

KMTNet Synoptic Survey of Southern Sky
(KS4)
&
Multi-Messenger Astronomy with KMTNet
(K-MMA)

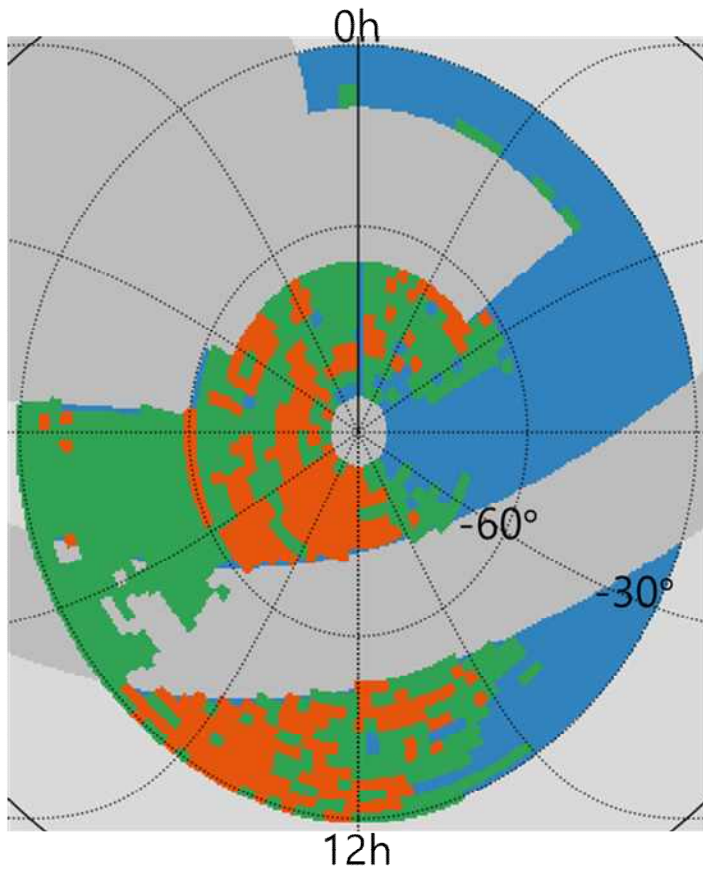
2022-08-30

M. Im (SNU)

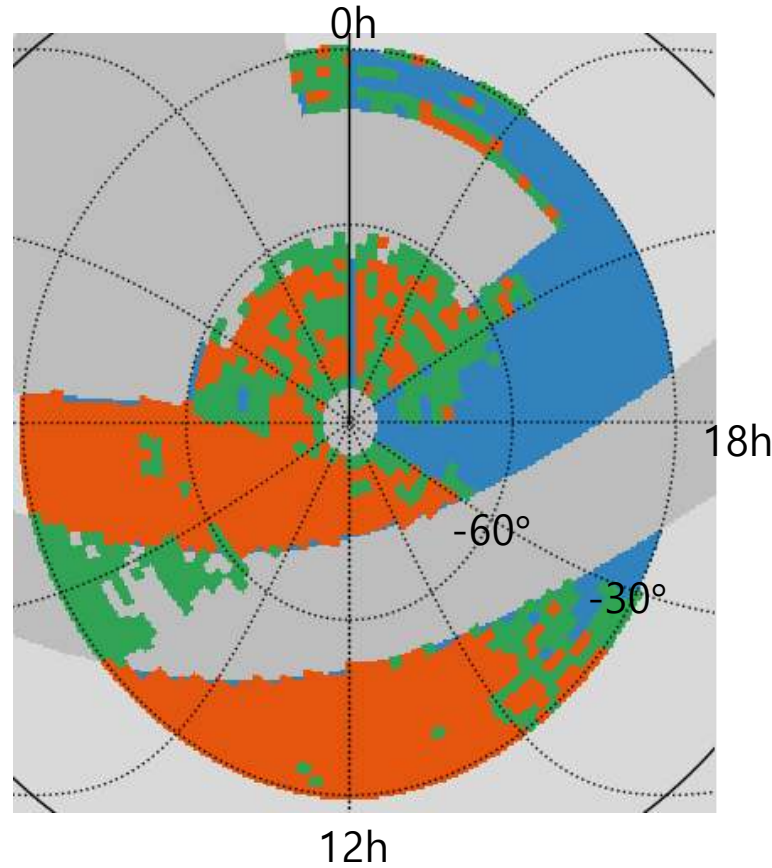
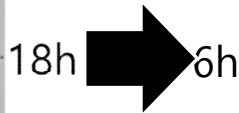
KS4 요약

- 약 4600 deg² 관측(4-band는 3000 deg²). 당초 목표 7000 deg²의 약 50% 관측 완료
- 2300 deg² 지역에 대한 EDR 준비중(2022년 가을 목표): catalog 및 stacked image
- EDR에 맞추어 4-5편의 KS4 논문발표 준비 중
- 차년도계획
 - 현재까지 관측된 4600 deg² 모두에 대한 양질의 all-band image 확보 노력
 - K-MMA 관측과의 balance를 위해 차년도 KS4 시간 일부를 K-MMA에 활용

