Mapping the Universe with the Square Kilometre Array

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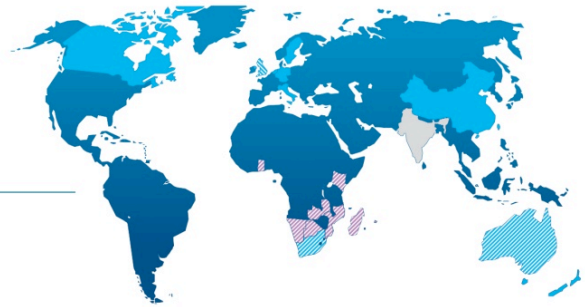
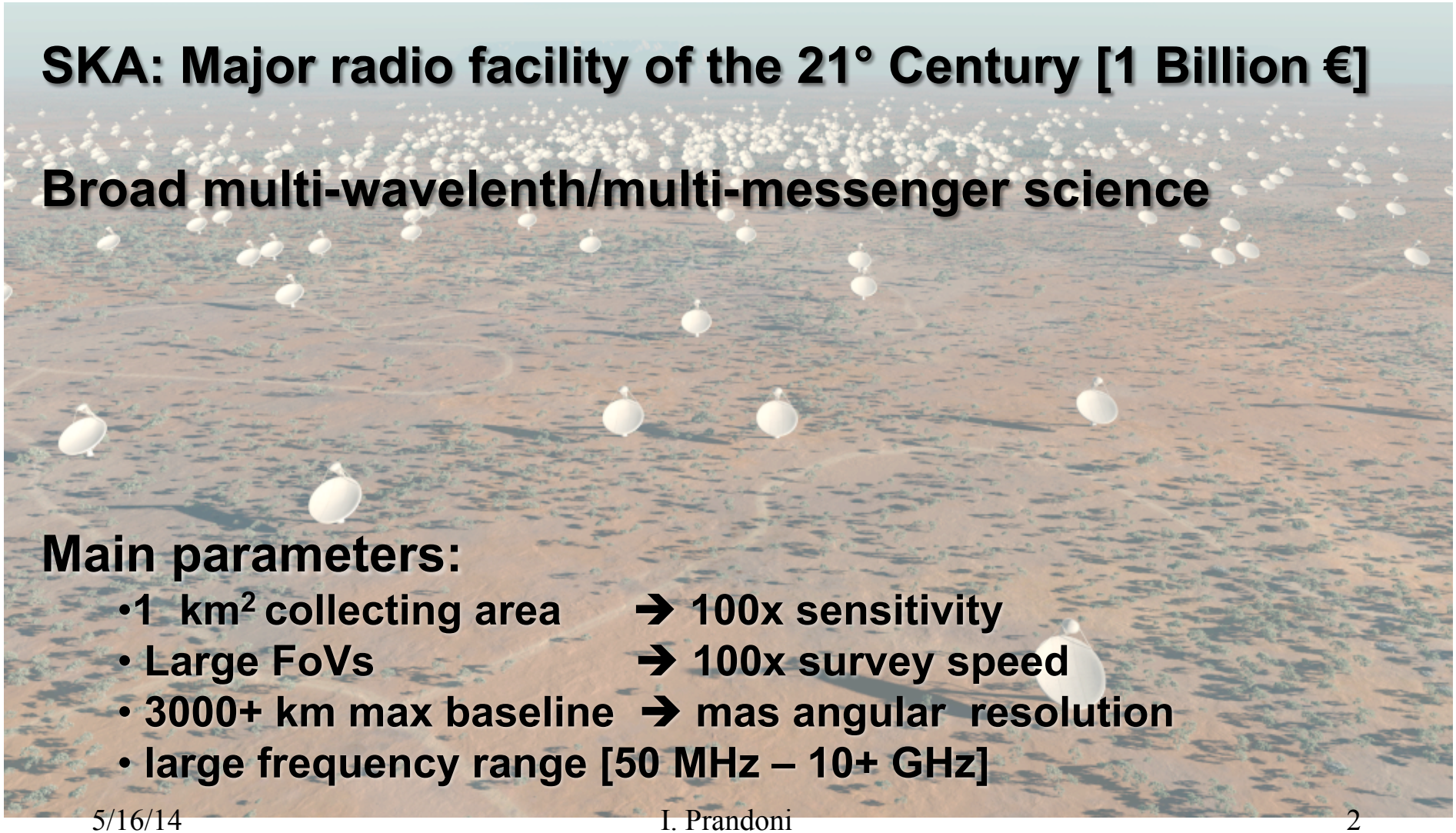
INAF - IRA

www.skatelescope.org

Exploring the Universe with the world's largest radio telescope



The SKA in a nutshell



SKA: Major radio facility of the 21° Century [1 Billion €]

Broad multi-wavelenth/multi-messenger science

Main parameters:

- **1 km^2 collecting area → 100x sensitivity**
- **Large FoVs → 100x survey speed**
- **3000+ km max baseline → mas angular resolution**
- **large frequency range [50 MHz – 10+ GHz]**

