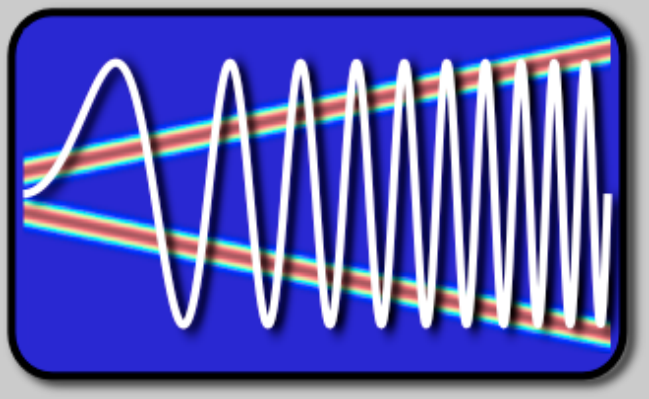
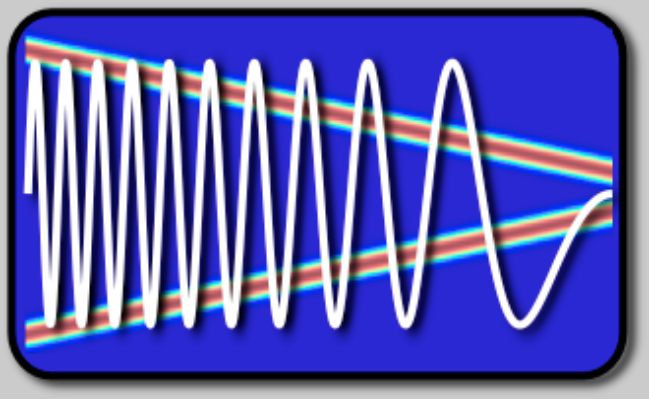


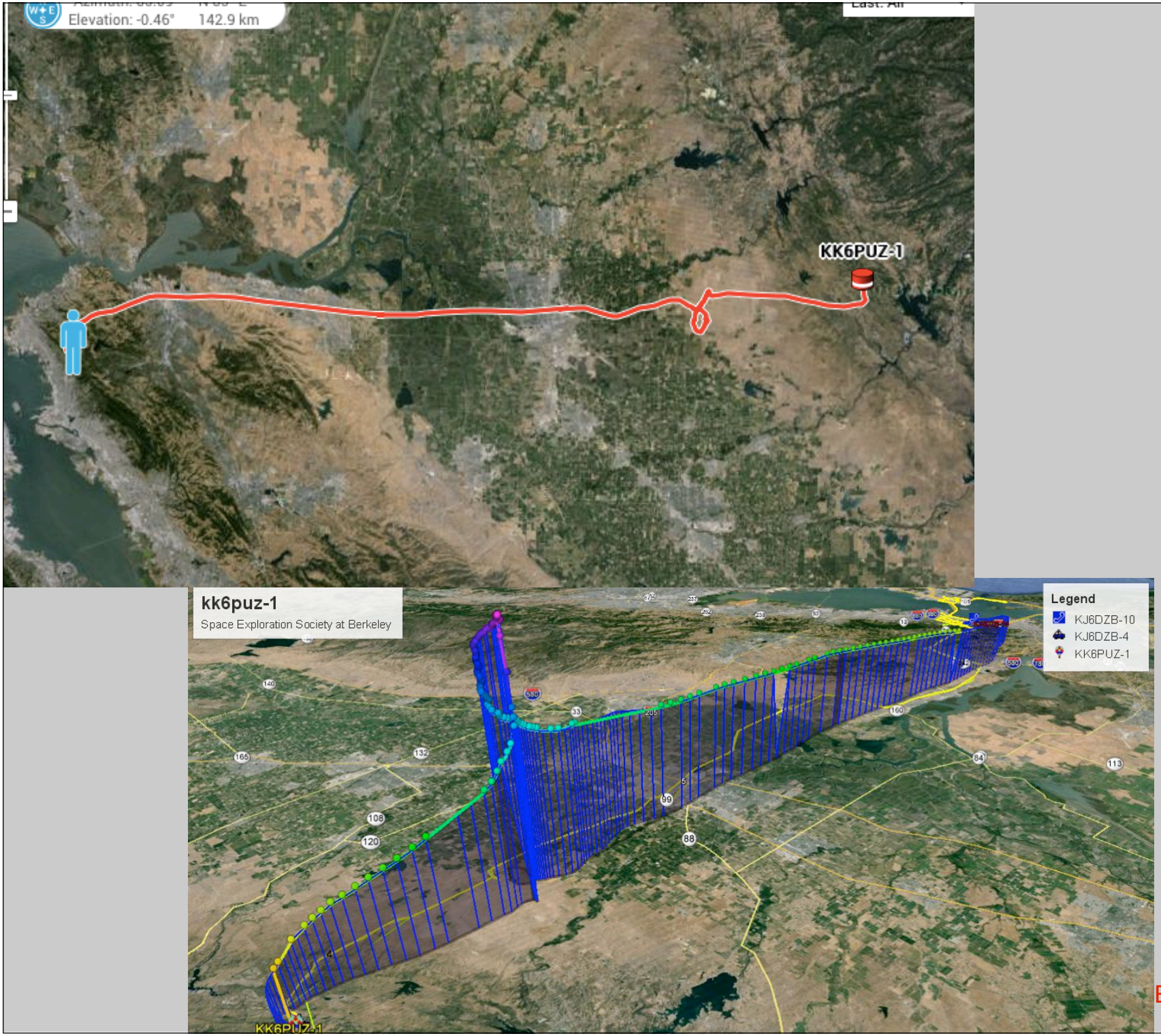
EE123



Digital Signal Processing

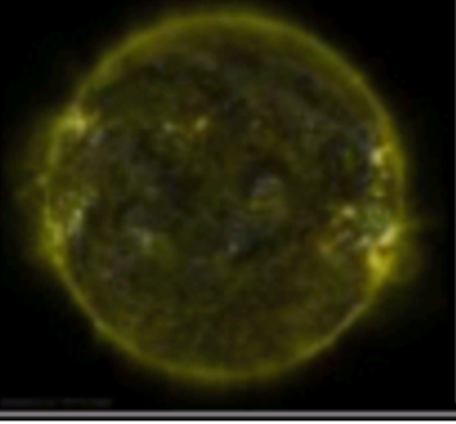
Lecture 22
Lab 4: Frequency Calibration using GSM
Compressed Sensing

