Fundamental Reference AGN Monitoring Experiment (FRAMEx): Overview and Status


USNO, Flagstaff, AZ


USNO, Washington, DC


Paris Observatory

Bryan Dorland, Nathan Secrest, Norbert Zacharias, Megan Johnson, Travis Fischer, Valeri Makarov, Charlie Finch (USNO)

Jean Souchay et al. (SYRTE/OP)

Journees

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Overview of Talk

Motivation

Scientific Goals

Overview of Current USNO Telescope Assets/Access

- Current optical assets
- Current radio assets
- 2019/2020 deployment of DST and NOFS 1.8 m telescopes
- UKIRT update
- Critical observing “gaps”

Current FRAMEx Projects

- Volume-limited AGN monitoring project
- DST-based AGN optical monitoring project

Summary

2020 AGNCRF Conference

Motivation

Transitioning from era of single, fundamental reference frame to multi-wavelength one, each wavelength with different characteristics, including sources of emission (i.e., "photocenters"), random and systematic errors, resolution/beam size, etc.

- Prior to 1 January 2019: ICRF2 (S/X)
- Post 1 January 2019: ICRF3 (S/X, K, X/Ka) + GCRF
- Future: *To be determined*

Numerous assessments comparing radio and optical source positions, offsets, etc.

- e.g.: Roland (2015, GAGNES)—effects of BBH on observed position; Zacharias & Zacharias (2015)—offsets between radio and optical reference frame positions; Makarov et al. (2018), "Precious radio-optical reference frame objects"; Petrov et al. (2018), comparison of VLBI jet and Gaia positions; Frouard et al. (2018), comparison of ICRF2, ICRF3 candidate and Gaia DR1 source positions

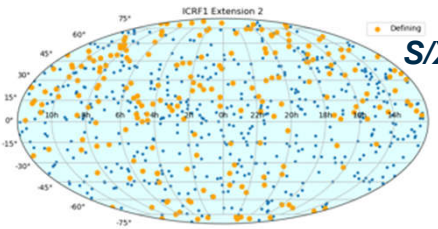
We are now entering the era of time-domain astronomy, and have the ability to observe and monitor critical targets in a queued/automated fashion synoptically, and process the resultant large volumes of data in a completely automated fashion

How can we use these new capabilities to help us address the issues associated with the Celestial Reference Frame?

- Selection/deselection of sources
- Understanding of static and time-dependent offsets vs. reference positions and between reference bands

