

The Science Ready Data Products Initiative

Slides by John Tobin - SRDP Project Scientist https://science.nrao.edu/srdp/



NRAO's Science Ready Data Products Initiative

The SRDP program is an observatory wide program to increase the scientific impact of NRAO's telescopes by making radio interferometer data easier to use, especially for non-experts by:

- Providing the expertise required to perform data processing, so users may focus on their science
- Leverage the use of pipelines to enable users to perform reimaging of data (currently ALMA) without running CASA themselves
- Provide users calibrated data without having to restore themselves

https://science.nrao.edu/srdp/



- Curating a rich collection of images and cubes for archival study

SRDP is pioneering the tools and processes for ngVLA Science Operations.



Science Ready Data Products

The SRDP Program is currently managing three projects:

- <u>Science Ready Archive and Operations</u>: Defining, creating, and making available science ready products.
 - NRAO Archive
 - VLA Pipeline
 - ALMA Pipeline limited to features to support user-defined reprocessing
- VLA Sky Survey: Synoptic all-sky survey at S-Band
 - Epoch 3 currently observing
- Telescope Time Allocation Tools replacement for current proposal submission/review tools



Science Ready Archive and Operations - Services

- NRAO Archive (<u>https://data.nrao.edu</u>)
- VLA
 - Quality assured VLA visibility data
 - S/C-band and higher frequencies, continuum data
 - Calibrated Measurement Set Download
 - Continuum images from VLA data (since late 2022)
- ALMA
 - User-Defined Imaging (AUDI)
 - Re-imaging of data with user-specified parameters
 - self-calibration on science targets
 - Calibrated Measurement Set Download
- VLBA, GBT, GMVA, and Historical VLA
 - Data hosted by NRAO archive
- CARTA service
 - View images currently available in NRAO archive
 - VLASS data, VLA images, and ALMA images created by AUDI



Science Ready Archive and Operations (SRDP)

- Set pipeline development priorities for
 - VLA pipeline
 - Extensions to ALMA pipeline to support SRDP services
 - NRAO Archive (and supporting subsystems)
- VLA calibration pipeline has been integrating VLASS-derived improvements over the past few years
- AVLA continuum imaging pipeline has been developed (adapted from from ALMA pipeline)
 - Users are now getting images delivered along with calibrations
- User-specified angular resolution for ALMA User-Defined Imaging



Caveats

- Focus is on pipeline-able features
 - Some user-defined settings, non-interactive execution
- ALMA Features supported for Cycle 5+ only; pipeline-calibrated data only
 - limitation of how data were archived previously
- Sometimes less ALMA data available for restores than there should be
- Cycle 5 data sometimes need special settings
 - Will get re-run behind the scenes if necessary by staff
- VLA data might have a calibration, but possibly not science quality
 - Still useful but some additional flagging may be needed
 - Images may still be 'ok' thanks to statwt task
 - Science quality calibrations started ~June 2019 (for select bands)
- VLA data back to late 2016 supported for restoration



ALMA SRDP Capabilities

- Downloading of restored measurement sets¹
 - Useful for archival data or users in other ALMA ARCs that do not get calibrated data
 - NA users get a calibrated MS(es) that are available for a limited time after QA2
- ALMA User-Defined Imaging¹
 - Make new ALMA images from archival (or your own!) data

¹ For data successfully processed by calibration pipeline, manual calibration not supported



Accessing SRDP capabilities

- User-access to most SRDP services will be through NRAO archive (<u>https://data.nrao.edu</u>)
 - NRAO Archive hosts data from:
 - Jansky VLA
 - ALMA (Cycle I+)
 - VLBA
 - Historical VLA
 - GBT (2014-2020)
 - GMVA
- This is NOT the ALMA archive (<u>https://almascience.nrao.edu/aq/</u>)
 - No NRAO SRDP services are available through the ALMA archive
 - ALMA archive does have some similar features like CARTA



