

REVIEW ON THE ITALIAN RADIO TELESCOPE RECEIVERS





RECOMMENDATIONS





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(on behalf of the WG)

AGENDA

- Background
 - Objectives (from #3 of ToR)
 - Deliverable (from #5 of ToR)
 - Process of the WG for elaborating the rec.
- Recommendations (incl. timeline and financial aspects)
 - on under development receivers
 - on future receivers
 - on management of the receiver group

OBJECTIVES 1/2

| 64m SRT | 32m MED | 32m NOTO | Northern Cross |
|---|--|---|---|
|  |  |  |  |

| Receivers currently in operation | Receivers under development | | Future receivers |
|---|--|---|---|
|  |  |  |  |

OBJECTIVES 2/2

Recommendations
should be based on:

Science-
driven

Technologically
ambitious

Boundary
conditions

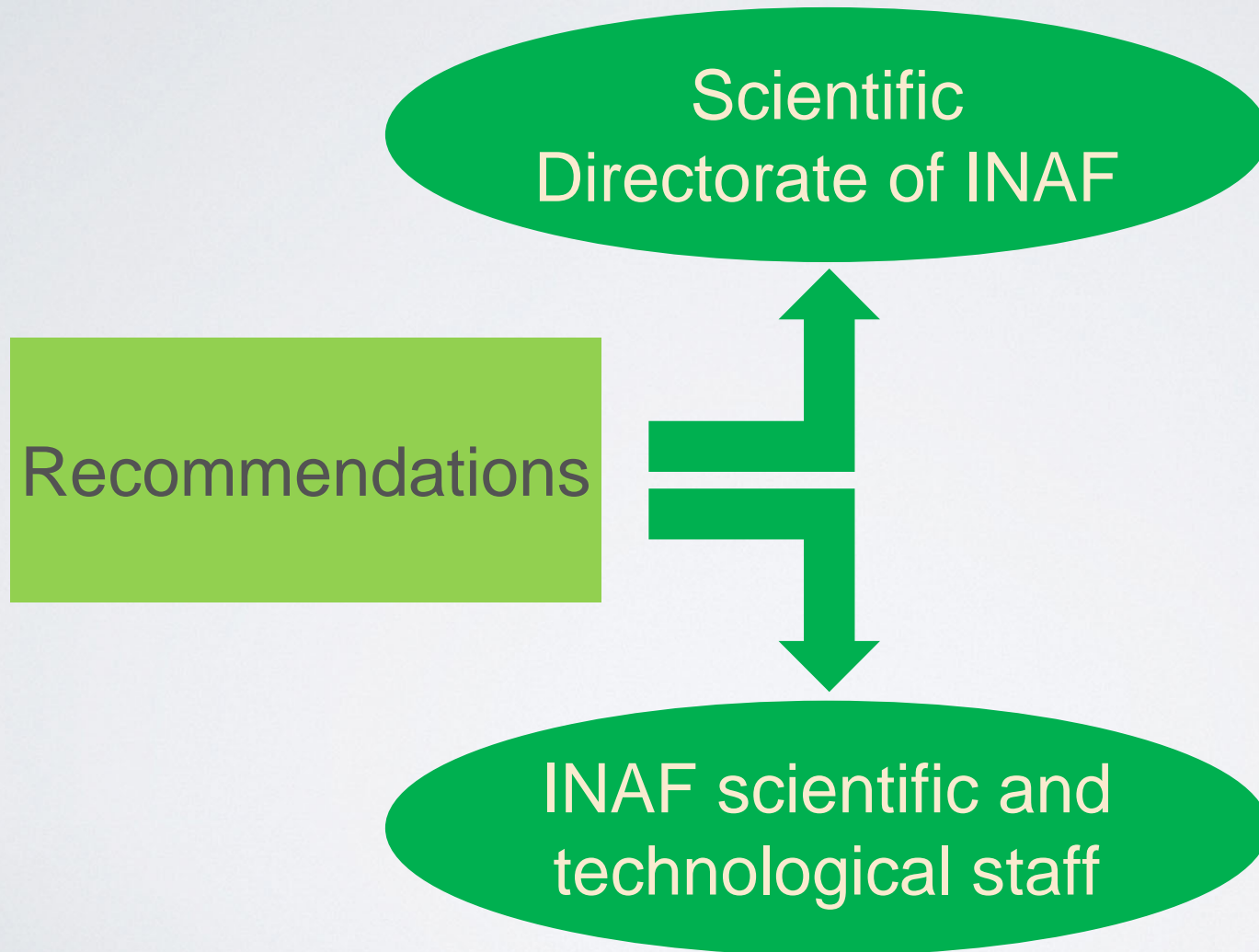
Out of our mandate
recommendations for:

Other RA
projects

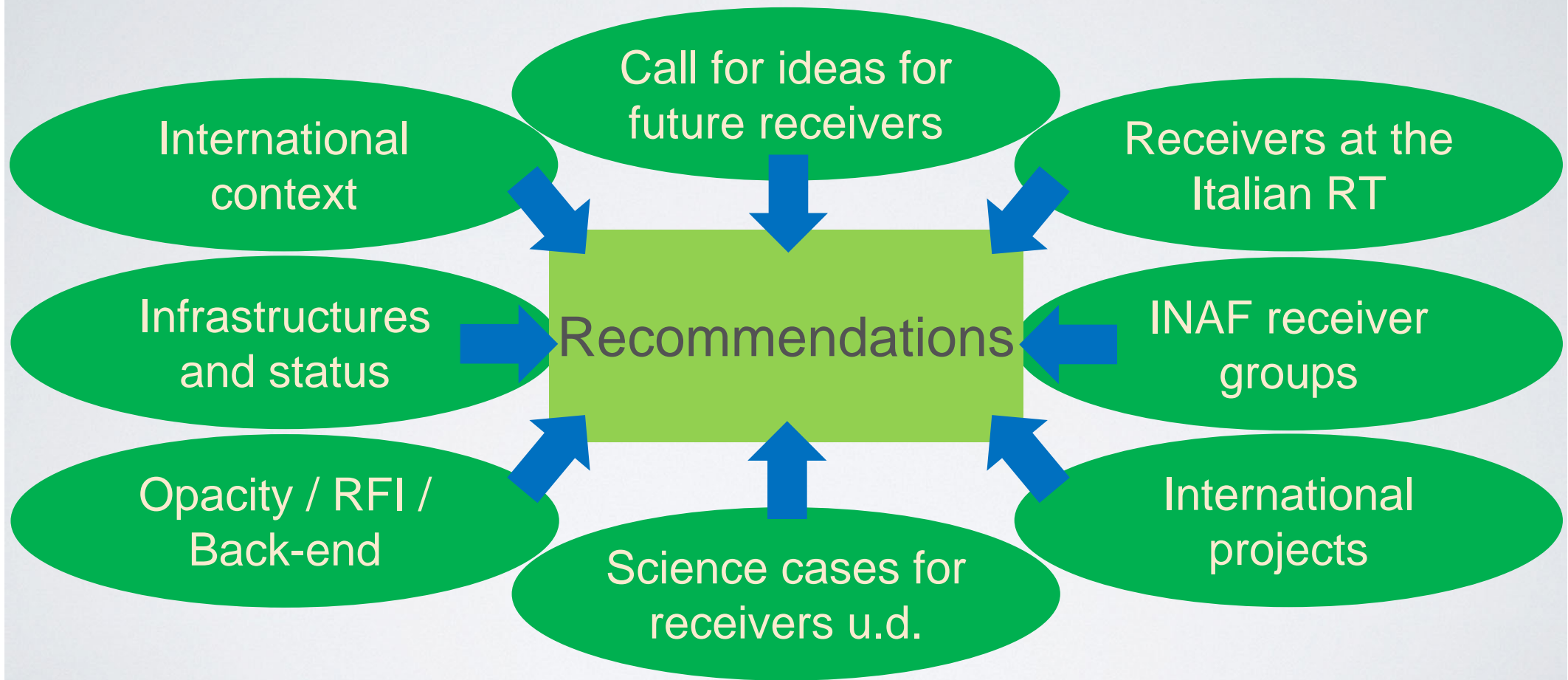
Back-end / sw /
infrastructure

Financial
