Managing and analyzing 700 nights of IGRINS data

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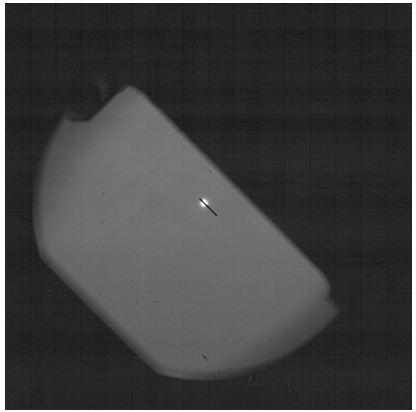
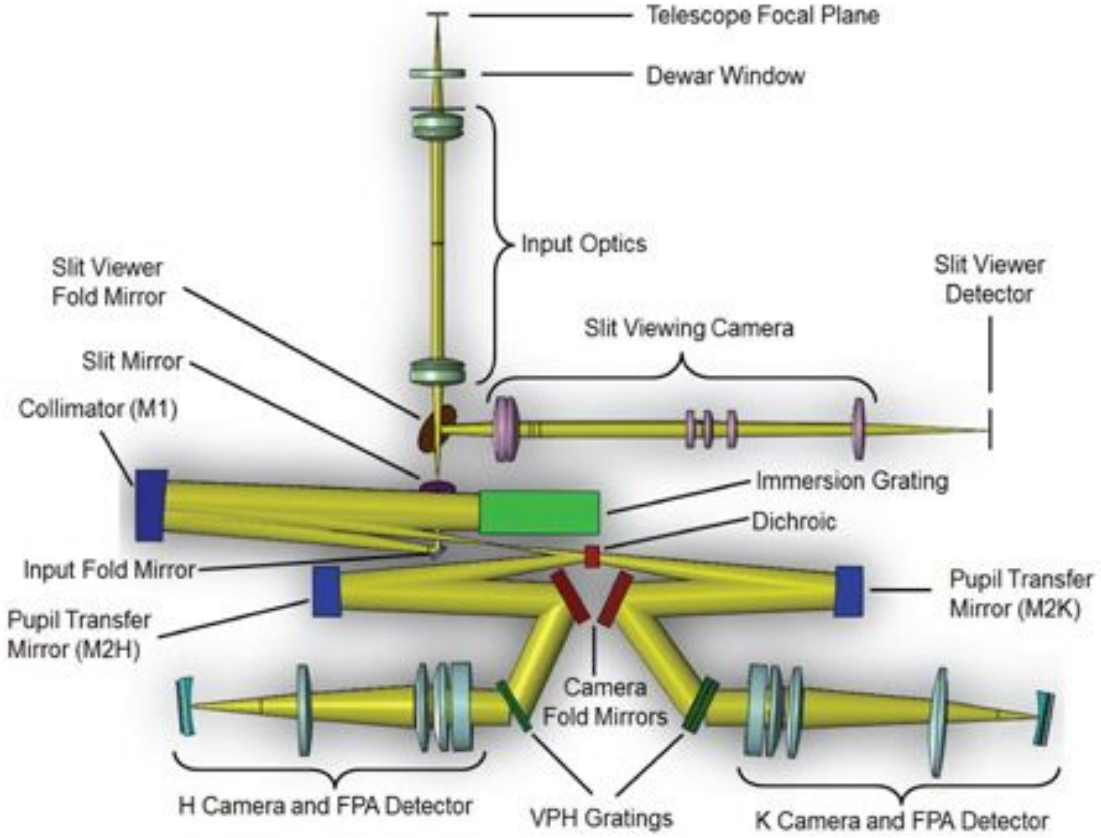
IGRINS Quick Overview

