PARTECIPAZIONE ITALIANA ALLA FASE B2/C
DELLA MISSIONE ARIEL

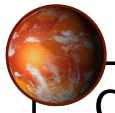
The Atmospheric Remote-Sensing Infrared Exoplanet Large-survey

2° Science Ariel-It meeting
G. Micela
25-27 May 2022

Ariel

Atmospheric Remote-sensing Infrared Exoplanet Large-survey

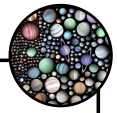
- M4 ESA mission (adopted Autumn 2020– Launch 2029 in L2 with CI)
- 1-m telescope, photometry+ spectroscopy from VIS to IR Simultaneous coverage 0.5-7.8 micron (R =1 to 300)
- Payload consortium: 16 ESA countries + NASA and JAXA
- Atmospheres of ~1000 exoplanets (rocky + gaseous; 300-3000K; stars A-M), mainly transits and eclipse



Individual planet

Chemical composition
Atmospheric circulation + cloud pattern
Equilibrium or non-equilibrium chemistry?
Impact with stellar environment
Coupling interior-atmosphere
Impact of stellar environment & system history

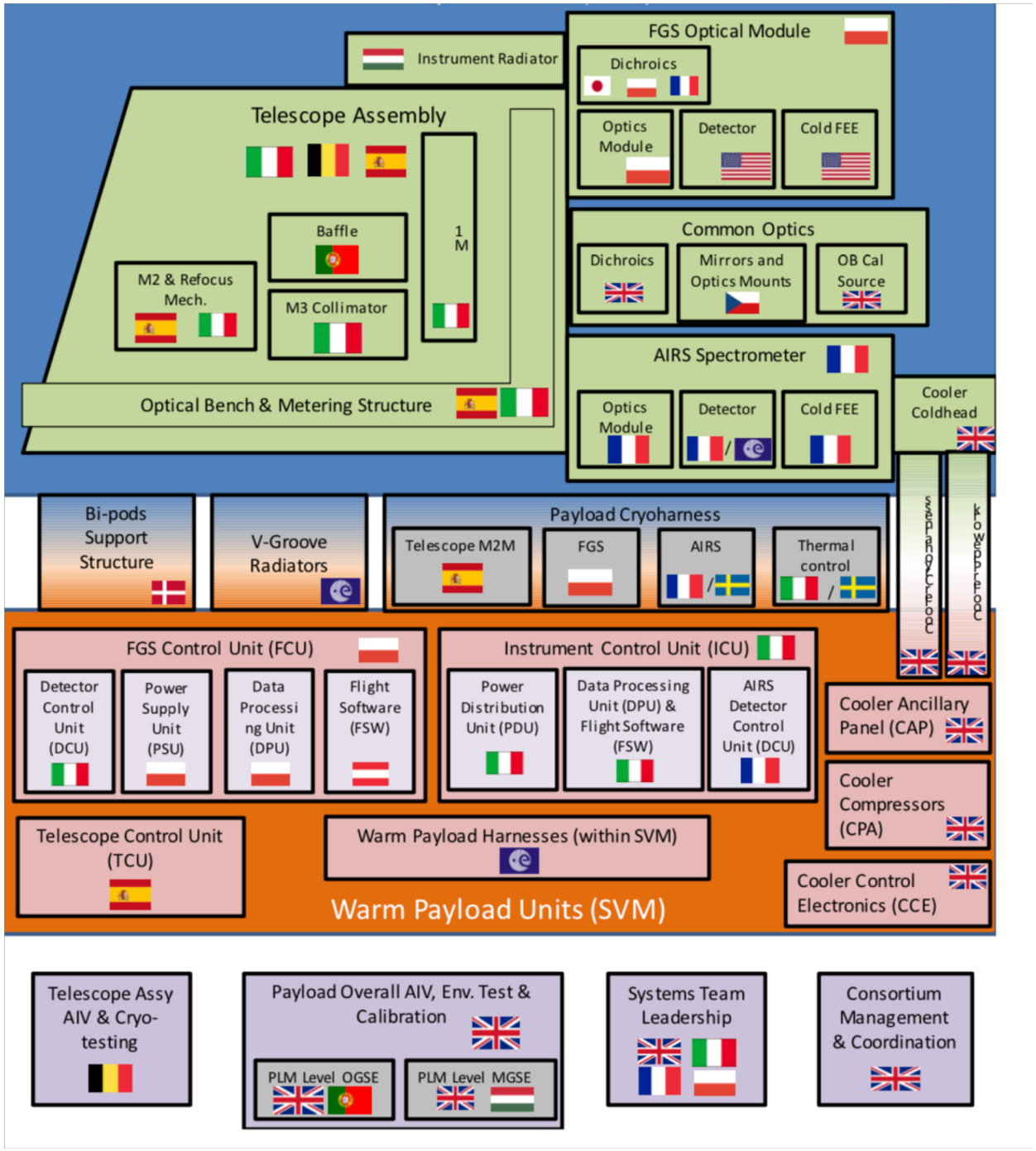
Large population of diverse planets



Chemical diversity
Correlation clouds–temperature-stellar-type
How fast atmospheres change through time?
Correlation elemental composition planet provenance
Coupling atmosphere-interior through time
Transition between terrestrial planets and sub-Neptunes

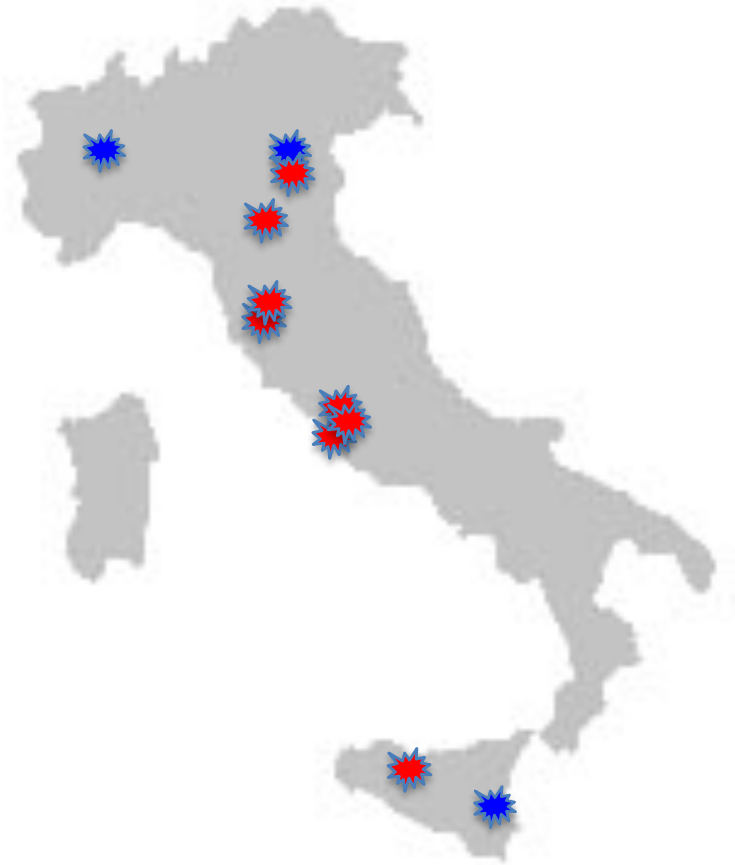
Ariel Payload architecture and responsibilities

(from the Ariel redbook)



The Italian players

- ASI
- INAF
- Università di Firenze
- Università La Sapienza
- CNR-IFN UOS Padova
- SSDC/ASI