constraints

DELIVERABLE

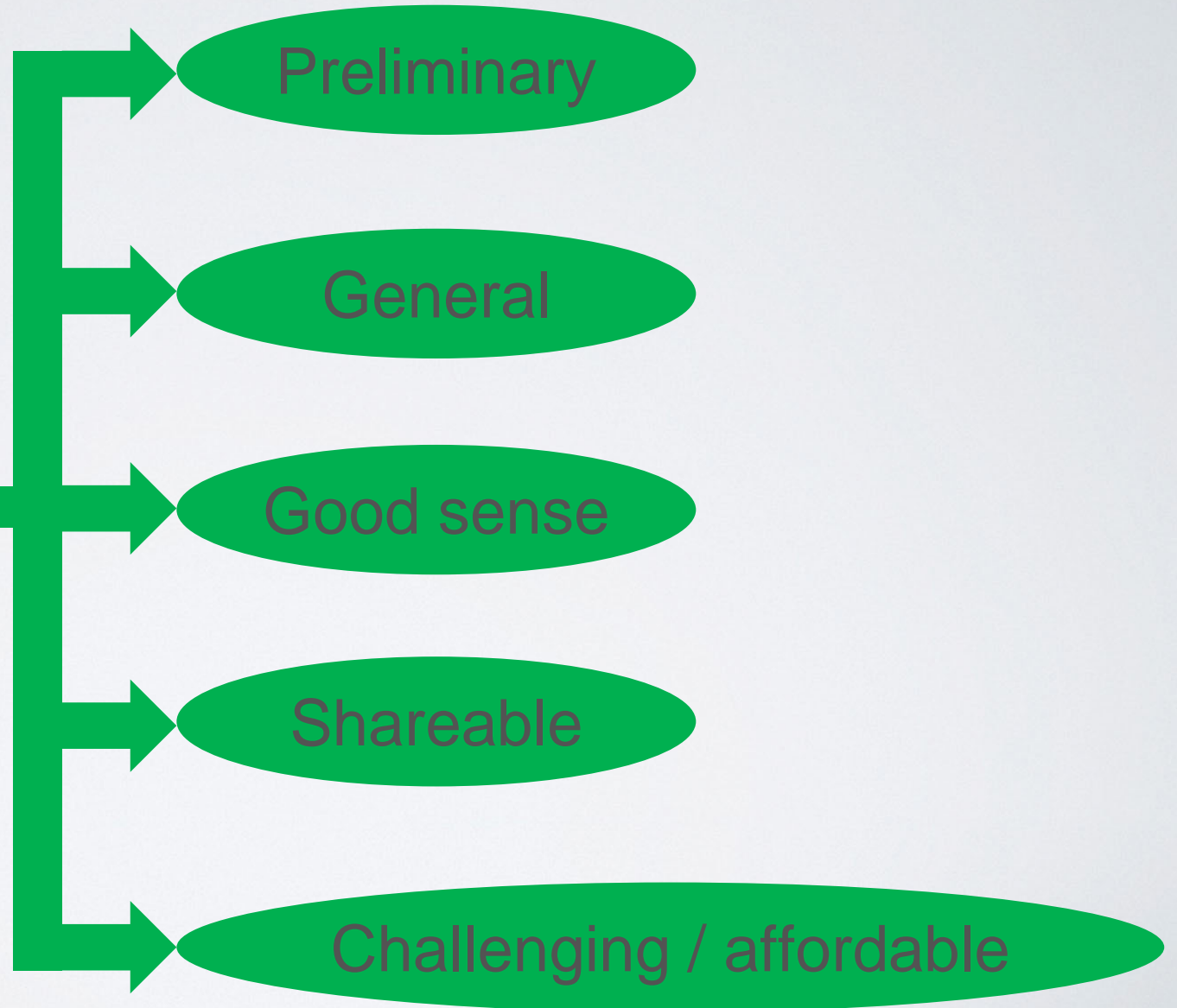


WHERE DO REC. COME FROM?



