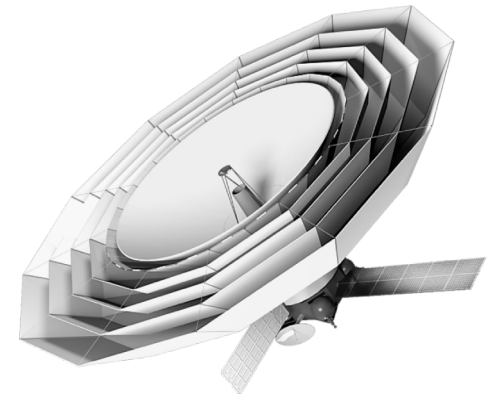


Roadmap for inclusion: Science and Instruments

Thijs de Graauw (ASC-LPI and ESO)



Topics for this presentation

- Introduction and basic approach
- Millimetron Science Management Plan, version 1.0
- Milestones and schedule for Millimetron instruments
- Roadmap for Millimetron Partnership: phased and organic approach
- Science working groups, as first step

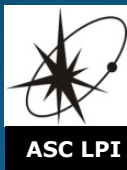
Reflections and Assumptions

Acknowledgements: FOR THE SMP heavily drawn from experience in
ISO, Herschel, RadioAstron and ALMA

Basic assumptions

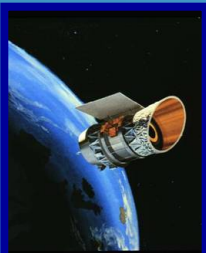
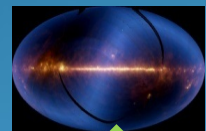
- This is a Mission with Guaranteed time and Open time; one OTAC (observing time allocation)
- Mission with two operating modes: VLBI and Single dish
- Mission Science Target: a few important well-defined **key (breakthrough) science cases** that decide **the instrument concept** selection
but observations can include proposals as in open observatory
- Heterodyne receivers will give Millimetron unique capability in future missions
- Decisions on science and instrument selection are biased/skewed by context:
Context in **science/budget/time**: Take into account: ALMA, JWST, and SPICA (not OST);
take into account ELT/GMT/TMT and with input from Spitzer, Herschel, etc..

We have to go for the feasible!



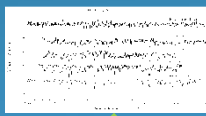
Main Space FIR-Submm Observatories; past and future

