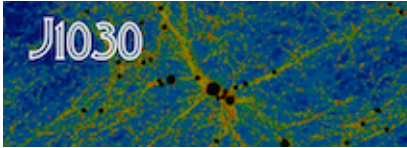


The J1030 deep survey: an INAF legacy field for early BH and structure formation

R. Gilli (OAS)
on behalf of the J1030 collaboration



Team



31 members : 14 INAF, 9 assoc., 8 international

2021-2023: ~3 FTE/yr (2 INAF + 1 Assoc)

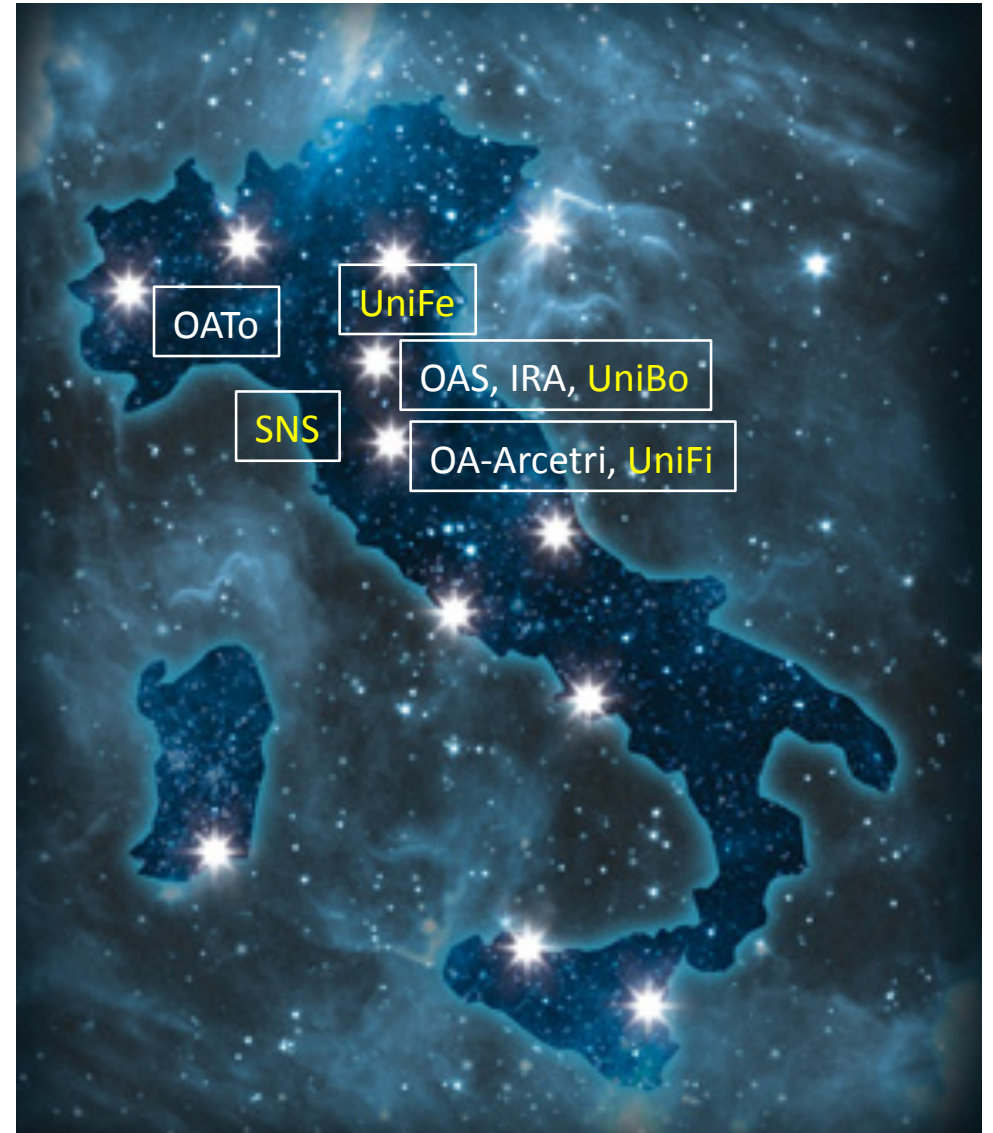
INAF		Assoc.	
OAS	IRA	UniBo	SNS
Gilli *	Prandoni	Vignali	Vito
Mignoli *	Liuzzo	Brusa	
Marchesi *	Massardi	Brienza	UniFe
Decarli *		D'Amato *	Rosati
Comastri	OA-Arcetri	UniFi	
Vanzella	Tozzi	Risaliti	OAS
Calura		Signorini *	Zamorani
Lanzuisi	OATo		
Cucciati	Balmaverde		

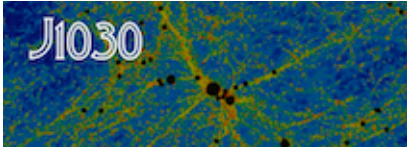
PhD/Postdoc

* 0.2-0.7 FTE/yr

International collaborators at

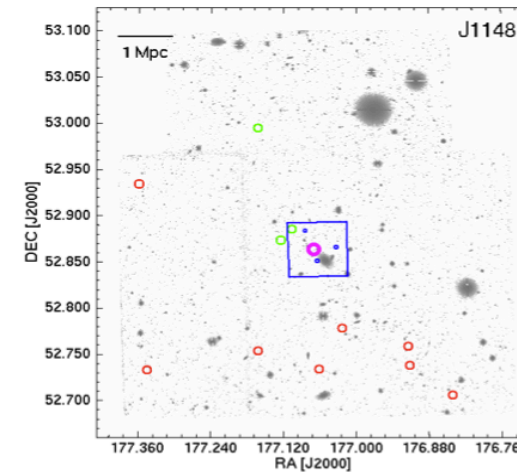
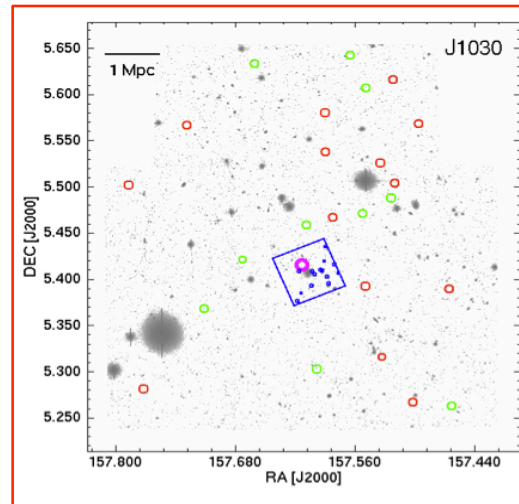
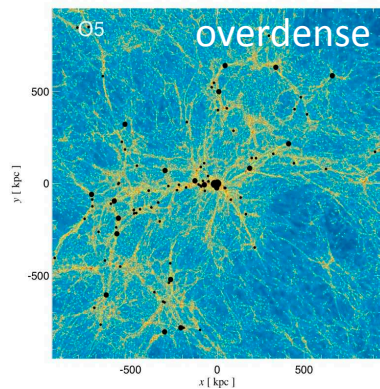
STSci, JHU, U Miami, U Barcelona, U Leiden



