



## SDR Makerspace

OSCW 2019

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Manolis Surligas

[manolis@libre.space](mailto:manolis@libre.space)

Libre Space Foundation



European Space Agency  
Agence spatiale européenne

# Libre Space Foundation

- A non profit organization based in Athens, Greece
- Focus on space applications
- Commitment to open technologies
- Educational activities



**Libre Space  
Foundation**

- Established in 2014 after winning the Hackaday prize
- The winning project was the core of the **SatNOGS**



# ESA SDR Makerspace

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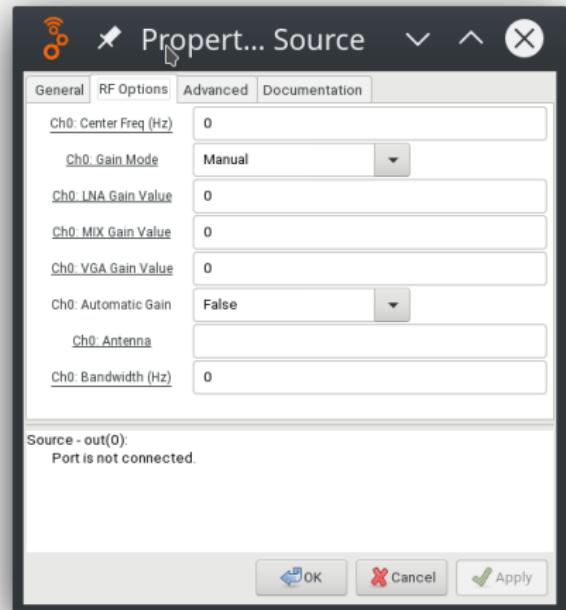
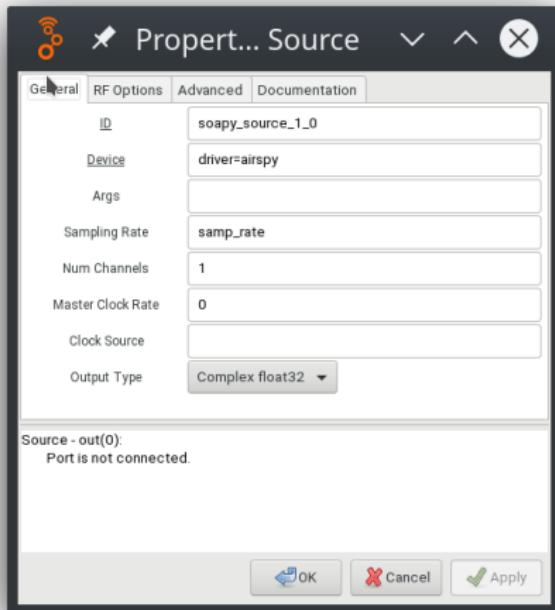
# ESA SDR Makerspace

- An ESA - LSF collaboration
- 14-month program with a budget of 500k euros
- Investigate the use of SDR technology in space applications
- Umbrella activity for 15+ subactivities around SDR and space communication
- Several subactivities include contributions to GNU Radio
- All results released as open source software and hardware