Fundamental Reference Frames over time

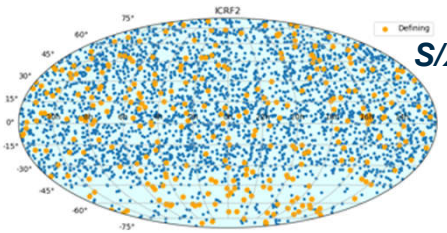
1998
ICRF1



S/X

717 sources

2009
ICRF2

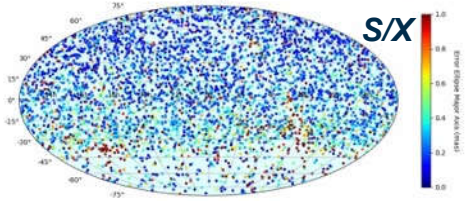


S/X

3414 sources

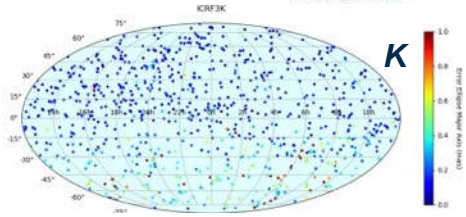
2019

4536 sources



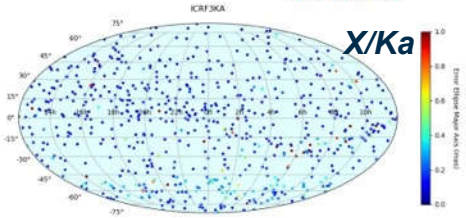
S/X

824 sources



K

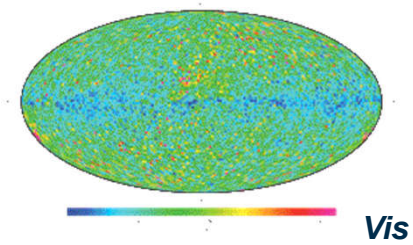
678 sources



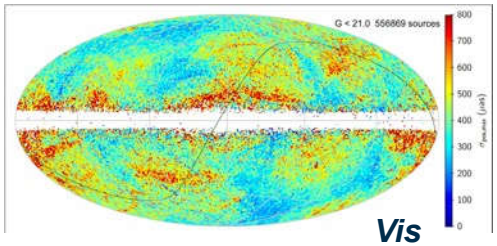
X/Ka

ICRF3

1997
HCRF



Vis



Vis

GCRF

Scientific Objectives/Goals of FRAMEx

Utilize combined radio, visible and infrared observing assets to monitor reference frame targets in order to:

- Select/deselect celestial reference frame and tie sources
- Characterize reference frame and similar sources
- Develop an understanding of how astrometry, photometry (and spectra) vary as a function of time, at various timescales (minutes/hours/days/weeks/months/years)
- Relate observational data to underlying astrophysics

Specific FRAMEx scientific observational goals: *identify and quantify the effects of*:

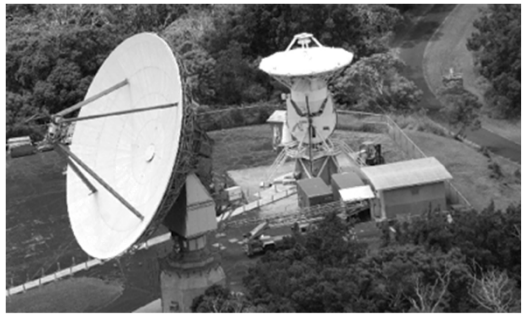
- Optical / radio jets—source of emission, variability vs. timescales
- Light from host galaxy (asymmetric or off-center AGN)
- Double core objects/binary black holes—population, typical separation, time evolution, effects between differing wavelengths
- Blended images / foreground objects
- Microlensing
- Etc.