- **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

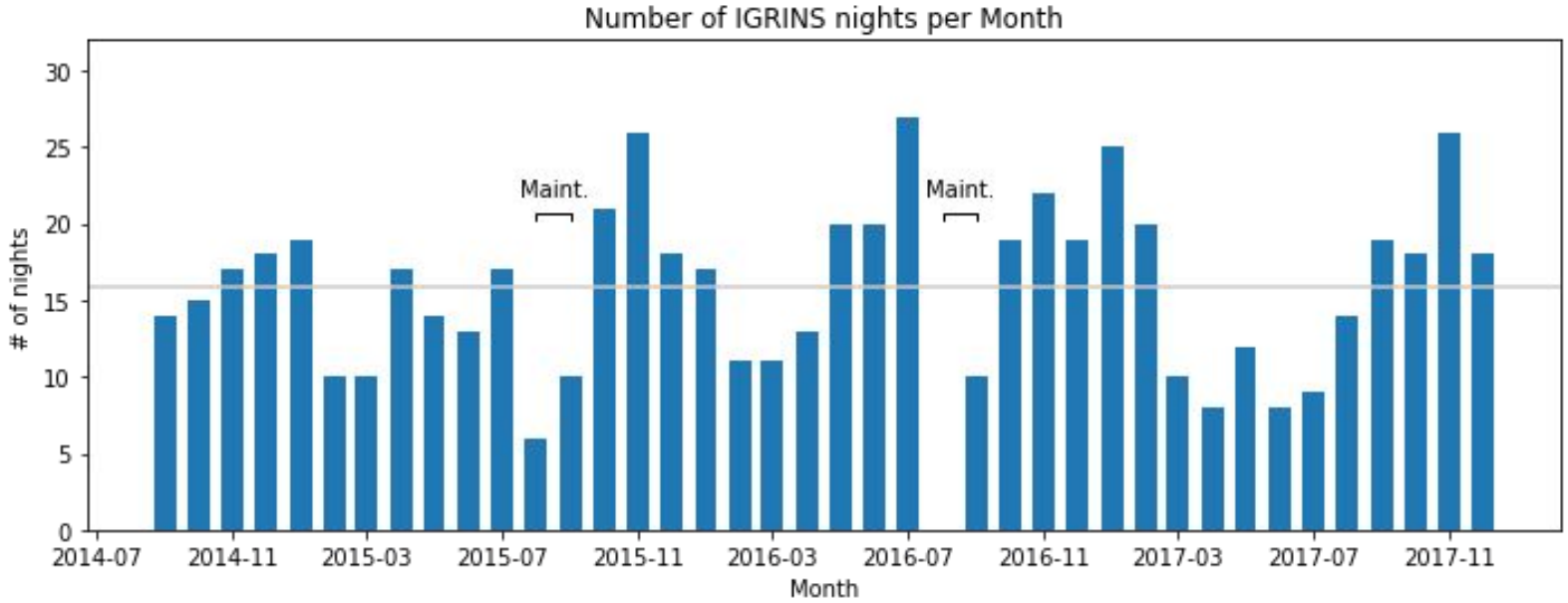
Started normal operation since 2014.09

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

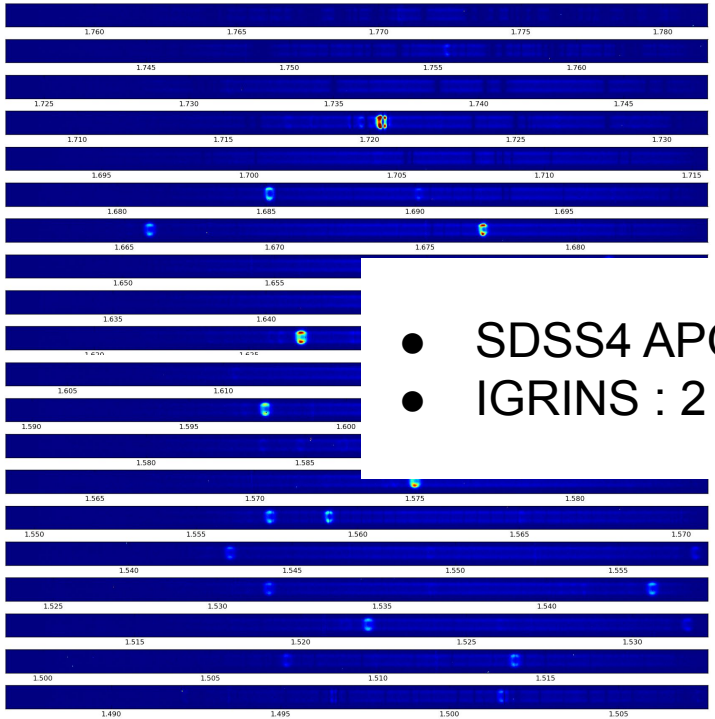
IGRINS Night statistics

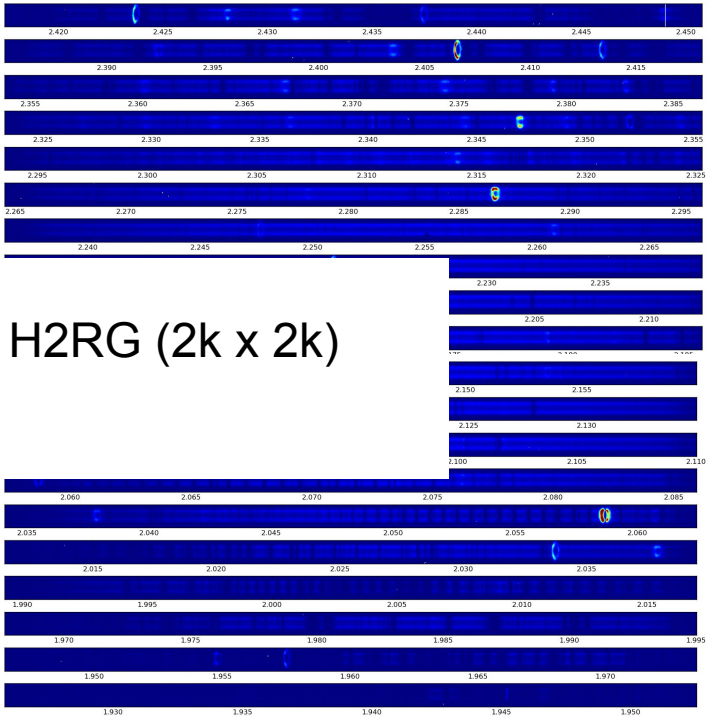


- > 700 nights
- > 3 TB raw data
- > 50,000 science images so far
- > 40,000 calibration images

NGC 7027 (Planetary Neb.)

Rectified 2D Spec.





- SDSS4 APOGEE : 3 x H2RG (2k x 2k)
- IGRINS : 2 x H2RG

H band

K band

Could be considered as a small-scale survey project.