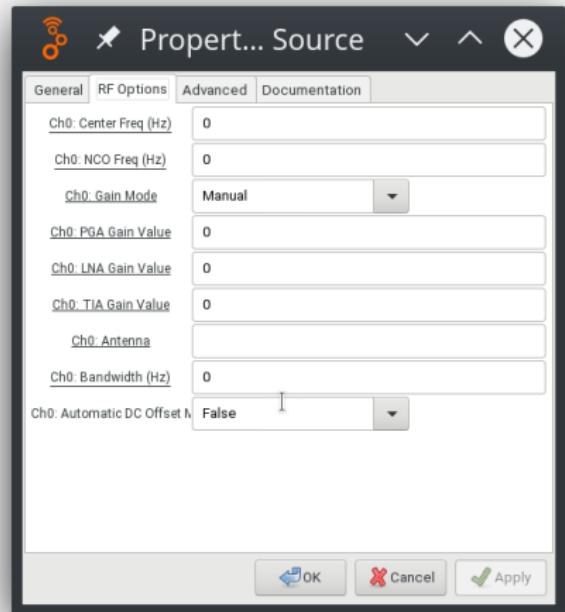
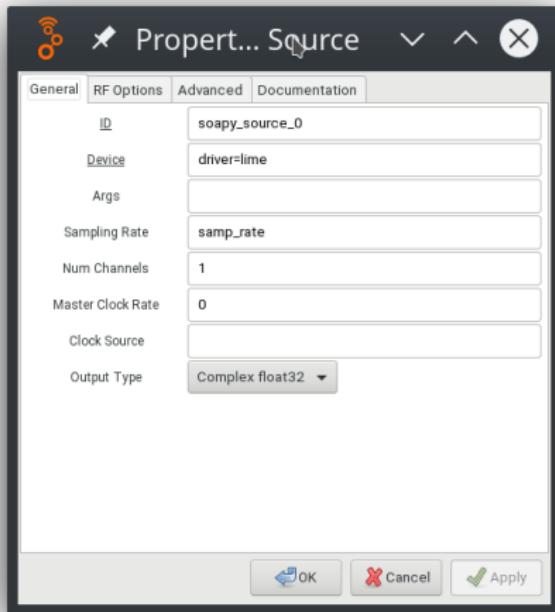
- Use Soapy API to interface with SDR hardware
- Extract device capabilities dynamically
- Deprecates the gr-osmosdr
- <https://gitlab.com/librespacefoundation/gr-soapy.git>



# gr-soapy

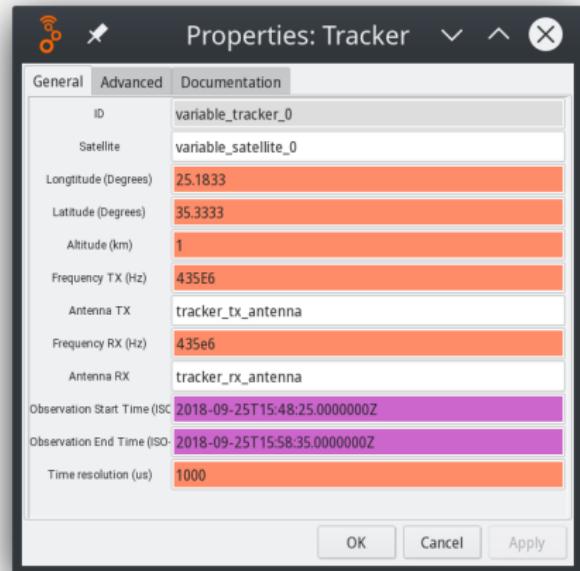
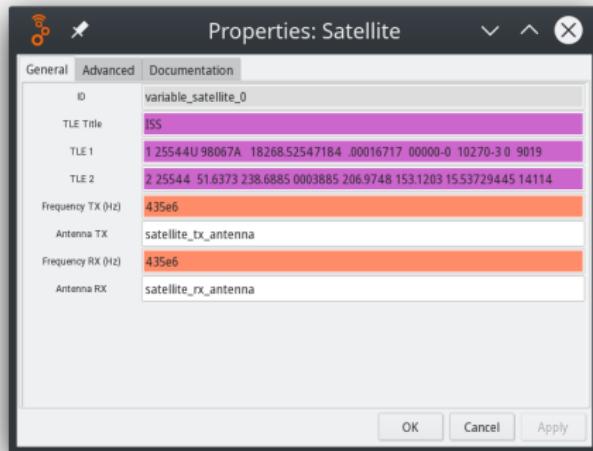


