

Collaborative Interference Cancellation for Radio Astronomy

NSF SWIFT - 2021

Aveek Dutta¹, Dola Saha¹ and Gregory Hellbourg²

¹Department of Electrical & Computer Engineering, University at Albany, SUNY

²Department of Astronomy, California Institute of Technology

NSF PI Meeting, September 11, 2025



(UAlbany, Caltech)



Collaborative Interference Cancellation for Radio Astronomy

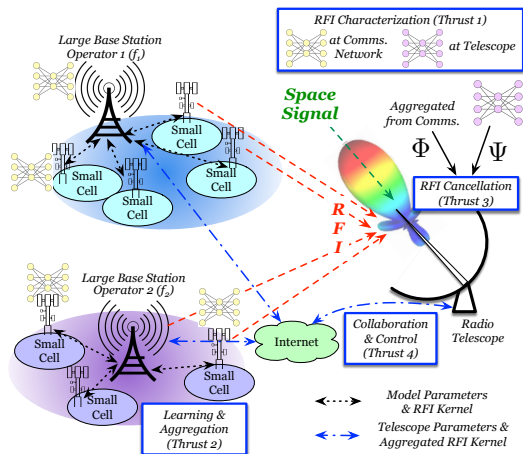
Caltech

PI Meeting, 2025

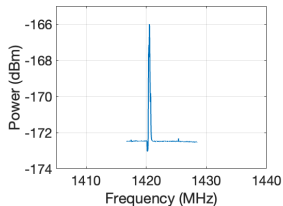
1 / 8

Project Objectives

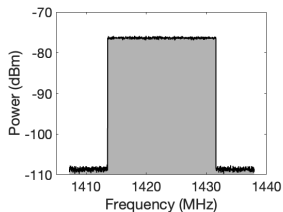
- Characterize RFI generated by communication networks.
- Distributed/federated learning of RFI and aggregate local characterizations.
- Bidirectional collaboration between cellular network and Radio Telescope.
- Cancel incident RFI at the telescope using the aggregated interference metric.
- Validate with experiments at OVRO with DSA-110.



Temporal and Spectral Characteristics



(a) H1 line @ 1420 MHz



(b) LTE signal at BS

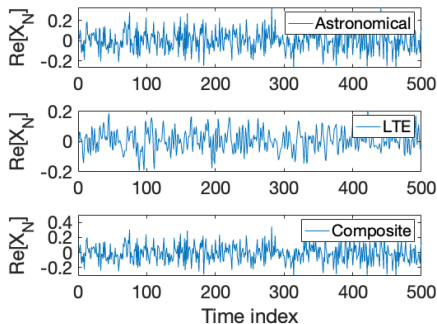


Figure: Signals in time domain

Composite Signal Model:

$$x_{f_c}[n] = x_A[n] + x_N[n] + x_R[n]$$

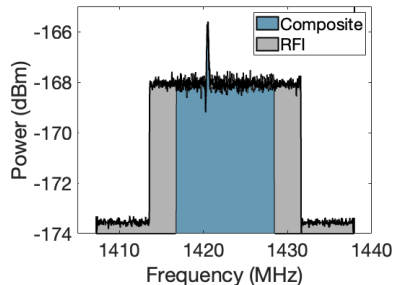
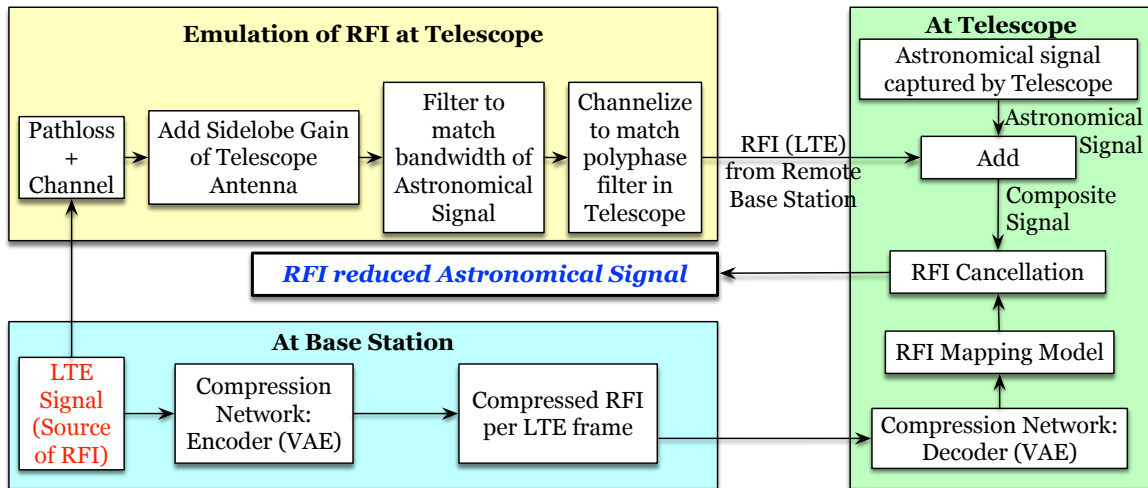


Figure: Composite Signal Spectrum

Astronomical Signal is captured by DSA-110, LTE signal is simulated.