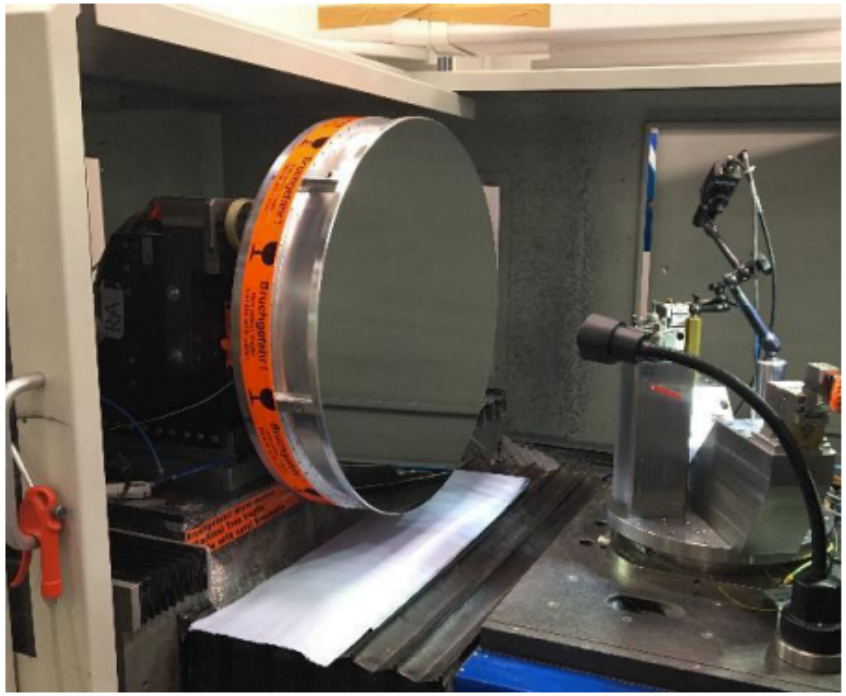
Macroactivities

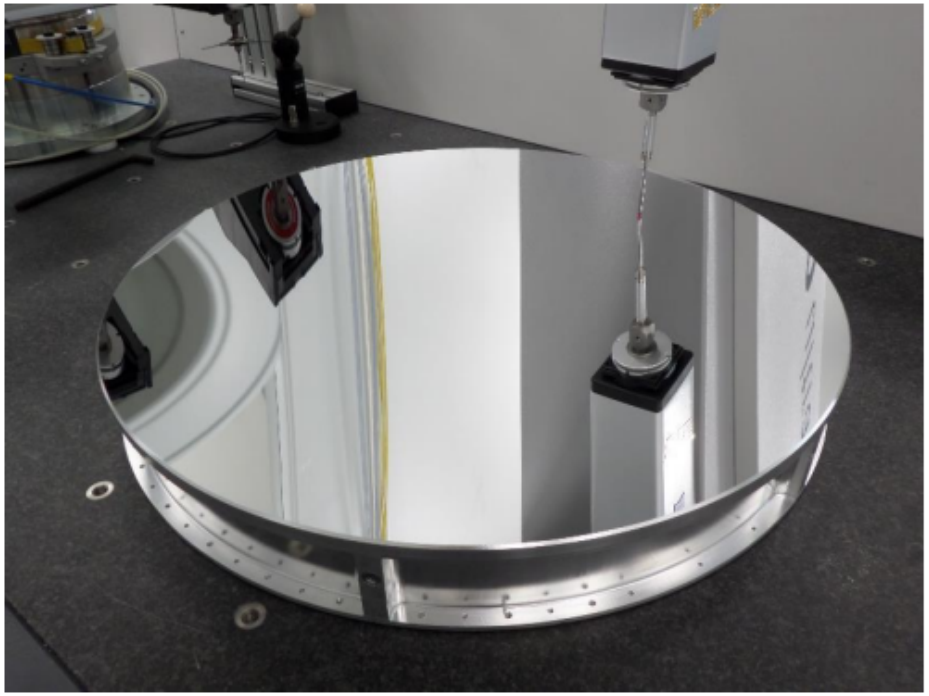
- Management activities;
- Science Preparation;
- PLM performance evaluation and simulations;
- Coordination of on-board electronics
  - *Instrument Control Unit*
  - *FGS Detector Control Unit*
  - *On-board Application Software*
- Coordination of the Telescope Assembly:
  - *Mirrors + mountings*
  - *Metering Structure*
  - *Optical Bench*
- Requirements of the thermal architecture of the PLM and interfaces with the SVM
- Participation to the architecture design and requirement definition of the Science Ground Segment
  - *Responsibility of IOSDC*
  - *Collaboration with SSDC*

Tecnological activities

- Industrial contracts managed directly by ASI
  - TA : Leonardo /Medialario
  - ICU: Kayser
  - DCU (FGS): OHB
- Scientific institutes (INAF, UniFi, UniRoma1, CNR/IFN) guarantee the compliance with the requirements and are the interface to the Consortium and ESA.

