



SKACH

**Square Kilometer Array Swiss project (SKACH)
Instrumentation program overview
@SKACH winter meeting 2023-01-12**

Hes·so
Haute Ecole Spécialisée
de Suisse occidentale
Fachhochschule Westschweiz
University of Applied Sciences
Western Switzerland

**HE^{VD}
IG** SCHOOL
OF
ENGINEERING
AND
MANAGEMENT

Dominique Bovey

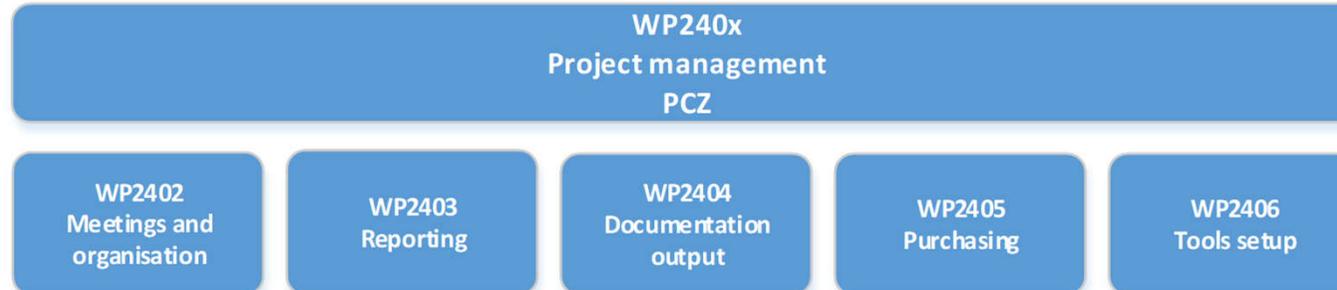
Presentation outline

- **Project status**
 - Current work on WP

- **Mid band 6 Electronic Breadboard**
 - Build1: in Oxford cryostat
 - Build2: for TBD test telescope

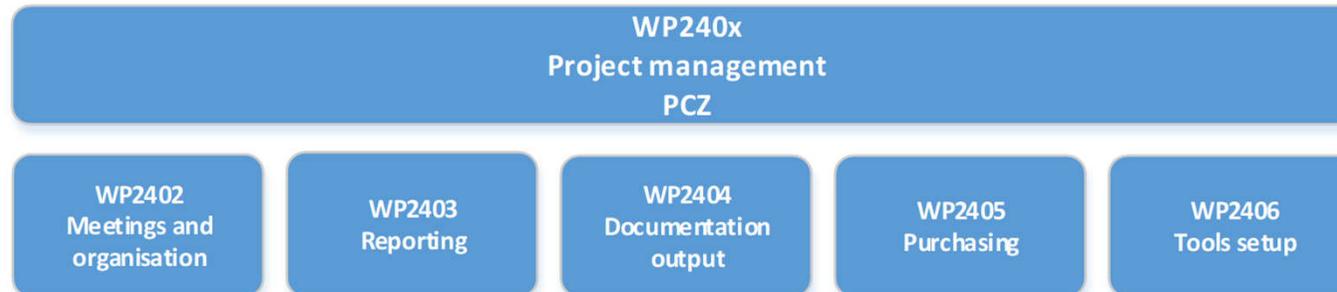
- **Outlook**
 - General outlook with currently allocated financing
 - Future financing needed to bridge the gap to industrialisation