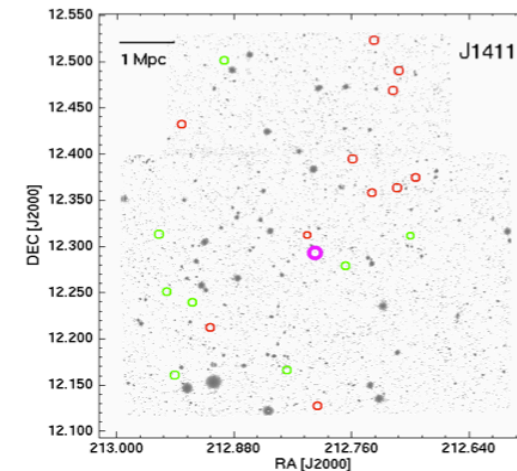
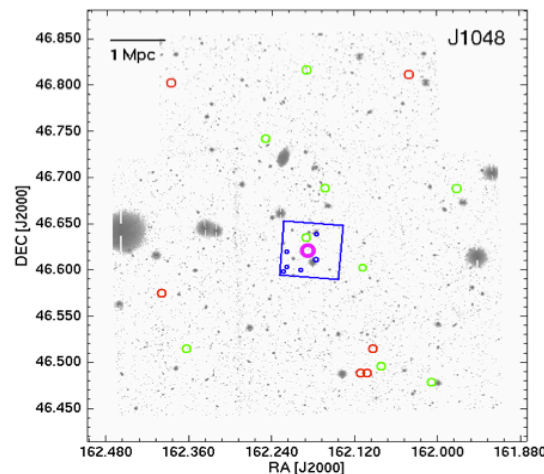
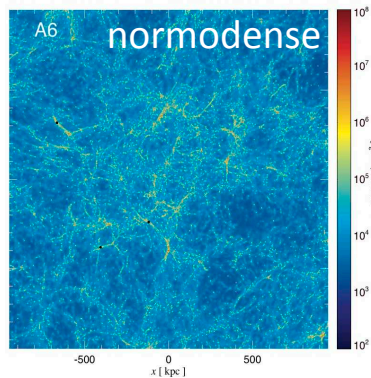


Initial project rationale

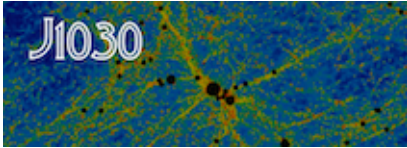
How, **where**, when the first SMBH formed? Program started with LBT/LBC observations of four QSOs at $z \sim 6$: J1030 was the most overdense