ALMA User Defined Imaging

- Make new ALMA images without downloading all the data or running CASA
- ALMA imaging pipeline with automasking is quite mature with science-quality output however...
 - Archived cubes are generated for full spw at native resolution
 - 10s of GB cubes possible/frequent
 - Size mitigation may prevent all sources/ spws from being imaged



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ALMA User Defined Imaging

- User-triggered imaging enables creation of new images using archive interface
 - User specifies cube they want¹
 - Frequency/velocity
 - Rest Frequency
 - Spectral averaging
 - Angular resolution*
 - Calibrated measurement set restored
 - Imaging pipeline runs
 - Image is QAed and ingested into NRAO archive
 - Video Demo: <u>https://vimeo.com/513590322/81ee77787e</u>
 - * The pipeline does the best it can within the limits of the data (i.e., no magic)
 - ¹ Defaults will make a standard cube that spans the spw.



RA

Run ALMA User-Defined Imaging (AUDI)

- Instructions on https://science.nrao.edu/srdp/
- Go to <u>https://data.nrao.edu</u>
- Search for some data (e.g., project code, target name, position/ radius)
- Click the '+' to see more detail about the project
- Click the blue 'Download Restored MS' button for the desired data
- Fill out the dialog box for a frequency-based or velocity-based cube
- A valid setting for the frequency-based cube is filled by default for the selected spectral window



How to use ALMA User-Defined Imaging (AUDI)

https://vimeo.com/513590322/81ee77787e



What's New in SRDP?

- Fully automated target self-calibration in imaging pipelines
 - Uses continuum and applies results back to spectral line and continuum data
- Included in AUDI imaging since June 2023 (hif_selfcal)
- ALMA and VLA pipelines will include selfcal task by default this fall
 - Single-field selfcal (standard and spectral scan)
- Stand-alone selfcal tools available (runs within CASA 6.4+)
 - Developed by J. Tobin and P. Sheehan
 - <u>https://github.com/jjtobin/auto_selfcal</u> (single-field selfcal)
 - Development Fork: <u>https://github.com/psheehan/auto_selfcal</u>
 - Adds support for mosaics, low-S/N (typically longer baselines)
 - Will become the 'new' stable in the next month or so



Auto-selfcal In Action



VLA S-Band A-config •

Without Selfcal

With Selfcal



Auto-selfcal In Action



• VLA S-Band A-config



Auto-selfcal In Action



- NGC 2071IR (HOPS-361) •
- ALMA Band 6 C43-6 •

Without Selfcal

GREEN BAN

Auto-selfcal: How does it work?

- Designed to mimic an interactive self-calibration workflow
- Heuristics added/ developed to automate the process
- Operates on single MOUS from ALMA or collection of VLA EBs with same targets/spectral setup

1	Pipeline-calibrated _targets.ms files	
	Plan self-calibration	If successful:
	Generate "pre" image, model	Adjust self- calibration
	Solve for gains, apply	clean threshold, etc.)
	Generate "post" image	If unsuccessful:
ţ	Evaluate success	Apply last successful (or remove) calibration





Auto-selfcal: Available versions

In the AUDI/upcoming Pipeline (CASA 6.5.3-28 + pipeline; CASA 6.5.4-9 +pipeline):

- Self-calibration of singlepointing ALMA and VLA datasets
 - Multi-source EBs work
 - \circ No mosaics
- Possible additional AUDI release with improved selfcal within next 4-6 months
- Current features from standalone tools will be in Pipeline task in 2024

In the Standalone tools:

- Near-field heuristics with improved nearfield mask generation
- Improved heuristics for "long baseline" datasets
- Mosaics work
- Available here soon (when stable): <u>https://github.com/jjtobin/auto_selfcal.git</u>
- Or here now (development): <u>https://</u> <u>github.com/psheehan/auto_selfcal.git</u>



Summary: Accessing SRDP capabilities

- User-access to most SRDP services will be through NRAO archive (<u>https://data.nrao.edu</u>)
 - NRAO Archive hosts data from:
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Other resources