The breadboard of the primary mirror



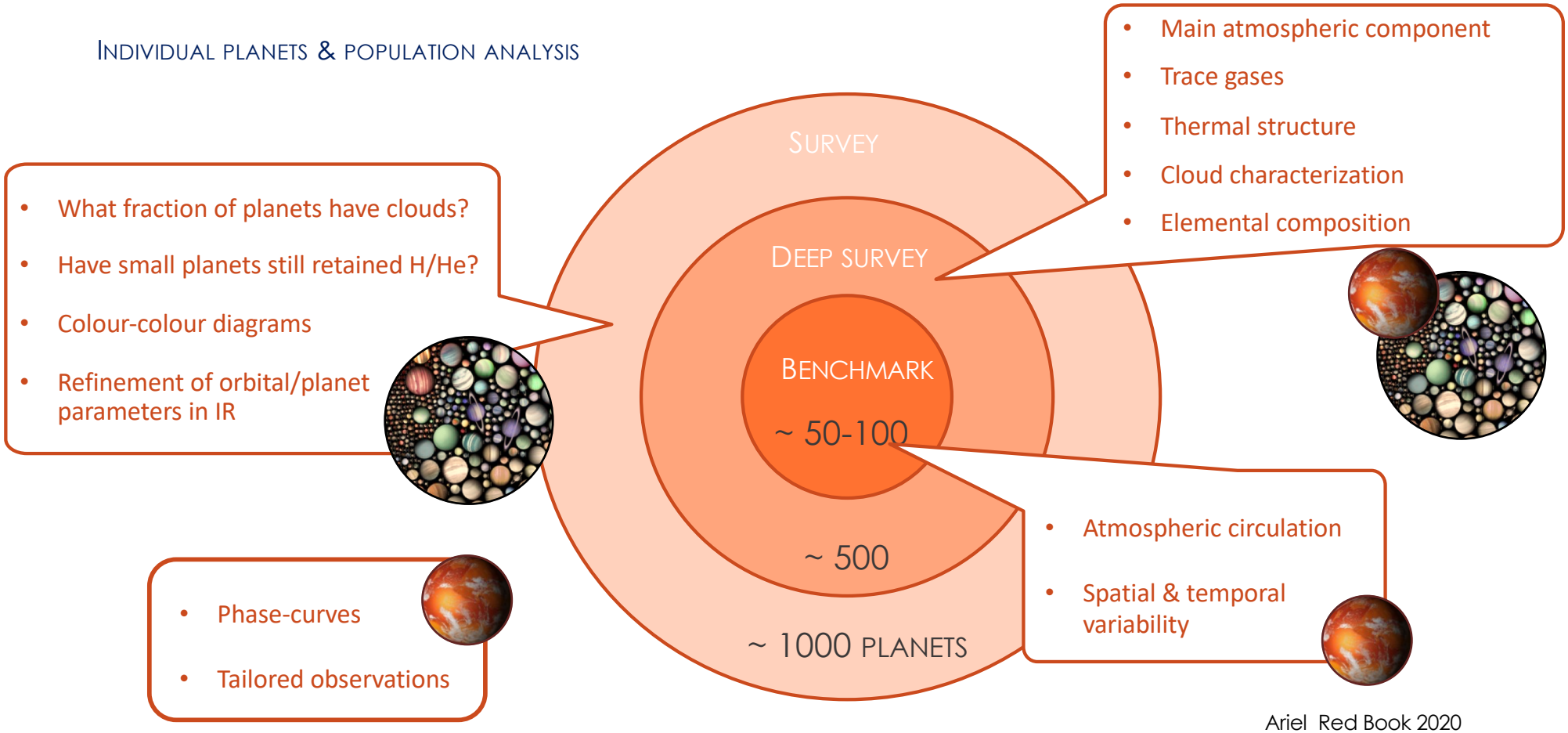


The consortium: After the adoption a more formalized approach

- *Membership form to be filled*
- *Committment in contributing to Ariel*
  - *Full members*
  - *Supporting members (< 2 years)*
  - *Affiliated*
- *~500 members - >110 from Italy*

- *Application to science WG membership*
- *Regular meeting of science WG coordinators*