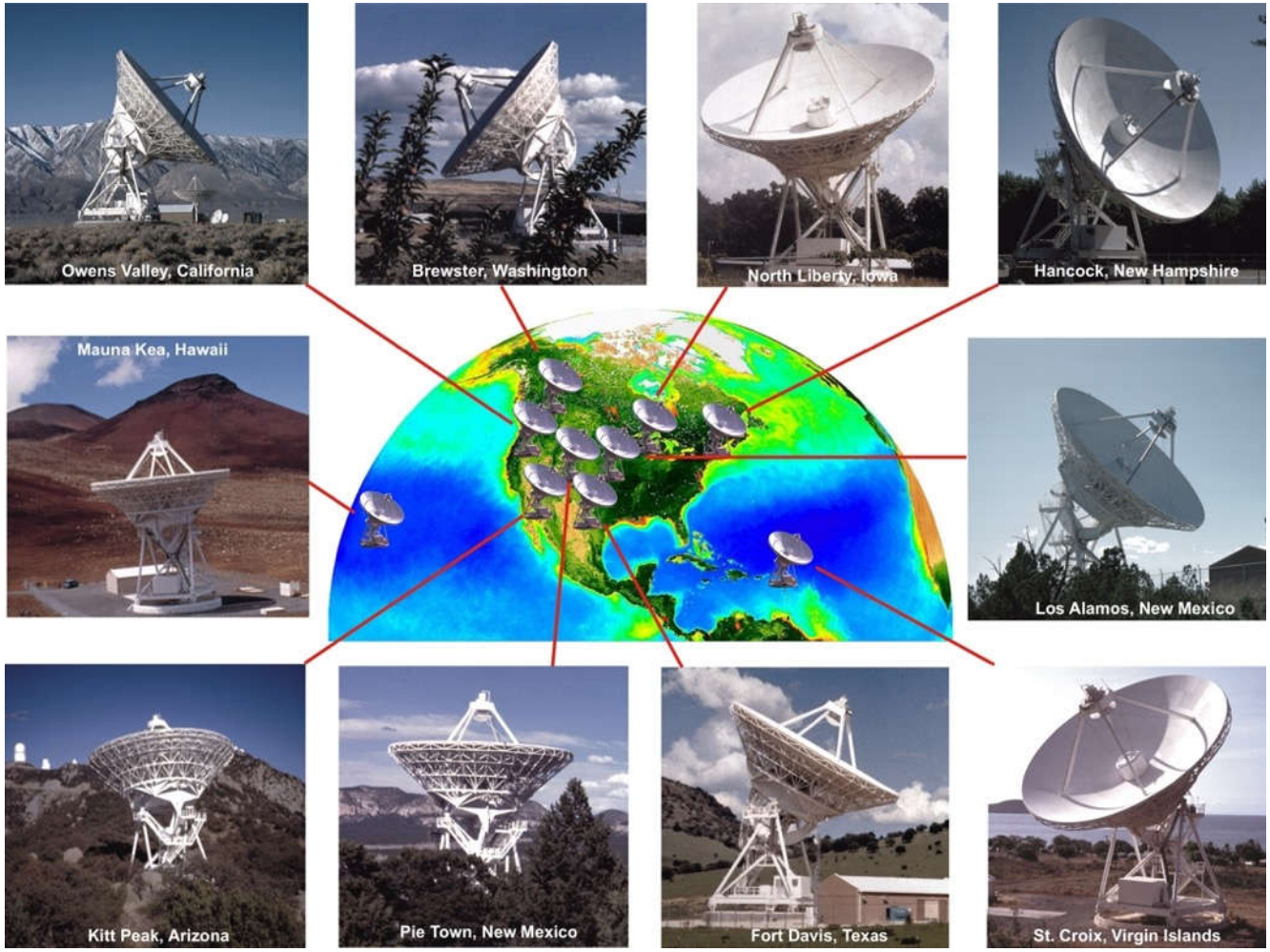
USNO Accessible Assets—2019/20 (Visible/IR)

**-indicates 2020 deployment*

+-Beginning 15 Jul 2017, USNO allocates 50% of UKIRT observing time

USNO Accessible Assets—2019/20 (Radio)