 You can ask for a zoom help session for any part of your ALMA data process at <u>https://help.almascience.org/</u>

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Demos

- CARTA VLASS NGC 1097 (UGC 595)
- CARTA HOPS-370
- Restore HOPS-370 2017.1.00419.S
- Reimaging HOPS-370 2017.1.00419.S 12CO



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× (VLASS1.1	0h7m24.984s	-36°30'0.000"	S	2.518	2.440	VLASS1.1.ql.T01t01.J000724-363000.10.2048.v1.l.iter1.image.pbcor.tt0.subim.fits
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Request #1012670869 by Anonymous User *

Image Processing Request

\ Initializing request....

Requested Projects / OUSets / Executionblocks

Project / OUSet / Executionblock File Size

Please wait; requested datasets list under construction....

Data entities 1-4 of 4



 Requests to view images in CARTA should take 30-60s

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 - activity





Sessions expire after 1 hour regardless of

activity



ALMA and VLA PI images also in Archive

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3	2017.1.00419.S	5h34m35.170s	-4°52'17.995"	06	0.275	1.639	uidA001_X1284_X149.HOPS-102_sci
	2017.1.00419.S	5h34m35.170s	-4°52'17.995"	06	0.269	1.601	uidA001_X1284_X149.HOPS-102_sci

- ALMA images currently
- limited to those created
- with 'AUDI' tool (later
- in the talk)
 - Full set of ALMA
 - images will be
 - available in the future
- VLA PI data from
- imaging pipeline pilot
- operations available
 - Imaging of all PI data
 - will begin later in the

year



A Simple Search

- If looking for your own data, much can be accomplished with simple searches
- A view of just your data also available
 - Log-in required
 - PI and Co-I projects



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+	22A-164	EVLA	Grain growth in protoplanetary disks in Ophiuchus A	cluster	2022-03-12 09:50	2022-04-18 11:25	18 execution blocks	
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+	21A-423	EVLA	Testing the Link between Accretion and Outflow in an	Outbursting Protostar	2021-05-14 23:23	2022-01-12 06:24	10 execution blocks	



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	+ 2019.1.0	0493.S ALN	/A Dire	ect Mass Measuremen	ts of Pre-Main Sequence	Stars in Upper Sco	2020-02-27 07:47	2022-01-05 16:09	7 execution blocks	•
	+ 2021.1.0	0844.S ALN	/A An (Wa	ALMA/JCMT Study of arped?) Protostellar Dis	the Time-Variable Class sk	0 Protostar HOPS 358 and	lts 2021-11-03 05:53	2022-01-03 03:22	3 execution blocks	-
	+ 2019.1.0	0458.S ALM	/A Wh	at is Carving the Gaps	in Young, Embedded Dis	sks?	2021-05-12 19:57	2022-01-01 05:26	11 execution blocks)



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+	22A-164	EVLA	Grain growth in protoplanetary disks in Ophiuchus A cluster	2022-03-12 09:50	2022-04-18 11:25	8 execution blocks
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+	21A-423	EVLA	Testing the Link between Accretion and Outflow in an Outbur	sting Protostar 2021-05-14 23:23	2022-01-12 1 06:24	0 execution blocks



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1	22A-195.sb41668223.eb41788343.59699.900189837965	22A-195	EVLA	2022-04-30 21:36:17	2022-05-01 00:47:43	535.468 GB	А	С, Х	visibility		264





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More Complex Searches

- More highly refined searches also possible
 - Combination of many parameters possible