KS4 Coverage (Completeness: %)



July 2021

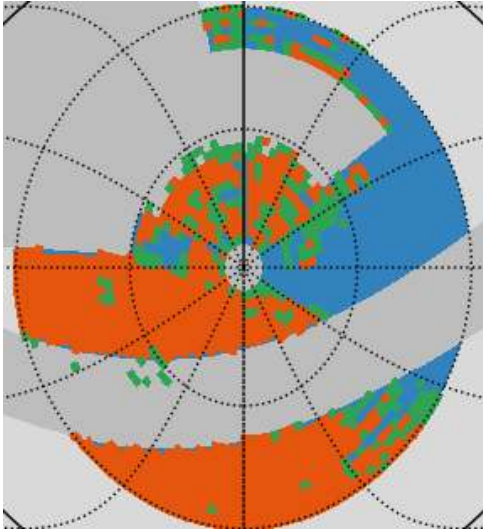


August 2022

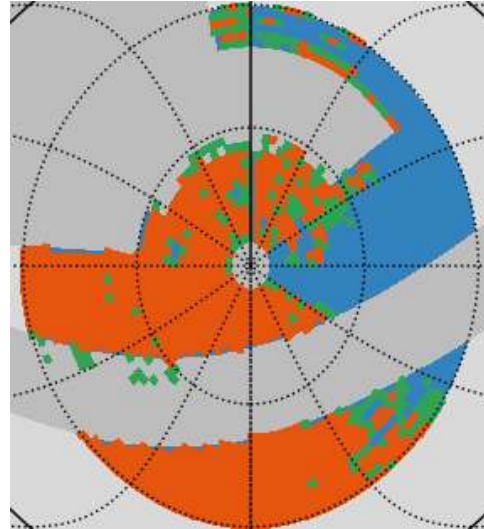
- **Blue** → KS4 Target fields
- Dark gray → DES coverage or Galactic latitude < 10 deg
- **Orange** (766 fields ~ 3000 deg²) → 4 bands and 4 dithering
- **Green** (417 fields ~ 1600 deg²) → < 4 bands or < 4 dithering