M. Lustig, EECS UC Berkeley

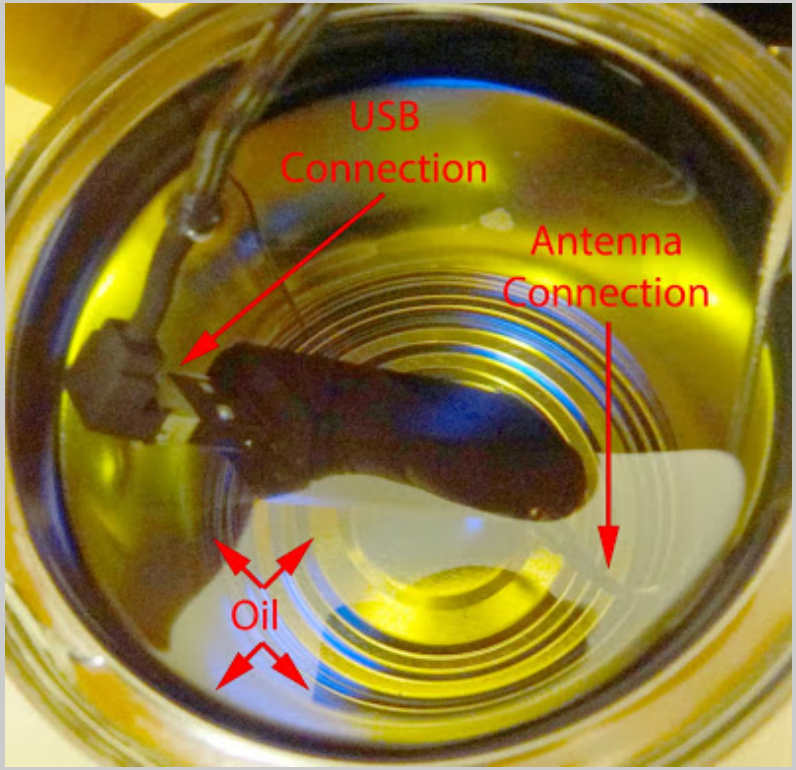


EECS UC Berkeley

Solar-Terrestrial Data/Predictions at www.qrz.com

18 Mar 2015 1500 GMT		Current Solar	Band	Day	Night
SFI 116	SN 060		80m-40m	Poor	Poor
A 116	K 5		30m-20m	Poor	Poor
XRY C1.4	304A 142.6		17m-15m	Fair	Fair
Aur 5	Lat 62.5°		12m-10m	Poor	Poor
Bz -0.3	SW 561.5		Geomag Field	MIN	STRM
PF 0.1	EF 651.0		Sig Noise Lvl	S4-S6	
MUF Bdr 17.16	@ 1445		CME (UTC)	None	
EME Deg	Good		(C) P Herrman NONBH 2013		

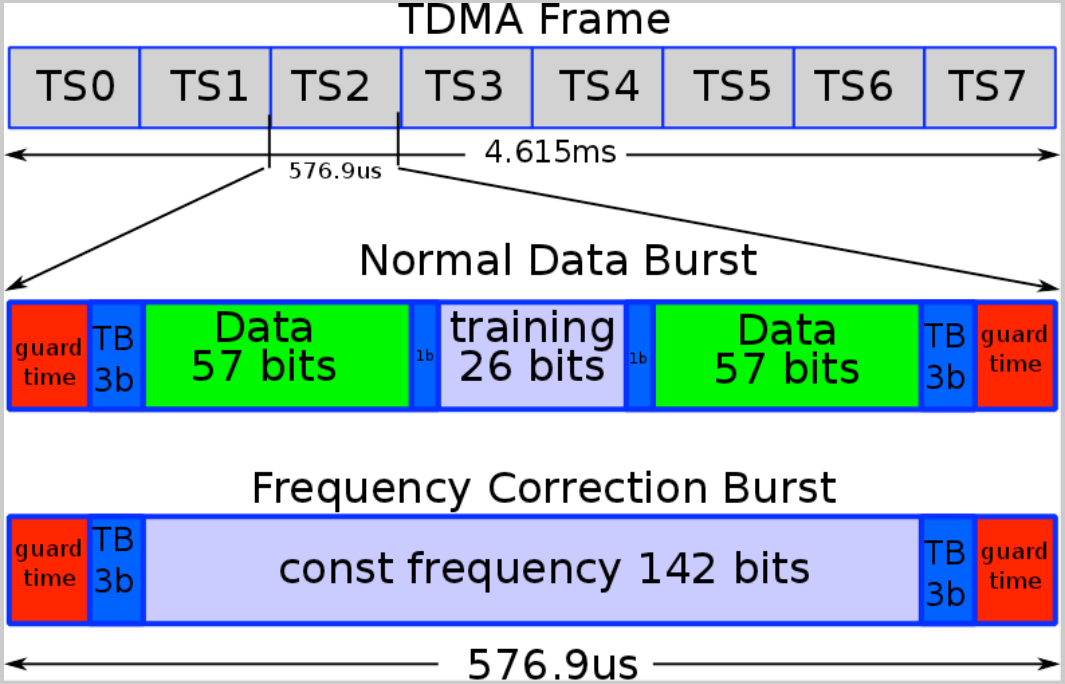
- SDR crystal oscillator has often has offset
- Also drifts with temperature
- Cellphones do the same!
- GSM protocol has built in synchronizations



