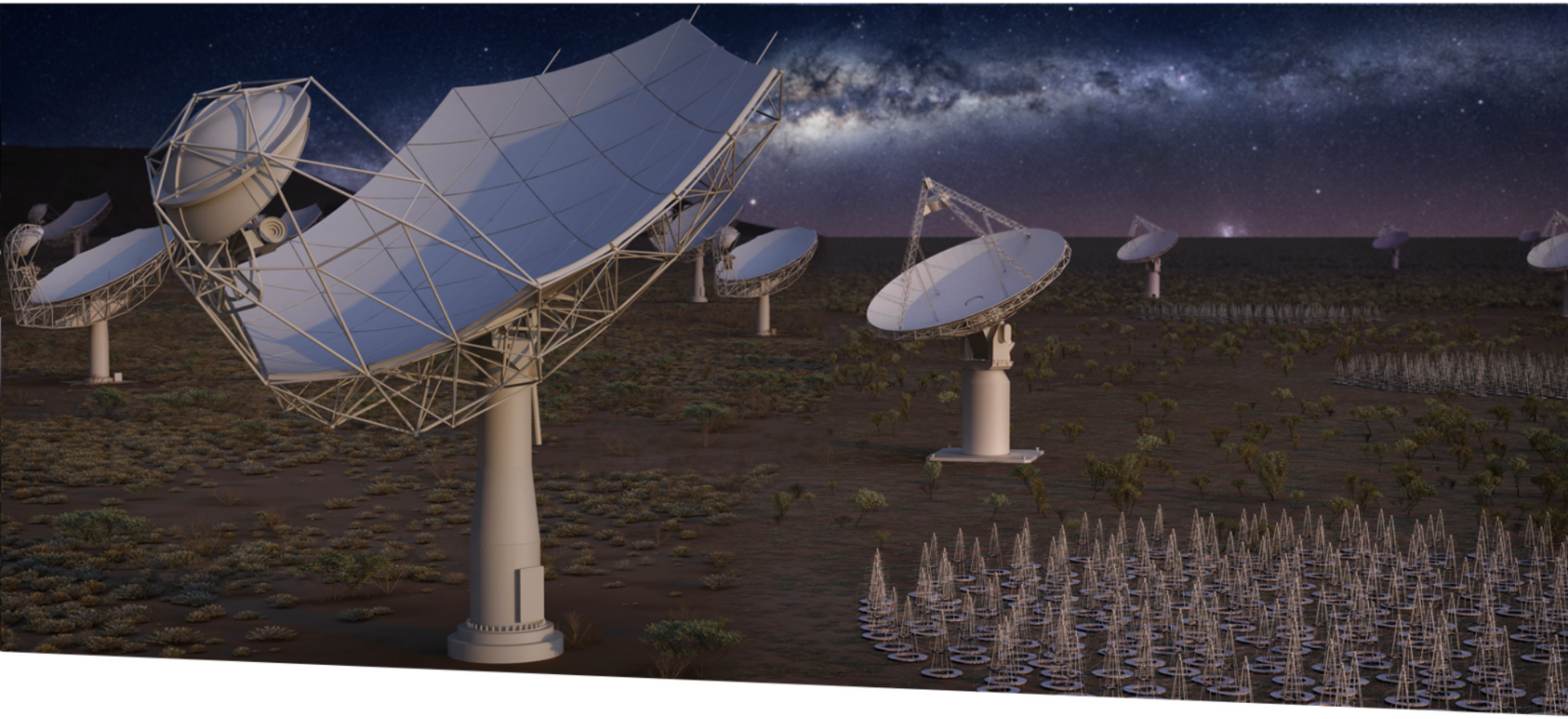
2016 SKA Engineering Meeting

2-6 October 2016

Stellenbosch, South Africa

#SKAengcon16

Towards Construction



SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Alistair McPherson

2 October 2016

Major events in 2016

- March 22-23: SKA1 System Review, SKA HQ
- April 4-6: 20th SKA Board Meeting, Pune, India
- April 19-21: 3rd IGO Meeting, Rome
- May 11-13: HPC/SDP Meeting, Shanghai
- May 23-25: SKA Management Review, SKA HQ
- July 13-14: 21st SKA Board Meeting, SKA HQ
- October 27-29: 4th IGO Meeting, Rome

Staffing

- New Starts
  - Luca Stringhetti – Project Engineer
  - Nick Rees – Head of Software & Computing
  - Mark Bowen – Domain Engineer DSH
- Current Recruitment
  - HPC Specialist – Filled
  - Control Specialist – under negotiation
  - Head of Procurement – Short listed
- New Adverts
  - 2 * Telescope Engineers
  - PM for SDP/TM
  - Coordinator for SRCCG
  - Administrative Assistant