First
all-sky
survey



IRAS 1983

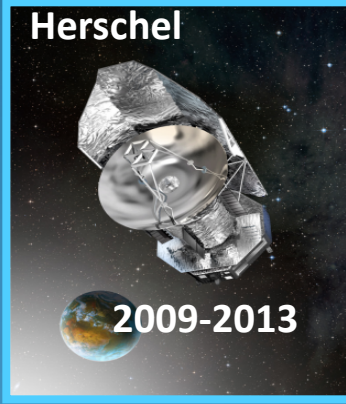
First
Spectrum
Survey



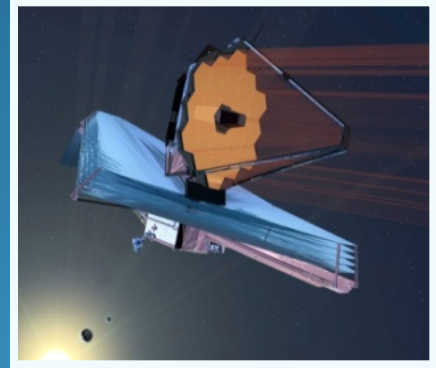
ISO 1995



Spitzer
2003



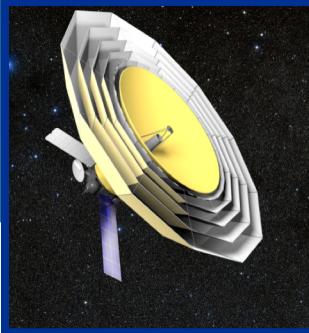
Herschel
2009-2013



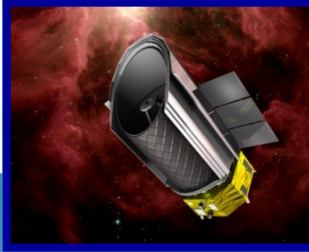
JWST 2021



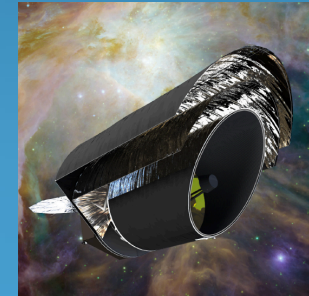
SOFIA
2011 >>



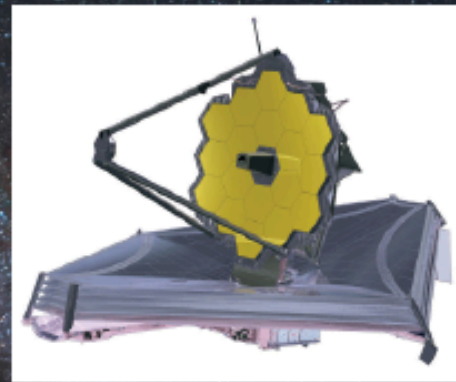
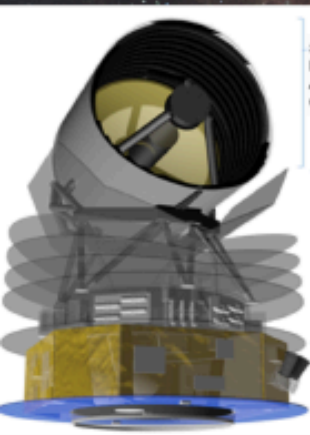
Mmtron 2029



SPICA 2032

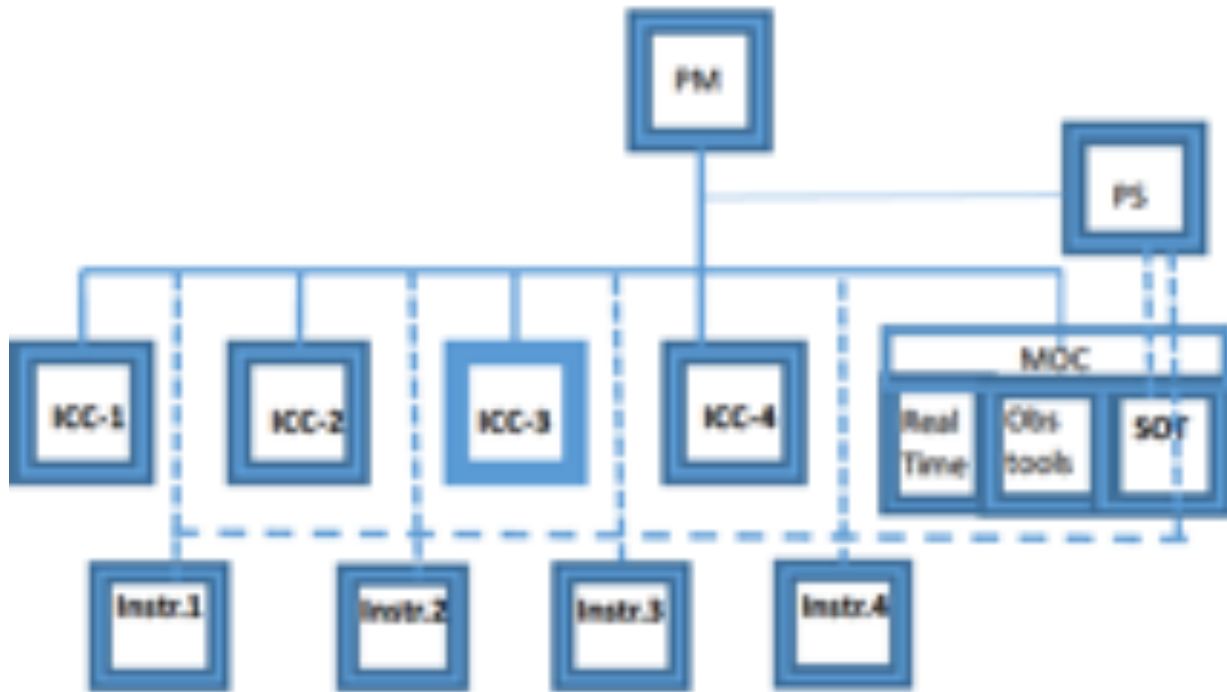


OST 2035



Millimetron context dominated by
ALMA and JWST, and possibly by SPICA

Millimetron Science management during development phase



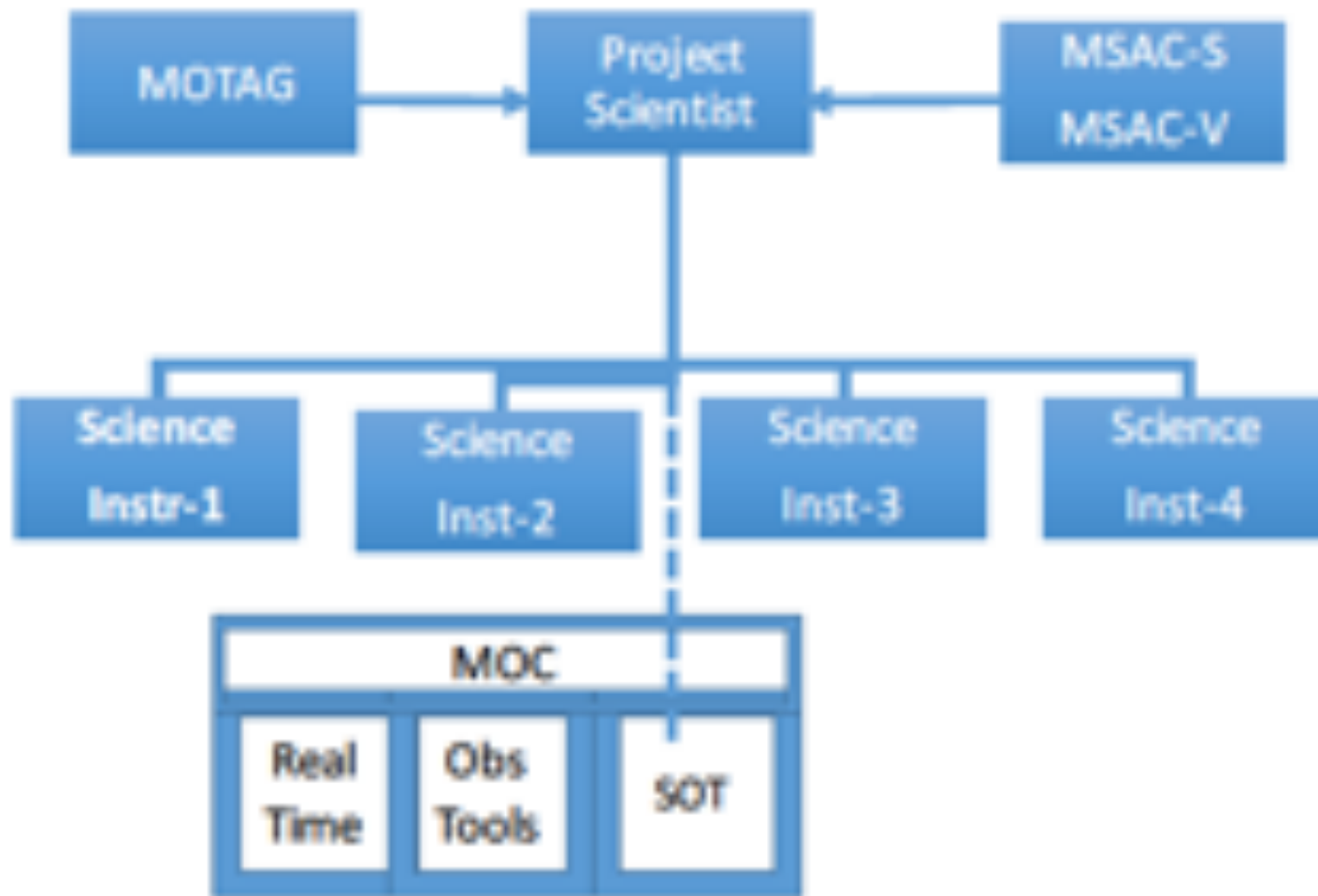
the PM is responsible for

- the preparations of the operations that takes place in the MOC.
- The PM is also responsible for the interface management between instruments and satellite

The Project Scientist

- monitors the instrument development concerning the scientific capabilities.
- responsible for the tasks of the Scientific Operations Team in the MOC.

The role of the Millimetron Project Scientist (PS)



The role of the Project Scientist (PS) with the advisory committees MSAC-V and MSAC-S and MOTAC, the Millimetron Observing Time Allocation Committee.

The PS also monitors the key programs as developed in the science instrument consortia

Millimetron Science Advisory Committee for Single Dish

The overall objective of the MSAC-S is

- to safeguard the scientific interests of the Millimetron mission in the single dish mode.
- It fulfills this task by giving advice, it has no executive power.

Its membership will include:

- the Millimetron Project Scientist (PS) as its Chairman,
- a number (tbd) Mission Scientists (MSs),
- the representatives of institutes of potential instrument providers,
- later-on these will be replaced by the instrument principal Investigators (PIs)

In general, the members of the MSAC-S will be expected to monitor and advise on all aspects of Millimetron which affect its scientific performance.

The tasks of the MSAC will be amongst others:

- assisting the PS in maximizing scientific return of Millimetron within its constraints,
 - advising on the optimization of the observing program and the calibration strategy, that can be derived from the performance and capabilities of the satellite and instruments; also during operations,
 - advising on the documentation for Announcement of Opportunity for observing proposals and providing guidelines to the MOTAC,
 - advising on the analysis of the data, and the quality of the data products,
 - advising on the organization and activities of the post-operations phase.
-
- The members of the MSAC-S, with the exception of the MSs, will have to provide **their own funding** to support their activities, and payment their travel and other expenses in connection with attending meetings of the MSAC-S.
 - ASC does pay these costs for the MScs (TBC)

The Millimetron Science Advisory Committee for VLBI

The overall objective of the MSAC-V is to safeguard the scientific interests of the Millimetron mission in the VLBI mode. It fulfills this task by giving advice, it has no executive power.

Its membership will include:

- the Millimetron Project Scientist (PS) or deputy, as its Chairman,
- two VLBI Mission Scientists (MSs),
- the representatives of the (largest) observatories involved
in the Space-Earth VLBI observatories.

Millimetron Science Management Plan (MSMP) additional chapters

3.2 Science Management and organization

3.3 Millimetron Science Advisory Committees

3.3.1 Millimetron Science Advisory Committees for single dish mode. (MSAC-S)

-S. ASC does pay these costs for the MSs.TBC.

3.3.2 Millimetron Science Advisory Committees for the Space-Earth VLBI mode. (MSAC-V)

3.3.3 Millimetron Observing Time Allocation Committee (MOTAC)

.

4. Millimetron Ground Segment (MGS)

4.1 Introduction

4.2 Millimetron Ground Segment Components

A Millimetron Ground Segment Working Group (MGS-WG)

4.3 Millimetron Operations Centre (MOC)

4.4 Instrument Control Centers (ICCs)

5. Millimetron Data Products and Data Rights

5.1 Data products that will be made available:

5.2 Data Rights:

Millimetron – Instrument Milestones

It is assumed that the focal plane units of the instruments will be mounted in a **Cryo-container** and their warm electronic boxes onto the **Instrument Service Model**.
These two are making together the **Integrated Instrument Payload**.

2029 Launch window (tbc)

2028 Jan. Start Integration and Integrated satellite tests (18 months)

**2028 Jan. Delivery Integrated Instrument Payload module with flight instruments
inside the Cryo-container and instrument service module, to Krasnayarsk**

2027, Jan. Start refurbishment of flight instruments, followed by retest in instrument cryostat.

2027, Jan. Start refurbishment of Cryo-container and instrument service module frame, followed by retest