HOW DO THEY LOOK?

Recommendations



Recommendations

TWO PERIODS

2017-2018



Almost all the receivers under construction should be completed

2019 and beyond



Development of future state-of-the-art receivers

2017-2018 for SRT

Either as it is currently planned
or downgraded to 7 feeds

| RT | RECEIVER | WHY? |
|-----|-----------------------------|---|
| SRT | S-band 3-4.5 GHz | Almost unique in the international scenario High-level science topics can be addressed with SD observations |
| SRT | Clow-band 4.2-5.6 GHz | Interest for VLBI (high publication rate) Hottest topics in today's radio astronomy |
| SRT | Q-band 33-50 GHz | Good opportunity to start testing metrology at relatively high frequency keeping at the same time a receiver with a high scientific impact No similar multi-feeds are available at foreign radio telescopes |
| SRT | ALMA 2-3 band 67-116 GHz | Time schedule is compatible with the SRT schedule. The ALMA receiver has remarkable high interest from a scientific point of view and allows for advanced technical performances The INAF-IASF group can take the responsibility of this task, thus there should be no additional workload on the receiver group. |

2017-2018 for MED and NOTO

| RT | RECEIVER | WHY? |
|------|--|--|
| MED | Ku-band 13.5-18 GHz | Continuous coverage from 12 to 26 GHz. Interest for continuum studies & spectral line analysis. Relevant in the International context (like long term monitoring programs and expansion of the EVN capabilities in this frequency range) |
| NOTO | S/X/L-band 1.3-1.8 / 2.20-2.36 / 8.18-8.98 GHz | High scientific interest especially for VLBI and IVS observations. |
| NOTO | W-band 85.945-86.545 GHz | Great interest for the participation to the observations of the GMVA network. Test the suitability of Noto (both telescope and site) for such frequency. |

Given the very limited cost of the adaptation of the ex-MPIfR receiver for the secondary focus, we would recommend to proceed with this solution. At a later stage, to adapt the ex-IRAM W-band receiver.

2019 AND BEYOND

A full use of MED in the Q and W bands requires an antenna refurbishment

| RT | RECEIVER | WHY? |
|------|---|---|
| SRT | PAF in C-band | Relevant interest both as a technological demonstrator and as a new receiver to perform cutting-edge science (3 proposals). The interest for a PAF receiver matches with the involvement of INAF in the SKA AIP project (PHAROS2). We encourage to develop a new PAF in the C-band with state-of-the-art performances. |
| SRT | Multi-feed in W-band | Considerable interest in such front-ends emerged from the Call for Ideas. Financial effort is being made by INAF to restore the active surface system of SRT to its best performances, opacity conditions at the SRT site are acceptable and RFI is not expected to be a concern in the coming years at such frequencies. |
| MED | Simultaneous frequency in K/Q/W-bands | This front-end gives represents a niche in which also the smaller Italian radio telescopes can give a substantial contribution. Strong collaborations are already in place with the KVN and VERA arrays, and could be reinforced by adding MED (and possibly NOTO) to simultaneous high-frequency experiments |
| NOTO | It needs to perform at nominal technical capabilities with also full operability of the frequency agility as well as to reach stable operational procedures | |

PROJECTS for FUTURE EVALUATION

| RT | RECEIVER | WHY? |
|------------------------|-----------------------------------|--|
| SRT / MED / NOTO | BRAND 1.5-15.5 GHz | <p>It is a new generation ultra-wide band receiver for VLBI, suited also for geodetic studies.</p> <p>This project pushes for advanced digital acquisition system especially to handle RFI issues.</p> <p>BRAND at SRT is a good opportunity in particular to perform geodetic studies since a classical S/X receiver is not available.</p> <p>Critical issues: 21 cm not available, high cross polarization, SRT primary focus crowded, able to satisfy the requirements for SD observations?</p> <p>The actual interest of BRAND will depend on its final design and capabilities.</p> <p>BRAND could be an interesting possibility also for the other two 32m radio telescopes.</p> |
| SRT | Camera in W-band 80-100 GHz | <p>The bolometer proposed by de Bernardis is a very challenging project promising to increase the scientific applications of SRT and to widen the astronomical community interested in the use of the Italian radio astronomical facilities.</p> <p>A similar project has been recently developed at GBT.</p> <p>It should be developed under the responsibility of the proposing group.</p> <p>Its integration at SRT, as proposed, seems challenging due to dimensional and mechanical constraints and would need a close interaction with the SRT staff during the design phase.</p> |

