Very Large Array Sky Survey Cutout Generator and Data Analysis

THE UNIVERSITY OF THE WEST INDIES

By: Jason D. Renwick BSc.
NRAO NINE Participant 2018

Supervised by: Dr. Brian Kent (Technical)
Anja Fourie (Project Management)

Who am I?

- Jason D. Renwick BSc.
  - Electrical and Computer Engineering (May 2018)
  - The University of the West Indies
- NRAO NINE Program
  - National and International Non-traditional Exchange
  - Data Analysis
  - Project Management
- Previous Research Internships in:
  - Prognostics/Electronics
  - Software and Image Stitching
  - Geospacial and Drone Imagery

THE UNIVERSITY OF THE WEST INDIES

Where is Trinidad?

Presentation Contents

- Overview of the NINE Program
- VLASS Dataset Summary
- My Summer project
- Lessons Learnt and moving forward

All astronomical images in this presentation have been sized to 2 arcminutes

NRAO NINE Program

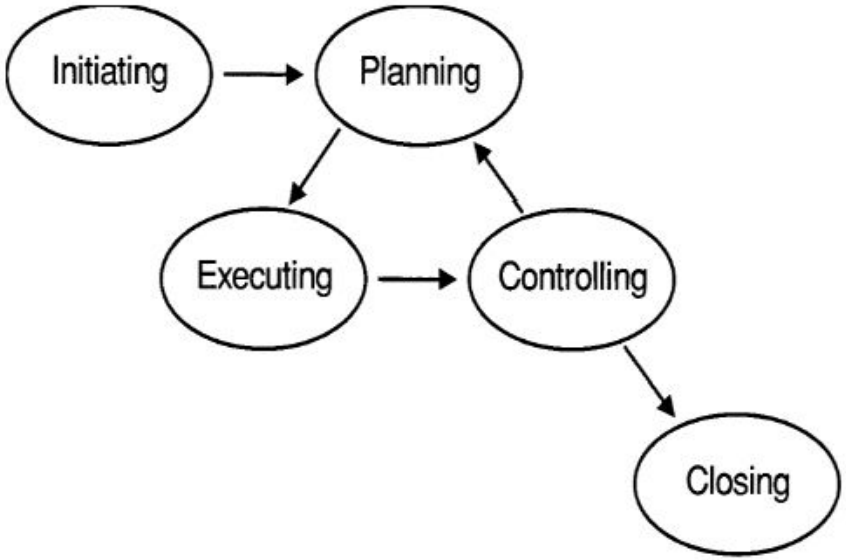
Mission:

“The NRAO NINE program has a vested interest in building a pipeline of talent within the radio astronomy field, and within under-represented communities. The anticipated outcome of this program will be worldwide partnerships with fast growing radio astronomy communities designed to facilitate the exchange of NINE trainers and the co-mentoring of under-represented groups of learners.”

- Step 1: Hands-On Experience
- Step 2: Mentoring/Teaching Techniques
- Step 3: ‘NINE Hub Program’ Development
- Step 4: NINE Hub Program Exchanges

NRAO NINE Program

- Low-cost computing
  - Raspberry Pi 3
- Opensource resources
  - Python, AstroPy
  - VLASS Quicklooks
- Project Management
  - Accountable
  - Iterative
  - Resilient
  - Confident

