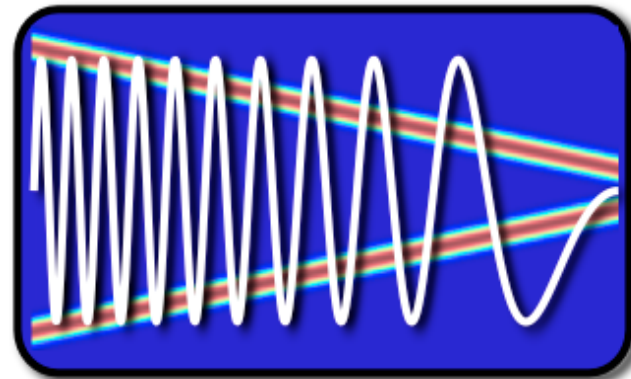


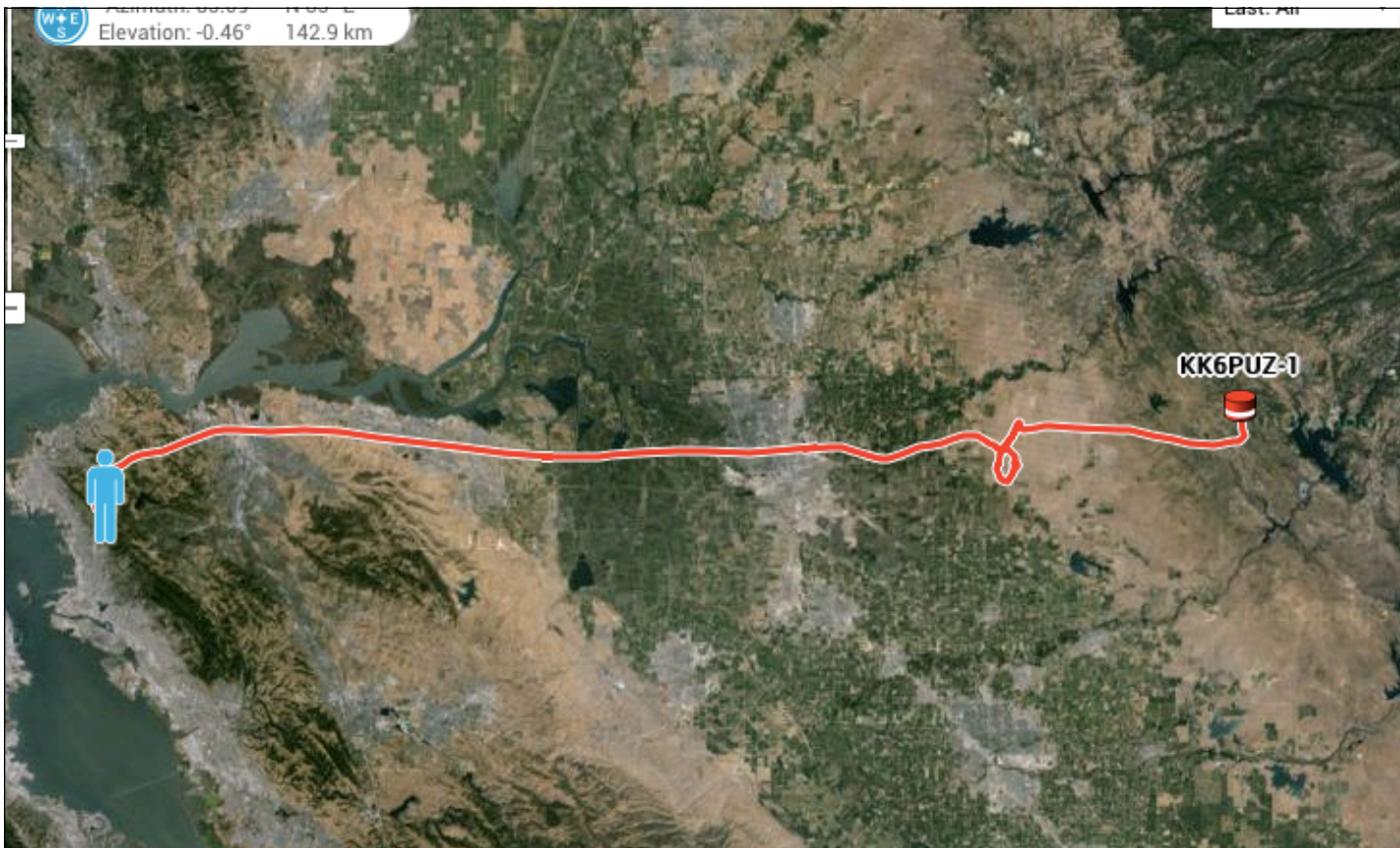
EE123



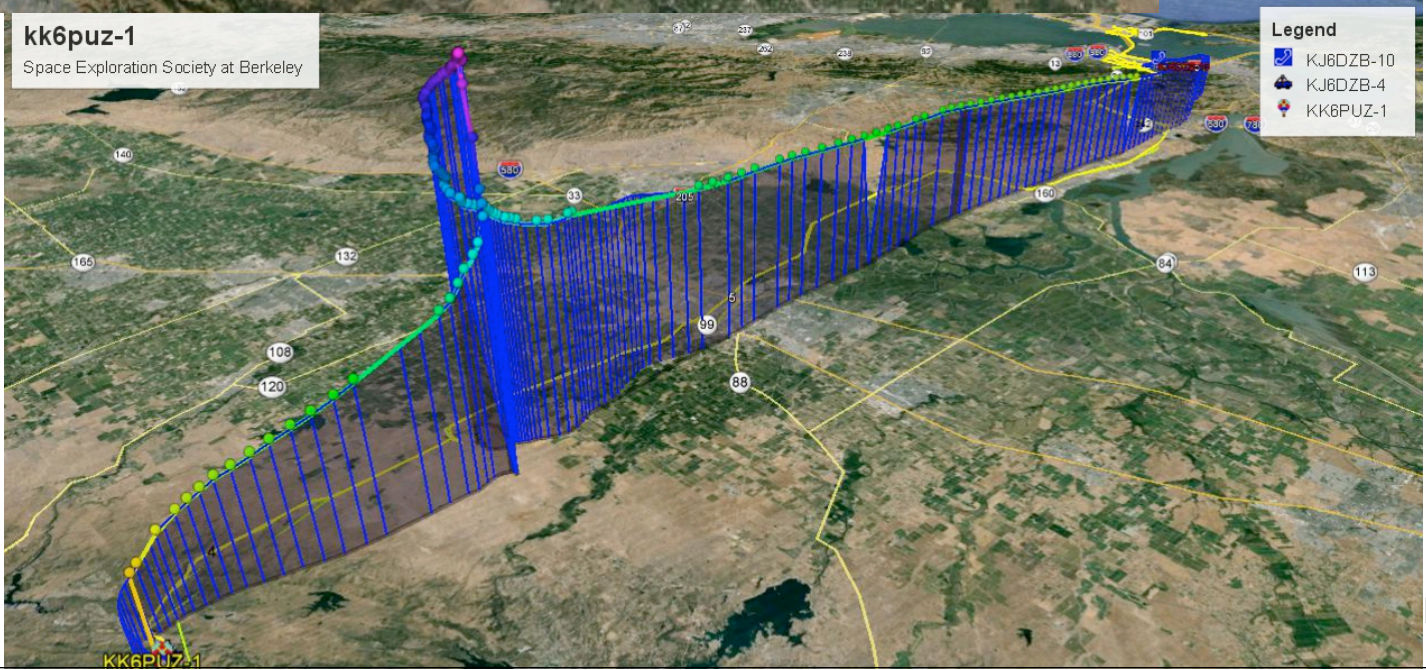
Digital Signal Processing

Lecture 22

Lab 4: Frequency Calibration using GSM
Compressed Sensing



kk6puz-1
Space Exploration Society at Berkeley



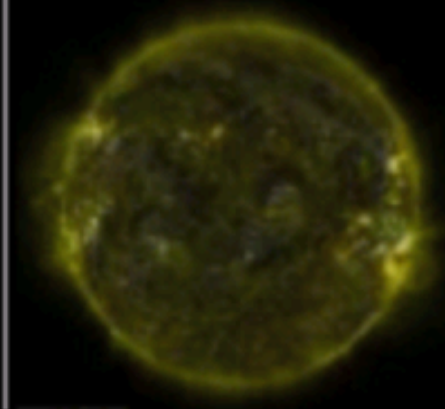
- Legend**
-  KJ6DZB-10
 -  KJ6DZB-4
 -  KK6PUZ-1

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

18 Mar 2015 1500 GMT

SFI 116 SN 060
A 116 K 5
XRY C1.4 304A 142.6
Aur 5 Lat 62.5°
