# WEAVE and Gaia:
## The 6D phase space

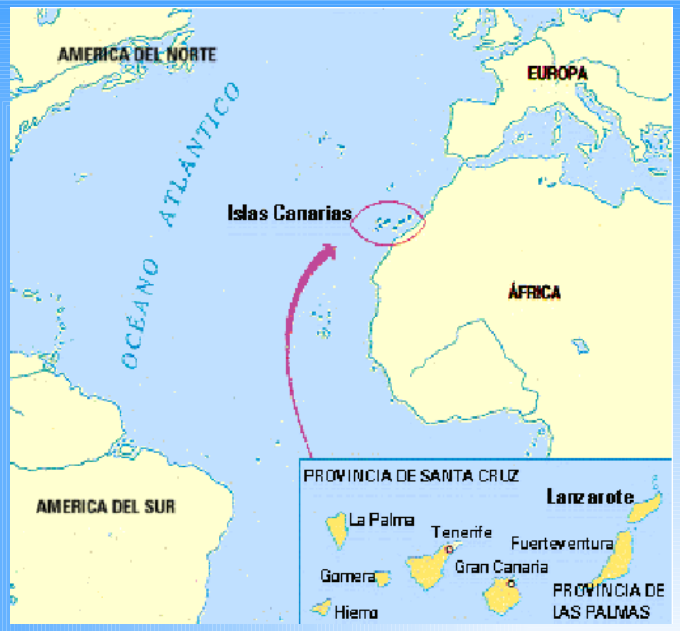
Maria Monguió
ICCUB-IEEC

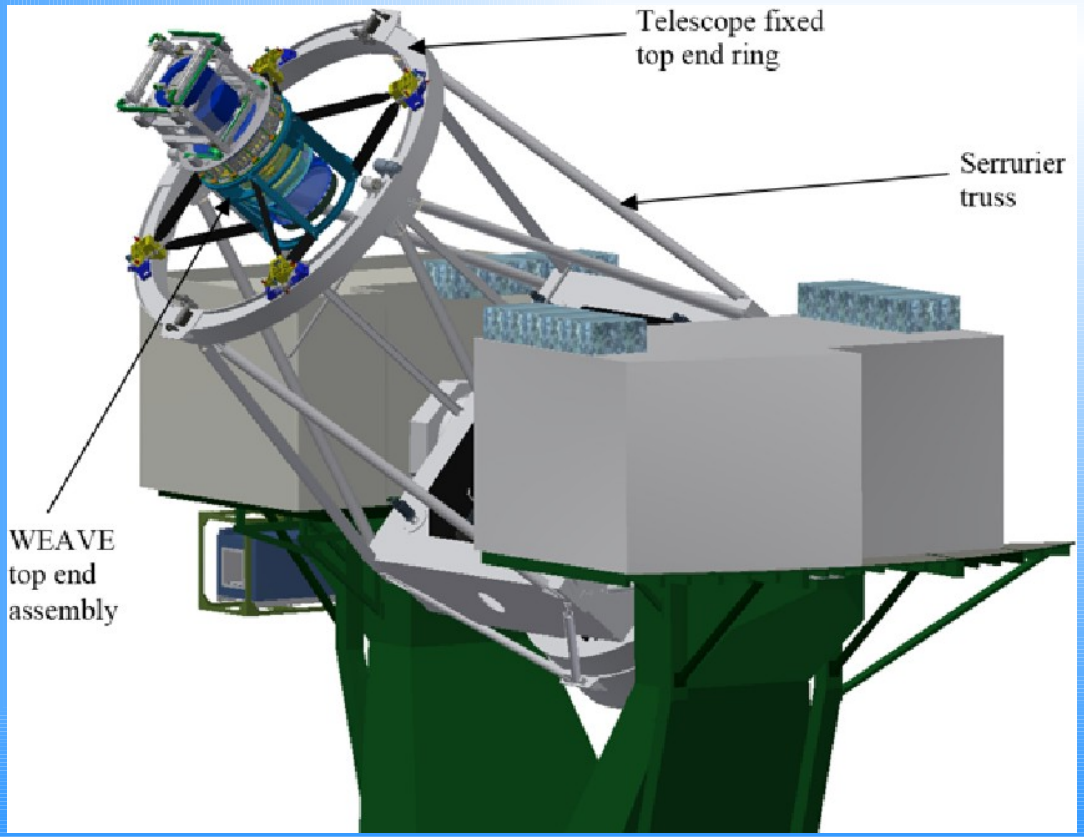
In collaboration with the WEAVE instrument and science teams

Barcelona, February 19th 2020

# Outline

- WEAVE technical capabilities
- Can I apply for WEAVE time?
- WEAVE surveys
  - Galactic archaeology
  - Stellar Circumstellar and Interstellar Surveys
  - White dwarfs

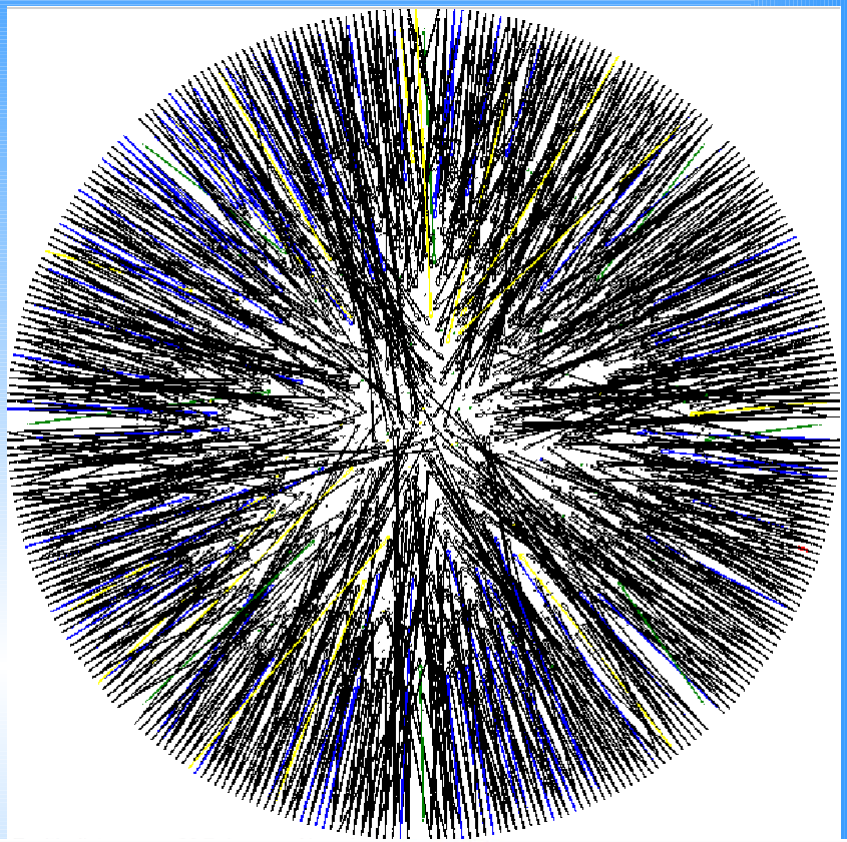

AMERICA DEL NORTE
EUROPA
OCEANO ATLANTICO
Islas Canarias
AFRICA
AMERICA DEL SUR
PROVINCIA DE SANTA CRUZ
Lanzarote
La Palma
Tenerife
Fuerteventura
Gran Canaria
Gomera
Hierro
PROVINCIA DE
LAS PALMAS

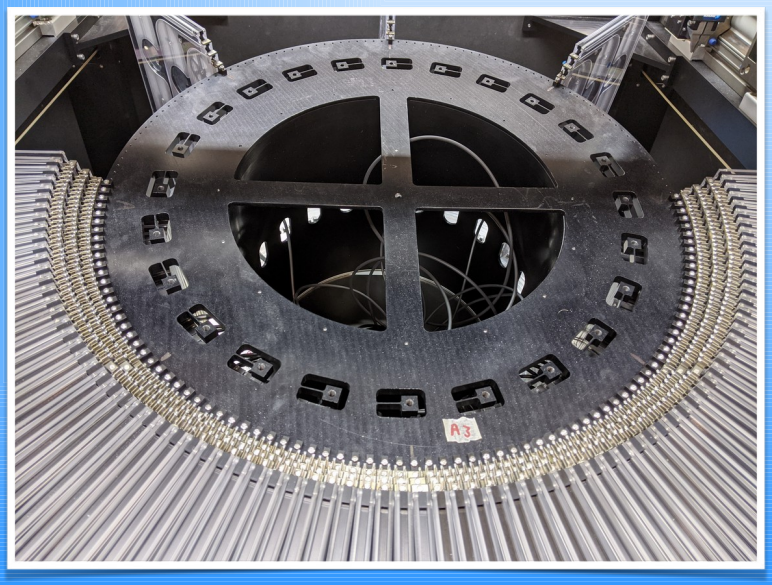

Telescope fixed
top end ring
Serrurier
truss
WEAVE
top end
assembly

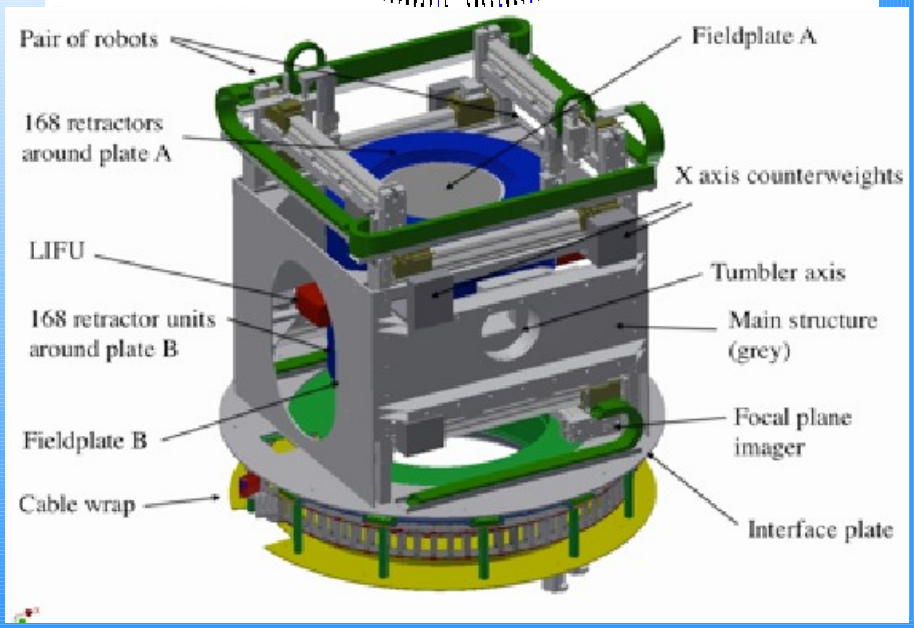
| | |
|---|---|
| Telescope, diameter | WHT, 4.2m |
| Field of view | 2° ø |
| Number of fibers | 960 (plate A)/940 (plate B) |
| Fiber size | 1.3″ |
| Number of small IFUs, size | 20 x 11″x12″ (1.3″ spaxels) |
| LIFU size | 1.3′x1.5′ (2.6″ spaxels) |
| Low-resolution mode resolution | 5750 (3000–7500) |
| Low-resolution mode wavelength coverage (Å) | 3660–9590 |
| High-resolution mode resolution | 21000 (13000–25000) |
| High-resolution mode wavelength coverage (Å) | 4040–4650, 4730–5450<br>5950–6850 |

# MOS

- FoV=2deg
- Fibres:
  - 960 PlateA
  - 940 PlateB
- Fibre size 1.3”

