Overview of SKA1 Technology Implications of Extensibility to SKA2

P. Dewdney

System Delta CoDR

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CoDR Report

- *Develop a two stage approach by defining a "baseline" SKA project and future "enhancements".*
  - a two stage technology development program including the baseline (Stage 1) and innovative technologies that need more time to prove their technical maturity and cost feasibility before committing to construction (Stage 2).
- Responded on the science side with DRM1.
- This talk will provide more detail on the technology side (also in Memo 125).
  - Stage 1 = SKA1
  - Stage 2 = SKA2 + Advanced Instrumentation Programme (AIP).
  - AIP examples:
    - the deployment of PAFs at the focus of the SKA1 dishes,
    - the deployment of a large Dense Aperture Array (DAA) operating at frequencies < 1.7 GHz,
    - Deployment of ultra-wideband feeds on the dishes.

SSEC SKA1 Concept (Memo 125)

SKA1 Technical Concept:

1. A low-frequency sparse aperture array
   - A/T_{sys} of ~ 2000 m^2/K
   - operating at frequencies between 70 and 450 MHz.
2. A dish antenna array with A_{eff}/T_{sys} of ~1000 m^2/K
   - ~250 15-metre antennas,
   - single-pixel feeds
   - frequency range of 0.45-3 GHz.
3. The arrays will be centrally condensed.
   - dishes and sparse aperture array stations co-located out to a maximum baseline length of 100 km from the core.
4. The dish array will be built to SKA2 specifications.

SKA1 Performance Parameters

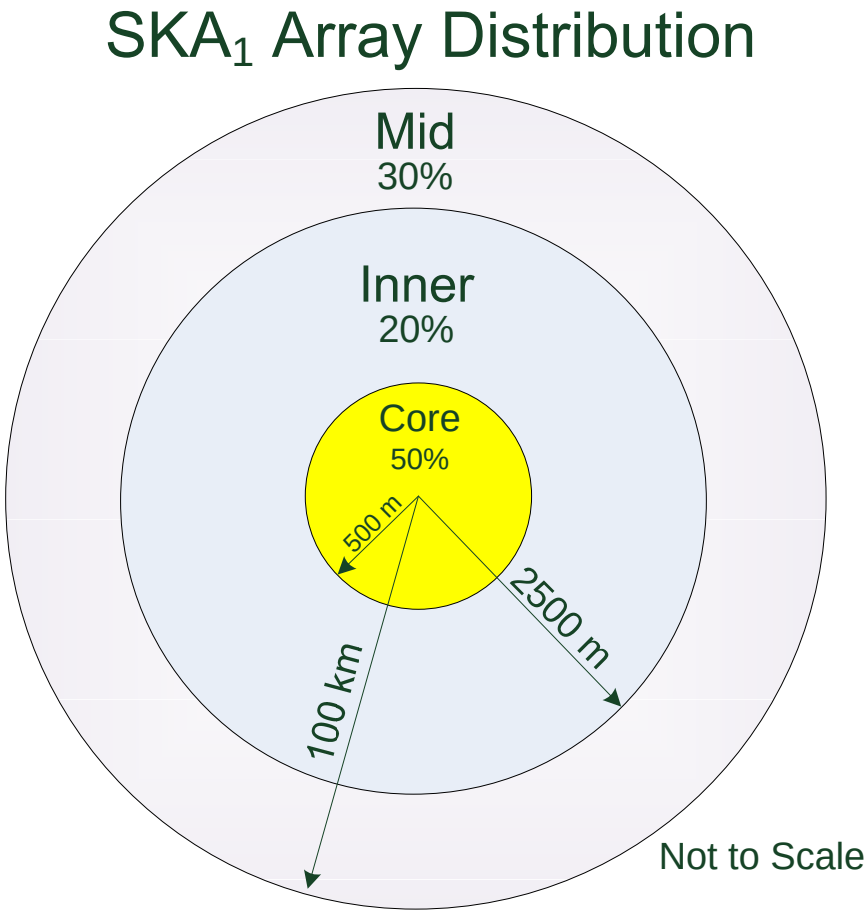
Unchanged in SKA1

- Lower Frequency Range?
- Frequency Resolution
- Time Resolution
- Configuration
- Imaging Dynamic Range
  (SKA2 compliant)
- Spectral Dynamic Range
- Polarization Performance