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+	22A-351	EVLA	A Search for a Local Population of Neutron Star Binary Mergers		2022-04-22 13:52	2022-05-05 15:05	3 execution blocks	•	
+	22A-092	EVLA	Ionized Jets from High-Mass Protostars: a VLA Quest for Resolution		2022-03-07 14:18	2022-05-05 14:05	8 execution blocks		
+	22A-388	EVLA	Resolving the nature of quasar flux-ratio anomalies in gravitational lenses		2022-03-15 13:28	2022-05-05 09:52	21 execution blocks	•	
+	22A-012	EVLA	Into a Heart of Darkness: 250pc-Scale ISM Dynamics of a z=6.34 Binary Starburst		2022-04-02 13:02	2022-05-05 08:37	4 execution blocks	•	
+	2021.1.00548.S	ALMA	Tomography of the peculiar Sgr C cloud: a higher density threshold for star formation in a environment?	highly turbulent	2021-10-03 23:42	2022-05-05 06:40	40 execution blocks	•	
+	2021.1.00379.S	ALMA	Unveiling the distribution of the cosmic-rays ionization rate with ALMA		2021-11-09 19:40	2022-05-05 06:39	11 execution blocks		



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Details and Observations/Images within project shown

+ 22A-268	EVLA	Testing the Link between Accretion and Outflow in an Outbursting Protostar	2022-02-18 02:31	2022-04-07 23:54	5 execution blocks	•
– 1A-423	EVLA	Testing the Link between Accretion and Outflow in an Outbursting Protostar	2021-05-14 23:23	2022-01-12 06:24	10 execution blocks	-

Title: Testing the Link between Accretion and Outflow in an Outbursting Protostar

Abstract: The deeply embedded protostar HOPS-373 has been found by the JCMT transient survey to have undergone a 25\% increase in 0.85mm continuum flux density, corresponding to a ~4x increase in accretion luminosity. Furthermore, VLA DDT observations in March/April detected flux density increases at 9.1mm and 5cm relative to archival pre-burst data at the same wavelengths. We now propose monthly monitoring of HOPS-373 at C-band from now until January 2022 (through D, C, and B-configurations). We will analyze the VLA 5cm lightcurve in conjunction with contemporaneous monitoring by the JCMT at 0.85mm. This will enable us to determine if the outflow activity (probed at 5cm) increases/decreases along with the accretion activity (probed by 0.85mm). The 0.85mm light curves are proportional to the luminosity of the system, and variations are due to changes in the accretion rate. The results from this proposal will provide observational confirmation (or rejection) of a close link between accretion and outflow activity.

PI: John Tobin

Legacy ID: AT585

Co-Authors: Watson Varricatt, Ho-Gyu Lee, Gregory Herczeg, Doug Johnstone, Jeong-Eun Lee, Sung-Yong Yoon, Carlos Contreras Pena

Proposal: Click to search



• Link to a list of scans



				12:15:57	13:35:41	GB		
*	21A-423.sb40054761.eb40727801.59502.41835891204	21A-423	EVLA	2021-10-15 10:03:55	2021-10-15 11:23:42	37.727 GB	В	C,
.	21A-423.sb40054557.eb40140843.59468.50435081018	21A-423	EVLA	2021-09-11 12:06:16	2021-09-11 13:12:38	18.876 GB	С	C,



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List of Scans



Archive Access Tool Back

Calibrations:

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Observation ID: 21A-423.sb40987809.eb41134421.59591.17637289352

Obs ID: 21A-423.sb40987809.eb41134421.59591.17637289352 Project Code: 21A-423 Legacy ID: AT585 Estimated Size: 62.470 GB Obs Release Date: 2022-07-14T05:24:21.799Z Data Product Type: visibility Receiver Band: C, X Array Configuration: B