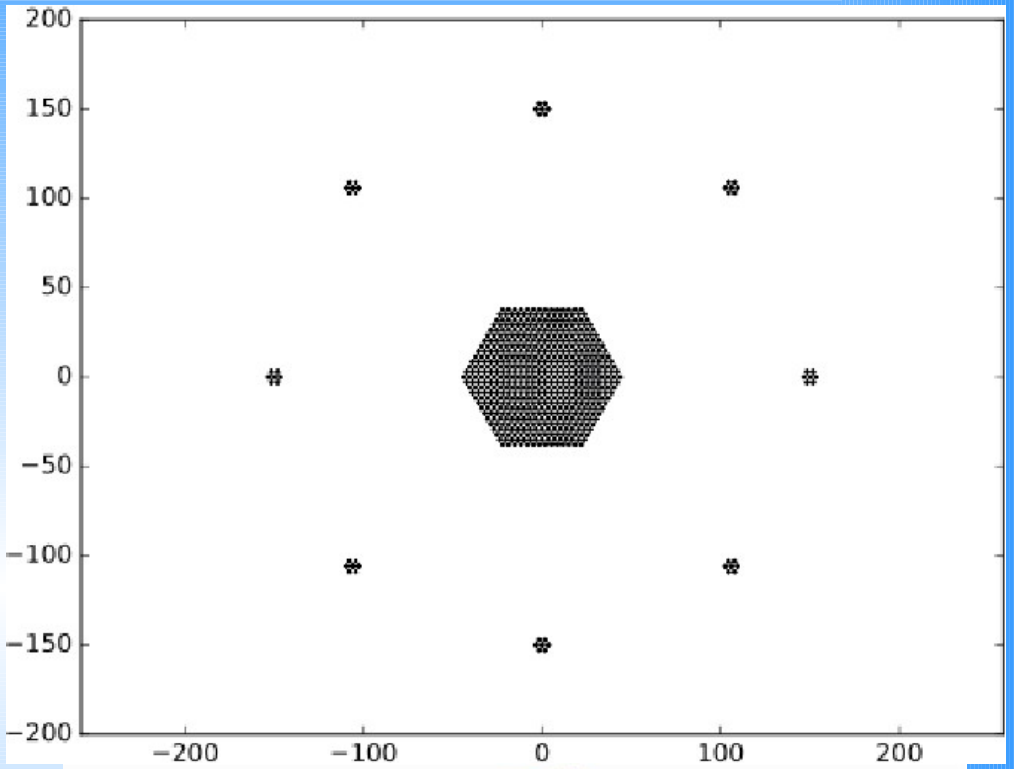


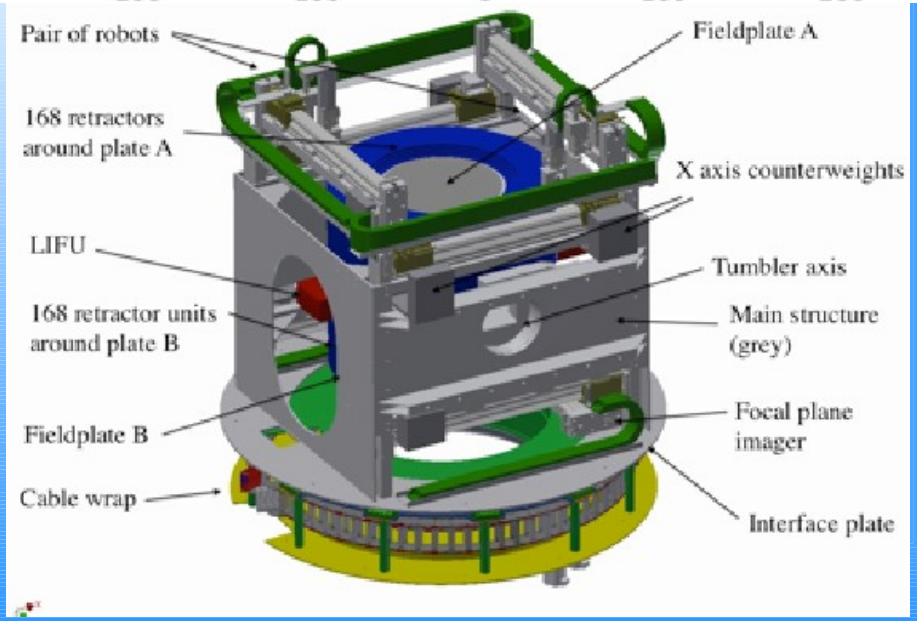




# LIFU

- Size: 1.3’x1.5’
- Spaxel: 2.6’’

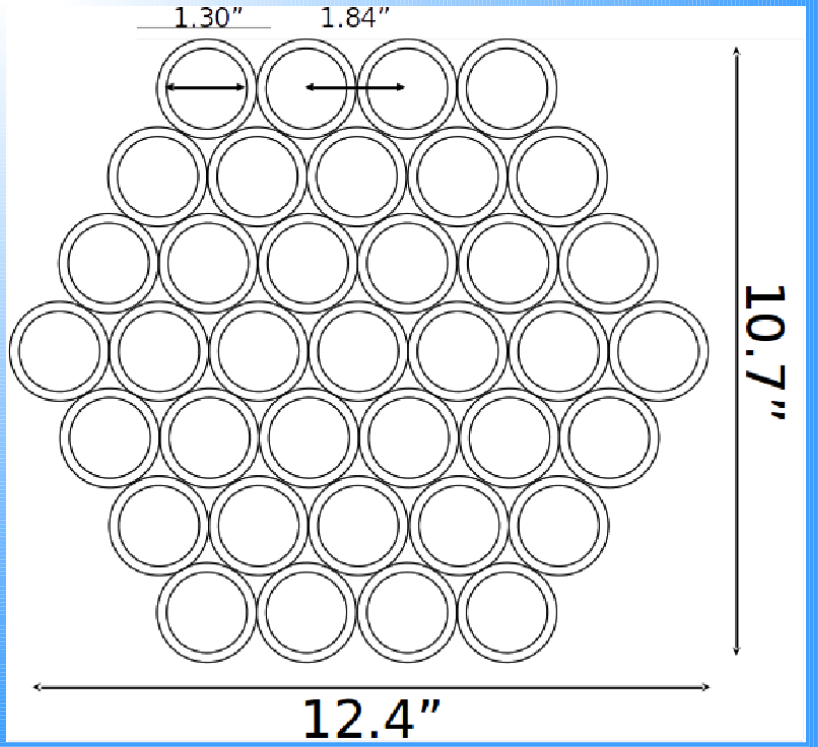


# miniIFU

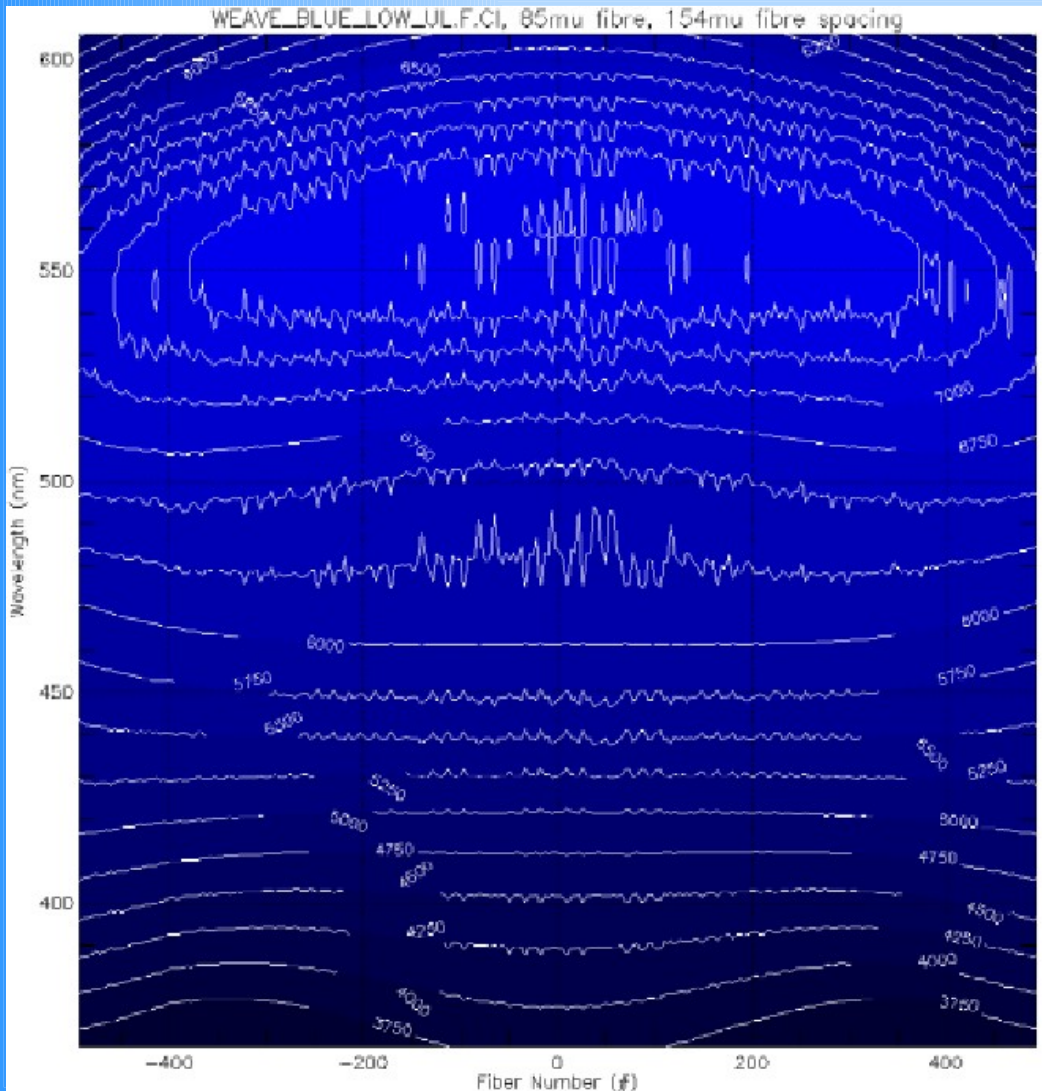
- 20 mIFUs
- Size: 11’’x12’’
- Spaxel: 1.3’’

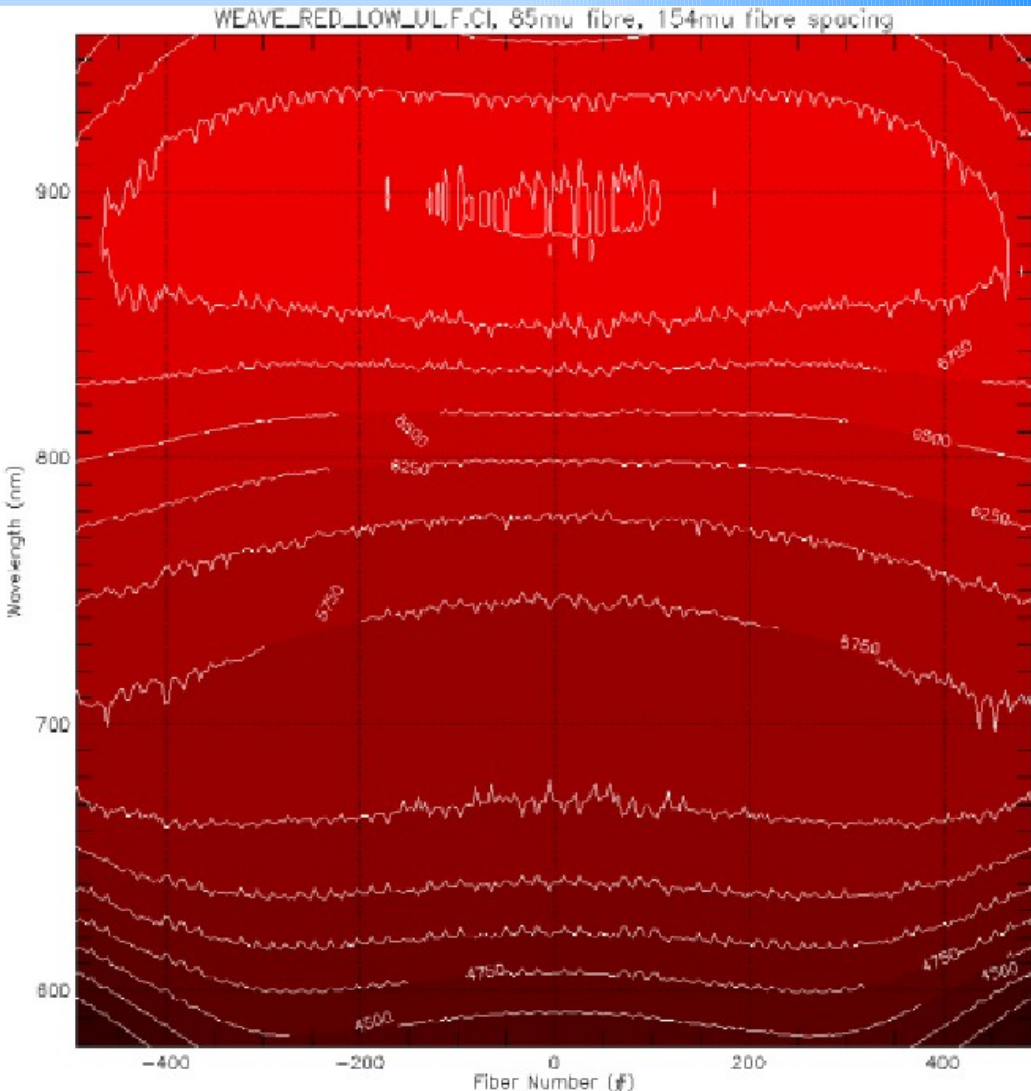
IFU modes cannot be used simultaneously with MOS fibres.