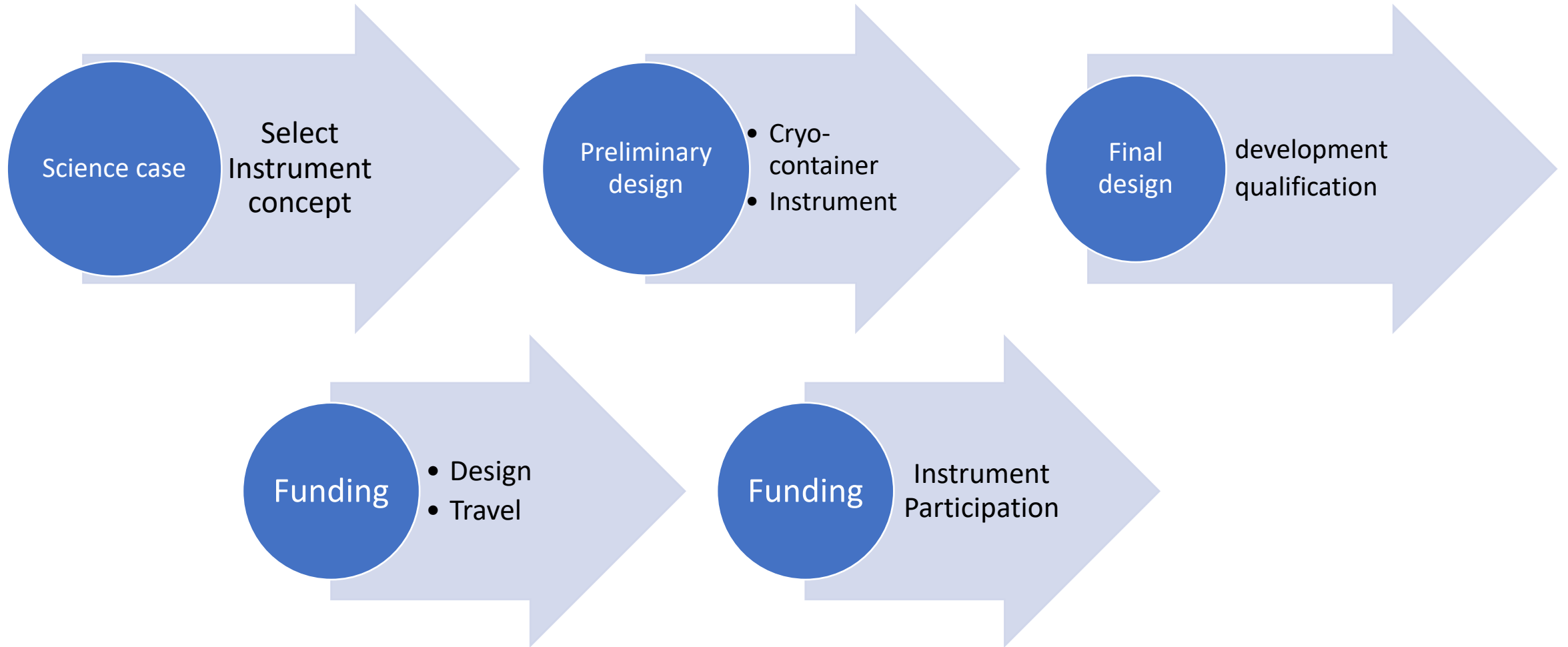
2027, Jan. End proto-flight tests in Cryo-container

2026, Jan. Start proto-flight tests in Cryo-container with instrument service module (12 months)

2025, July Start integration of instruments into Cryo-container and instrument service module

2025, July	Delivery proto- flight instruments for test in Cryo-container; Location: European Integration Center (EIC)
2024, Sept	Start Cryo-container/Instrument service module tests
2024, Sept	Delivery cryo-container/Instrument service module to EIC, for testing Cryo-container
2023 Jan	Start instrumentation qualification model tests in each instrument cryostat
2023 Jan	Qualification Models of instruments ready for tests
2021 Jan	Final freezing main interfaces between instruments and satellite, Start design development instruments and qualification model
2020 May	Start instrument payload accommodation study; concept phase
2020 April	Antenna performance re-evaluation (rms precision and estimated temperature)
2020 Jan	Draft Science Cases and Instrument definition

First steps on the roadmap



Next Step: Millimetron Science Working Groups

- **Objectives:** The Millimetron Science Working Groups (SWG) are teams that
 - define and describe the strongest key **science cases** for the MSO and
 - come up with an associated **instrument concept**
 - Also define and outline other important astrophysical areas where the MSO can uniquely and significantly contribute.
- **The outcome** should be a **set** of short but comprehensive paper-letters,
 - that outlines the explicitly unique science rationale of the MSO
 - and give the associated instrument concept
 - to be used for raising interest and funding with colleagues, institutes, agencies, etc..
- **Delivery Date of Chapters for integration 23 December 2019**
- **Review by senior peers to advise Millimetron leaders on instrument complement (Jan- May 2019)**

PS: In order to keep the document concise,

it needs to be supported by extensive literature references.

Millimetron Science Working Groups

Areas (in bold the Russian member of the working group)

- *VLBI working group (**Alexey Rudnitskiy**)*
- *Relativistic Gravity and VLBI (**Yuri Schekinov**)*
- *CMB spectral shape (**Dmitri Novikov**)*
- *The trail of water trail and molecules for life (**tbd**)*
- *ISM Polarisation (**tbd**)*
- *Galaxy evolution and compact obscured cores/feedback (**Sergey Pilipenko**)*
- *Solar system studies (**tbd**)*
- *Etc...*

- **A Russian member** is to be the convenor/motor of the relevant SWG,
not necessarily chairing the working groups.