File: 21A-423 2022 01 12 T06 37 17.380.tar

• Not currently in a particular order

• We plan to revise this view to be more useful

Longitude	Latitude	Target Name	Min Frequency	Max Frequency	Scan Intent	Polarizations	Temporal Res	Scan Duration
5h46m30.990s	0°2'33.900"	HOPS-373	3.9760000 GHz	7.8960000 GHz	["OBSERVE_TARGET"]	["RR, RL, LR, LL"]	3.03	478.7 sec
5h46m30.990s	0°2'33.900"	HOPS-373	3.9760000 GHz	7.8960000 GHz	["OBSERVE_TARGET"]	["RR, RL, LR, LL"]	3.011	478.7 sec
5h52m50.101s	3°13'27.243"	J0552+0313	3.9760000 GHz	7.8960000 GHz	["SYSTEM_CONFIGURATION"]	["RR, RL, LR, LL"]	3.032	448.75 sec
5h52m50.101s	3°13'27.243"	J0552+0313	3.9760000 GHz	7.8960000 GHz	["CALIBRATE_PHASE","CALIBRATE_AMPLI"]	["RR, RL, LR, LL"]	3.219	41.85 sec
5h52m50.101s	3°13'27.243"	J0552+0313	3.9760000 GHz	7.8960000 GHz	["CALIBRATE_PHASE","CALIBRATE_AMPLI"]	["RR, RL, LR, LL"]	3.219	41.85 sec
5h52m50.101s	3°13'27.243"	J0552+0313	3.9760000 GHz	7.8960000 GHz	["CALIBRATE_PHASE","CALIBRATE_AMPLI"]	["RR, RL, LR, LL"]	3.223	41.9 sec
5h52m50.101s	3°13'27.243"	J0552+0313	3.9760000 GHz	7.8960000 GHz	["CALIBRATE_PHASE","CALIBRATE_AMPLI"]	["RR, RL, LR, LL"]	3.219	41.85 sec
5h46m30.990s	0°2'33.900"	HOPS-373	3.9760000 GHz	7.8960000 GHz	["OBSERVE_TARGET"]	["RR, RL, LR, LL"]	3.011	478.7 sec
5h52m50.101s	3°13'27.243"	J0552+0313	8.3320000 GHz	8.4600000 GHz	["SYSTEM_CONFIGURATION"]	["RR, RL, LR, LL"]	1.009	175.55 sec
5h52m50.101s	3°13'27.243"	J0552+0313	3.9760000 GHz	7.8960000 GHz	["CALIBRATE_PHASE","CALIBRATE_AMPLI"]	["RR, RL, LR, LL"]	3.223	41.9 sec
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Request Data



Click on the icon to download just the calibration tarball

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3	21A-423.sb40987664.eb41071109.59578.29402234954	21A-423	EVLA	2021-12-30 07:03:24	2021-12-30 08:23:07	37.723 GB	В	C, X	visibility	1	21
3	21A-423.sb40987519.eb41022980.59555.359109490746	21A-423	EVLA	2021-12-07 08:37:07	2021-12-07 09:56:53	37.703 GB	В	C, X	visibility	1	21
3	21A-423.sb40930802.eb40950618.59524.51107608796	21A-423	EVLA	2021-11-06 12:15:57	2021-11-06 13:35:41	37.747 GB	В	C, X	visibility	1	21
	21A-423.sb40054761.eb40727801.59502.41835891204	21A-423	EVLA	2021-10-15 10:03:55	2021-10-15 11:23:42	37.727 GB	В	C, X	visibility	1	21
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• Select an observation to see the download options

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× 1	21A-423.sb40054557.eb40140843.59468.50435081018	21A-423	EVLA	2021-09-11 12:06:16	2021-09-11 13:12:38	18.876 GB	С	С, Х	visibility	1	17



Download Options for VLA

- Login required for proprietary data download (no more keys)
- Local delivery will be possible for any logged-in user in the next ~month
- tar file option not recommended, use wget -r (see archive documentation, link on slide 3)

Launch Workflow Task	on: 21A-423 ×
User Email (required):	jtobin@nrao.edu
Request Description:	EVLA Processing Request
Destination Directory:	Specify directory (must be logged in & staff) /lustre/
Create tar file:	□ Return results as a tar file
Choose download data format:	 SDM tables only (metadata only) SDM-BDF dataset (metadata + visibilities) Basic Measurement Set (uncalibrated) Calibrated Measurement Set
Apply telescope flags:	Apply flags generated during observing
CASA Pipeline Version:	6.2.1-7 2021.2.0.128 (recommended) -
Restore previous CMS	21A-423_2022_01_12_T06_37_17.380.tar- Estimated Processing Time: 3 hour
	Cancel Submit Request
4256.59450.60758923611 21	A-423 EVLA 2021-08-24 2021-08-24 17.519

