Managing and analyzing 700 nights of IGRINS data

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IGRINS Quick Overview

- Simultaneous H & K w/ R ~ 40,000.
- Two detector: H & K
- ~25 orders per each detector
- Slit characteristics w/ 2.7m telescope
 - Slit length = 15"
 - Slit width = 1"
- Optimized for stellar sources. Works reasonably well for compact extended sources.
- KASI + UT Austin







Optical Layout



IGRINS can be adopted to different telescopes by replacing its input-optics.

Deployment schedule so far

Started normal operation since 2014.09

5 years of operation:

- HJST 2.7m : 2.5 yrs
- DCT 4.3m : 3 visits (1.5 yrs)
- 1st Gemini (8.1m) visit : 4 months
- 2nd long-term visit : 2020~, at least for 3 years

Dates	Telescope	
2014.03 ~ 2014.07	HJST	Commissioning
2014.09 ~ 2015.07	HJST	Normal Operation
2015.08	UT Lab	Maintenance
2015.09 ~ 2016.07	HJST	Normal Operation
2016.08	UT Lab	Maintenance
2016.09	DCT	Commissioning
2016.10 ~ 2017.02	DCT	Normal Operation
2017.03 ~ 2017.08	HJST	Normal Operation
2017.08 ~ 2018.01	DCT	Normal Operation
2018.02	UT Lab	Maintenance
2018.03	Gemini South	Install & Commissioning
2018.04 ~ 2018.06	Gemini South	Normal Operation
2018.07 ~ 2018.08	UT Lab	Maintenance
2018.09 ~ 2019.04	DCT	Normal Operation
2019.05 ~ 2019.11	UT Lab	Maintenance
2020.02 ~	Gemini South	Normal Operation

IGRINS Night statistics



Number of IGRINS nights per Month

- > 700 nights
- > 3 TB raw data

- > 50,000 science images so far
- > 40,000 calibration images

NGC 7027 (Planetary Neb.)

Rectified 2D Spec.

1.760		1.765	1.770		1.775	1.780	80		2.420	2.425	2.430	2.435	2.440	2.445	
													• • • •		0 = =
1	.745	1.750		1.755	1.76	50				2.390	2.395	2.400	2.405	2.410	2.415
	1.730		1.735	1.740		1.745			2.355	2.360	2.365	2.370	2.375	2.380	2.3
1.710	1.3	715	1.720		1.725	1.730	0		2.325	2.330	2.335	2.340	2.345	2.350	
1.695		1.700	1.705		1.710		1.715		2.295	2.300	2.305	2.310	2.315	2.320	
		0													
1.680		1.685	1	690	1.695				2.265	2.270	2.275	2.280	2.285	2.290	
				6											
1.665		1.670		1.675	1.68	10			2.24	0	2.245	2.250	2.255	2.260	2.265
1.635	1.6	1.640			SDS:	S4 A	NPOC	GEE : 3	3 x H2F	RG (2	2k x 2	k)	2.150	2.155	T
1.635 1.635 605	1.6 1.595 .580	1.640	1600	▶ { ▶ ¹	SDS: GRII	S4 A NS :	2 x	GEE : 3 H2RG	3 x H2F	RG (2	2k x 2	k)	2.150 2.125 2.100	2.155 2.130 2.105	
1635 3 2 m 1605 1 1.565	1.6 1.595	1.640	1.600		SDS: GRII	S4 A NS :	2 x	GEE : 3 H2RG	3 x H2F	24 RG	k x 2.	k)	2.150 2.125 2.125 2.100 2.075	2.155 2.130 2.105 2.000	
1.635 3.635 1.605 1. 1.565	1.6 1.595 580	1640 V EYE 510 158 1570	1.600		SDS: GRII	S4 A NS :	2 x	GEE : 3 H2RG	3 x H2F	20 (2	k x 2.	k)	2.150 2.125 2.00 2.075	2.155 2.130 2.105 2.080	0
1635 3 400 1605 1 1565	1.595	1640 V 210 S10 158 1570	1.600		SDS GRII	S4 A NS :	\PO(2 x	GEE : 3 H2RG	8 x H2F	2040 2040	k x 2 ⁶³	k) ²⁰⁷⁰	2.150 2.125 2.125 2.000 2.075	2.155 2.130 2.105 2.000 2.000	0 2.060
1635 1655 1365	1.6 1.585	1640 V 244 510 158 1570	1.607 1.509		SDS GRII	S4 A NS :	\PO(2 x	GEE : 3 H2RG	3 x H2F	204 204	⁴⁵	k) 2070 20	2150 2150 2100 2105 2100 2005	2.159 2.130 2.130 2.130 2.000 2.000	() 2.060
1635 3.635 	1.4 1.595 .580 1.555	1.640	1600 1500	273 1.550	SDS GRII	S4 A NS :	2 x	GEE : 3 H2RG	8 x H2F	20 2040 15	⁴⁰⁵ 2.045	2070 2023	2135	2.153 2.130 2.050 2.050 2.055	2.060
1635 1605 11565 1540	1.0 1.595 580	1640 1440 1540 1540 1540	1.600 3 1.560		SDS GRII	S4 A NS :	2 x	GEE : 3 H2RG	8 x H2F	20 2240 13	⁸⁹ 2005	k) 2010 2025	2.130 2.130 2.130 2.130 2.075 2.075 2.030	2155 2130 2130 2130 2130 2000 2005 2005	2060
1.635 1.505 1.565 1.540	1.0 1.595 .580 .555 .1555	1.640 1.442 1.0 1.570 1.545	1.665	273 273	SDS GRII 1.56	S4 A NS :	2 x	GEE : 3 H2RG	3 x H2F	2040 2,240 15	⁸⁵ 200 200	2010 2010 2013 2013	2.130 2.130 2.125 2.120 2.075 2.075 2.030	2.150 2.130 2.000 2.005 2.005 2.005 2.005	2000
1.635 • 4 m 1.605 1.565 1.540 5	1.0 1.595 .580 1.555	1.640 10 158 1570	1600 1500	273 1.550	SDS GRII 150 150	S4 A NS :	2 x	GEE : 3 H2RG	8 x H2F	20 200 200 15	⁴⁰⁵ 2.020 2.020	2070 2023 2023 2.023	2.130 2.130 2.133 2.135	2.155 2.105 2.080 2.055 2.035 2.035	2.060
1.035 1.005 1.005 1.565 1.540 255	14 1595 1590 1555 1515	1.640 1.540 1.545 1.545 10 1.545	1.000 1.000 1.500	277 277 1.550 1.525	SDS GRII	S4 A NS : 1.55	2 x	GEE : 3 H2RG	3 x H2F	2640 2.640 13 1.995	⁸⁵ 2.039 2.039 2.039 2.039	k) 2070 2002 2003 2003 2003 2003 2003 2003	2.130 2.130 2.130 2.130 2.130 2.130 2.130 2.130 2.030 2.030 2.030 2.030 2.030 2.030 2.030 2.030 2.030 2.030 2.1300 2.130 2.13000 2.13000 2.13000000000000000000000000000000000000	2.15 2.10 2.00 2.005 2.035 2.035 2.035	2.015
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1.035 1.635 665 1.565 1.565 1.569	1.00 550 1.555 5 5 5	1.640 1.570 1.545 10 1.545	1.000 1.500 1.533	277 277 1.550 1.550	SDS GRII 1505 1500	S4 A NS : 1335	APOC 2 x	GEE : 3 H2RG	3 x H2F	2640 2640 15 1995 10	⁸⁵ 2.020 2.020 72 1.555	k) 2070 2023 2023 2023 2023 2023 2023 2023	2.130 2.130 2.130 2.130 2.130 2.130 2.030 2.030 2.030 2.030 2.030 2.030 2.030 2.030 2.030 2.030 2.1300 2.130 2.1300 2.1300 2.1300 2.1300 2.1300 2.1300 2.1300 2.1300 2.1	2.05 2.05 2.09 2.05 2.05 2.05 2.05 2.05 2.05 2.05 2.05	2.000 2.013