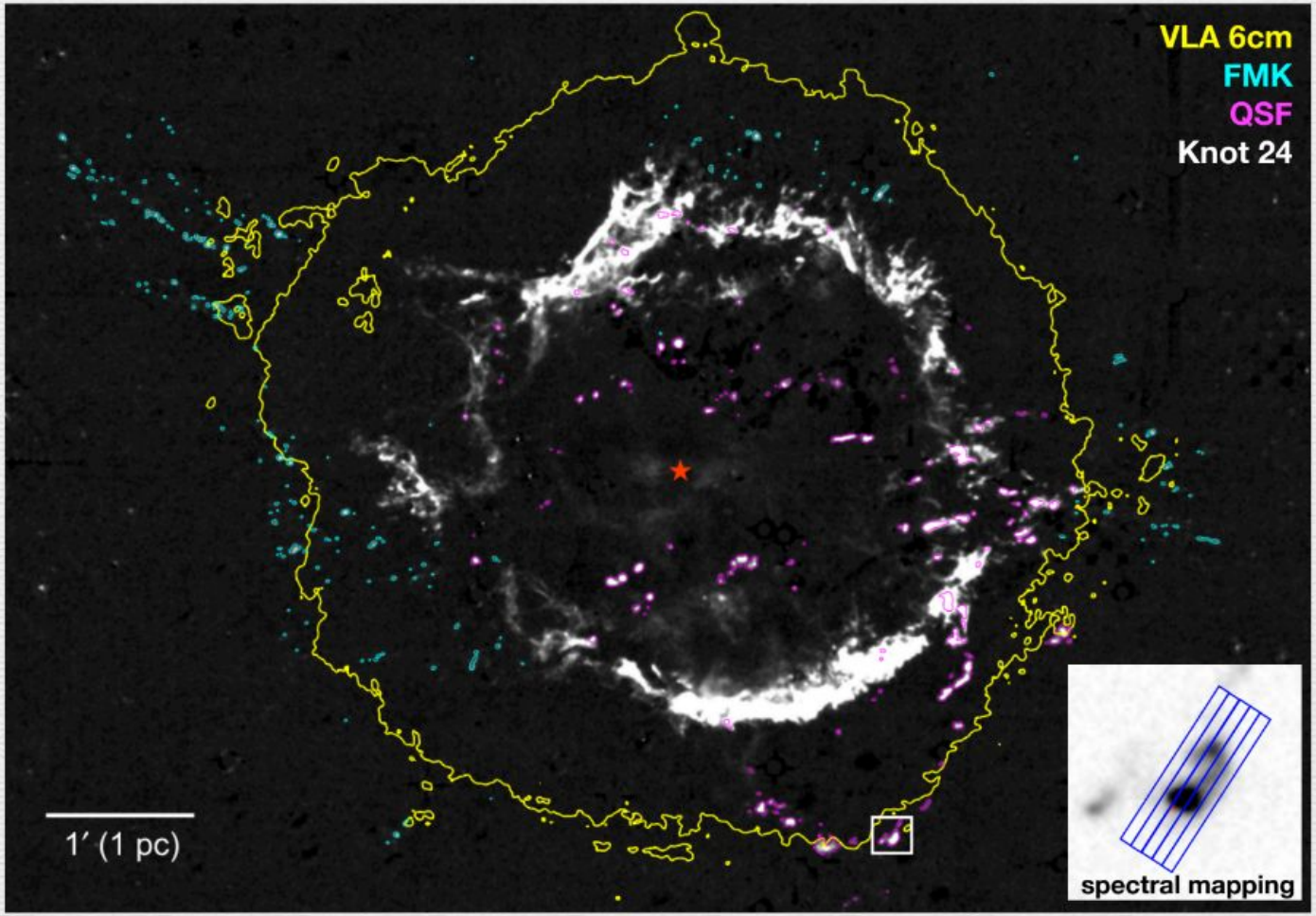
- Operation
- Data Reduction

Papers

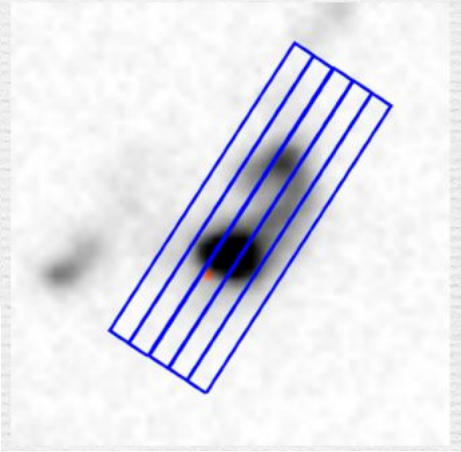
- ~50 papers so far
- 8 with Koreans as a 1st authors
- We need more publication (~700 nights!)

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

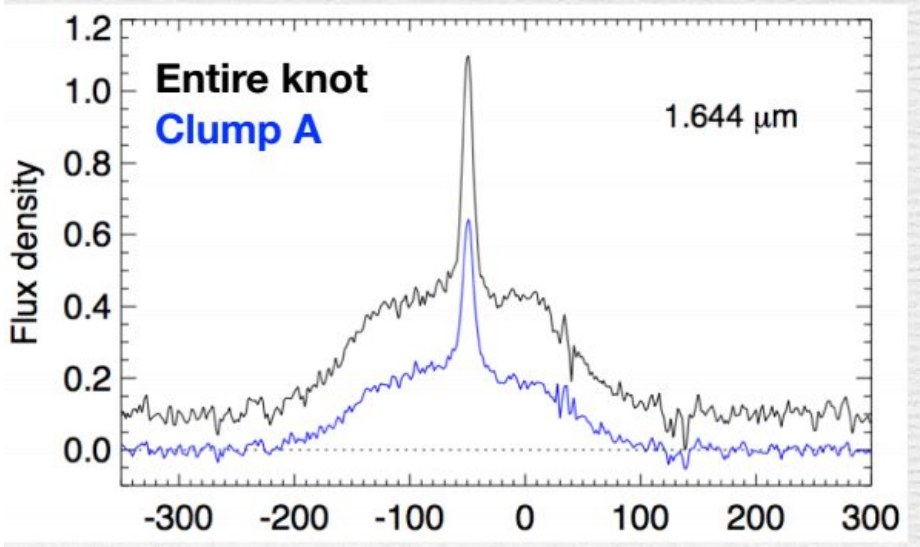
Deep [Fe II] 1.644 μm image of Cas A (Koo+18)



- **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 λ/Δλ ≃ 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

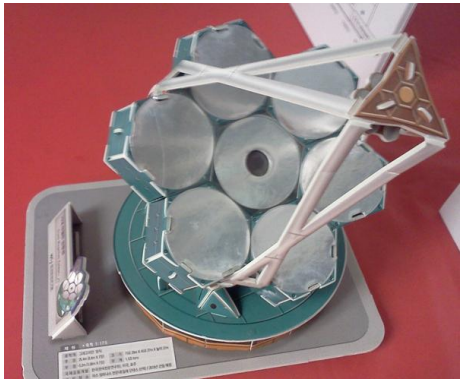
My 2 cents

- Minimize **on site** human interaction
- Lower maintenance overhead
- Ready for remote operation

} Cloud services!

- Good discipline in general network programming

➢ **Firebase** : NoSQL Realtime Database + alpha



Firebase

IGRINS targets - Google She React App

igrins-jj.firebaseapp.com/status

Apps Bookmarks Save to Mendeley Search Browse Type II supernov... News 읽기 댓피스 24 Other bookmarks