Download Options for VLA

- SDM-BDF raw data (recommended for manual processing and pipeline reruns)
- Basic MS raw data but converted to MS from SDM
- Calibrated MS MS with VLA pipeline calibration applied (if available)
- Apply flags only really applicable to Basic MS
- Generally want to use latest CASA+pipeline

User Email (required):	jtobin@nrao.edu
Request Description:	EVLA Processing Request
Destination Directory:	Specify directory (must be logged in & staff) /lustre/
Create tar file:	□ Return results as a tar file
Choose download data format:	 SDM tables only (metadata only) SDM-BDF dataset (metadata + visibilities) Basic Measurement Set (uncalibrated) Calibrated Measurement Set
Apply telescope flags:	Apply flags generated during observing
CASA Pipeline Version:	6.2.1-7 2021.2.0.128 (recommended) -
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	Estimated Processing Time: 3 hours
4	Cancel Submit Request
4256.59450.60758923611 21.	A-423 EVLA 2021-08-24 2021-08-24 17.519

Submitted Request

- All submitted requests go to 'Request Handler'
 - Checks authorization for data
 - Provides some status of where request is at
 - completely non-interactive
 - safe to close window (or go back to archive with back button)
 - E-mail notification when done will be sent
 - Cannot cancel jobs or get exact status updates



Request #1007704374 by John Tobin * EVLA Processing Request - Initializing request.... Requested Projects / OUSets / Executionblocks Project / OUSet / Executionblock File Size Please wait; requested datasets list under construction.... Data entities 1-1 of 1



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 From do-not-reply@nrao.edu★
 > Reply → Forward Archive Archive Delete More

 Subject NRAO Archive Request 1008243591: Complete
 5/6/22, 12:32

 To Me★
 5/6/22, 12:32

 Dear Anonymous User:
 Thank you for using the NRAO archive.

 Your EVLA Processing Request is complete. The data selection (35.3GB) is available from this link:
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 The files may also be accessed directly here:
 https://dl-dsoc.nrao.edu/anonymous/1008243591/dhpsaf38p0h7mvkm52v5a93hft/

 Best regards,
 The NRAO Archive

- Look for an e-mail notification
 - Link to staged location at end of message
 - download via terminal command:
 - wget -r --reject "index.html*" -np -nH -cut-dirs=3 https://dldsoc.nrao.edu/anonymous/1008243591/dhpsaf38p0h7mvkm52v5a93hft/
 - Terminal command essential if not using tarred download
 - MSes and SDMs have a bunch of subdirectories within them



VLBA Data Through the NRAO Archive

NRAC	National Ra Enabling forefront re	dio Astronomy search into the Universe a	Observatory tradio wavelengths			version: 4.1.0
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+ BO068	B VLBA	Water maser astrometry i	n the very young object CARMA-6	2022-03-14 11:44	2022-04-11 14:20	10 execution blocks



VLBA Data

-	BO068	VLBA	Water maser astrometry in the very young object	2022-03-14 11:44	2022-04-11 14:20	10 execution blocks	a
			CARMA-6				

Title: Water maser astrometry in the very young object CARMA-6

Abstract: Protostellar jets play a fundamental role in the evolution and re-distribution of angular momentum during the formation of new stars. The milliarcsecond angular resolution and very high astrometric precision capability of the VLBA applied to the 22 GHz water maser line offer a unique opportunity to explore the kinematical structure of protostellar jets close to the central engine, on spatial scales of a few au. We propose follow-up VLBA observations of the recently detected 22 GHz water masers in the Class 0/l object CARMA-6 at the heart of the Serpens South cluster. With these new observations, combined with data from previous epochs, we will measure the proper motions of the maser spots, allowing us to i) study the jet kinematics near its launching point, ii) investigate the relationship between the observed velocity gradients of the masers and the outflow/jet/disk geometry, and iii) search for signatures of jet rotation, jet precession and/or episodic ejection. In addition and very importantly, we will obtain the parallax of the source, which will be the first direct measurement of the distance to the embedded protostar and thus to the Serpens South cluster. **PI:** Gisela Ortiz