# Grating - LR

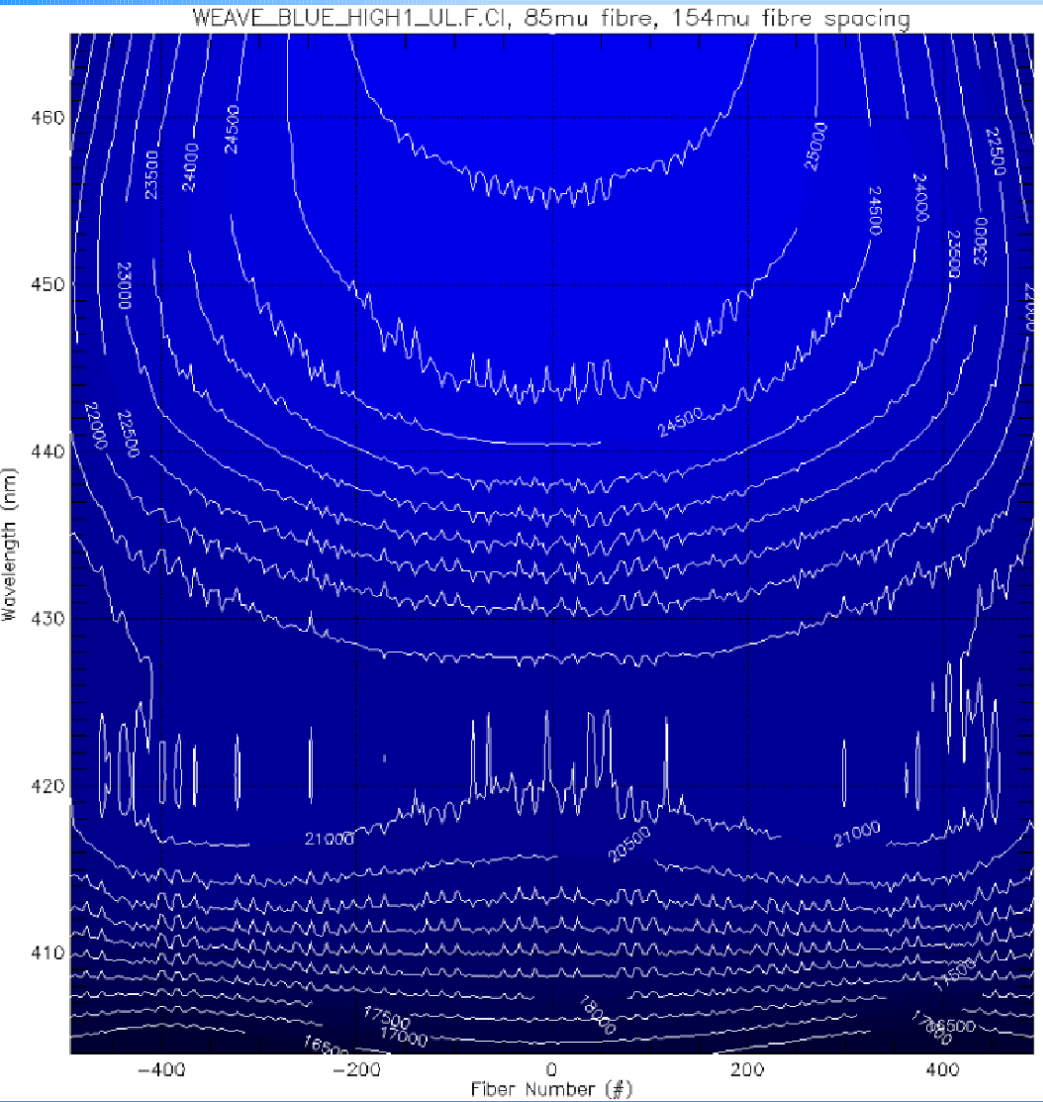
- R=5750 (3000-7500A)
- Coverage: 3660-9590

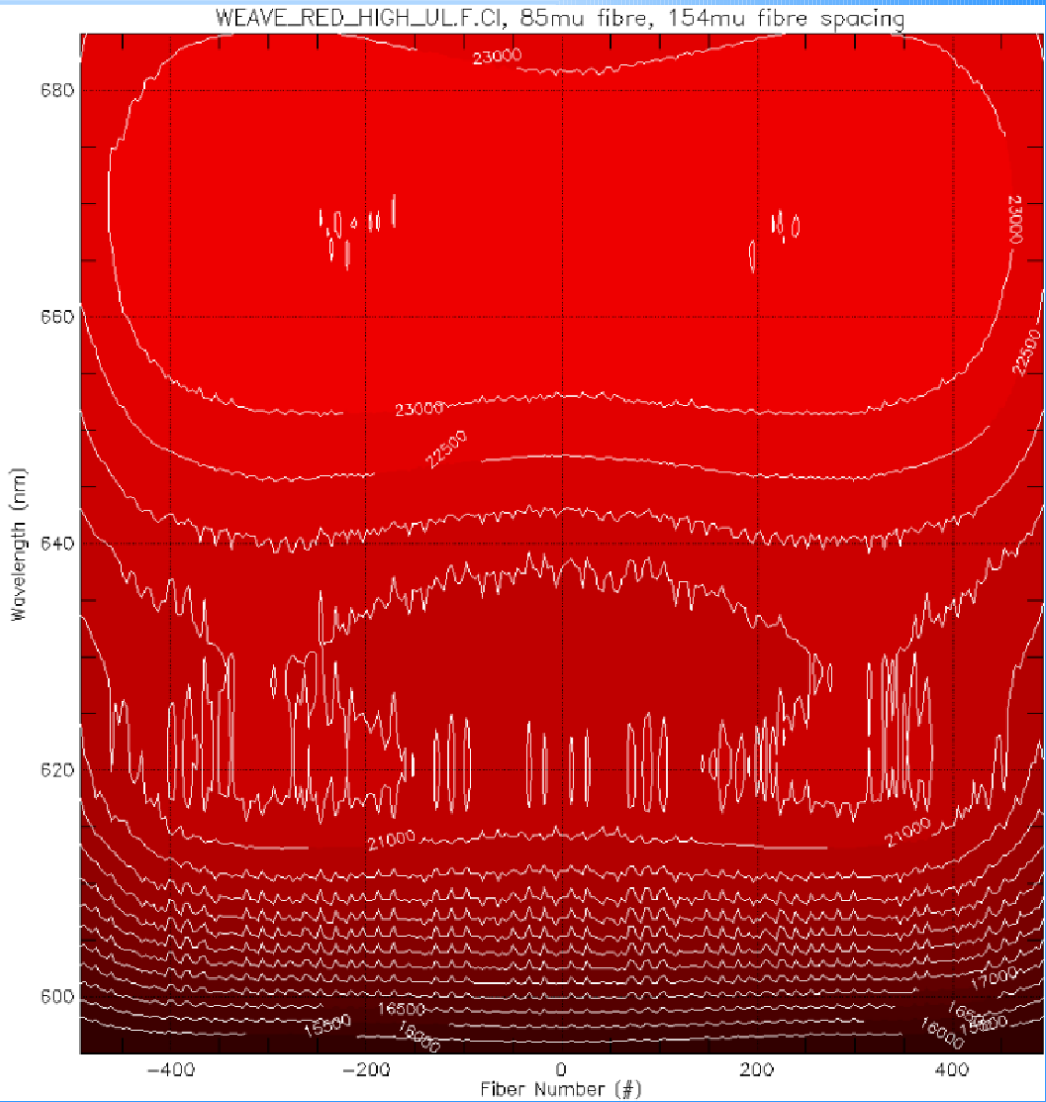


# Grating - HR

- R=21000 (13000-25000A)
- Coverage: 5950-6850 +
  4040-4650 or 4730-5450

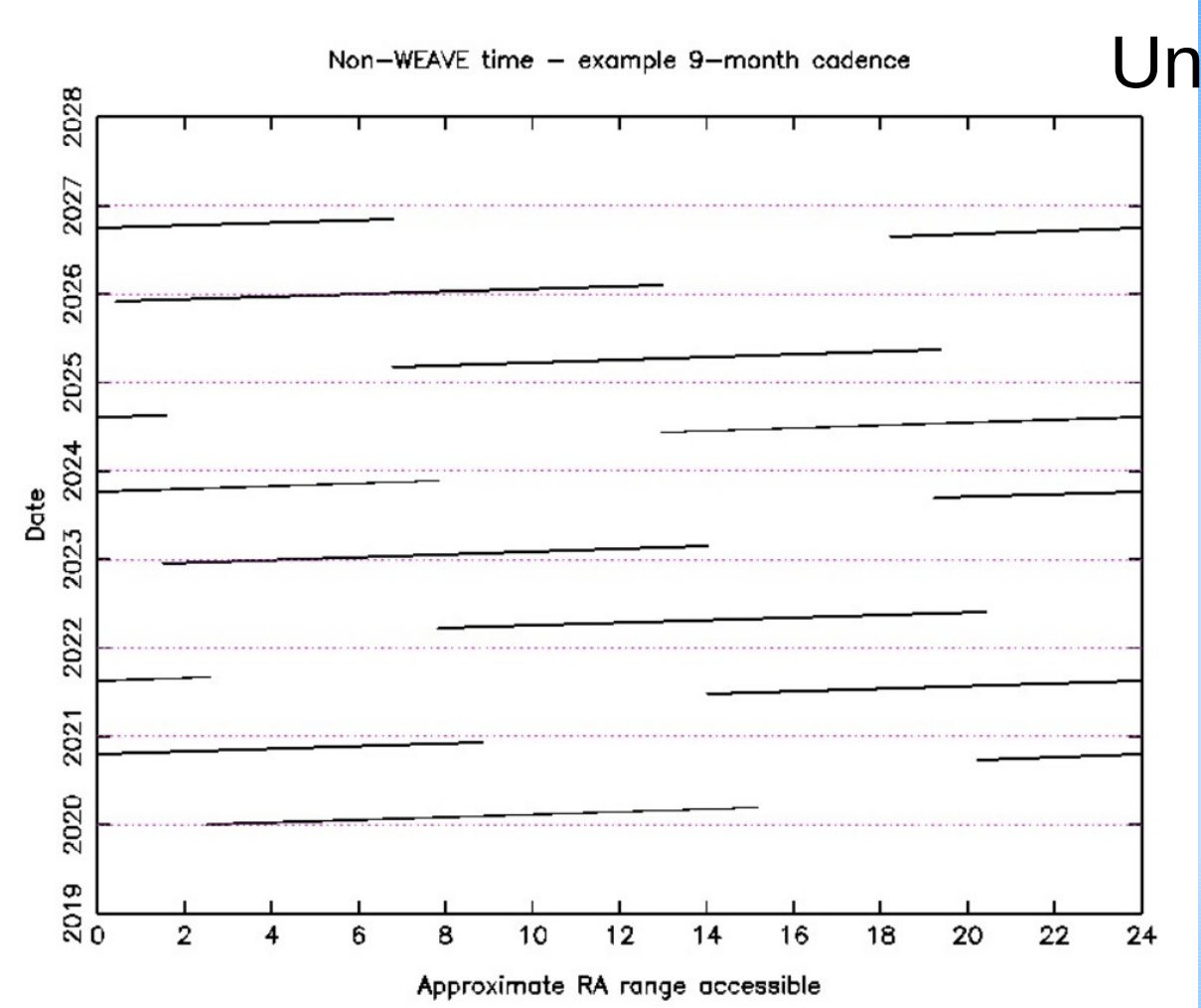


# A bit of politics….

- WEAVE is a consortium of:
  - Spain
  - The Netherlands
  - UK
  - France
  - Italy
- 70% of 5 years of observing time to WEAVE surveys (226.4 nights/year)
  - (+2?)
- 30% remaining time to ING
  - WEAVE or other WHT instruments

Under discussion




- PI applications to WEAVE
- Moving ISIS proposals to WEAVE

# Timeline

- September 2020: First light
- Followed by commissioning
- Survey Verification Oct-Nov 2020
- Survey start before end 2020
- PI applications for WEAVE in 2021B

# WEAVE Science team

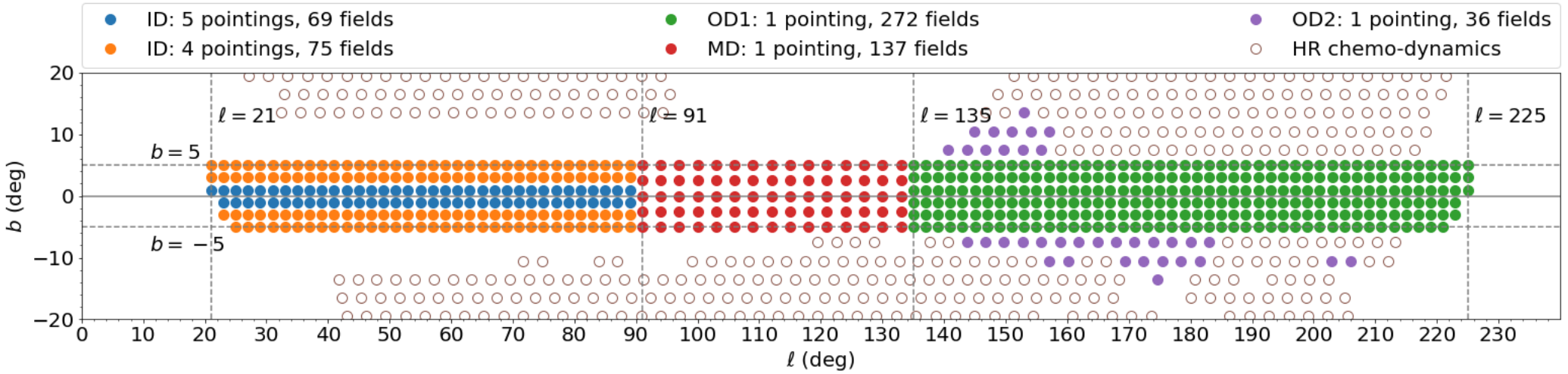
- Project Scientist: Scott Trager (Groningen)
- Deputy PS: Shoko Jin (Oxford/Groningen)
- Surveys:
  - Galactic Archaeology (Vanessa Hill, OCA)
  - Stellar Circumstellar & Interstellar Physics (Janet Drew, UCL)
  - White Dwarfs (Boris Gaensicke, Warwick)
  - WEAVE-LOFAR (Dan Smith, Hertfordshire)
  - Stellar Populations Survey (Bianca Poggianti, INAF-Padova)
  - Galaxy Clusters (José Alfonso López Aguerri, IAC)
  - QSO (Mat Pieri, LAM)
  - Apertif (Jesus Falcón Barroso, IAC)