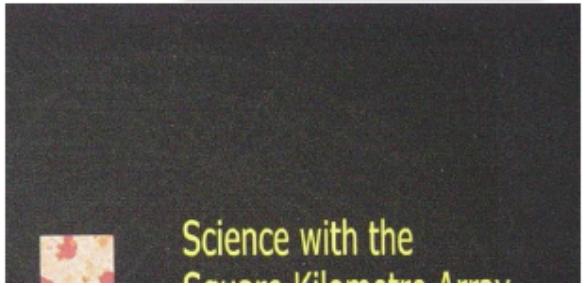
Courtesy R. Braun

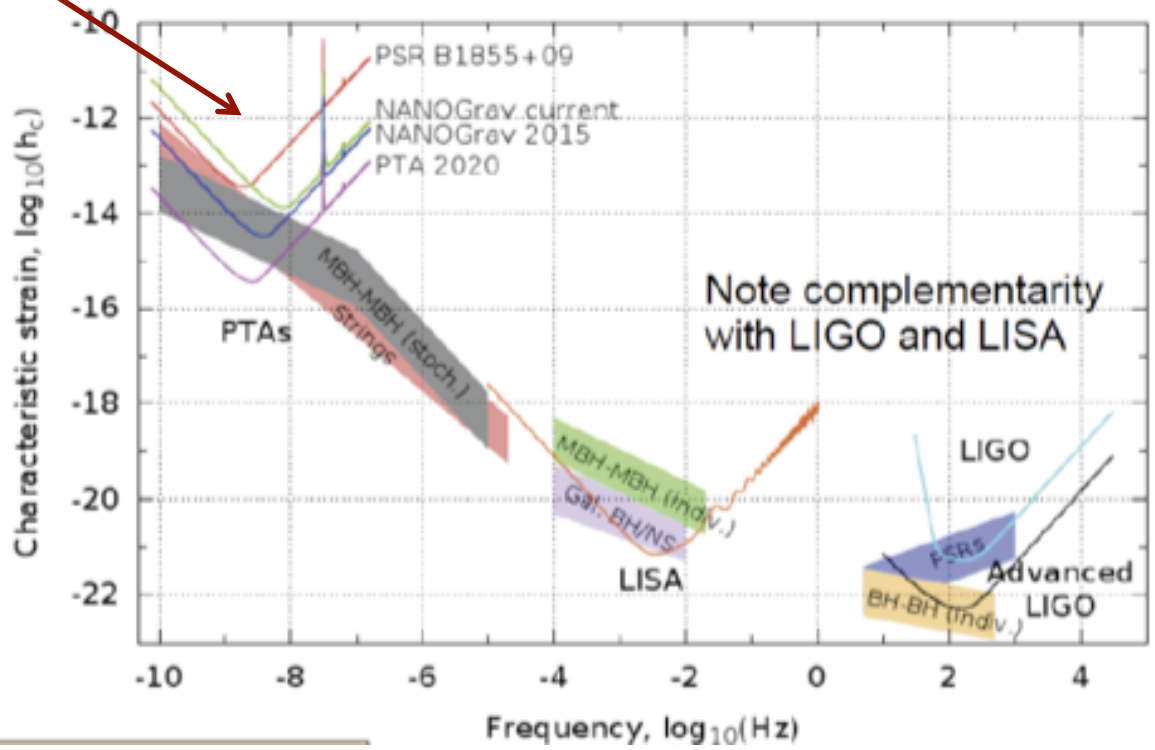
SKA Key Science

SKA Science Book (now being update) **2004**

- Strong-field Tests of Gravity with Pulsars and Black Holes
  - **Phase 1 headline science**
- Galaxy Evolution, Cosmolo
  - **Phase 1 "H I through cosm science**
- Emerging from the Dark Ag Reionization
  - **Phase 1 "H I through cosm science**
- The Cradle of Life & Astrob
- The Origin and Evolution c

With design philosophy of *E Unknown*





Courtesy R. Braun

SKA Key Science

SKA Science Book (now being update)

- Strong-field Tests of Gravity with Pulsa Black Holes

  Phase 1 headline science

- Galaxy Evolution, Cosmology, & Dark Energy

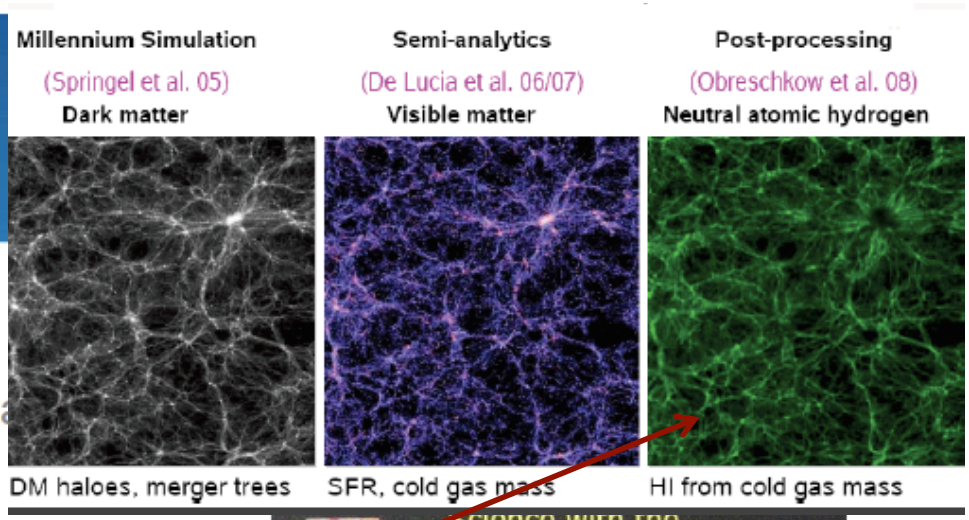
  Phase 1 "H I through cosmic time" headline science