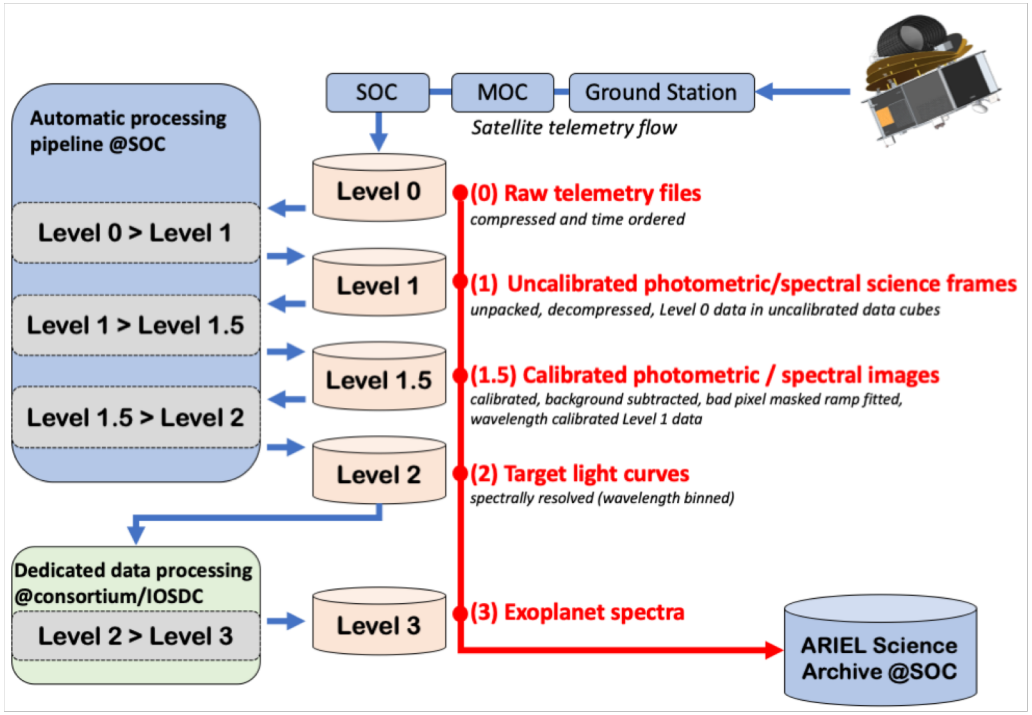
Ariel 4-Tier approach



Ariel Red Book 2020

Data processing and release

A VERY OPEN APPROACH



Science Demonstration Phase

Data will be released immediately after processing, consolidation and quality control up to Level 2 products.

Nominal Science Operations Phase

- **Tier 1** data public immediately after quality control is completed;
- **Tier 2** data public 6 months after quality control is completed;
- **Tier 3** data public 6 months after quality control is completed;
- **Tier 4** data public 1 year after quality control is completed.

Complementary Science data

- 5%-10% time available for other science, allocated through ESA calls
- Proprietary to the proposers for 6 months

Ariel Dry Run in 2025

GETTING READY FOR 2029….

- Consortium and ESA science teams will work as if Ariel were launched in 2025
- Target selection, observational strategies, scheduling, interaction with the external community will be done as if Ariel were launched in 2025
- A great opportunity to prepare for the real launch in 2029! We will learn from mistakes about how to improve our approach
- Precise timeline to be discussed with ESA team and payload team
- Input from community e.g. through web tools, Ariel open conference…
- An Ariel “Blue Book” (colour TBC) will be prepared.
- We will have Ariel Special Issue, published e.g. in new MNRAS journal about instruments and data

An incomplete list of Ariel scientific activities in Italy

- Contribution to the observing plan
  - Stellar fundamental parameters
  - Stellar activity
  - Planetary mass measurements
- Contribution to data analysis development
  - Stellar activity deconvolution
  - Atmospheric modelling
  - Simulators
  - Participation to Exoclock
- Ariel scientific exploitation
  - Signatures of planetary formation
  - SPI diagnostics
  - TTVs
- Synergies with other instruments

Science WGs and Italian members

1	Albedo and reflected light	**7**
2	Atmospheric chemistry	**18**
3	Computational statistics and machine learning	**15**
4	Connection planet interior-atmospheres	**6**
5	**Data analysis techniques**	**22**
6	Ephemerides	**5**
7	**High-cadence photometry**	**5**
8	**Mass measurement**	**5**
9	Phase-curves	**7**
10	**Planet formation**	**24**
11	Prebiotic chemistry and astrobiology	**12**
12	Spectral retrieval	**12**
13	Spectroscopic database	**8**
14	**Stellar activity**	**18**
15	**Stellar characterisation**	**20**
16	Synergy with ELT and ground-based observations	**12**
17	Synergy with JWST	**3**
18	**Synergy with Plato and Cheops**	**6**
19	Synergy with Solar System science	**5**
20	Synergy with TESS	**4**
21	**Upper atmosphere/star-planet interaction**	**10**
22	Complementary science (BD, YSO, Solar System etc.)	**12**
23	Outreach and citizen-science activities	**18**