Status: Towards System PDR

Recommendations from March 2016 System Review	Actions taken
1. Complete L1 requirements with traceability & compliance with the key science goals but do not spend any more effort in formulating or linking to L0 requirements.	Rev08 and Rev 09 released; Rev 10 Dec '16
2. Flow down the operational concepts and calibration requirements to include them in the L1.	Rev 08 incl. ops; Rev 10 to include calibration
3. Release all technical budgets with allocations down to L2.	Some in Rev09; rest in Rev 10
4. Complete the release of all system-level ICDs.	ICD review held 21-23 June and follow-up actions underway
5. Ensure the coherence of the integrated system design with the overall architecture, the ICDs and the L1 and L2 requirements.	System PDR meetings addressing (next slide)
6. Invite the Director of Science, in consultation with the SWGs, to endorse the L1 requirements as meeting the science goals before the system PDR.	Done – Dir Sci now a signatory to L1 releases
7. Complete the project management plan for the SKAO including schedule, WBS, milestones and resources (Gantt chart) to cover the SKAO activities from now to at least the CDR covering all key activities as alluded to in this review.	Done and ongoing – changes via consortia ECPs
8. Hold a system PDR as soon as practical and before too much at-risk work occurs towards the CDRs in the element consortia.	System PDR meetings addressing (next slide)
9. The panel recommends that no further re-scoping is attempted before the CDR.	Subject to Board decision
10. Modify the organigram (or include additional charts) to indicate the SKAO staff that support the element consortia within their discipline and showing that each consortium has PM, SE coverage.	Already on org chart
11. Consider adopting a more standard way of marking risks so that a high risk for which there exists a clear mitigation plan (albeit not yet implemented) does not score the same as a high risk for which there is yet no plan	Implemented in Sept update
12. Complete the Hazard Analysis as soon as practical so that potential safety issues can be designed out.	Ongoing – safety reps appointed and 1st drafts in

Office key milestones June to December '16

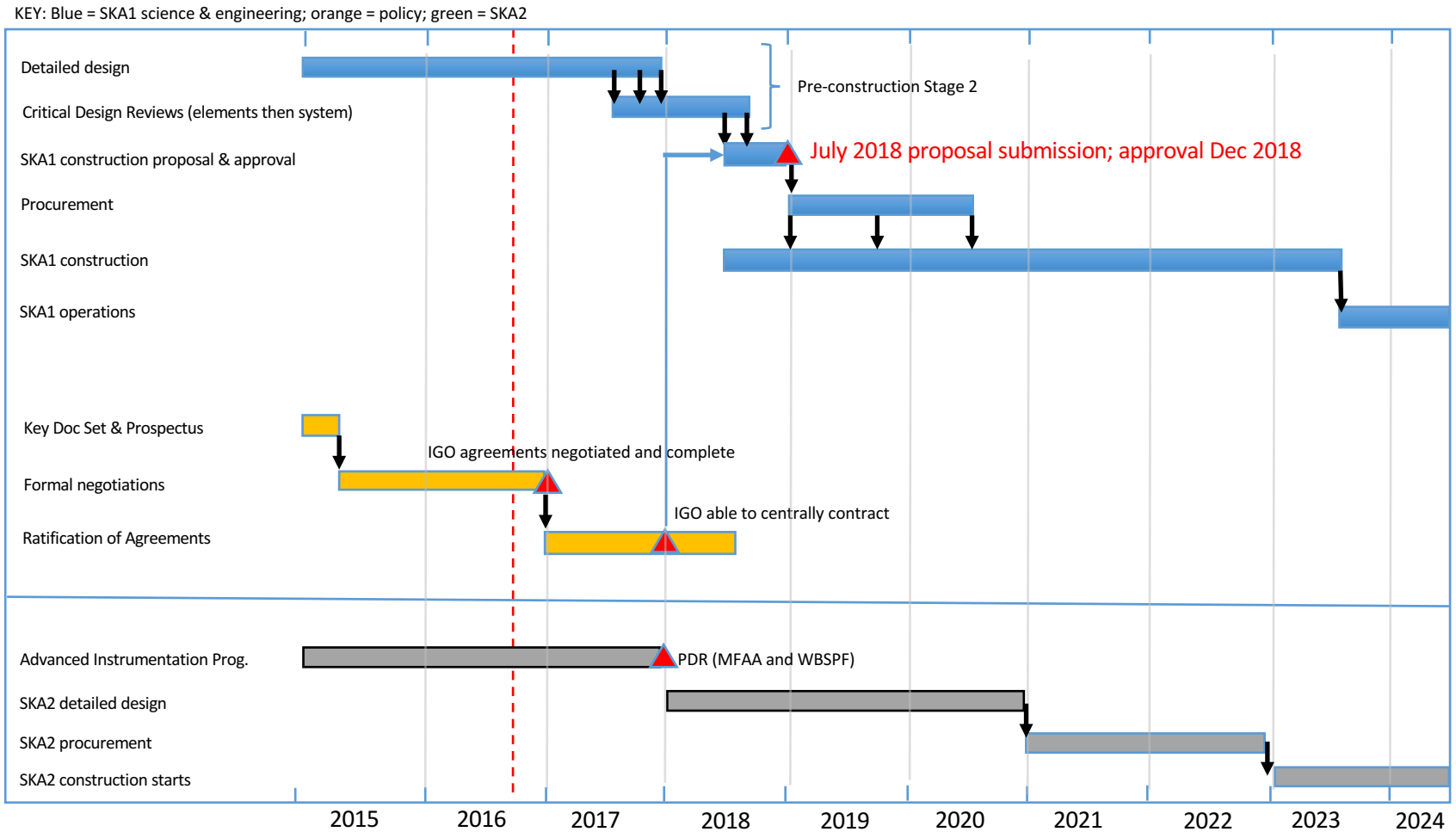
Milestone	Date	Met	Key dependency/other comment
Initial Expression of Interest update to IGO	16th June	✓	Member submissions 3rd June
System PDR: ICD review	21st-23rd June	✓	Report released 1st August
Cost update for July Board	29th June	✓	Consortia submissions 3rd June
L1 Requirements Revision 8 released	30th June	✓	Released 5th July
L1 Requirements Revision 9 released	12th September	✓	Released 13th September
Cost update for IGO#4	12th September	✓	Consortia submissions 5th September
System PDR: Design review	20th-21st September	✓	Report in preparation
System PDR: Budget review	24th–25th October	-	Fortnightly reviews tracking
System PDR: ICD update	31st October	-	Follow-up from ICD review
Cost update for November Board	10th November	-	Consortia submissions 5th September
Construction schedule for November Board	10th November	-	Engineering Meeting key input sessions
System PDR: Panel sign-off	6th-7th December	-	Panel members confirmed
L1 Requirements Revision 10 released	6th December	-	Latest ECPs to be raised by 24th October CCB; latest inputs to Wallace by 22nd November