http://sdrformariners.blogspot.com/2013/12/cooling.html

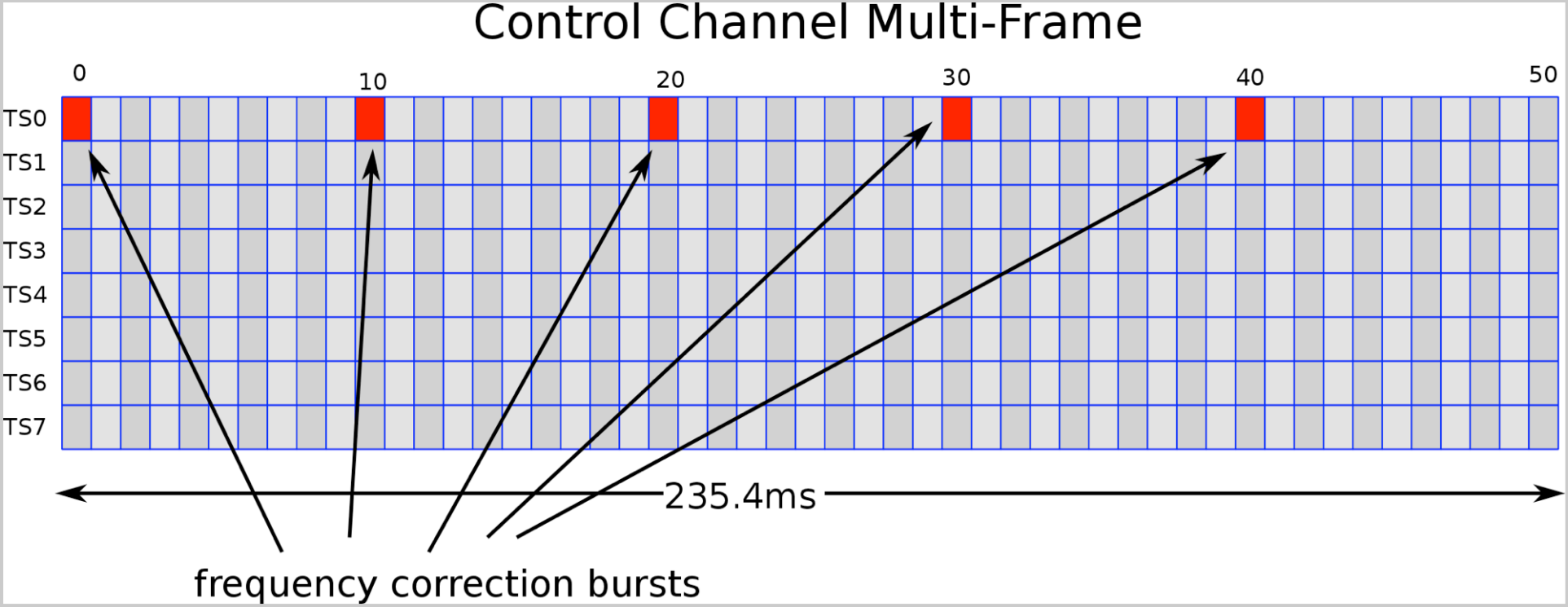
GSM-850

- Frequencies 200KHz channels
  - –Uplink 824-849
  - –Downlink 869-849
- TDMA: Time division multiple access