Bz -0.3 SW 561.5
PF 0.1 EF 651.0
MUF Bdr 17.16 @ 1445
EME Deg Good

Current Solar



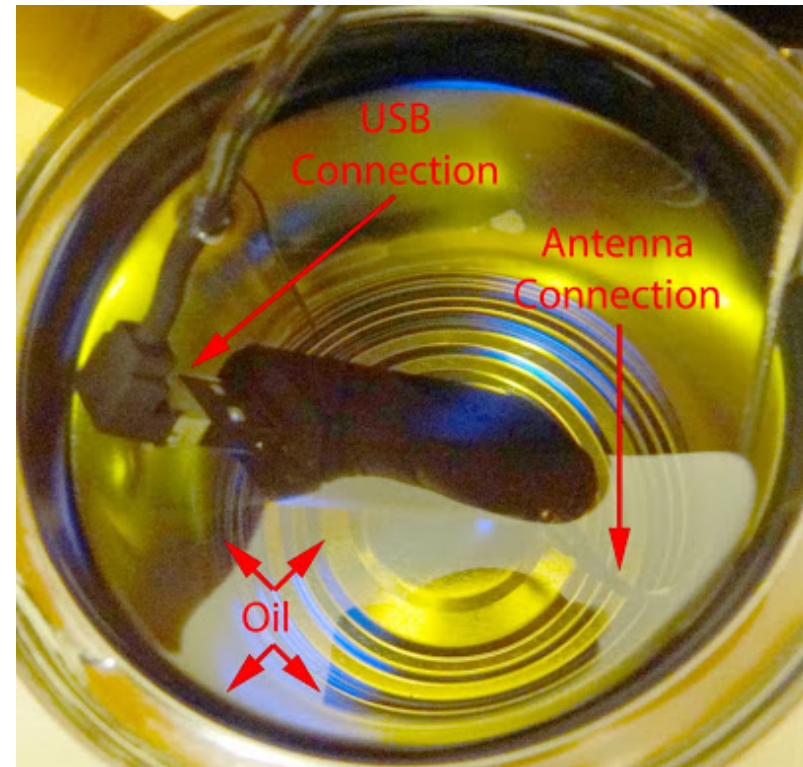
Band	Day	Night
80m-40m	Poor	Poor
30m-20m	Poor	Poor
17m-15m	Fair	Fair
12m-10m	Poor	Poor
Geomag Field	MIN STRM	
Sig Noise Lvl	S4-S6	
CME (UTC)	None	

(C) P Herrman NONBH 2013

Lab 4

- SDR crystal oscillator has often has offset
- Also drifts with temperature
- Cellphones do the same!

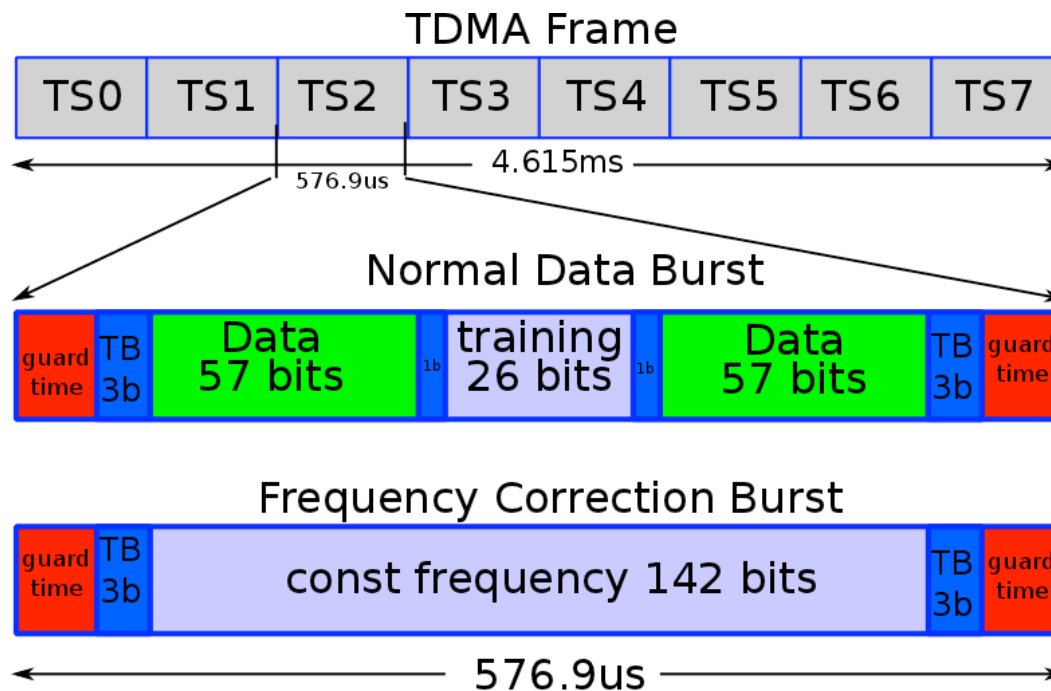
- GSM protocol has built in synchronizations