Legacy ID: BO068

Co-Authors: Adele Plunkett, Sergio Dzib, Thushara Pillai, Laurent Loinard, Carolina Rodríguez-Garza, Yan Gong

Segment It Observation Start It Observation Stop File Size Bands Correlation Files Image:	Segments	Images					
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VLBA Data

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VLBA Download options (or lack)

- No processing options, just standard download
- Only FITS format is available for download

Launch Workflow Task o	on: BO068 ×
User Email (required):	
Request Description:	VLBA Download Request
Destination Directory:	Specify directory (must be logged in) /lustre/
Create tar file:	☐ Return results as a tar file
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ALMA Data Through the NRAO Archive

 Does not replace ALMA Science Archive, but adds functionality

NRAO Rat	tional Rad	dio Astronomy Observatory search into the Universe at radio wavelengths				version: 4.1.0
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Title: The Hunter's Gift: A Bounty of Forming Disks to Further Our Understanding of Protostellar Evolution

Abstract: The formation of a protostar and its Keplerian disk remains a poorly characterized process, but ALMA now provides an opportunity for significant progress. These forming disks also hold the key to measuring the most fundamental parameter of newborn stars, their masses derived from the Keplerian disk rotation. The measurement of protostar masses and the properties of forming disks for large ensembles of systems is essential to solidifying our knowledge of star and planet formation. Our ALMA Cycle 3 survey of 330 protostars in the Orion molecular clouds at 0.13" (50 AU) resolution yielded >100 well-resolved continuum images of apparent protostellar disks. We propose to observe a sample of 20 disk candidates around 10 Class 0 and 10 Class I protostars, drawn from a representative range of luminosities (0.4 L_sun to 480 L_sun). With these observations, we will confirm whether or not each disk is Keplerian, using molecular line tracers (primarily C18O J=2-1), measure the change in mass and mass accretion between the Class 0 and I phases, how much the disk properties depend on stellar mass, and how much disk structure evolves from Class 0 to Class I and later stages.

PI: John Tobin

- 0

Co-Authors: Dominique Segura-Cox, Mihkel Kama, Friedrich Wyrowski, Magnus Persson, William Fischer, Sarah Sadavoy, Mayra Osorio, Erin Cox, Ewine van Dishoeck, Nicole Karnath, Tom Megeath, Merel van 't Hoff, Kaitlin Kratter, Ana Karla Diaz Rodriguez, Guillem Anglada, Hector Arce, Laura Perez, Elise Furlan, Michael Dunham, Stella Offner, Zhi-Yun Li, Patrick Sheehan, Brian Stephenson, Amelia Stutz, Leslie Looney, Nickalas Reynolds