EBB Work breakdown: WP240x PM



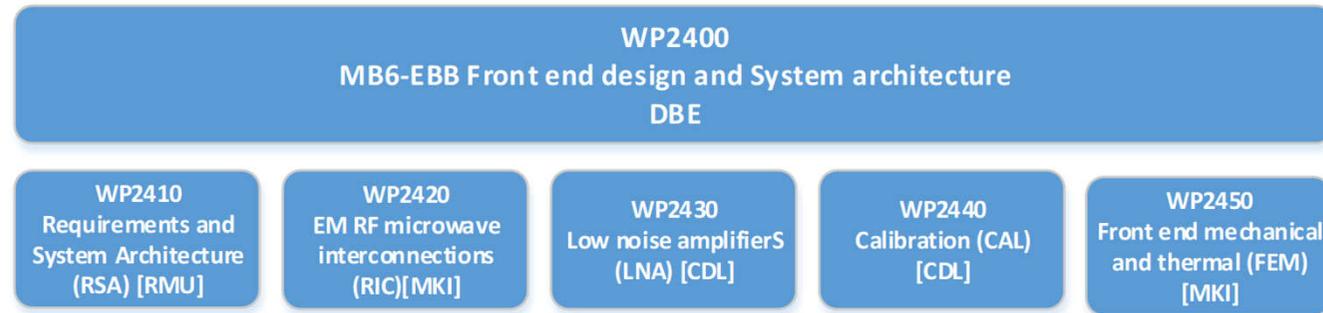
- **WP2404:** Documentation: PM plan, design&development plan (DDP), Master test plan (MTP), risk analysis, EMC control plan and the template for the “Stories” for the “agile” Sprints
- **WP2405:** purchasing is a critical activity in the current times of shortage of electronic components, establishing a Long Lead Item list
- **WP2406:** setting up and maintaining Cameo and git

EBB Work breakdown: WP240x PM



- **WP2404: Documentation:**
 - Project management plan (PMP)**
 - Design&development plan (DDP)**
 -  **Risk analysis,**
 - Template for the “Stories” for the “agile” Sprints**
 -  EMC control plan
 -  Master test plan (MTP)
-  **WP2405:** purchasing is a critical activity in the current times of shortage of electronic components, establishing a Long Lead Item list
- **WP2406:** Cameo and git
 - setting up
 -  maintenance

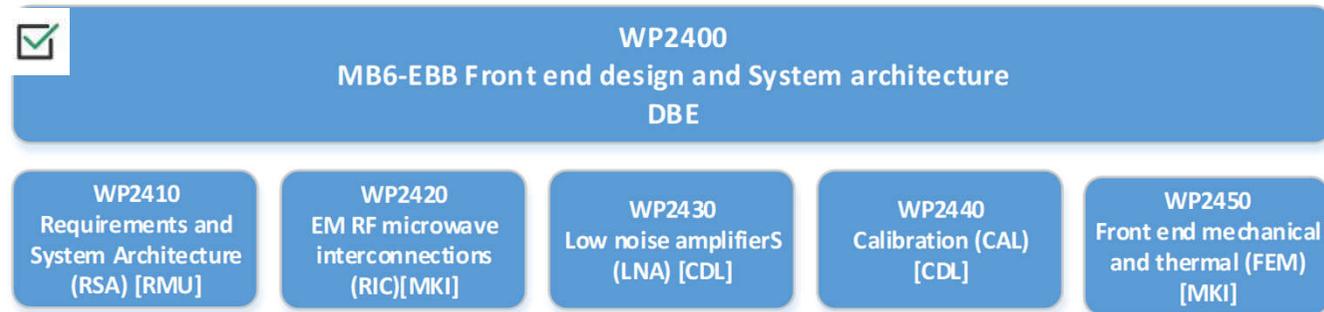
EBB Work breakdown: WP2400 front-end



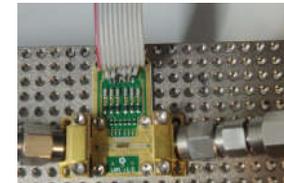
- **WP2410:** functional, interface and science **requirements** are analysed. **System architecture** design and input requirements are produced for the **detailed design** of the instrument.
- **WP2420:** the **interconnections** in the front end transport very weak microwave signals and must shield them from external noise with absolutely minimal loss. Includes the OMT which separates H and V polarisations
- **WP2430:** the first **low noise amplifier** sets the noise performance of the whole instrument.
- **WP2440:** A **calibration** source must be switched in and out
- **WP2450:** **thermo-mechanical** issues which also have an impact on the noise performance are handled in this WP

Possible partnership with a UK university!