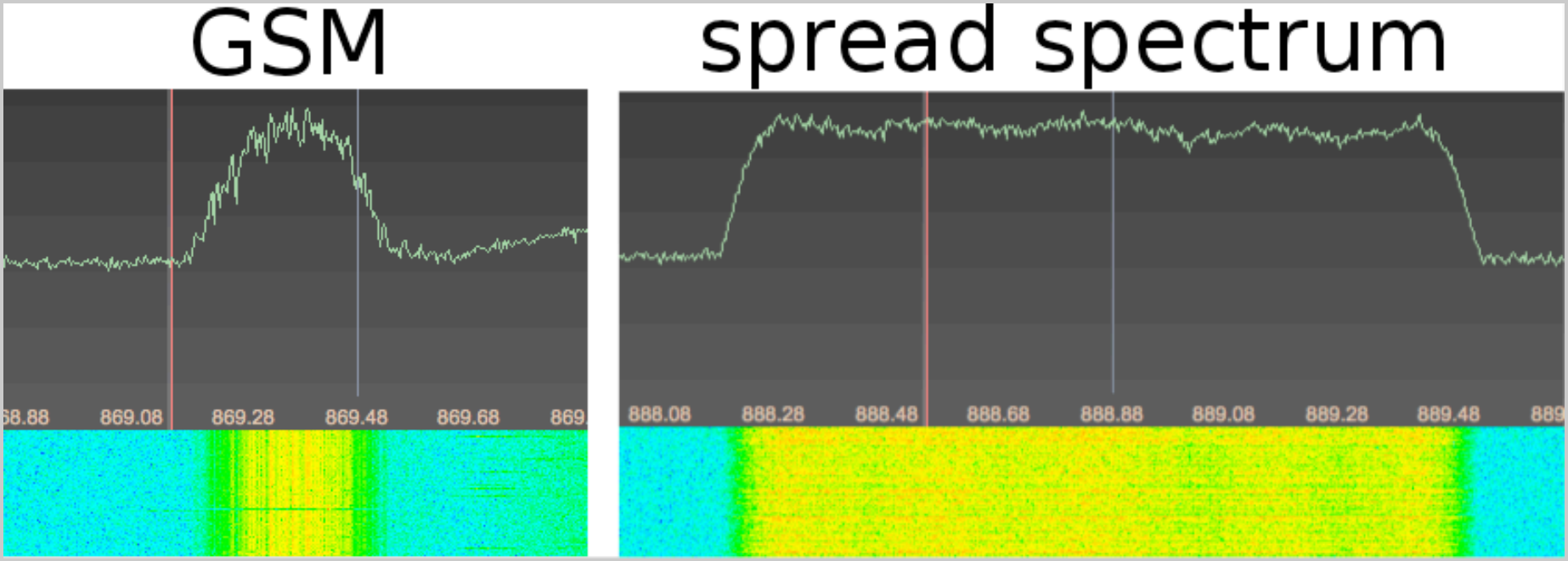


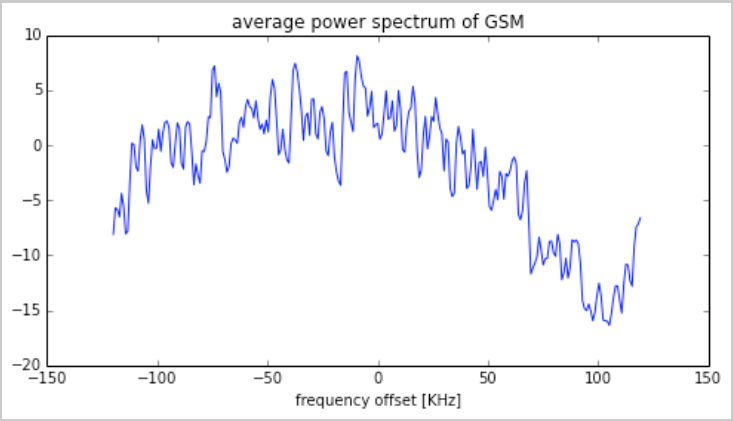
GSM Frequency Correction Channel

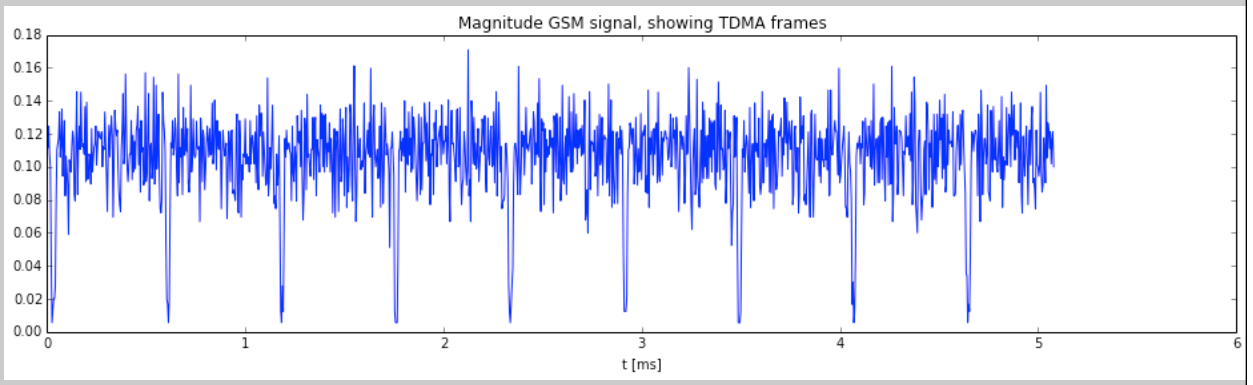
- Pure frequency bursts @67.7083KHz



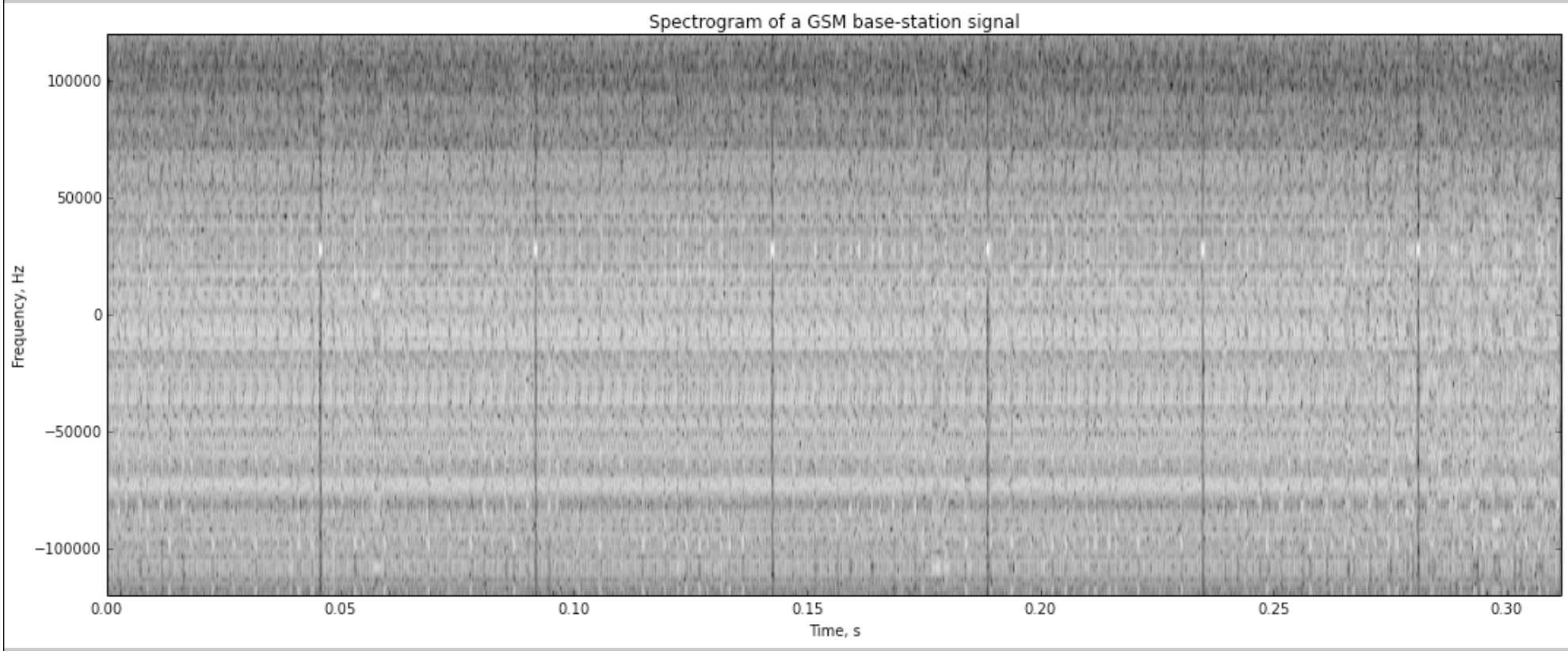
How to find GSM Base Stations





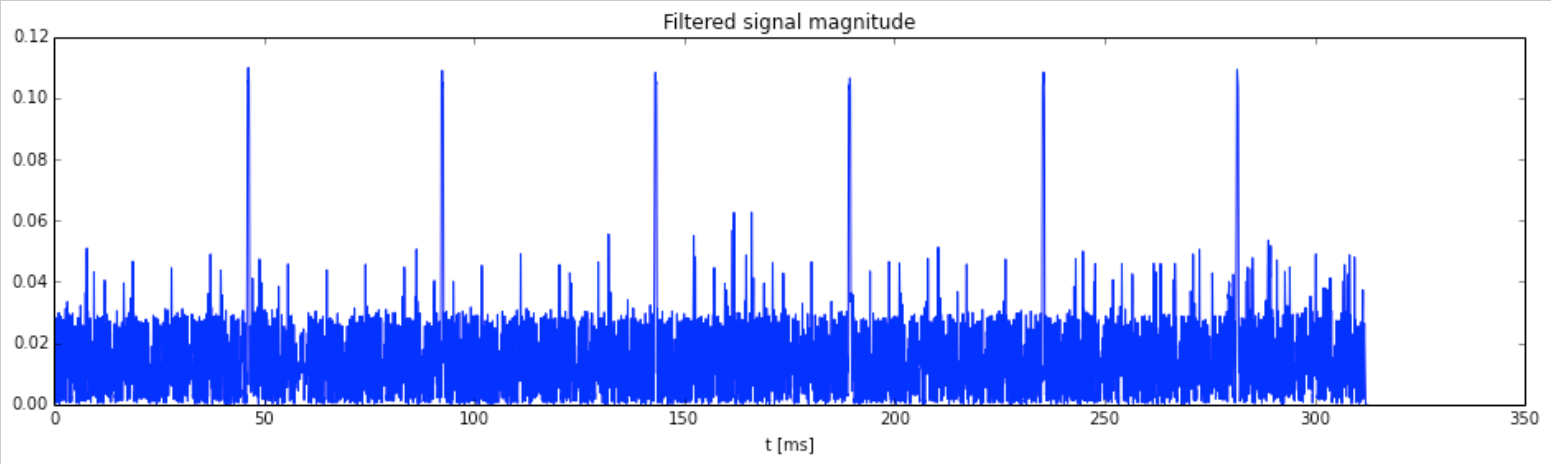


