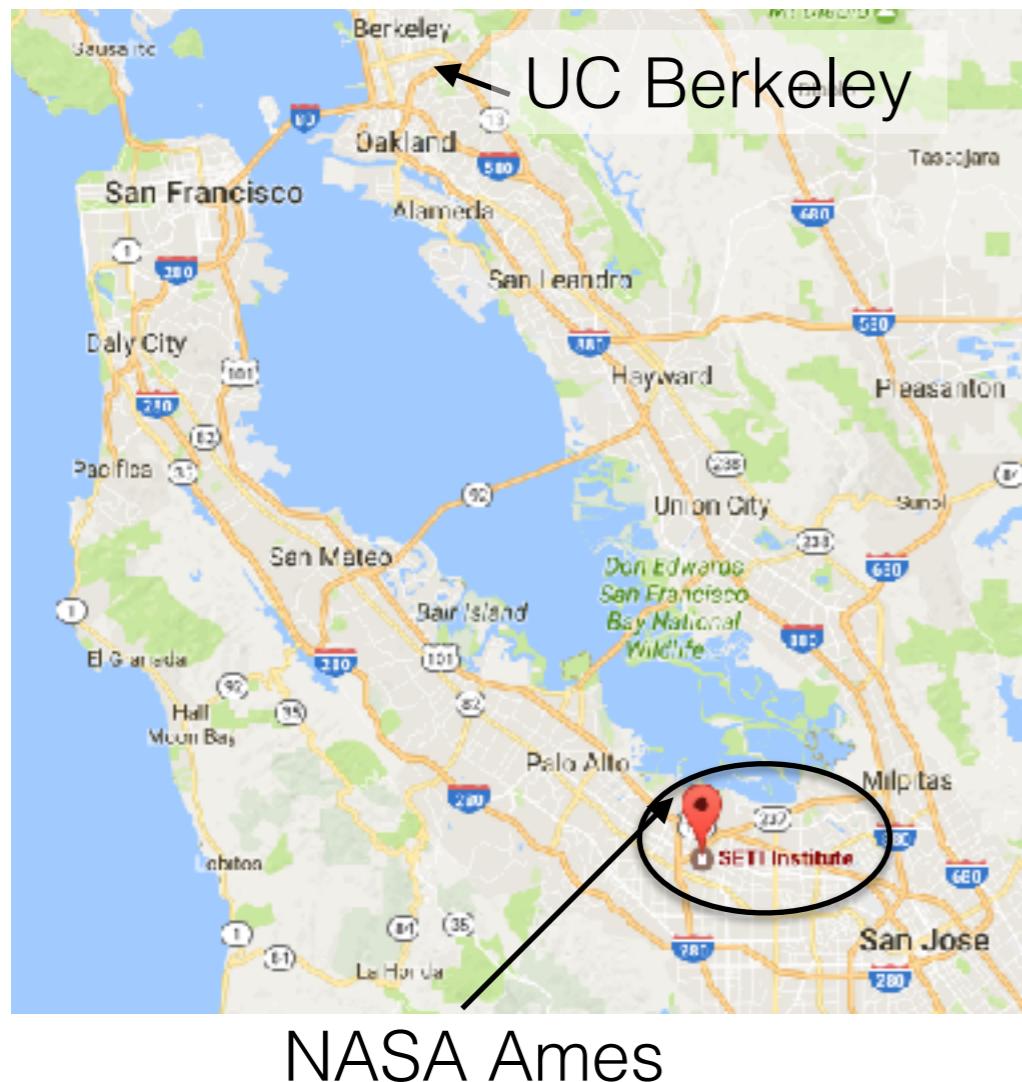


G. Adam Cox

IBM Watson Data Platform

Search for Extraterrestrial Intelligence



Non-profit Research Center

Founded in 1984

- Tom Pierson* (CEO)
- John Billingham (NASA)
- Bernard Oliver (HP)
- Frank Drake (NASA)
- Jill Tarter (UCB)
- a few others

“focus on the research and education aspects of all factors of the Drake Equation”

Over 130 scientists: Radio, Optical, Astrobiology, etc.

Notable Faculty

Dr. Jill Tarter



Bernard Oliver Chair of SETI Research
Cornell University, UC Berkeley PhD

Lifetime Achievement Award from
Women in Aerospace
NASA Public Service Medals
California Academy of Sciences Fellow
- Board of Trustees
AAAS Fellow
Time 100 most influential people

Dr. Seth Shostak



Senior Astronomer
Princeton University, CalTech PhD

Klumpke-Roberts Award
Fellow of the Committee for Skeptical
Inquiry
TV/radio/podcast SETI and Science
Evangelist

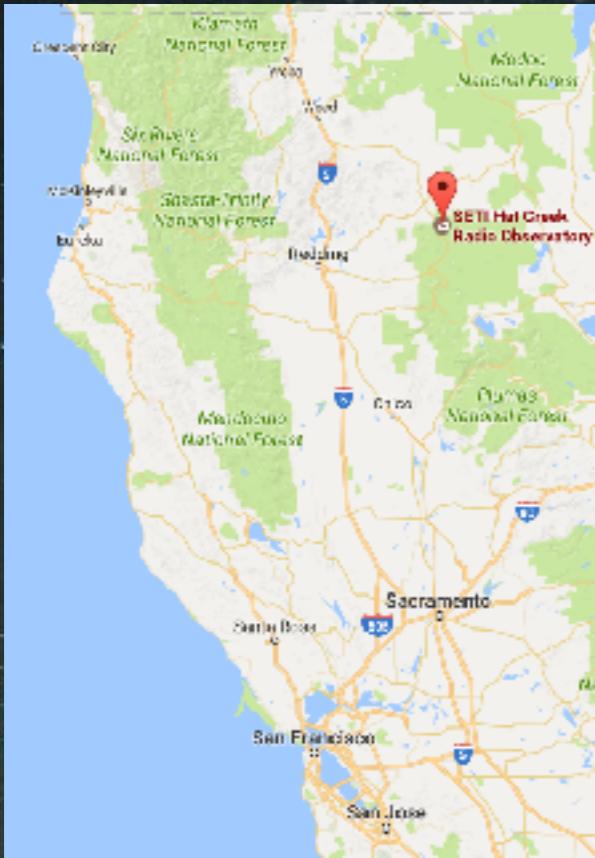
Dr. Frank Drake

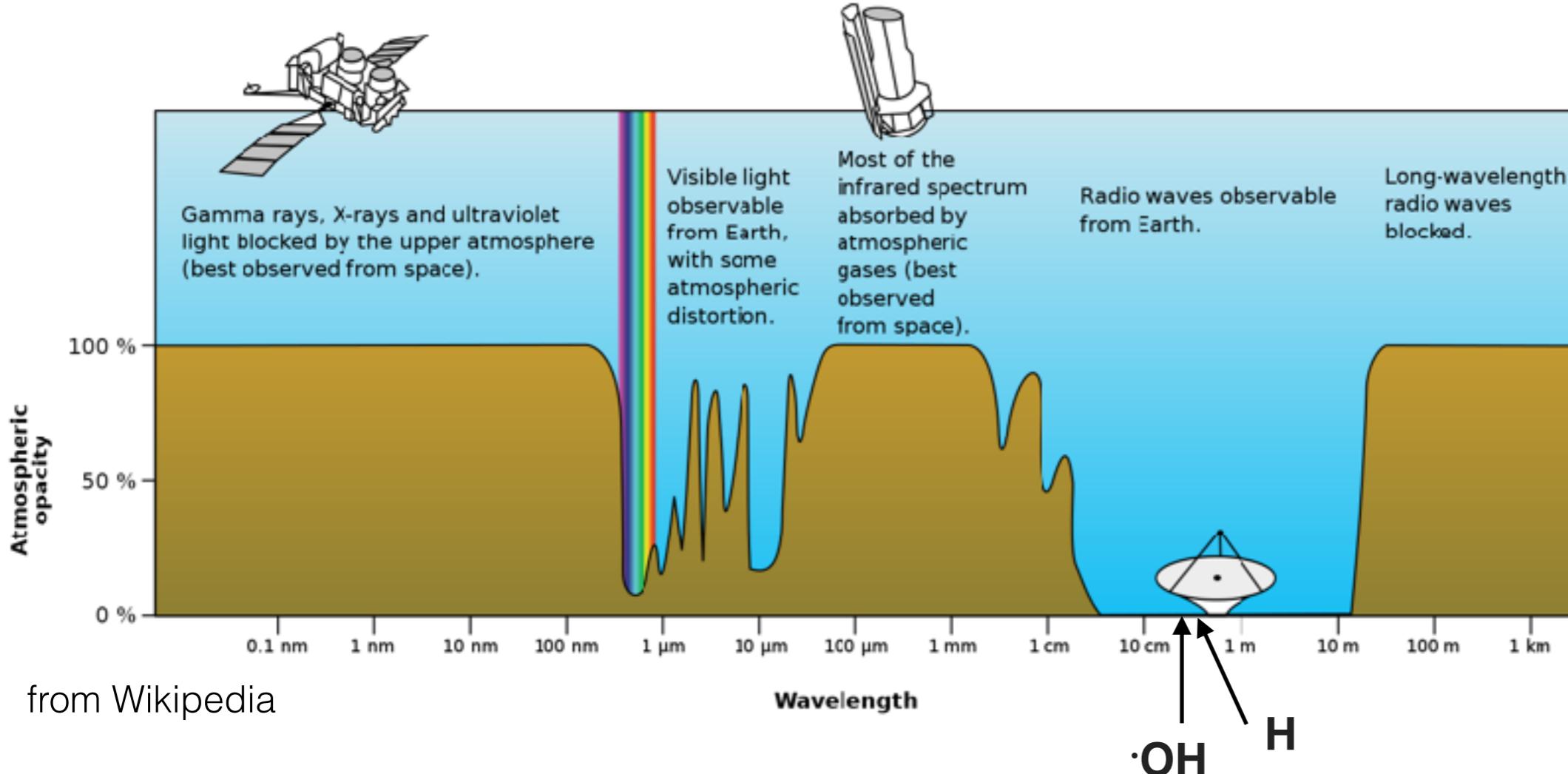


Chairman Emeritus
Cornell, Harvard PhD

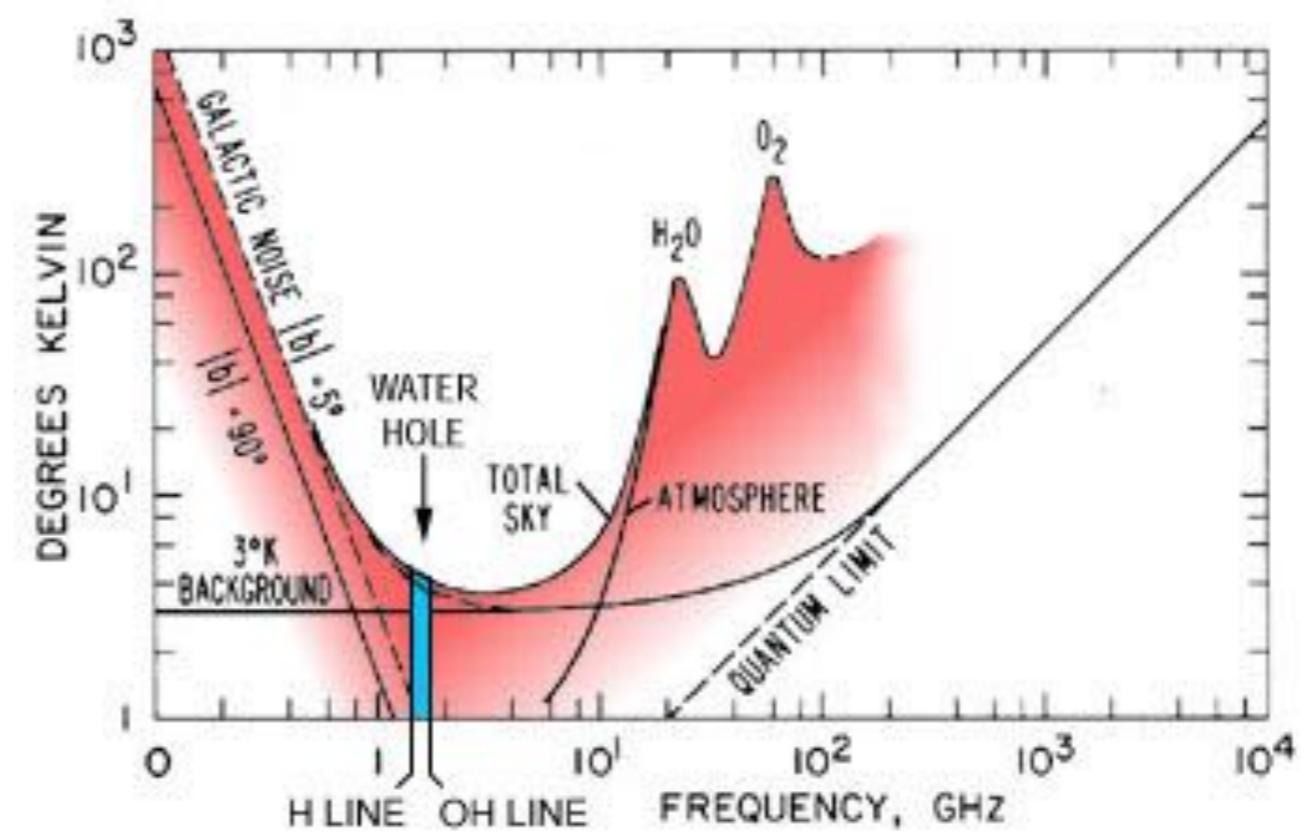
“Father” of modern SETI
Developer of the Drake Equation

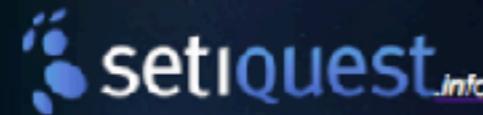
National Academy of Sciences
President of the Astronomical Society of
the Pacific
Director of the Arecibo Observatory
Emeritus Professor UCSC
Board of Trustees SETI Institute





“water hole”





4 viewers watching

[Donate to SETI Institute](#)

- [Help - What is this?](#)
- [Observing Status](#)
- [Obs Progress](#)
- [Spacecraft Tracking](#)
- [Eller Fire 2014](#)
- [Rainbow](#)