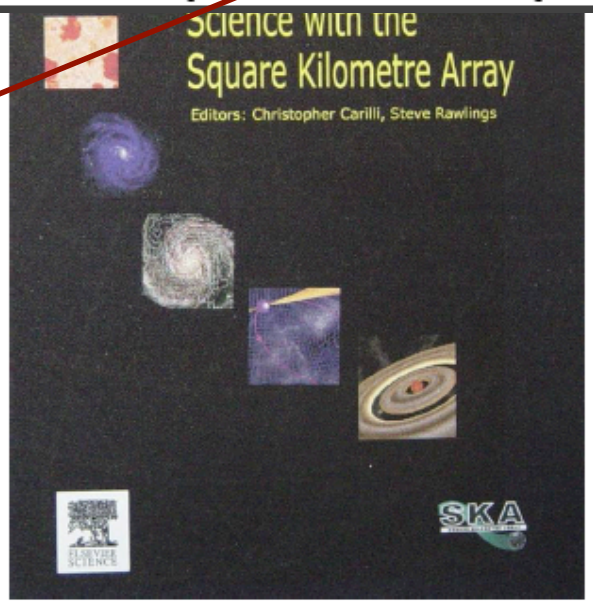
- Emerging from the Dark Ages and the Epoch of Reionization

  Phase 1 "H I through cosmic time" headline science

- The Cradle of Life & Astrobiology
- The Origin and Evolution of Cosmic Magnetism

With design philosophy of *Exploration of the Unknown*





Science with the Square Kilometre Array
(Carilli & Rawlings, 2004)

Courtesy R. Braun

SKA Key Sc

SKA Science Book (now

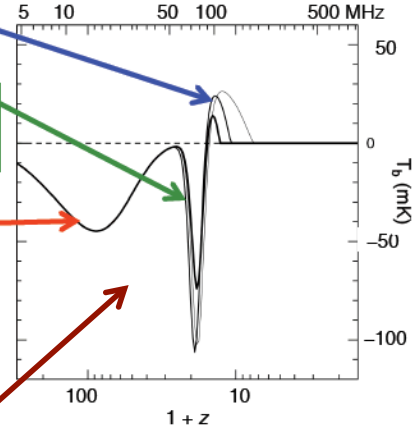
- Strong-field Tests of Gr
  Black Holes
  Phase 1 headline scien
- Galaxy Evolution, Cosn
  Phase 1 "H I through cc
  science

Neutral Hydrogen 21 cm spin-flip transition provides probe of neutral intergalactic medium before and during formation of first stars

EoR

Cosmic Dawn

Dark Ages



$\nu = 1420\ \text{MHz}/(1+z)$

$\lambda = 21\ \text{cm}\ (1+z)$

- Emerging from the Dark Ages and the Epoch of Reionization
  Phase 1 "H I through cosmic time" headline science
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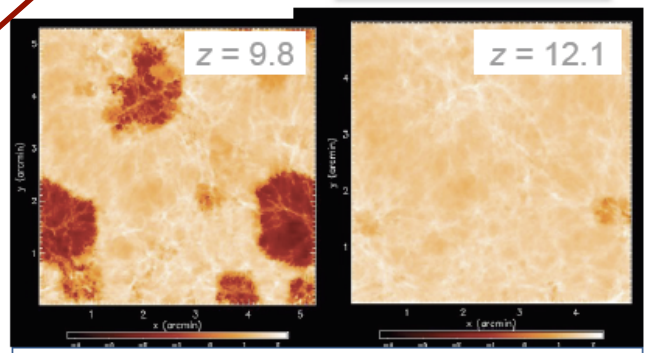

SKA objective: Image the IGM transition in the H I (21-cm) line

Kilometre Array
(Carilli & Rawlings, 2004)

Courtesy R. Braun

SKA Key Science

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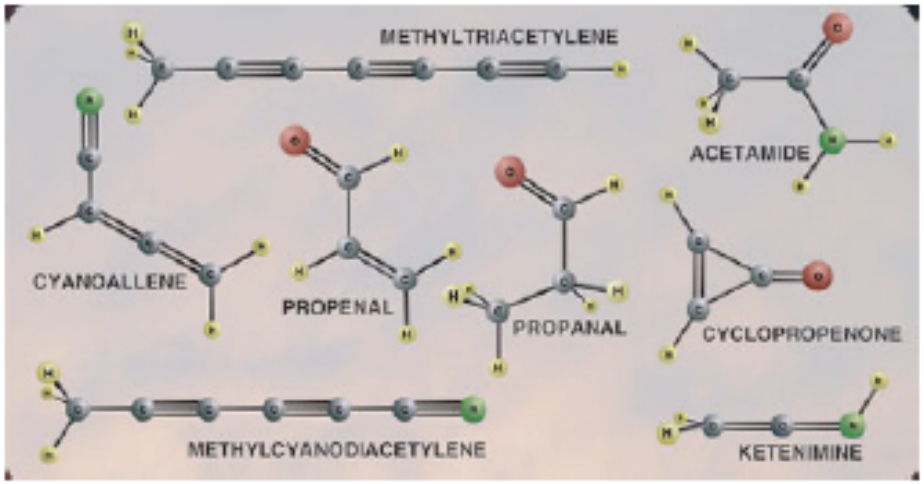