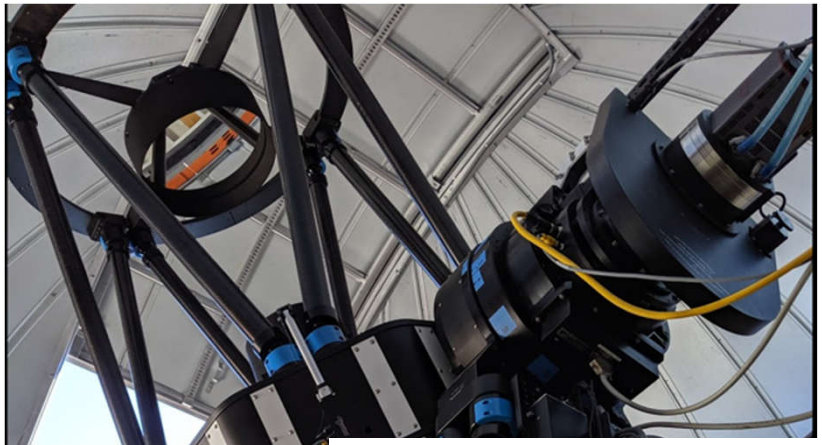


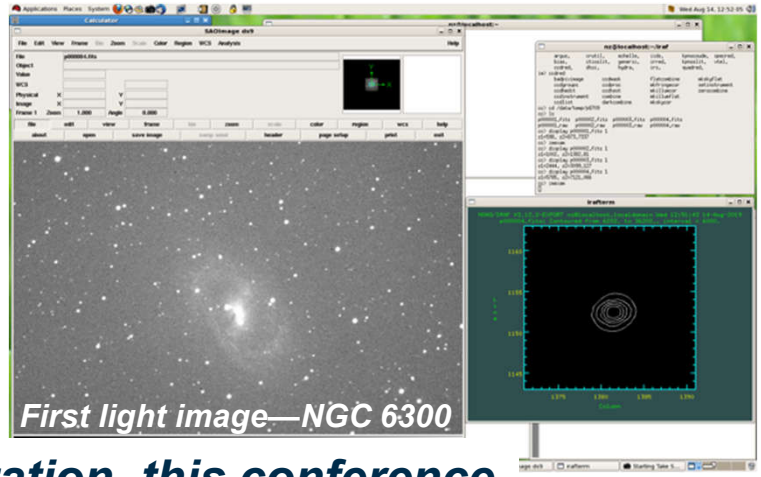


(Above) Kokee Park 20- and 9-m antennae; (right) Very Long Baseline Array (VLBA)

Beginning 1 Jan 2017, USNO Allocates 50% of VLBA observing time

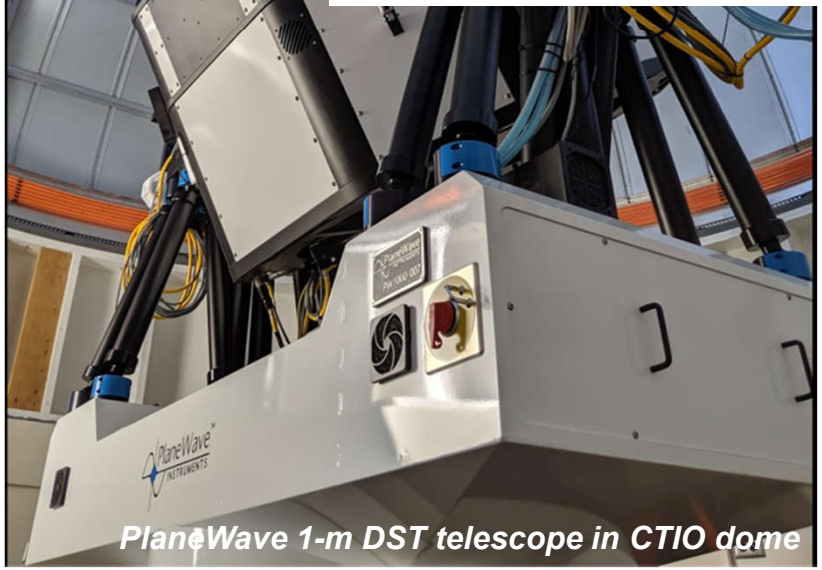
1-m Deep South Telescope (Visible/NIR) Deployed to Chile in 2019





First light image—NGC 6300

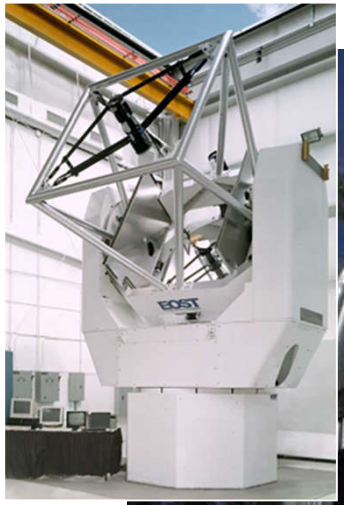
See Zacharias et al presentation, this conference