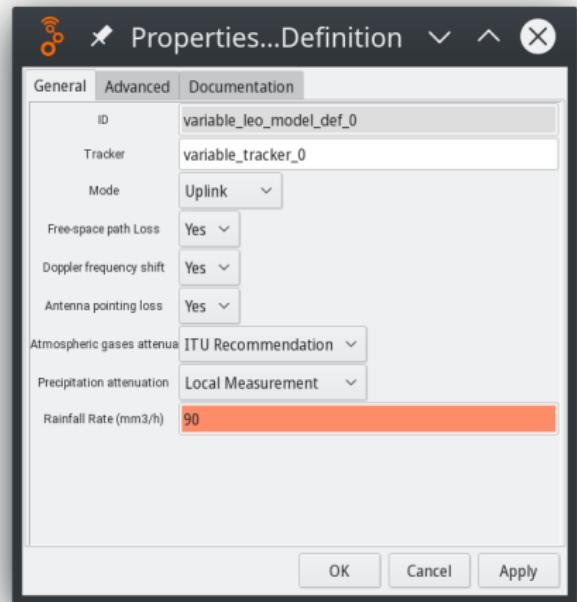
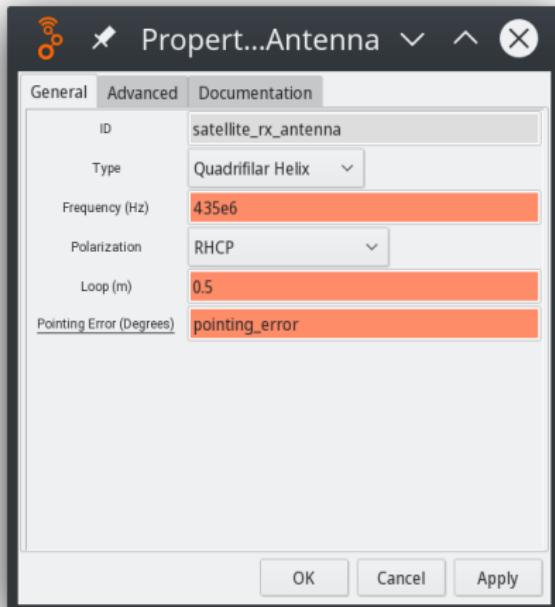
# gr-soapy



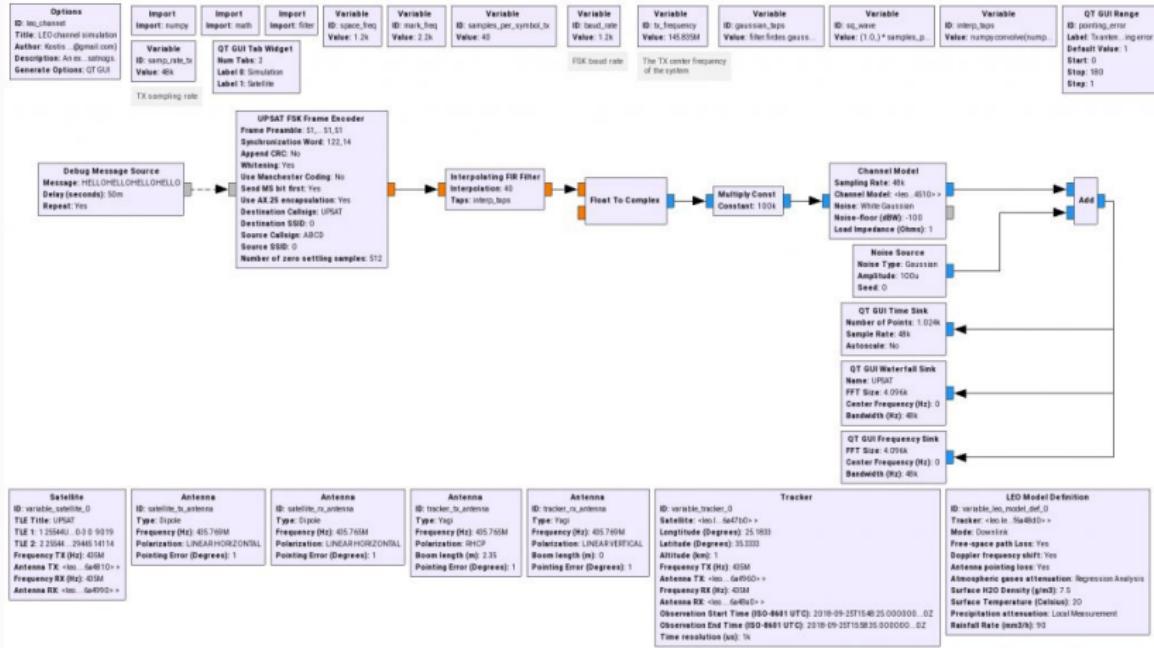
Devices	TX	RX	Multiple Channels	Gains	DC offset Correction	IQ Balance Correction	Auto Gain Control	Frequency Correction
Usrp b210	✓	✓	✓	✓	✓	✗	N/A	N/A
LimeSDR mini	✓	✓	N/A	✓	✓	N/A	N/A	N/A
PlutoSDR	✗	✓	N/A	✓	N/A	N/A	✓	N/A
AirSpy R2	N/A	✓	N/A	✓	N/A	N/A	✓	N/A
RTL-SDR	N/A	✓	N/A	✓	N/A	N/A	N/A	✓
Redpitaya	✓	✓	N/A	N/A	N/A	N/A	N/A	N/A
Blade RF	✓	✓	N/A	✓	✓	✗	N/A	N/A
Hack RF	✗	✗	N/A	✗	N/A	N/A	N/A	N/A