Several papers in the last year

- Bruno G., Lewis N.K., Valenti J.A., Pagano I., Wilson T.J., Schlawin E., Lothringer J., Lanza A. F., Fraine J., Scandariato G., Micela G., Cracchiolo G., Hiding in plain sight: observing planet-starspot crossings with the James Webb Space Telescope, 2022, MNRAS, 509, 5030-5045
- Carleo I., Desidera S., Nardiello D. et al., The GAPS Programme at TNG. XXVIII. A pair of hot-Neptunes orbiting the young star TOI-942, 2021, A&A 645, A71
- Charnay B., Medonca J.M., Kreidberg L., et al. A survey of exoplanet phase curves with Ariel, 2021, ExpAstr, in press
- Cracchiolo G., Micela G., Morello G., Peres G., Correcting the effect of stellar spots on ARIEL transmission spectra - II. The limb-darkening effect, 2021, MNRAS, 507, 6118-6131
- Encrenaz T, Coustenis A., Gilli G. et al. Observability of temperate exoplanets with Ariel, 2021, ExpAstr, in press
- Guilluy G., Gressier A., Writght S. et al. ARES IV: Probing the Atmospheres of the Two Warm Small Planets HD 106315c and HD 3167c with the HST/WFC3 Camera, 2021, AJ, 161, 19
- Kokori A., Tsiaras, Edwards B. et al. ExoClock Project: An open platform for monitoring the ephemerides of Ariel targets with contributions from the public, 2021 ExpAstr, in press
- Kokori, A., Tsiaras A., Edward B., et al. ExoClock project II: A large-scale integrated study with 180 updated exoplanet ephemeride, 2022, ApJS, 258, 40
- Locci D., Petralia A., Micela G., Maggio A., Ciaravella A., Cecchi-Pestellini C., Extreme-ultraviolet- and X-Ray-driven Photochemistry of Gaseous Exoplanets, 2022, PSJ, 3,1

Several papers in the last year

- Maggio A., Locci D., Pillitteri I., et al.,New Constraints on the Future Evaporation of the Young Exoplanets in the V1298 Tau System, 2022, ApJ, 925, 172
- Maldonado J., Petralia A., Damasso M., et al..,HADES RV programme with HARPS-N at TNG. XIV. A candidate super-Earth orbiting the M-dwarf GJ 9689 with a period close to half the stellar rotation period, 2021, A&A, 651, A93
- Morello G., Casasayas-Barris N., Orell-Miquel J., Pallé E., Cracchiolo G., Micela G.,The strange case of Na I in the atmosphere of HD 209458 b. Reconciling low- and high-resolution spectroscopic observations, 2022, A&A, 657, 97
- Mugnai L. V., Al-Refaie A., Bocchieri A., Changeat Q., Pascale E., Tinetti G.,Alfnoor: Assessing the Information Content of Ariel's Low-resolution Spectra with Planetary Population Studies, 2021, AJ, 162, 288
- Mugnai, Lorenzo V., Modirrousta-Galian D., Edwards B. et al. ARES V: No Evidence For Molecular Absorption in the HST WFC3 Spectrum of GJ 1132 b. 2021, AJ, 161, 284
- Suarez Mascareno A., Damasso M., Lodieu N. et al., Rapid contraction of giant planets orbiting the 20-million-year-old star V1298 Tau, 2021, Nature Astronomy, Advanced Online Publication
- Szabó G. M., Kalman S., Pribulla T. et al. High-precision photometry with Ariel, 2021, ExpAstr, in press
- Wolkenberg P., Turrini D., Effect of clouds on emission spectra for super Venus, Astrophysics and Space Science, 2022, 367, 15

Next steps

- Continue to participate to the activities of the science WGs of interest
- Preparation of science talks for the October Consortium meeting in Bologna *(10-12 Oct –TBC)*
- Plan our contribution to the Dry Run
- Send to me your papers/presentations relevant to Ariel

- Main goal of this meeting: **Increase collaborations, synergy and visibility of the italian contribution**