Status: Towards System PDR

- Other actions:
  - Consortia have been asked to respond to each L1 release with compliance matrices, traceability to L2 and below, and ICDs
  - Requirements Forum established
  - Functional analyses aligned
  - Telescope Teams continue to address specific telescope level issues

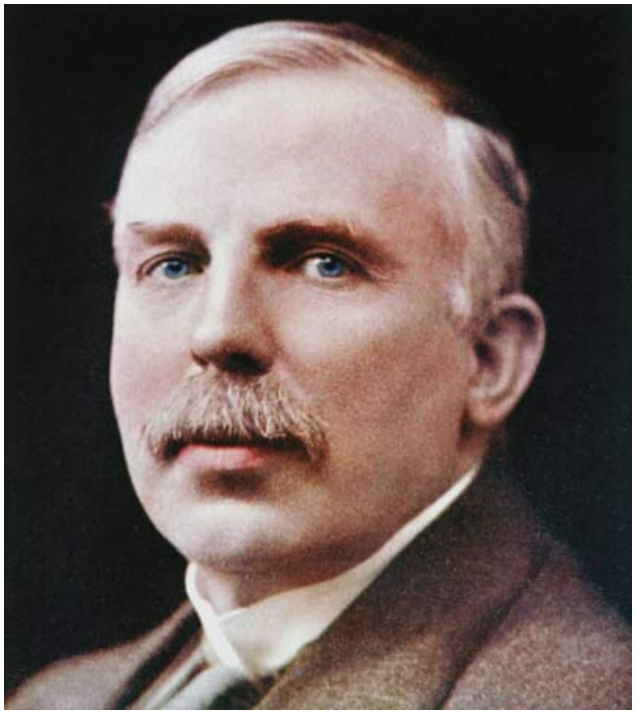
- System PDR staged:
  - ICDs – 21-23 June 2016 (report released)
  - Design – 20-21 September 2016 (held last week)
  - Budget – 24-25 October 2016 (planned)
  - External Panel sign-off – 6-7 December 2016 (members now confirmed)

High-level SKA Roadmap



SKA1 Construction Programme

- **Scope:** draft WBS and Cost Book released Q2 2016 for initial Expression of Interest process
  - 8 Members responded, all WPs covered, on average 2 Members per WP, some 5
  - next draft release Q4 2016 to include consortia input received over the summer plus Observatory level WPs
- **Costs:** 3 sets of construction and operations cost estimates received from consortia in 2016
  - Increasing level of maturity
  - Currently exceed the construction cost cap
  - Phased deployment options being modelled
- **Schedule:** draft being developed for the November Board of Directors meeting, with focus on getting to Array Release 1 for both telescopes
- **Support & facilities:** definition/negotiations proceeding ON ITFs and Construction Support Centres

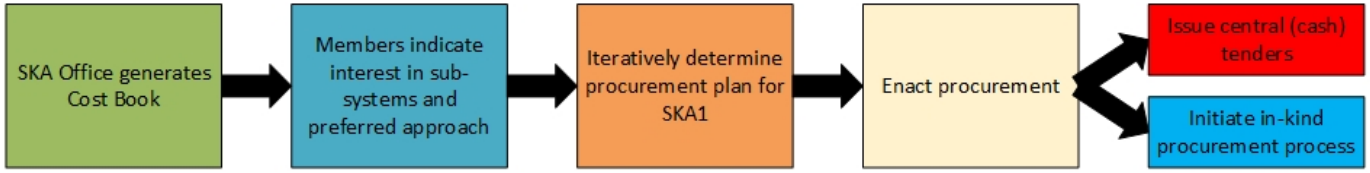


"Gentlemen, we have run out of money. It's time to start thinking."
— **Ernest Rutherford**