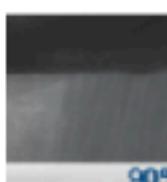
Wind 12.85mph

Gusts to 24mph

48°F / 9°C

Tonight

Today



Low: 34°F High: 50°F

ATA Webcams



Observer Notes



Jrseti

observing now

24880
current activity

03:44:19
activity start time - 164s

3
number of beams

4066.76
tuning frequency - mhz

first look
target type

43.410
bandwidth - mhz

0.861°
array field of view

0.0238°
beam field of view

Beam 1: SDSS-DR7-50159

RA=9.11833h, Dec=12.9959d

Beam 2: SDSS-DR7-50160

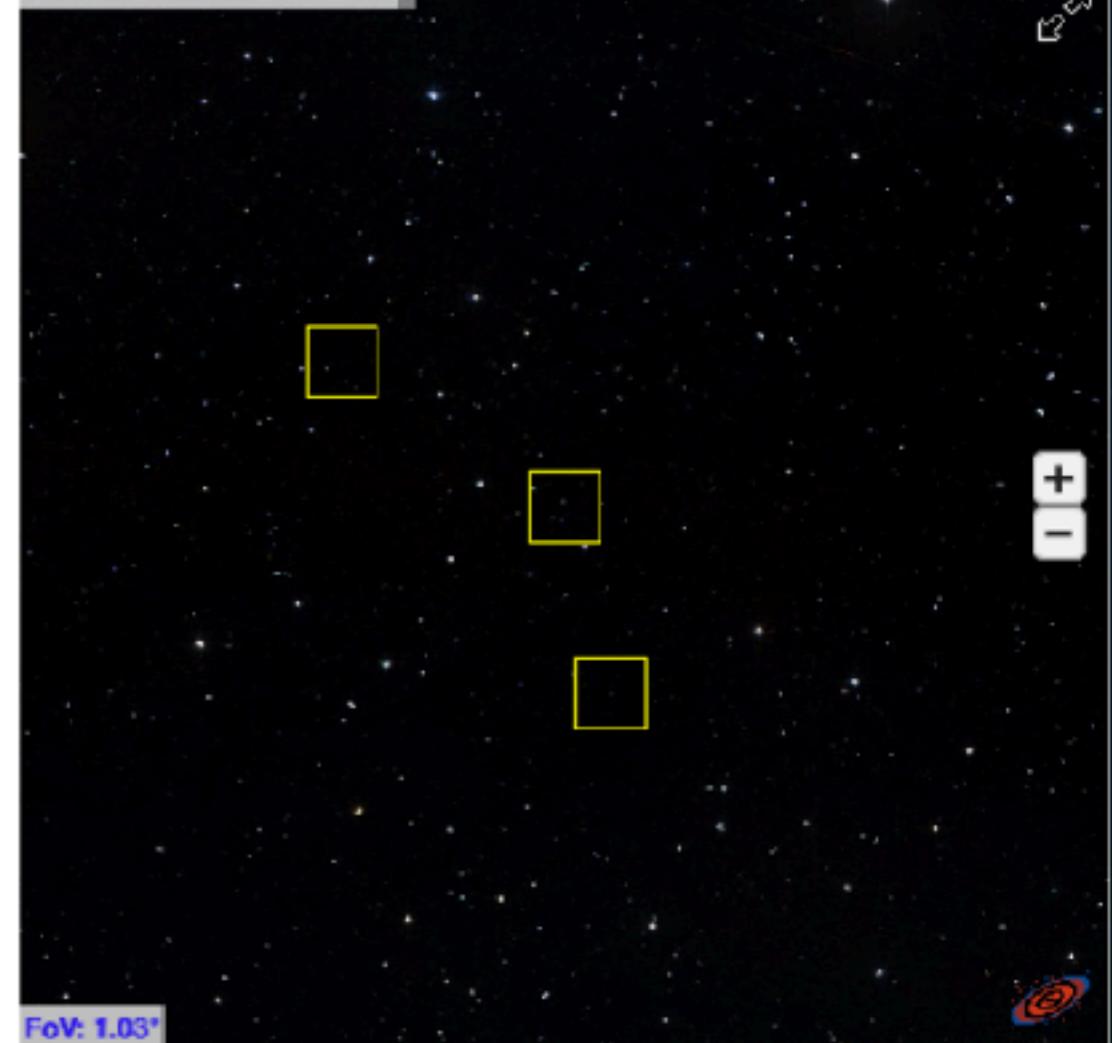
RA=9.10085h, Dec=12.6811d

Beam 3: G009-046

RA=9.10394h, Dec=12.8600d

collecting data for activity 24880 - 28s

09 08 12:061-12:23:20:63



[2016-04-14 03:13:03] Beam 1 is now repaired. 3 beams tonight!

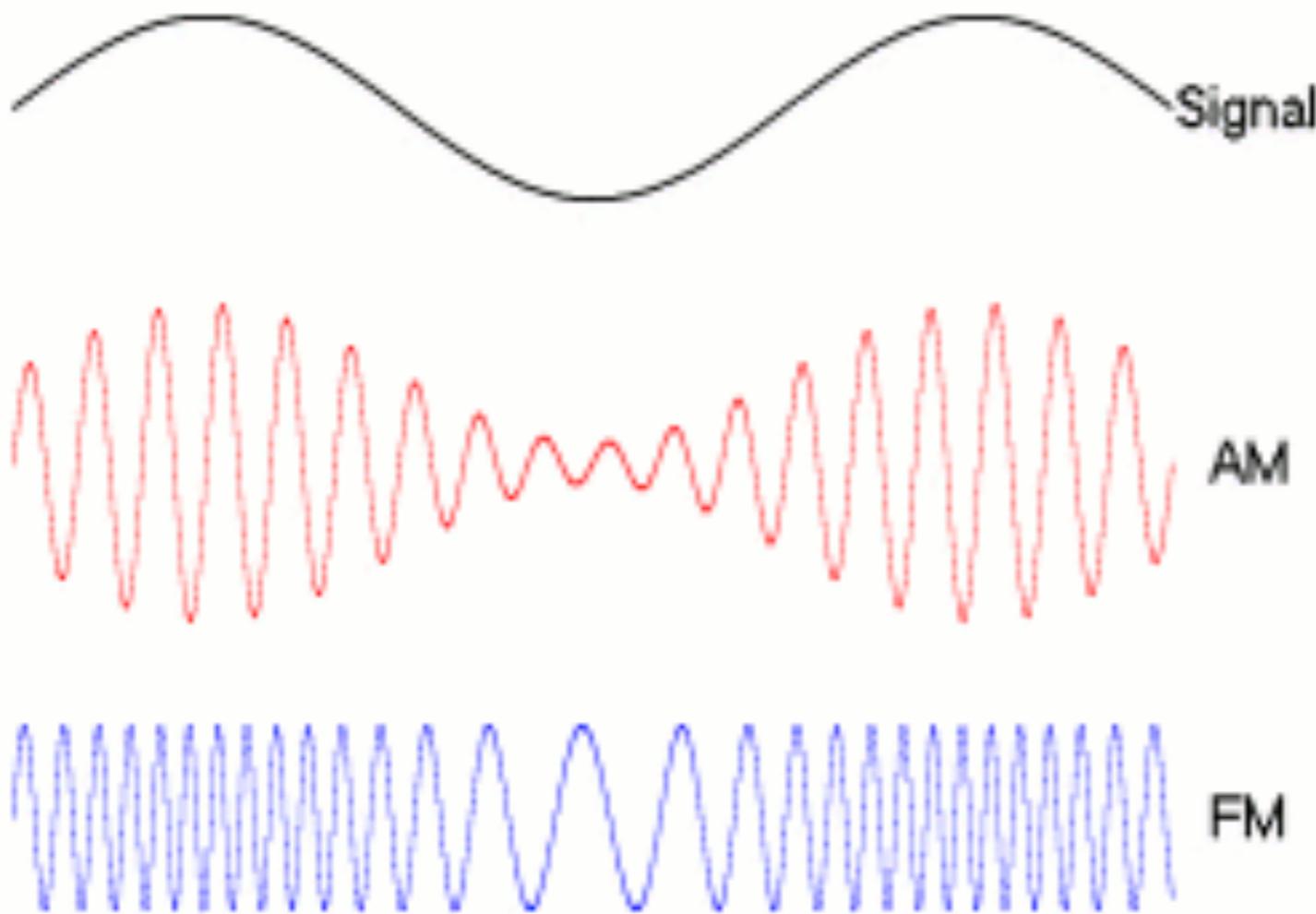
[2016-04-14 03:14:18] twitter seems to have problems right now. Hoping to get more viewers.

[2016-04-14 03:20:57] Calibrations should be finished soon. Be patient!

[2016-04-14 03:24:01] The observing - which starts after the calibrations - is more interesting!

[2016-04-14 03:29:58] Calibration only goes up to 4170MHz. Observing 4000 to 4170 MHz tonight

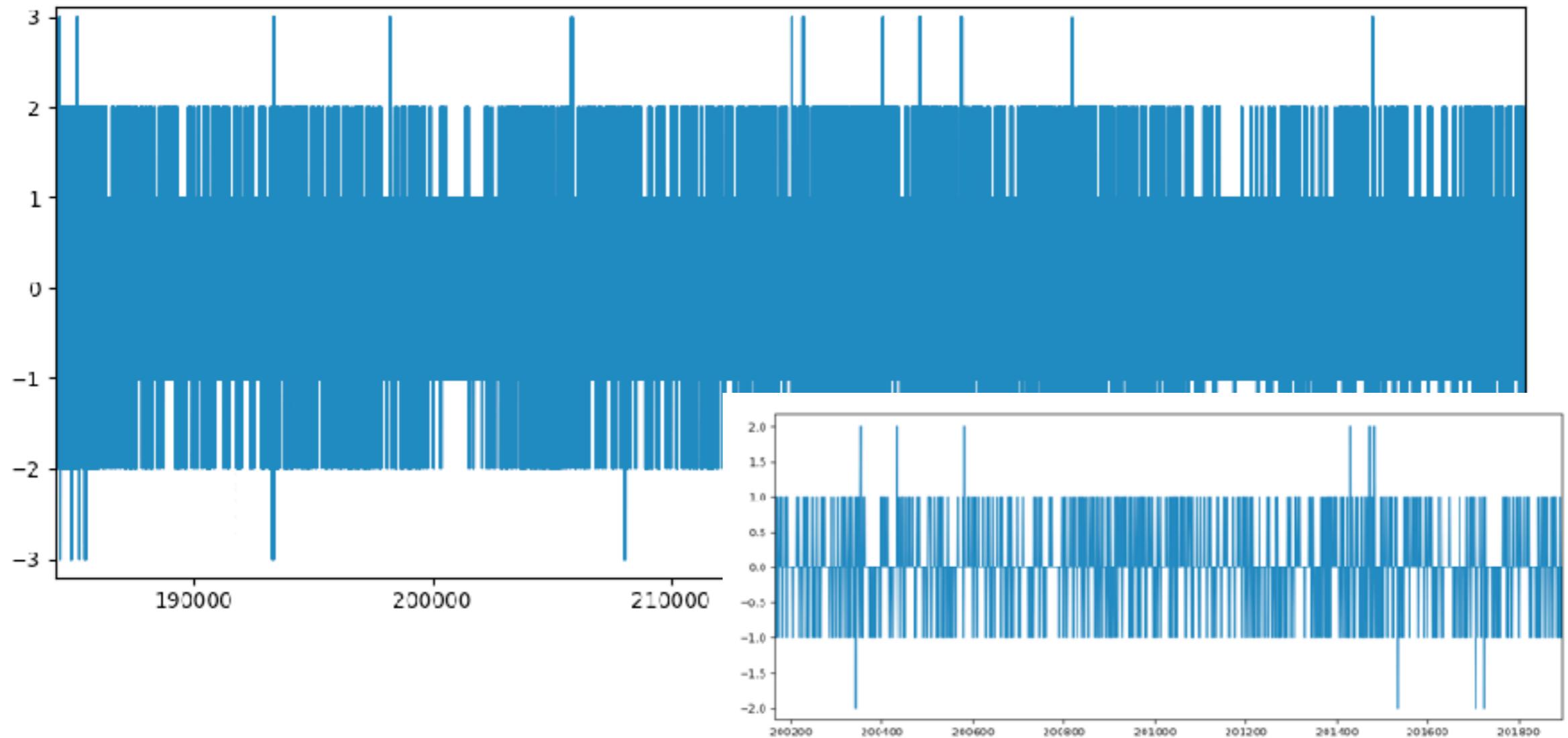
[2016-04-14 03:37:27] Networking problem! Figures - after I ask twitter followers to visit my site. Trying to recover...



Information here

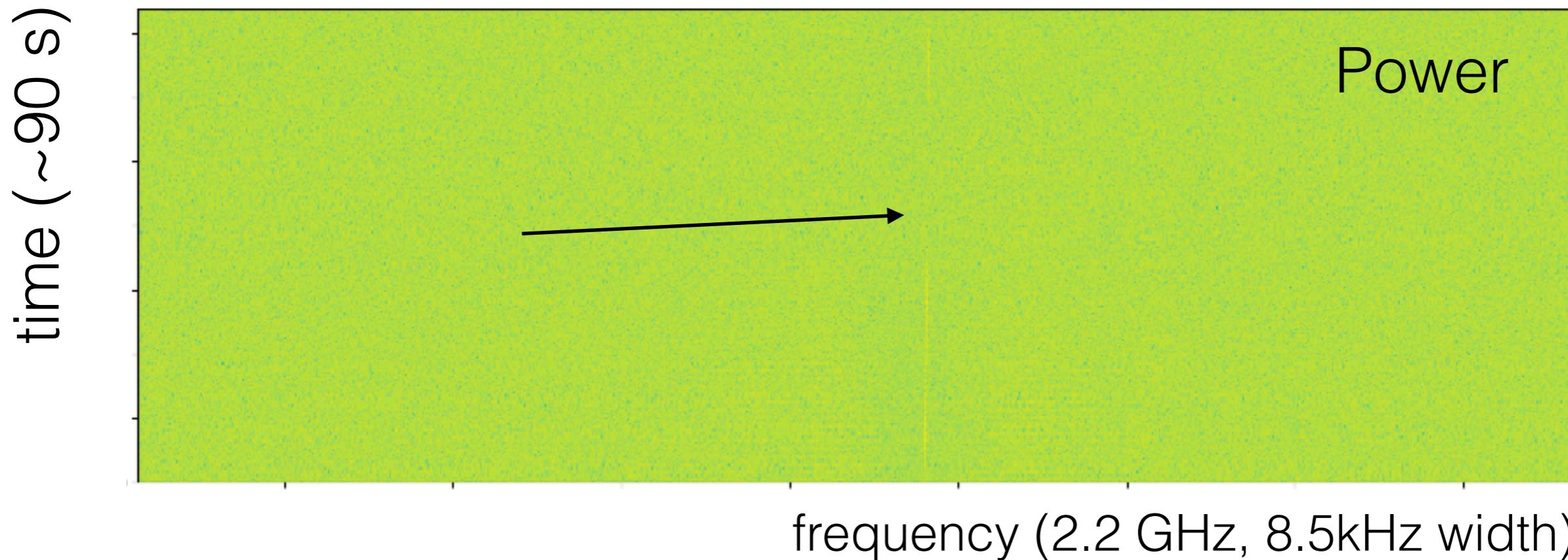
“Carrier Frequency”
1 - 10 GHz

What does SETI data look like?

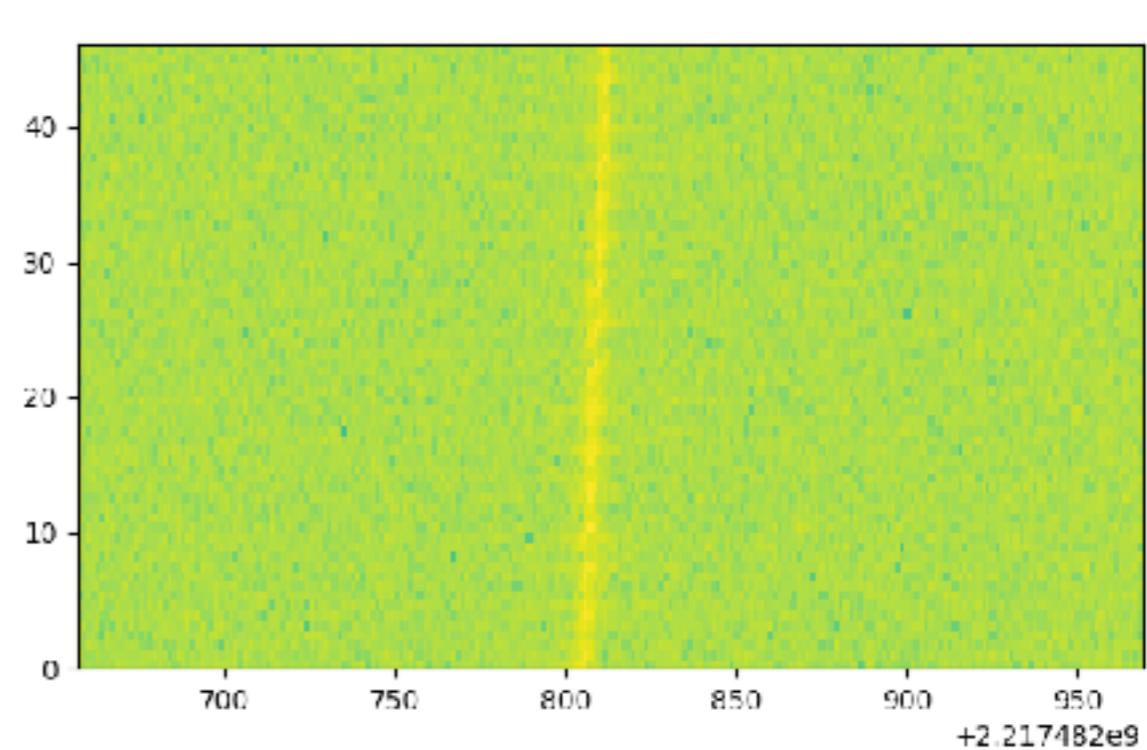


Signal + background noise
This is a “high power” signal.

Spectrogram

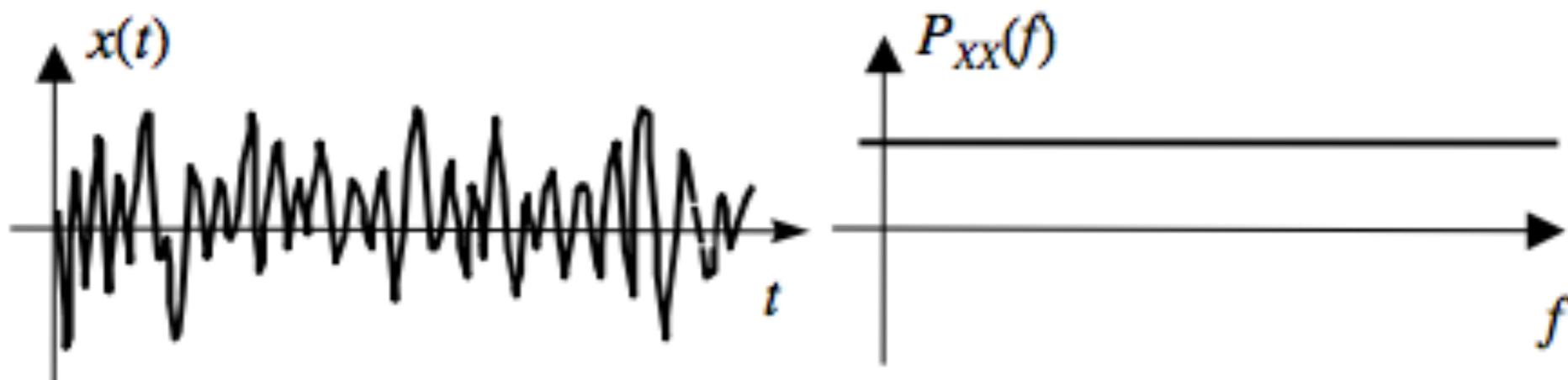
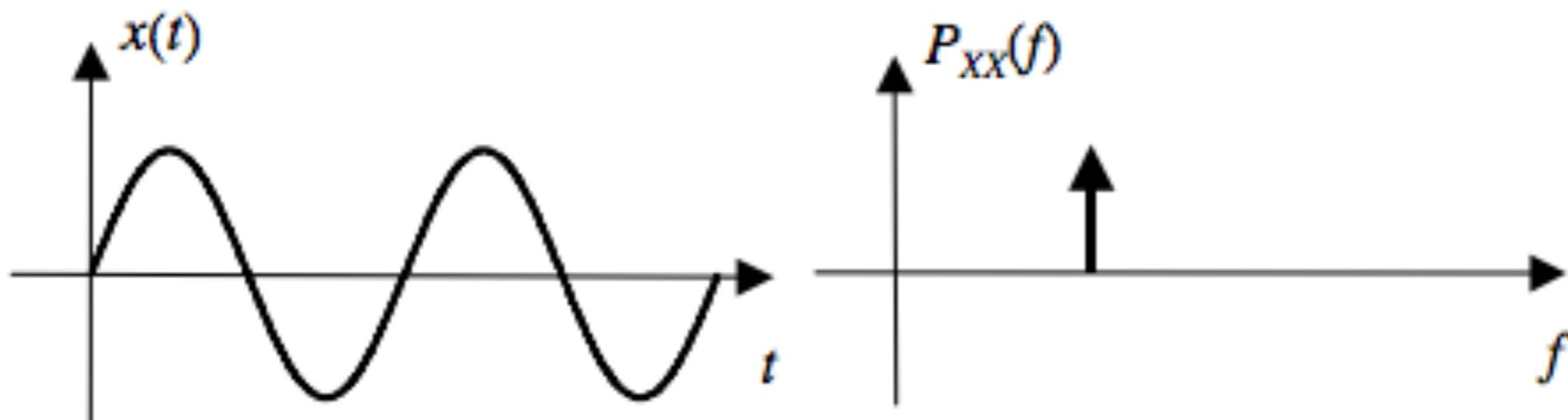


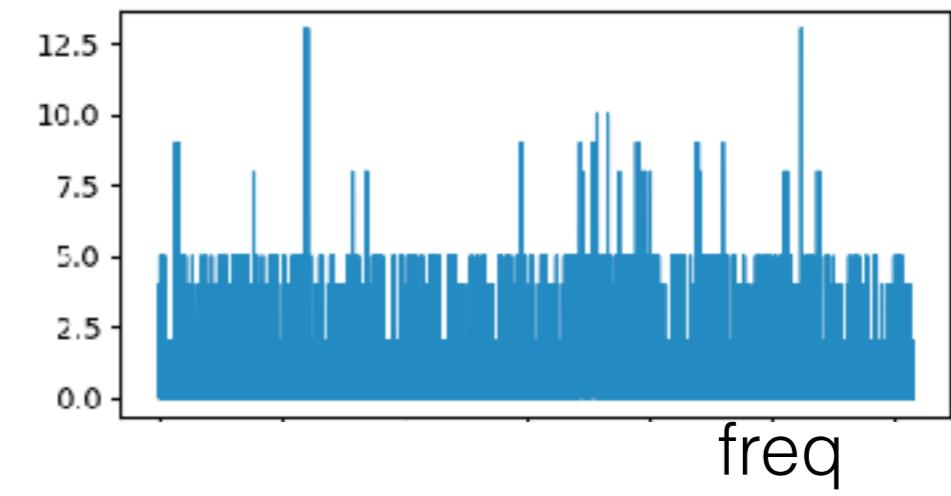
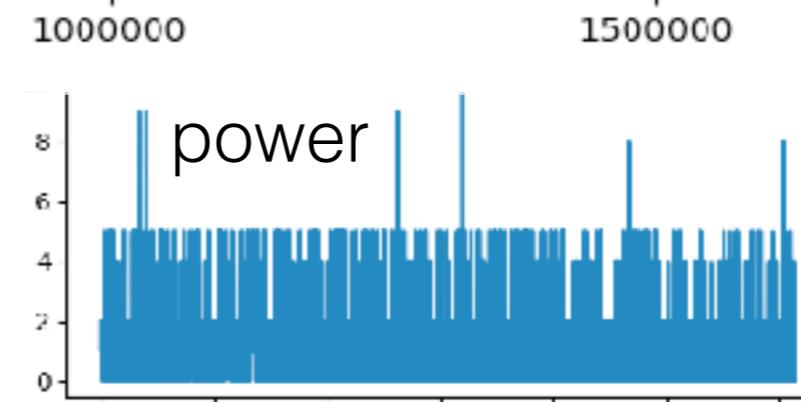
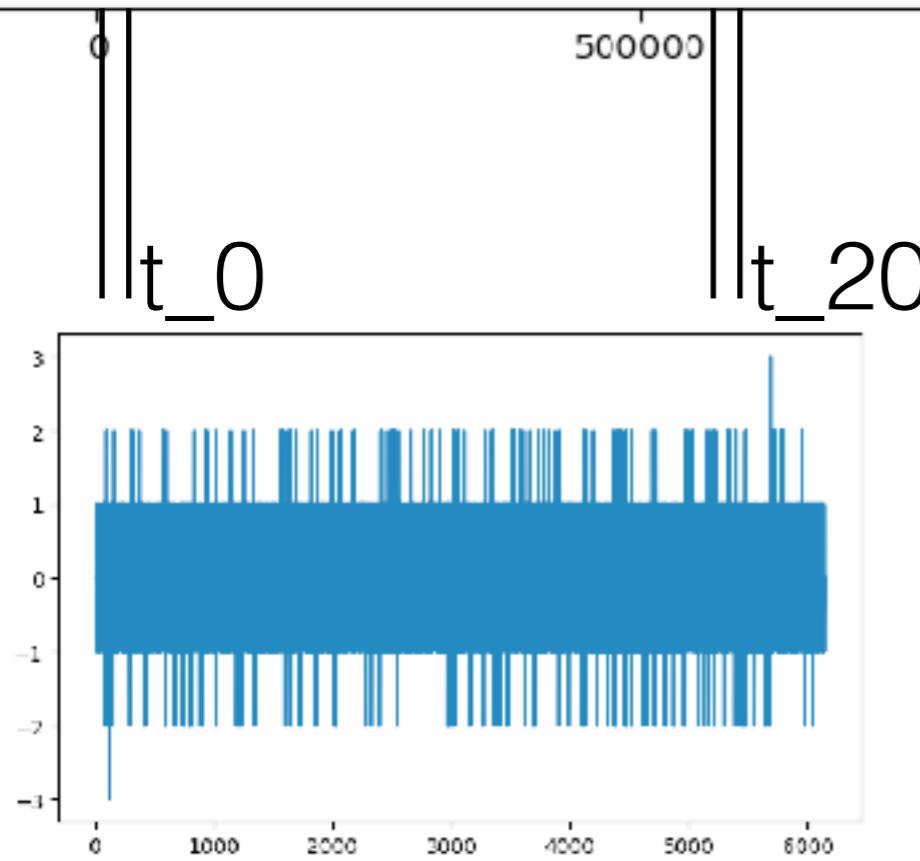
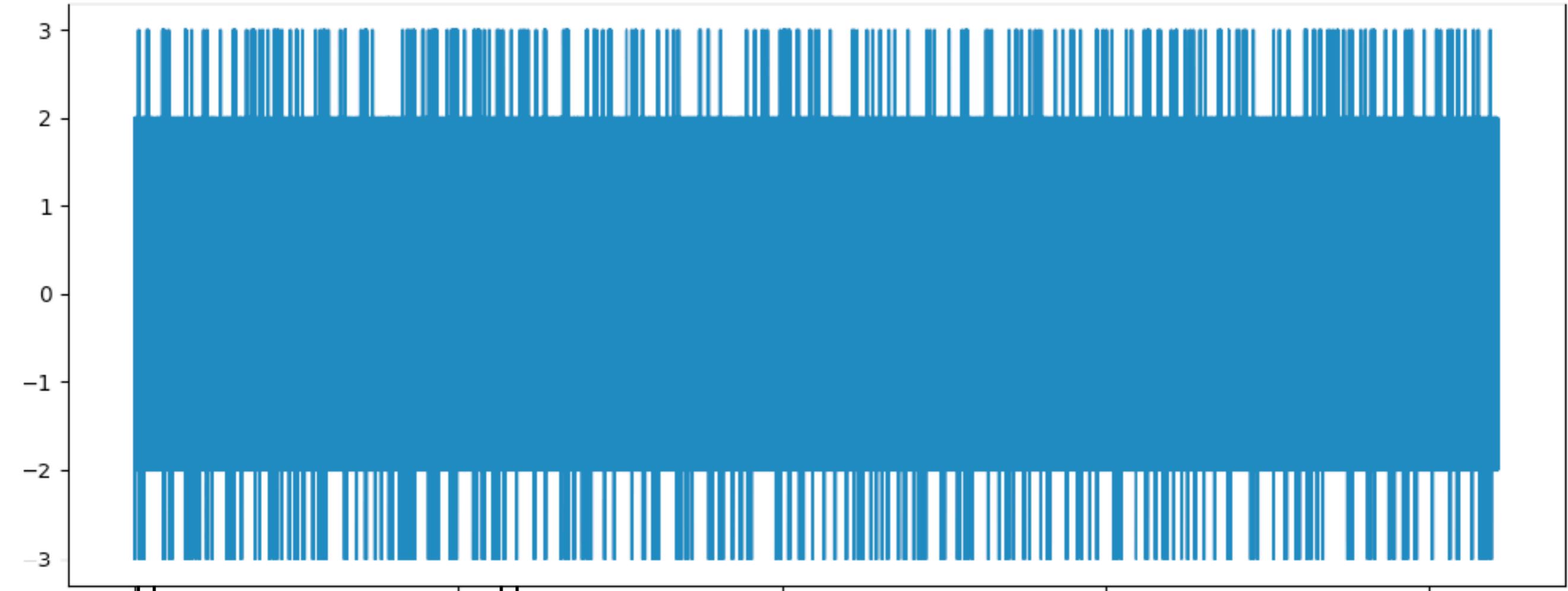
Narrow Band
Carrier Frequency

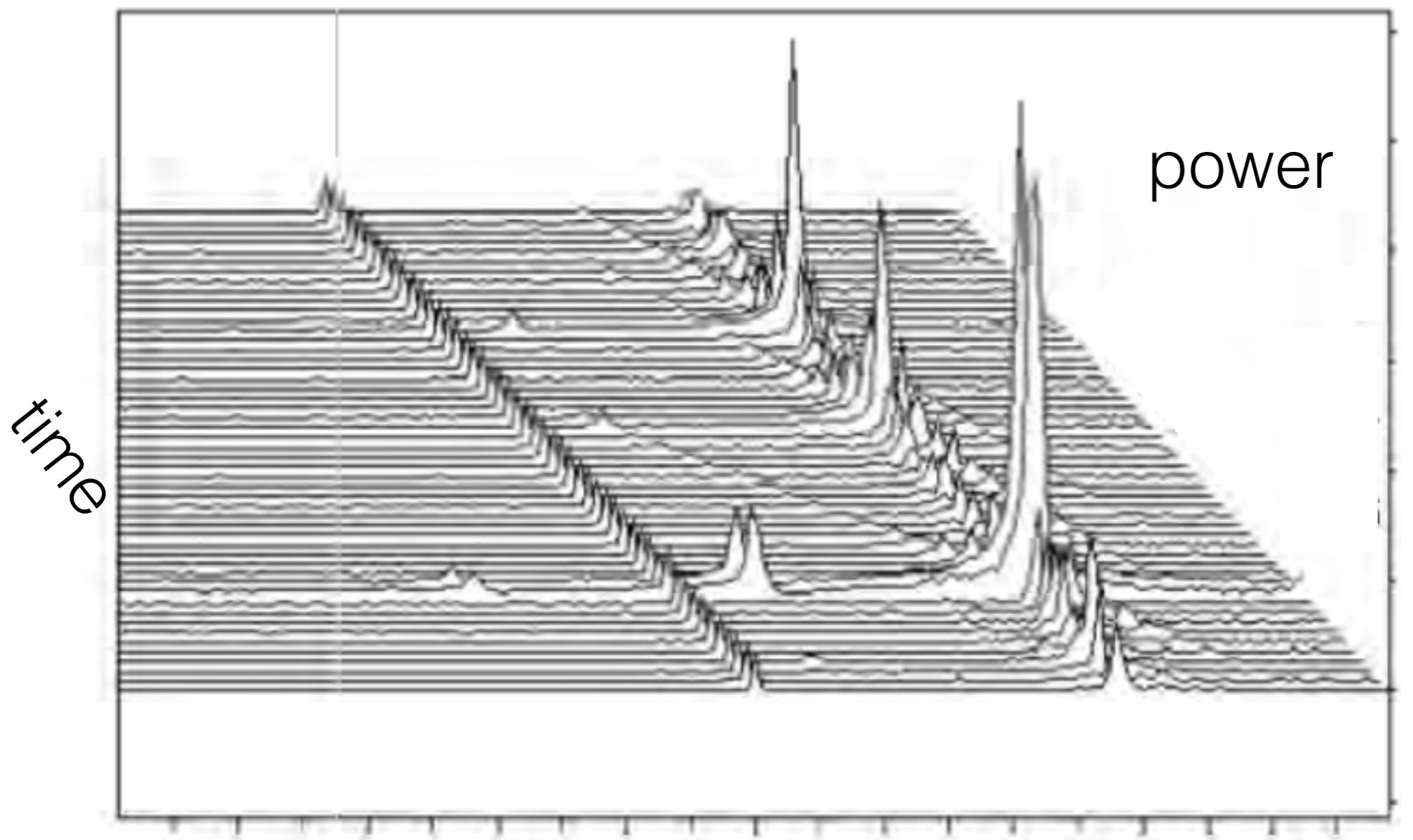


How do we build a spectrogram?

Step 1. Understand Power spectrum

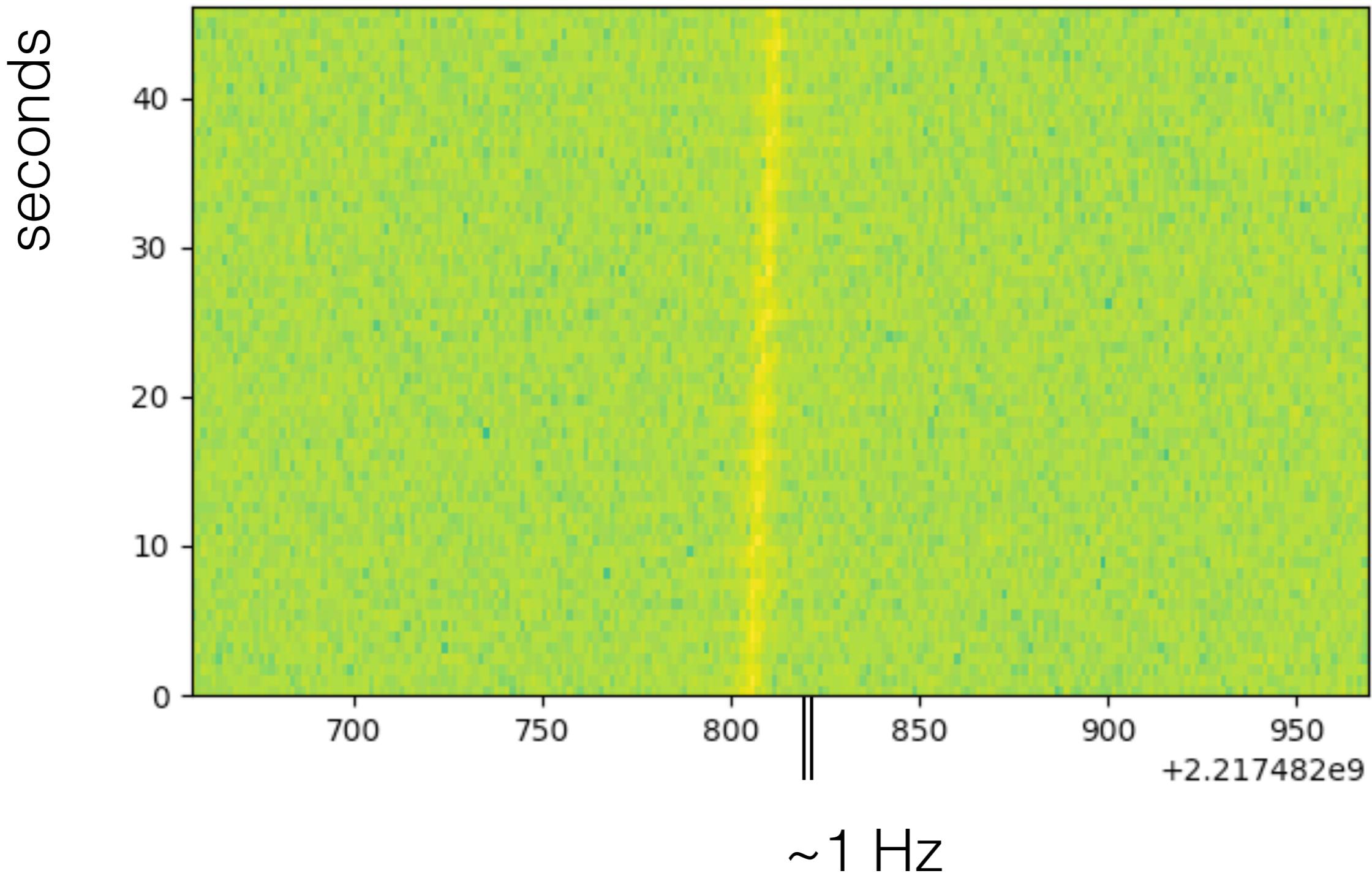




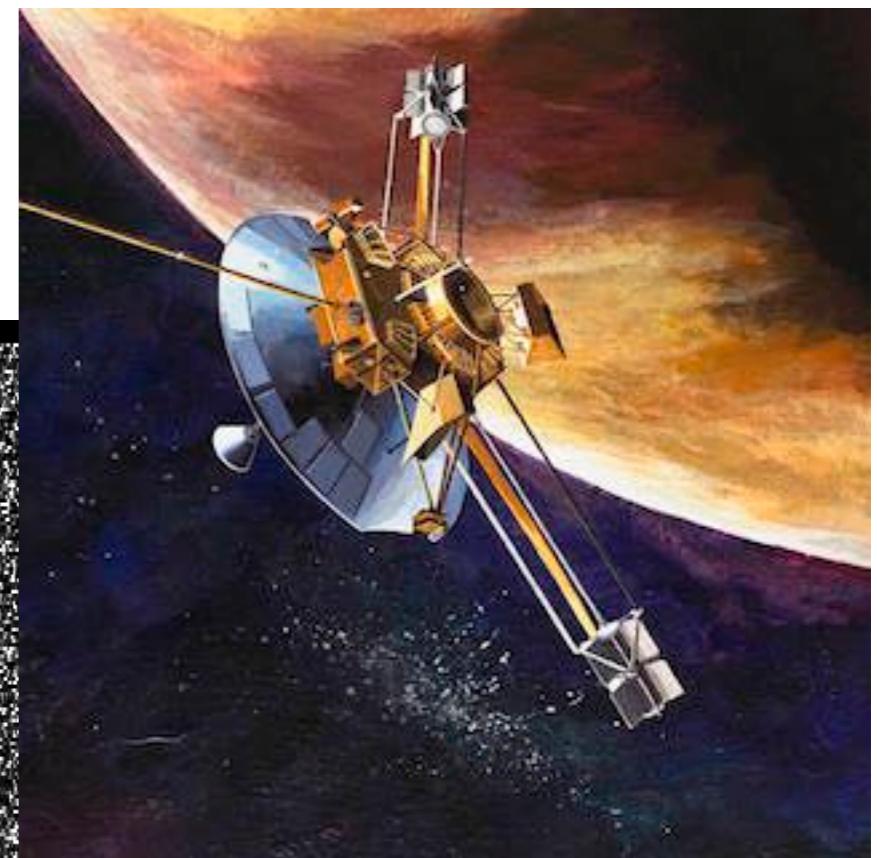
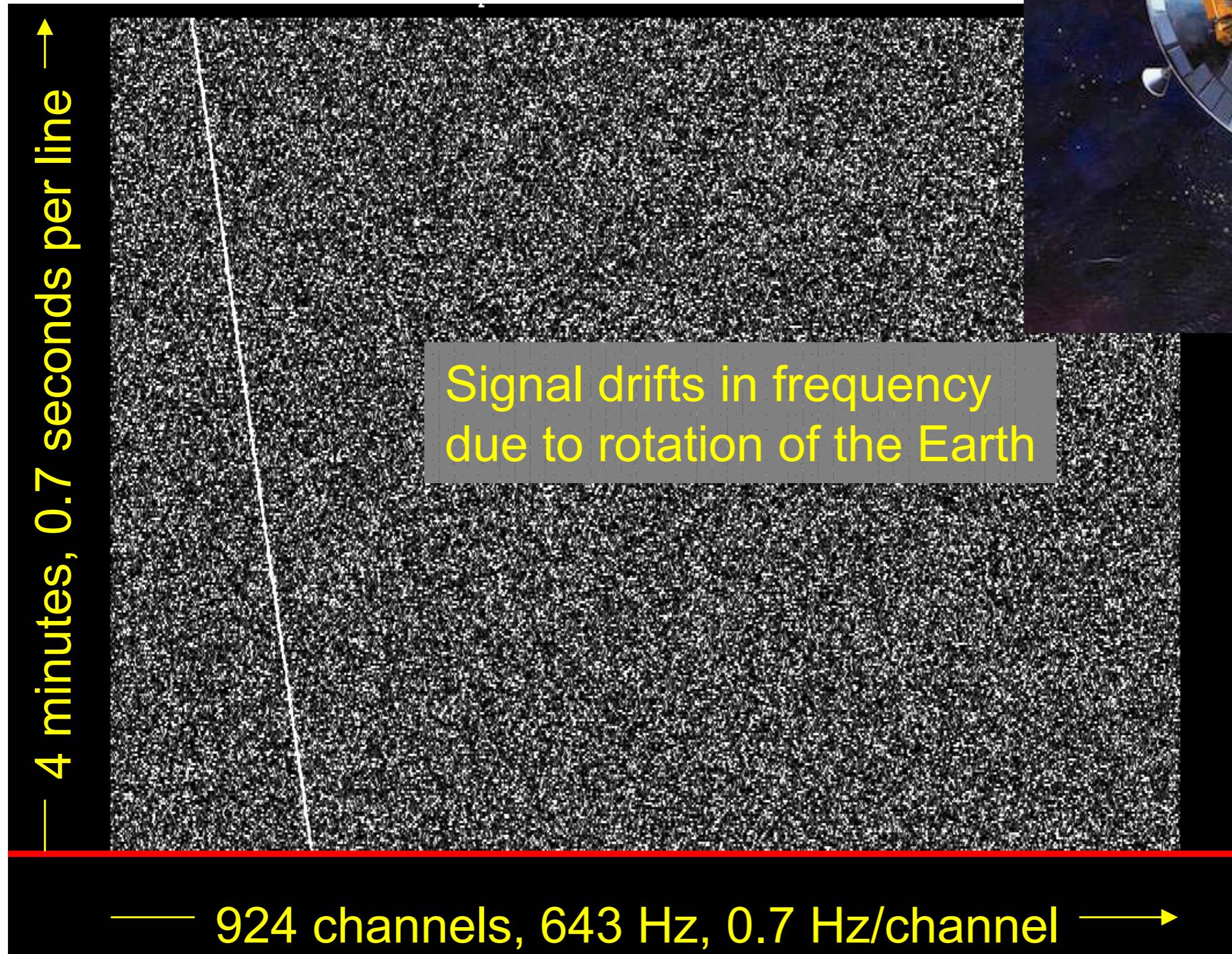


frequency

Also called “waterfall” plots

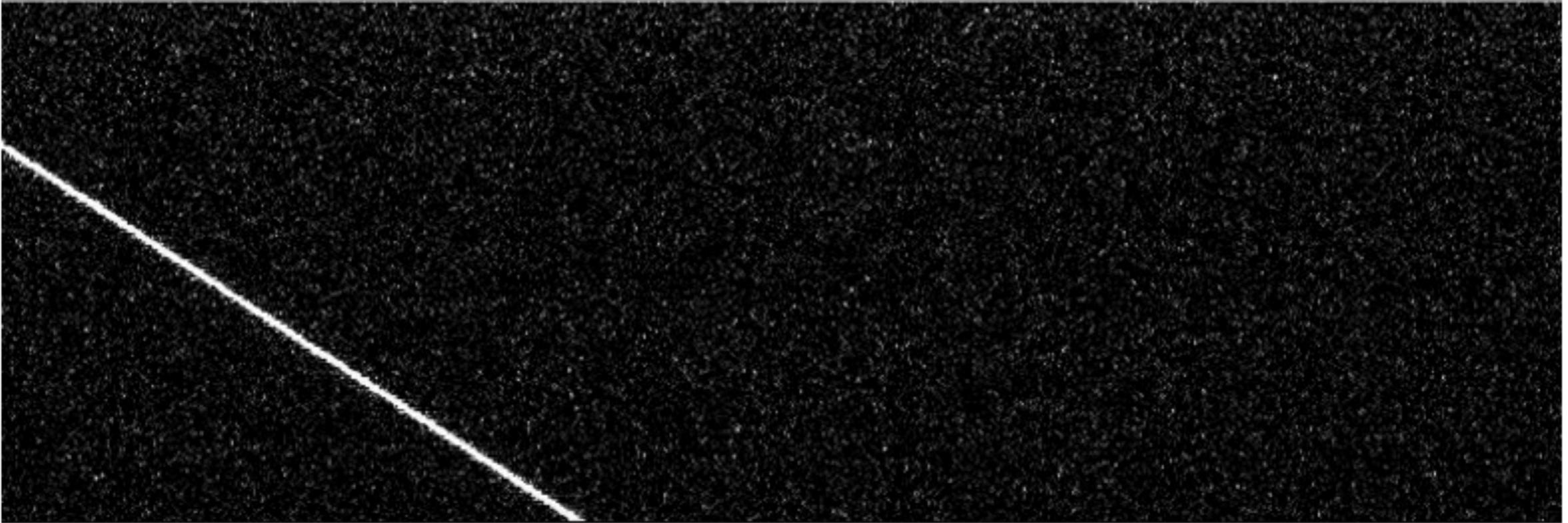


Carrier signal from Pioneer 10



Rosetta Aug 20, 2014

Waterfall: File: 2014-08-20_04-40-54_UTC.act17870.dx2003.id-3.L.archive-compamp
Center Freq: 8421.527467 MHz Subband: 0131 BW: 533.3 Hz #Half Frames: 0256 ActId: 17870



Waterfall: File: 2014-08-13_04-50-40_UTC.act17817.dx2000.id-4.L.archive-compamp
Center Freq: 8421.440000 MHz Subband: 0825 BW: 533.3 Hz #Half Frames: 0256 ActId: 17817

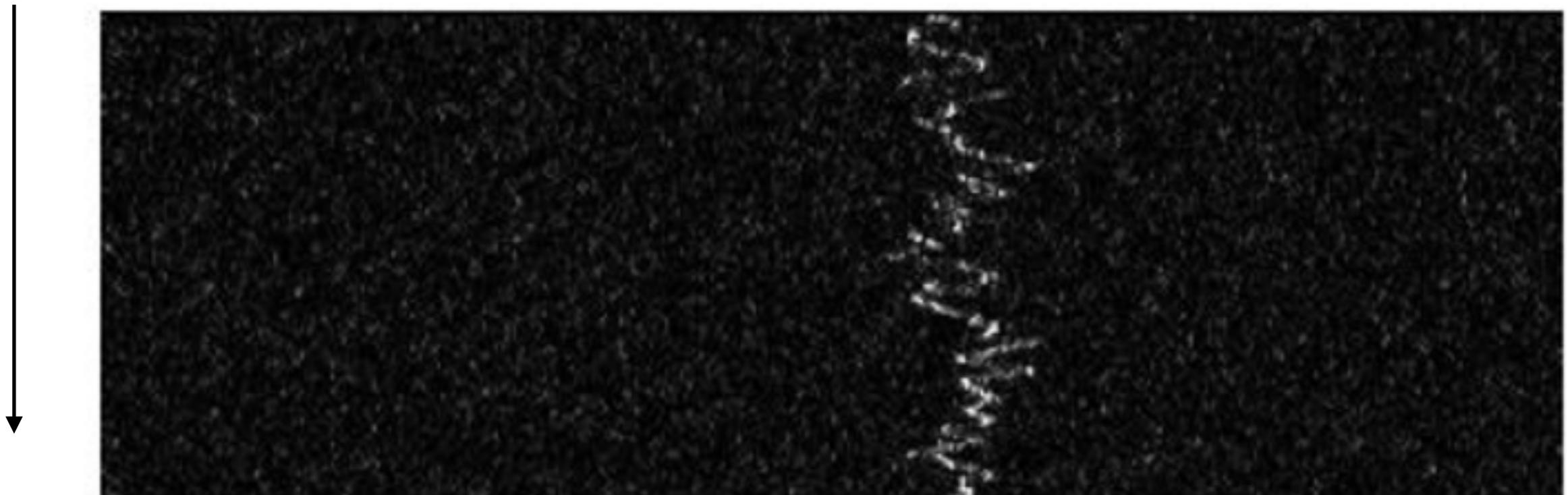


Voyager Aug 13, 2014

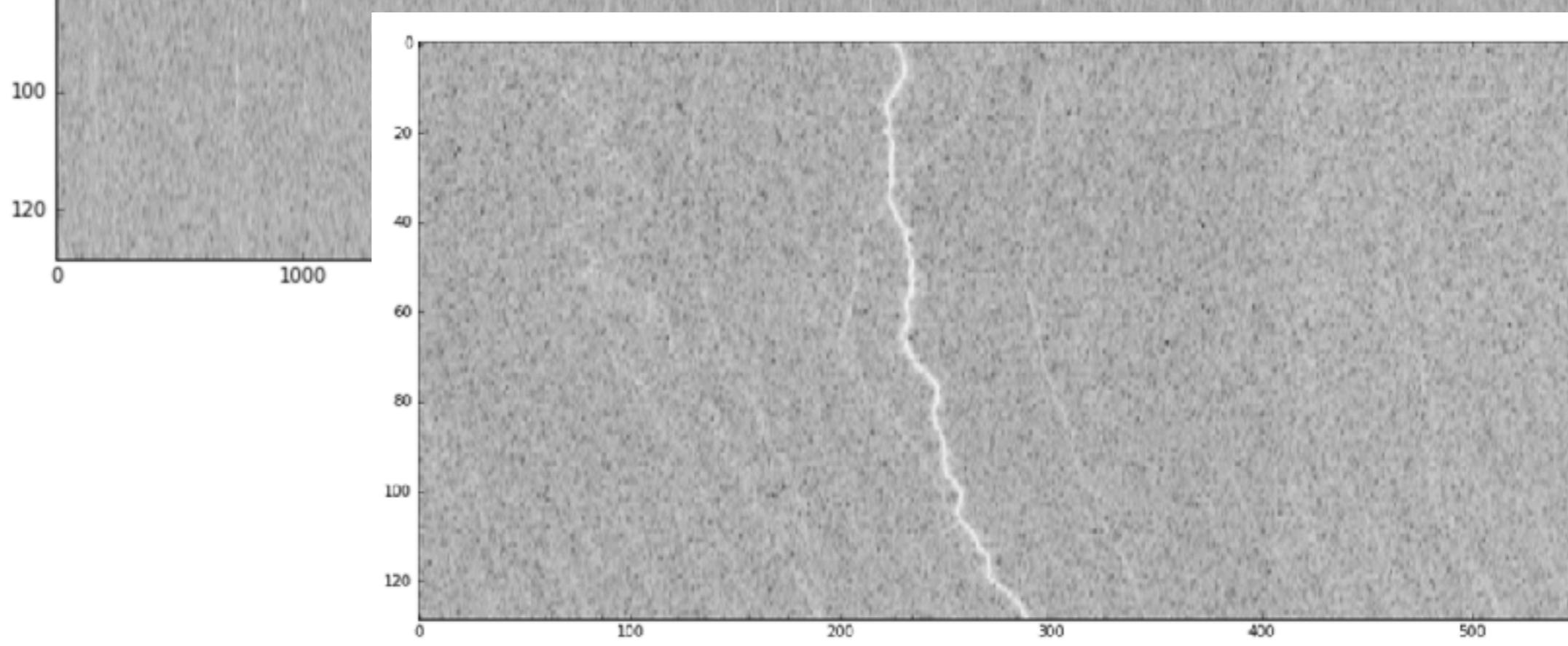
Waterfall: File: 2014-08-13_03-33-21.UTC.act17805.dx2002.id-3.R.archive-compamp
Center Freq: 8419.338133 MHz Subband: 1312 BW: 533.3 Hz #Half Frames: 0256 ActId: 17805

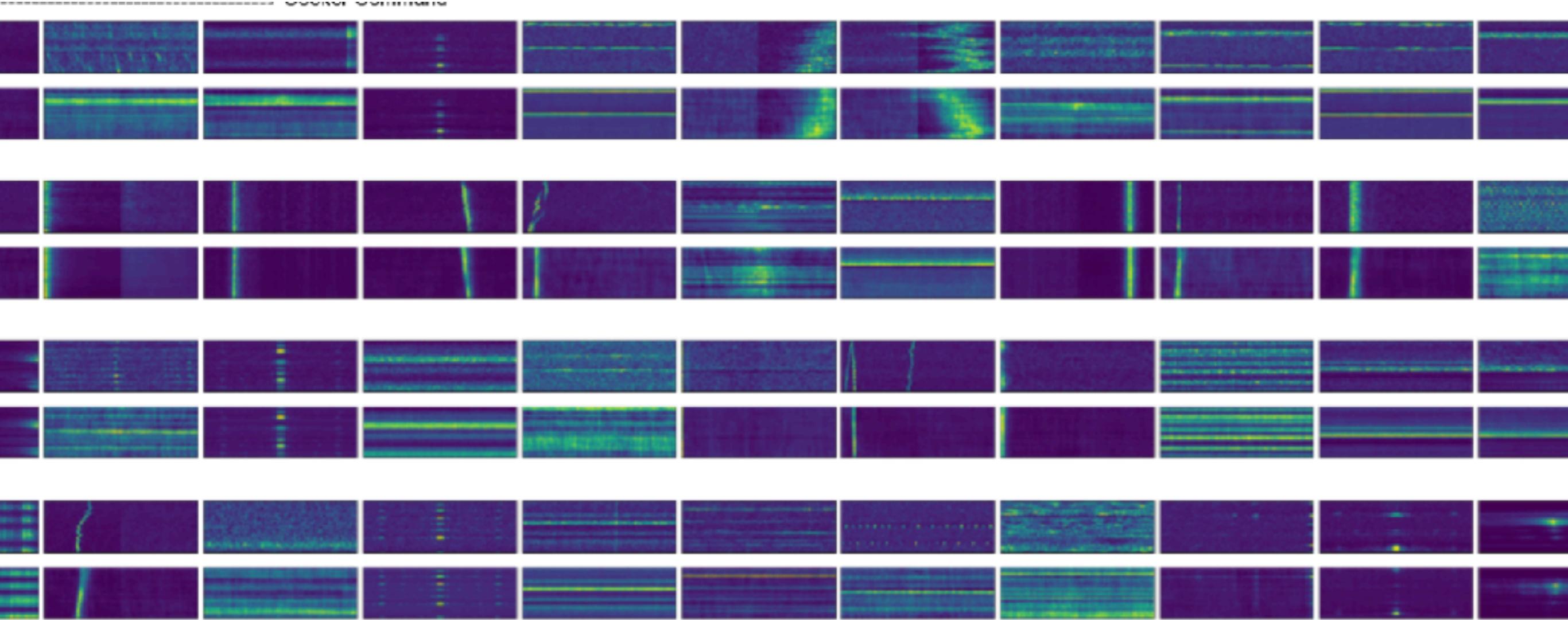
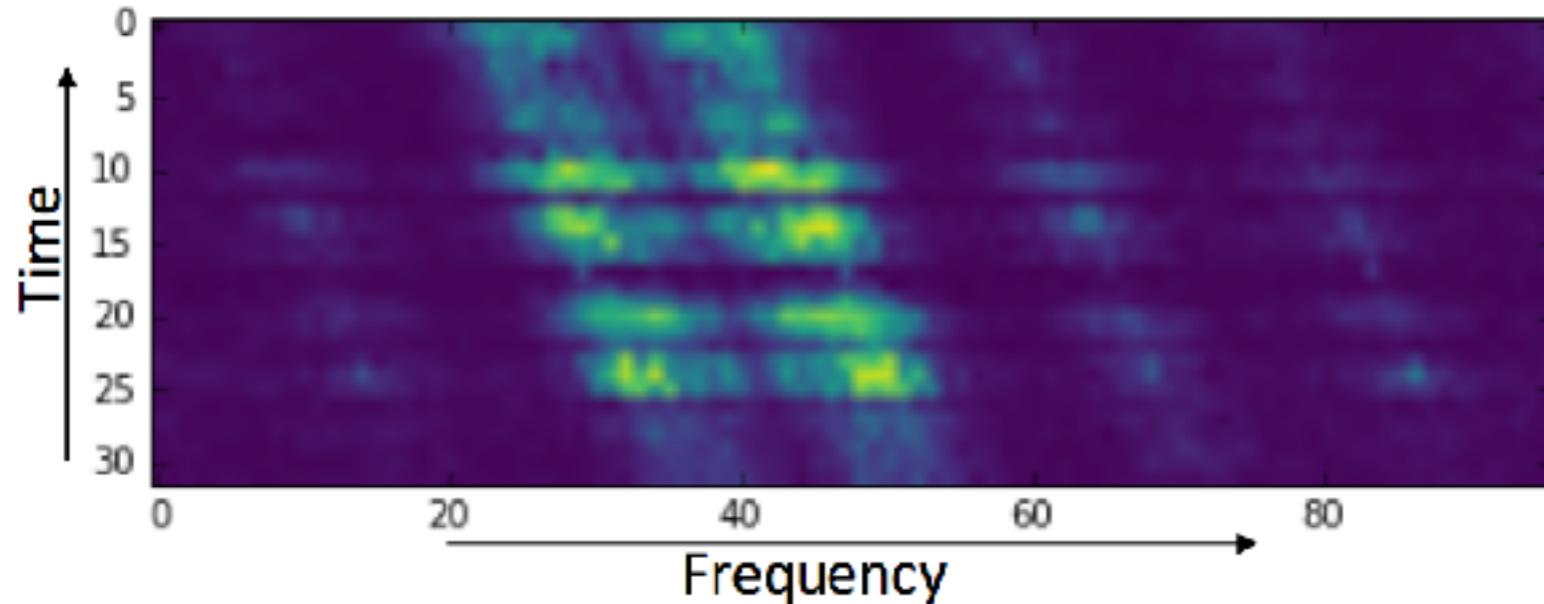
Waterfall: File: 2014-08-13_03-33-21.UTC.act17805.dx2002.id-3.L.archive-compamp
Center Freq: 8419.338133 MHz Subband: 1312 BW: 533.3 Hz #Half Frames: 0256 ActId: 17805

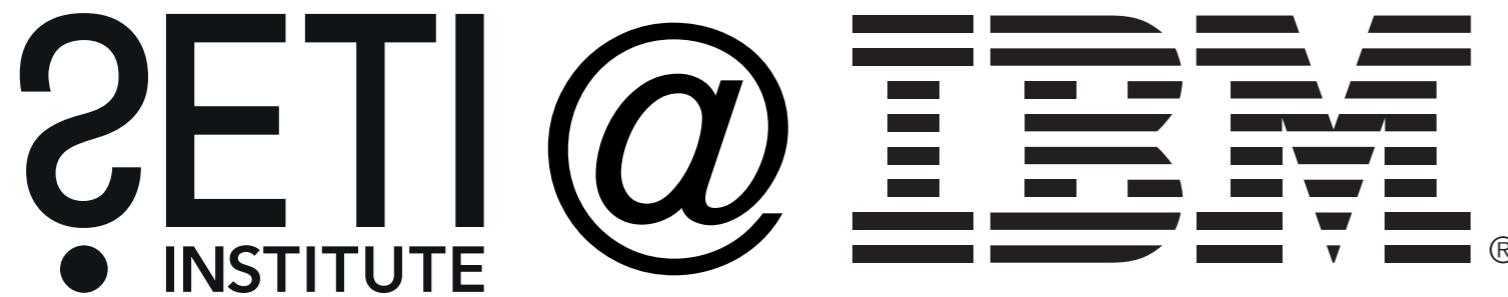
time



frequency





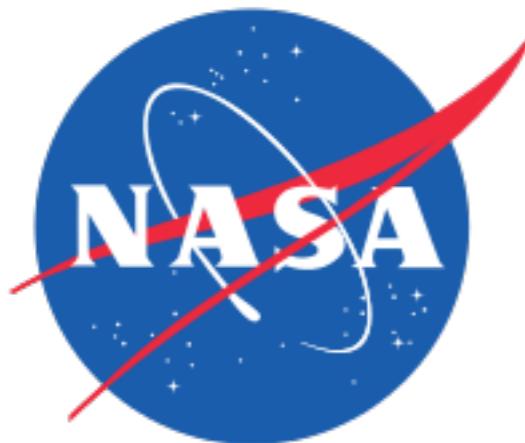


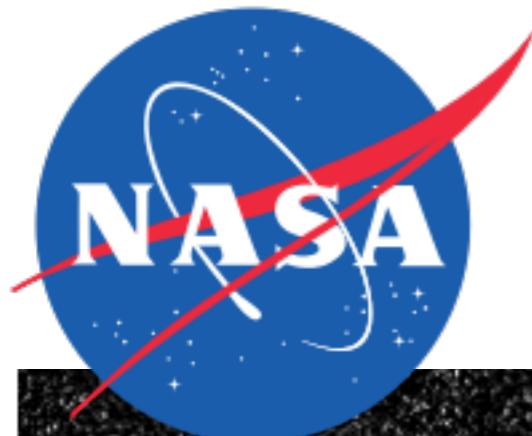
2015 : IBM Emerging Technologies / jStart Group +
SETI + NASA

jStart Goal: Exercise IBM's latest data management
and analytics offerings for worthy projects, with needs
close to business.

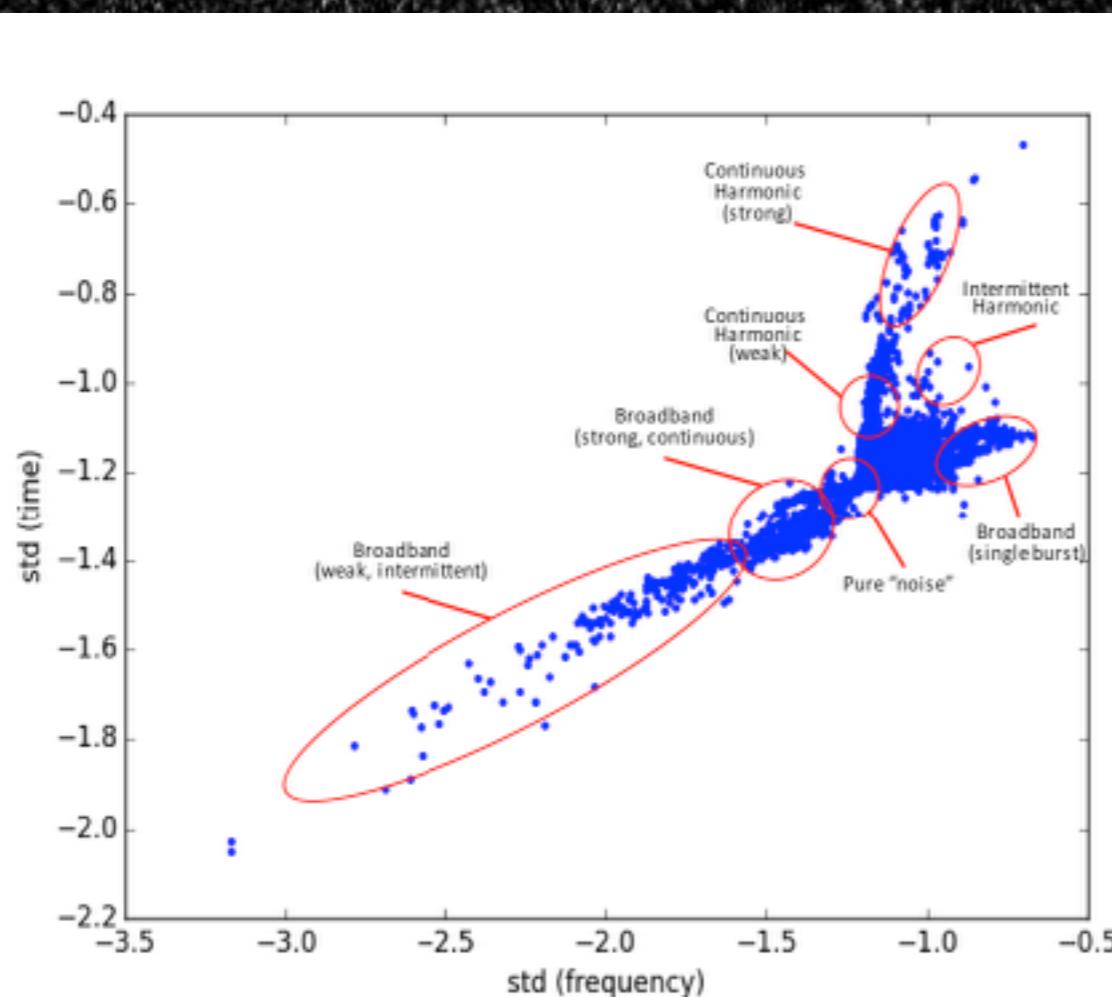
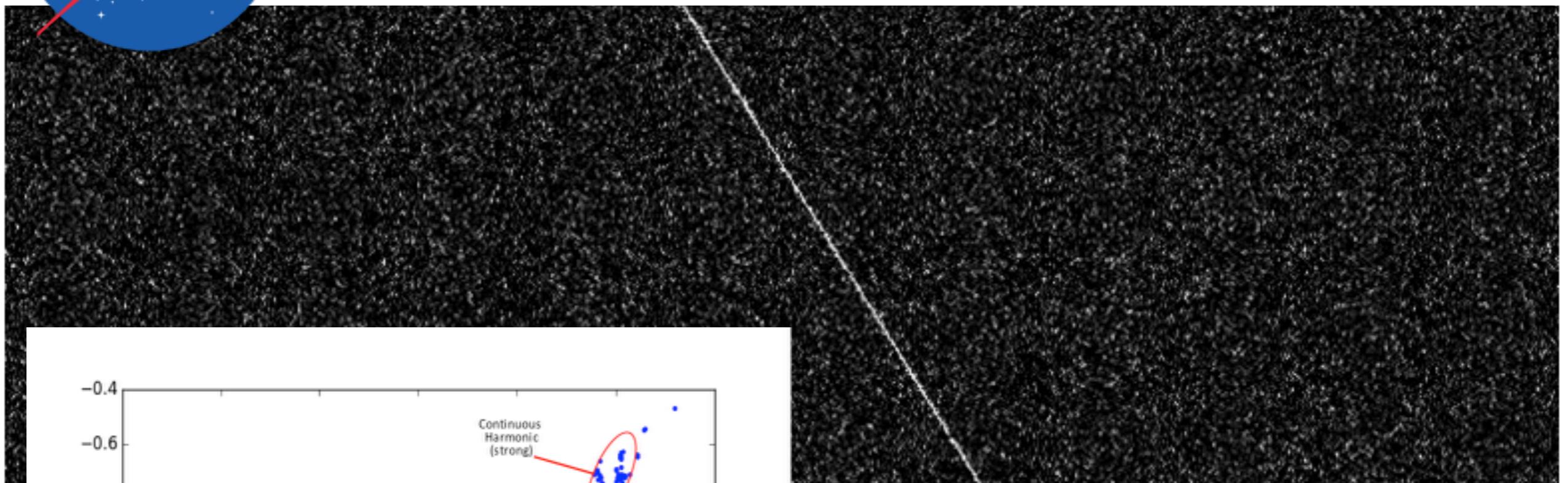
Object Storage + Apache Spark via Softlayer/Bluemix

Unclassified “Candidate” triggered events





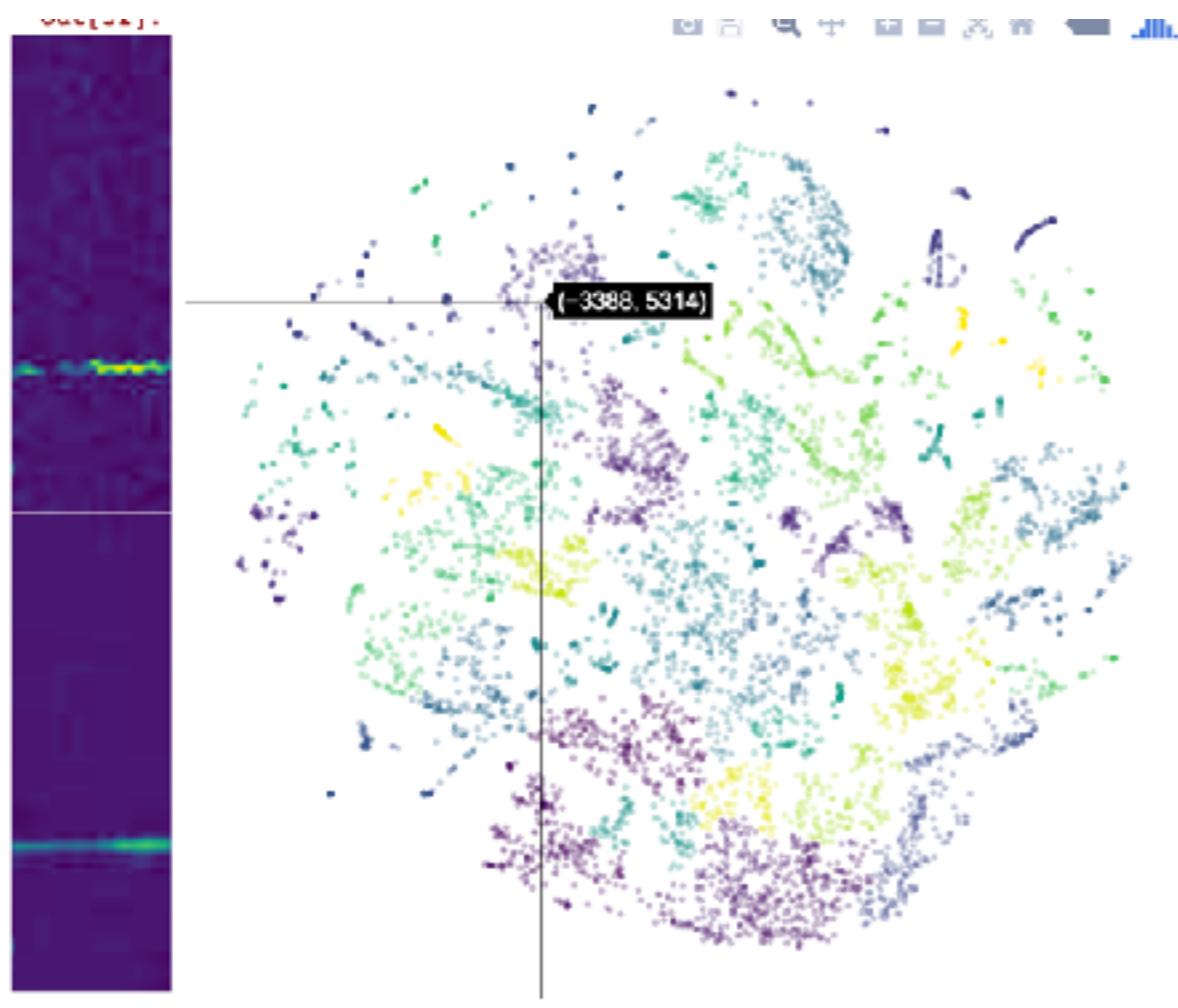
Unclassified Signals. Traditional Physicist Manual “feature extraction”



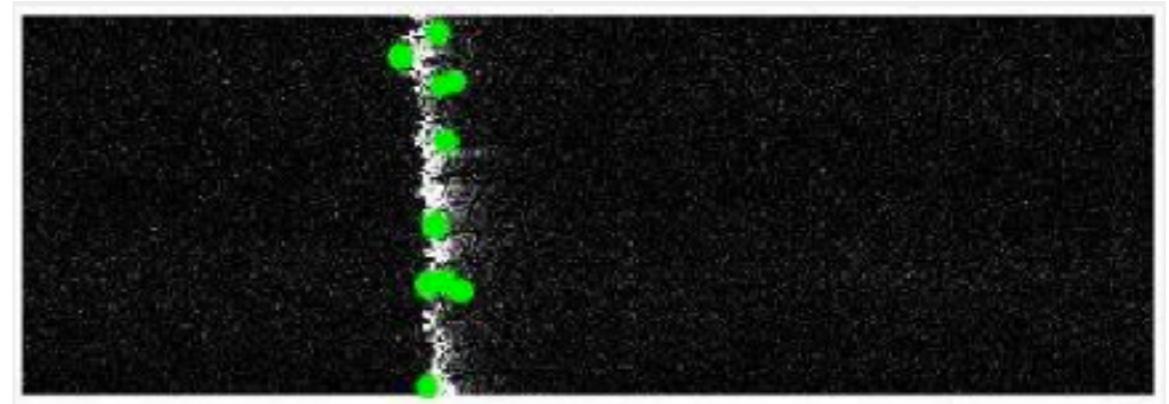
- 3rd/4th-Nth moments
- Excess Kurtosis
- Entropy
- Gradient, Asymmetry

IBM Research South Africa Cognitive Astronomy (F. Luus)

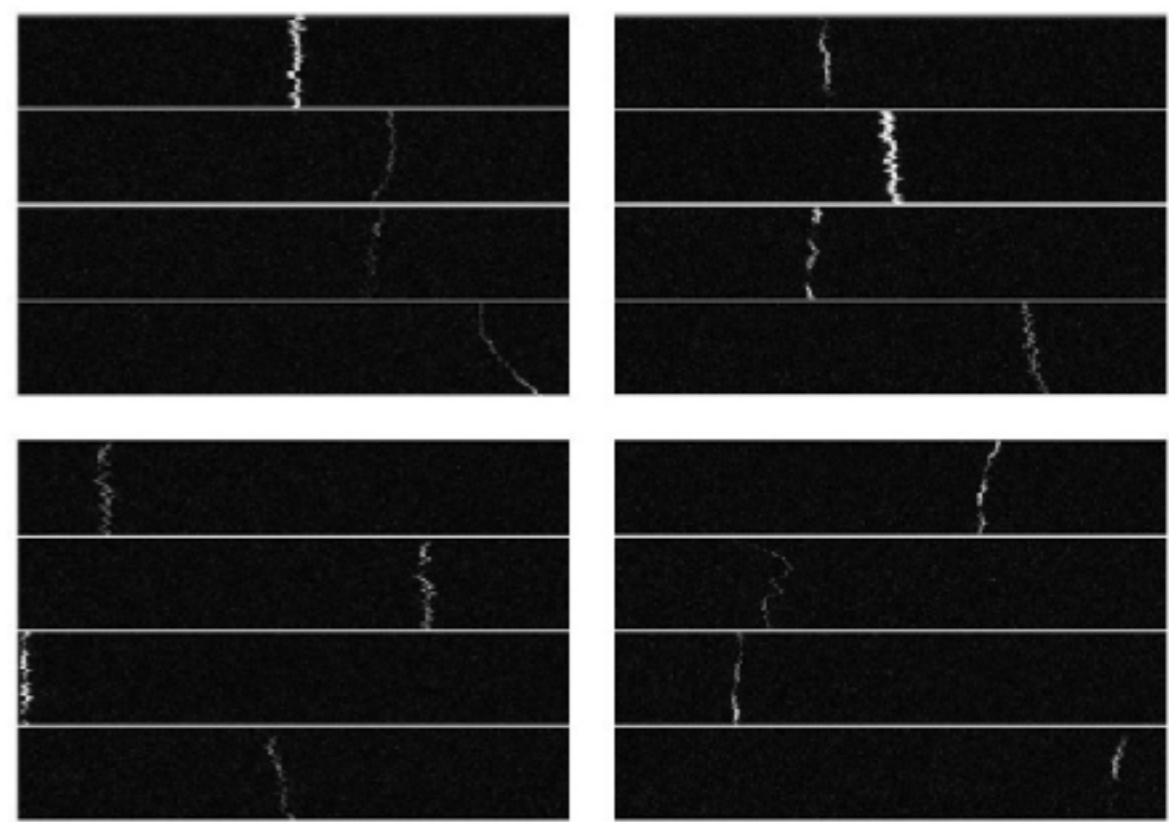
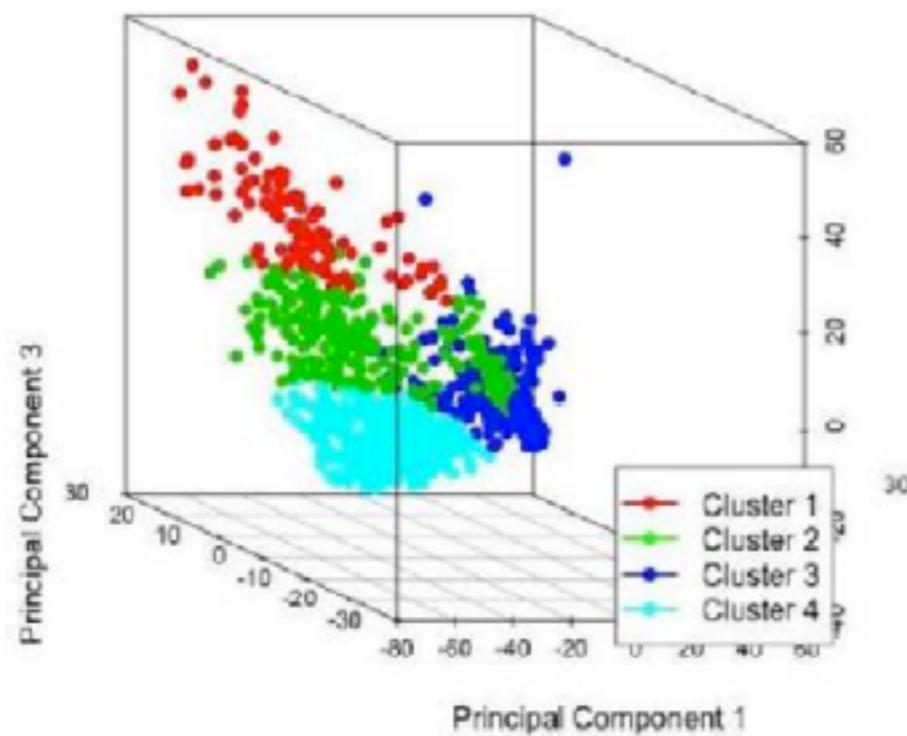
Feature Extraction / Autoencoder / tSNE



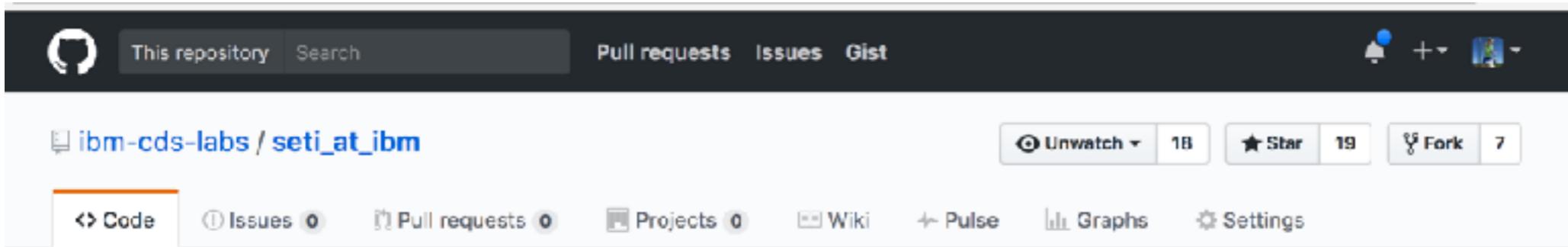
SIFT feature extraction + Clustering -> ‘squiggles’



k-means



SETI@IBMCLOUD is available since September 2016.



Public Access to SETI “candidate” events (2013 to 2015)

- Signal MetaData (from SonATA)
- Raw complex-valued time-series data
- `ibmseti` Python package

Introduction Notebooks

After you work through these notebooks, you will have used the HTTP API to access the SETI data, saved that data to your IBM Object Storage service, produced a spectrogram from the raw SETI data, and extracted some features, which may be used in a machine-learning analysis.

- [Introduction to the HTTP API](#)
- [How to store data to your Bluemix Object Store](#)
- [Retrieve the data from Object Store and calculate a spectrogram](#)
- [Retrieve the data from Object Store and calculate features from the spectrogram](#)

Building on this work

What actionable outcome can we take from these works?

Are there ways to make improvements for

- 1) Quantitative understanding of SonATA triggering
- 2) Signal Classifications
- 3) Trigger Efficiencies

Simulated ('labeled') data set

1. Test SonATA quantitatively
2. Build robust signal classification tools
 - Add to Data Analysis Pipeline
 - potentially move classifications “upstream”

With a highly accurate classifier:

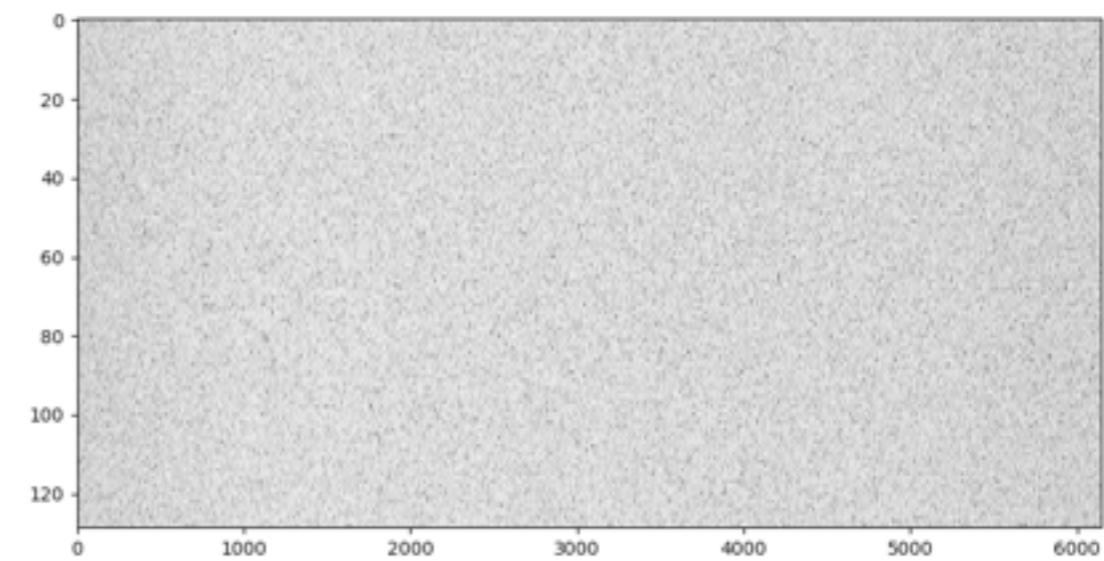
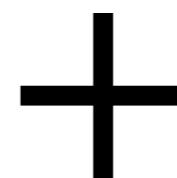
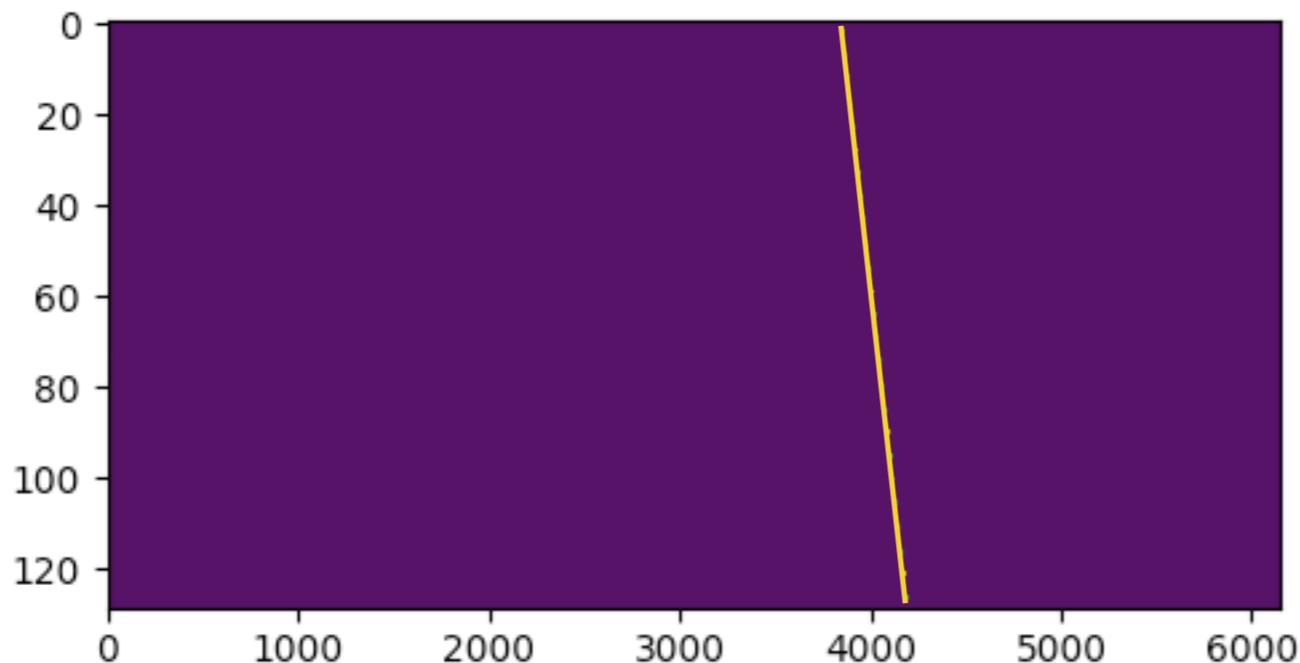
1. Improve observations
 - observe signal class changes
2. Different Observational Decision Making
3. Search for persistence of other signal types

Other outcomes from well-trained signal classification model:

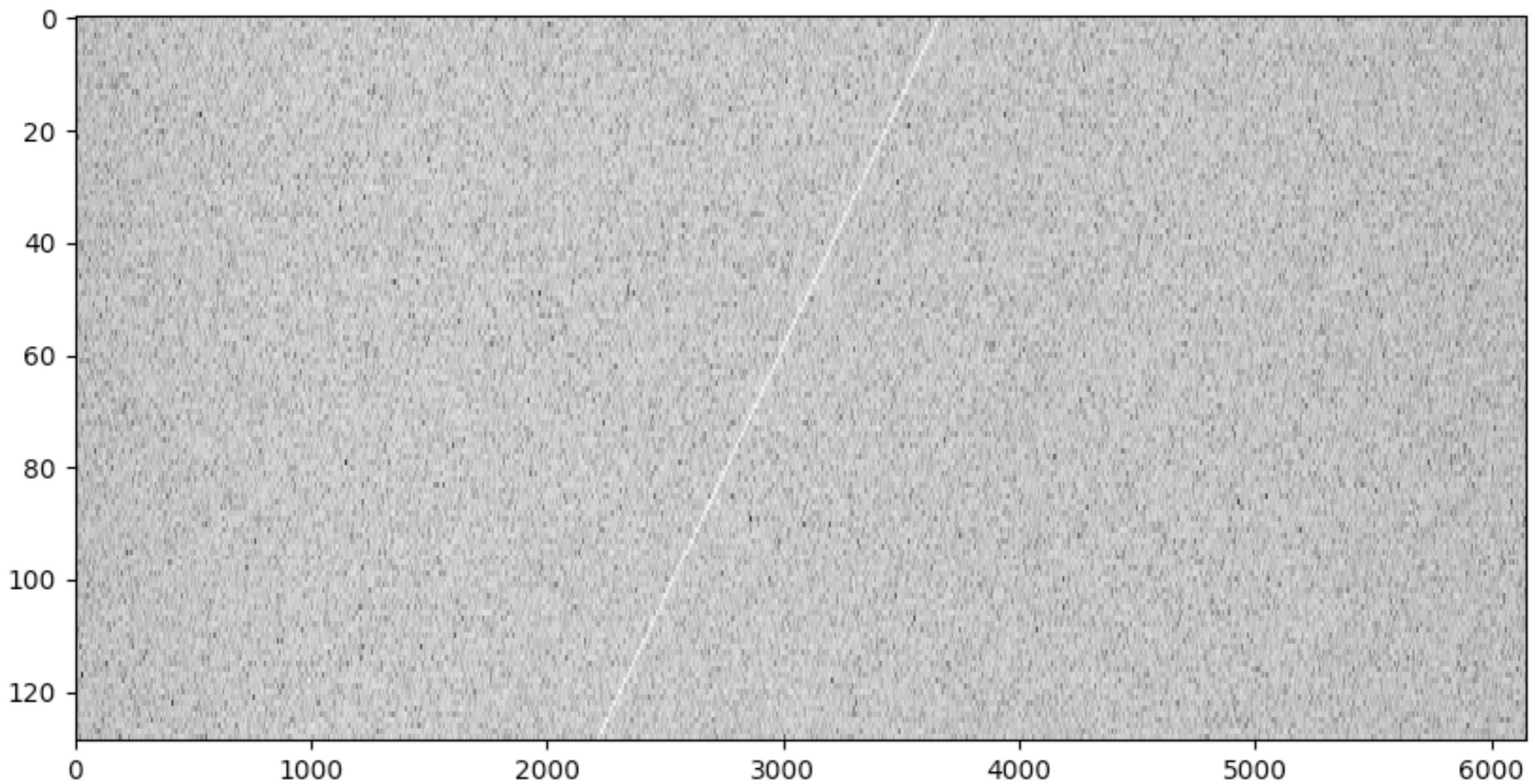
1. Reuse Model to train on other signal types
2. Breakthrough Listen
3. Applicable to other problems

Simulation Data Set

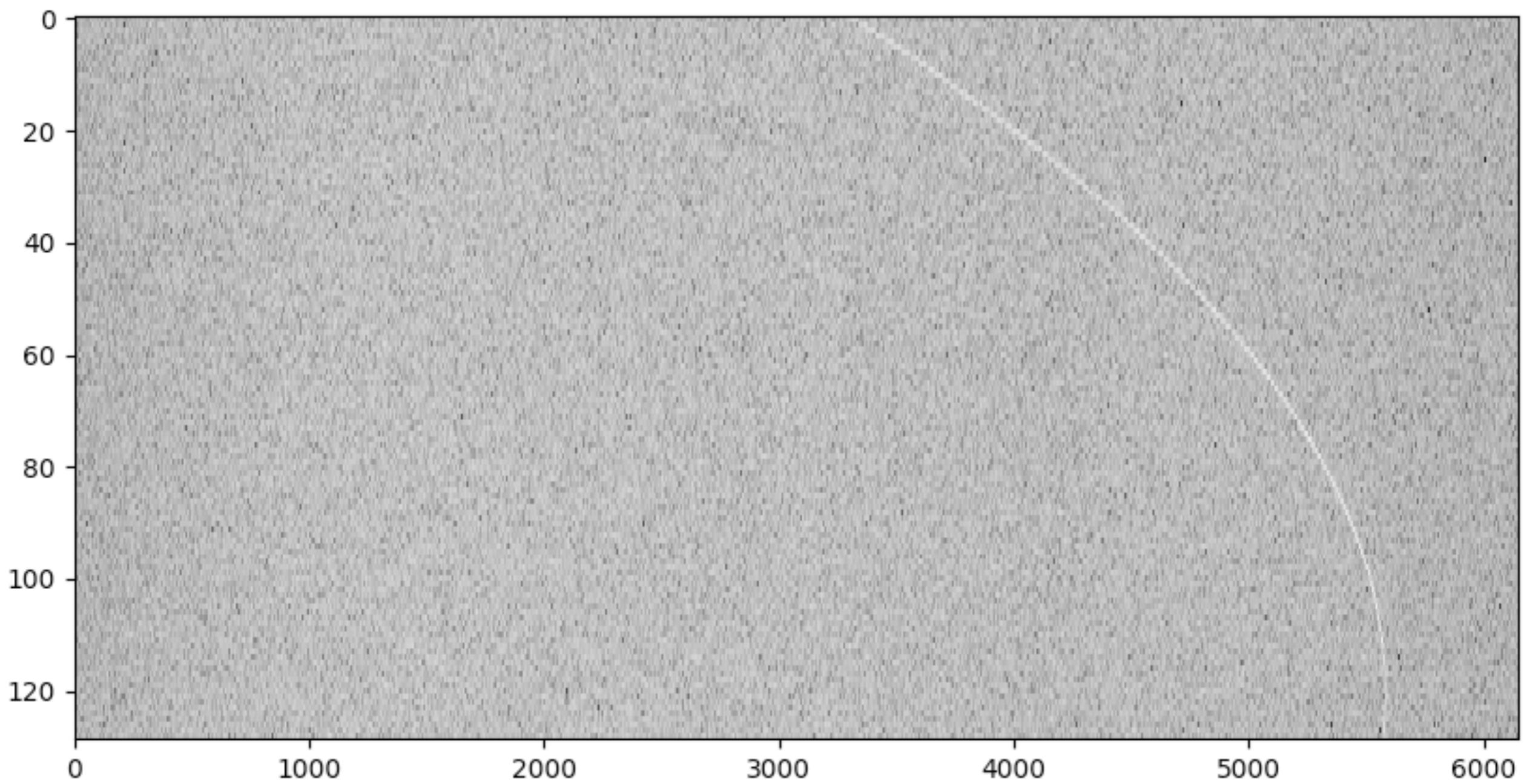
6 classes: 75k of each class



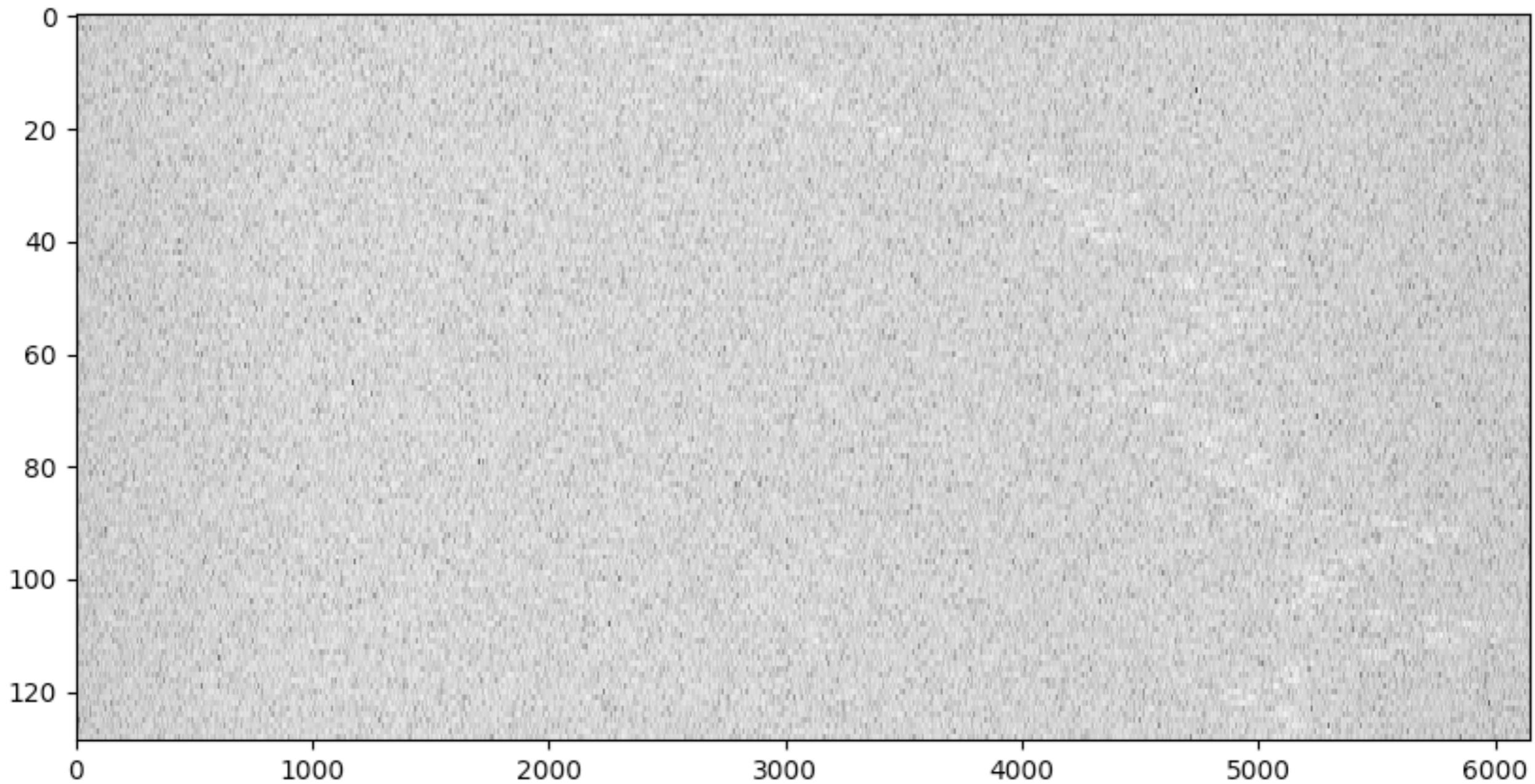
narrowband



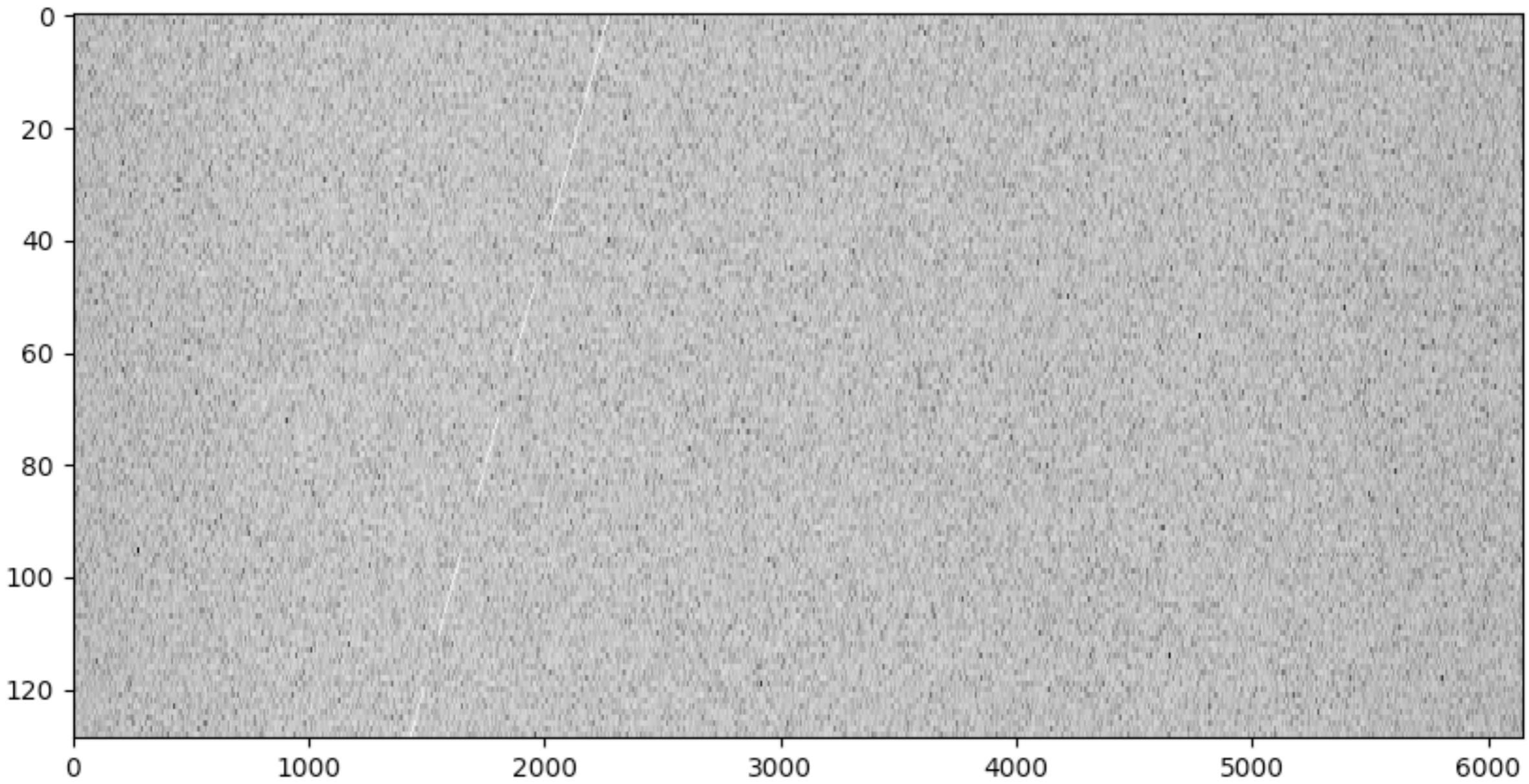
narrowbanddrd



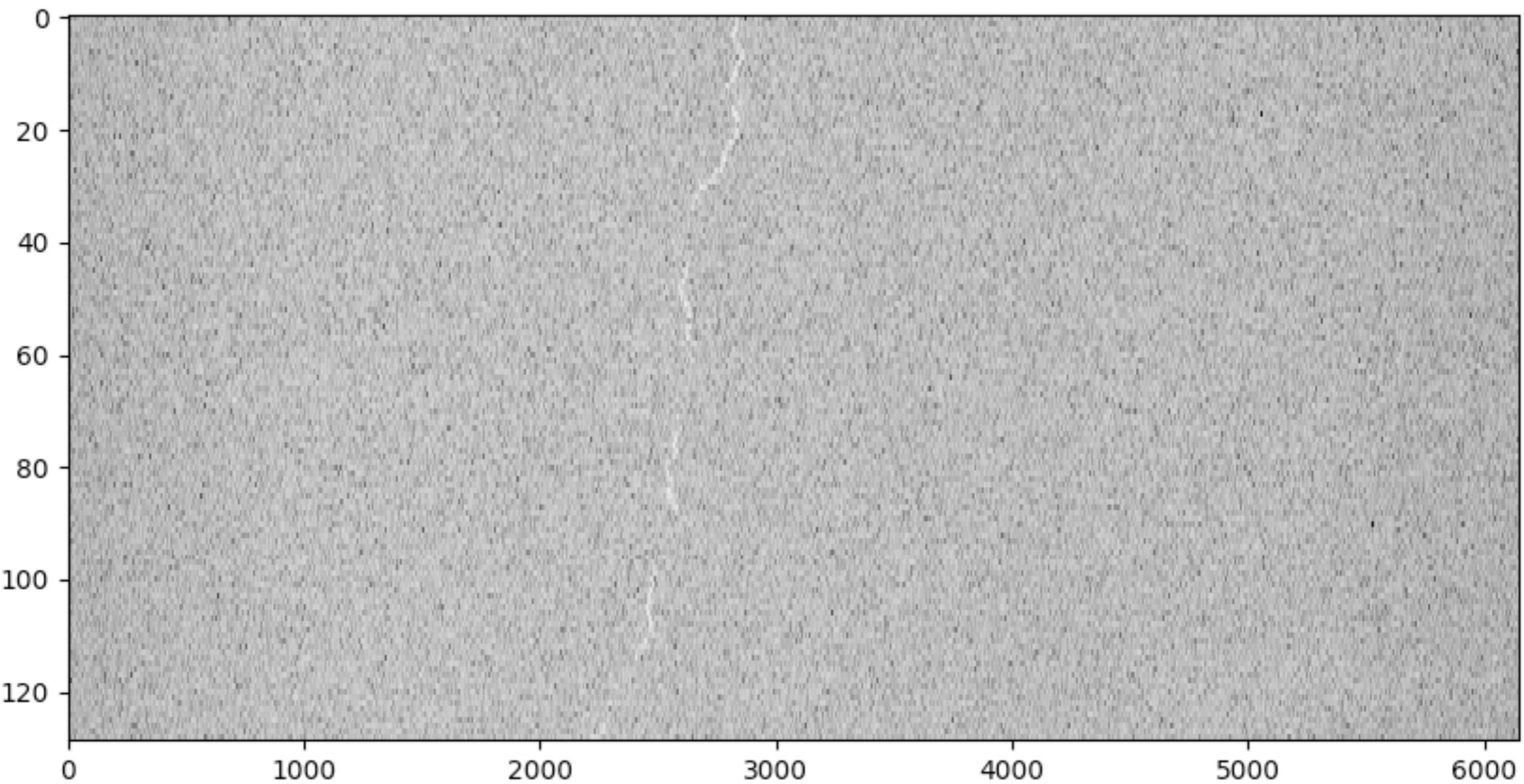
squiggle



squarepulsednarrowband



squigglesquarepulsednarrowband



Code Challenge / Hackathon

Code Challenge: Best Signal Classifier

June 1* - July 31

- Classifier installed at ATA
- Co-Author peer reviewed paper
- Assistance presenting
- top 3 runners-up ->“white paper”

Hackathon:

- Best Classifier: Tour of ATA at HCRO
- Best w/o NN/Watson
- Best Signal Processing technique
- “Most Interesting”

*or very soon thereafter!



Hackathon @ SF:Galvanize June 10-11

- weekend access to [IBM Watson Visual Recognition](#)
- weekend access to an [IBM Apache Spark Enterprise cluster](#)
- **weekend access to [IBM PowerAI Deep Learning platform on Nimbix Cloud](#)**
- tutorials covering IBM Watson VR, Tensorflow, and [Skymind's DL4J](#)
- extended trial account on [IBM Bluemix](#)
- extended trial account on [IBM Data Science Experience](#)

Saturday

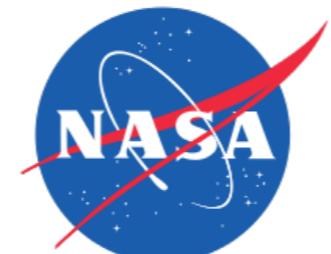
Talk by Dr. Jill Tarter and Dr. Gerry Harp of the SETI Institute

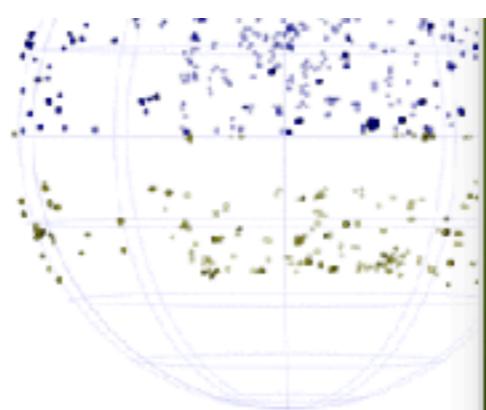
Sunday

Talk by Dr. Danny Price of the UC Berkeley SETI Research Center

Thank you!

seti.org/ML4SETI



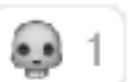


Paul Allen

03:03 local time



1



1



1



1



2 replies

Last reply about 1 hr ago



gadamc 10:45

Hi @amit, @voien21 and @aa...
you're looking for people to p...



deepam 22:08

joined #general. Also, @au79 j...



Message #general

[View profile](#)

[Direct Messages](#)

[View files](#)

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[Invite to a channel ...](#)

[Message au79](#)