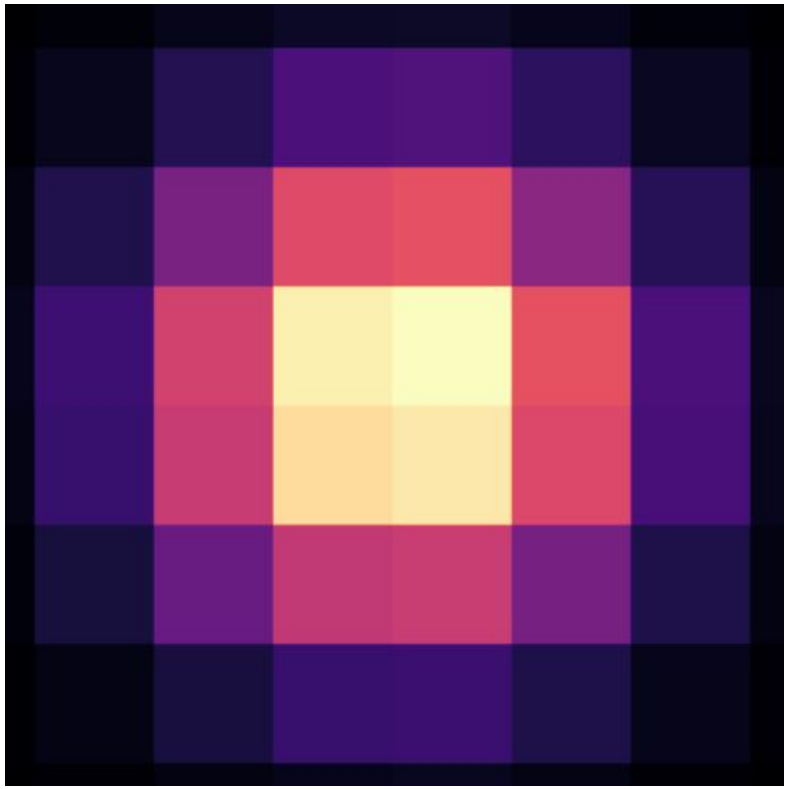


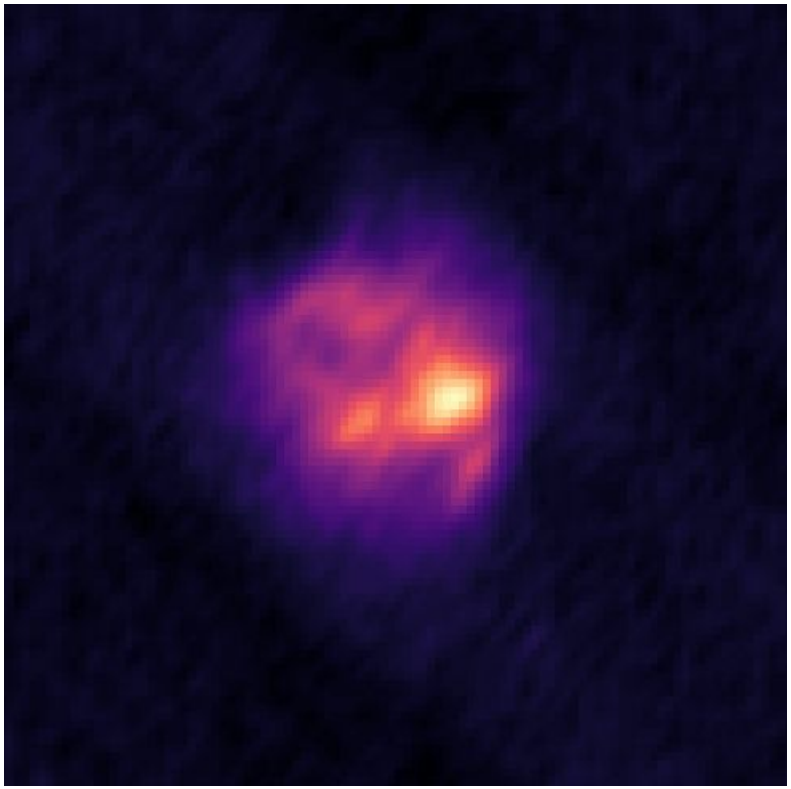
Very Large Array Sky Survey (VLASS): Overview

- All-sky (33,885 deg2 above declination –40°)
- Frequency: 3 GHz (2–4 GHz, less RFI affected regions) “S-band”
- High angular resolution: 2.5’’ (VLA B/BnA-configurations)
- Synoptic: 3 epochs separated by 32 months
- Uses OTF (On-The-Fly) mosaicking
- Status: observed first half of first epoch (~17,000 sq. deg.) Sep 2017 through Feb
- 2018, delivered 16,500 sq. deg. of “Quick Look” images (17538 FITS)