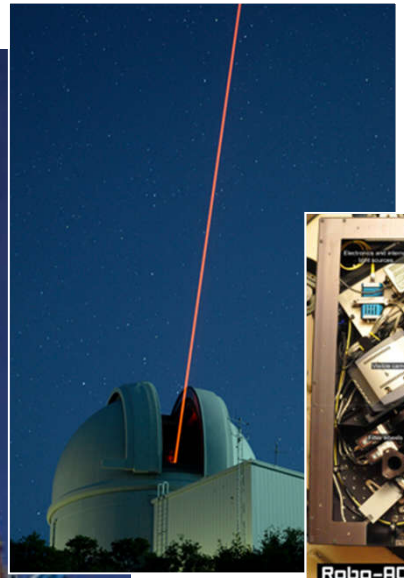
PlaneWave 1-m DST telescope in CTIO dome

CTIO DST Dome

1.8-m Vis/N-MIR Telescope Deployment Underway at NOFS (Flagstaff, AZ)



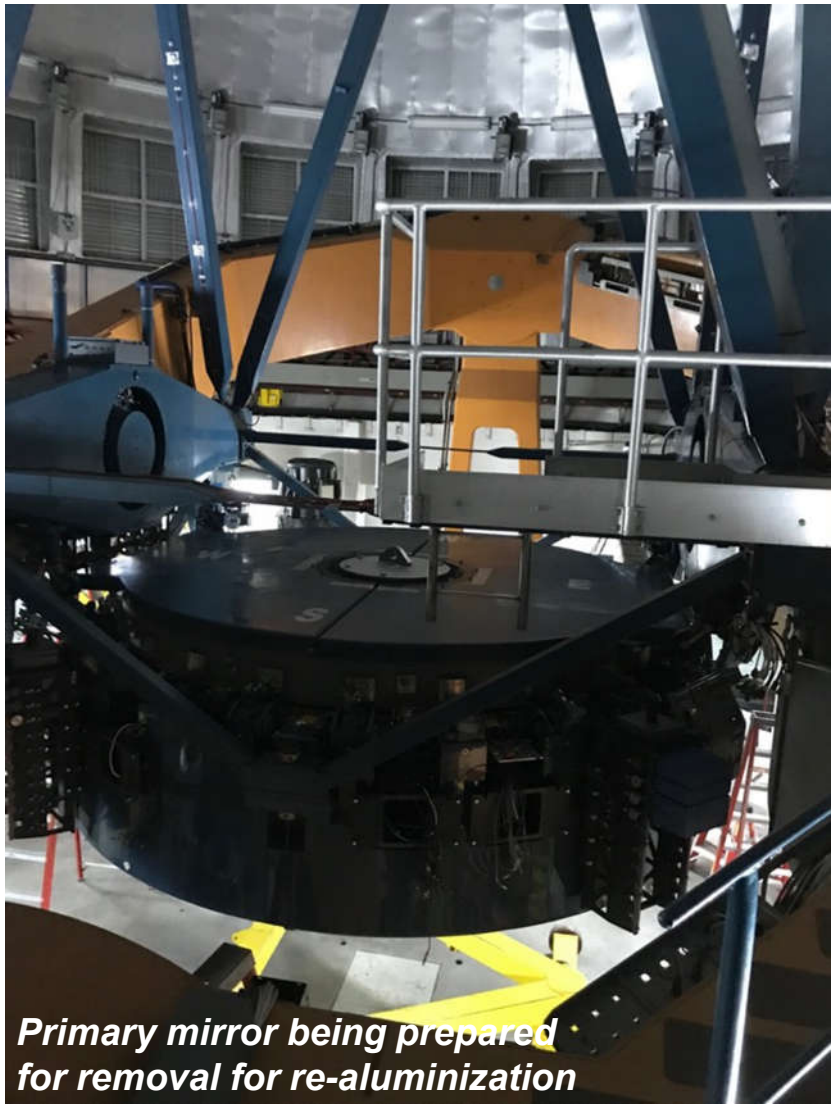
1.8-m dome nearing completion in Sept 2019; telescope deployment expected by end of 2019; first light in 2020



First facility instrument: RoboAO system (PI: Christoph Baranec (UH/IfA)

- Diffraction Limited optical / near infrared imaging of ICRF3 sources
- Diffraction-limited performance for $m_V < 17$:
  - ~0.1” (i-, z-bands)
  - ~0.2” (J-,H-bands)
- Efficient queue-mode observing
  - 150 targets per night typical.