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

GSM-850

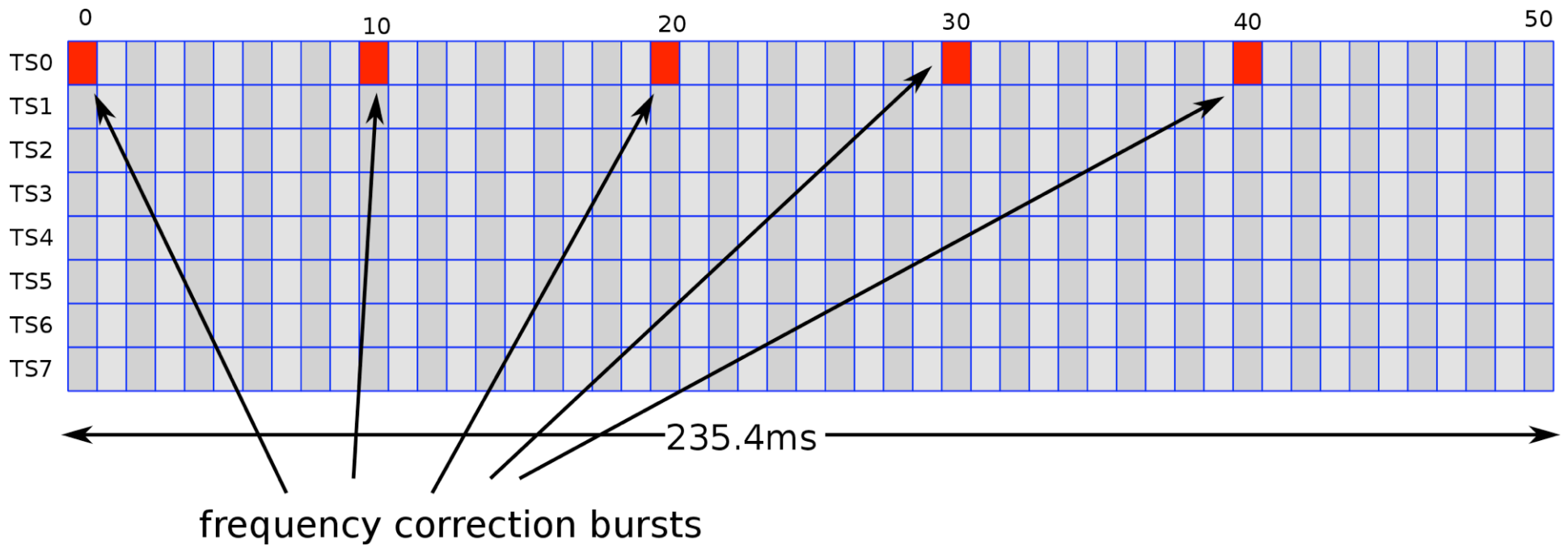
- Frequencies 200KHz channels
 - Uplink 824-849
 - Downlink 869-849
- TDMA: Time division multiple access



GSM Frequency Correction Channel

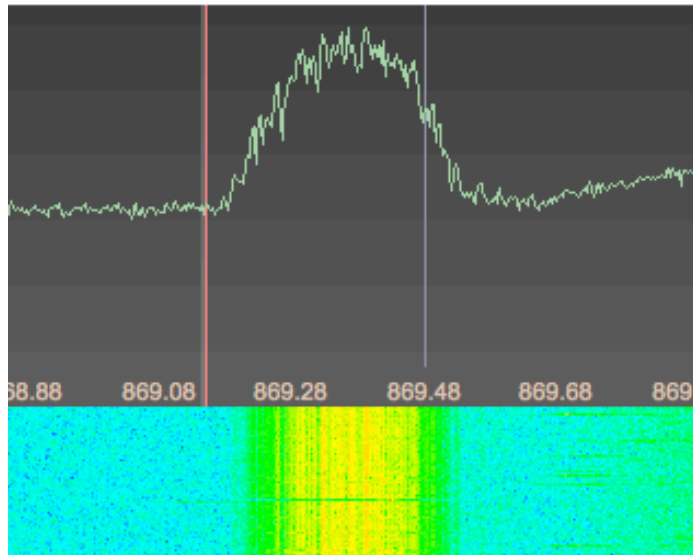
- Pure frequency bursts @67.7083KHz

Control Channel Multi-Frame

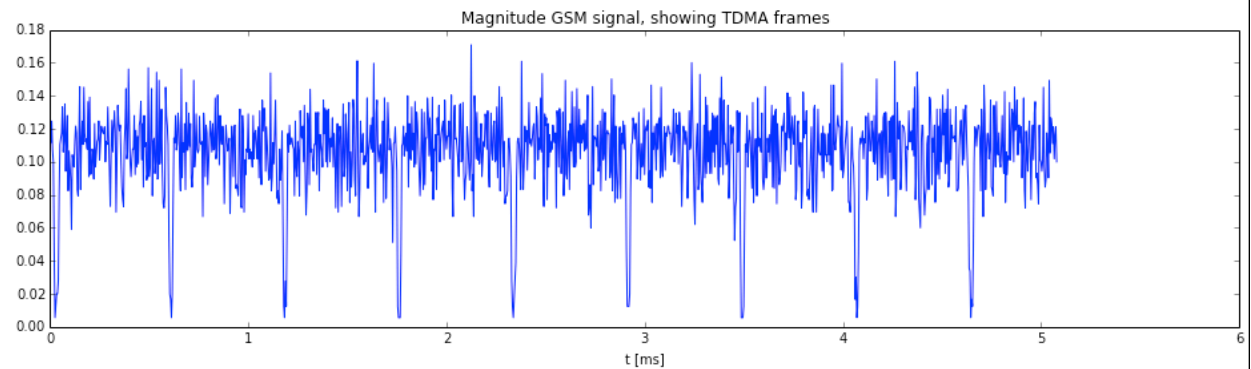
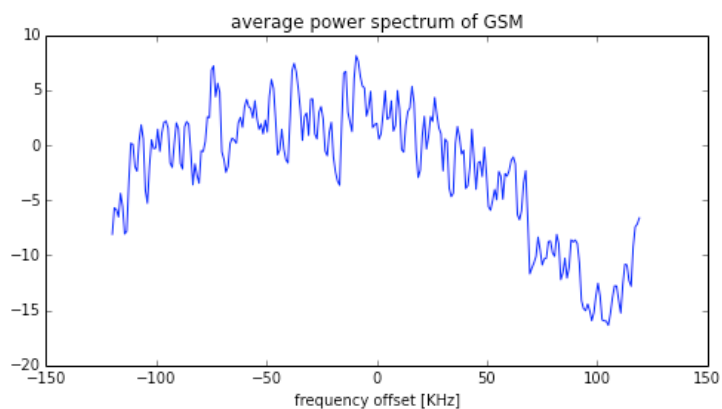
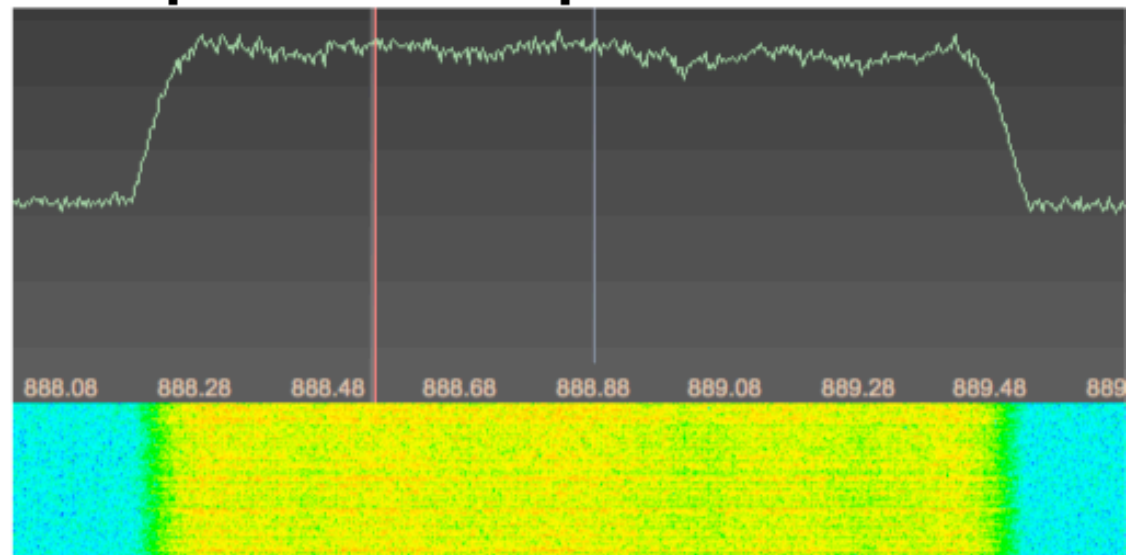