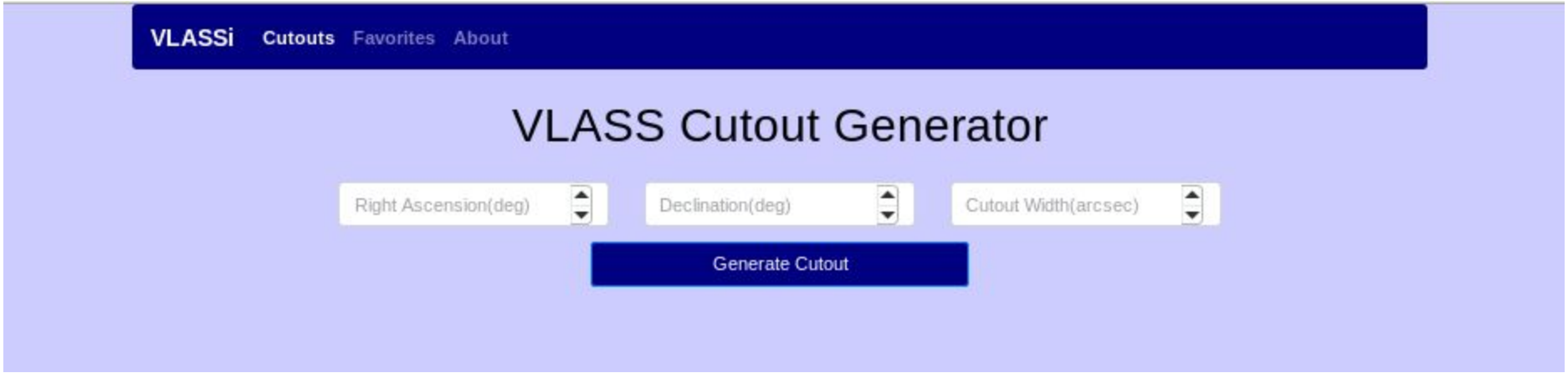
VLASS Compared to NVSS

- Angular Resolution:
  - NVSS: 45 arcsecond
  - VLASS: 2.5 arcsecond

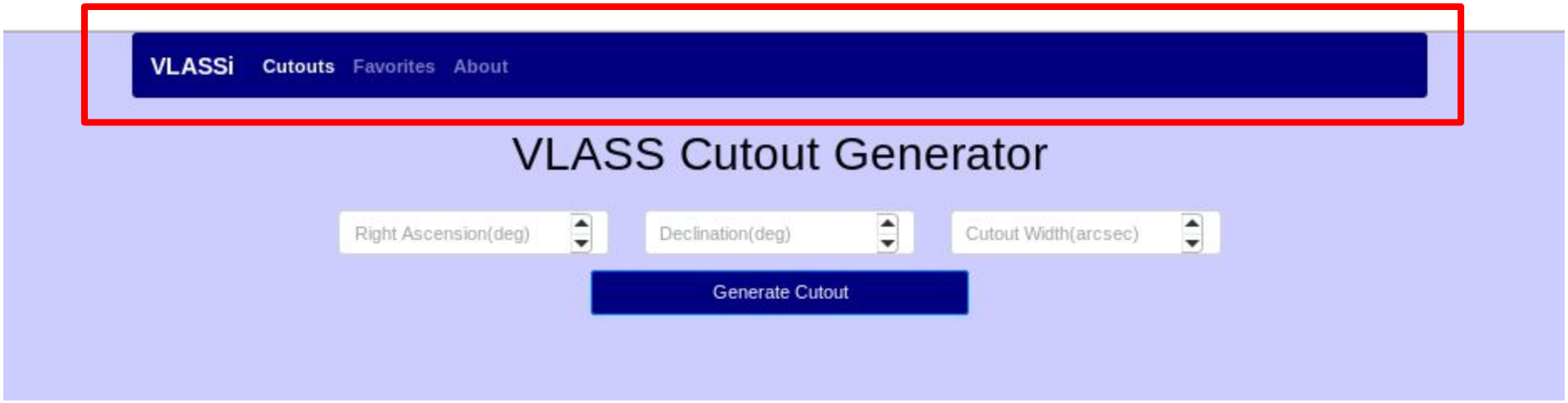




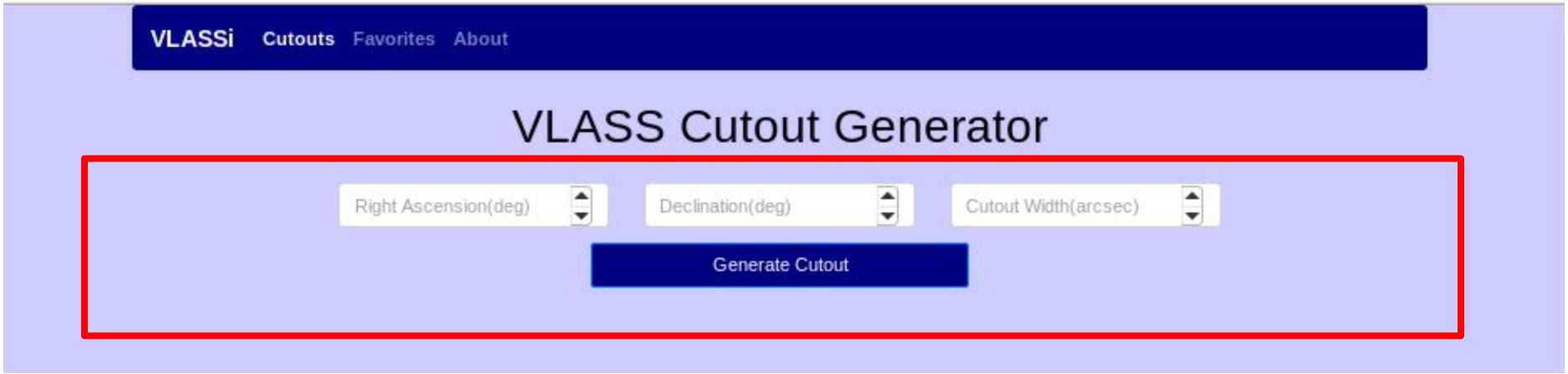
Web-based User Interface: Value Added Interface



Web-based User Interface: Value Added Interface