Complex organic molecules detected at radio wavelengths

Science with the Square Kilometre Array
(Carilli & Rawlings, 2004)

Courtesy R. Braun

SKA Key Science

- All-sky rotation measure surveys provic sight

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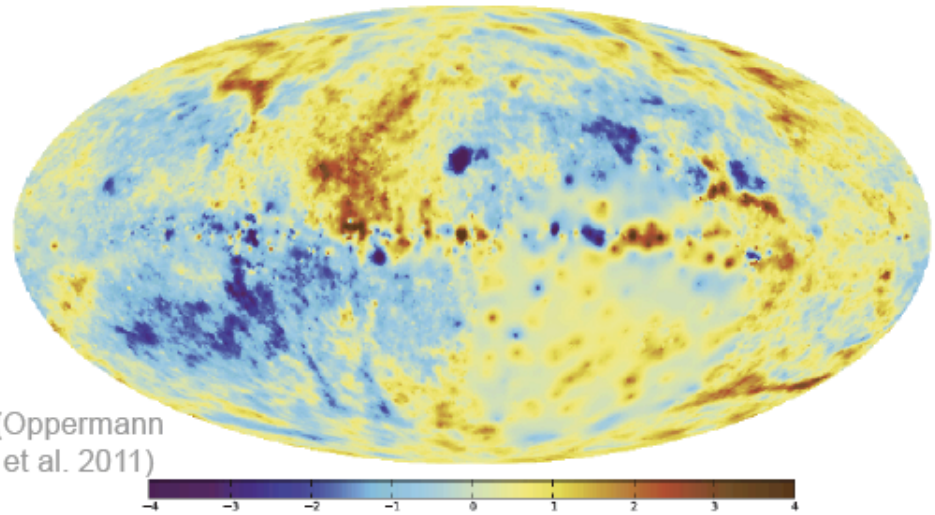


(Oppermann et al. 2011)

Science with the Square Kilometre Array
(Carilli & Rawlings, 2004)

The SKA in Phases

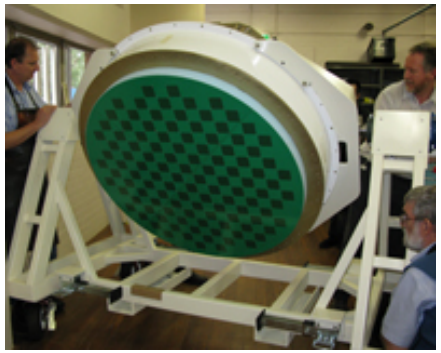
SKA will be implemented in phases:

- Precursors: Meerkat (RSA, 2017), ASKAP (Aus, 2016)
- SKA_1 subset (~10% area) of SKA_2

SKA1-low (sparse AA): Freq. Range: 70 - 350 MHz

SKA1-mid (dish+SPF): Freq. Range: 0.45 – 10 GHz (3 Bands)

SKA1-survey (dish+PAF) : Freq. Range: 0.7 – 1.7 GHz
PAF for Survey Speed



- SKA_2 : full SKA capability between 70 MHz and 10 GHz
- SKA_3 (TBD): extension of SKA_2 to 30 GHz

Phased construction allows maximum use of advances in technology and incremental fine-tuning of science drivers/technical requirements