Expression of Interest - Purpose

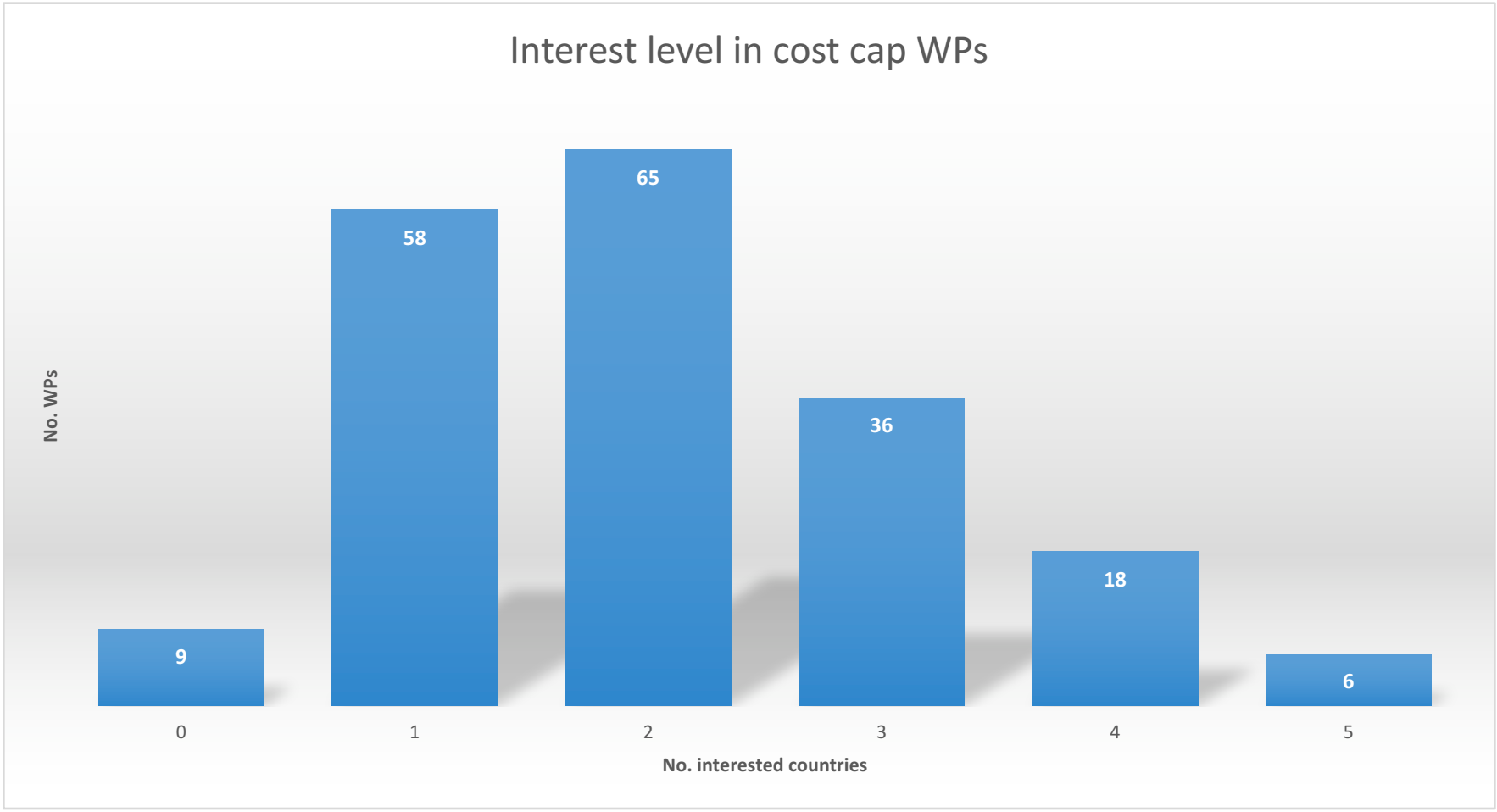
- The purpose is to provide Members, the SKA Board and IGO negotiators visibility of the workpackages, the logic behind the partitioning and an indication of their expected costs to inform and facilitate negotiations on contributions
- The desired effect is to create the correct environment for industry to participate to the maximum extent
  - Through using industry standard and industry friendly structures
- The output of the EoI will be the input of the Procurement Plan