Web-based User Interface: Value Added Interface



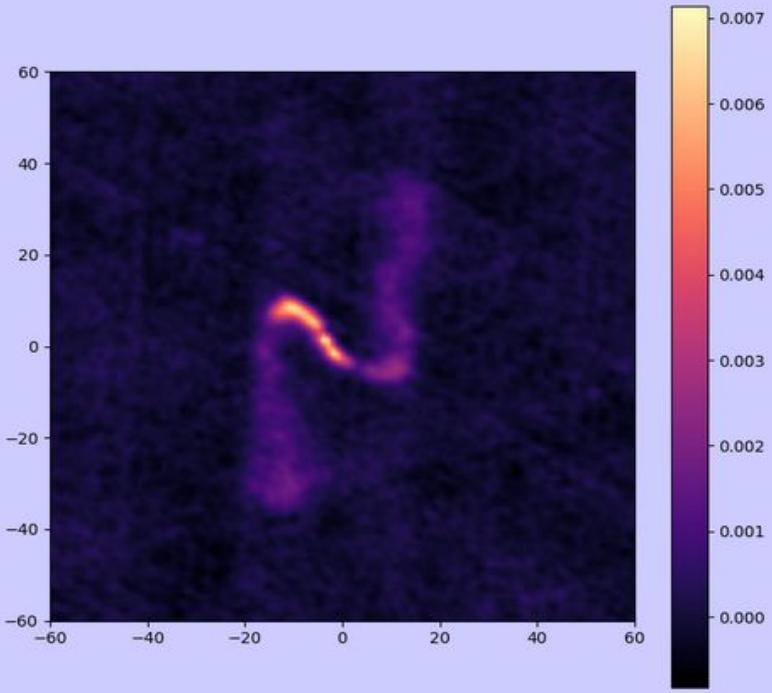
VLASSi Cutouts Favorites About

VLASS Cutout Generator

135.652 52.063 120

Generate Cutout

VLASS Result



VLASS Cutout Info

Optical Image: DSS2-Colored

Infrared Image: 2MASS(H + J + K)