Courtesy P. Diamond

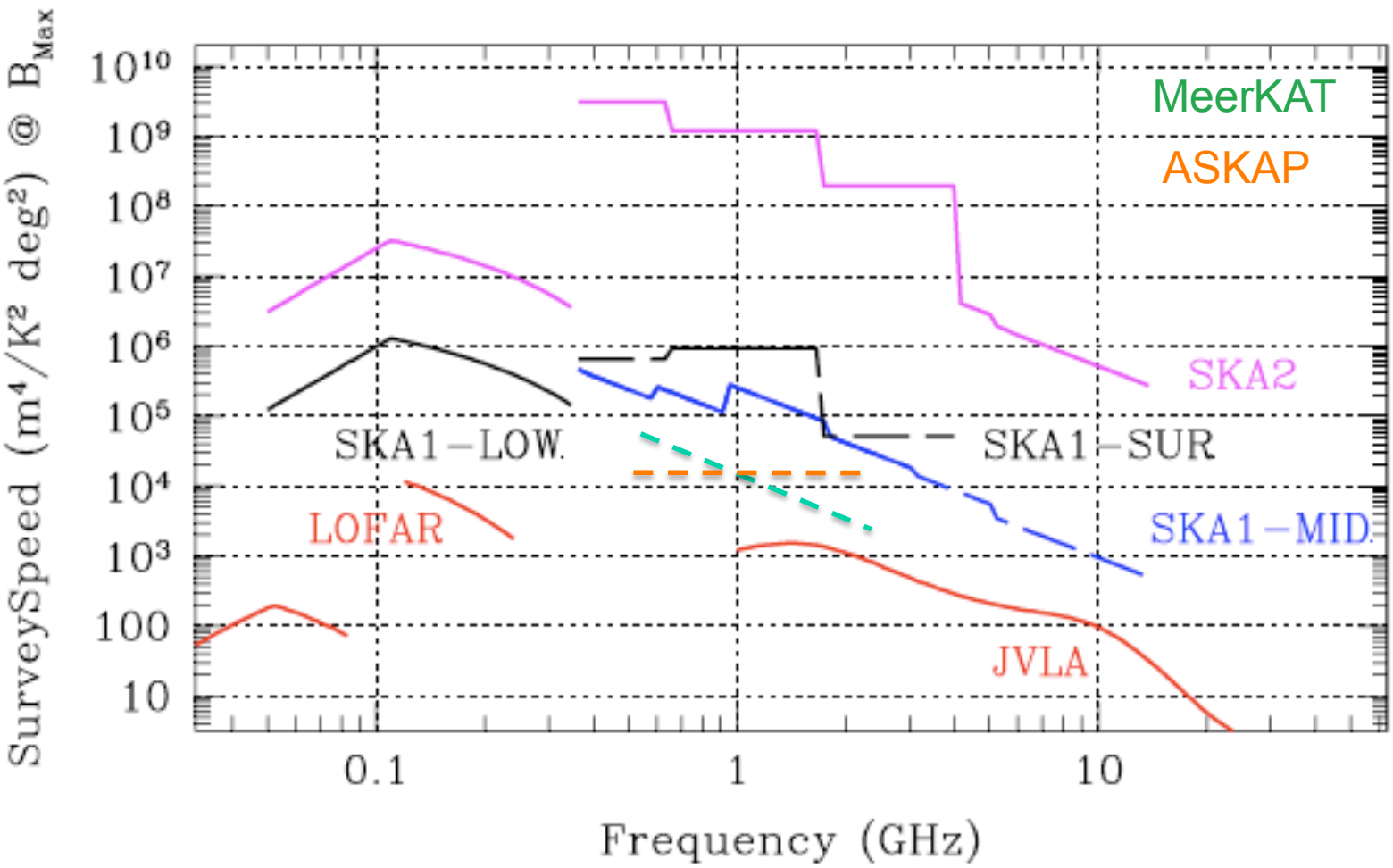
SKA Phase 1 (SKA1)
Cost: €650M

SKA1_MID
254 Dishes including:
64 x MeerKAT dishes
190 x SKA dishes

SKA1_LOW
Low Frequency Aperture Array Stations

SKA1_SURVEY
96 Dishes including:
36 x ASKAP
60 x SKA dishes

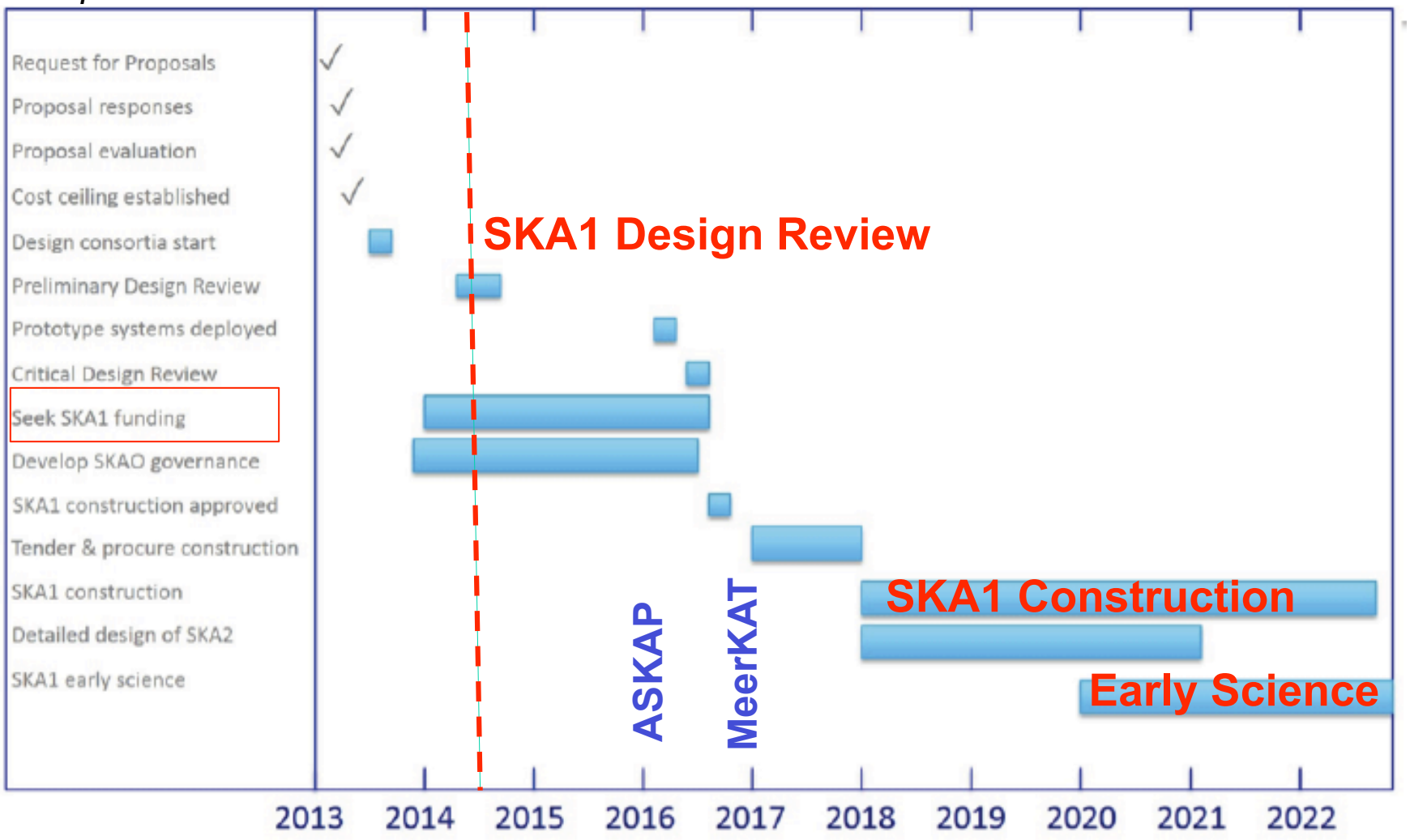
Performance Comparison - Survey Speed



Adapted from Braun, 2014

Timeline

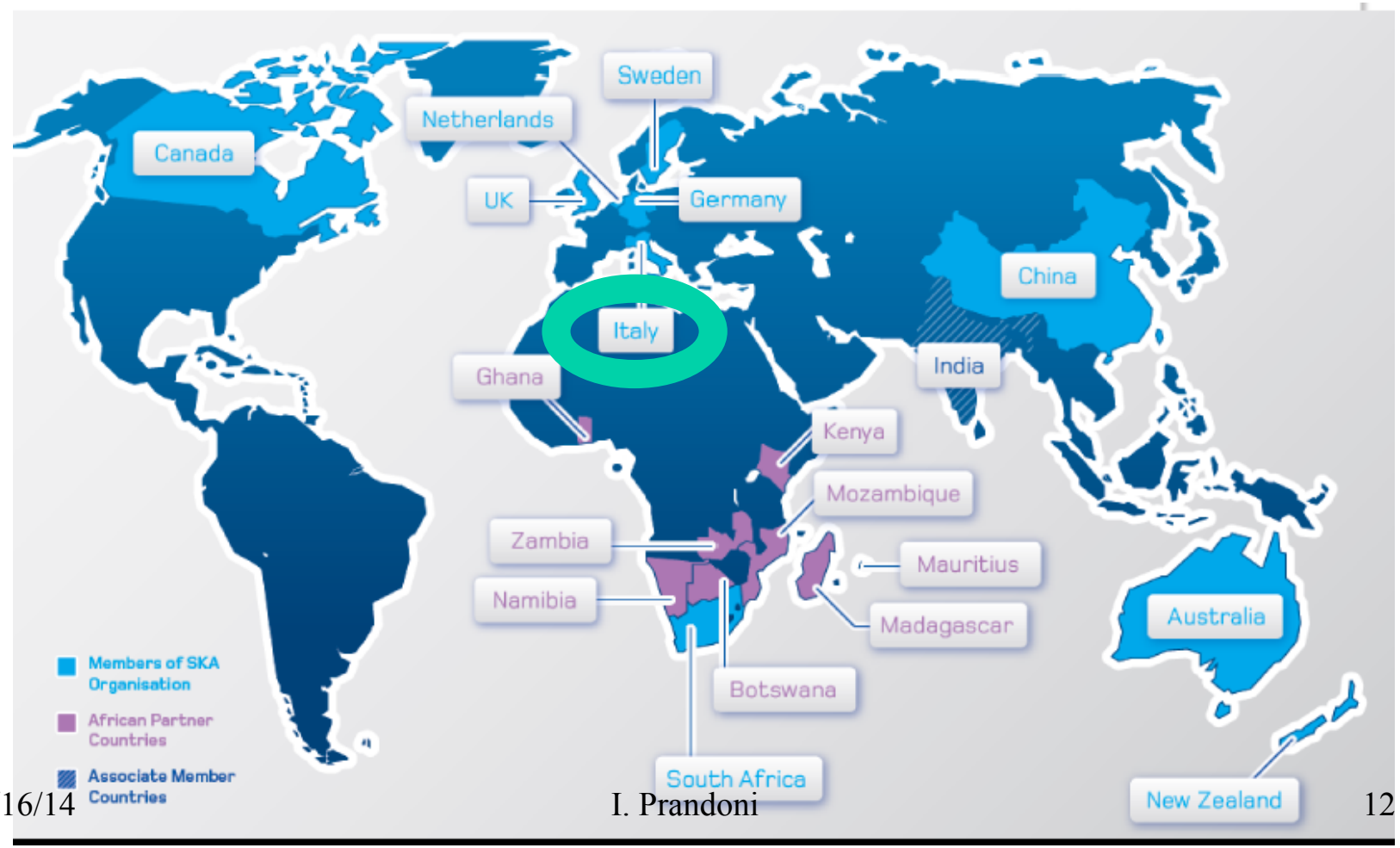
Adapted from P. Diamond