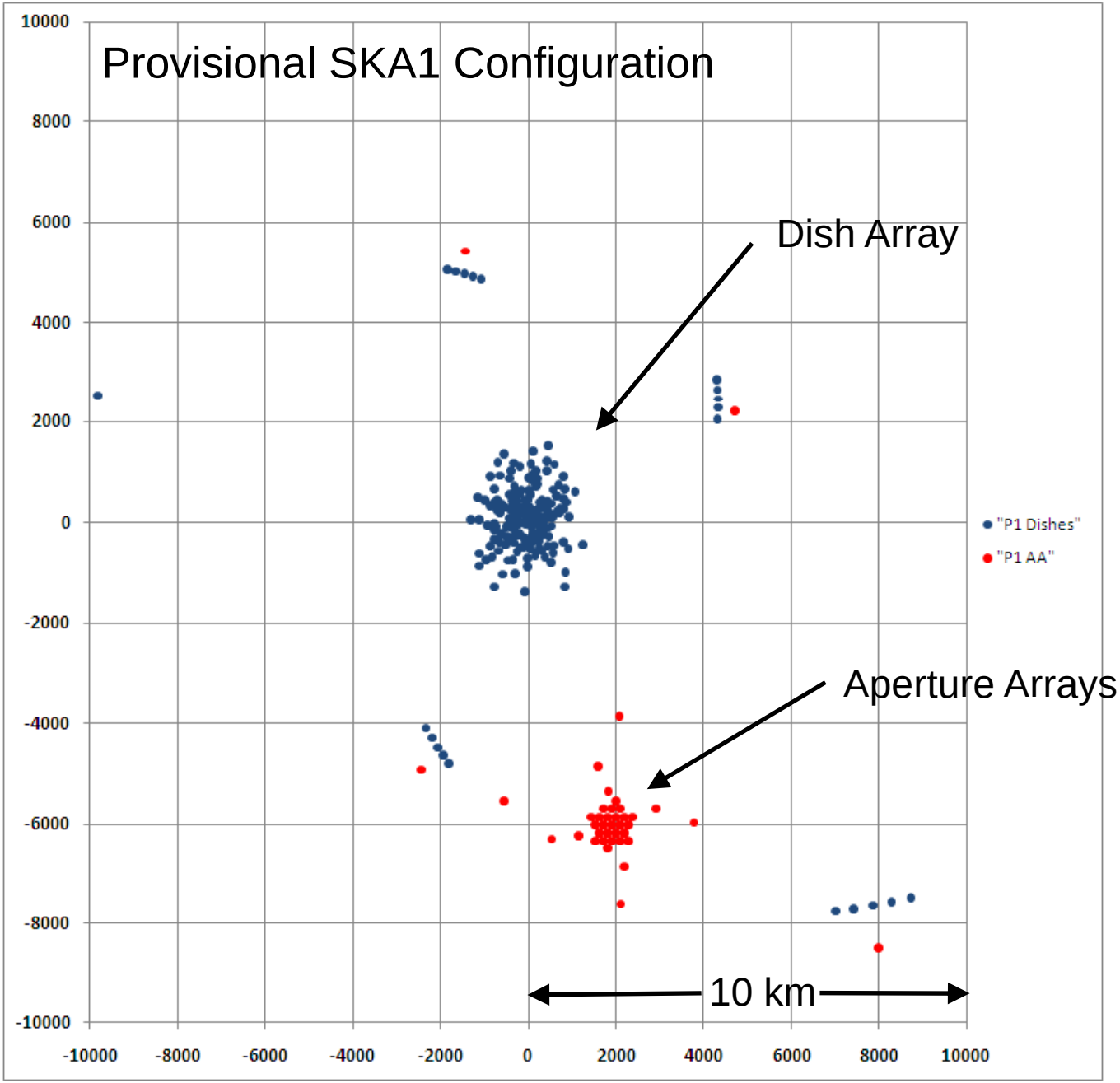
Modified in SKA1

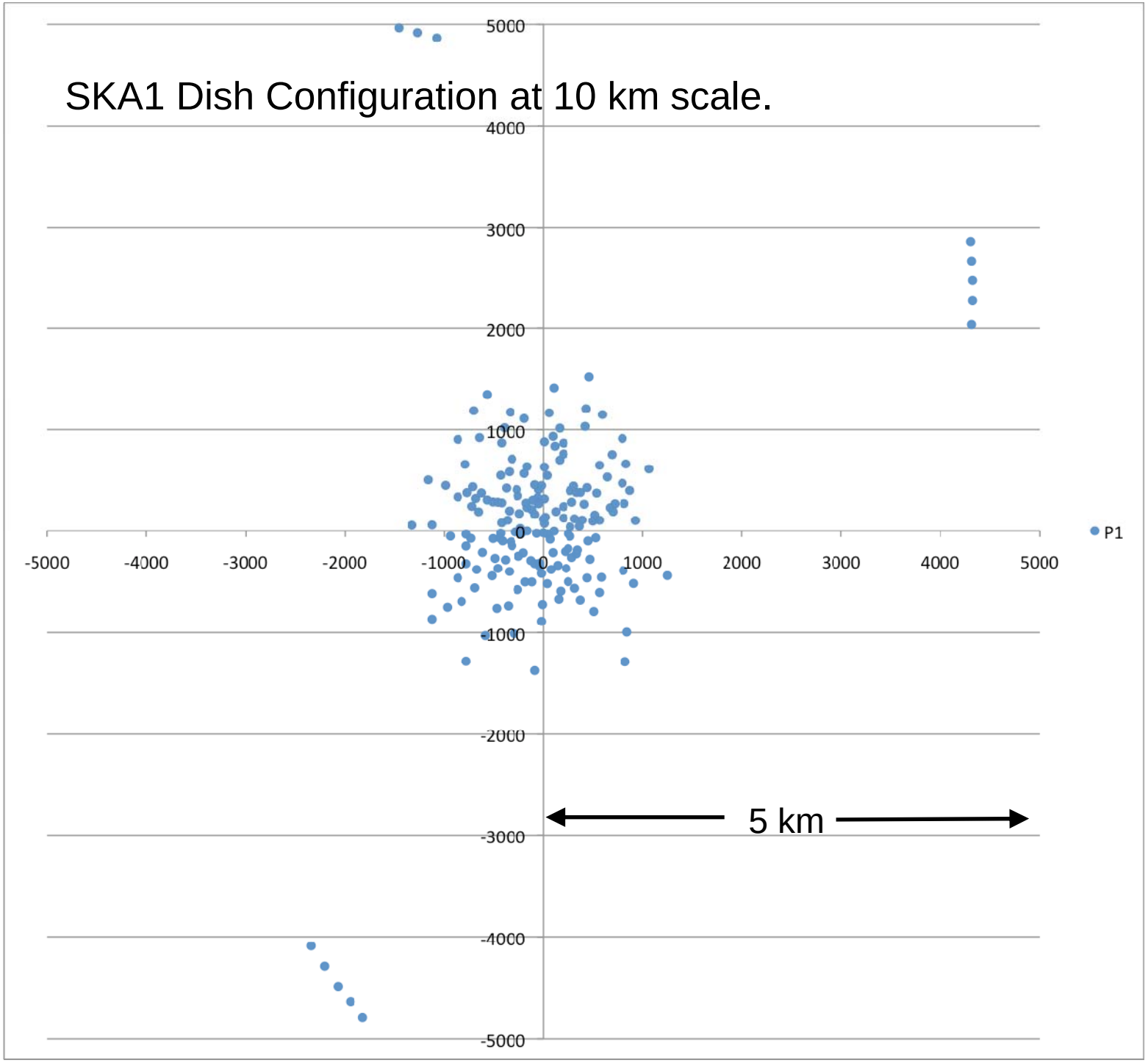
- Upper Frequency Range
- Sensitivity
- Survey Speed
- Maximum Baseline