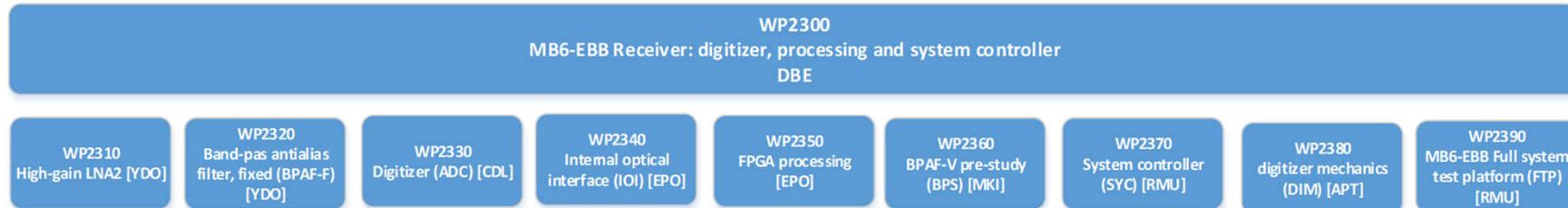
EBB Work breakdown: WP2400 front-end



- **WP2410:**
 -  functional, interface and science **requirements** are analysed.
 -  **System architecture** design and input requirements to be produced for the **detailed design** of the instrument.
-  **WP2420:** microwave **interconnections:** prelim work on OMT v1
-  **WP2430:** LNA1 v1 is being done (delay due to mechanical part=shield)
 - Gain 23dB vs 30 (different polarisation)
-  **WP2440:** A **calibration** source must be switched in and out
-  **WP2450:** **thermo-mechanical** issues which also have an impact on the noise performance are handled in this WP

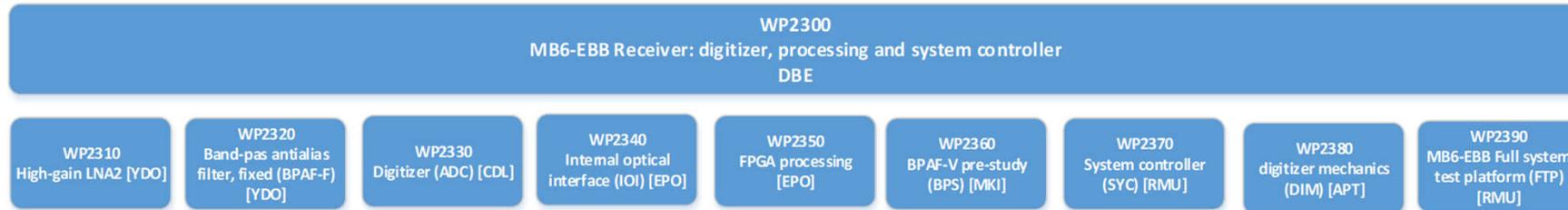


EBB Work breakdown: receiver

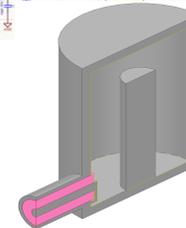
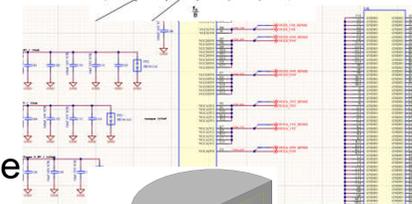
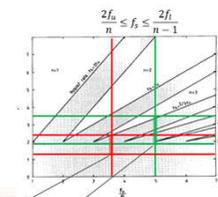
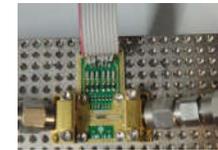


- **WP2310: amplify** LNA1 (output of FE) to the full-scale level of the ADC
- **WP2320:** band pass **anti-alias** filter for and selecting the frequency band. This is a fixed-frequency analog component in the EBB
- **WP2330:** analog to digital converter (**ADC**) (**digitizer**). Max sampling rate 12.8 gigasamples per second, and a bandwidth of several times the sampling rate (35GHz@-3dB!). Digital output on 11x high speed serial lines.
- **WP2340: optical digital interface** to place the FPGA away from the front-end. Digital to optical fibre to digital interface
- **WP2350:** The digital data are **processed** by very high performance FPGA to provide the correctly formatted information in a protocol acceptable to the correlator of the SKA.
- **WP2360:** this WP is a pre-study to explore **how to make a bandpass filter variable** by changing its dimensions by micro-actuators.
- **WP2370:** the **system controller** receives commands from the OMC to set the instrument operational parameters, and sends instrument status data to the OMC.
- **WP2380:** mechanics
- **WP2390:** test system allowing automated test of the whole instrument during development