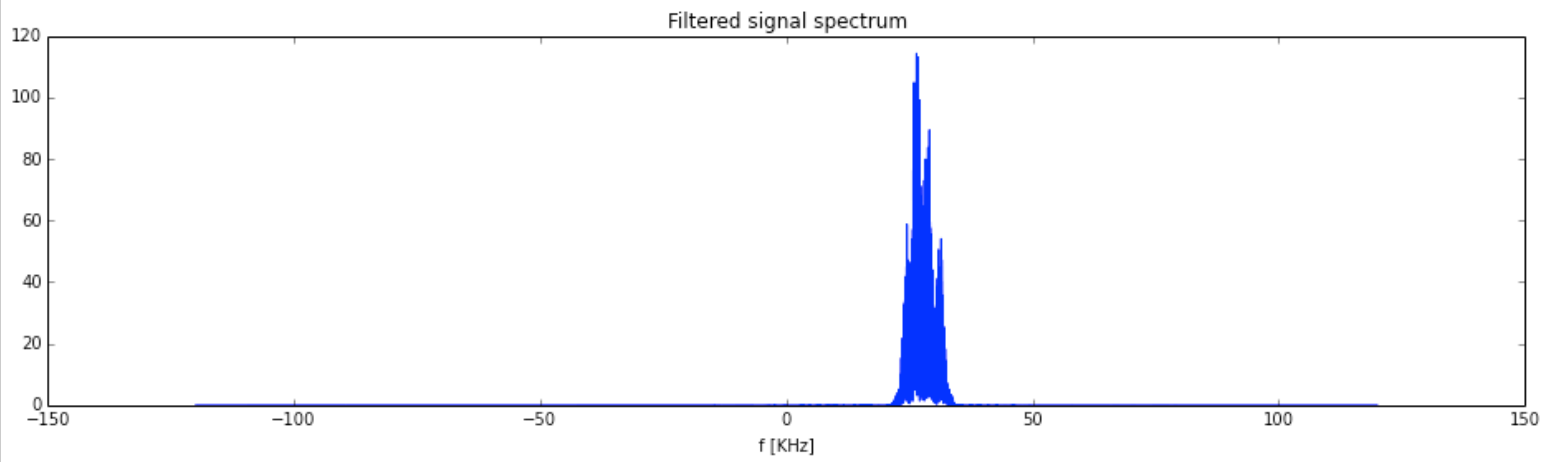
Spectrogram of GSM



How to find Bursts?

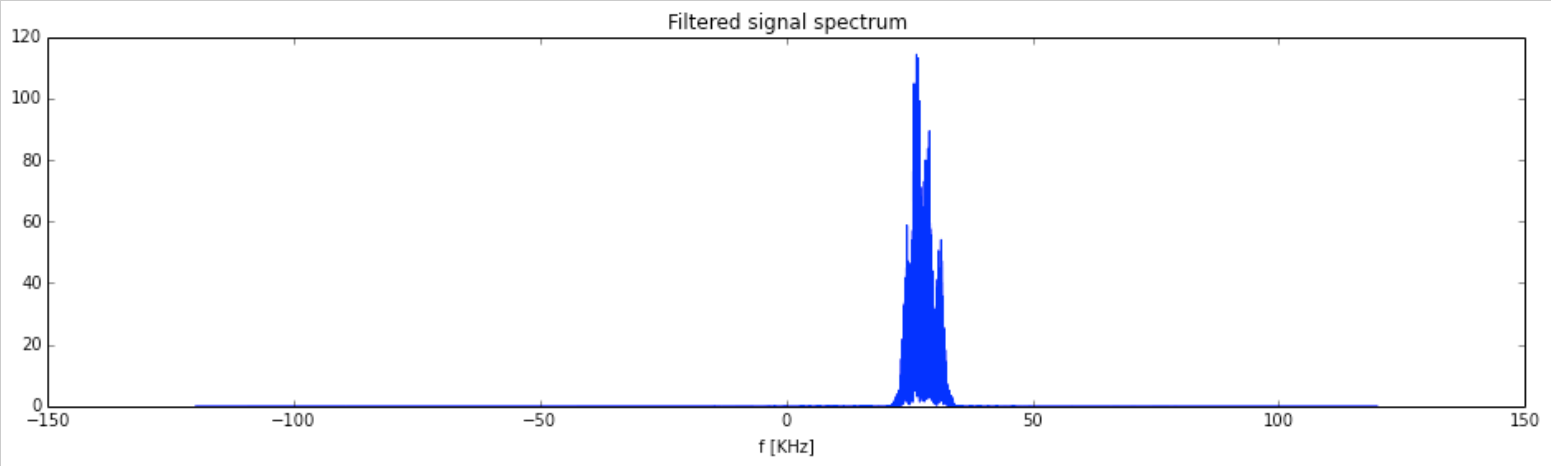
- Use Bandpass filter and compute magnitude of result

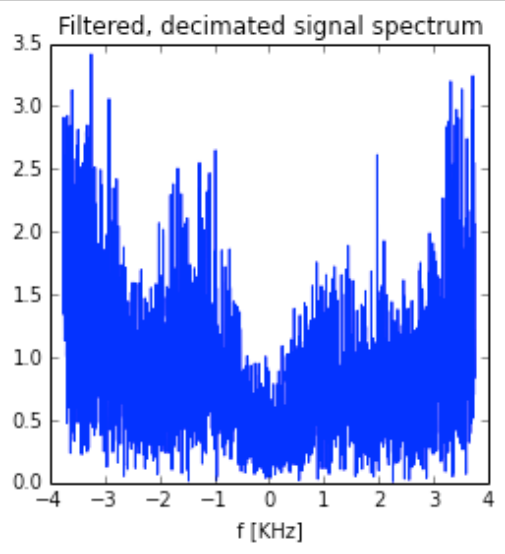




How to find Bursts?

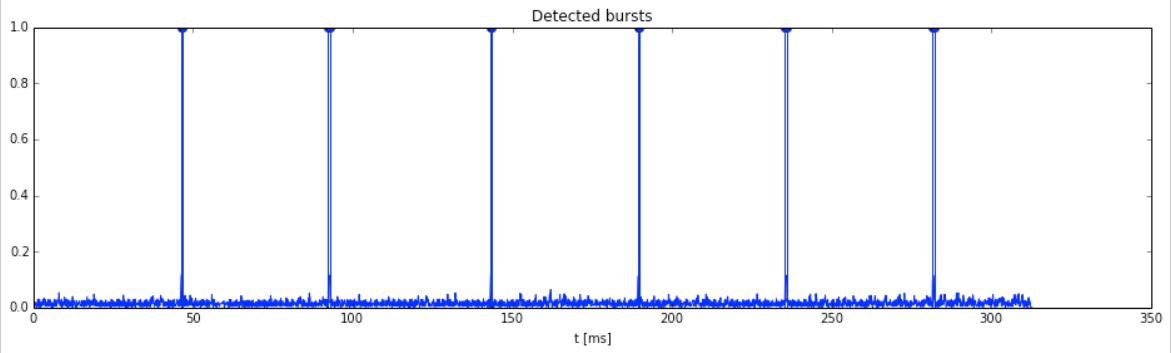
- Can process at lower rate!