How to find GSM Base Stations

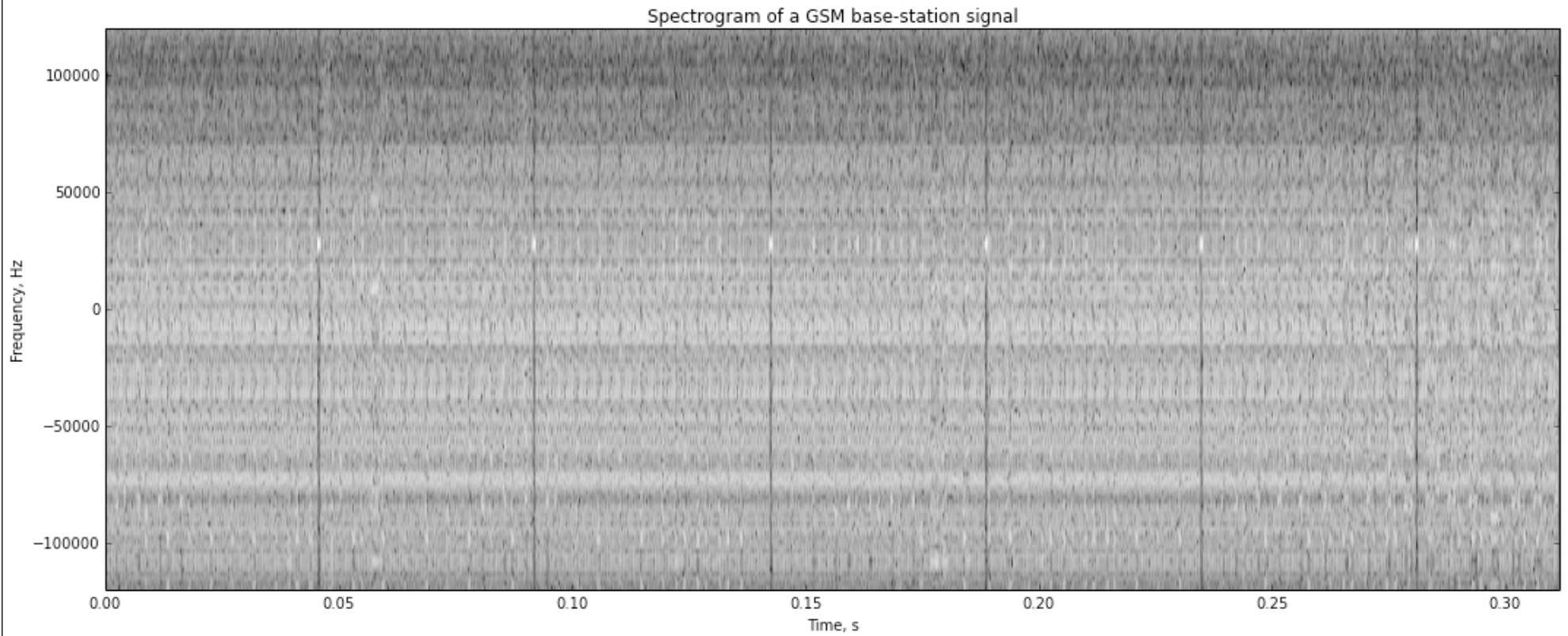
GSM



spread spectrum

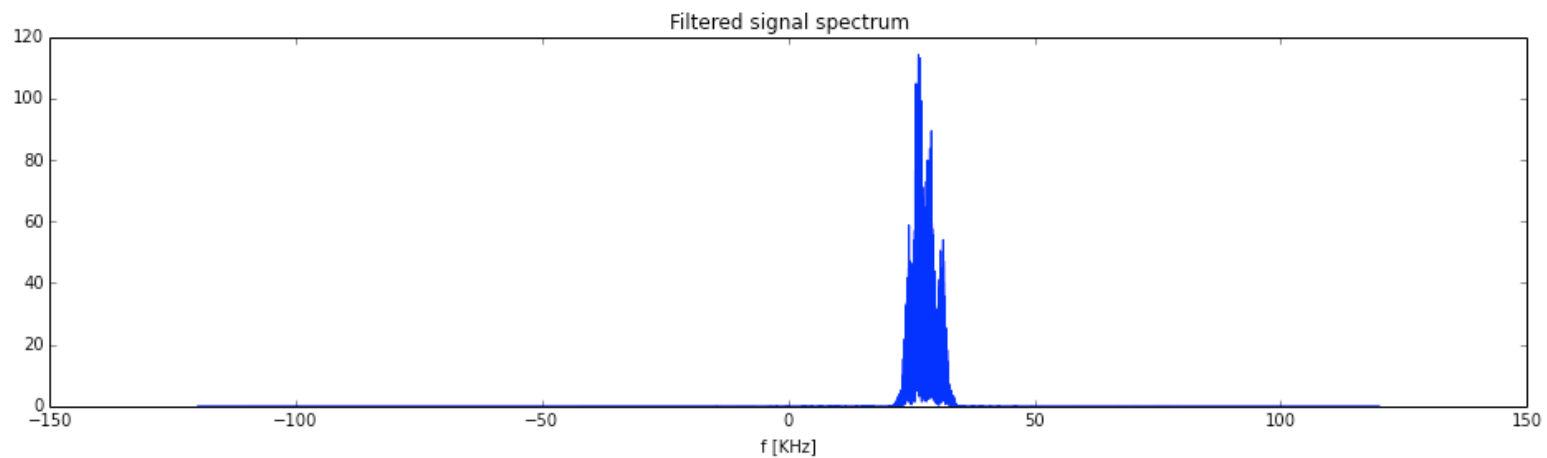