TIMELINE

| Status | RT | RECEIVER | '17 | '18 | '19 and beyond |
|-----------------------------|------|---------------------------|---|------|--|
| Under development receivers | SRT | S-band | OAC | OAC | |
| | SRT | Clow-band | IRA OAC OAA | | The construction of these receivers is in a quite advanced stage and the workload is distributed in the receiver group |
| | SRT | Q-band | IRA OAC | IRA | |
| | SRT | ALMA 2-3 band | IASF | IASF | |
| | MED | Ku-band | IRA OAA | IRA | |
| | NOTO | S/X/L-band | IRA | | |
| | NOTO | W-band | | IRA | |
| New receivers | SRT | PAF in C-band | For each project, minimize the number of group to be involved | | |
| | SRT | Multi-feed in W-band | | | OAC |
| | MED | Sim. freq. in K/Q/W-bands | | | IRA |

FINANCIAL CONSIDERATIONS (k€)

| Status | RT | RECEIVER | '17-'18 | '19 & beyond |
|-----------------------------|------|---------------------------|---------------------------------|--------------------------------|
| Under development receivers | SRT | S-band | Fully funded | |
| | SRT | Clow-band | Fully funded | |
| | SRT | Q-band | 600 (19 feeds) 180 (7 feeds) | |
| | SRT | ALMA 2-3 band | 80 | |
| | MED | Ku-band | Fully funded | |
| | NOTO | S/X/L-band | 80 | |
| | NOTO | W-band | Negligible | |
| New receivers | SRT | PAF in C-band | | ~2700 |
| | SRT | Multi-feed in W-band | | ~1700 |
| | MED | Sim. freq. in K/Q/W-bands | | ~3000 (w AS) ~2200 (w/o AS) |
| TOTAL | | | 760 (19 feeds) 340 (7 feeds) | ~7400 (w AS) ~6600 (w/o AS) |

MAJOR UPGRADES ON EXISTING RX

Instantaneous bandwidth

To enlarge the instantaneous bandwidth in the K-band receivers up to the whole band available. This will be done providing sub-bands 1 GHz wide by using new down conversion boards.