System Simulation for RFI Mitigation



Technical Approaches

RFI Cancellation from **Single Source (BS)**

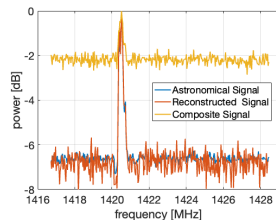
- DSP based Decomposition: Karhunen–Loève Transform (KLT) [1,2]
- Neural Network based Approach [3]
 - Reduced Computational Complexity and Communication Overhead

RFI Cancellation from **Multiple Sources (BSs)**

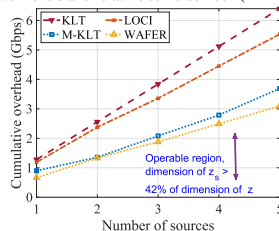
- DSP based Decomposition: Karhunen–Loève Transform (KLT) [4]
 - Reduced Communication Overhead
- Neural Network based Approach [5, 7]
 - Reduced Computational Complexity & Communication Overhead

Bidirectional Collaboration Framework

- Dynamic protection zone for RFI from LEO satellites [7]
- Jointly maximize throughput in ORAN while minimizing RFI [8].



Power levels are relative to noise floor (-174 dBm)



Communication Overhead

Broader Impact

Community Engagement

- Active collaboration over 4 years between radio astronomy (Caltech) and wireless communication researchers (UAlbany) – *Two concurrent SWIFT projects.*
- Looking to engage with members of the ORAN community and other radio telescope sites to test the cancellation techniques on *real RFI datasets.*

Knowledge Dissemination

- Publications: 5 Conference + 3 Journal publications + 1 Patent disclosure.
- In person presentation in DySPAN '21, '24, '25 as well as in ICC '23 and NSF PI meetings.

Student Advising and Training

- 4 PhD students funded at different stages of their PhD.
- Placement: Amazon Lab 126, Qualcomm, Internships at AT&T Research.

Publications

1. Maqsood Careem, Shuvam Chakaraborty, Aveek Dutta, Dola Saha, Gregory Hellbourg, *Spectrum Sharing via Collaborative RFI Cancellation for Radio Astronomy*, in **IEEE DySPAN 2021 [BEST PAPER]**.
2. Shuvam Chakaraborty, Gregory Hellbourg, Maqsood Careem, Dola Saha and Aveek Dutta, *Collaboration with Cellular Networks for RFI Cancellation at Radio Telescope*, in **IEEE Transactions on Cognitive Communications and Networking**, 2023.
3. Shuvam Chakaraborty, Dola Saha, Aveek Dutta and Gregory Hellbourg, *LOCI: Learning Low Overhead Collaborative Interference Cancellation for Radio Astronomy*, accepted in **IEEE ICC 2023**.
4. Shubham Chakaraborty, Dola Saha, Aveek Dutta and Gregory Hellbourg, *Low Overhead Multi-Source RFI Cancellation*, in **IEEE DySPAN 2024**.
5. Sirajum Munira, Shubham Chakaraborty, Dola Saha, Aveek Dutta and Gregory Hellbourg, *WAFER: WAVEform-based Feature Extraction for RFI Cancellation from Multiple Sources*, **IEEE DySPAN 2025**.
6. Sirajum Munira, Shubham Chakaraborty, Dola Saha, Aveek Dutta and Gregory Hellbourg, *WAFER: WAVEform-based Feature Extraction for RFI Cancellation from Multiple Sources*, (extended version) under review in **IEEE Open Journal of Antennas and Propagation (OJAP)**.
7. Sirajum Munira, Dola Saha, Aveek Dutta and Gregory Hellbourg, *Dynamic Protection Zone for Radio Astronomy*, **IEEE DySPAN 2025**.
8. Tayyebbeh Gashteroodkhani, Aveek Dutta, Dola Saha and Gregory Hellbourg, *CORPUS: Collaborative ORAN for Passive Users of the Spectrum*, under review.

Thank You!
Questions?

`adutta@albany.edu`