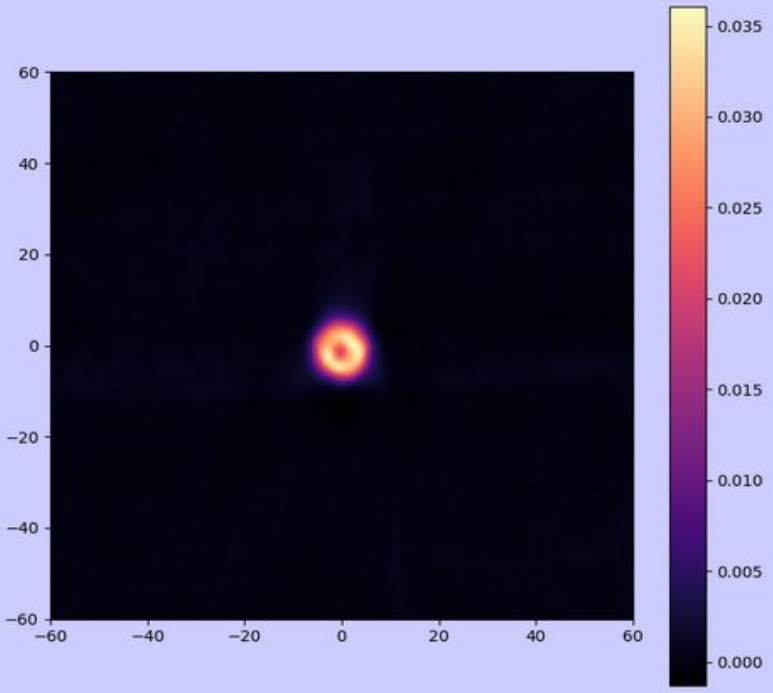
VLASSi Cutouts Favorites About

VLASS Cutout Generator

262.115 -35.125 120

Generate Cutout

VLASS Result



VLASS Cutout Info

Optical Image: DSS2-Colored

Infrared Image: 2MASS(H + J + K)