KS4 Coverage in Each band

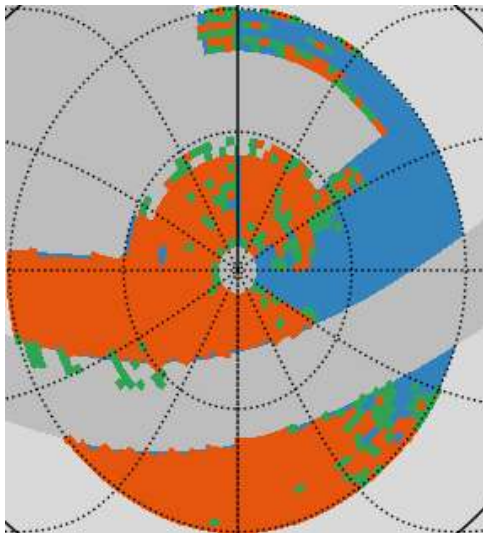
B band



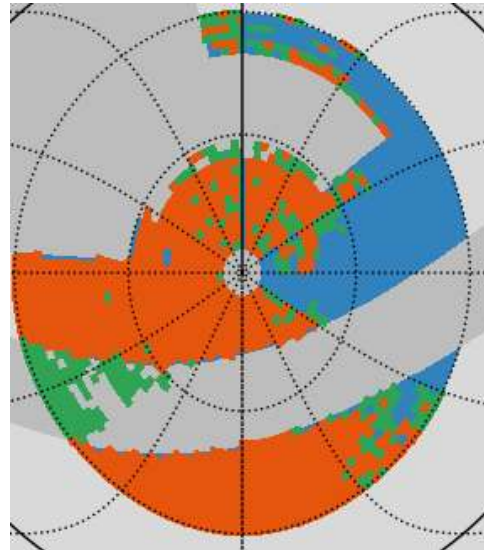
V band



R band



I band



- Orange → 4 dithering
- Green → < 4 dithering

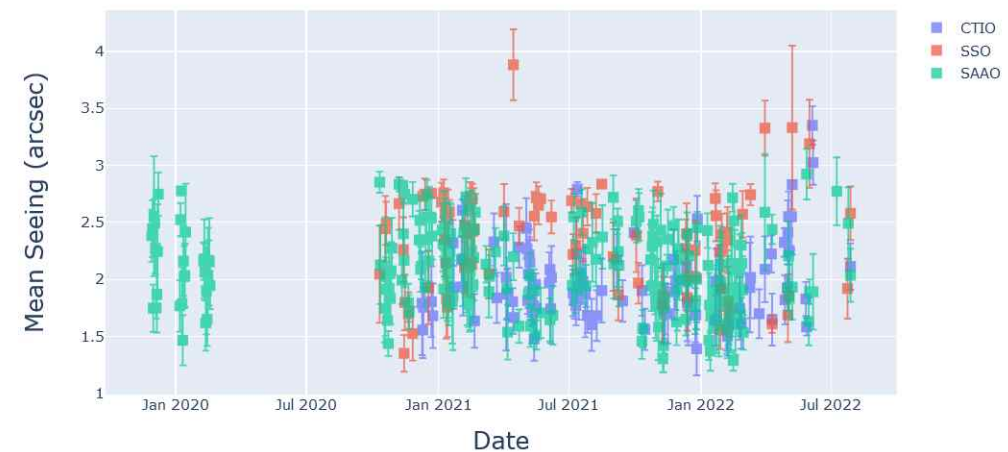
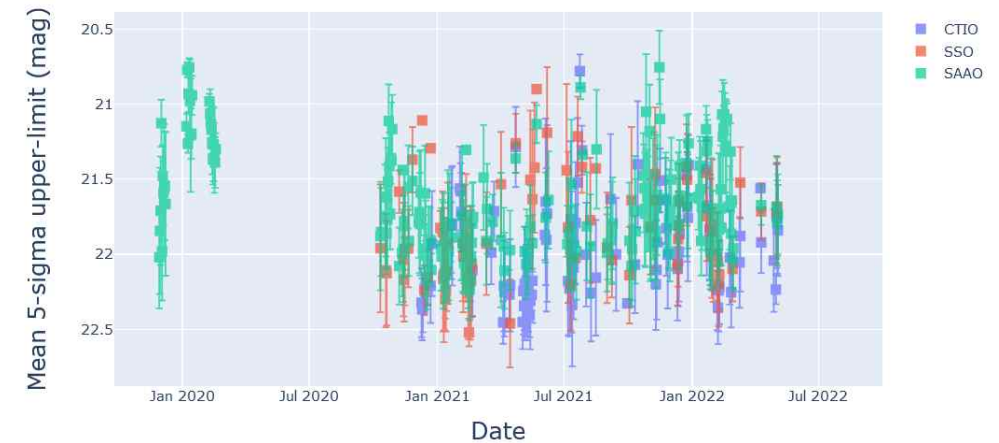
KS4 data base 구축 - 시상, 관측자료 깊이 등을 기록

KS4 Portal: PostgreSQL + Django Web Framework

Now (2022-08-24 15:43:27): Ingested 26,422 Pointings and 64,741 Chips (279 nights)

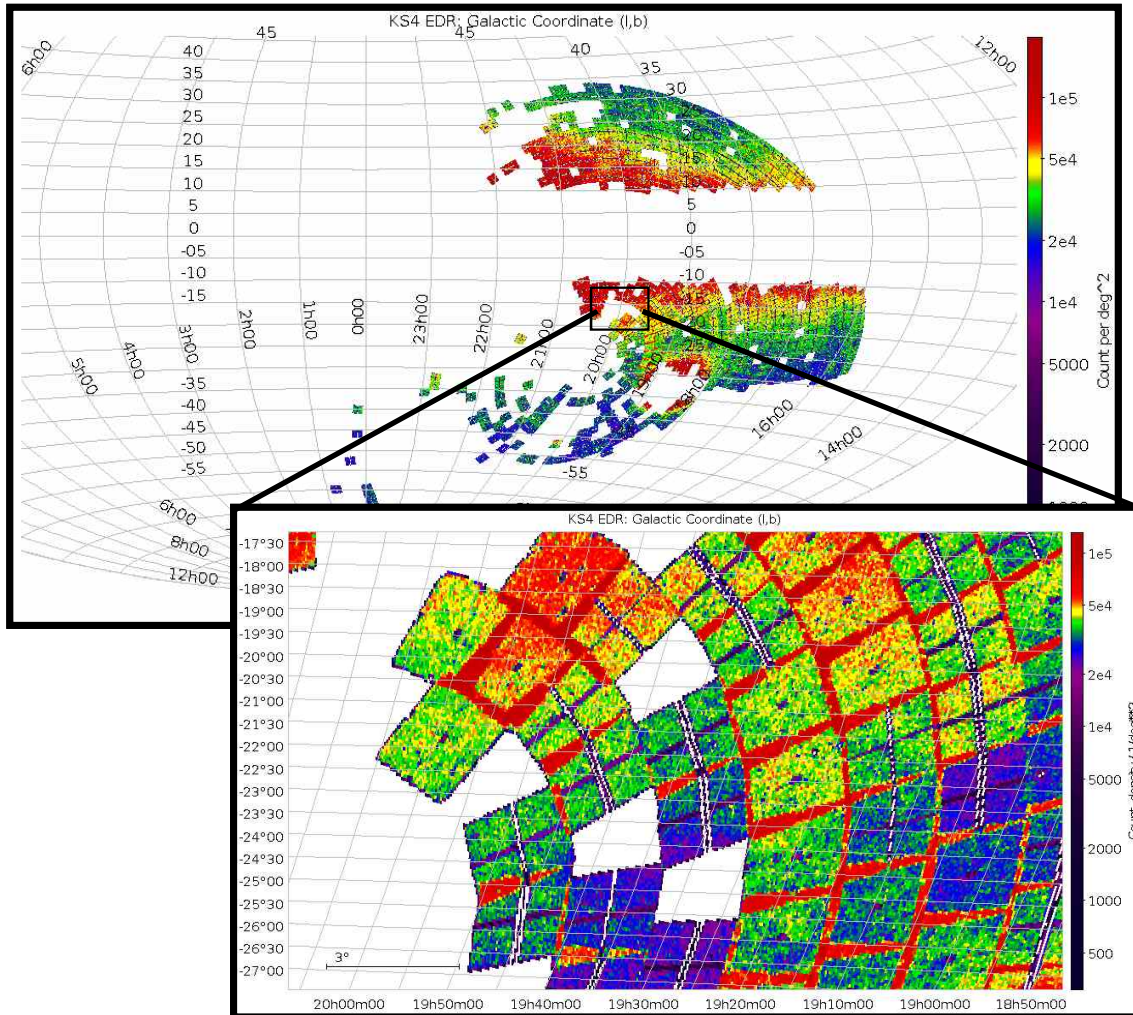
Latest Night for DB ingestion: 2022-07-28 New