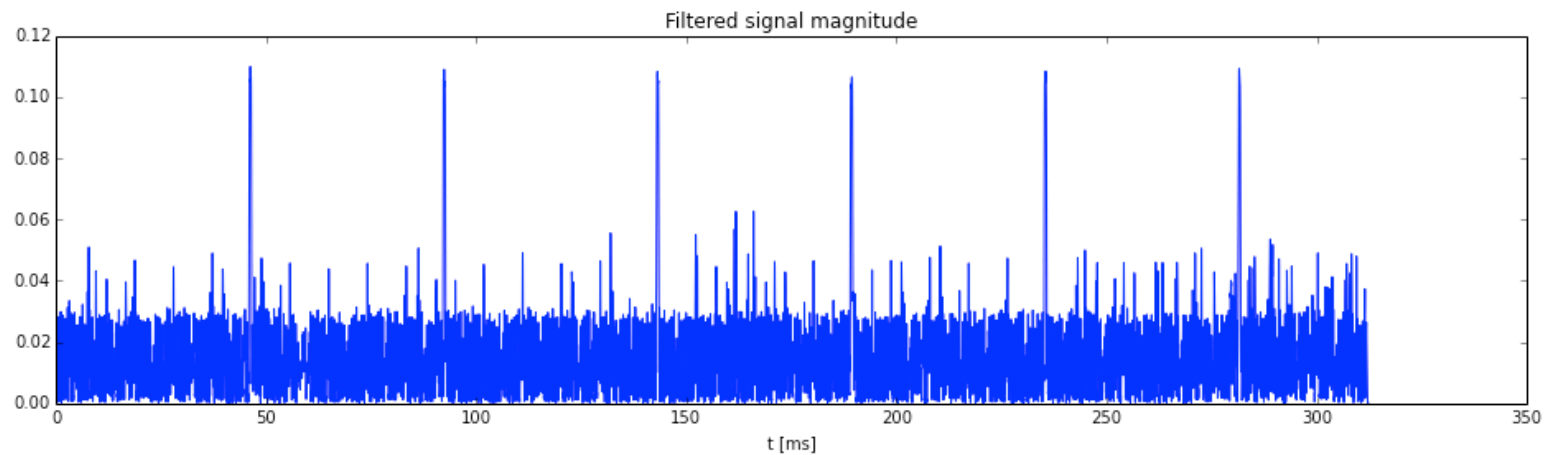


Spectrogram of GSM



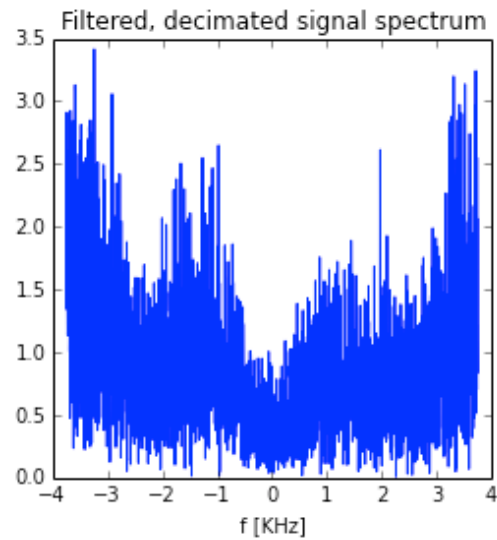
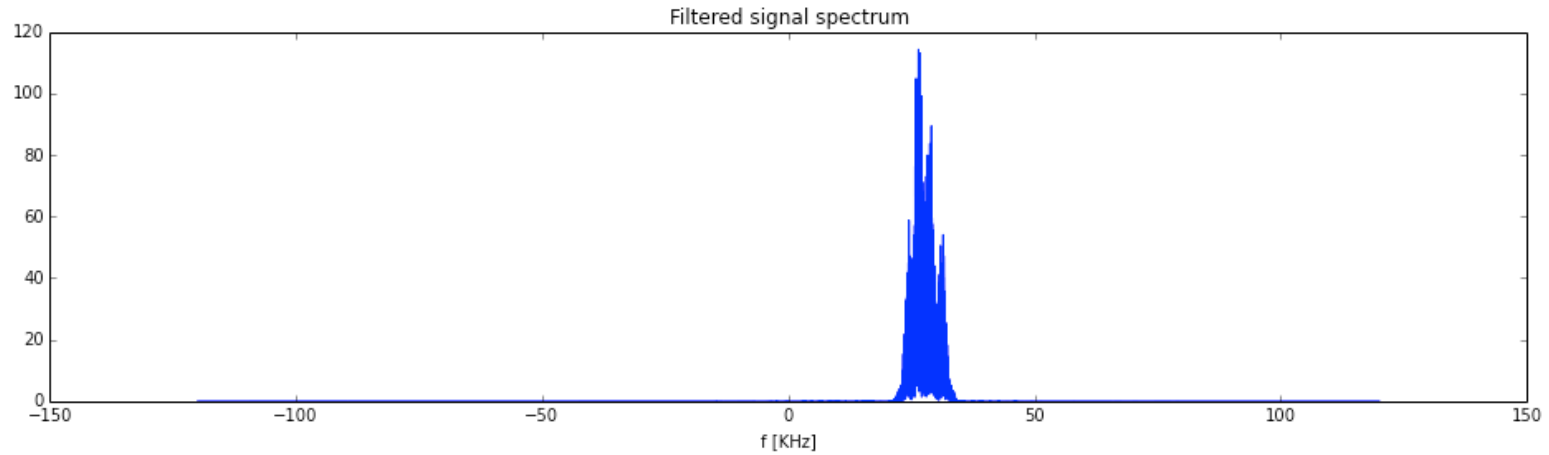
How to find Bursts?