Morselli+14

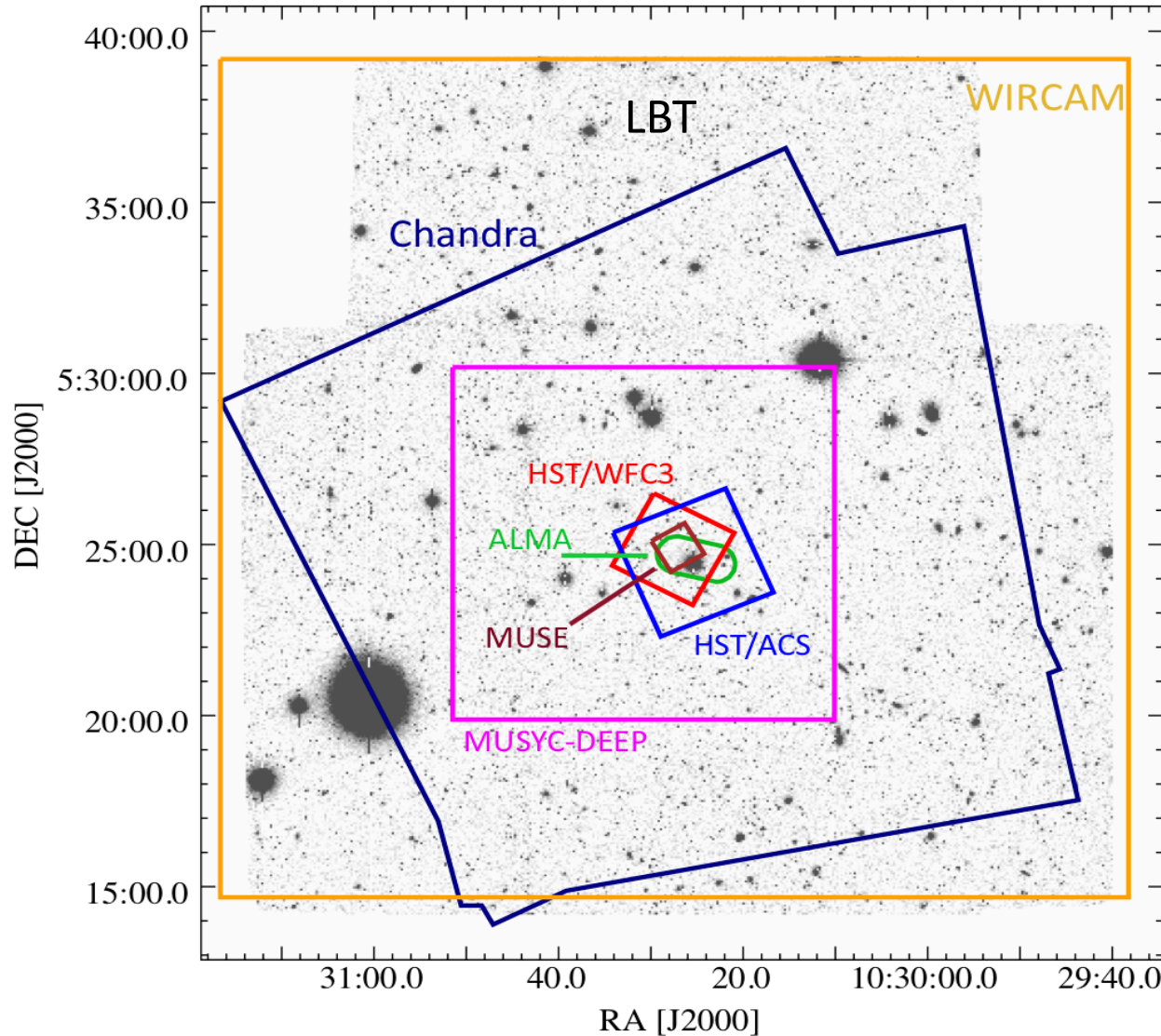


overdensities elusive
(e.g. Mazzucchelli+17)

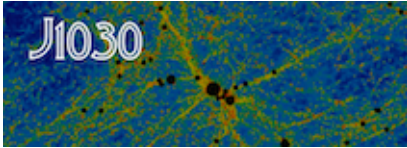


The J1030 field

INAF PI-ship

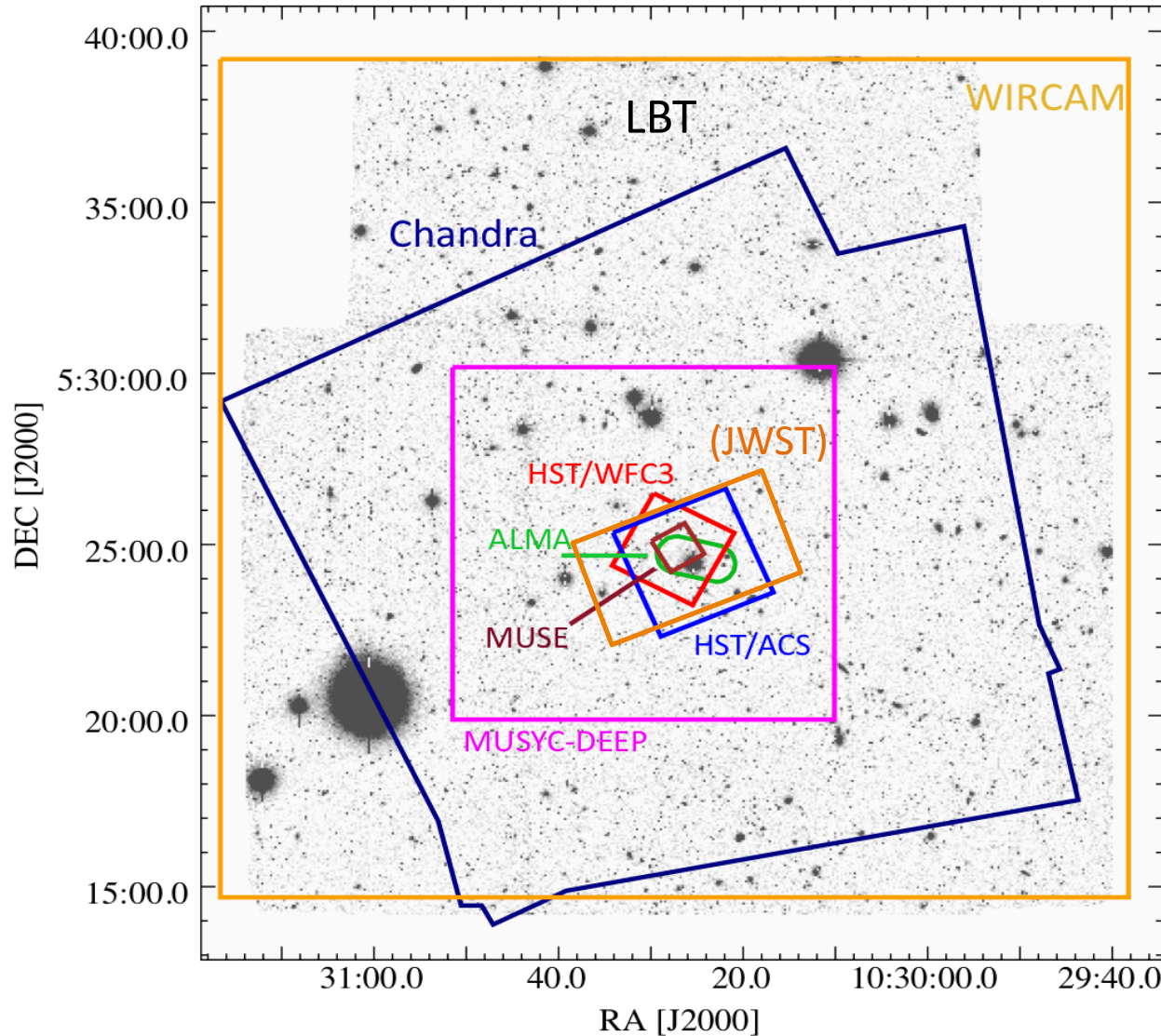


- Dense multi- λ coverage:
LOFAR, VLA, JVLA, ALMA, Herschel, Spitzer, MUSYC, CFHT, LBT (LBC,MODS,LUCI,SOUL), HST, VLT (MUSE,FORS2), XMM, Chandra
- Equatorial field
- Bright star in the center allows AO observations