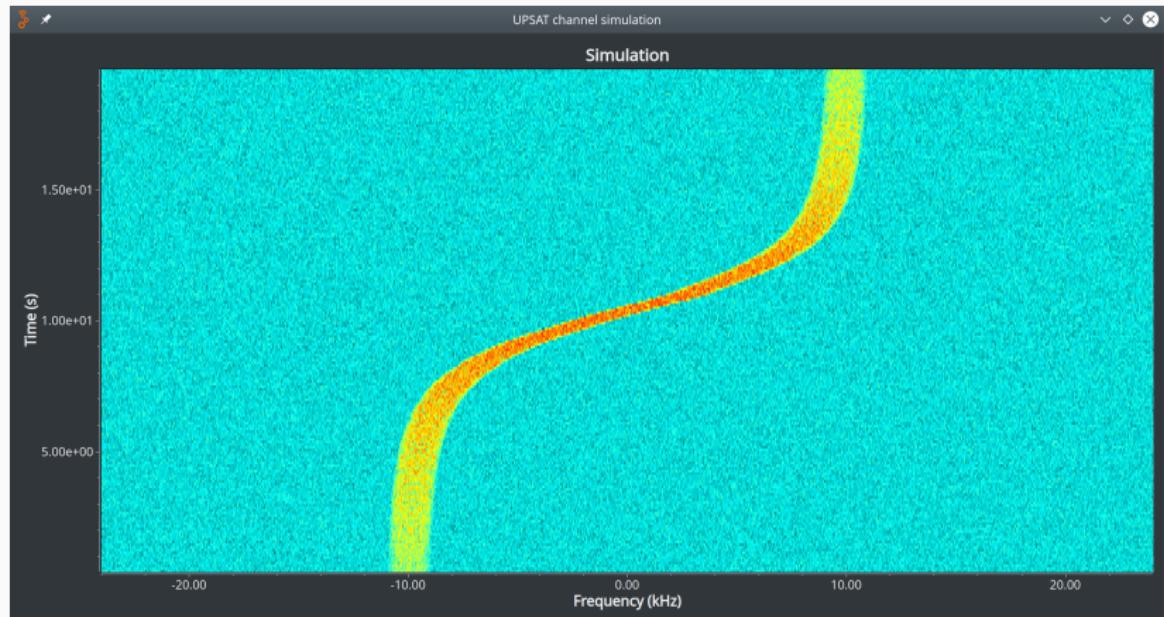
- A model emulating the LEO channel
- Path loss based on distance and/or atmospheric absorption
- Doppler effect
- **Great** tool for prototyping and experimentation
- <https://gitlab.com/librespacefoundation/gr-leo.git>