DB Model	Quick Access: Directory Path	Progress
Pointing Only	/data5/ks4/data/20220728/kmta.20220728.010521.fits	-
Pointing+Chip Combination	/data5/ks4/data/20220331/kmts.20220331.057466.fits	
Astrom. QA	/data5/ks4/database/B/1394.215-38 /ks4.1394.215-38.B.dith1.kmts.20220331.057466.kk.fits	94.0%
Redo Astrometry		
Phot. QA (ZP scaling)	/data6/tempdatabase/B/1394.215-38 /ks4.1394.215-38.B.dith1.kmts.20220331.057466.kk.fits	91.0%
Phot. QA for EDR New		90.0%
Image Stacking for EDR New	/data6/tempdatabase/stack/	662 Fields (Ndith=4)
Catalog Production for EDR New	/data6/tempdatabase/catalog/result/	



➔ Provide the up-to-date survey progress and quality assurances

KS4 Early Data Release (EDR) 준비 중



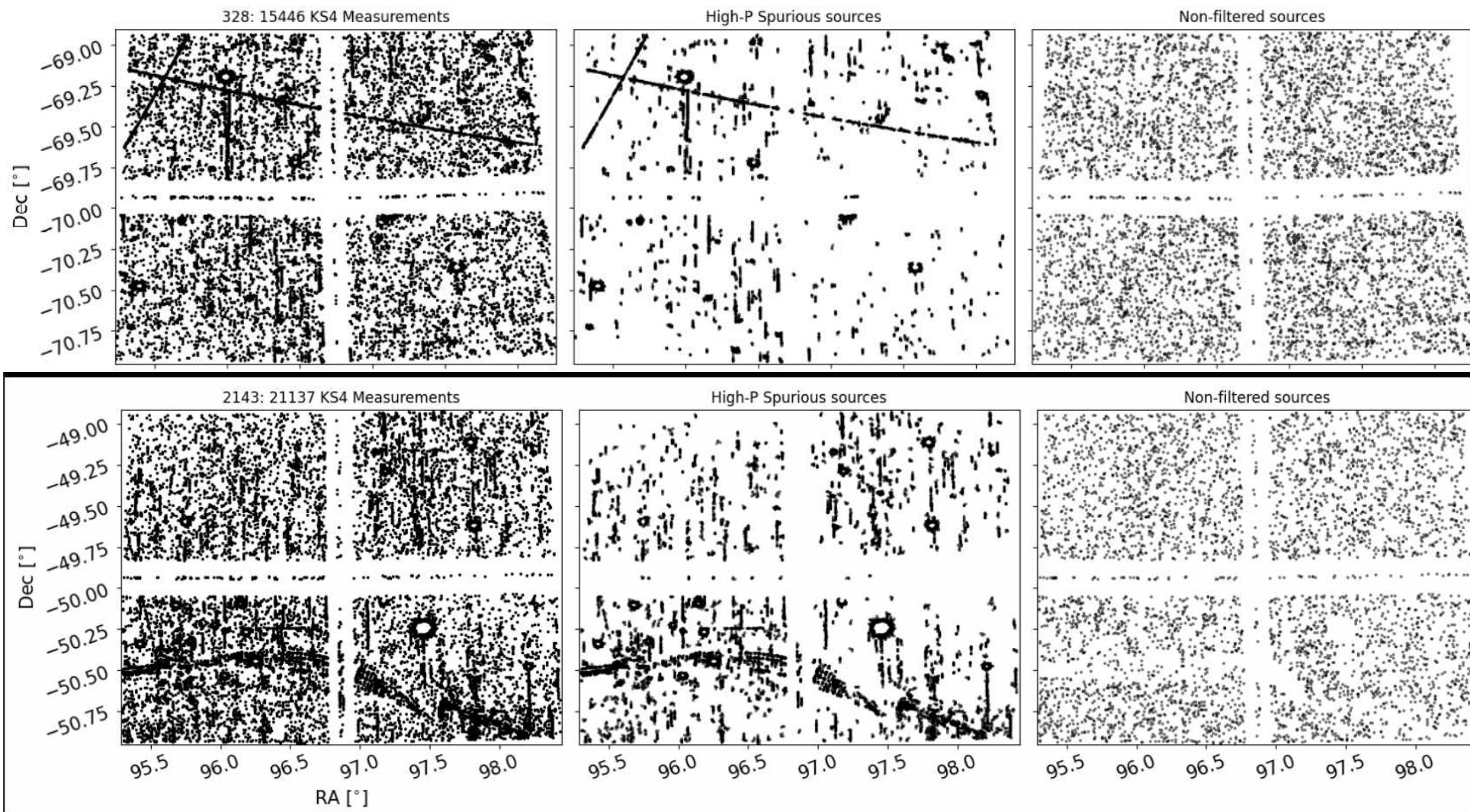
HEALPix source density map (NSIDE=1024; 3.44 arcmin)