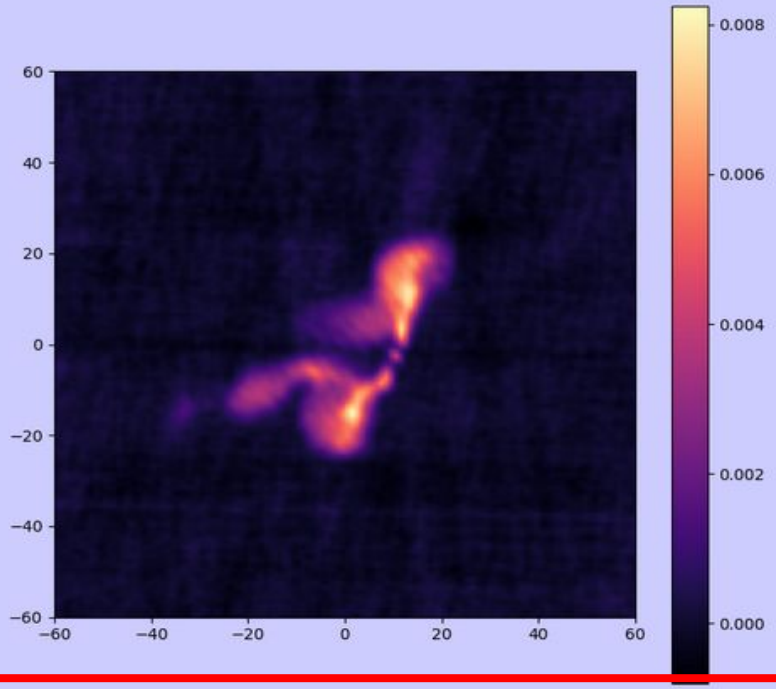
VLASSi Cutouts Favorites About

VLASS Cutout Generator

194.345 -30.363 120

Generate Cutout

VLASS Result



VLASS Cutout Info

Optical Image: DSS2-Colored

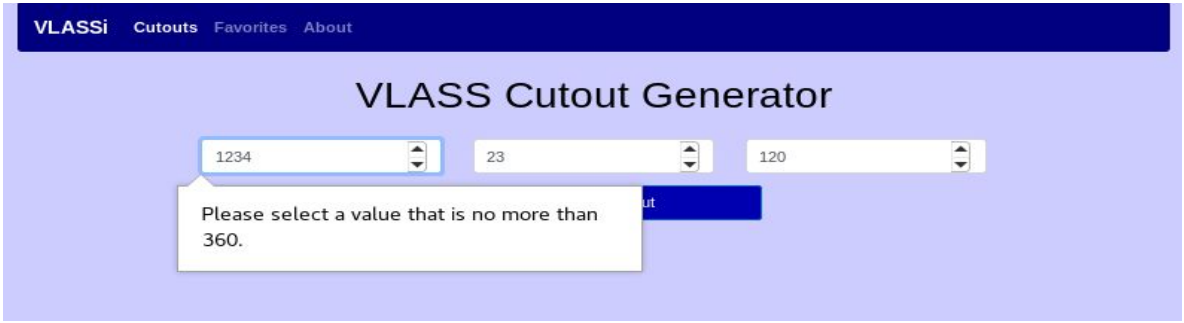
Infrared Image: 2MASS(H + J + K)

Technologies Used

- Back-End
  - Model View Controller - Django (python)
  - MySQL Database
  - AstroPy
  - Web Crawler
- Front-End
  - HTML + CSS for static information
  - Javascript for interactions
  - Aladin Lite for Optical/IR Images
- System
  - Raspberry Pi 3

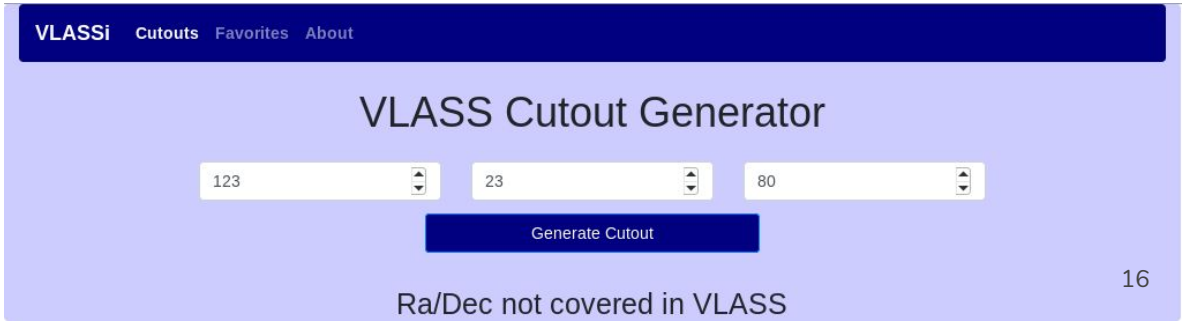
Features

- Input Limits:
  - 0 <= RA (deg) < 360
  - -90 < Dec (deg) < 90
  - 10 < Width (arcsec) < 1000
- VLASS Coordinate Search
  - Determines if the input RA/Dec is covered by VLASS (so far)