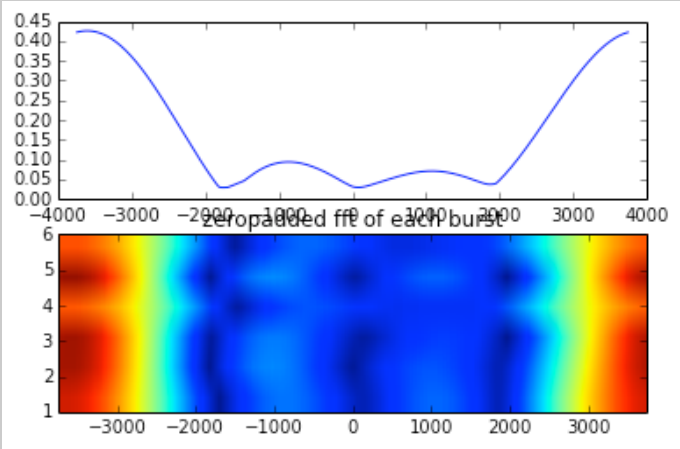




Detect Bursts and Compute Frequency

- Detect bursts at low rate sampling
- Compute frequency
- Calculate the original frequency!



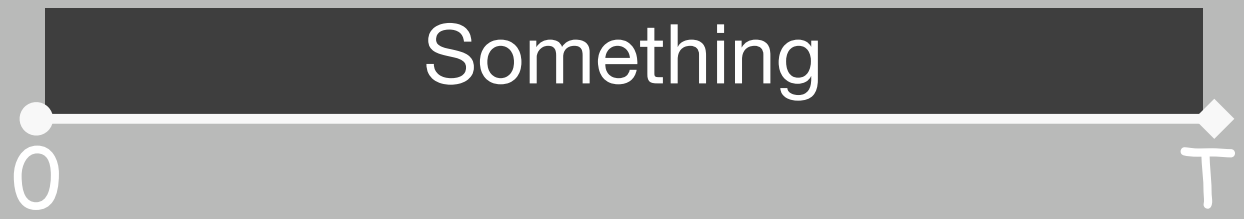


Compressive Sampling

Q: What is the rate you need to sample at?

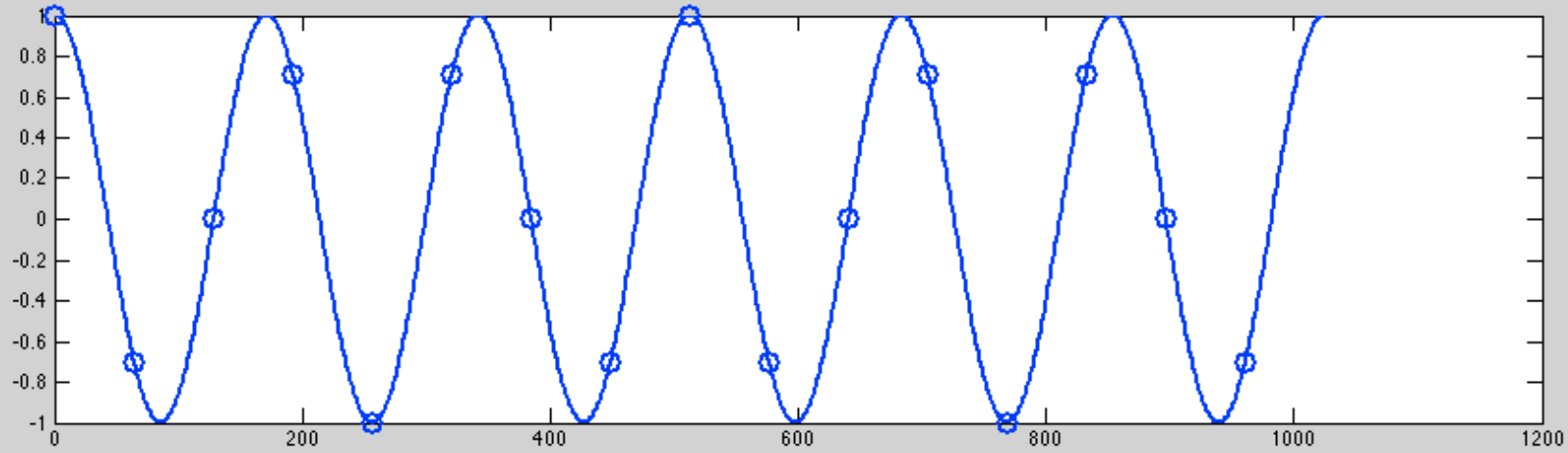
A: At least Nyquist!

Compressive Sampling



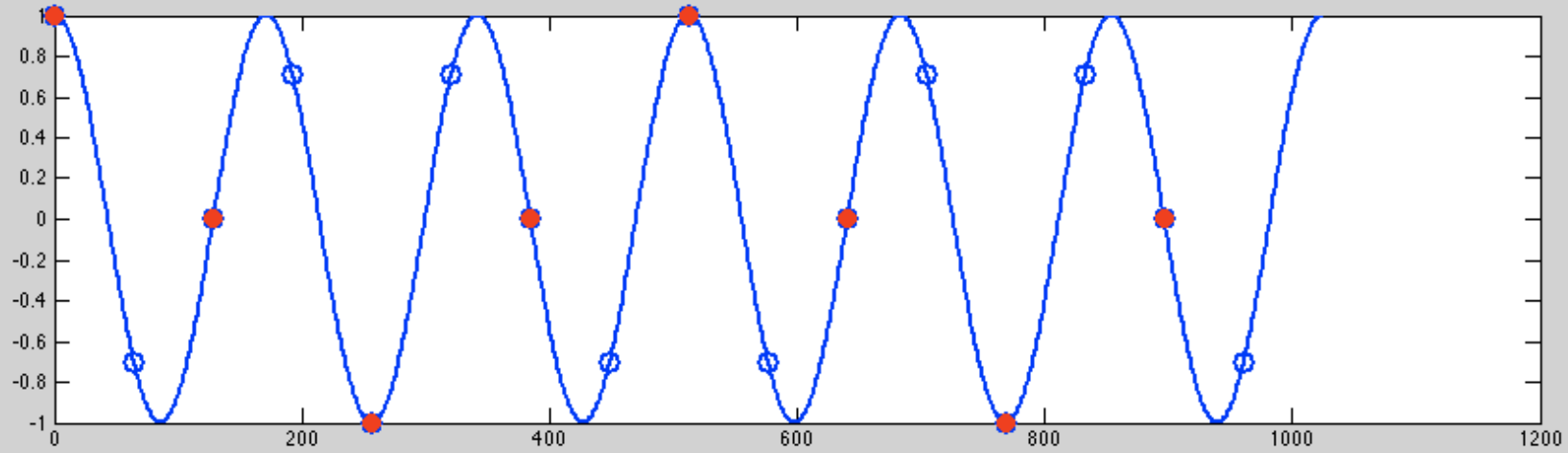
Q: What is the rate you need to sample at?