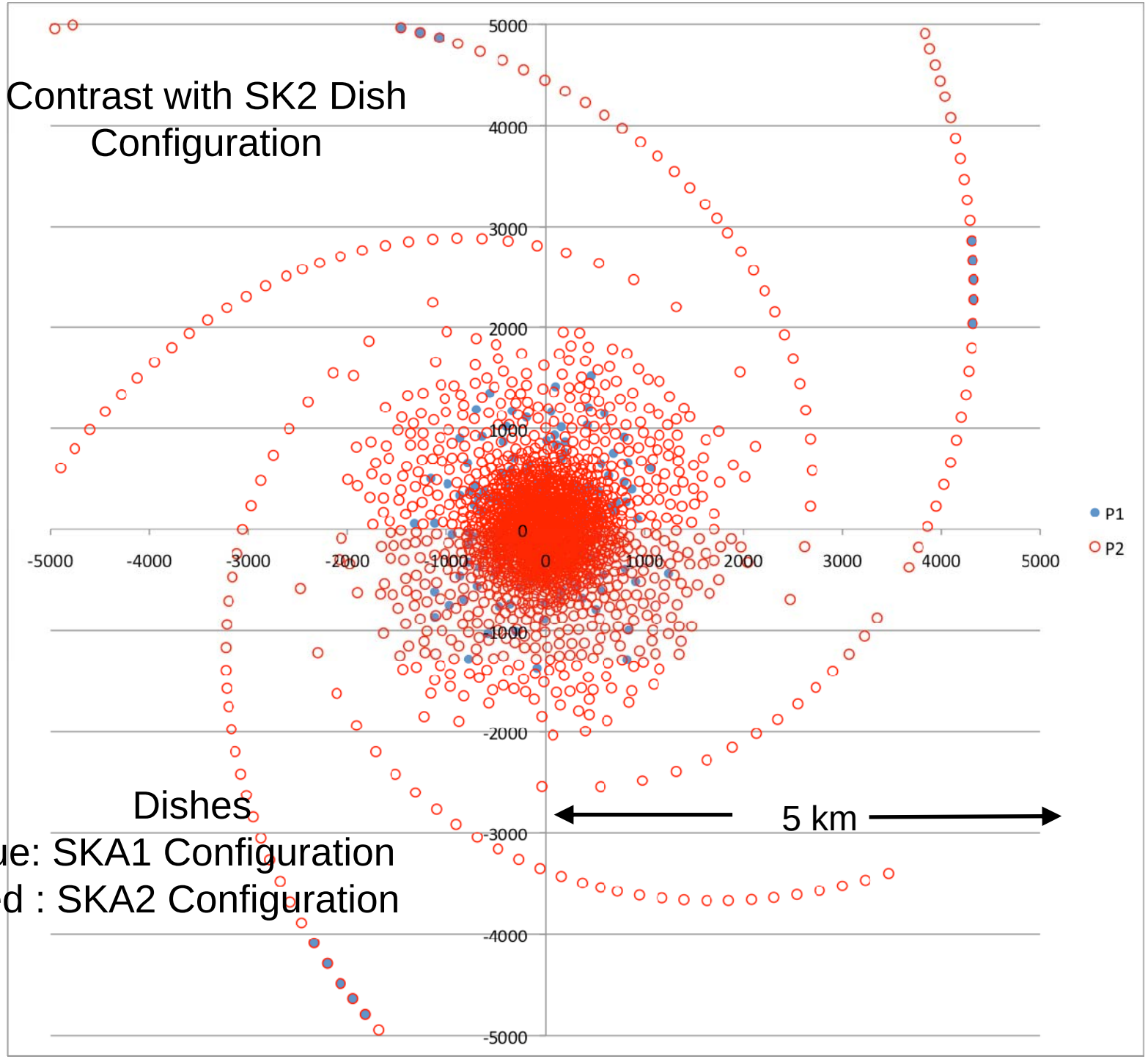
SKA1 Distribution of Collecting Area



Present assumption: Both dishes and AA-low are distributed in the same way. (Likely to change: DRM1 calls for different distribution at low frequencies).


Provisional SKA1 Configuration
Dish Array
Aperture Arrays
10 km
"P1 Dishes"
"P1 AA"
10000
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
-10000
-10000
-8000
-6000
-4000
-2000
0
2000
4000
6000
8000
10000


SKA1 Dish Configuration at 10 km scale.
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-5000
-4000
-3000
-2000
-1000
0
1000
2000
3000
4000
5000
P1
5 km