- Use Bandpass filter and compute magnitude of result



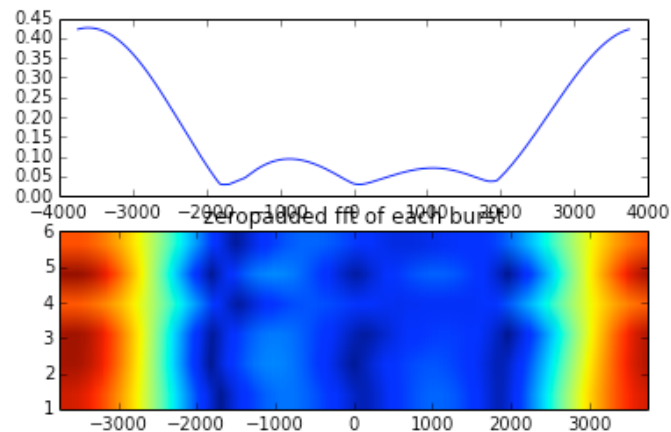
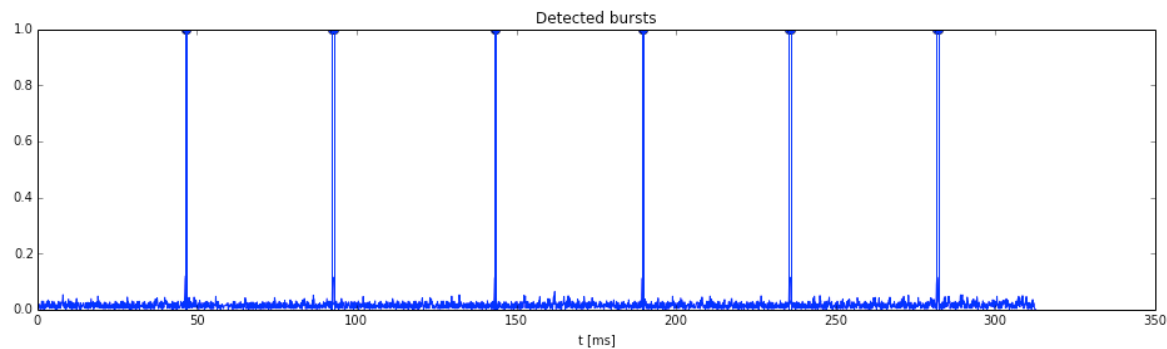
How to find Bursts?

- Can process at lower rate!



Detect Bursts and Compute Frequency

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



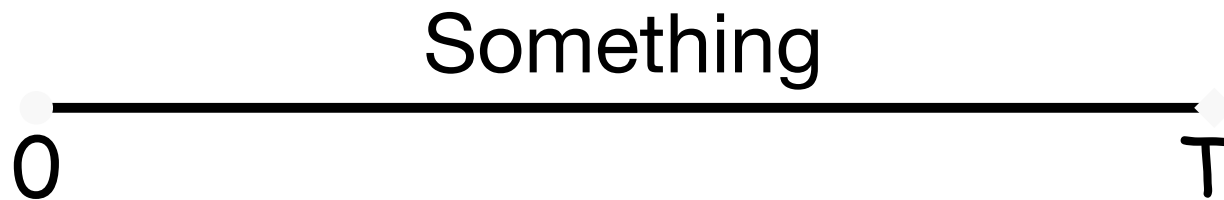
Compressive Sampling



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

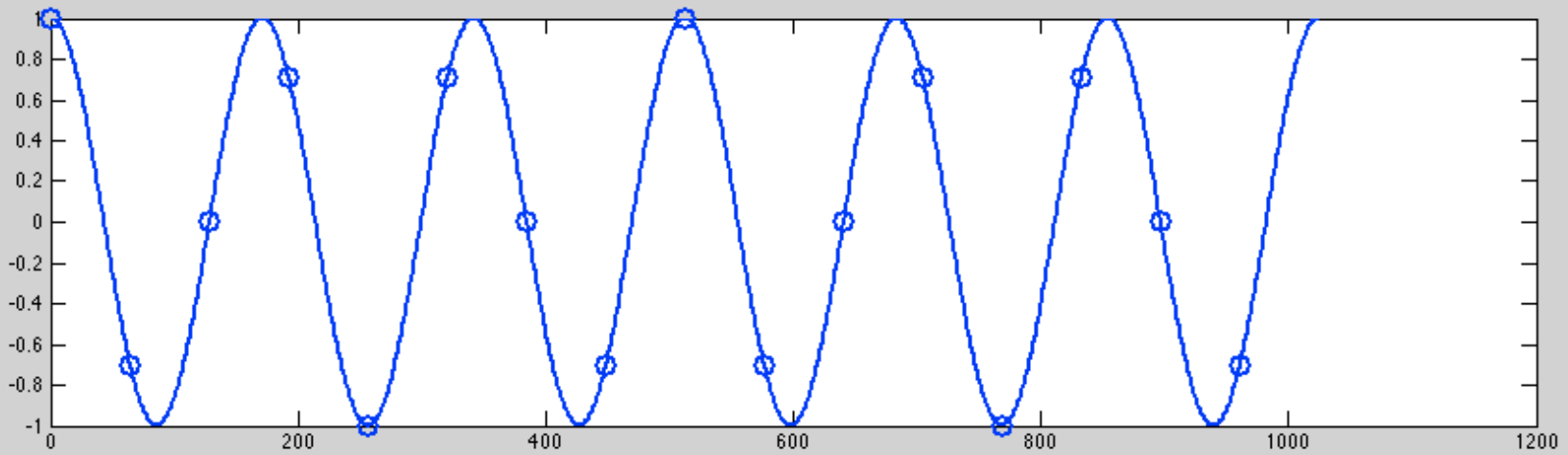
A: At least Nyquist!

Compressive Sampling



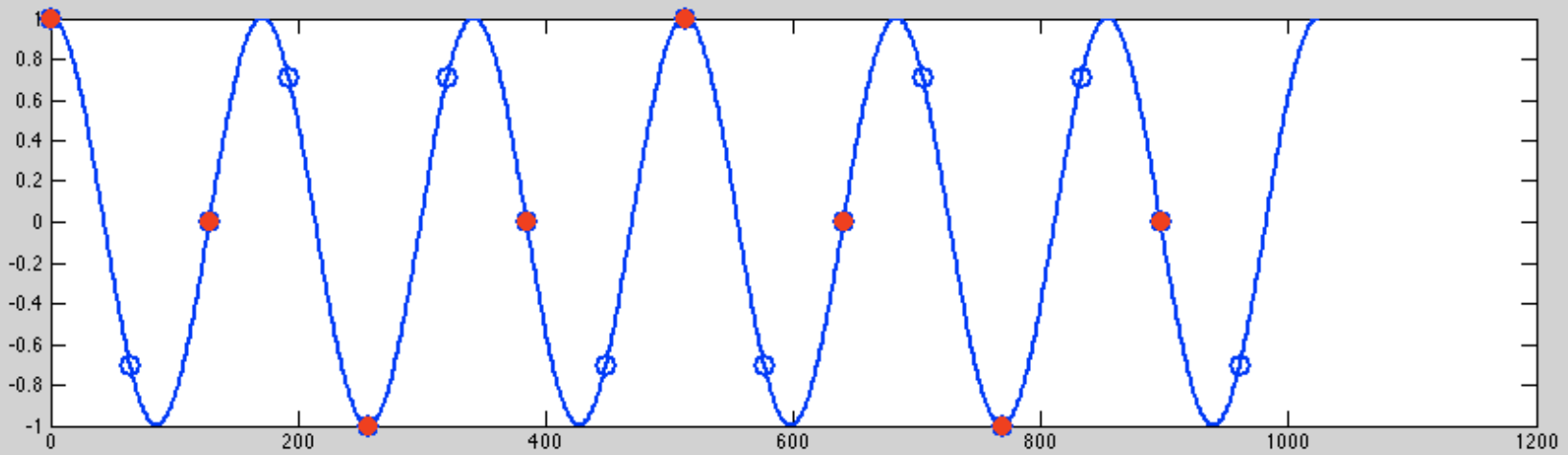
Q: What is the rate you need to sample at?