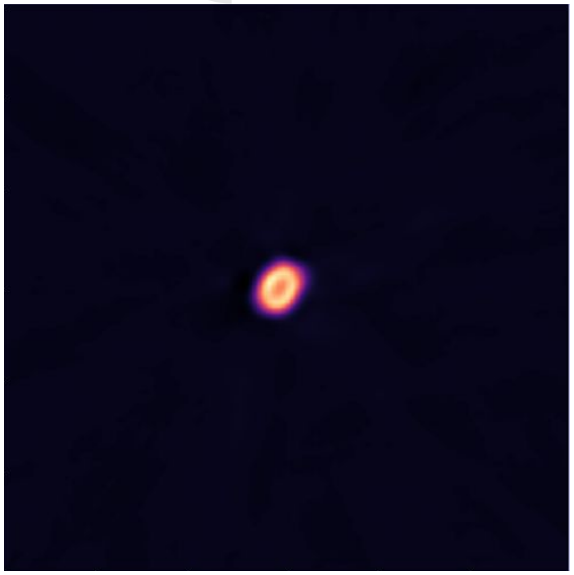


- handles up to 20 simultaneous queries

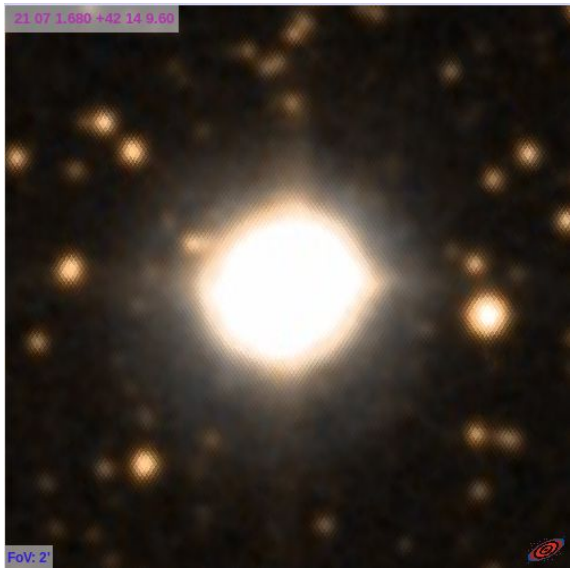
- Keeps a cache of 20 VLASS files (1gb)



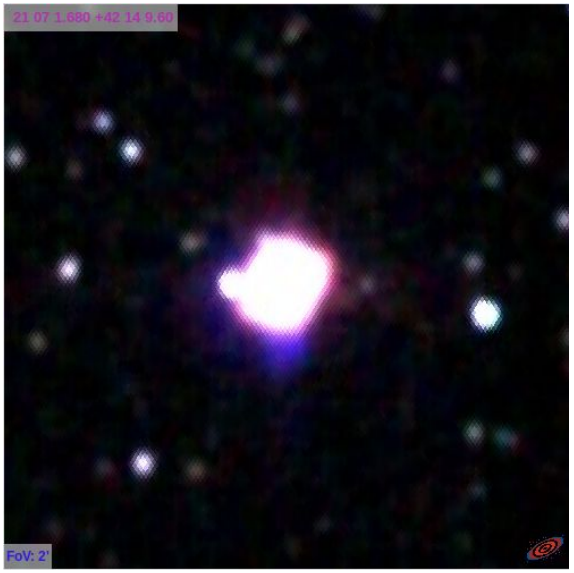
Features - Optical and IR



Radio (VLASS)



Optical (DSS2 Blue+Red+nIR)



Infrared (2MASS H+J+K)

Live Demo:

http://192.168.160.194:8000/

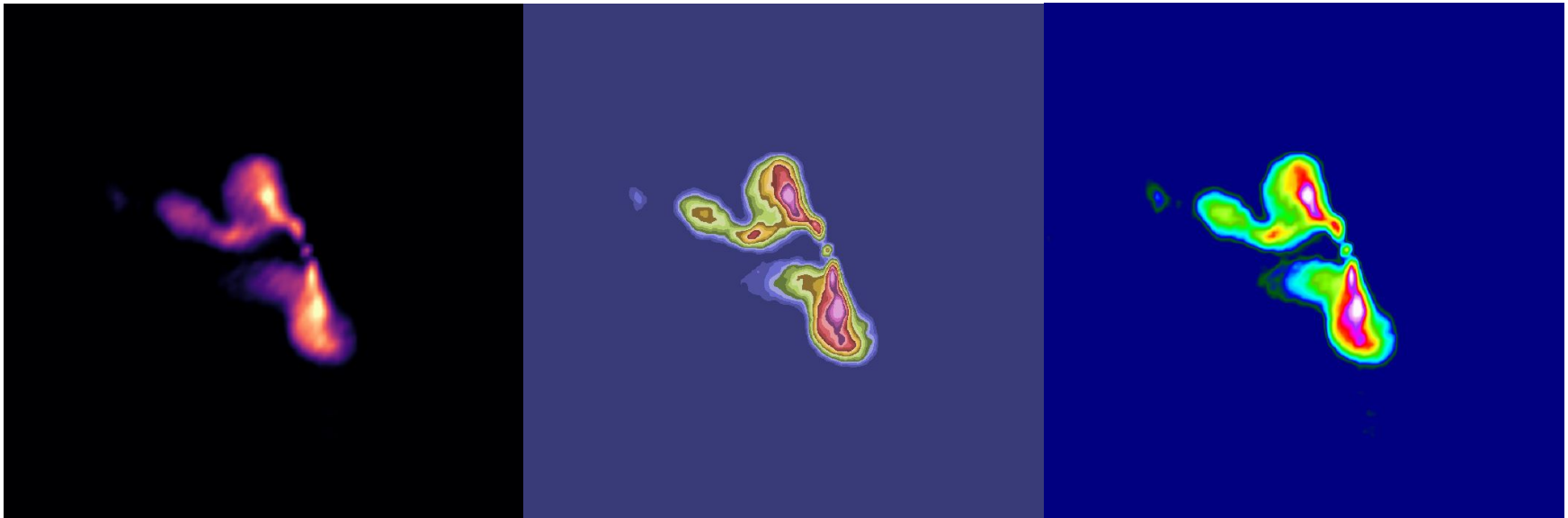
RA= 156.192059, Dec= -18.642329

Features....Coming Soon

- Generate FIT with raw data
  - Include a download button
- Create a user-base with cutout history
- Deploy on WWW

Lessons Learnt

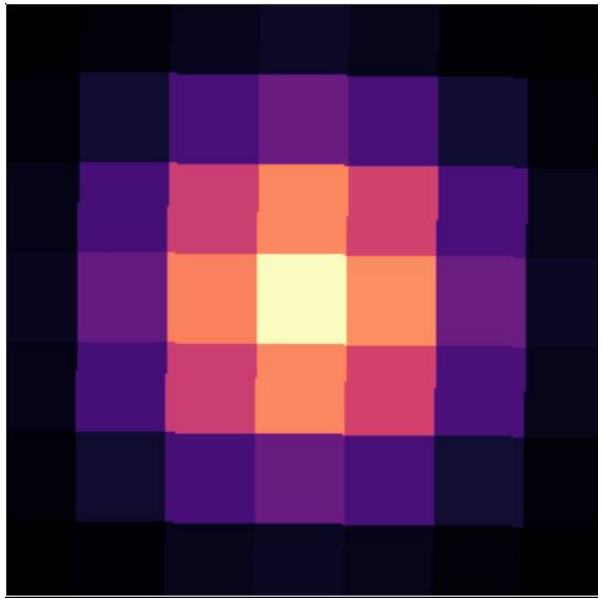
- Measure twice, cut once
  - Especially when it takes 120 hours to ‘cut’
- Divide ‘impossible’ tasks to manageable sizes
- Document your code during development
- ‘Git commit’ often with meaningful messages



Knowledge Transfer

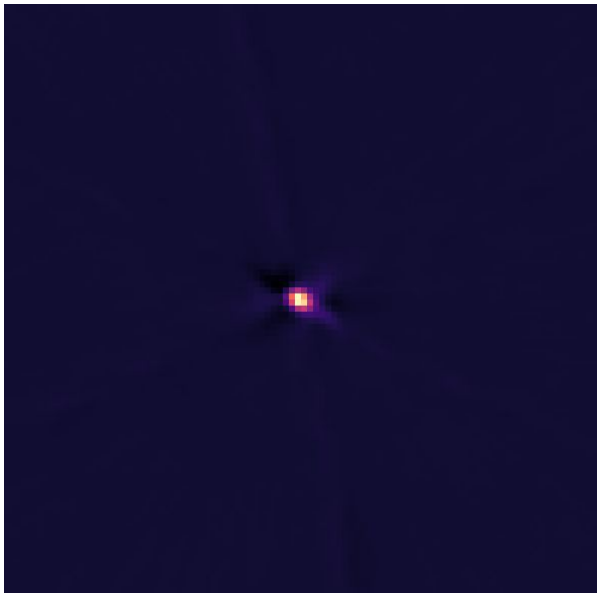
- Tutorials
  - Intro to Python
  - Using a Raspberry Pi
  - Retrieving and Manipulating VLASS Data
- Postgraduate research

Future Work - Positional Accuracy



RA: +0.3937”

Dec: +0.4268”



Future Work

- Training a Convolutional Neural Network (CNN) to recognize point sources or radio jets
- Quantify morphology of galactic structures with computer vision techniques e.g. blob detection or gaussian fitting
- Search the dataset for new sources not recognized in NVSS
  - With thresholding or CNN
- Search for transient between VLA FIRST and VLASS

Thank You!

Questions?

192.168.164.190:8000

THE UNIVERSITY
OF THE
WEST INDIES