A: Maybe less than Nyquist....



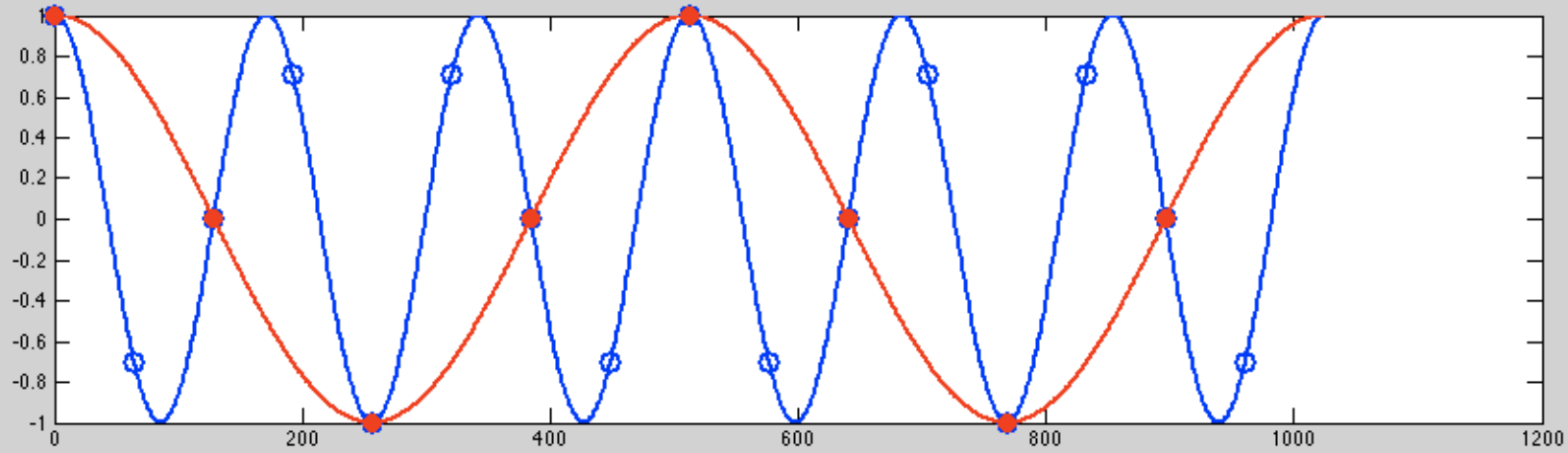
You are given samples of an harmonic function. You know there's only 1 frequency, but you don't know which.

1. Is it Nyquist sampled?
2. How would you reconstruct?



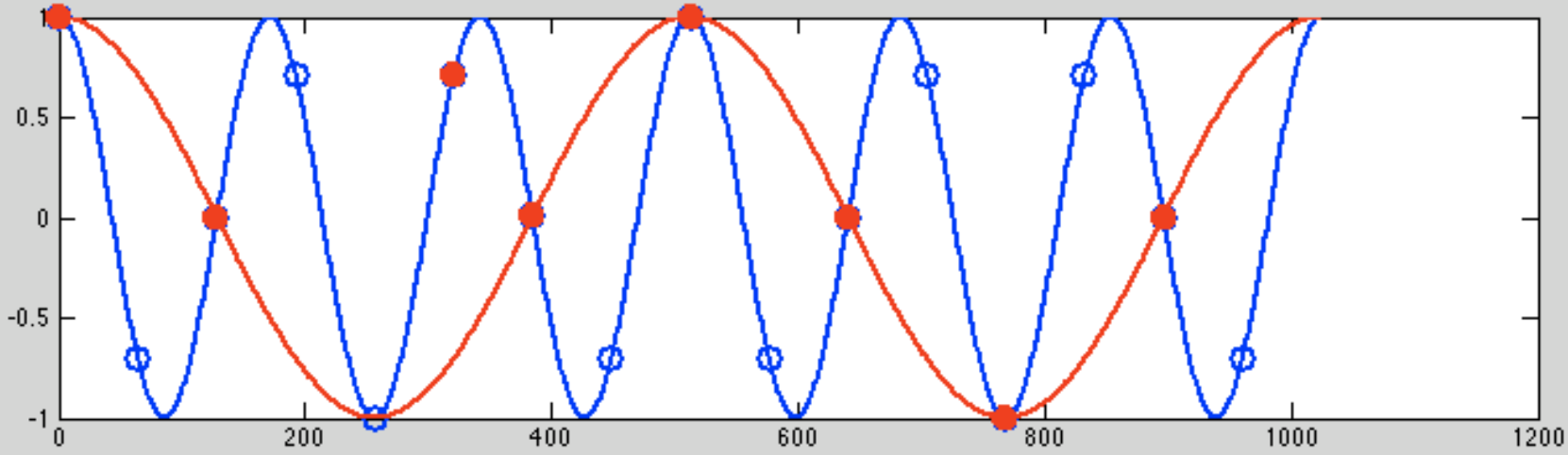
You collect half the samples at half the rate

1. Is it Nyquist sampled?
2. Can you reconstruct?



You collect half the samples at half the rate

1. What's the problem?
2. How can it be resolved?



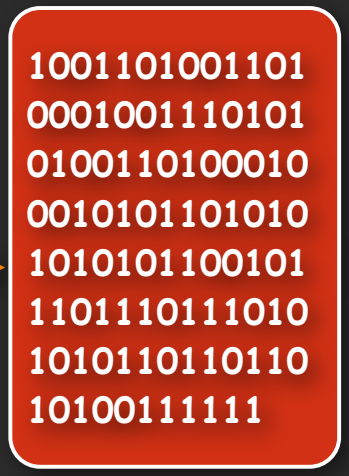
Non-uniform sampling solves the ambiguity!