A: Maybe less than Nyquist....



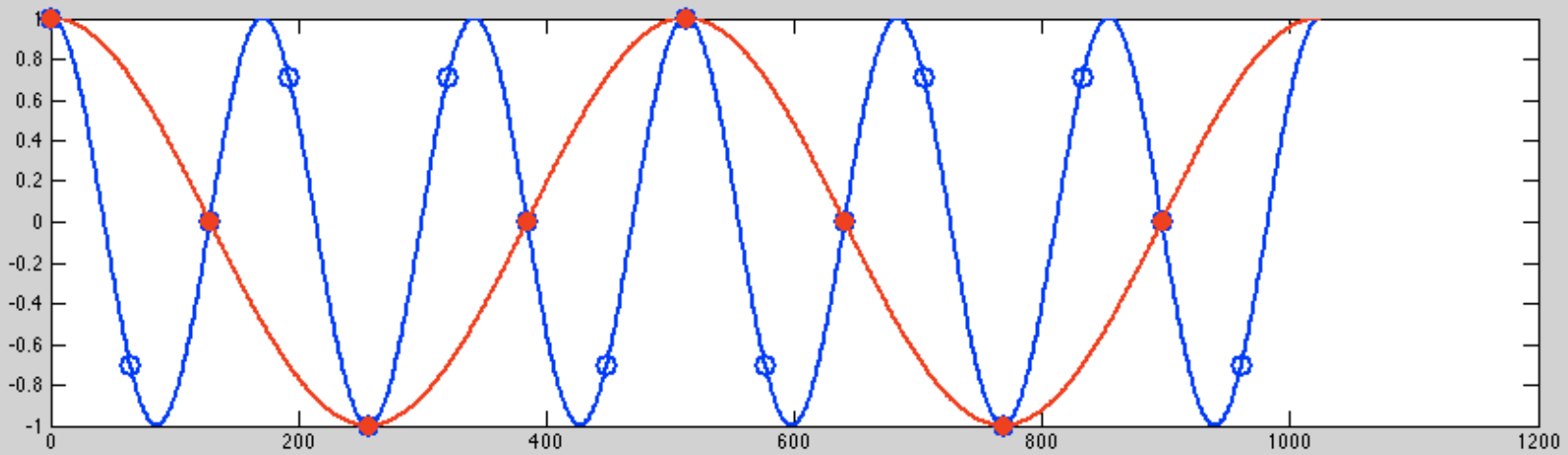
You are given samples of an harmonic function. You know there's only 1 frequency, but you don't know which.

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



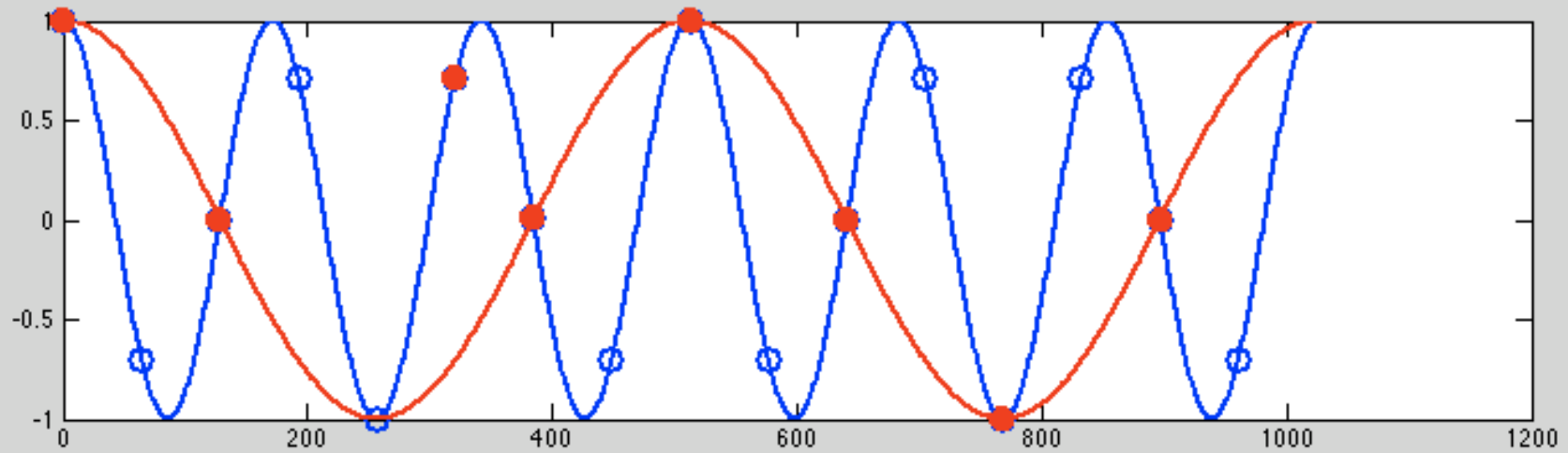
You collect half the samples at half the rate

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



```
1001101001101
0001001110101
0100110100010
0010101101010
1010101100101
1101110111010
1010110110110
10100111111
```