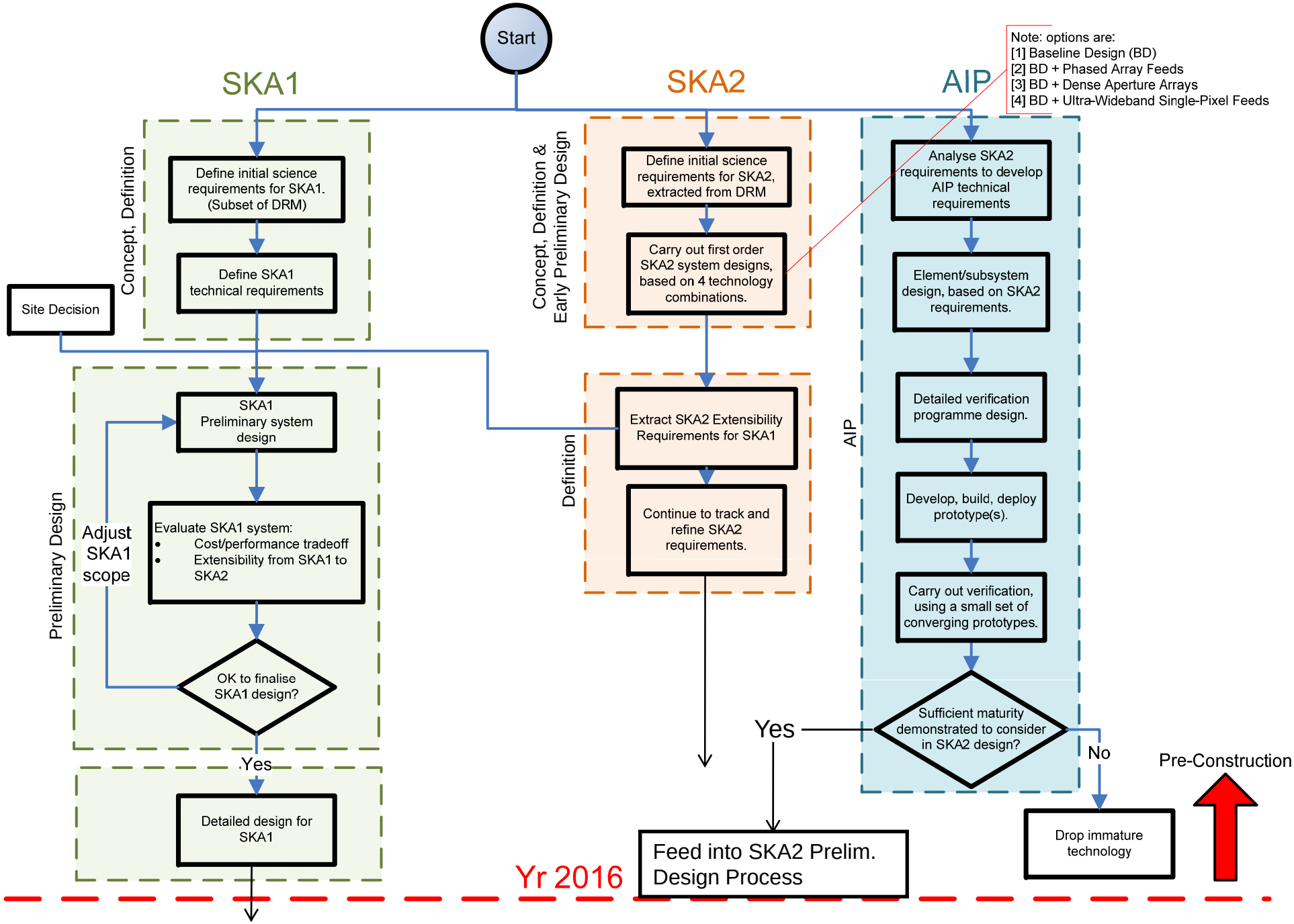

Contrast with SK2 Dish Configuration
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-5000
-4000
-3000
-2000
-1000
0
1000
2000
3000
4000
5000
P1
P2
5 km
Dishes
Blue: SKA1 Configuration
Red : SKA2 Configuration

SKA1 => SKA2

- Describe the basic methodology and system implications that must be taken into account in SKA1 so that it can be extended to SKA2.

- SKA1 has been broadly defined (science & technology).
  - Considered as a “step” along the way to constructing SKA2.
- However, the full technology complement for SKA2 is not yet well defined
  - a flexible plan for SKA1 => SKA2 is needed.
- The AIP will continue to develop innovative technology for:
  - phased array feeds on the dishes (PAFs),
  - Mid-frequency Aperture Arrays (AA-mid),
  - Ultra-wideband single pixel feeds on the dishes (WBSPFs).
- Development of AIP technologies
  - parallel with design and roll-out of SKA1 until early 2016
  - decision made on usage in SKA2.