1. What if there are 2 frequencies? What would you do?

Image Compression

Images are compressible

Standard approach: First collect, then compress



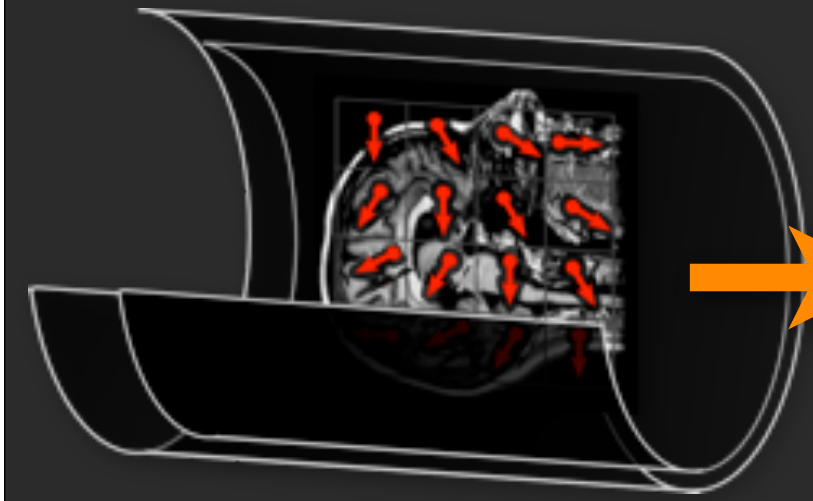
Compression

101000110100
1101011

Image Compression

Medical images are compressible

Standard approach: First collect, then compress



1001101001101
0001001110101
0100110100010
0010101101010
1010101100101
1101110111010
1010110110110
10100111111

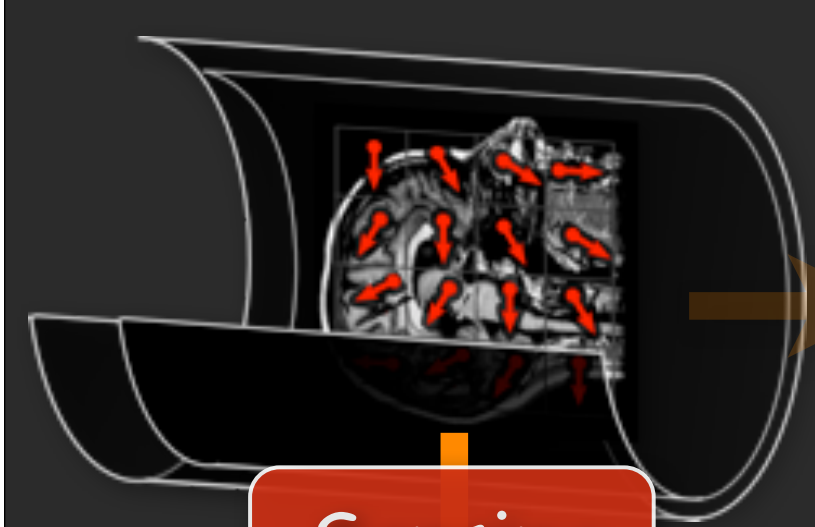
Compression

101000110100
1101011

Compressed Sensing

Medical images are compressible

Standard approach: First collect, then compress



Sensing

1001101001101
0001001110101
0100110100010
0010101101010
1010101100101
1101110111010
1010110110110
10100111111

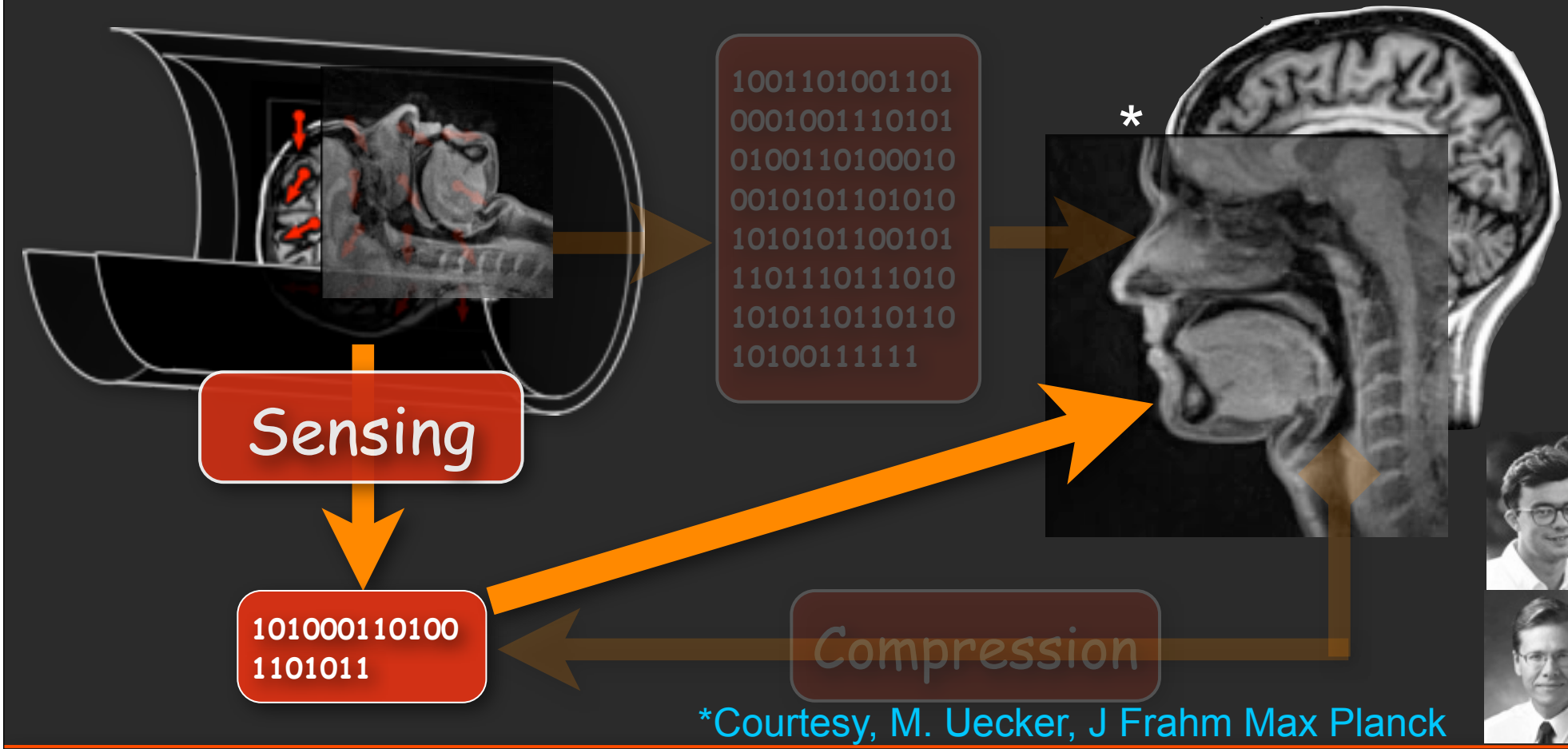
101000110100
1101011

Compression

Compressed Sensing

Medical images are compressible

Standard approach: First collect, then compress



*Courtesy, M. Uecker, J Frahm Max Planck