IGRINS Status

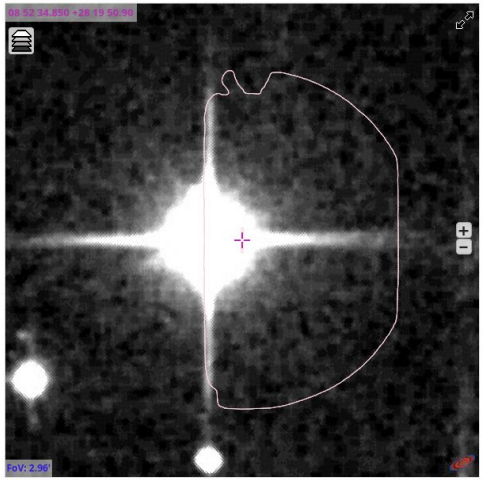
75732

R.A., Dec. = 08:52:34.850 +28:19:50.90

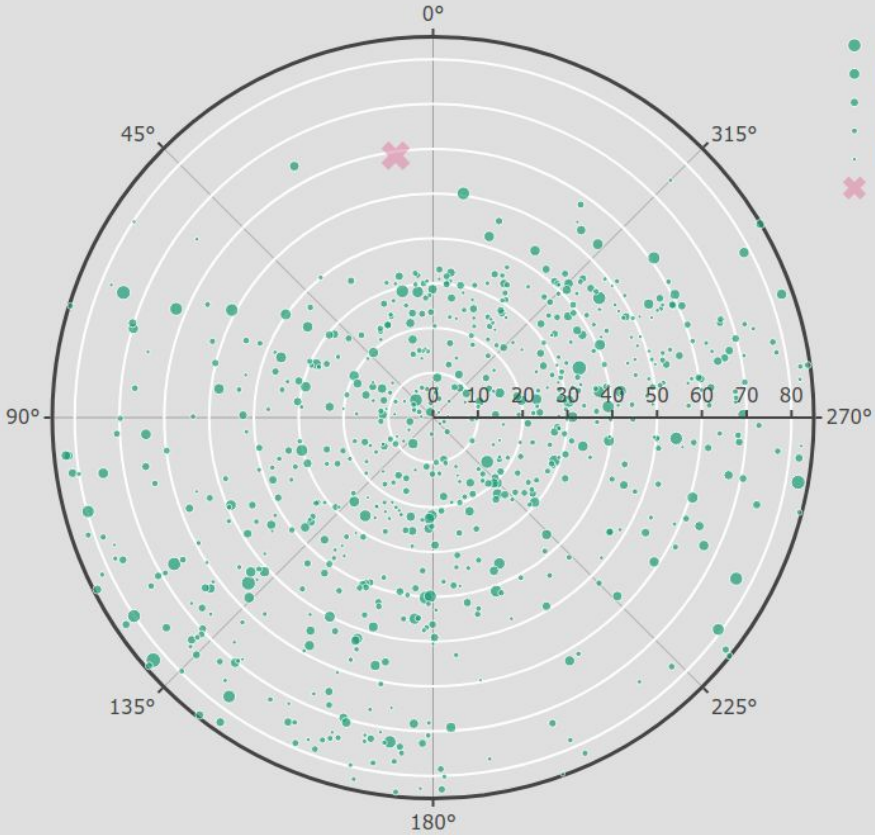
PA = 0.2

DCT 4.3m - 0.074'' - flip:yes

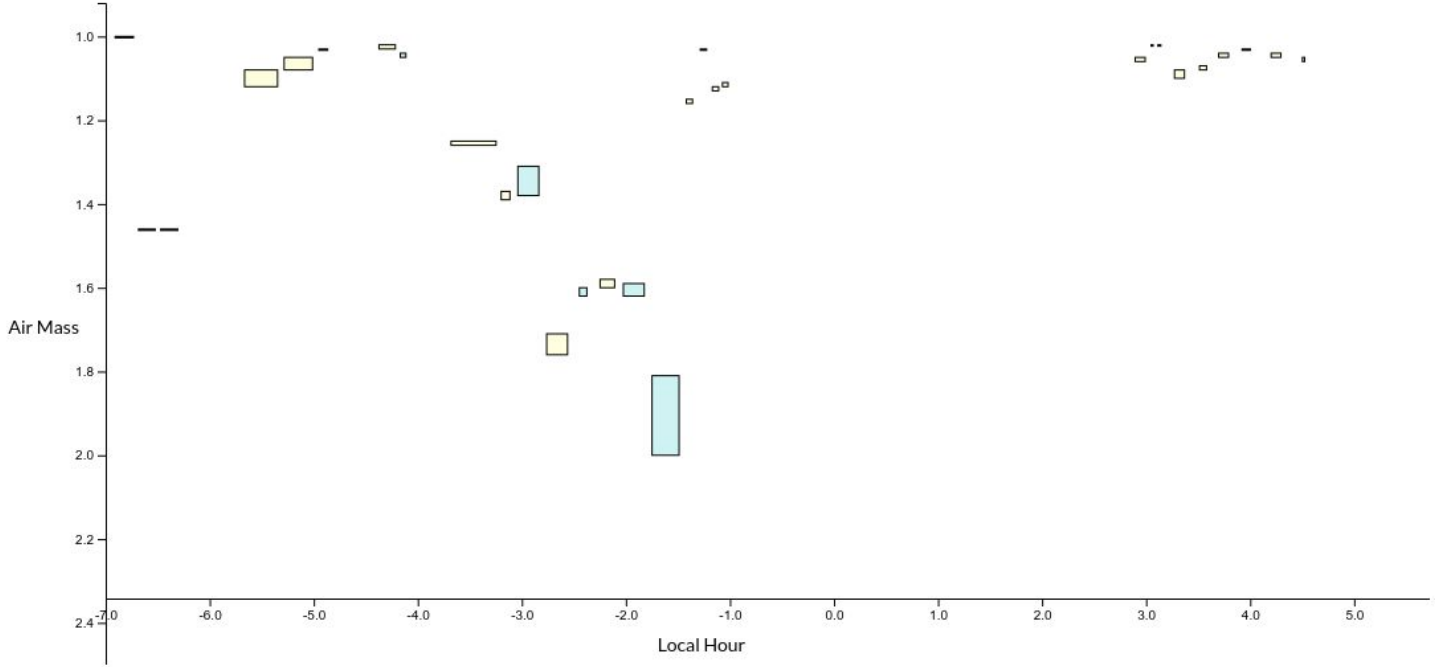
Reset



Update show Airmass

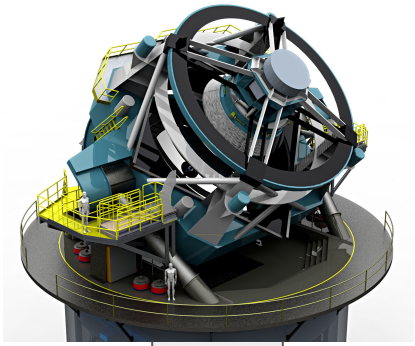


ObsDate : 20170907



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 OFF
21	FLAT	FLAT ON	30	16	1.46	ON ON ON ON ON ON ON ON ON ON
31	TAR	KELT9	120	16	1.10	A B B A A B B A
39	TAR	G076.3829	120	16	1.06	A B A B B A
45	STD	HR 7734 V 6.5	60	16	1.03	A B B A