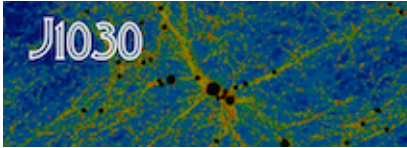


The J1030 field

INAF PI-ship



- Dense multi- λ coverage:
LOFAR, VLA, JVLA, ALMA, Herschel, Spitzer, MUSYC, CFHT, LBT (LBC,MODS,LUCI,SOUL), HST, VLT (MUSE,FORS2), XMM, Chandra
- Equatorial field
- Bright star in the center allows AO observations
- JWST GTO (NIRCam)

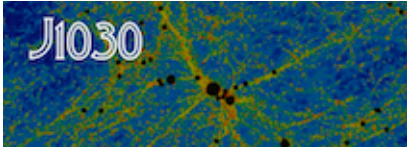


Website and repository



Project summary,
high-level data products (images, catalogs, spectra)
publications available here:

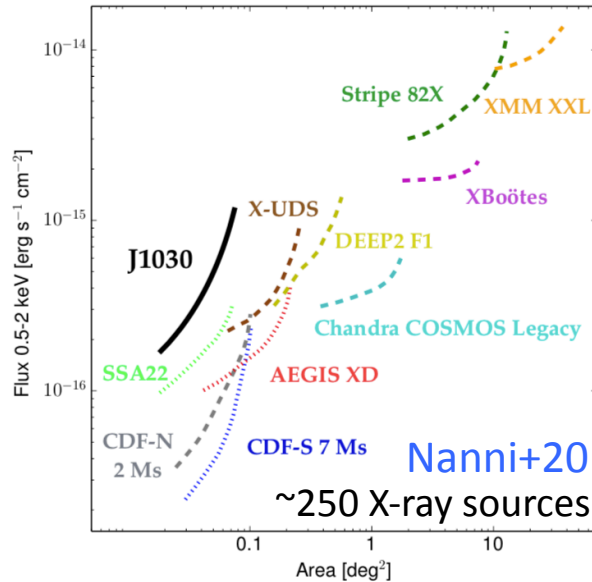
<http://j1030-field.oas.inaf.it/>



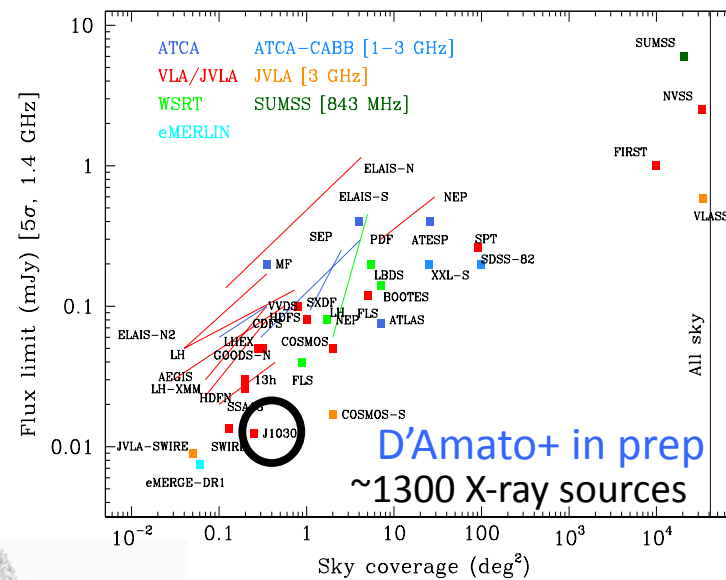
Main INAF observing programs in J1030



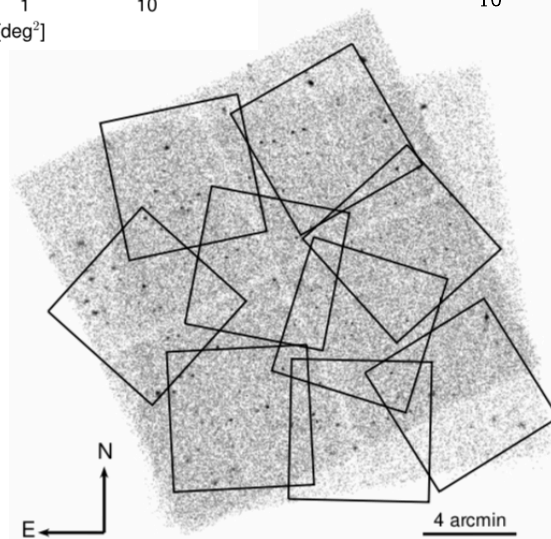
2017: Chandra LP, 500ks (139hrs)