- Survey period: Dec 2019 ~ Jan 2022
- Coverage: 2368.6 sq. degrees
- 622 KS4 Fields w/ more than four visits
- B-V-R-I Stacked Images (at least 480 sec)
- SExtractor Dual-mode catalogue based on I-band: 96,576,268 sources (w/ duplicated entries)
 - Basic SExtractor parameters
 - MAG_APER
 - MAG_AUTO
 - SSFLAG (flag for spurious sources)
 - Add value-added information?

Data reduction status

- All the data have been preprocessed and stacked
- Preliminary catalog of all sources is made for EDR
- Galaxy cluster search and bright high redshift quasar search is under way

Removal of spurious sources w/ SSFlag



Known Issues: Telescope Tracking Error

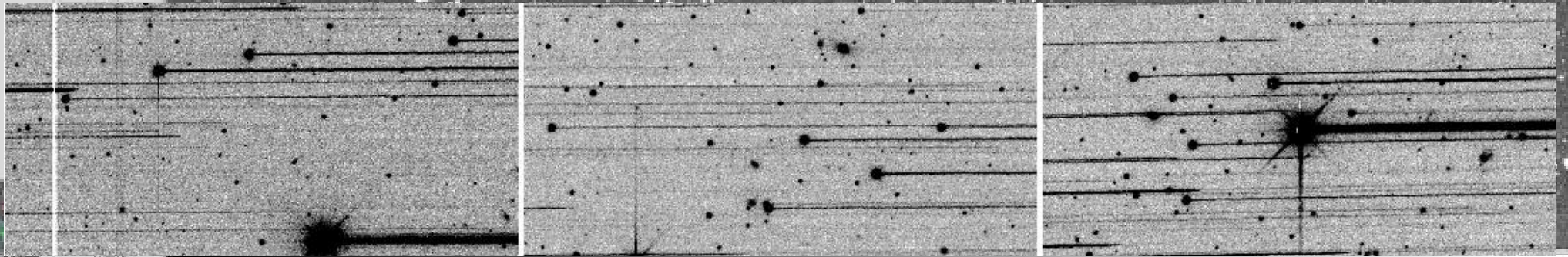
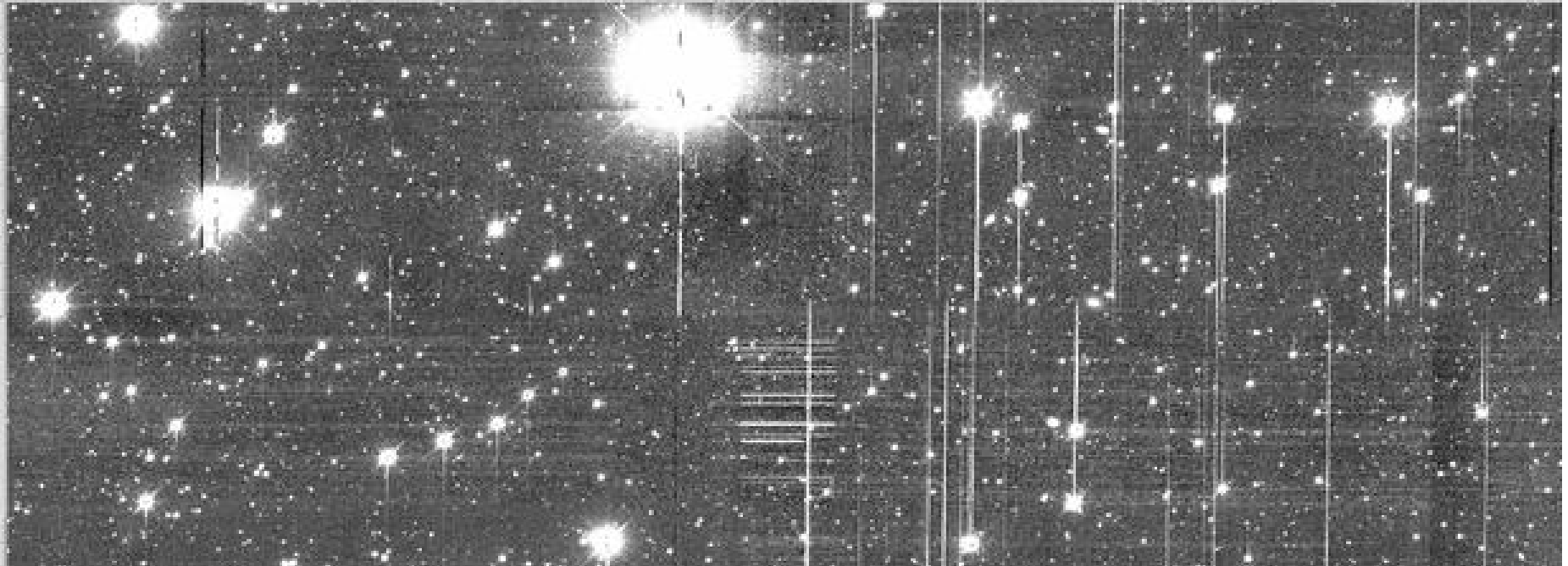
SACImage ds9

File Edit View Frame Zoom Scale Color Region WCS Analysis Help

file
edit
view
frame
bin
zoom
scale
color
region
wcs
analysis
help

File
ks4.1046.088-3
Object
1046.088-34
Value
6.36316
fk5
5:52:48.2401
-33:58:04.061
Physical
X 11083.617
Y 11290.159
Image
X 11083.617
Y 11290.159
Frame 2
x 0.217874
0

new
rgb



last

-30

-18

-5.5

6.5

19

31

42

55

67

Astrometry 체크 및 개선

KS4 Astrometry QA - Idea

We need a standard for classifying astrometry quality of a chip. Simply measuring the misalignment of such a large image is not effective in finding bad parts of the image (see figure 1.a.). Hence came up with such method:

Divide a single chip into 8X8 tiles (64 sections) (see figure 1.b.)

Calculate the followings for each section:

- rmsalign rms of misalignment
- alignstd standard deviation of misalignment and
- number of detected objects

Determine astrometry quality for each and every section with the calculations above

Figure 1.a : Accuracy map for entire MEF

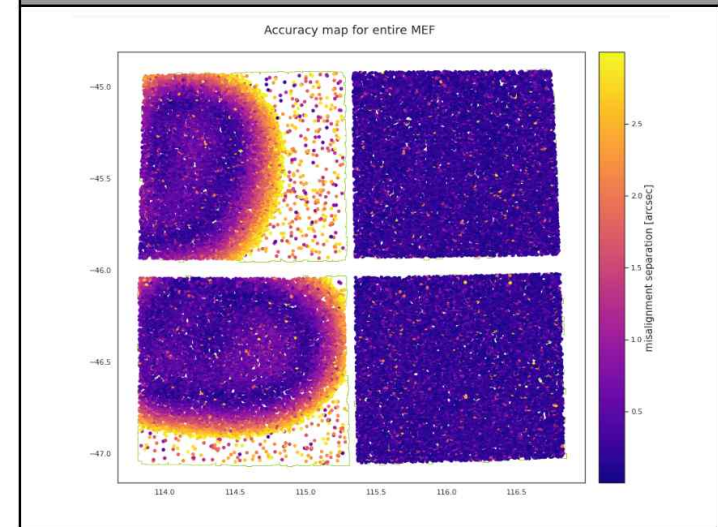
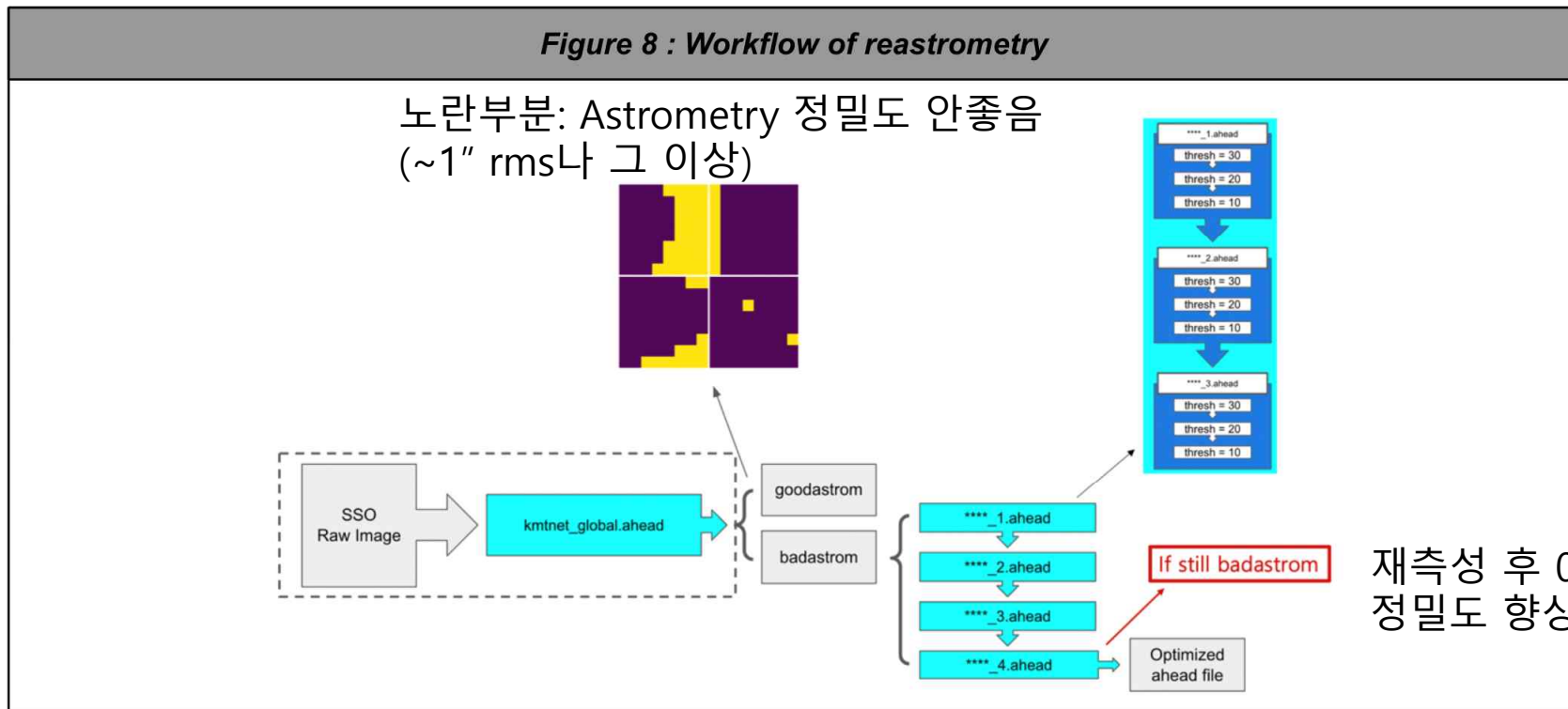


Figure 1.b : Section numbers

63	62	61	60	59	58	57	56
55	54	53	52	51	50	49	48
47	46	45	44	43	42	41	40
39	38	37	36	35	34	33	32
31	30	29	28	27	26	25	24
23	22	21	20	19	18	17	16
15	14	13	12	11	10	9	8
7	6	5	4	3	2	1	0

KS4 Astrometry QA - reastrometry

Finding the correct astrometric parameters (using SCAMP) via changing .ahead file and threshold value



Who do what?

- Observation plan generation - 김준호
- Data reduction/catalog generation – 9,10,11월 김준호/박보미/백승학/장서원
- Data quality check – 김준호/박보미/정만근/백승학/임구/장서원/김소피아
- Transient search/data reduction improvement – 백승학/장서원/임구/김준호/
장서원
- Database – 장서원
- Multi-wavelength catalog – 박보미/고은희/백인수/이성국

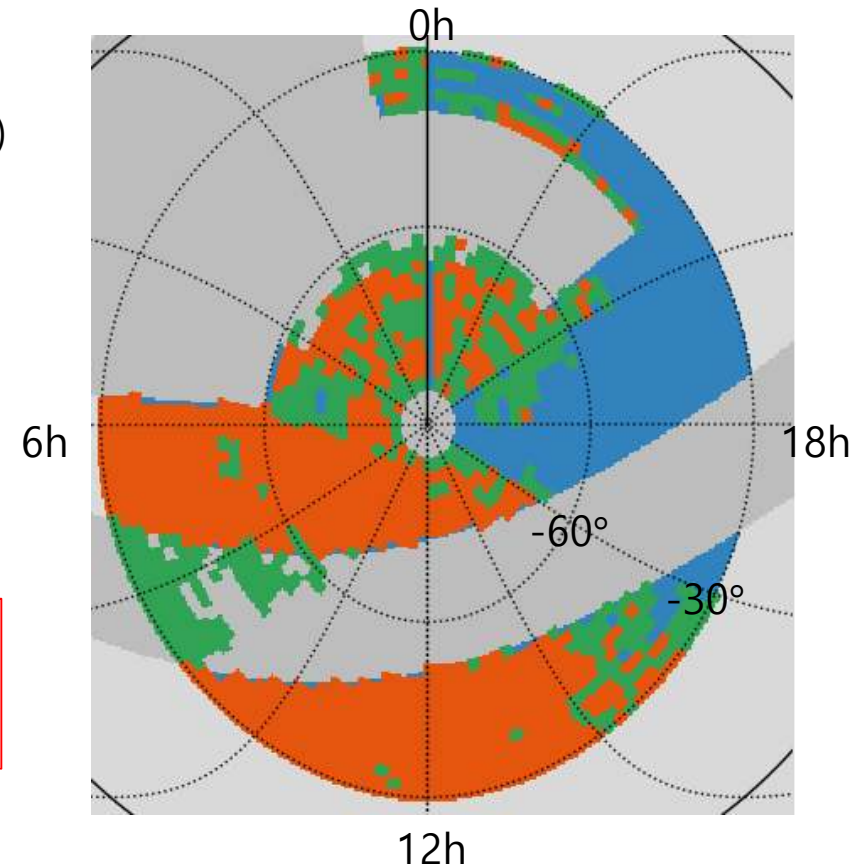
Science that can be done with KS4 data

- Galaxy cluster search – galaxy evolution in different environment, cosmology, cluster search at low and high redshift
- High redshift (bright) quasars: $z=4, 5, 6$, and beyond (z-band 10-sigma 20등급 및 J-band)
- AGN search
- Low redshift galaxy survey + photo-z for GW-oriented galaxy catalog
- Reference image creation (BVRI \leftrightarrow PS1, ML)
- Multi-band merged catalog (SkyMapper, VHS, DECAM, WISE, etc)
- MB data