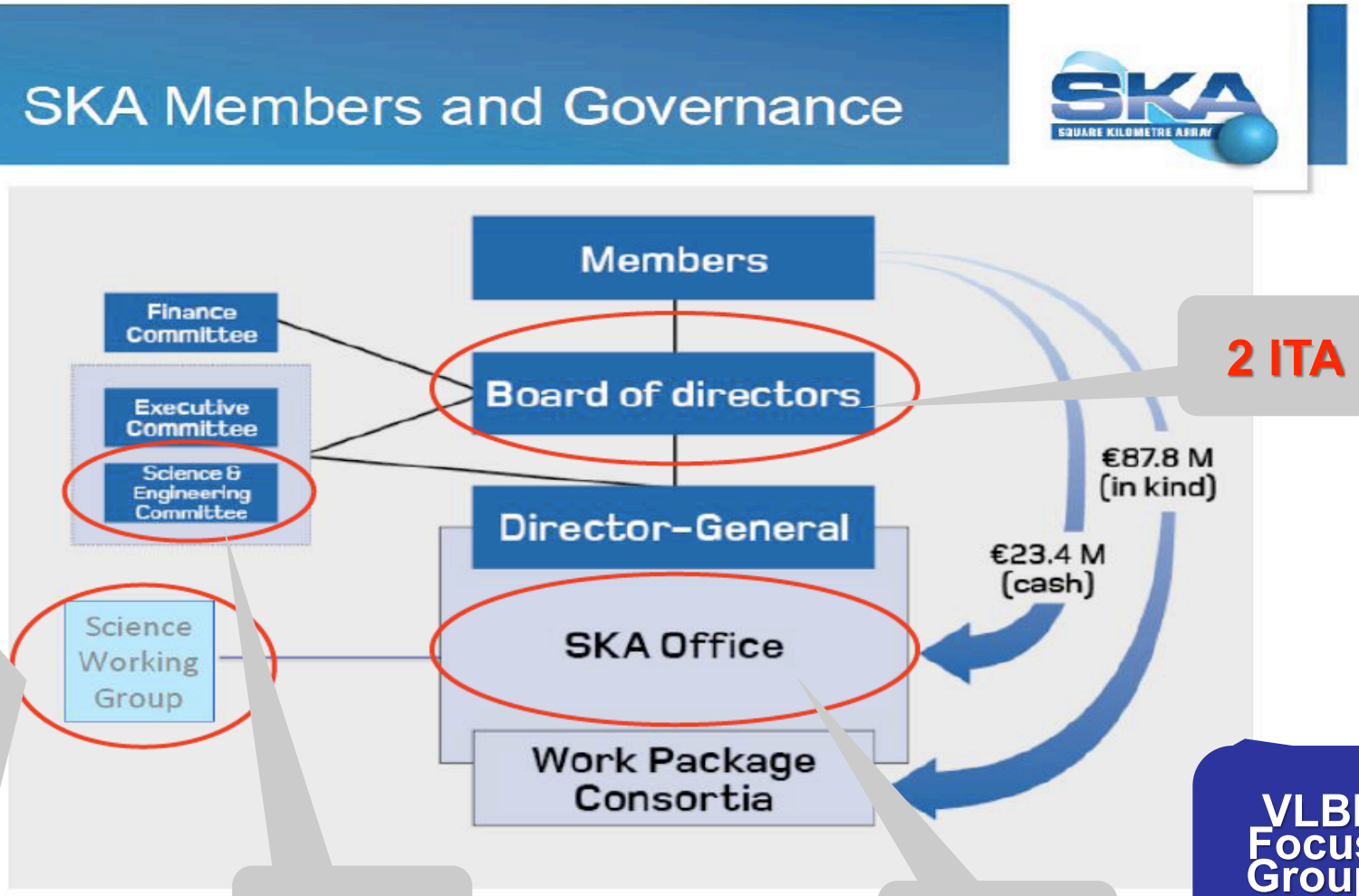
The SKA Organization

Founded in 2011

Scope: seek Funding and coordinate Design Phase



SKA Governance - Role of Italy



- EoR
- HI
- Continuum
- Cosmology
- Magnetism
- Pulsars
- Transients
- Cradle of Life

