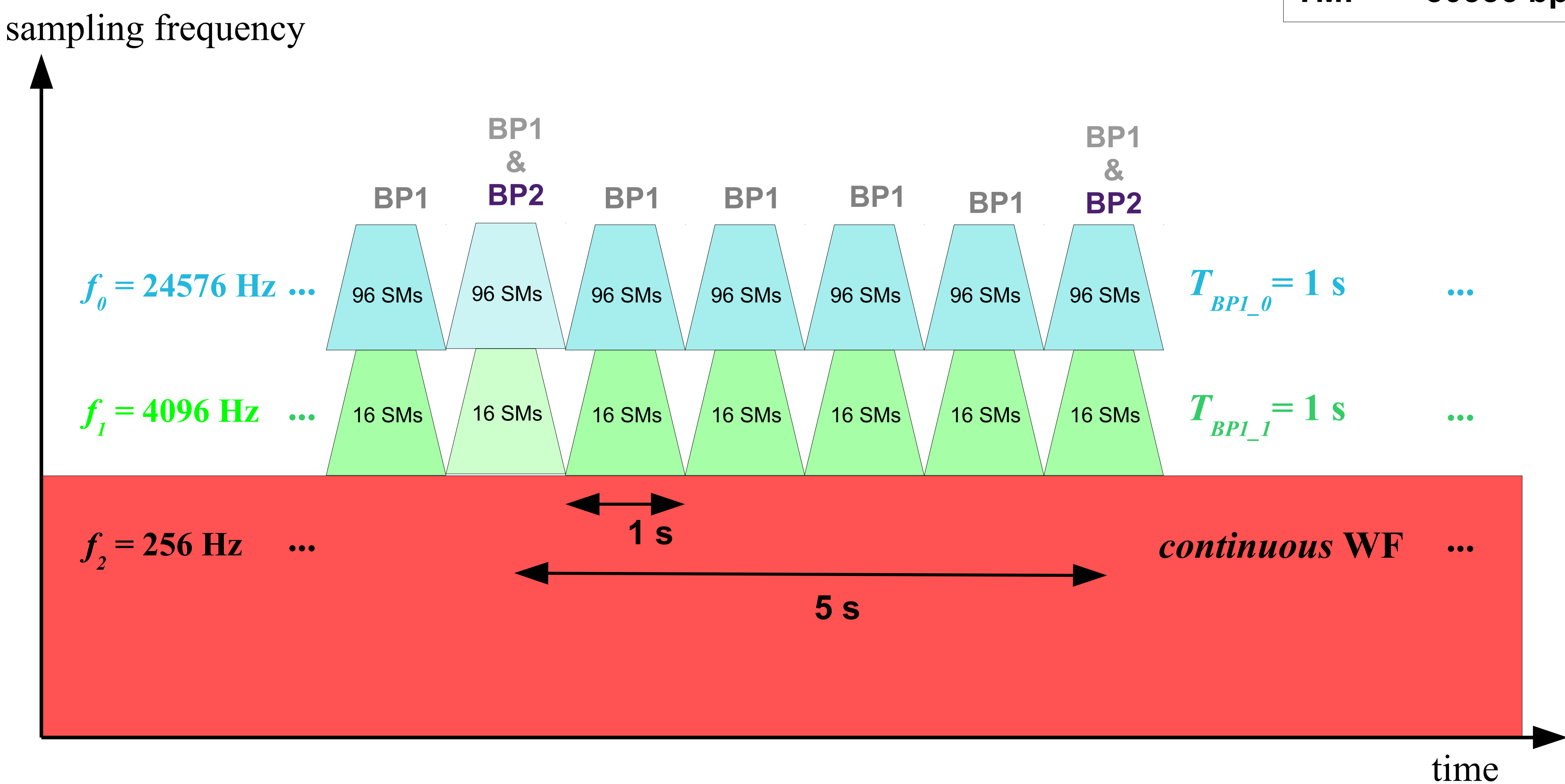
LFR Selected Burst Mode 1

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