Process steps and WBS development

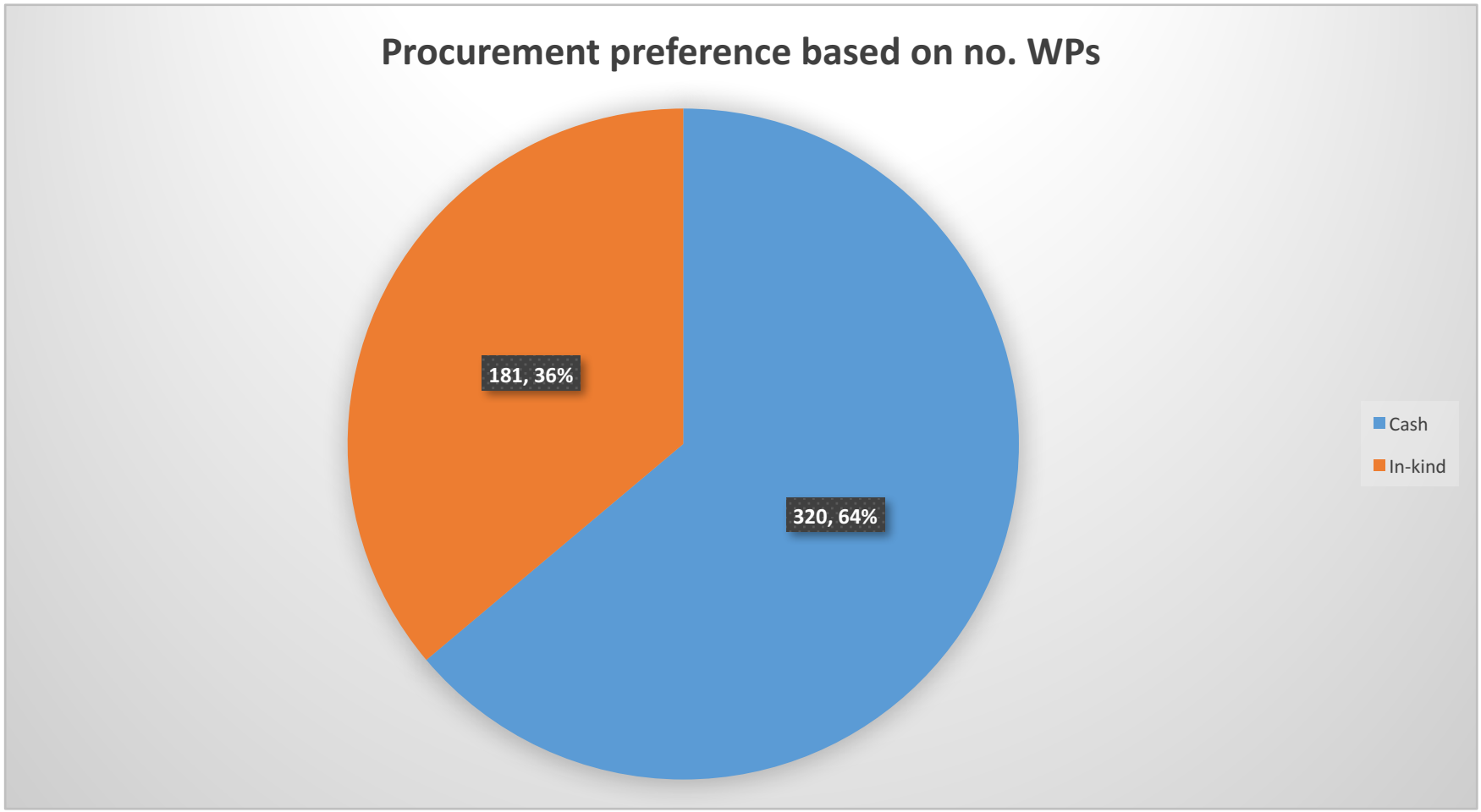


- Cost Book
  - Developed 'intelligently' with appropriate granularity and structure
- Negotiating parties want to understand potential for a fair work return
  - Some steps in discussion on a potential procurement plan, optimising approach to help to facilitate work return ambitions while minimising project risk
- A Construction WBS (leading to Cost Book) has been drafted, which reflects the need to build up the Telescopes hierarchically

Interest Level



Procurement Preference



Definition of CDR

- Information Note on ‘Definition of CDR’ drafted to help Consortia in understanding
  - Accompanying document ‘Technical Preparation for Procurement’ has also been drafted
  - These documents improve upon and add to the definition of CDR deliverables in the SoWs
- Lays down the necessary status and documentation of the design at CDR
  - First step to full industrialisation
- Discusses the support of the transition from CDR to Procurement by key personnel through Construction Support Centres (CSCs)
  - CSCs succeed the Pre-Construction phase Consortia