2018: JVLA, 40hrs, PI Prandoni

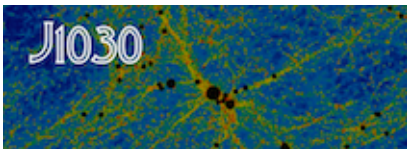


J1030 is among the 4-5 deepest extragalactic fields in both X-ray and radio



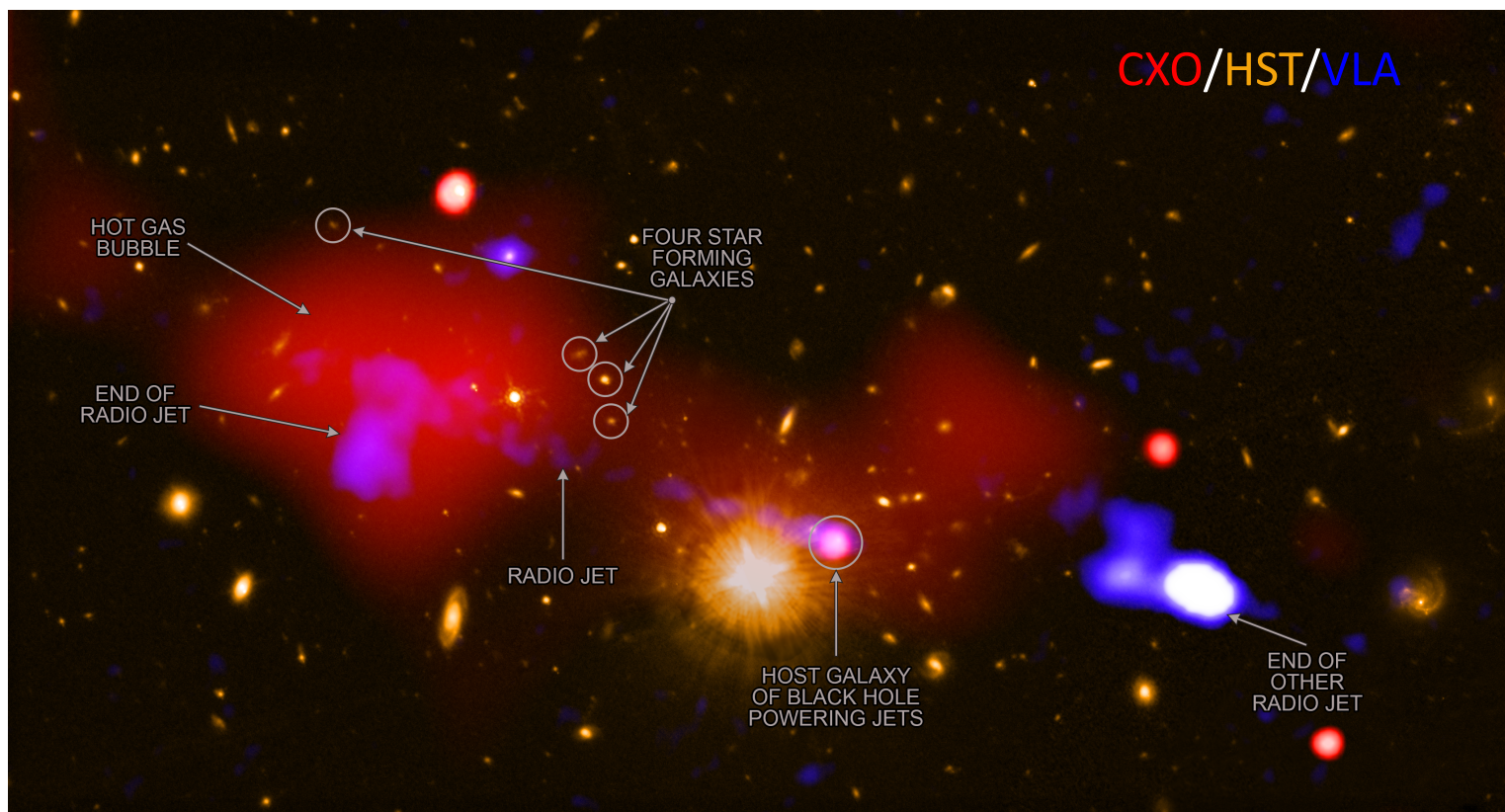
2018/2019: LBT, 52hrs (MODS/LUCI)
strategic program to follow-up Chandra sources (120 z-spec measured)

Marchesi+21, ~submitted



Some results

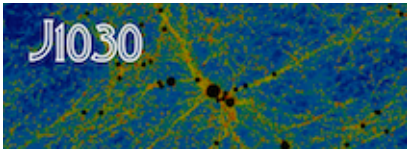
Discovery of a protocluster around an FRII radio-galaxy at $z=1.7$



NASA/Chandra PR, Nov 2019

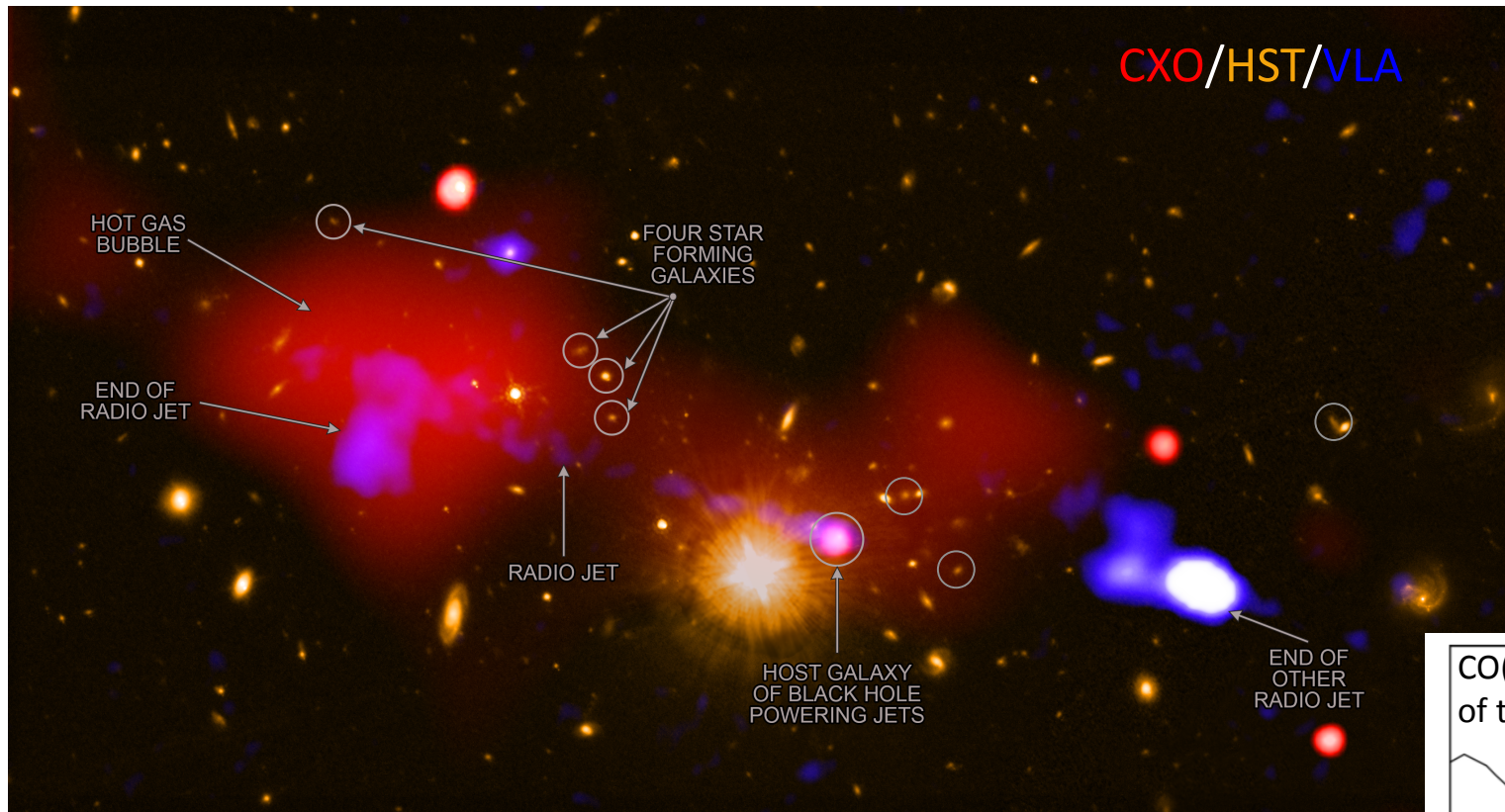
first evidence of positive AGN feedback on
multiple galaxies on hundreds of kpc scales