Data analysis in the era of big survey

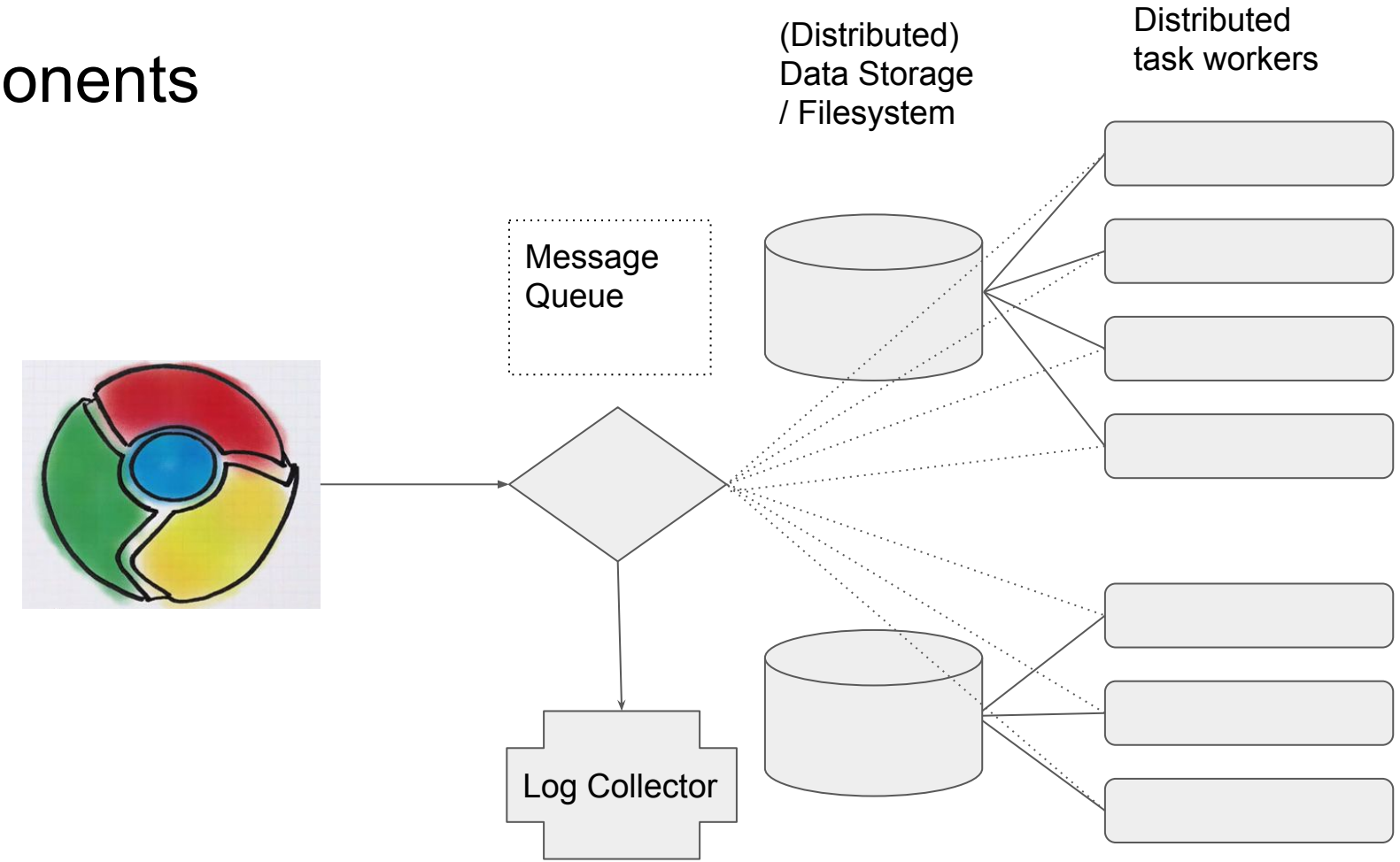


- **Cloud Computing**
- **HPC Cluster**

Processed (Big) Data

- **Dedicated computing resource**

Components


(Distributed)
Data Storage
/ Filesystem
Distributed
task workers
Message
Queue
Log Collector

Implementation

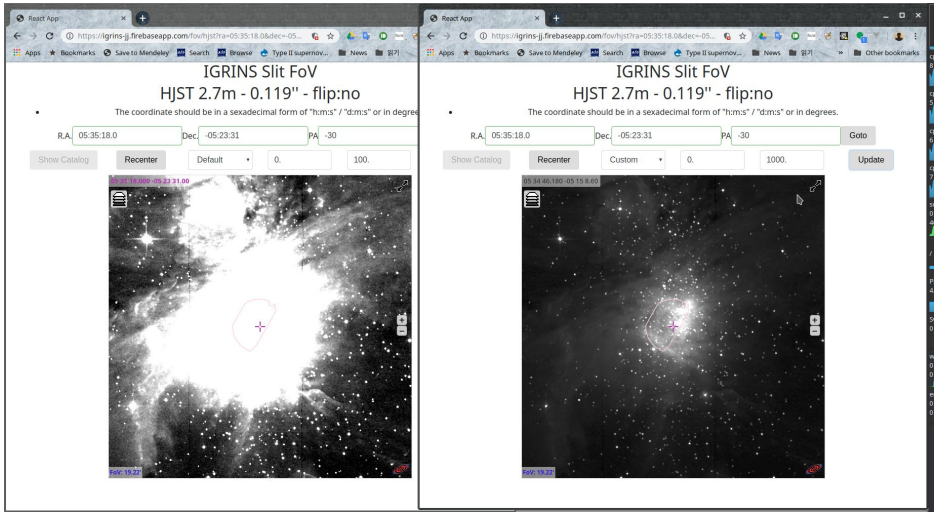
- Distributed task runner : **Wrapper to the IGRINS pipeline using Celery**
- Message queue - RabbitMQ
- Storage : Filesystem / MinIO (S3-compatible)
- Logging : ELK stack

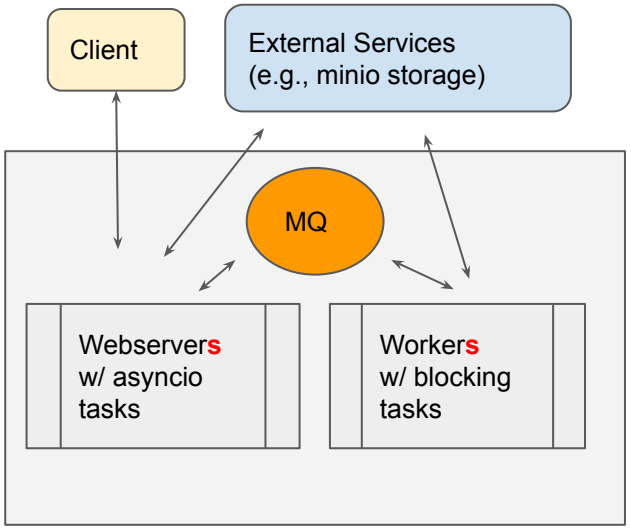
horizontal scalability (scaling out)

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

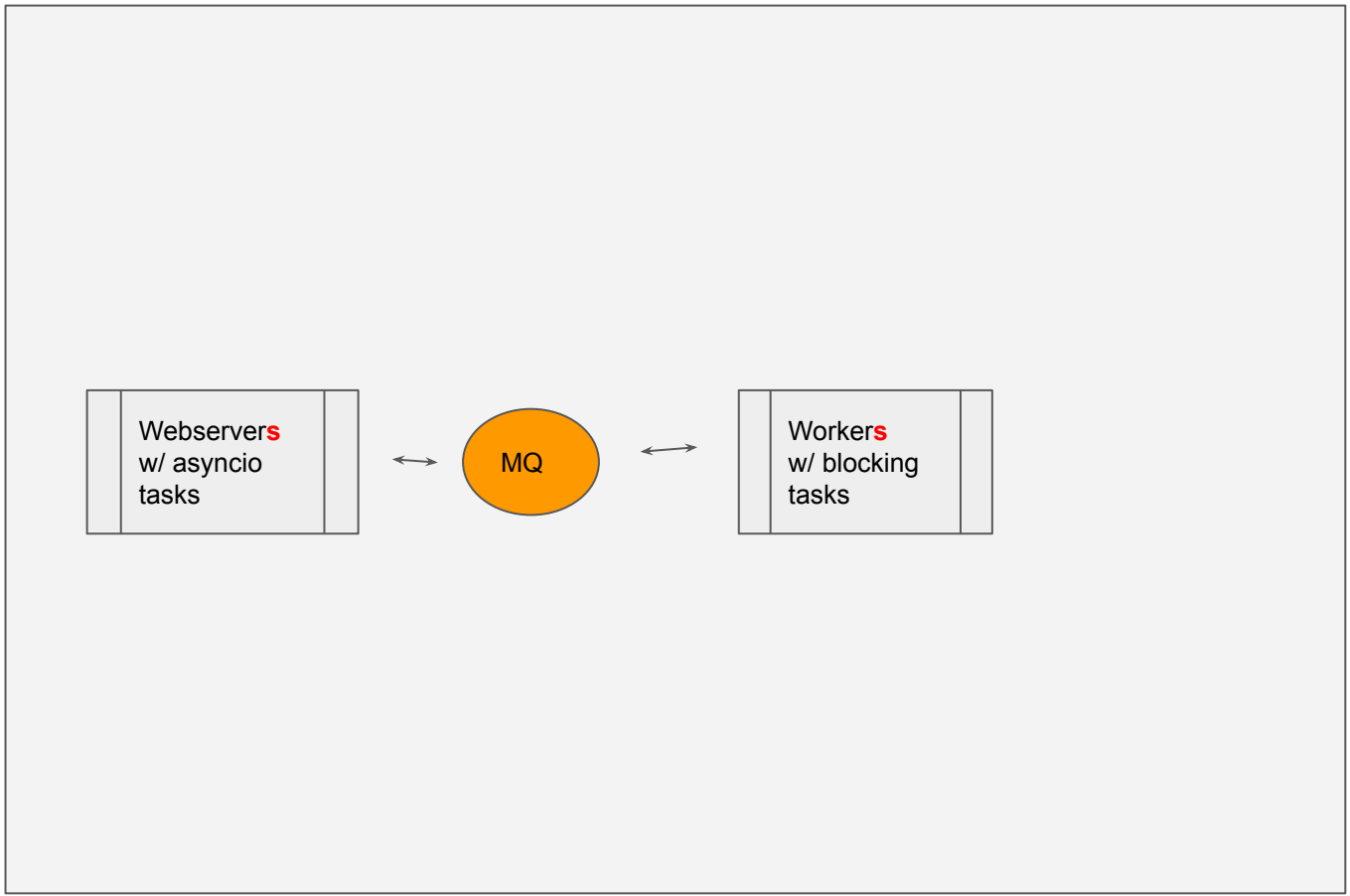
Proxy server for Aladin HIPS fits-to-jpeg

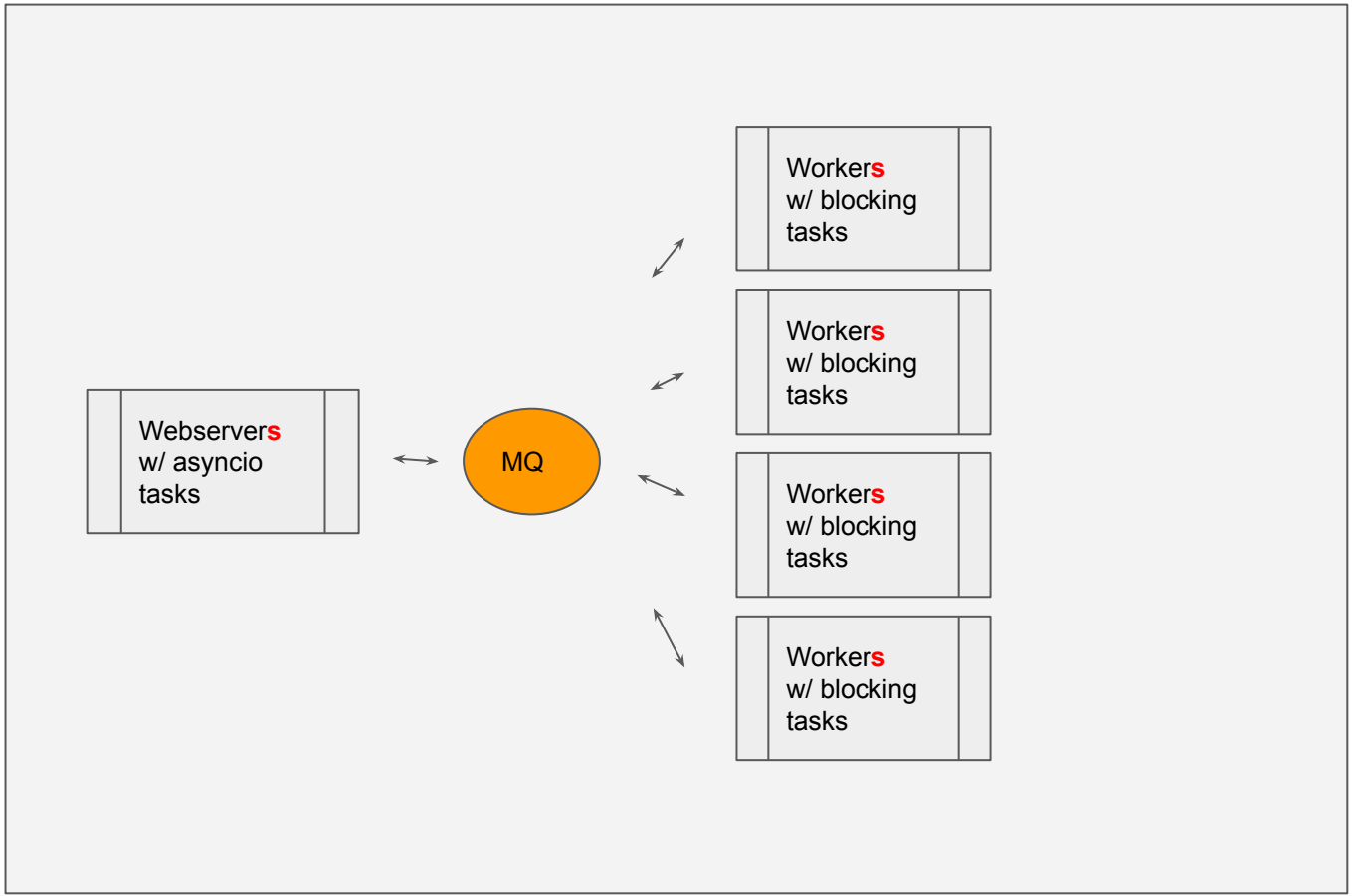
- Fetch fits files from aladin HIPS server and convert them to jpeg with provided image scales





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


Webservers
w/ asyncio
tasks
MQ
Workers
w/ blocking
tasks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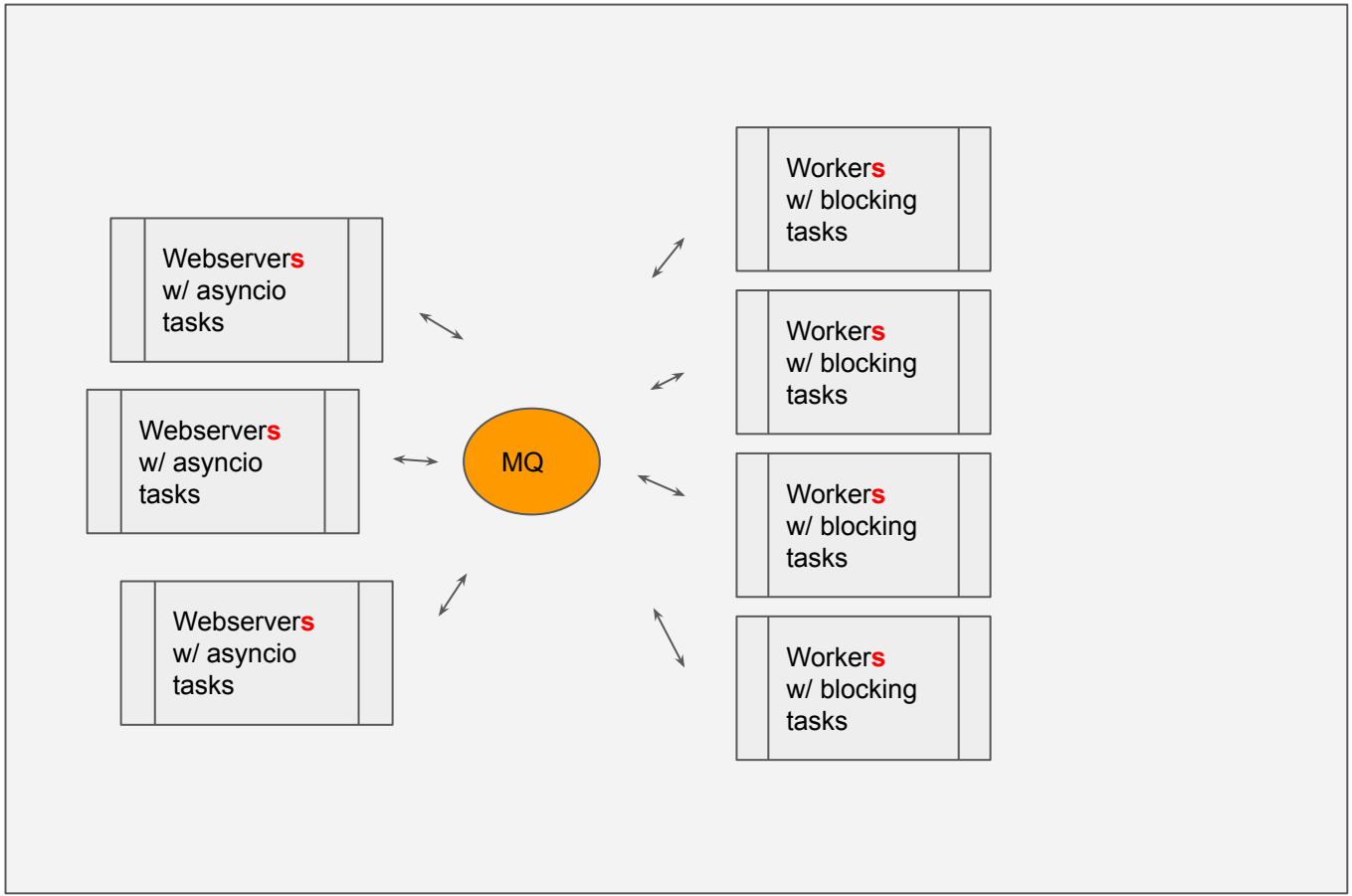
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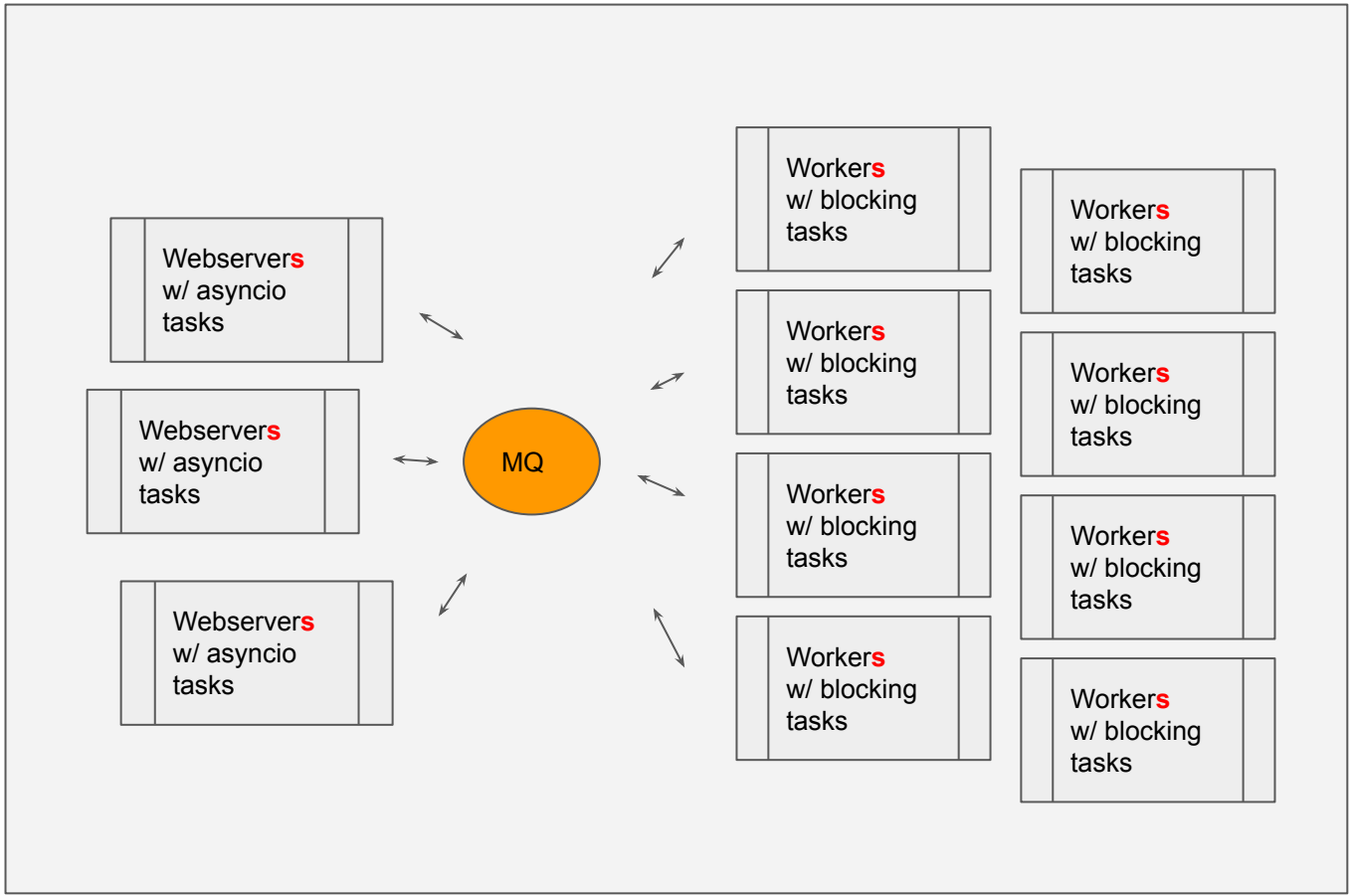
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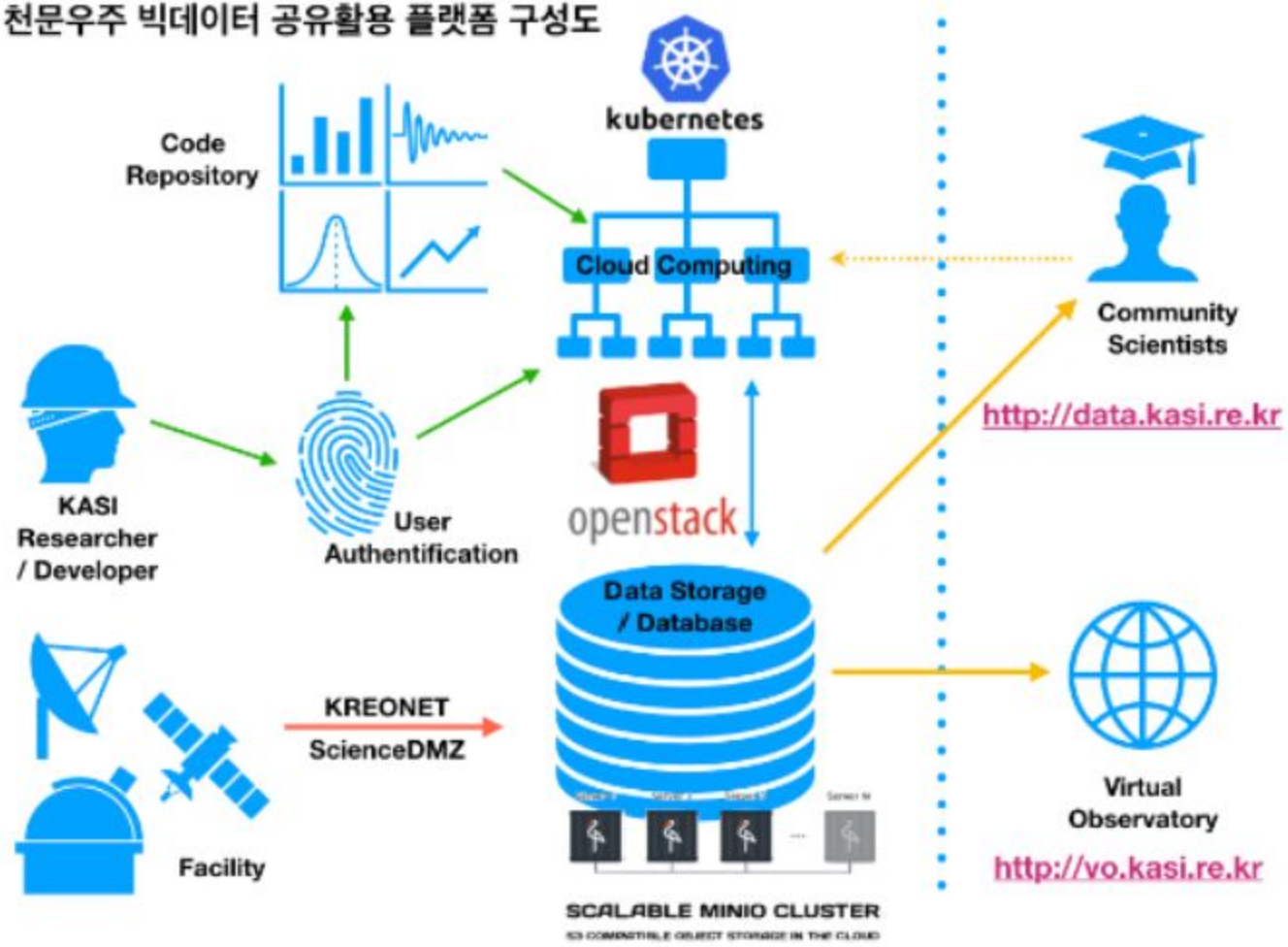
천문우주 빅데이터 공유활용 플랫폼 구성도



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