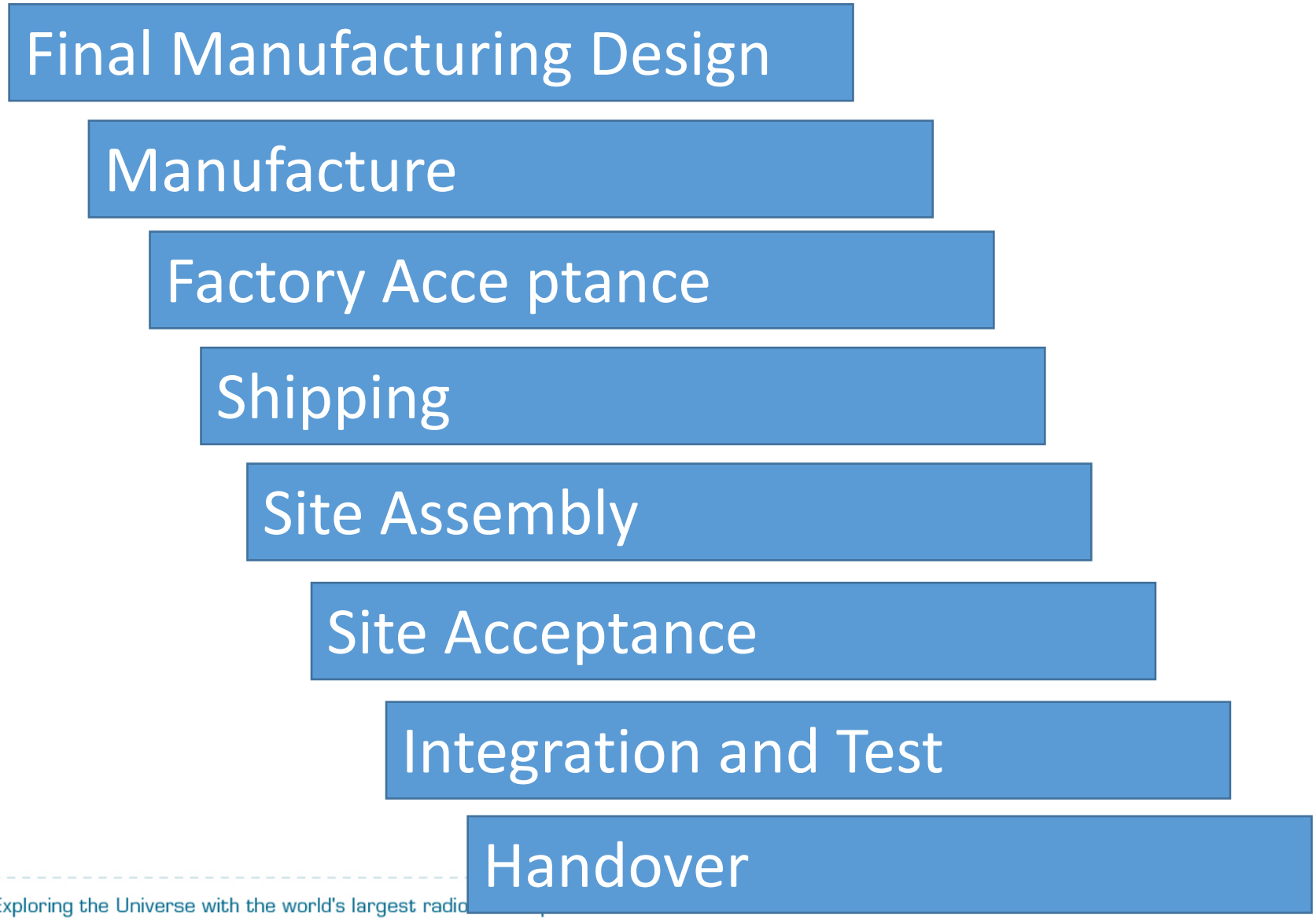
CDR Output

- Design:
  - Validated by analysis and prototypes
  - Information available for manufacturing
  - Operational and maintenance aspects have been analysed and taken into account
- Design Pack Includes
  - All analytical evaluation
  - Definition of processes required for manufacture, verification and installation
  - Analysis of operational and maintenance aspects
  - As-designed documentation pack

CDR to Construction

- Consortium CDRs
- System CDR
- External Cost Review
- Construction Proposal
- Permission to Construct
- Implement Procurement Plan
- Agree Contracts/Agreements
  - Specifications
  - Statements f Work
  - Reference Designs
  - Interface Control Documents
  - Standards

Construction Phases



Consortia Role in Construction

- Pre-Construction Role
  - Design Consortia
    - Funded by nations
    - Systems engineering from SKAO
- Construction
  - Preserving knowledge of design
  - Support of SKA Office
  - Support to Contractors/Suppliers

Preserving SKA knowhow

- IP and knowhow created during pre-construction, and world class expertise, will be utilised to the maximum extent possible during Construction and beyond
  - Key personnel will be critical to this
- Pre-Construction Consortia will cease to exist, however:
  - Key personnel will be involved in Construction
  - Key personnel will be engaged via Construction Support Centres which may be existing institutions or collaborations between institutions

How to do this? (I)

- Key personnel and institutions, through the Construction Support Centres mechanism could be involved, optionally, in two ways:
  - By joining Construction consortia to provide hardware and software
  - By obtaining consultancy contracts with the SKA Observatory

How to do this? (II)

- Two possible scenarios:
  - If the ’reference design’ is used
    - key personnel and institutions will be directly involved in supply
    - The Observatory will have minor consultancy contracts with third party experts
  - If the ‘reference design’ is not used
    - The Observatory will consult directly with key personnel and institutions

Implementation

- The Construction WBS does not presently reflect either scenario
- Careful consideration would need to be given to meshing academia/R&D cultures with industry cultures
- Consultancy would not involve supply of hardware or software
  - It would be time only
- The choice of scenario would depend upon the outcomes of procurement activity and cannot be predicted with full confidence
- Consultancy would be a contribution to Construction, could be in-kind, and would receive valuation

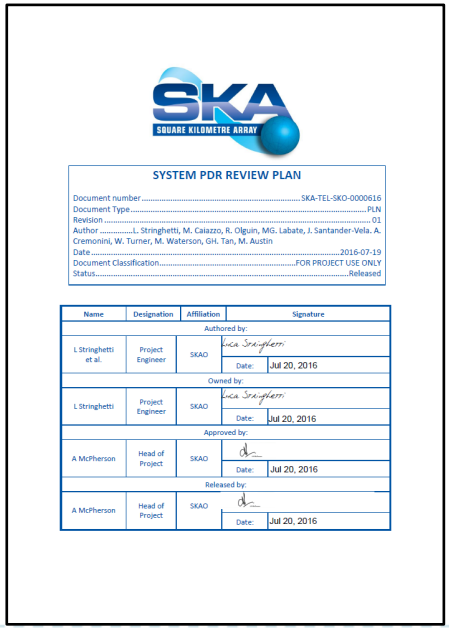
Plan

- Feedback on Fair Work Return Definitions from IGO#4
- Develop Instructions for Next EoI
- Call for revised EoI
- Develop Procurement Plan
- Gain agreement with Procurement Plan with Members

System PDR

- Internal ICDs PDR 21st June 2016
- Internal Design (I) PDR 20th September 2016
- Internal Design (II) PDR 24th October
- External panel PDR – Sign OFF 6th and 7th December

- PDR plan available in eB



SYSTEM PDR REVIEW PLAN

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Revision 01
Author ..... L. Stringhetti, M. Caiazzo, R. Olguin, MG. Labate, J. Santander-Vela. A. Cremonini, W. Turner, M. Waterson, GH. Tan, M. Austin
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ICDs: Review Conclusions

- **ICDs (generally) are not at PDR level….yet.**
- We need to update ICDs in the next months, but before the external PDR system review, to get to the following level of maturity.