Gilli+19



Some results

Discovery of a protocluster around an FRII radio-galaxy at $z=1.7$



ALMA
D'Amato+20

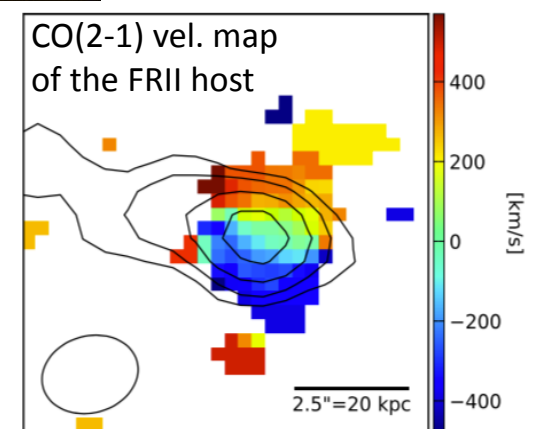
progenitor of a
 $>10^{14} M_{\text{sun}}$ cluster

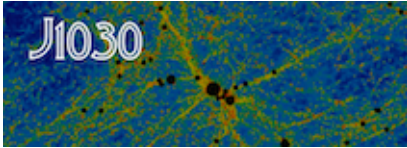
FRII is proto-BCG

NASA/Chandra PR, Nov 2019

first evidence of positive AGN feedback on
multiple galaxies on hundreds of kpc scales

Gilli+19



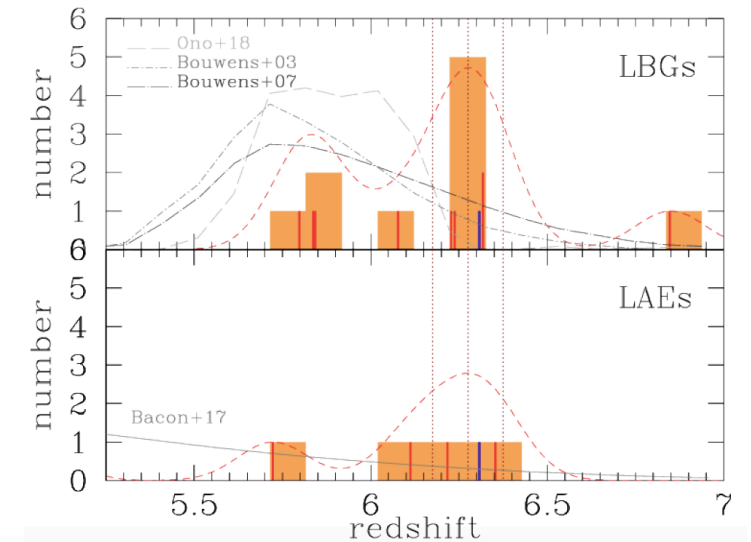
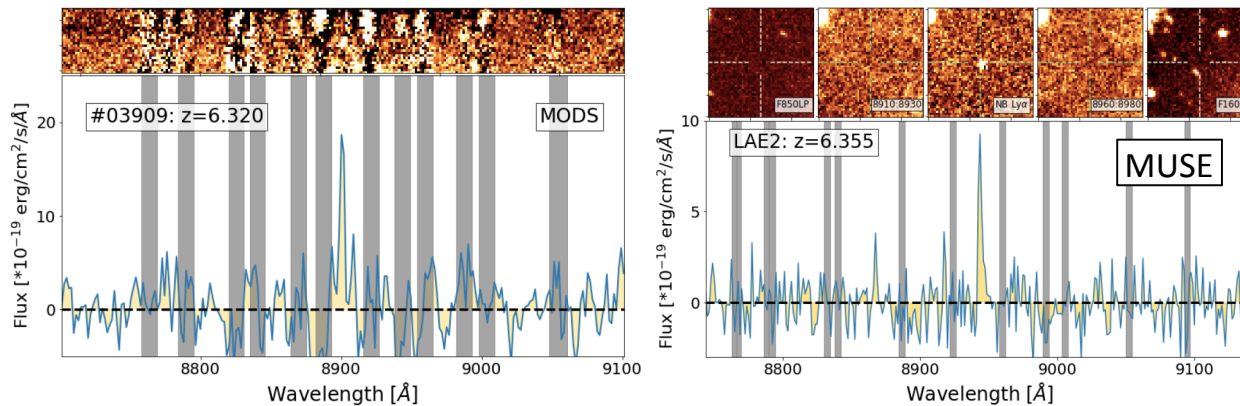


Some results

Overdensity around the $z=6.3$ QSO: the web of the giant

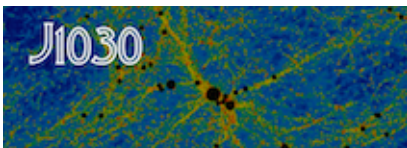
Mignoli+20

6 obj with $z_{\text{spec}} \sim 6.3$ (MUSE, FORS2, MODS, DEIMOS)