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Launch Workflow Task on: 2017.1.00419.S × Active Search Inputs: Text Search Tobin User Email (required): itobin@nrao.edu **Request Description:** ALMA Processing Request View Projects View Observations View IT Project 11 Instrument Last Obs **Destination Directory:** Specify directory (must be logged in & staff) /lustre/ 2017.1.00419.S ALMA 2018-01-07 6:14 Return results as a tar file Create tar file: Title: The Hunter's Gift: A Bounty of Forming Abstract: The formation of a protostar and its significant progress. These forming disks Choose download data SDM tables only (metadata only) also hold the key to measuring the most funda easurement of protostar masses and the format: ALMA SDM+BDF (metadata + visibilities) properties of forming disks for large ensemble le 3 survey of 330 protostars in the Orion molecular clouds at 0.13" (50 AU) resolution v Basic Measurement Set (uncalibrated) e a sample of 20 disk candidates around 10 Class 0 and 10 Class I protostars, drawn from confirm whether or not each disk is Calibrated Measurement Set Keplerian, using molecular line tracers (prima ases, how much the disk properties depend on stellar mass, and how much disk structure 3 Apply telescope flags: Apply flags generated during observing PI: John Tobin Co-Authors: Dominique Segura-Cox, Mihkel Cox, Ewine van Dishoeck, Nicole Karnath, CASA|Pipeline Version: 6.2.1-7 | 2021.2.0.128 (recommended) -Tom Megeath, Merel van 't Hoff, Kaitlin Kratte nham, Stella Offner, Zhi-Yun Li, Patrick Sheehan, Brian Stephenson, Amelia Stutz, Le Restore previous CMS uid://A001/X1284/X149-MOUSes Estimated Processing Time: 5 hours It Obs MOUS Submit Request Cancel HOPS-383 a 06 TM1 2018-0





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Title: The Hunter's Gift: A Bounty of Forming Disks to Further Our Understanding of Protostellar Evolution

Abstract: The formation of a protostar and its Keplerian disk remains a poorly characterized process, but ALMA now provides an opportunity for significant progress. These forming disks also hold the key to measuring the most fundamental parameter of newborn stars, their masses derived from the Keplerian disk rotation. The measurement of protostar masses and the properties of forming disks for large ensembles of systems is essential to solidifying our knowledge of star and planet formation. Our ALMA Cycle 3 survey of 330 protostars in the Orion molecular clouds at 0.13" (50 AU) resolution yielded >100 well-resolved continuum images of apparent protostellar disks. We propose to observe a sample of 20 disk candidates around 10 Class 0 and 10 Class I protostars, drawn from a representative range of luminosities (0.4 L_sun to 480 L_sun). With these observations, we will confirm whether or not each disk is Keplerian, using molecular line tracers (primarily C18O J=2-1), measure the change in mass and mass accretion between the Class 0 and I phases, how much the disk properties depend on stellar mass, and how much disk structure evolves from Class 0 to Class 1 and later stages.

PI: John Tobin

Co-Authors: Dominique Segura-Cox, Mihkel Kama, Friedrich Wyrowski, Magnus Persson, William Fischer, Sarah Sadavoy, Mayra Osorio, Erin Cox, Ewine van Dishoeck, Nicole Karnath, Tom Megeath, Merel van 't Hoff, Kaitlin Kratter, Ana Karla Diaz Rodriguez, Guillem Anglada, Hector Arce, Laura Perez, Elise Furlan, Michael Dunham, Stella Offner, Zhi-Yun Li, Patrick Sheehan, Brian Stephenson, Amelia Stutz, Leslie Looney, Nickalas Reynolds

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	•	HOPS-383_a_06_TM1	2018-01-07 04:49	2018-01-07 06:14	89.366 GB		0.220"	06	1	Download Restored MS	Re-Imaging



Frequency-based Cube

Active Search Inputs: Text Search Tobin	Launch User Imaging or	n: 2017.1.00419.S	×		
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Velocity-based Cube

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so hold the key to measuring the most fund roperties of forming disks for large ensemble nolecular clouds at 0.13" (50 AU) resolution y class 0 and 10 Class I protostars, drawn from ceplerian, using molecular line tracers (prime in stellar mass, and how much disk structure 1: John Tobin Co-Authors: Dominique Segura-Cox, Mihkel fom Megeath, Merel van 't Hoff, Kaitlin Kratte	Rest Frequency: Start: Width:	Frequency Space	Velocity Spa	ace GHz km/s	heasurement of protostar masses and the cle 3 survey of 330 protostars in the Orion ve a sample of 20 disk candidates around 1 Il confirm whether or not each disk is bases, how much the disk properties depend on Cox, Ewine van Dishoeck, Nicole Karnath unham, Stella Offner, Zhi-Yun Li, Patrick	
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