#	Review Statement	Note	Action
1	**Not all the ICDs are signed and agreed.**	Even if it is acceptable that at PDR level the ICDs are not "frozen", the PDR version must be agreed and signed.	Baseline ICDs. (To be completed 2 weeks before Milestone#4 of the PDR process as indicated in [AD3])
2	**Identification of interfaces is not always complete. (few cases)**		Complete identifications. See above. (To be completed 2 weeks before Milestone#4 of the PDR process as indicated in [AD3])
3	**The quality of the ICD document is not always satisfactory**	• Reference in the AD to the correct version of the L1 req. and when applicable to the current version of L2. • Describe in the Interface Verification chapter the interface verification plan/strategy.	Improve the quality of the document. For Milestone #4 the score shall be at least 4 or above.

During Requirement Forum there was a discussion on what an ICD should look like. Three different meetings on this topic have been organised SEMP and PMP will be updated accordingly

ICDs: Review Conclusions

- **ICDs (generally) are not at PDR level….yet.**
- We need to update ICDs in the next months, but before the external PDR system review, to get to the following level of maturity.

#	Review Statement	Note	Action
4	**Interface requirement elicitation is not complete**	Some TBD are acceptable at PDR level but all the interfaces shall be addresses.	Improve completeness I. For milestone #4 the score shall be at least 4 or above.
5	**Interface definition is not complete**	For PDR level the ICD shall be almost complete and therefore the description part shall be rather complete. Many ICD are a list of requirements but very little is done for the description part (or implementation). We must say that in some cases most of the interfaces are described with a shall statement, even if they describe an implementation of an interface. In this cases the level of completeness of the description part can be recovered easily.	Improve Completeness II. For milestone #4 the score shall be at least 3 or above.

ICD definition is a system activity and bad management of these interfaces add risk to the project for the integration/verification stage. For PDR level it is expected a higher level of completeness, even if it is “normal” to have (few) changes between PDR and CDR.

Design I: Review Preliminary Conclusions

- **REQUIREMENT** : Was impossible to provide a System Compliance matrix at the PDR because the L2 requirement compliance matrixes from consortia were not delivered in time. We are working to have a Compliance Matrix updated before the end of October in order to present it in time for the PDR sign off.
- **DESIGN** : Preliminary design is in place. Not fully documented in a systematic way. Some actions are in place.
- **ANALYSIS**:
  - FUNCTIONAL ANALYSIS. Planned a new version for 15/11/16. Review is about to start. Level of the analysis compliant with the PDR
  - RAM Analysis. Level of the analysis compliant with the PDR
  - SAFETY Analysis. Some important documentation is still in draft version. Agreed a detailed plan for next steps/deliveries.
- **VERIFICATION**: A lot of work is planned in the AIV consortium and in the SKAO office. Plans are available but new releases have been planned.

Stairway to ……Revision 10

- Rev 9 Release on the 12th September.
- Revision 10 Expected 6th December.
- Normal tasks:
  - Implement agreed ECPS (~5)
  - Implement future agreed ECP (Estimation is less than 5)
  - Update Glossary
- Improvement tasks
  - Implement context diagram
  - REV9 Review will be open soon. There will be a number of reviews with specific topics. Some of them have already been initiated. These reviews will have the objective to engage relevant people on a specific focus. Refer to Engineering Forum meeting for detailed schedule.
  - At the end of the reviews requirements will be modified, generated, or created and all these changes will be traced with the ECP process.

SKA1-Mid TT Update

- Good progress has been made in resolving issues since last Engineering Meeting
  - Four Resolution Teams have completed their task:
    - TT Mid RT1: Construction Phasing
    - TT Mid RT2: RFI Characterisation
    - TT Mid RT3: Mid Sampling Clock off-set
    - TT Mid RT6: Noise injection
  - Number of issues identified has saturated

Issue Status	2015-11-12	2016-09-23
Resolved	0	18 (incl. 4 major by RTs)
Watch (Track)	22	10
Major	12	12
Minor	7	3
Total	**41**	**43**

SKA1-Mid TT Update

- SKA1-Mid TT survey
  - As outlined in the TT Terms of Reference, about 6 months after kick-off a first evaluation about the operational experience of the TTs should be held
  - Key findings from SKA1-Mid TT survey in May 2016
    1. TT is in general meeting the expectations as defined in the ToR
       - No need to amend the ToR or TT scope
    2. Experience with time to complete RT task is that it takes longer than foreseen
    3. Improve interaction between Low TT and Mid TT
    4. Aim for improving attendance to TT meetings
  - Without exception the response to the TT activities at all levels has been very positive and encouraging to proceed as foreseen

SKA1-LOW TT Update

- Work was dominated by large issues, calibration, configuration, cost reduction:
  - TT Mid RT1: Construction Phasing
  - TT Mid RT2: RFI Characterisation
  - TT Mid RT3: Mid Sampling Clock off-set
  - TT Mid RT6: Noise injection

Issue Status	2016-09-27
Proposed	2
In Progress	10
Open for Comment	2
Approved	0
Closed	6
Watched	5
Total	**25**

SKA1-LOW TT Update

- SKA1-LOW TT survey findings

  - Key findings from LOWTT survey in June 2016
    - Progress meetings positively, frequency of meetings good, announcement could improve
    - Issues within LOW TT are often too large: split into smaller issues
    - Improve prioritisation
    - Efficiency of the resolution teams needs improvement.
  - Recommendations
    - Create oversight by dividing issues in themes
    - Increase efficiency by clearer milestones and better process
    - Prioritise the work
    - Clarification of the mandate

The TT-LOW team is seen as a valuable addition to the SKA-project. The cross-consortium approach is valuable and contributes to system awareness.

