FRONTIERE DELL'ASTROFISICA ITALIANA:

come ottimizzare il ritorno scientifico dalle grandi infrastrutture internazionali

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INAF
ISTITUTO NAZIONALE DI ASTROFISICA
NATIONAL INSTITUTE FOR ASTROPHYSICS

Parte 2:
Per introdurre la discussione

2.1 DM with CTA: the role of INAF – E. Branchini
2.2 CMB experiments & INAF – P. de Bernardis
2.3 A INAF strategy for cosmological surveys – G. Guzzo
- Euclid – G. Guzzo & SB
- SKA – I. Prandoni & SB
2.4 The need for computing infrastrucures? - SB

www.toonsup.com/hsbcartoon

CTA & DM: toward a collaborative effort

➔ INAF is playing a key role in CTA from the technological side.

- Expertise on DM ID well rooted in the Italian community at large
- LNGS AMS, Pamela and, above all, Fermi have prompted a strong interest in and originated a widespread know how
- Mostly located within INFN and Universities
- Background mostly on particle physics but with strong cosmological / astrophysical expertise acquired over the years

NOTE: INAF has the expertise for all the phenomenology/model/ theory of structure formation !!

➔ How to grow the expertise in the INAF community?

➔ Compete/collaborate with INFN/University community?

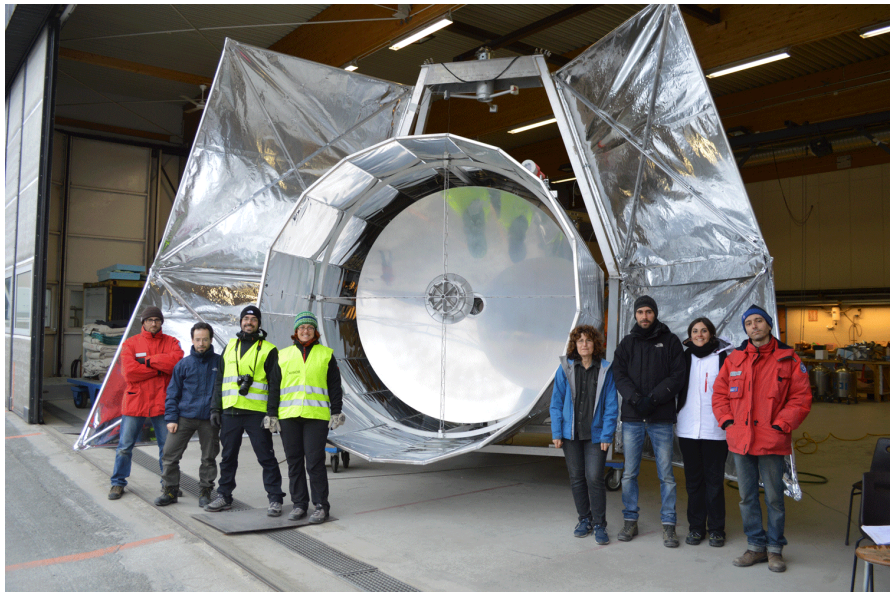
➔ Attract them under the INAF umbrella instead? How?

The future of CMB studies

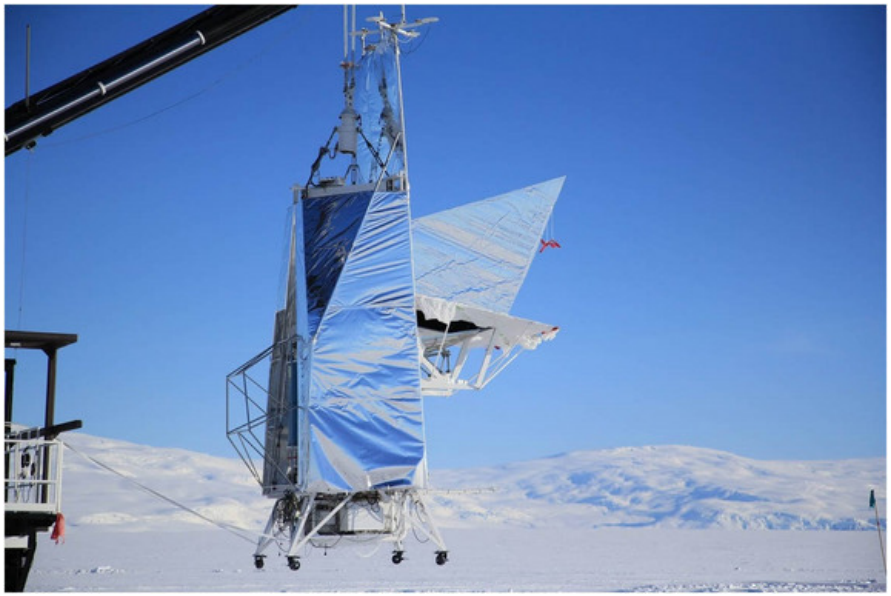
- CMB science targets, today:
  - B-modes, gaussianity, spectral distortions, to test inflation
  - Full-sky E-modes with high S/N to measure reionization history
  - E-modes and anisotropy at small scales to get N_{eff} and m_n
  - Sunyaev-Zeldovich effect to survey baryons (complement X-ray surveys at high z)
  - Lensing to survey dark matter (complement optical surveys at high z)
- Requirements for implementation
  - All of the above require extreme sensitivity AND high accuracy
  - Detector arrays for sensitivity
  - Elaborate modulation schemes for accuracy
  - Multiband to fight foregrounds – low PWV sites; several necessary bands cannot be measured with ground-based experiments, so space missions (balloons and satellites) are required.

CMB: current / forthcoming experiments

- High angular resolution (mainly SZ)
  - Large telescopes at f < 200 GHz : SPT, ACT etc.
  - Balloon-borne telescopes at f > 200 GHz (OLIMPO, PIPER, etc.)
- Medium angular resolution (mainly polarization)
  - Ground-based telescopes with large detectors arrays: Polarbear, CLASS, @ atacama
  - Ground-based bolometric interferometers: QUBIC @dome-C (http://www.qubic-experiment.org/)
  - Balloon-borne polarimeters: SPIDER, PIPER, EBEX, LSPE (see arXiv 1208.0281) ...
- Spectral distortions:
  - space-borne measurements are mandatory here. Proposals: PIXIE, PRISM, SAGACE (with OLIMPO and as approved pathfinder)



OLIMPO (see *planck.roma1.infn.it* for details)



EBEX (see *groups.physics.umn.edu/cosmology/ebex/index.html*)

CMB: forthcoming activities

- Analysis of existing data (Planck +), exploiting synergies with other cosmology observables.
- Development of future experiments
  - Enabling technologies (detector arrays, modulators, spectrometers, calibrators, space/groundbased platforms, analysis techniques) on pathfinder experiments (as EBEX, LSPE, OLIMPO,QUBIC)
  - Stage-IV
    - Array of ground based telescopes observing synergically with a total of 10^5 detectors across several atmospheric windows (< 200 GHz)
    - Exquisite sensitivity and fast mapping speed
  - Space (including balloons)
    - For large scale polarization across a much wider frequency range, and also for absolute spectrum measurements. Proposals to be approved: PIXIE (NASA), liteBIRD (JAXA), COrE+ (ESA M5)

CMB: enabling technologies in Italy

- Detector arrays: TESs (Genova + Pisa + Roma INFN), KIDs (Roma+ Grenoble), CEBs (Roma + Chalmers), Coherent & Feedhorns (Milano, Milano Bicocca, Bologna)
- Polarization modulators: HWP, VSPM, Cryogenic rotators (Roma)
- Sites: Antarctica, Atacama, Stratospheric balloon (Svalbard facility), Space (ESA proposals)
- Data analysis, Simulation, Scientific Interpretation: Planck LFI & HFI community

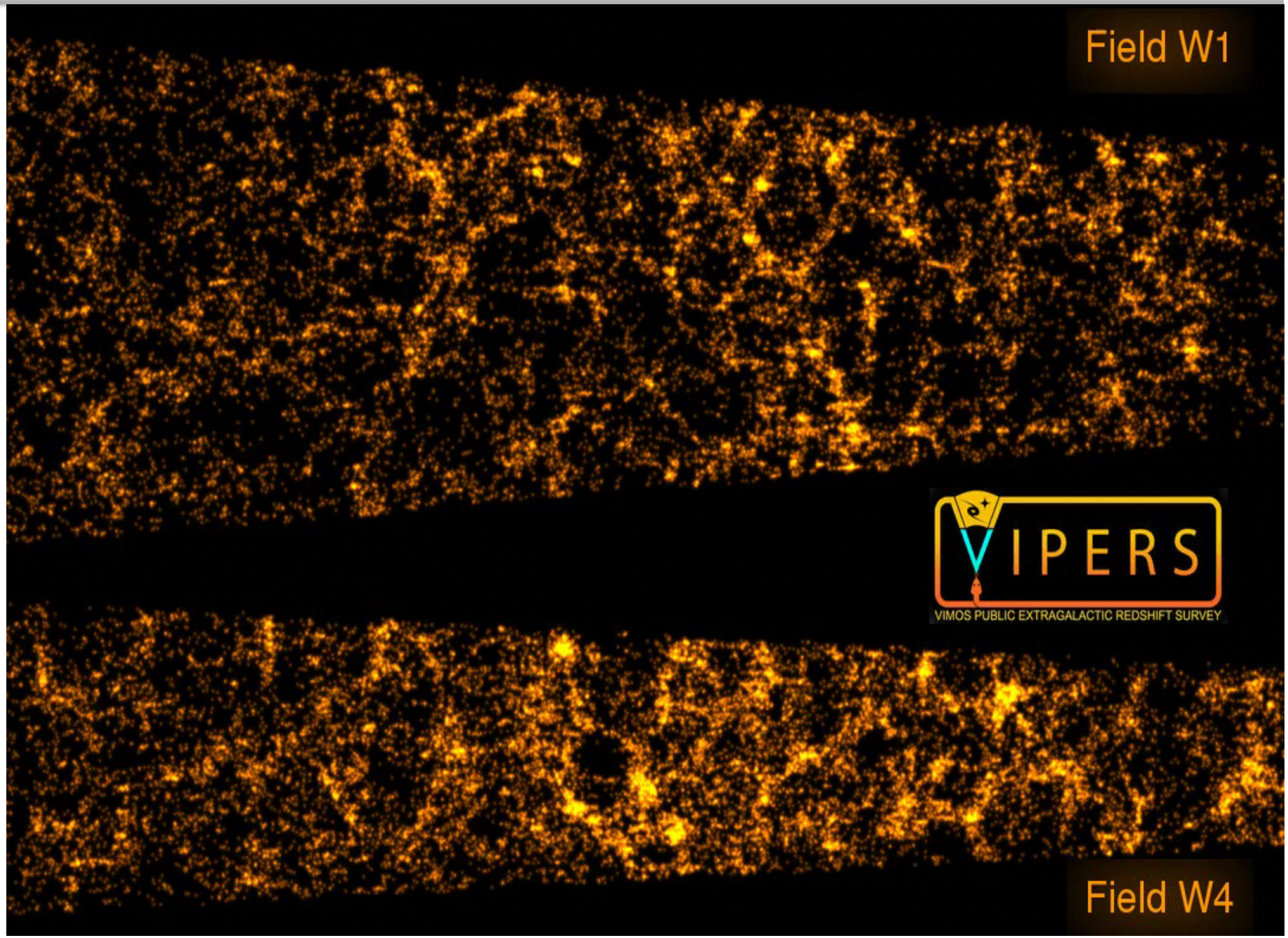
Personnel :

- Posizioni di responsabilità nei progetti Planck, LSPE, COrE+, sono state già assunte dalla comunità italiana INAF a tutti i livelli, da posizioni di PI a Project manager, a responsabilità per strumentazioni, simulazioni, analisi dati, interpretazione scientifica.

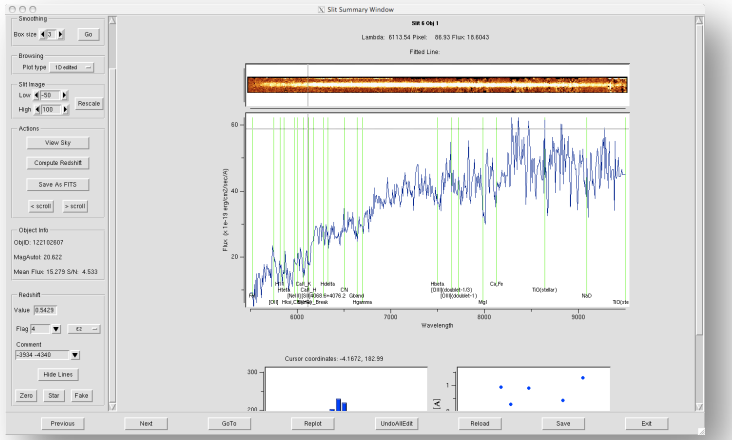
CMB: possibili strategie INAF

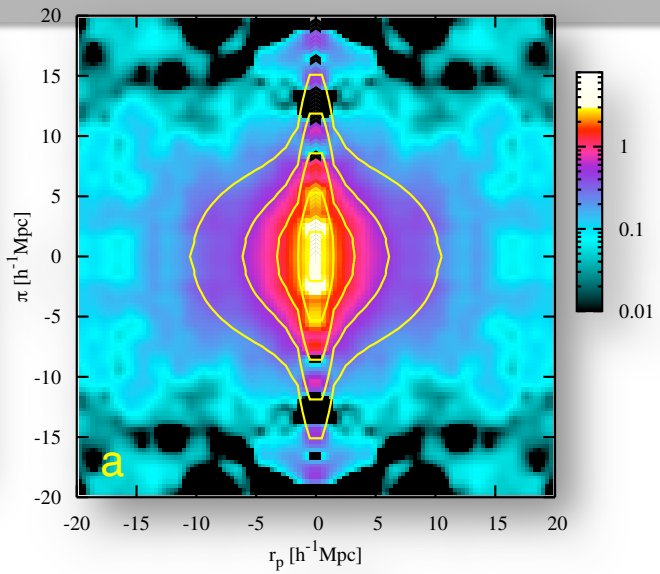
- Cosa:
  - Sostegno alle analisi di legacy scientifica di Planck
  - Supporto agli esperimenti di CMB con contributi italiani (es. EBEX, LSPE, OLIMPO, QUBIC), al perfezionamento di tecnologie, alle attività per proposte in risposta alle Call ESA
  - Favorire sinergie di CMB con misure di struttura su larga scala su breve e medio termine (es. Euclid)
  - Favorire sinergie con SKA (studi su polarized low frequency foregrounds, reionization, cosmic magnetism, etc.)
- Come:
  - Inserimento e sostegno di profili di competenze CMB all'interno del piano di reclutamento del personale INAF
  - Sostenere con PRIN INAF e fondi esterni ove disponibili, con borse INAF per Ph.D. e post-docs

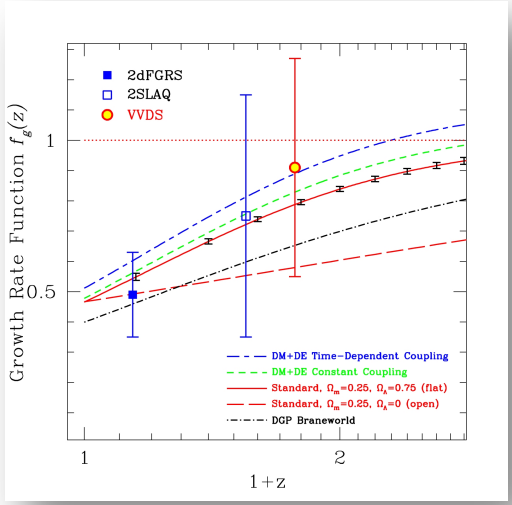
The lesson of VIPERS



The legacy of VIPERS (and previous surveys)







- Natural consequence of scientific leadership started with VVDS/VIMOS (but remember ESP...)
- **VVDS – zCOSMOS – VUDS – VIPERS – CLASH ...** : unique data analysis software expertise developed in INAF (at IASF).
- In VIPERS full data reduction and redshift measurement has been responsibility of INAF (***EasyLife*** pipeline, Garilli et al. 2012, PASP, 124).
- This adds to project coordination (P.I. L.Guzzo) and scientific leadership in both areas of cosmology and galaxy evolution
- VIPERS and CLASH-VLT: very good return for Italian community, interesting paradigms
- Still, funding to support Italian participation through PRIN has been a problem at some point, despite "Large-Programme, Italian P.I." status, which should have been a guarantee of coverage

(Guzzo et al. 2008, Nature 451, 541)

Euclid-IT

- Comunita' italiana come "founding member" ➔ **bottom-up**
- PI-ship italiana in SPACE – co-PIship in DUNE
- Forte interesse della comunita' cosmologica, sia osservativa che teorico/numerica
- Forte commitment in ruoli di responsabilita'/leadership in SWGs, OUs, etc. (management del SGS)

➔ Italia non coinvolta in altre grandi survey (DES, eBOSS, DESI)

➔ Partecipazione italiana a LSST?

Chi supporta Euclid-IT?

- ASI: contratto 2012-15 (scade 13/08/15)
- INAF: stipendi degli FTE
- Universita': cofinanziamento AdR e stipendi degli FTE
- MIUR: PRIN-2010 + PRIN-2012
- EU: indirettamente ERC grants, ITN, SPACE

➔ Domanda: quale supporto HW per SDC-IT?

Euclid-IT

Euclid come missione strategica per INAF:

- Supporto da INAF a Euclid all'interno di una strategia scientifica, o meglio, di ritorno scientifico, piu' generale:
  - **Salvaguardare il ritorno scientifico**
  - Partecipazione a LSST e WFIRST? A che livello?
  - Una roadmap per "survey science" che includa SKA
- Ruolo guida di INAF per definire collaborazione con ASI, Universita' e INFN

Quale approccio al problema (se le risorse sono meno del previsto):

- Evitare la tentazione di "mantenere il proprio gruppetto"
- Monitoraggio stretto da parte di **ASI & INAF** alle attivita' supportate dai due Enti

➔ Audit delle attivita' da parte di **ASI & INAF** !

An Italian Roadmap to SKA cosmology

2015-2018: critical to get *best* SKA1 design and to get prepared for KSPs

- Need to establish an Italian view to be supported in International SKA context (WGs, Committees, etc.)
- Need to coordinate Italian (technical and scientific) efforts in preparation of KSPs
- Need to get involved (incl. leading roles) in KSP planned for precursors/ pathfinders

➔ LOFAR? ASKAP, if included as part of SKA?

SKA-IT & Cosmology

Criticality:

- Italian hard-core cosmologists traditionally far from radio-astronomy
- Italian hard-core radioastronomers traditionally far from cosmology
- How to get ready to make the best use of SKA?

Opportunity:

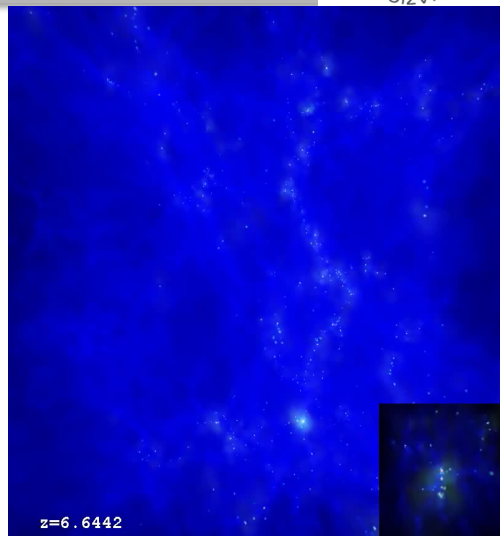
- Diffuse awareness that this gap needs to be cured
- Growing interest and interactions between these two communities

How?

- Sharing PhD students and early postdocs on projects of common interest
- Ease the flow of information on who's doing what for SKA

➔ A obvious duty of an Italian SKA Board

Facilities are not only telescopes



A policy of INAF is needed (and long overdue !) for:

- High-performance computing (HPC)
- High-throughput computing (HTC)
- Ultra-wide band connectivity

Crucial for scientific exploitation of cosmological surveys!!!!!

Data storage and preservation infrastructure in place (IA2 service), BUT:

➔ INAF doesn't even have a Tier-2 machine !

➔ Fragmentation in a number of (often obsolete) small clusters

➔ No expertise on HW configuration & middleware

➔ No collaboration with HW companies to develop HPC/HTC facilities tailored on our needs

Another example of industrial astronomy

Facilities are not only telescopes

Case 1: cosmological simulations for the exploitation of surveys

- Testbed for the development and validation of pipelines of data analysis
- Calibrate cosmic structures as tracers of cosmic evolution: e.g. cosmic shear and convergence fields, galaxies, clusters of galaxies, HI distribution, ...
- Astrophysics of galaxy formation and interplay with studies of baryonic structures

NOT a solution: grid/cloud computing, PRACE, CINECA(?)

➔ Simulation codes for astrophysics & cosmology: among the most intensive and tough to parallelize

➔ Apps well suited for HW companies developing exascale-oriented architectures

Facilities are not only telescopes

Case 2: getting ready for SKA

- Beyond GARR-X to deal with the data flow
- A data centre for SKA?

Example of LOFAR: in NL triggered a large amount of efforts for model/theory simulations

A INAF computing centre needs far more than "just" a Tier-1 machine:

➔ A hosting infrastructure
➔ Mid- and long-term data storage (~1/2 of the cost)
➔ Personnel
➔ Commitment for a long-term policy: a machine becomes old in 4 years!
➔ Shall we rather make a deal with other institutes or HPC centre?

Parte 3:
DISCUSSIONE