EBB Work breakdown: receiver



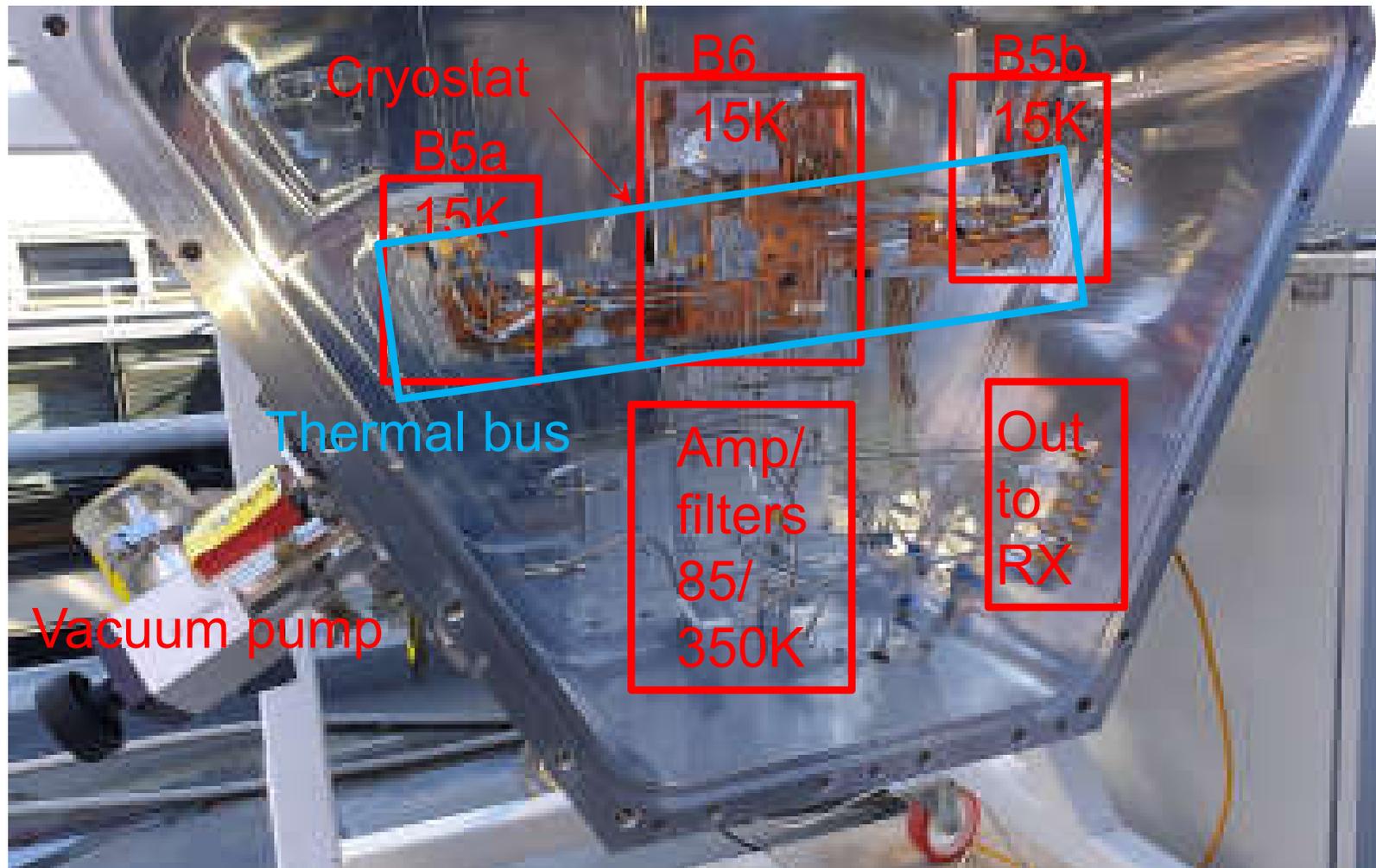
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WP2310: design decision pending results of WP2430. Second LNA needs a lot of gain (60..70dB) , initially planned to use Diramics MMIC, however this is pending on the performance measurements of this module. If they cannot get above 23 dB then HEIG-VD will make a design made of COTS parts; otherwise case the Diramics parts will be used.
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WP2320: Band pass alias filter. Specifications of filters defined, will be sent to filter manufacturers in Jan 2023. The possibility to cover the bands 15-30GHz is being checked by HEIG-VD engineers.
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WP2330: ADC, HEIG-VD still waiting for the (mechanical) requirements Input line RF simulation to be done, then mechanical and PCB design.
- 
WP2360: Variable Filter → coaxial waveguide. Parameters for mechanical movement identified. The extension of the bandwidth (over the bandwidth required for the present Midband 6) is still under investigation. External size of the cavity: about D3.4x3.95mm, with a D1 mm rod moving inside. The travel is several mm.
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WP2340,2350,2370-90: on hold