Software Harmonization & Training

- Software Staffing
  - One person providing controls expertise.
  - Second person providing High Performance computing expertise.
- Software Engineering Process
  - Development of Standards
    - Gathered inputs: https://confluence.skatelescope.org/display/SE/Software+Engineering+Process+Inputs
  - Development of development reference platform.
    - Harmonizing tools.
    - Provision will probably require office staffing.
- Tango Training
  - Tango training for all interested parties – provided by Elettra Synchrotron.
  - Cost will be about €800 per person (payable by individual institutions) plus some top-up by SKAO.
  - One course in SA after the engineering meeting.
  - Another course in Europe in Trieste.
  - Other courses (India, Australia SA 2, Europe 2) TBD.

The Developing SKAO Spectrum Management Programme

- ‘Internal’ to the Project
  - **Put RFI/EMI issues on the project agenda**
  - Support Host Organizations
    - Support RQZ preservation activities, understand RFI monitoring needs, etc.
  - Support Consortia
    - Interaction during design & development – Guidelines/Project requirements, etc.
  - Look for ‘gaps’ in our understanding/handling of related topics & processes
- ‘External’ to the Project
  - Establish direct links with governmental radio administrations of SKA member states to raise awareness & foster support at international level.
  - Participate in the regulatory work of the International Telecommunications Union.
    - **Support the process of registration of SKA sites with the ITU & inclusion in international regulatory texts**
  - Collaborate with international radio astronomy and science spectrum management organizations to push forward our common spectrum protection issues.

Towards Construction

SKAengcon#16

- Took into account Feedback from SKAengcon#15
- More separate meetings
- Fewer Plenary Sessions
- Closed Sessions – By Invitation Only
- Meeting Information in Confluence

  https://confluence.skatelescope.org/display/PPM/Engineering+Meeting+Template+2016

Towards Safety in Construction (and beyond!)

Wednesday 3:15pm
Simonsberg

Designers, from concept to detail, are required to identify hazards which may create significant risks for contractors, users and maintenance personnel and seek to reduce them.

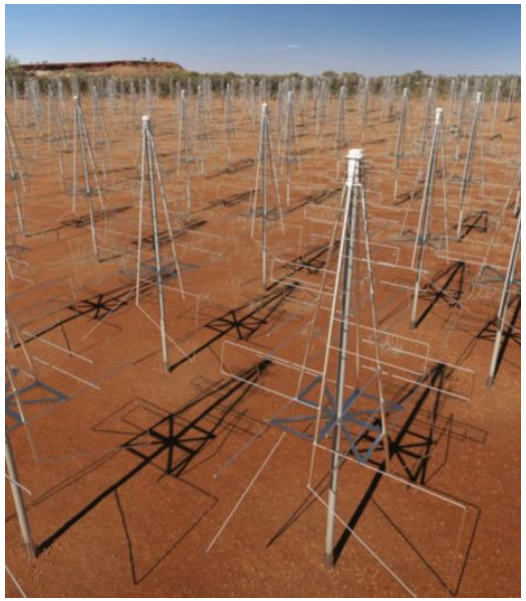
Construction Planning

SKA-1 MID

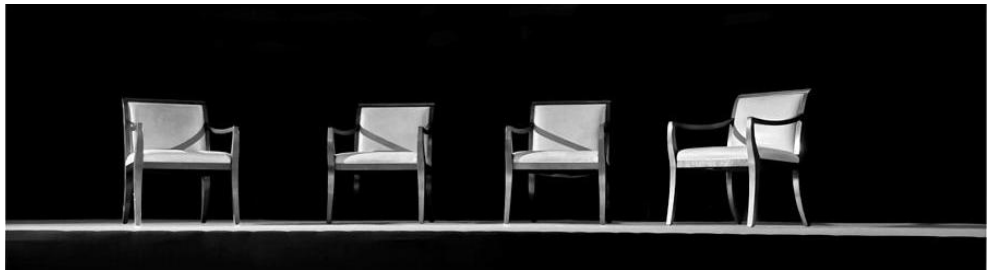
Tuesday 9:00am Reynolds

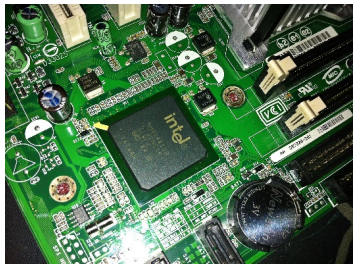
SKA-1 LOW

Tuesday 2:00pm Reynolds



Tuesday – 2:30 pm, “Big Industry, Big Projects”

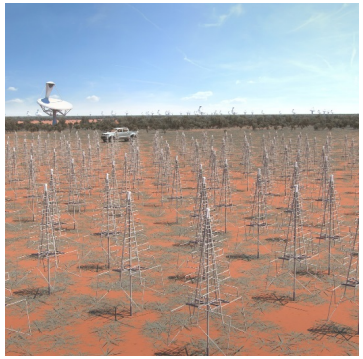




Live on stage!

Four representatives from major international consultancy, engineering, project management, and high-technology companies.

Come and hear about: procurement and contracting, strategic alliances, and lessons learned.



A session not to be missed!

SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope