Locust “Fake Track” Generator Tutorial

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10/11/18

Generating pre-defined tracks with Locust

- Purpose: Generate custom Project 8 CRES-like tracks within Locust to be used for further analysis (e.g track finding with deep learning)
- A “fake” track Locust generator has been added to Locust (LMCFakeTrackSignalGenerator) with register name “fake-track”
- Track characteristics can be specified from a config file
  - Template config: https://github.com/project8/locust_mc/Config/Tutorial/LocustFakeTrack.json
- This will produce an egg file which may be processed with Katydid
  - Template config: https://github.com/project8/locust_mc/Config/Tutorial/katydid_faketrack.json

Parameters in Locust config file

```
{
    "generators":
    [
       "fake-track",
       "lpf-fft",
       "decimate-signal",
       "gaussian-noise",
       "digitizer"
    ],

    "fake-track":
    {
    "signal-power": 1.0e-15,
    "start-frequency": 20.05e9,
    "start-vphase": 0.0,
    "slope": 0.6,
    "start-time": 0.001,
    "end-time": 0.005,
    "lo-frequency": 20.0e9
    },
```

- Configuration for the generation of a single track

Signal power (W)
Track start frequency (Hz)
Starting voltage phase (rad)
Track slope (MH/ms)
Track start time (s)
Track end time (s)
LO oscillator frequency (Hz)

Parameters in Locust config file

- Configuration for the generation of a single track

```
"gaussian-noise":
{
"noise-floor": 2.7e-21,
"domain": "time"
},

"digitizer":
{
"v-range": 1.0e-4,
"v-offset": -0.5e-4
}
```

Noise floor (W/Hz)

Digitizer range (V)

Digitizer offset (V)

Note: Don’t saturate digitizer!

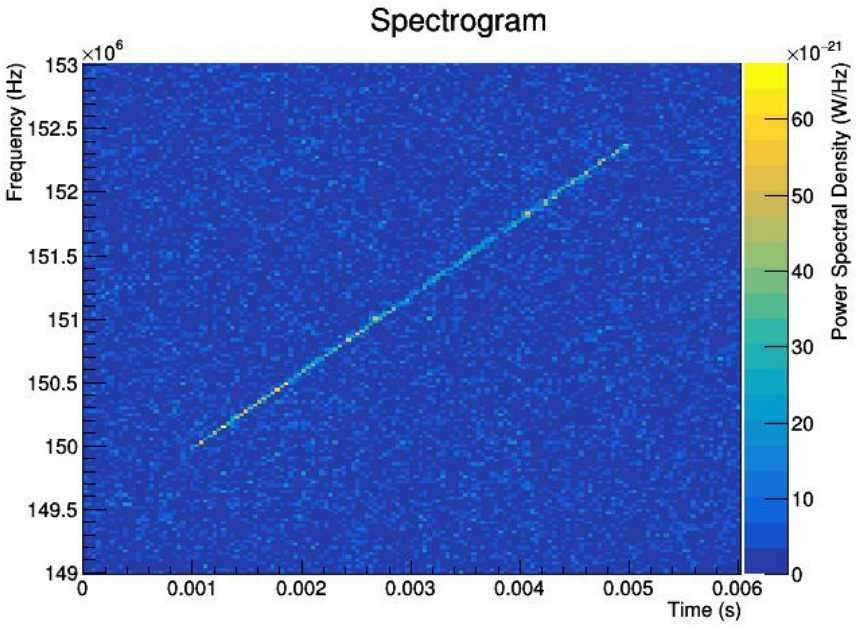
Generating a fake track

- Edit the Locust config file to specify the egg file output

```
"simulation":
{
        "egg-filename": "/path/to/output/locust_faketrack.egg",
    ...
```

- Generate single fake-track egg file:
  - /path/to/LocustSim -config=/path/to/LocustFakeTrack.json
- Katydid processing to obtain 2D histogram of PSD values
  - /path/to/Katydid -c /path/to/katydid_faketrack.json -e /path/to/locust_faketrack.egg --waterfall-writer.output-file="path/to/output/locust_faketrack_waterfall.root"
- Output root file may be processed with ROOT macro to plot waterfall picture:
  - https://github.com/project8/locust_mc/Config/Tutorial/PlotFakeTrackImages.c
  - Use PlotImages()

“Fake track” + Gaussian noise example

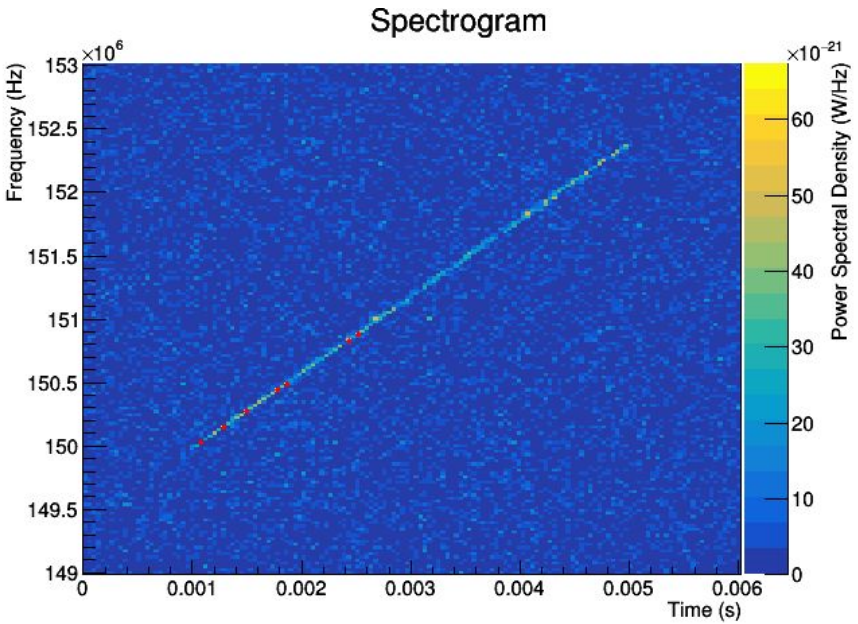


- Waterfall plot can be generated
- Signal PSD = 1e-15/(200e6/8192)

  = 40e-21 W/Hz

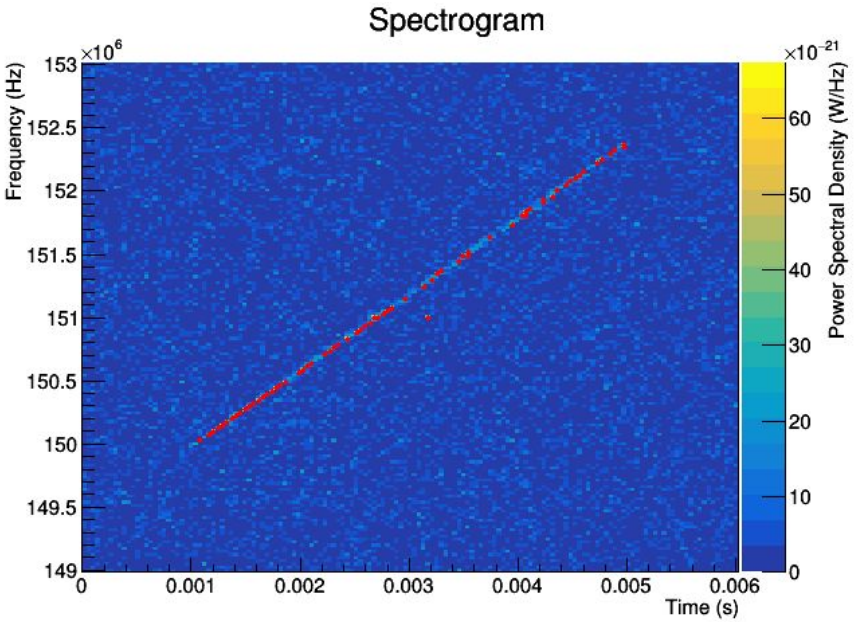
- Noise PSD = 2.7e-21 W/Hz
- SNR = 15
- Start frequency of 20.05 GHz - 20 GHz = 50 MHz shifted by +100 MHz due to processing with RSA settings in Katydid config
- Slice size = 8192

Labeling pixels using power threshold



- Bins may be labeled as belonging to track or background using a minimum power threshold cut
- Threshold may be set in PlotImages() of ROOT macro
- Ex. Mark bins as “track” (red) if PSD > 50e-21 W?Hz

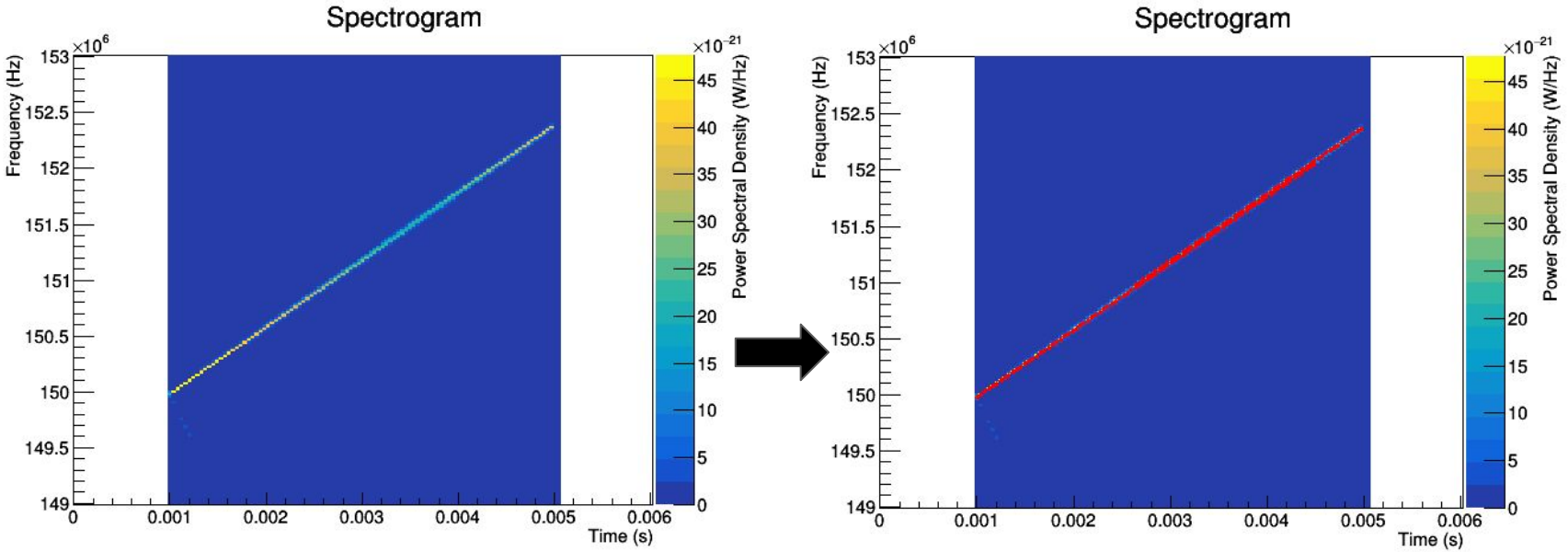
Labeling pixels using power threshold



- Increasing threshold to “track” if PSD > 25e-21
- This helps us label more of the track but not all, and a noise point is included

Labeling pixels using power threshold

- If we generate a fake track without gaussian noise labeling is more effective
  - Remove `"gaussian-noise"` Locust generator
- Ex. set power threshold to 10e-21



Generate away!