# gr-leo



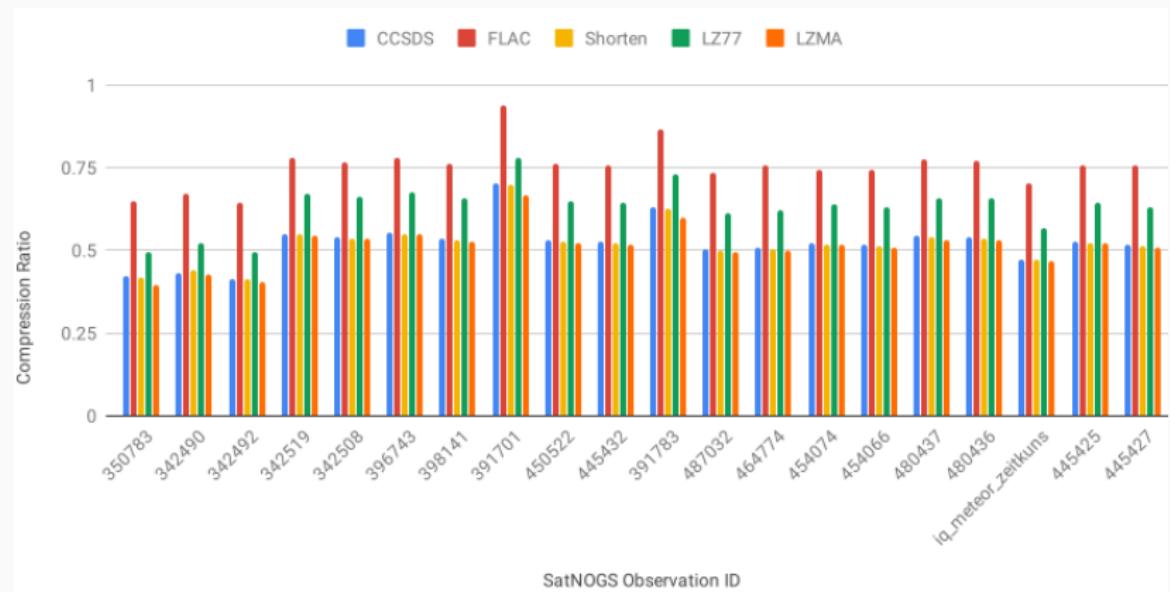


# IQzip

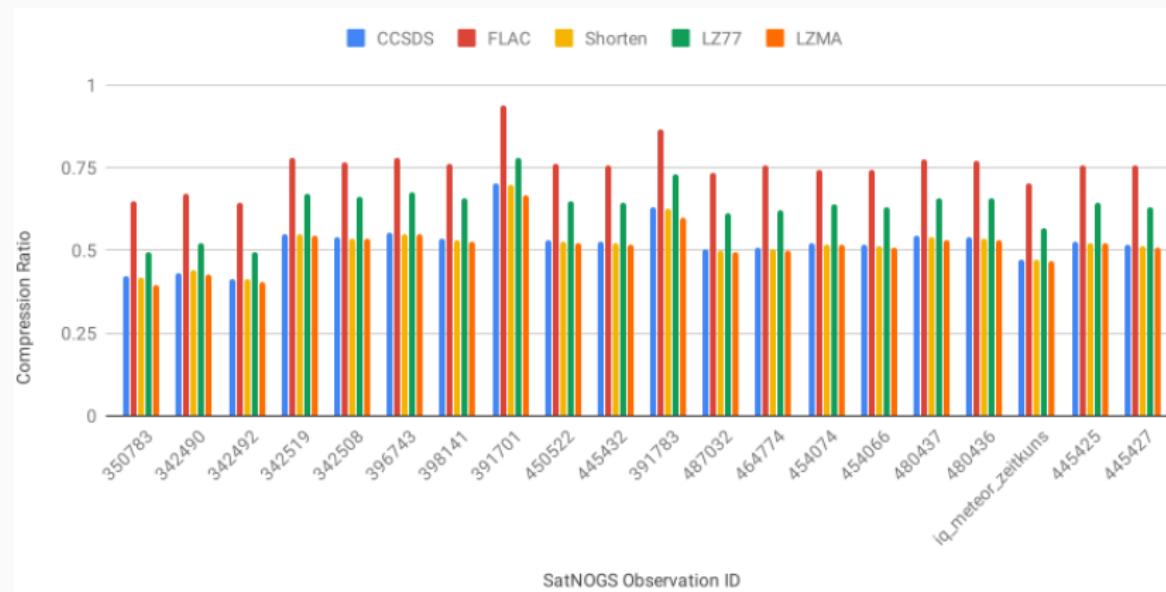
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- Focus on **lossless** compression of IQ data
- Investigate the best compression algorithm in terms of:
  - Compression ratio
  - Compress/Decompress computational resources
  - Standardization
- Implement API and tools for compress/decompress IQ data
- <https://gitlab.com/librespacefoundation/sdrmakerspace/iqzip>





And the winner is:



And the winner is: **CCSDS 121.0-B-2!**

- GNU Radio encoders and decoders implementing the CCSDS recommendation
  - Reed Solomon
  - Convolutional Coding  $R = 1/2, 2/3, 3/4, 5/6, 7/8$
  - Turbo Coding
  - PCM
  - LDPC
- Testing with CCSDS modem from ESA!!!
- <https://gitlab.com/librespacefoundation/gr-ccsds>

# SDR HW Evaluation

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- Characterize the performance of almost all available SDR devices
- Measurements for:
  - Noise floor
  - Receiver Dynamic Range
  - RX/TX spectral purity
  - TX Power
- [https://gitlab.com/librespacefoundation/  
sdrmakerspace/sdrevl/wikis/home](https://gitlab.com/librespacefoundation/sdrmakerspace/sdrevl/wikis/home)

# SDR & Machine Learning

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- Signn
  - Satellite signal classification through CNN
  - <https://gitlab.com/librespacefoundation/sdramakerspace/signn>
- gr-orbitsense