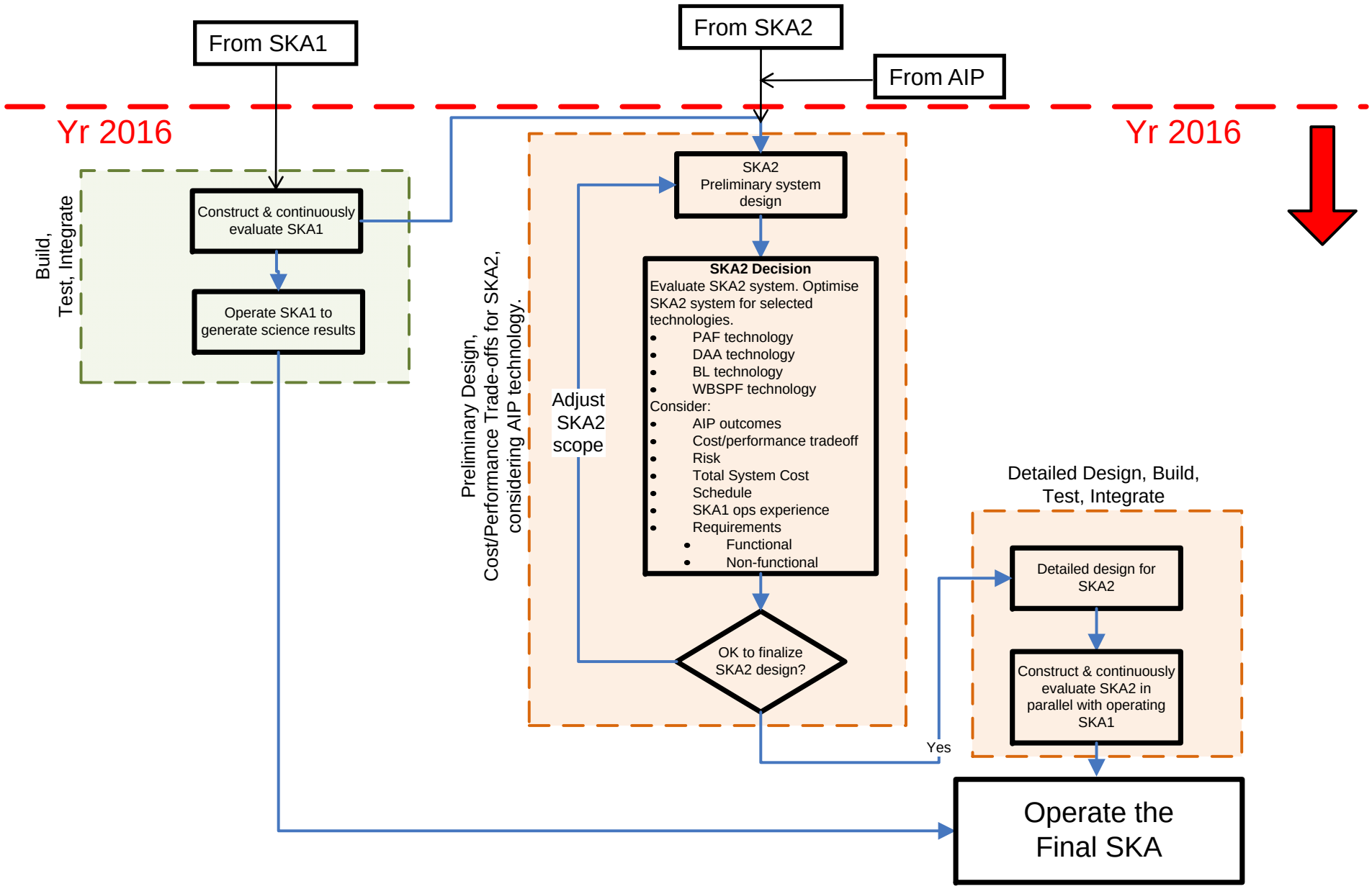
SKA1 => SKA2 Transition



Extensibility of SKA1 to SKA2

- Issues to contend with:
  - SKA2 technology or scope cannot be fully defined now.
  - Timescale of parts of SKA2 may depend on technology.
  - Planning and execution of SKA1 must account for continued system development to SKA2:
    - Even if cost-efficient, SKA1 cost will be higher.
- Classify parts of SKA1:
  - Elements/sub-systems that are too valuable to abandon must be designed and constructed to SKA2 requirements.
  - Components with short lifetimes or those that impede Phase 2 installation will have to be removed or abandoned.
  - Software, algorithms and much of the underlying hardware will be continuously developed and adapted indefinitely.