Compression

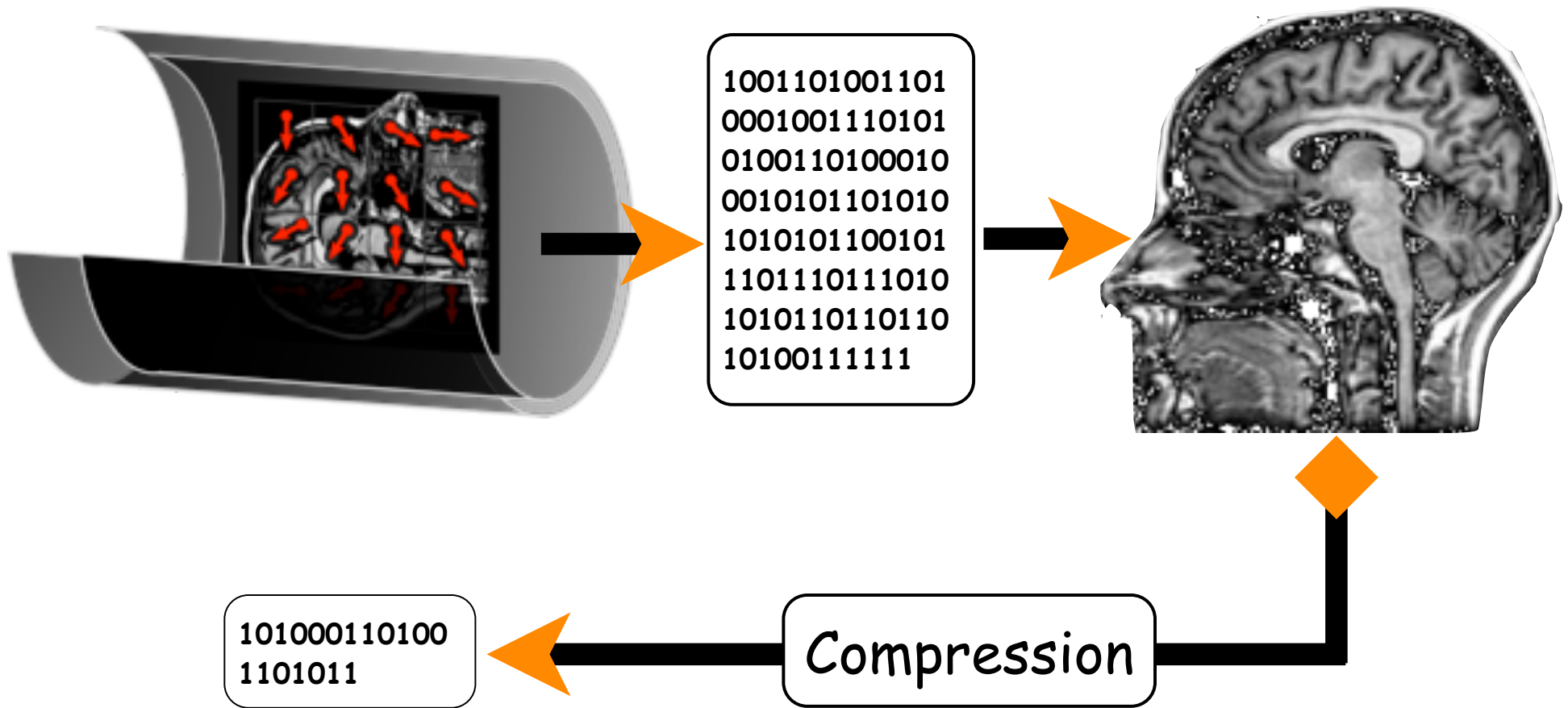


```
101000110100
1101011
```

Image Compression

Medical images are compressible

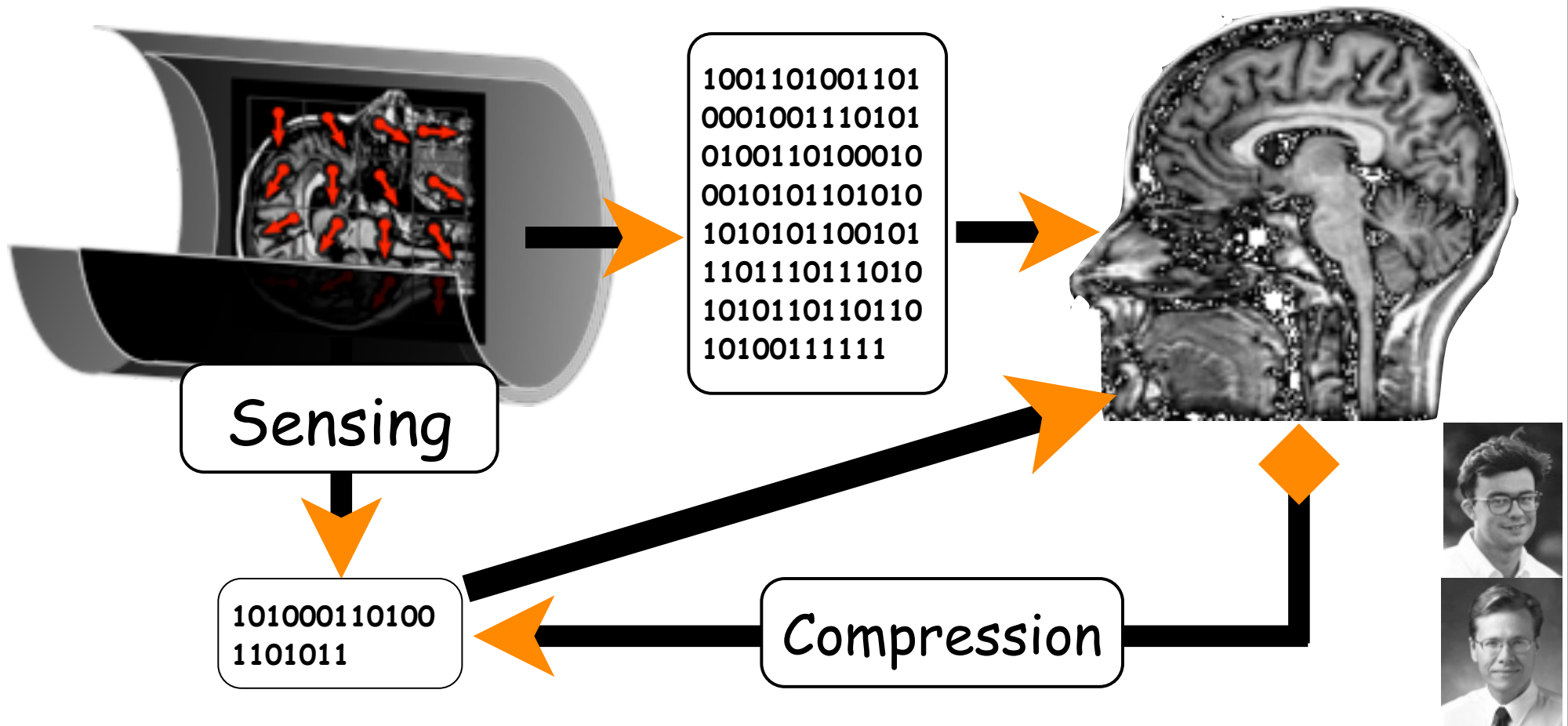
Standard approach: First collect, then compress



Compressed Sensing

Medical images are compressible

Standard approach: First collect, then compress



Compressed Sensing

Medical images are compressible

Standard approach: First collect, then compress