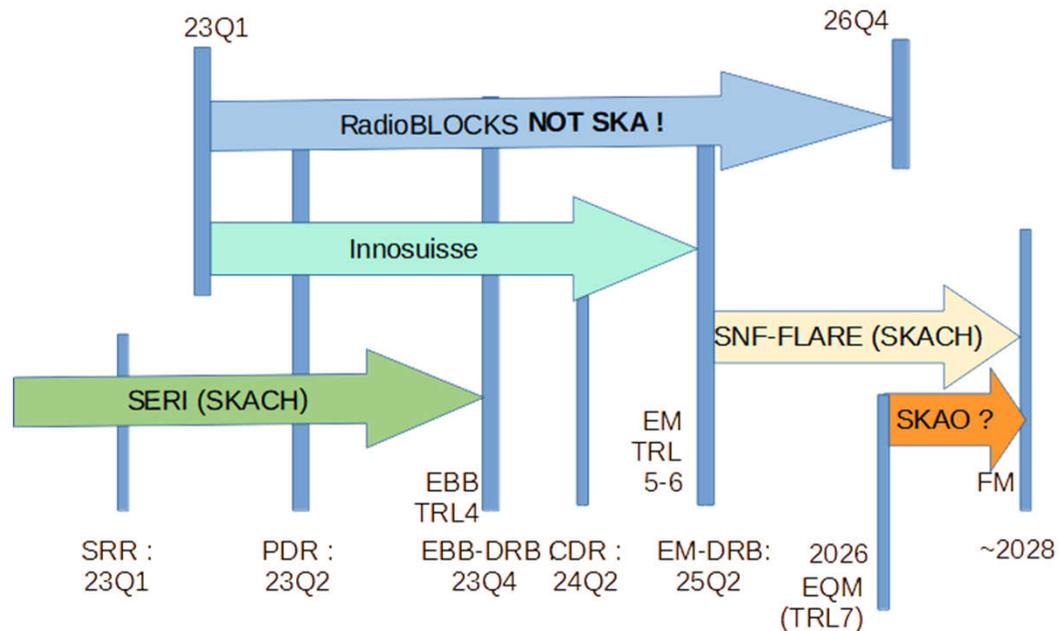
MB6 instrument EBB options

- **EBB build 1 “Oxford SKA”**
 - Front end mechanical build based on the cryostat enclosure designed by Oxford University for SKA MID bands 5a, 5b and 6
 - All functional blocks of MID-band 6 front end (OMT, CAL, 2x LNA1) to be designed for insertion into the cryostat 3D mechanical model
 - EBB: ambient temperature, no vacuum
 - RX (filter, LNA2, ADC, optical interface) in independent casing (placed on indexer platform)
 - FPGA in 3rd shielded box (corresponding to pedestal)
 - **Condition:** that Oxford University
 - Shares the 3D (STEP) model of the cryostat (requirement)
 - Lends/sells a finished mechanical unit to HEIG-VD (nice to have)
 - Consequences:
 - Imposes field testing on SKA-MID
 - Easy path to EM+ version (15K cryogenic/vacuum operation)
 - **250kg unit**
- **EBB build 2 «to be determined»**
 - To be defined according to test telescope
 - Only ambient (SKACH)/77K(Innosuisse) operation
 - Lighter unit implementing the elements designed (ideally) for the «build1+»
 - More practical to handle

MB6 EBB build 1 «Oxford»



Financing outlook



- (all dates >2023 are indicative)
- Horizon Europe Radioblocks is mentioned but has totally different spec from SKA (different frequencies, processing, interfaces, mechanical...)
- Innosuisse project(s) should lead to EM (with industrial partner)
- SNF-FLARE will be submitted by SKACH board (funding for Instrumentation program will be included)
- SKAO funding possible for TRL7+ only (industrialisation), towards industrial partner

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