SKA1 => SKA2 Transition (cont'd)



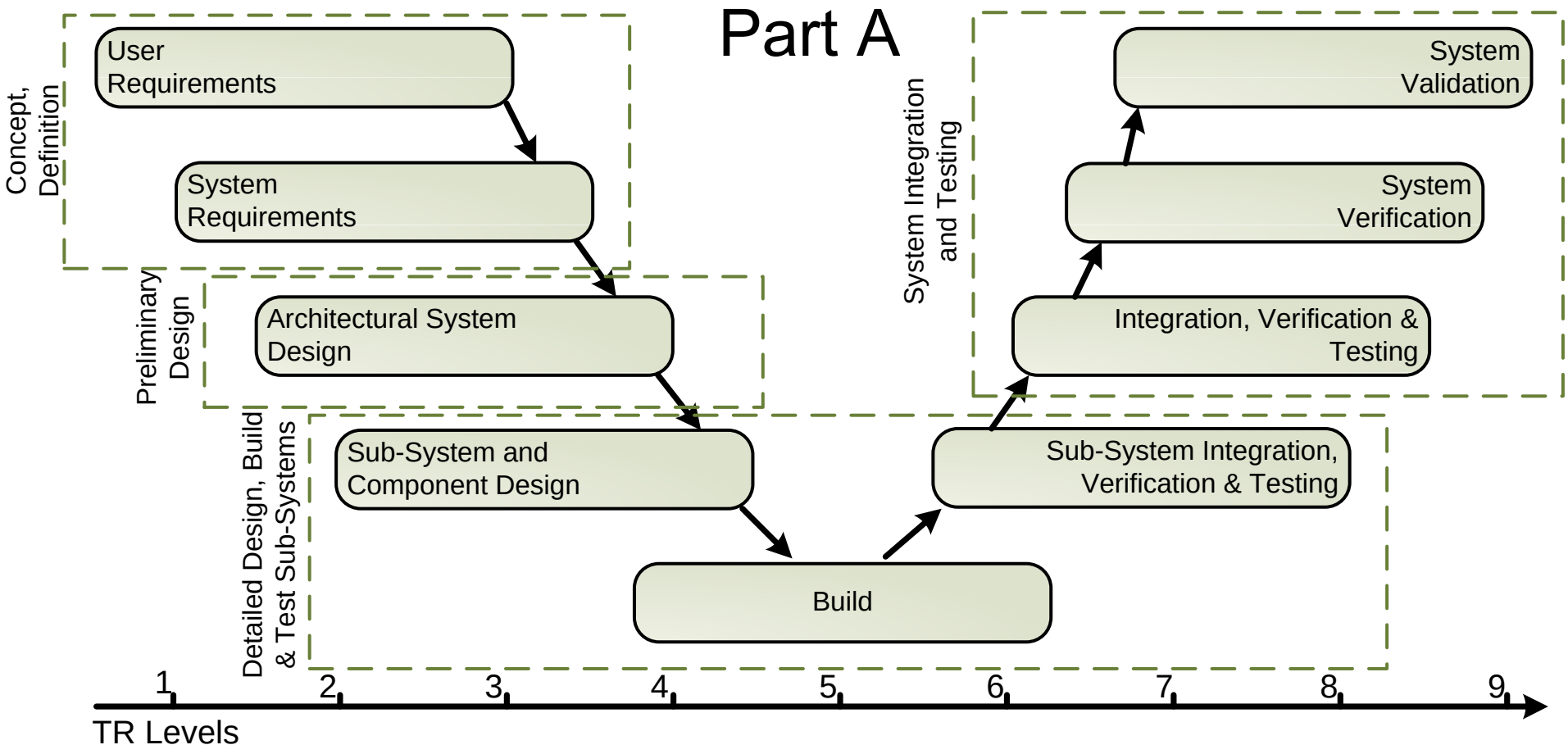
Important SKA1 => SKA2 Factors

SPDO

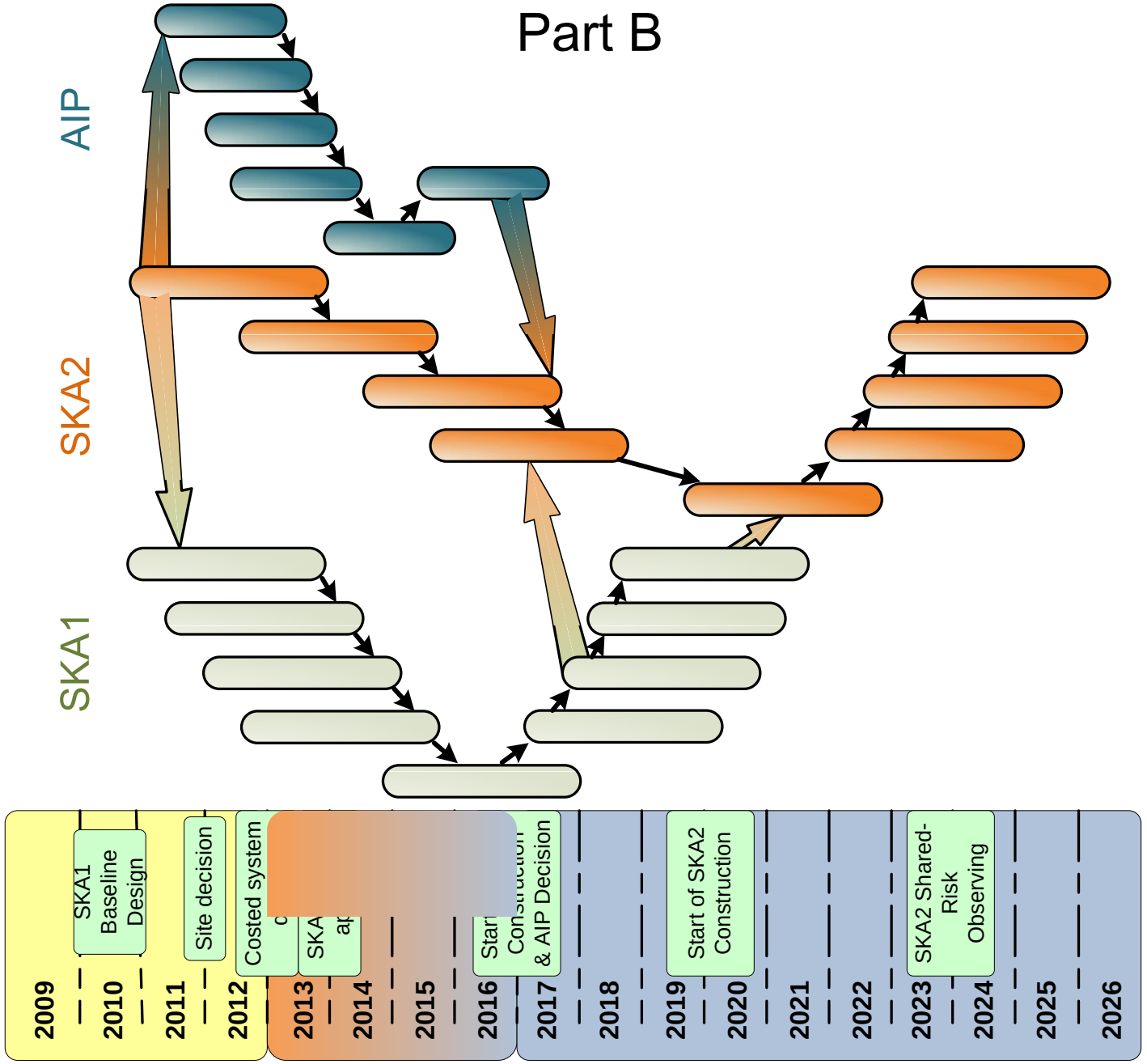
- 2016 is the decision date for technology selection for SKA2.
  - Implies that the trade-offs between science, performance, cost and technology will be deferred until after SKA1 construction start.
  - But by 2016, SKA1 will be partially rolled out,
    - major changes in SKA1 design will not be possible.

- The central section of the array is separated into 3 cores.
  - Provides opportunities for serial or quasi-parallel development and/or introduction of new technologies when they are ready.
- Generally tricky transition in infrastructure, data transport and power planning to go from SKA1 to SKA2.
  - These items are not easily scalable.
  - Cost may be substantial.

Large Project ‘V’ Diagram showing SKA Phases



‘V’ Diagram for SKA_1, SKA_2, AIP Programs



A Validation Step

- Starting with a performance model of the system (e.g. the High Level Description)
  - Must conform to met requirements.
  - Cross-check with original science case.
- What fraction of the original science can be done with this model system?
  - (“back-project” requirements)
- Are we building the right thing?
- Examine also for generality and completeness.

End