# Galactic Archaeology

- LR disc (T. Antoja, B. Famaey)
- HR halo (E. Tolstoy, V. Hill)
- High Latitude LR (G. Battaglia, V. Belokurov)
- Open Clusters (A. Vallenari)

# Galactic Archaeology

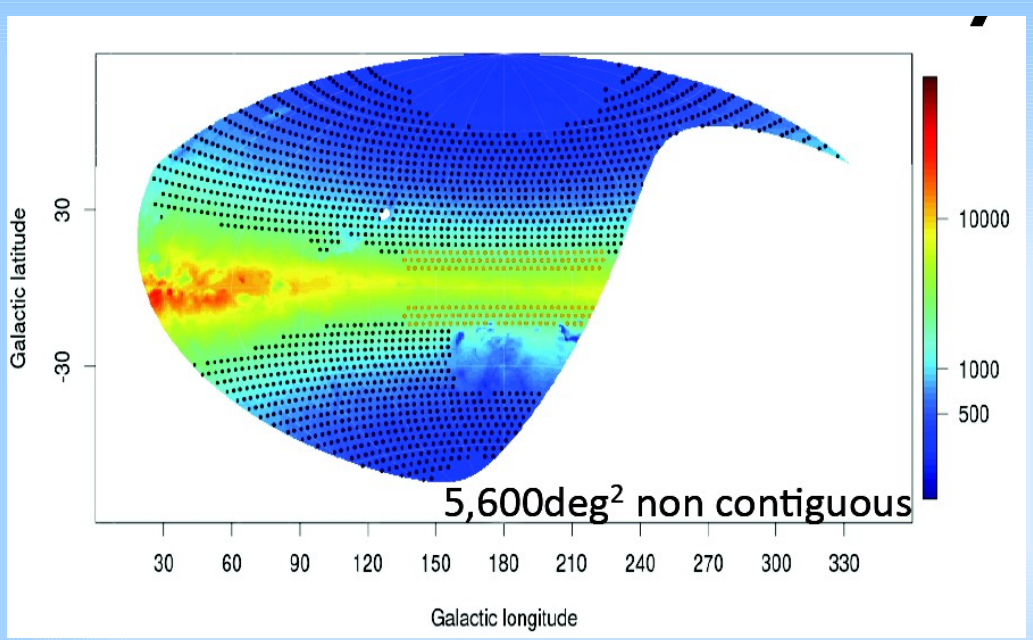
- LR disc (T. Antoja, B. Famaey)




- Disc Dynamics: 6D:
  - Axisymmetric / non-axysimetric potentials
  - Moving groups
  - Radial migration
- Targets selected using Gaia and photometric surveys
  - Red Clump stars
  - Giants

# Galactic Archaeology

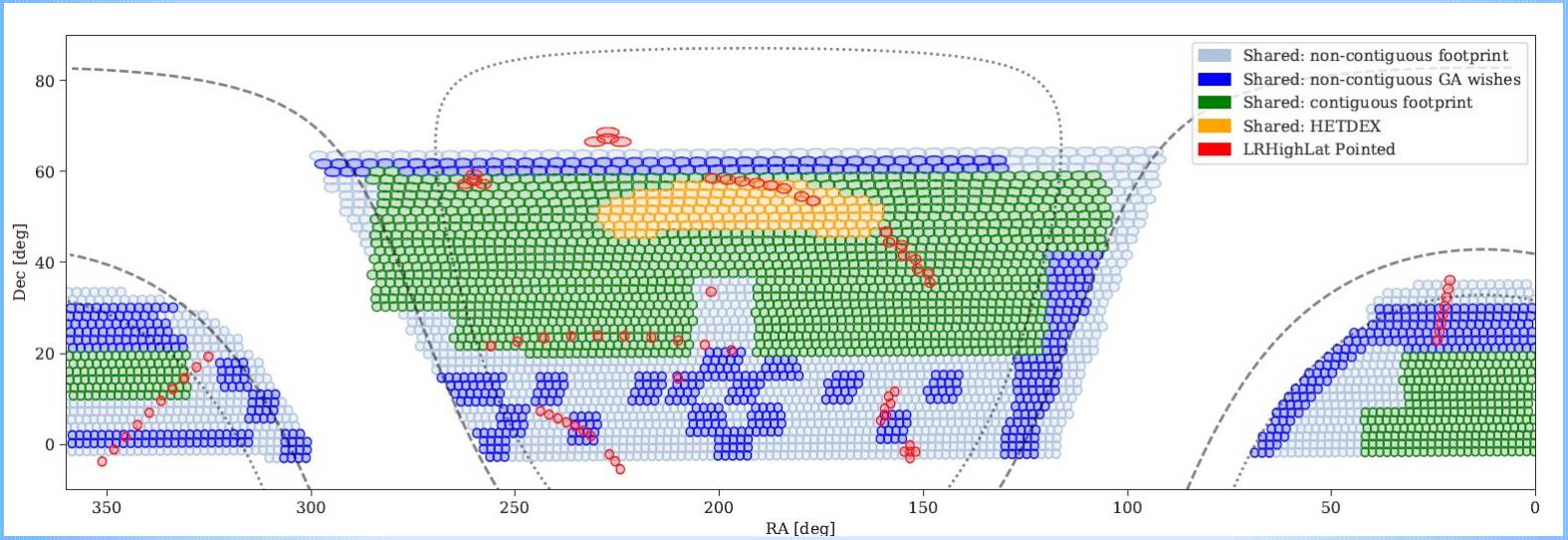
- HR halo (E. Tolstoy, V. Hill)




- Chemical labelling and age-dating
  - Thin/thick disc through chemical tagging
  - Very metal poor stars
  - Red giants in northern Globular clusters

# Galactic Archaeology

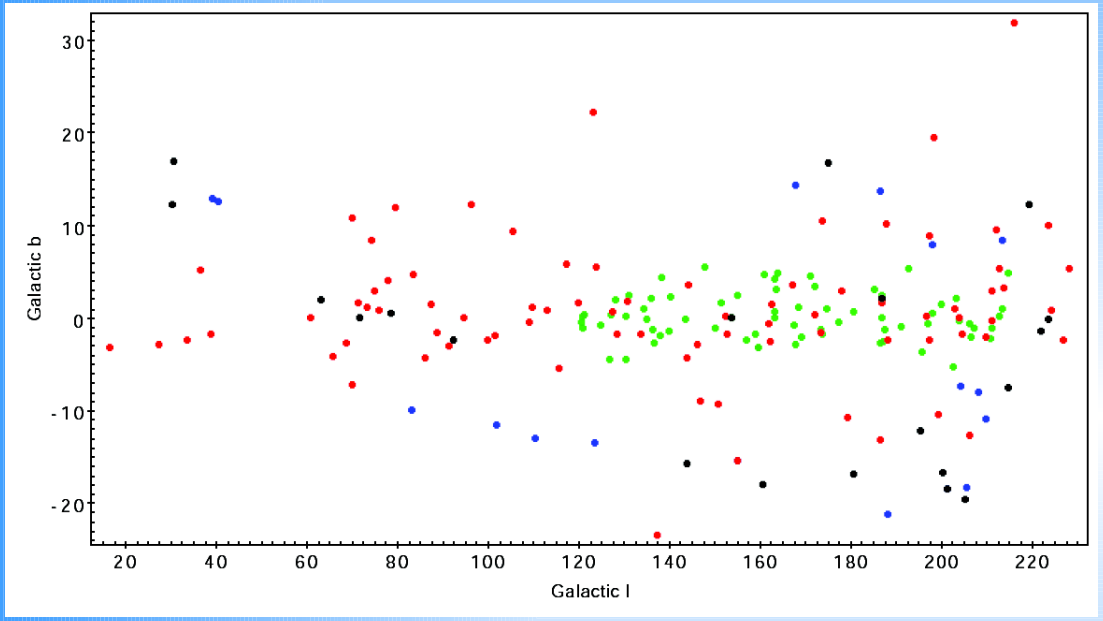
- High Latitude LR (G. Battaglia, V. Belokurov)

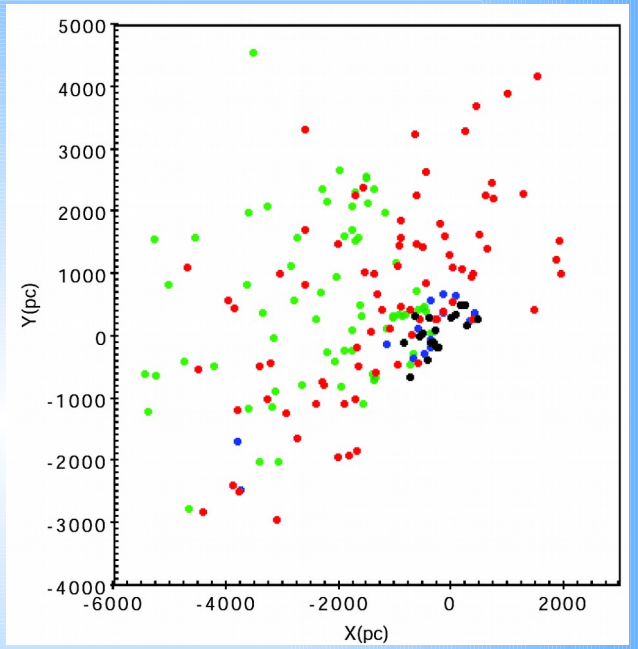



- Formation scenarios of the halo
- RGBs in the outer halo (<100kpc)
- Total mass of the Milky Way
- Substructure and streams
- Dwarf satellite galaxies
- Dark matter

# Galactic Archaeology

- Open Clusters (A. Vallenari)