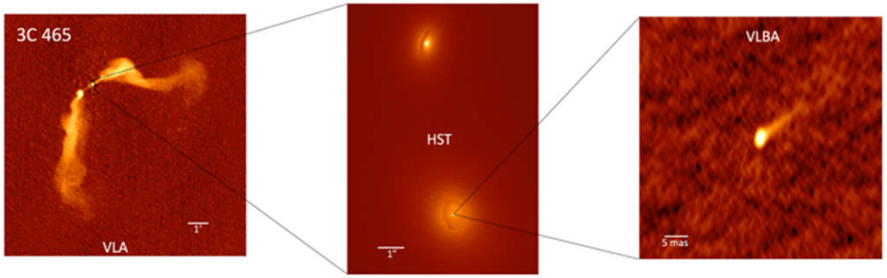
3.8-m N-MIR UKIRT Status

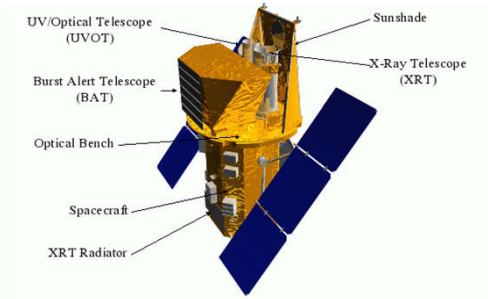


Since 15 July 2017, USNO has allocated 50% of UKIRT time

- ***Currently executing K (~80% complete) and H band (~5% complete) deep surveys of Northern Hemisphere (excluding polar cap) to complement recently completed J-band survey***
- ***Re-aluminization of primary and secondary completed in early October—restored ~0.3 magnitudes of sensitivity***
- ***Available to support CRF observations, e.g. FRAMEx***

Initial FRAMEx Projects





1. Volume-Limited Sample of AGN

- Study a volume limited sample of bonafide AGN as detected from the Swift Burst Alert Telescope (BAT) AGN Spectroscopic Survey (BASS) with the VLBA at 5 GHz.
- *See Fischer et al. presentation*

2. Optical monitoring of reference frame QSOs with the Deep South Telescope

- Queued observations with DST 1-m of a set of AGN supporting the “Volume Limited” sample, as well as other AGN targets identified as “troublesome”
- *See Zacharias et al. presentation*

Summary

Moving into era of multi-wavelength, very high accuracy reference frames

AGNs present differently in different wavelengths

FRAMEx collaboration: utilize USNO and OP available observing assets to observe and monitor relevant AGNs in order to better understand phenomenology, constrain underlying astrophysics, and quantify observable behavior of AGN

FRAMEx underway with two initial projects:

- Volume-limited sample
- Optical monitoring with DST

Contact information: bryan.dorland@navy.mil; norbert.zacharias@navy.mil; megan.johnson@navy.mil; nathan.secrest@navy.mil ; travis.fischer.ctr@navy.mil

CONFERENCE ANNOUNCMENT: Active Galaxies and Quasar Reference Systems in the Gaia Era

Active Galaxies and Quasar Reference Systems in the Gaia Era (“AGNCRF”)

Date: June 15-19, 2020
Location: Institut d'Astrophysique de Paris

Dedicated meeting to bring together AGN and CRF researchers to discuss outstanding questions in AGN research that affect apparent positions of AGN/quasars, including:

- Current understanding of optical/radio offsets (physical nature)
- AGN physics: jet launching, obscuration, variability, binarity, feedback, etc.
- Strategies for maximum, all-sky, uniform samples of AGN/quasars
- Other positional effects: lenses, dual AGN, dislodged AGN
- Astrometry in practice: multi-wavelength CRF, catalog matching strategies

Many SOC, LOC members here at Journees

Currently soliciting speaker suggestions

Contact: Nathan Secrest, Jean Souchay, Brigitte Rocca