  - Signal presence or absence detection
  - Optimized for low SNR scenarios
  - <https://gitlab.com/librespacefoundation/sdramakerspace/gr-orbitsense>
- gr-dnn
  - GNU Radio based framework for easy integration of Machine learning models
  - <https://gitlab.com/librespacefoundation/sdramakerspace/gr-dnn>

## More! (Under dev)

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- SDR hardware radiation testing
- Direct sampling experimentation
- Improvements on UHD driver
- MIMO enabled ground station
- Framework for SDR testing CI/CD
- More info at:
  - <https://sdrmaker.space>
  - <https://gitlab.com/librespacefoundation/sdramakerspace>

# Join the Conference!



The poster features a light blue background with circular patterns. At the top left is a stylized 'W' logo composed of blue and yellow segments. To its right, the text 'SDR makerspace' is displayed, with 'SDR' in a large, bold, black sans-serif font and 'makerspace' in a smaller, dark blue sans-serif font within a black rectangular box.

**Software Defined Radio  
for Satcom Applications**

# Conference

28-29 November 2019  
Swiss Aeropole  
(Payerne, Switzerland)

**esa**

**Hes-SO**  
University of Applied Sciences and Arts  
Western Switzerland

**Libre Space Foundation**

swiss aeropole

Entrance is free;  
**registration required.**  
For more informations:  
<https://sdrmaker.space/sdrconference19>

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