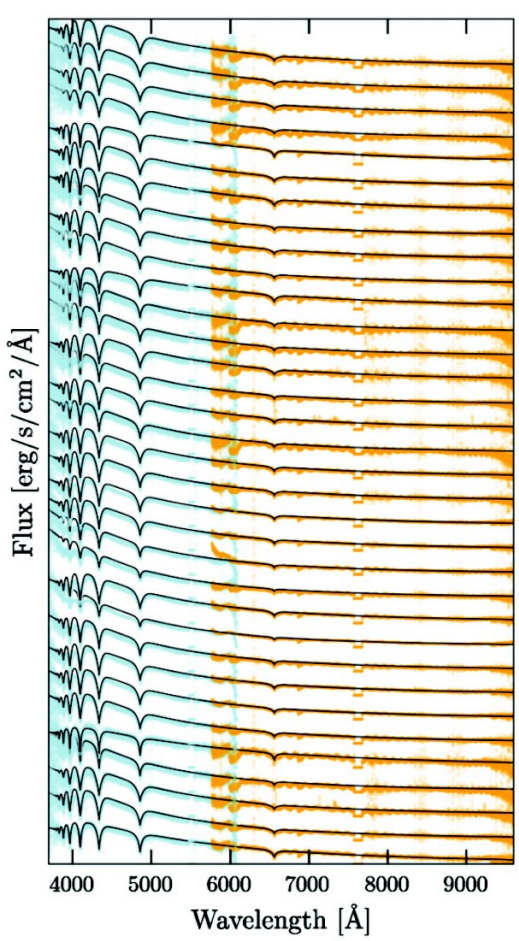


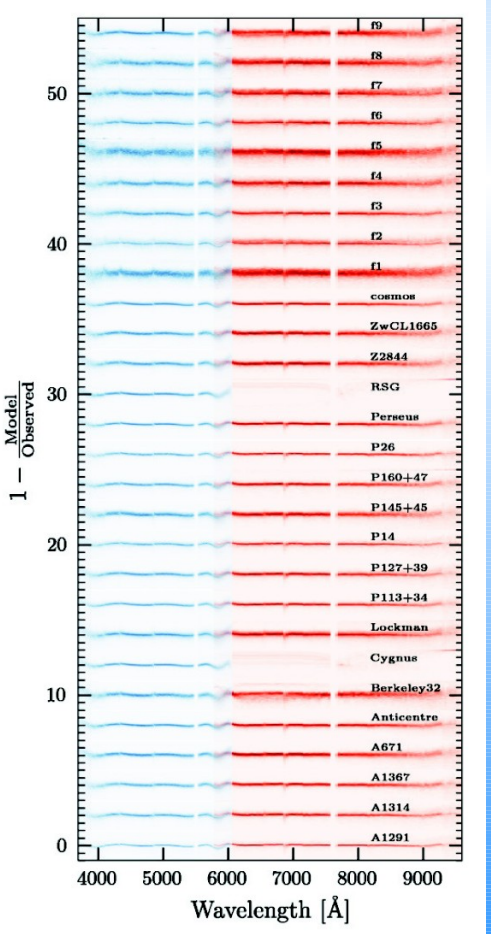



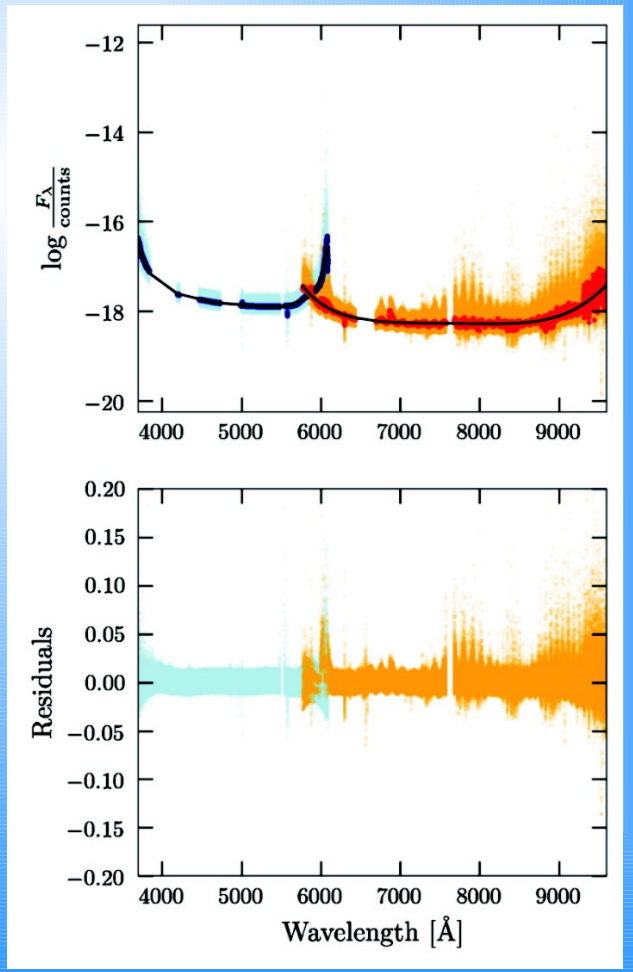

- As probes of Galactic disc
- Formation, evolution, disruption of clusters
- Stellar evolution
- ~300 clusters in HR or LR.

# White Dwarfs

- Used for calibrations: few WD in each OB
  - Only two free parameters (Teff, logg)
  - Ideal to compute calibration function

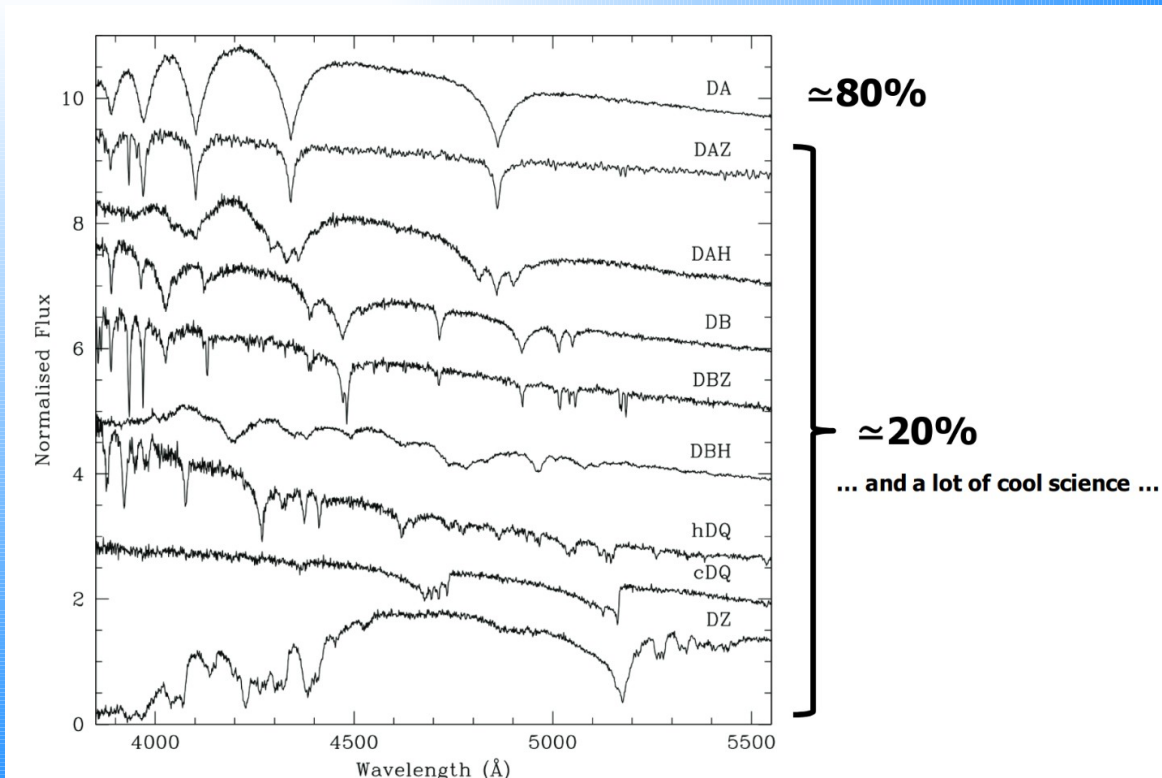


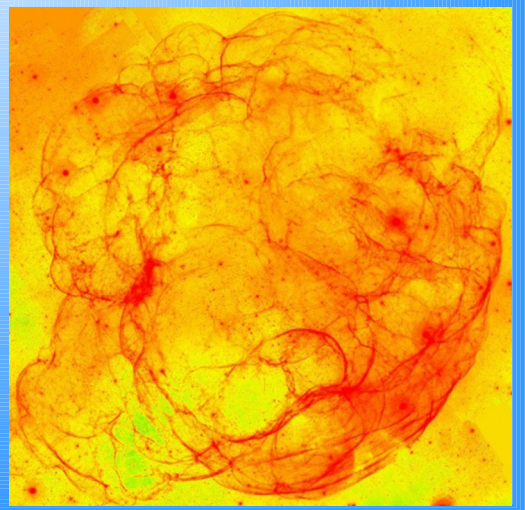
# White Dwarfs

- But also interesting science (with ~70 000 WD):
  - Complete sample at d<50pc with π, Teff, logg. To study IMF, SFH, scale height
  - WD polluted by planetary debris
  - Identification of rare white dwarf species



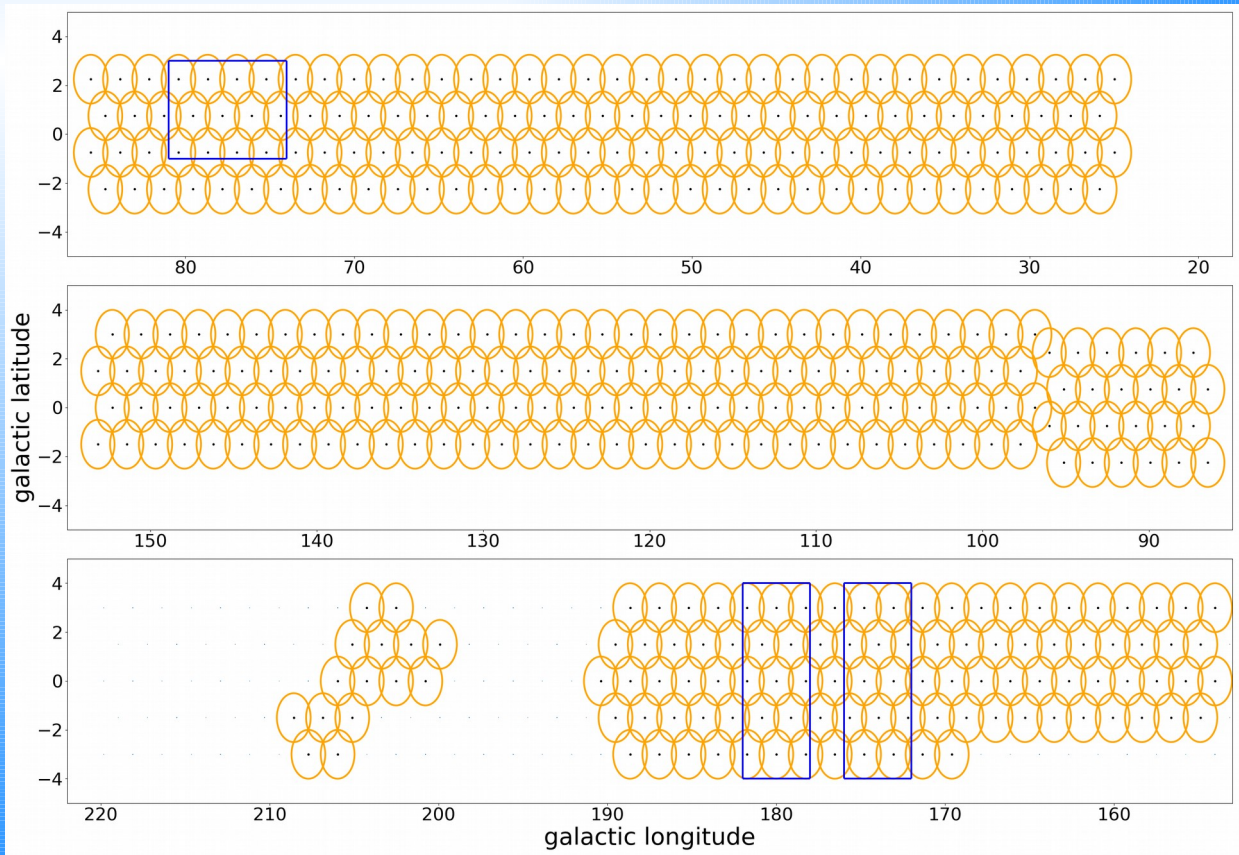
# SCIP

- Covers the northern Galactic plane in LR
  - Stellar evolution
  - Galactic structure
  - Inter stellar medium: 3D extinction, law variation
- Different type of targets:
  - BA stars as Galactic probes
  - Stellar evolution: OB stars, BA, RSG, YSO, WD/IB, Be, CEP
  - Ionised ISM, PN, SNR



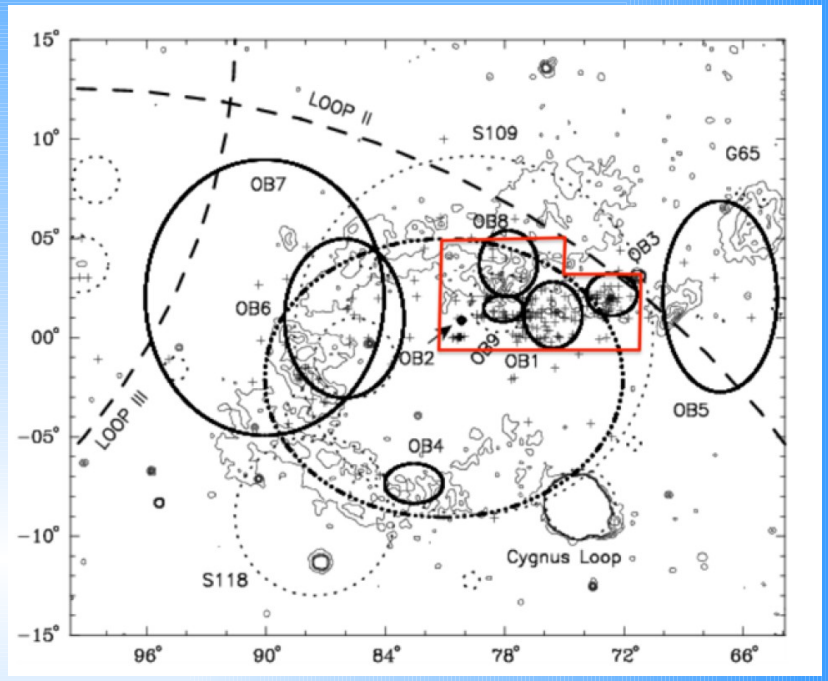
# SCIP

- LR survey (J.Drew)
- HR surveys:
  - HR Cygnus (A.Herrero)
  - HR Anticentre (M.Monguio)



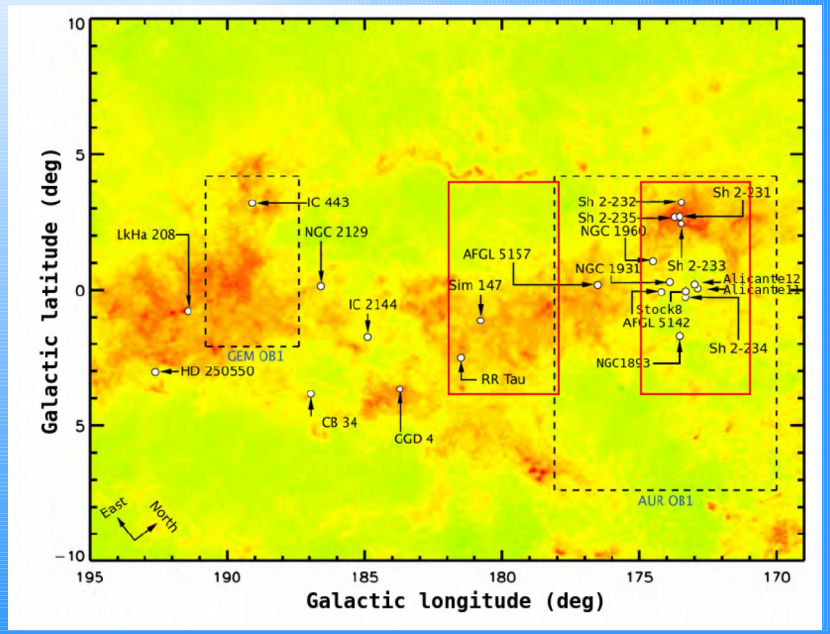
# SCIP

- HR Cygnus
  - OB stars:
    - Accurate parameters
    - rotational velocity,
    - Abundances
    - binary fraction
  - Stellar formation in the Cygnus region
    - Theory of stellar evolution
    - Spatial patterns in kinematics, abundances



# SCIP

- HR Anticentre (mainly BA stars):
  - Structure and dynamics in the outer Galaxy
    - Trends vs R (age, metallicity, kinematics)
    - Larger structures (spiral arms, warp, flare, streams)
    - In comparison with older GA targets
  - Stellar physics at intermediate masses
    - Chemical peculiarity – binarity – rotation
  - Star formation in the AC:
    - Young clusters (OB,YSO)
    - Associated to spiral arms?



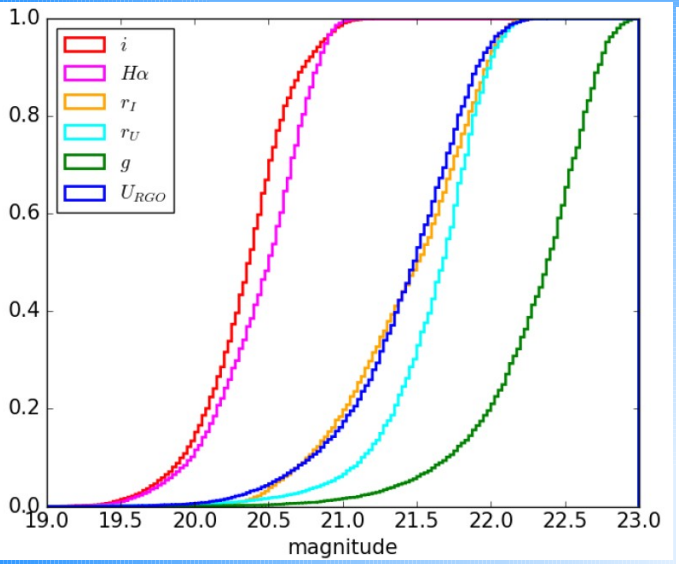
# IGAPS survey

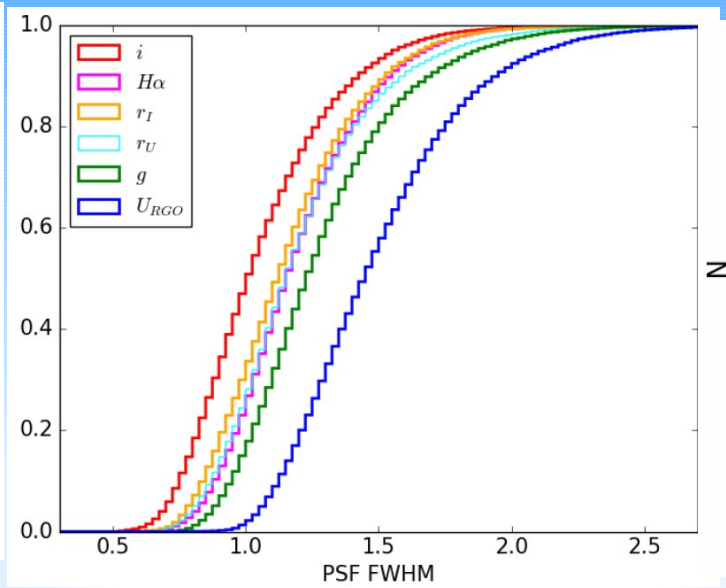
- IPHAS+UVEX : i, Hα, r(x2), g, $U_{RGO}$
- WFC@INT
- Northern Galactic plane 30<l<215, |b|<5
- Astrometry based on Gaia
- Photometric calibration based on PanStarrs (gri)

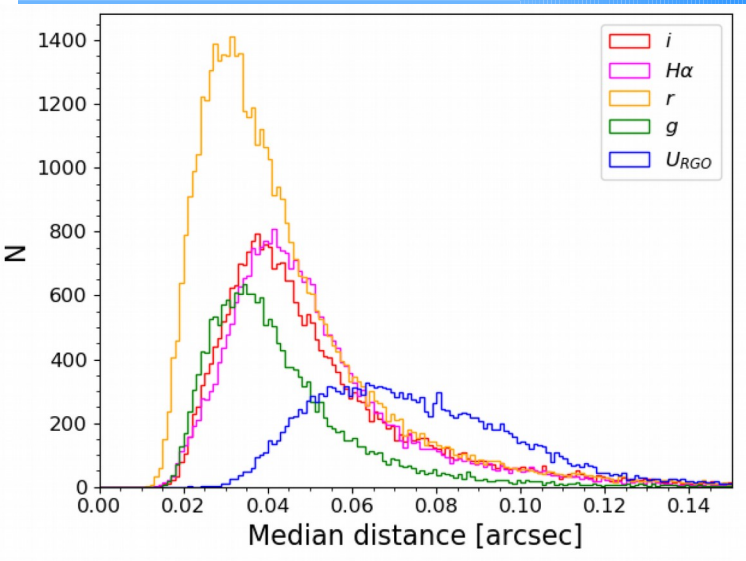
| Property | Value | Comment |
|---|---|---|
| Telescope | 2.5-m Isaac Newton Telescope (INT) | |
| Instrument | Wide Field Camera (WFC) | |
| Detectors | Four 2048×4100 pixel CCDs | |
| Pixel Scale | 0.33 arcsec pixel$^{-1}$ | |
| Filters | $i$, $H\alpha$, $r$, $g$, $U_{RGO}$ | 2 $r$ epochs available |
| Magnitude System | Vega | $m_{AB}$ provided as alternative |
| Exposure times (seconds) | $i$:10, $H_\alpha$:120, $r$:30, $g$:30, $U_{RGO}$:120 | |
| Saturation magnitude | 12($i$), 12.5($H\alpha$), 13($r$), 14($g$) 14.5($U_{RGO}$) | |
| Limiting magnitude | 20.4($i$), 20.5($H\alpha$), 21.5($r$), 22.4($g$), 21.5($U_{RGO}$) | median 5$\sigma$ detection over the noise. |
| median PSF FWHM (arcsec) | 1.0($i$), 1.2($H\alpha$), 1.1($r$), 1.3($g$), 1.5($U_{RGO}$) | |
| Survey area | ~ 1860 square degrees | |
| Footprint boundaries | $-5° < b < +5°$, $30° < \ell < 215°$ | |
| Beginning/end dates of observations | August 2003 – November 2018 | see Figure 1 |

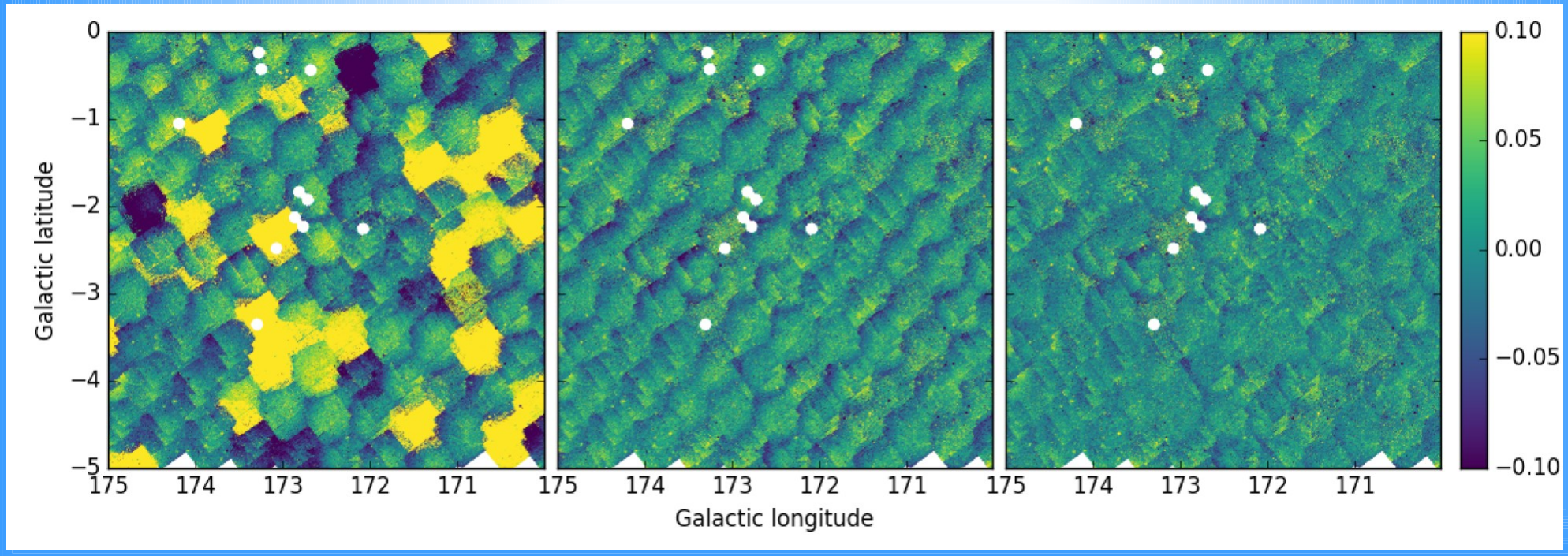
**Table 1.** Key properties of the merged IGAPS survey.

# IGAPS survey

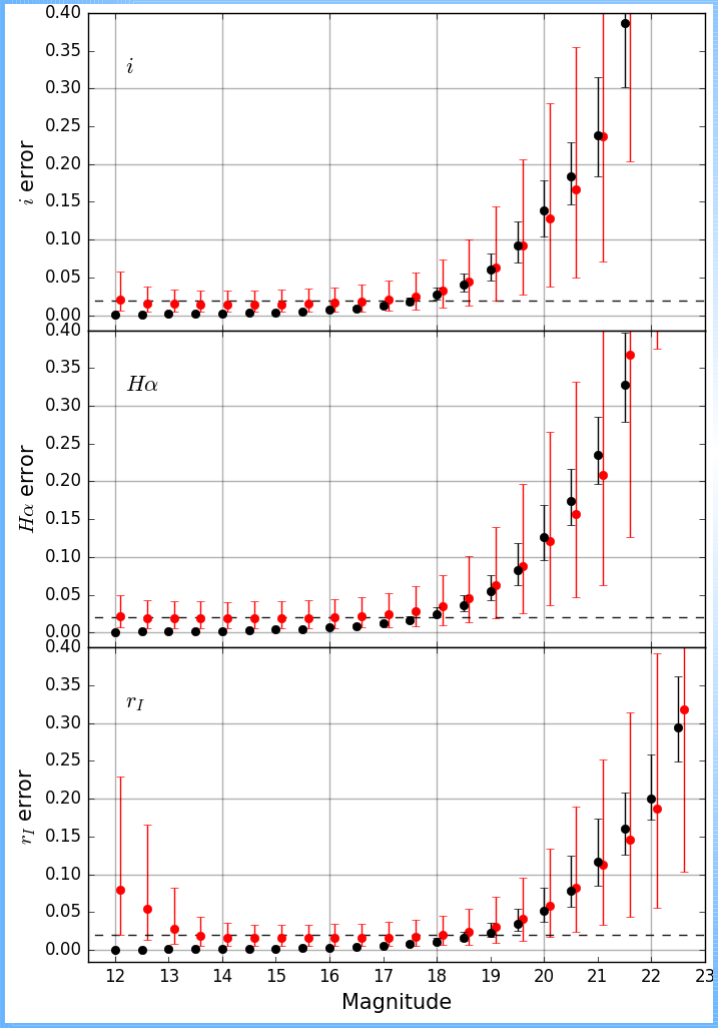


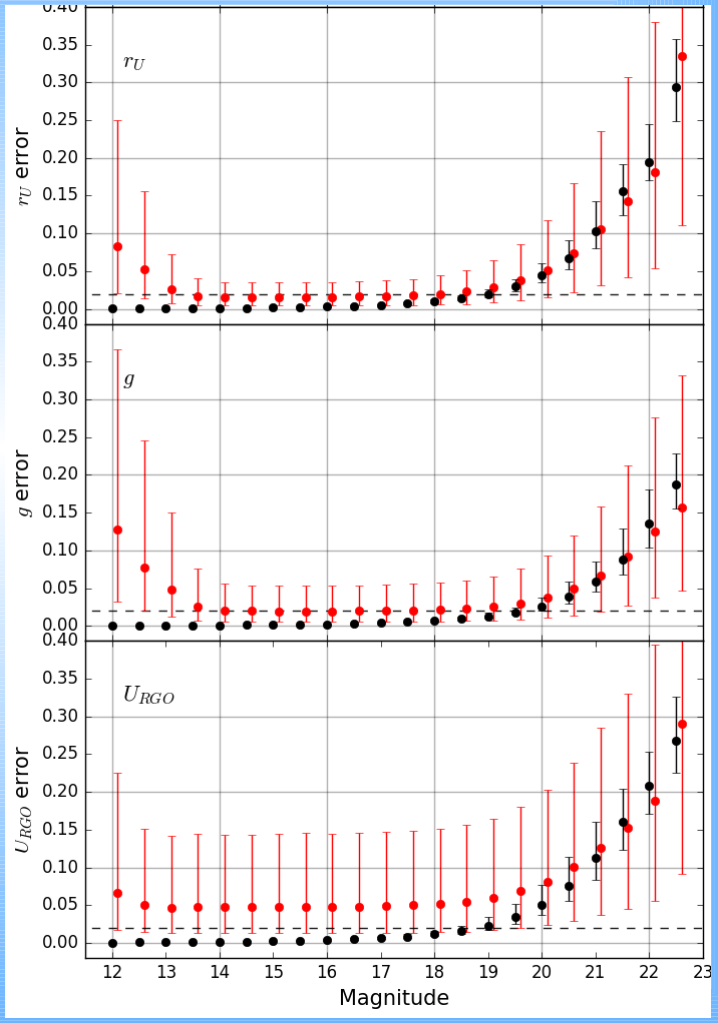



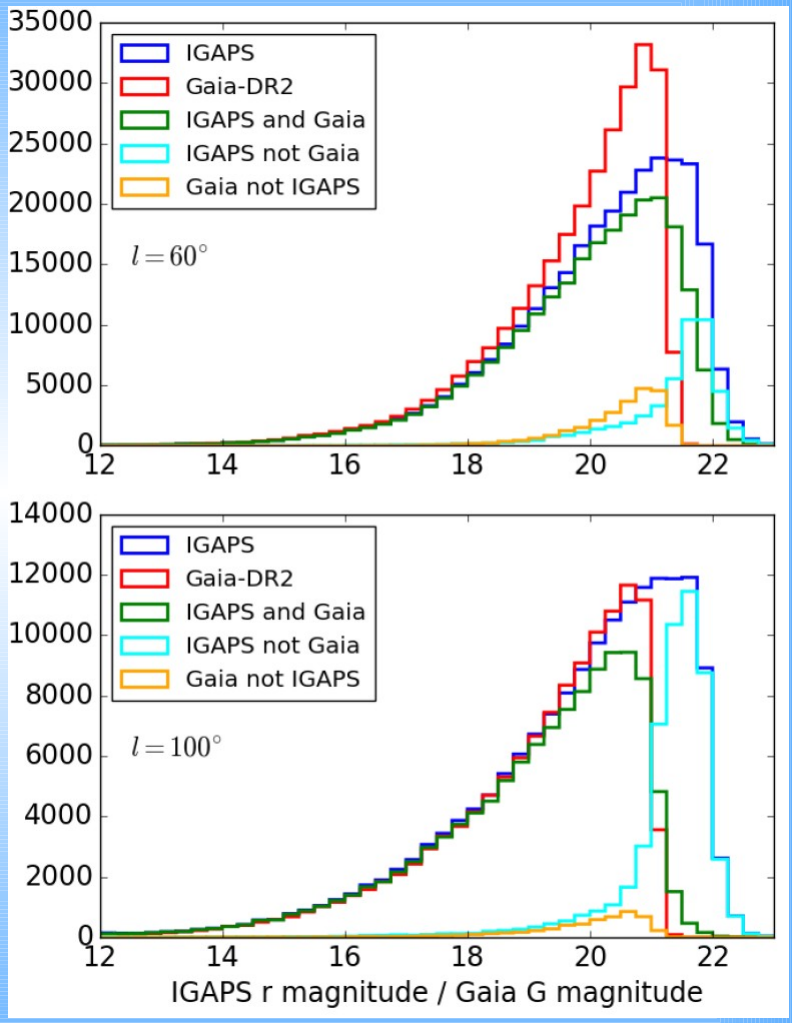
# IGAPS survey



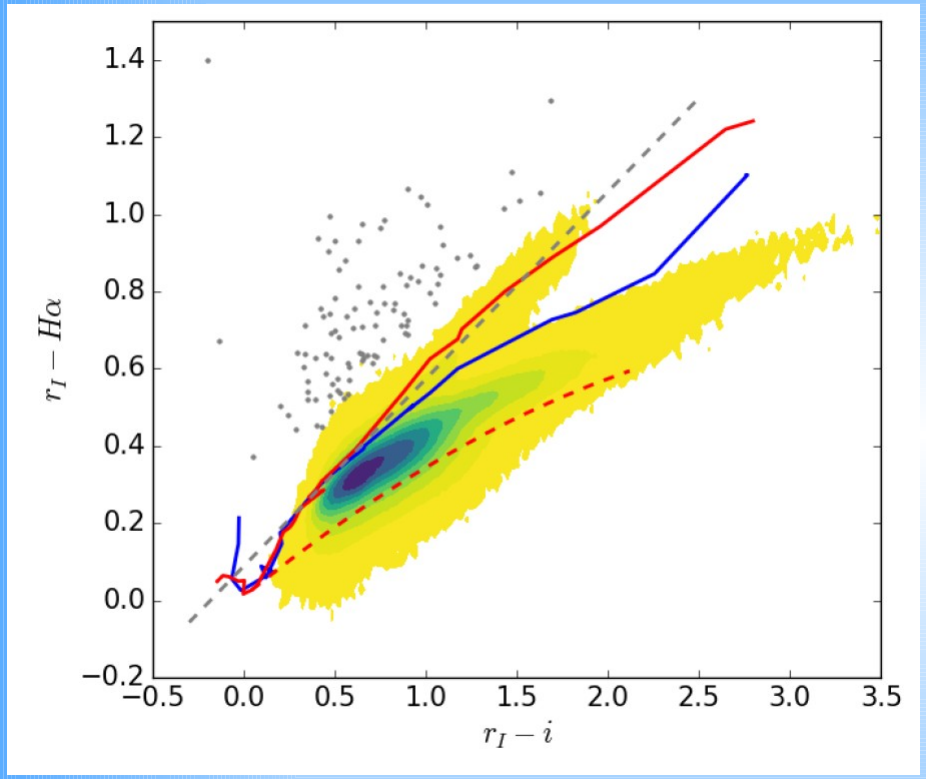



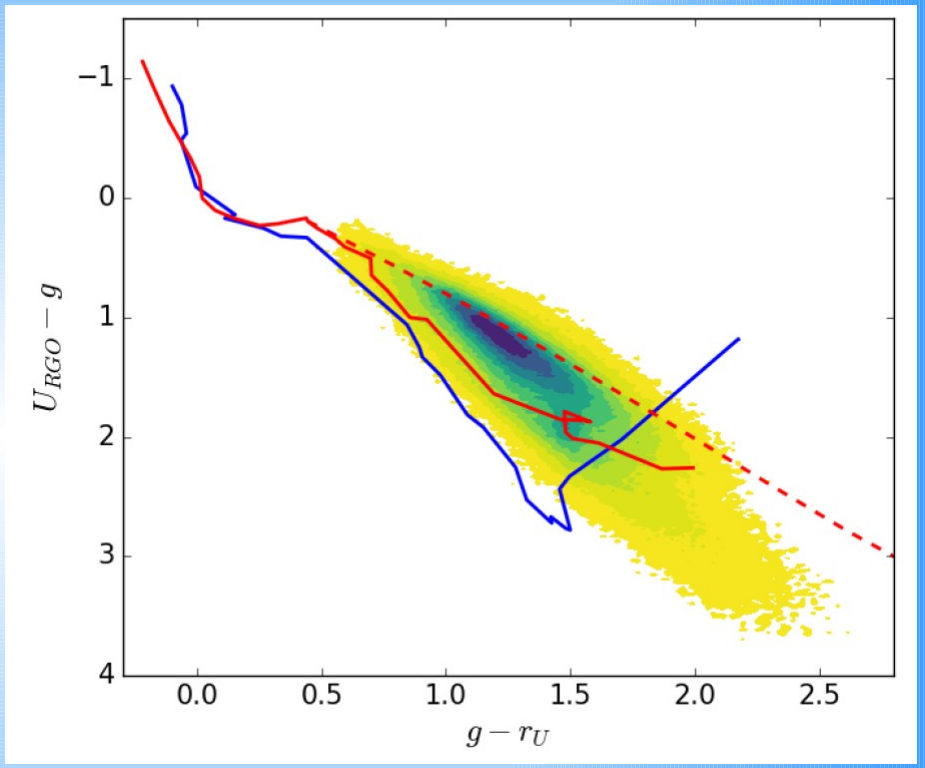
# IGAPS survey

| | N ($\times 10^6$) | N ($\times 10^6$) errBits=0 |
|---|---|---|
| IGAPS (surveys combined) | | |
| All | 295.4 | 205.2 |
| IPHAS | 264.3 | 186.1 |
| UVEX | 245.8 | 170.7 |
| IPHAS + UVEX | 214.7 | 151.6 |
| IPHAS | | |
| $i, H\alpha, r_I$ | 168.4 | 115.4 |
| $i, r_I$ | 31.7 | 25.2 |
| $i$ | 25.6 | 18.9 |
| $H\alpha$ | 15.7 | 11.2 |
| $r_I$ | 16.3 | 12.0 |
| UVEX | | |
| $r_U, g, U_{RGO}$ | 54.3 | 30.0 |
| $r_U, g$ | 101.1 | 72.7 |
| $r_U$ | 76.2 | 60.6 |
| $g$ | 12.7 | 6.8 |



# IGAPS survey



# IGAPS survey

*Astronomy & Astrophysics* manuscript no. output
February 14, 2020

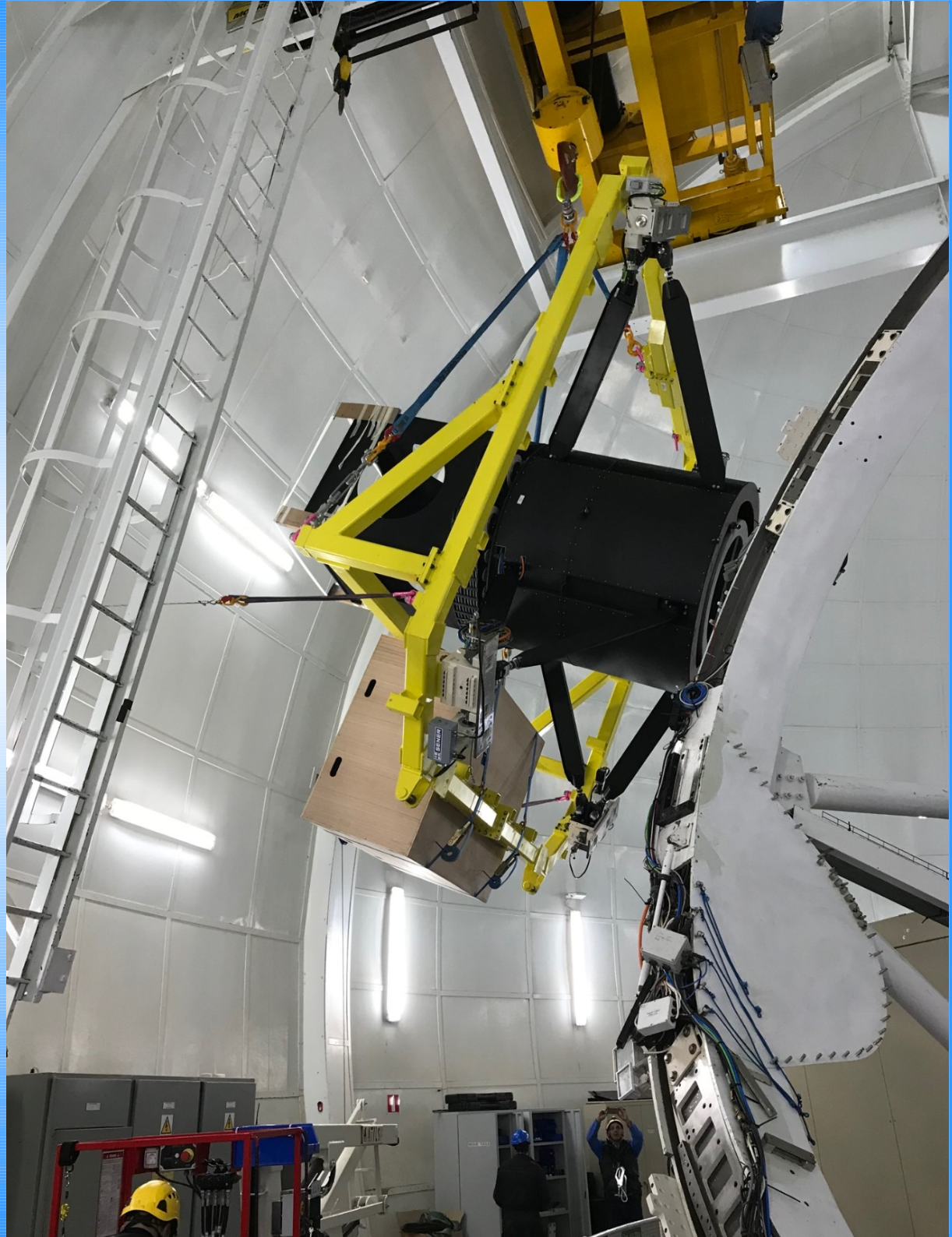

## IGAPS: the merged IPHAS and UVEX optical surveys of the Northern Galactic Plane

M. Monguió[1,2], R. Greimel[3], J. E. Drew[1,4], G. Barentsen[1,5], P. J. Groot[6,7,8,9], M. J. Irwin[10], J. Casares[11,12], B. T. Gänsicke[13], P. J. Carter[13,14], J. M. Corral-Santana[11,15], N. P. Gentile-Fusillo[13,15], S. Greiss[13], L. M. van Haaften[6,16], M. Hollands[13], D. Jones[11,12], T. Kupfer[6,17], C. J. Manser[13], D. N. A. Murphy[10], A. F. McLeod[6,16,18], T. Oosting[6], Q. A. Parker[19], S. Pyrzas[13,20], P. Rodríguez-Gil[11,12], J. van Roestel[6,21], S. Scaringi[16], P. Schellart[6], O. Toloza[13], O. Vaduvescu[11,22], L. van Spaandonk[13,23], K. Verbeek[6], N. J. Wright[24], J. Eislöffel[25], J. Fabregat[26], A. Harris[1], R. A. H. Morris[27], S. Phillipps[27], R. Raddi[13,28], L. Sabin[29], Y. Unruh[30], J. S Vink[31], R. Wesson[4], A. Cardwell[22,32], R. K. Cochrane[22], S. Doostmohammadi[22,33], T. Mocnik[22], H. Stoev[22], L. Suárez-Andrés[22], V. Tudor[22], T. G. Wilson[22], and T. J. Zegmott[22]

*(Affiliations can be found after the references)*

Received December 17, 2019; accepted February 12, 2020

Thanks!

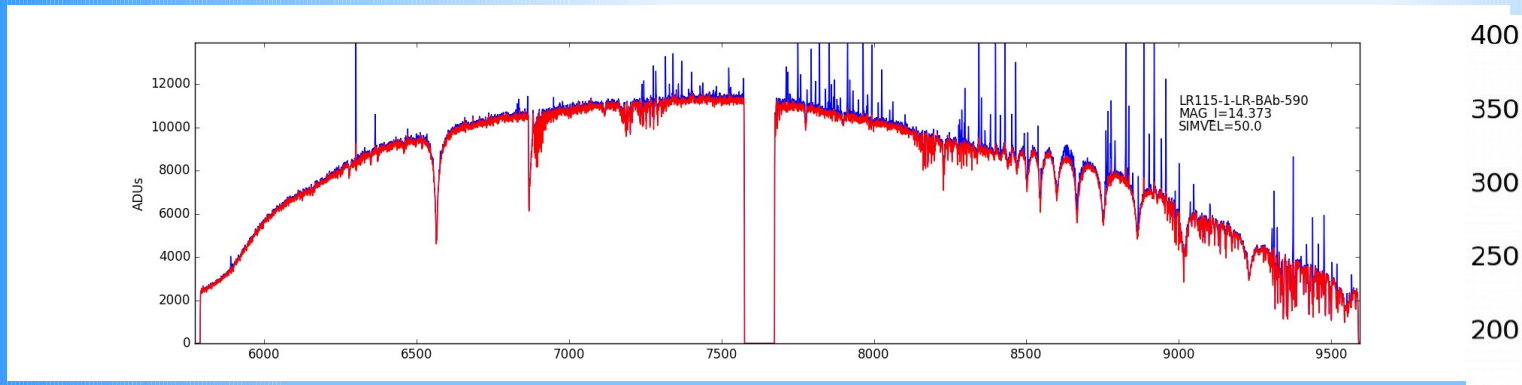


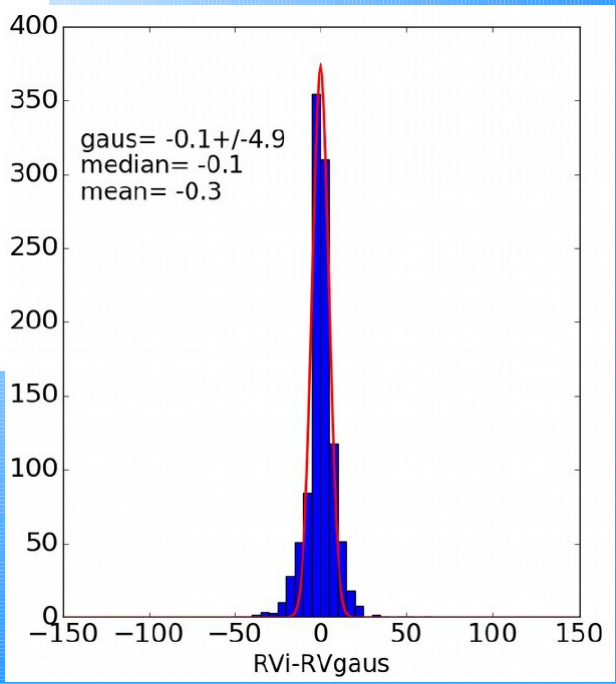
# Operational Rehearsals

- 3 Operational Rehearsals:
  - OpR1: pure data flow from “telescope” to data reduction systems to archive, no science involvement
  - OpR2: data flow from “telescope” to data reductions to archive using science simulations
  - OpR3: full simulation of survey strategy and data quality

# OpR3

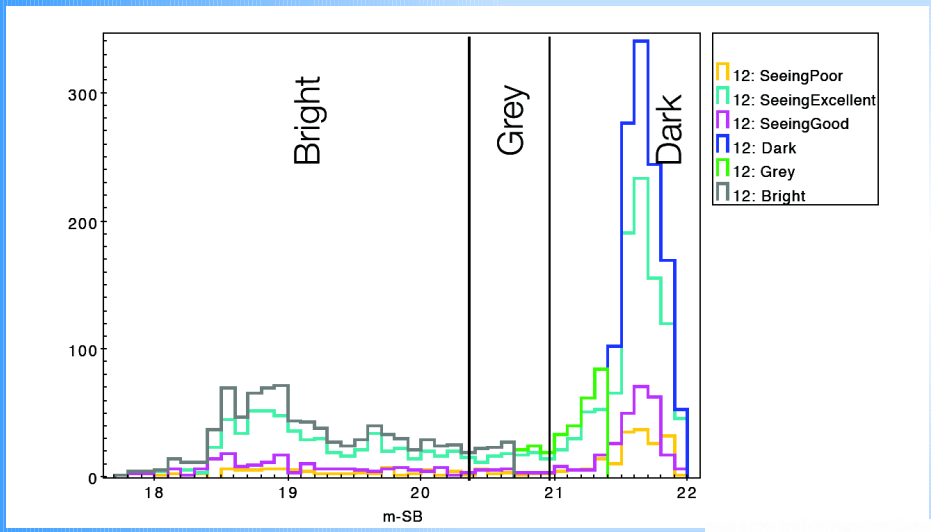
- OpR3b: Three weeks of survey data were simulated,
  - including data flow
  - Configure tool
  - Analise spectra
  - Check physical parameters pipelines

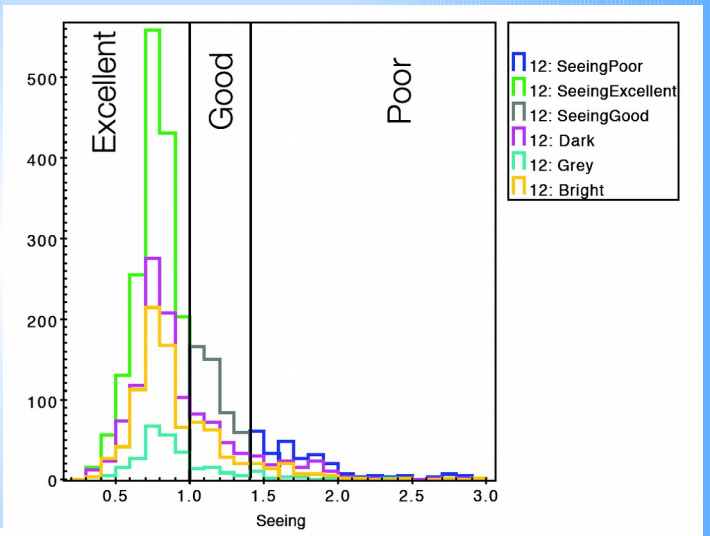


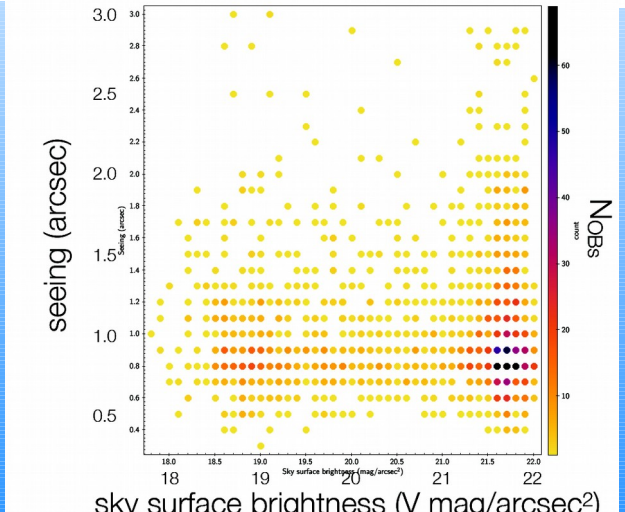



# OpR3

- OpR3c: 18 months of scheduling
  - Historical weather patterns
  - OB submission every trimester



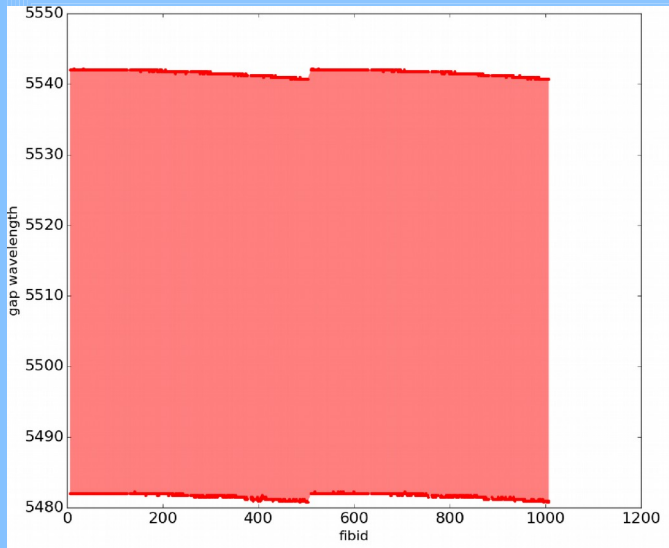



# Survey verification

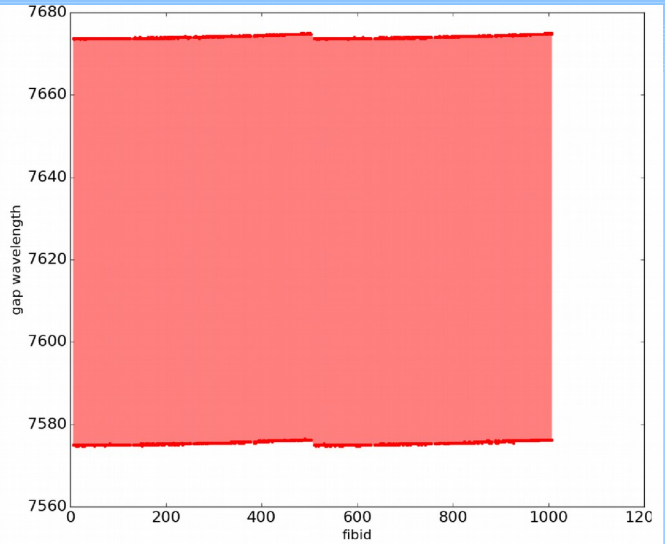
- Open call in August 2019
- 70-30% between survey-PI time
- Proposals being reviewed

# Resolution

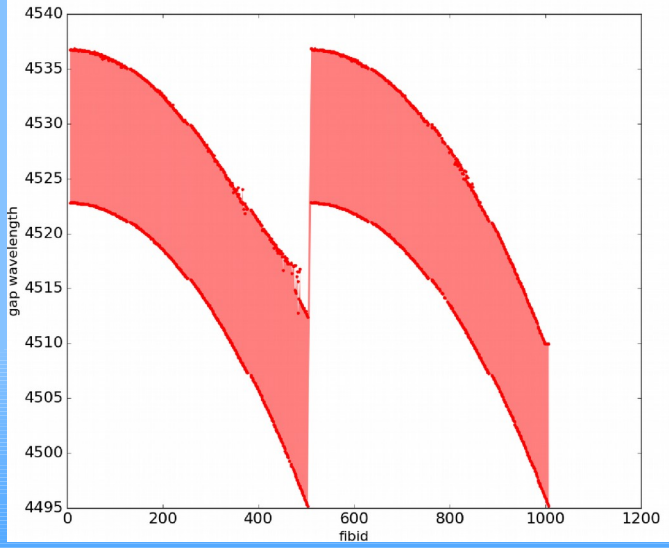
LR blue




LR red




HR blue




HR red