차년도 관측계획 1

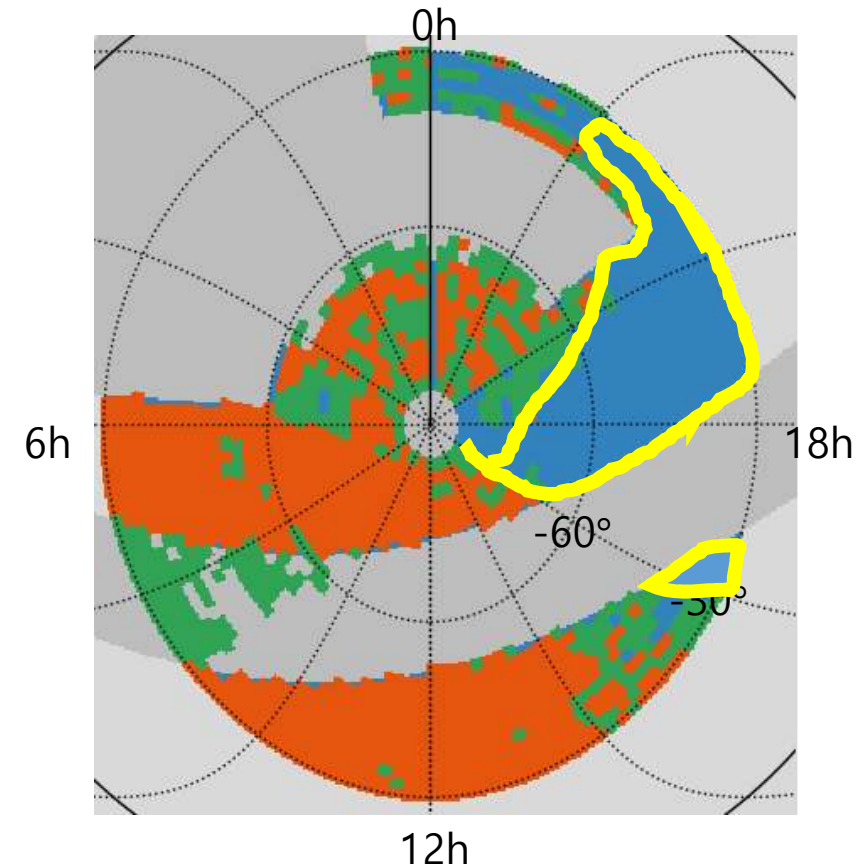
- 다음 지역을 중점적으로 우선관측(약 100시간 소요 예상)
 - ✓ 4-band coverage가 덜 된 지역 관측
 - ✓ Isolated된 tile들 관측
 - ✓ 날씨, 기기문제 등으로 자료의 질이 불량한 지역 재관측

녹색 지역 중 band coverage가 적은 지역 위주로 관측
최종적으로 4600 deg² 지역 관측



차년도 관측계획 2

- Bulge season 때문에 관측이 저조한 지역(노란 선으로 표시한 지역) → 관측 포기
- GW O4 run을 위해 남은 KS4 시간 일부를 MMA ToO 관측에 활용 타 프로그램과의 조율 필요(예: KS4 관측 시간 일부를 미리 타 관측프로그램이 사용하는 대신 KS4관측시간을 MMA를 위한 ToO로 2023년 3월 이후 기간에 배치)



Activity ahead

- Organize KS4 meeting
- Database construction
- Science papers
 - KS4 cluster paper
 - AGN search paper
 - High-z QSO paper
 - Overview paper
 - Database/pipeline paper

K-MMA 요약

- KS4를 위해 K-MMA 시간 사용
- 일부 K-MMA 시간은 DWF 등 국제공동연구에 활용(FRB field monitoring 논문 제출 예정)
- 중력파 O4 관측(2023년 3월 개시 예정)을 위한 K-MMA ToO trigger 등에 대한 협의 필요
- KS4 관측시간 일부를 K-MMA 시간으로 활용 희망(타 프로그램이 KS4 시간을 미리 사용하고, 그 시간을 2023년 3월 이후 K-MMA ToO 시간으로 할당)

MMA with KMTNet (K-MMA)

- K-MMA time is now being used for KS4
- A limited hours of observations used for FRB (fast radio burst) in collaboration with Australian group → papers are in preparation
- O4 run to start in 2023 March or later: we are getting prepared for rapid identification of GW EM counterparts (pipeline refinement, search algorithm improvement, database construction)

GW O4 run 준비

- O4 run is scheduled to start in March, 2023
- KS4 시간을 MMA로 할애?(타 프로그램에 KS4 시간 미리 배정?)
- O4 ToO requirements
 - 관측 Trigger 자유롭게 (bulge time 제외)
 - 관측 후 data transfer 등 속도 up