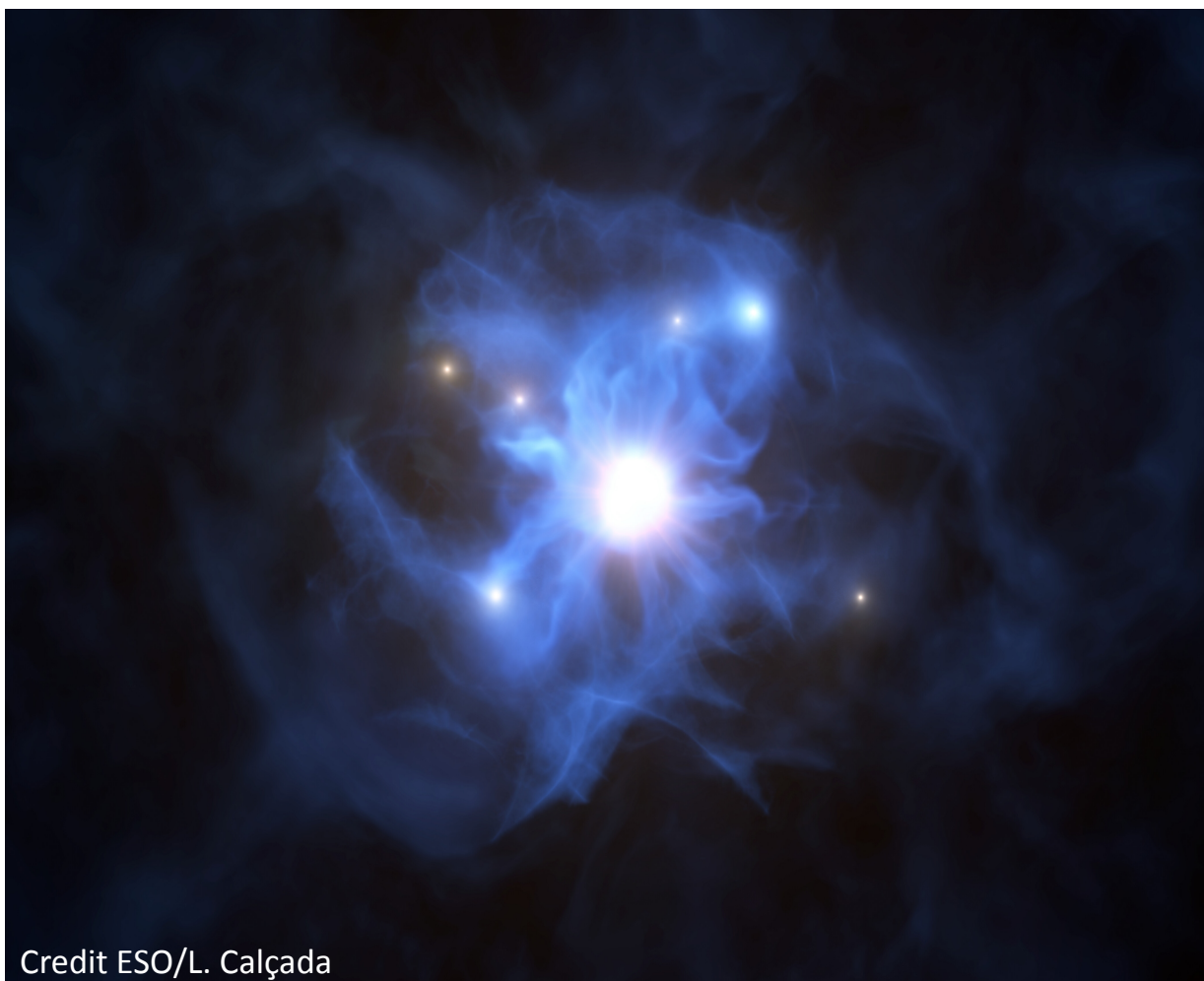
$\delta > 1.5-2$ over $\sim 780 \text{ pMpc}^3$,
significance $> 3.5\sigma$, $M_{\text{halo}} > 10^{12} M_{\text{sun}}$

first spectroscopic confirmation of a galaxy
overdensity around a SMBH at cosmic dawn



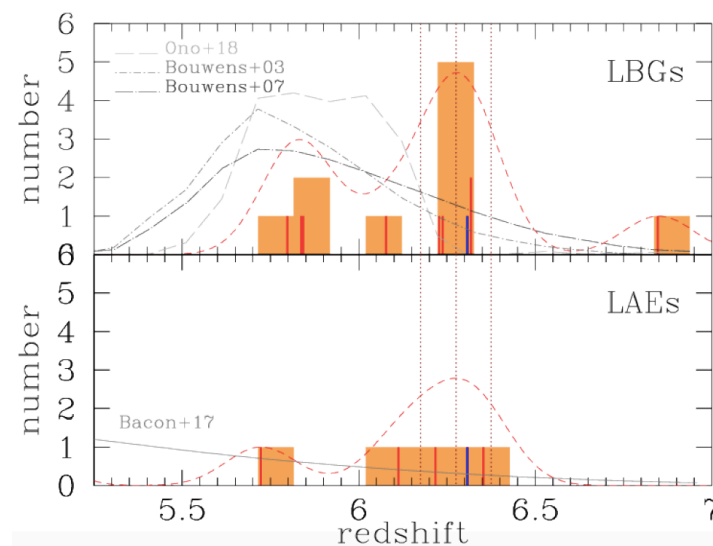
Some results

Overdensity around the $z=6.3$ QSO: the web of the giant

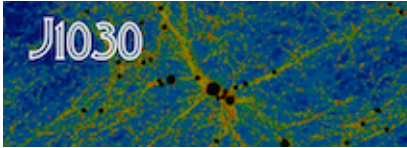


Credit ESO/L. Calçada

Mignoli+20



ESO (and LBTO) PR, Oct 2020
 significant press coverage,
 including NYT



Papers and forthcoming results



9 papers published since project start (all led by INAF or assoc.): 8 since 2017

In 2020, 3 papers published

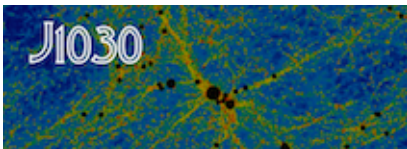
In 2021 : 1 published, Peca+21, X-ray redshifts for obscured AGN

1 submitted to A&A, Marchesi+21, redshift identification of X-ray sources (z-spec and z-phot)

2 in prep. D'Amato+21, JVL A catalog, QSO detection, ...