H band

K band

Could be considered as a small-scale survey project.

- Operation
- Data Reduction

Papers

- ~50 papers so far
- 8 with Koreans as a 1st authors
- We need more publication (~700 nights!)

Year	2015	2016	2017	2018	2019	Total
# papers	1	11	12	11	12	46
Korean PI	1	4	2	1	0	8



- IGRINS on DCT at Lowell Observatory on 2018 Dec. 25 (UT)
 - H (1.47-1.81 µm) and K (1.95-2.48 µm) band with $\lambda/\Delta\lambda\simeq 45000$ (Δv = 7-8 km s^-1)
 - 0.63" × 9.3" slit × 5 positions = 3.15" × 9.3" with PA=147°
- Using IGRINS, Koo et al., for the first time, revealed the existence of CSM yet to be processed by the shock thus preserving its pristine nature.
- High spectral resolution ISM mapping can provide new window to the cold side of the ISM.



Operation matters!

Most time-consuming job during the data reduction is correcting the incorrect house-keeping information due to software/human errors.

My 2 cents

- Minimize on site human interaction
 - E.g., You don't want to waste your precious sky time with typing the target coordinates, and later find that the coordinate was wrong
- Lower maintenance overhead
 - You computers will fail you soon or later
- Ready for remote operation
 - VNC is not enough, e.g., you need to hear also.
- Good discipline in general network programming

My 2 cents

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Firebase : NoSQL Realtime Database + alpha

Cloud services!



Update

show Airmass





ObsDate : 20170907



OBSID	OBJTYPE	OBJNAME	EXPTIME	FOWLER	AM	FRAMES
1	DARK	DARK	30	16	1.00	
11	FLAT	FLAT OFF	30	16	1.46	OFF OFF OFF OFF OFF OFF OFF OFF OFF
21	FLAT	FLAT ON	30	16	1.46	ON
31	TAR	KELT9	120	16	1.10	ABBAABBA
39	TAR	G076.3829	120	16	1.06	ABABBA
45	STD	HR 7734 V 6.5	60	16	1.03	ABBA





Implementation

- Distributed task runner : Wrapper to the IGRINS pipeline using Celery
- Message queue RabbitMQ
- Storage : Filesystem / MinIO (S3-compatible)
- Logging : ELK stack

horizontal scalability (scaling out)

- Scale-up : buy better computers (more cores, more ram, etc)
- Scale-out : buy many computers

Proxy server for Aladin HIPS fits-to-jpeg

• Fetch fits files from aladin HIPS server and convert them to jpeg with provided image scales





https://igrins-fov.gems0.org/fov/dct?ra=05:35:17.7&dec=-05:23:41&pa=45











Discussion

- There are several number of Korean-led survey projects (e.g., KMTNet), but I don't think there has been many discussion on how we can / or **let other astronomers to use those data most effectively.**
- Wanted to draw attention about the role Korean community as a **producer of the survey data** not just as a consumer.
- Not just using established software products, there are lots of room for improvement where you can **contribute**!
 - Role of the institute
 - Role of junior members (grad. students)

Thank You