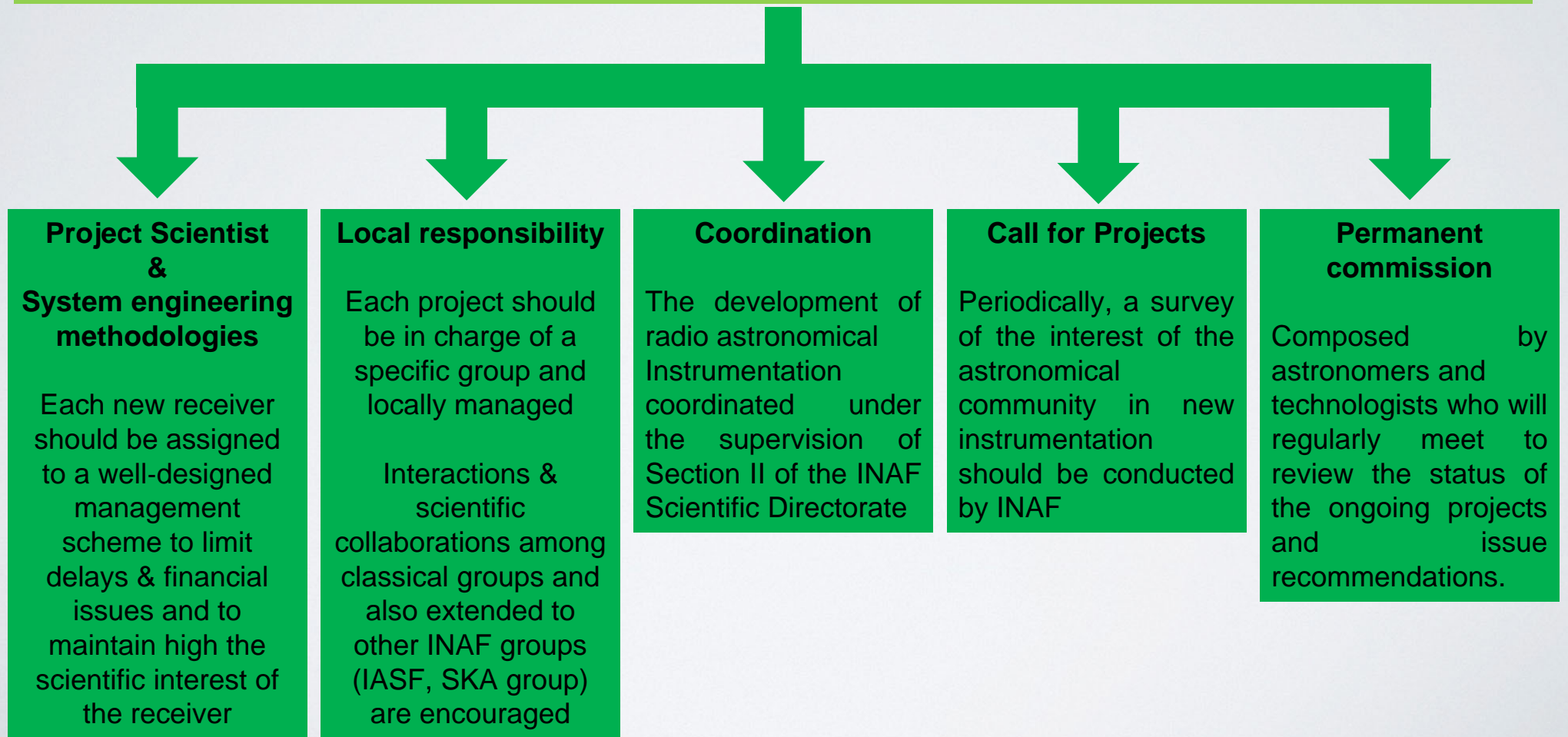
Low Noise Amplifiers

The K-band receiver shows a bad reliability in some cryogenic LNAs, recurrently repaired. Today a substitution of all fourteen amplifiers is possible commercially, with a considerable mechanical effort inside the dewar in order to fit the different dimension of the LNA chassis.



BEST PRACTISES FOR THE FUTURE

Maintaining a leading position in receiver development within the International context



SPACE SCIENCE at SRT

- Recommendations regarding future ASI development of receivers dedicated to space science activities are out of the scope of this working group.
- However, we would like to point out the existence of an idea for a future receiver (Paolo Tortora's idea in X/Ka) that could be of interest for ASI.
- A critical issue is related to the RFI generated by ASI (receiving) devices. This aspect should be seriously considered keeping in mind the extremely sensitive radio astronomical receivers.
- The most relevant compatibility issue is related to the installation of high-power transmitters, whose installation needs a very detailed and accurate analysis to prevent damages to the INAF receivers and equipment.

NORTHERN CROSS

- The use of the NC in the next years will be focused more on space science applications than on classical radio astronomical studies. No specific interests raised from the call for ideas on exploiting the Northern Cross for astronomical purposes.
- The NC is a propriety of the University of Bologna which should be involved in any discussion on possible upgrades.
- Very likely a significant refurbishment of the NC, like for example increasing the frequency band or the sensitivity, could make it very interesting for the low-frequency astronomical community.
- Decisions on possible upgrades of the NC are not of pertinence of this WG.

**THANKS FOR
YOUR ATTENTION**