Brienza+21, LOFAR results on $z=1.7$ FR II/protocluster:
radio spectral index map,
evidence for IC/CMB emission

2021-2023 : 3 FTE/yr \rightarrow current rate is 1 paper/FTE/yr



Planning

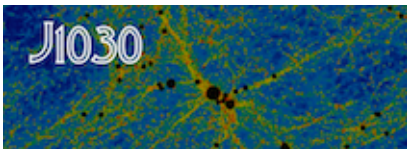


Intensive multi- λ proposal submission activity

Jan-May 2021

21 proposals submitted: 2 accepted - GMRT (PI M. Brienza)
- NOEMA (PI R. Decarli)
17 pending - 1 CFHT (through Opticon)
- 1 Gemini
- 3 ESO/VLT
- 1 HST
- 1 Chandra VLP
- 5 ALMA
- 3 LBT
1 DDT rejected - ESO
1 DDT accepted but not executed - LBT

ALL proposals led by INAF PIs



Specific goals

#1 - $z=6.3$ QSO and LSS

- increase significance and determine overdensity profile, LSS mass : find additional members, determine their spatial distribution and LF, find other SMBHs in the LSS
- compare with results in blank sky fields
- study of the $z=6.3$ SMBH/host system

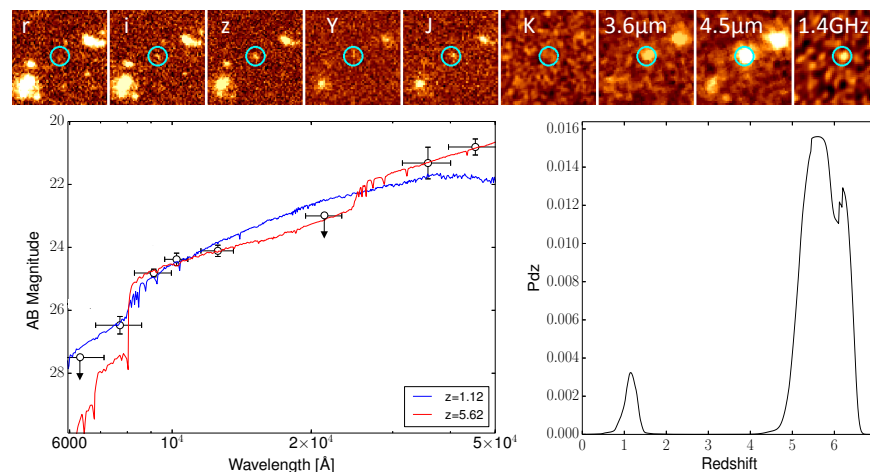
#2 - $z=1.7$ FR II and protocluster

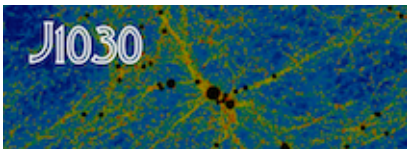
- track the whole LSS extension, find additional members, measure total mass, fate, ...
- confirm positive feedback, understand its physics and SMBH role in cluster formation

#3 - AGN survey science

- discover hidden SMBHs at high- z
- probe evolution of obscuration

J1030 features a few excellent obscured QSO candidates at $z > 5$





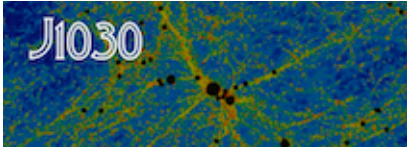
Broader goals



1) Make J1030 an INAF deep field (the only in a highly-biased field)

Steps needed:

- Increase awareness/involvement of other INAF structures (outstanding INAF expertise in multi- λ deep surveys)
- Reach depth and multi- λ coverage equal to deepest blank sky surveys (CANDELS fields), e.g.:
 - HST mosaic (proposed) \rightarrow mandatory to make it a legacy field
 - 3Ms Chandra VLP (proposed: ranked very high last Cycle, would make it 2° deepest field after 7Ms CDFS)
 - Get redshifts: besides computing photo-z, J1030 is an excellent target field for MOONS



Broader goals



2) Stimulate research and enhance INAF competitiveness on early SMBH and LSS science

J1030 research lines have tight connections with other INAF programs/projects
e.g. [schede INAF: z6qso](#), [XQR-30](#), [Hyperion](#), [Spiderweb](#), [SKA_Galev](#), [Blackout](#), ...

Ex. 1: build on current INAF privileged position on X-ray protocluster probes

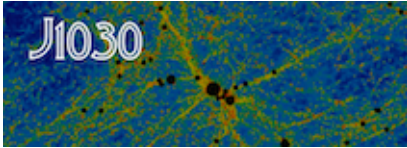
J1030 and Spiderweb largest Chandra programs with INAF PI and the two deepest X-ray obs. of protoclusters worldwide. Unique look at AGN feedback, triggering, ICM physics, ...

Ex. 2: exploit full LBT potential

LBT/LBC is likely the best tel/inst combination worldwide to target overdensities around early QSOs (e.g. binocular mode makes it 2x faster than Subaru/HSC)
≥5 such proposals submitted by different INAF groups at the 2021 LBT call: devise large programs, e.g. competitive with existing Subaru/ALMA programs

Ex. 3: connect with theory groups within INAF

devise simulations tailored to observed LSS features (large volumes, positive feedback, ...)



Funding & critical issues



INAF and ASI main source of funding since project start, mostly for personnel and travels (tot ~ 250k€, residual ~10-15k€)

Formerly funded positions

1yr Postdoc (B. Balmaverde, now staff OATo)

1yr AdR (A. Peca, now PhD U. Miami)

1 PhD (R. Nanni, now postdoc U. Leiden)

Currently funded positions

1 PhD (Q. D'Amato, UniBo/IRA – **end in Dec 2021**)

2yrs Postdoc (S. Marchesi, OAS – **end in May 2021**)

1 PhD (M. Signorini, UniFi – end 2023)

NEED CONTINUITY

Funding opportunities

PRIN-MUR-2020 (pending, PI Decarli)

Collaboration with Universities (UniBo, UniFi, UniFe)