20 ITA

2 ITA

1 ITA

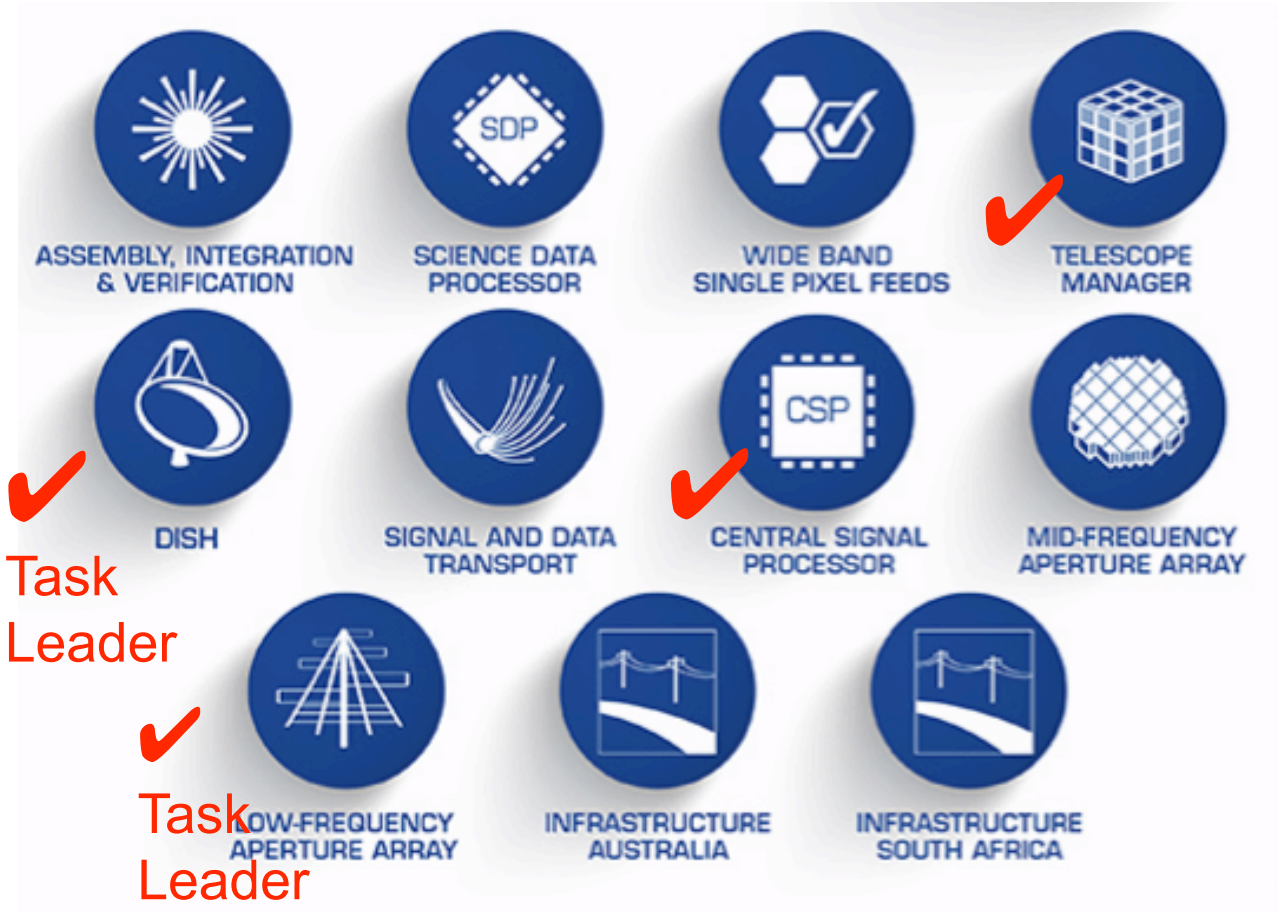
3 ITA

VLBI Focus Group

2 ITA

SKA_1 Design Consortia – Role of Italy

Started in 2013



SKA-related Activity - Italy

SCOPE: maximize return of Italy investment
→support Italian participation to **technology/industry/science** SKA-driven activity, from precursors to SKA_1 & SKA_2

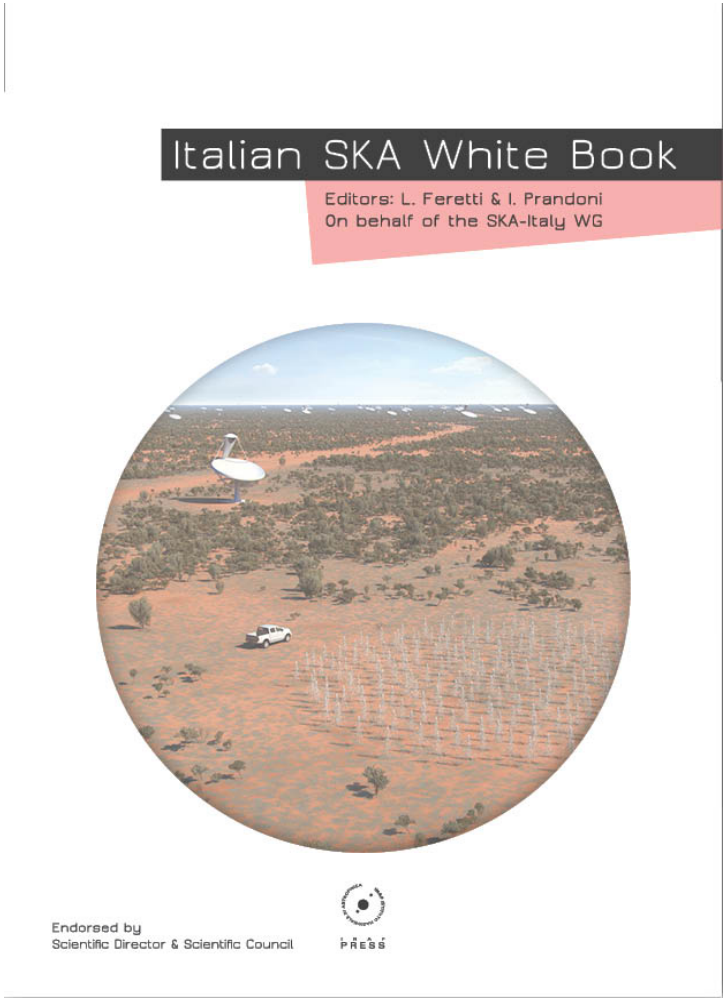
Building a SKA Community → much interest, expertises, and synergies are emerging:

- **SKA-Italy Meetings every 2 years**
  2012, Rome, ~100 participants)
  Next: Sept. 2014, Bologna

- **SKA Italy White Book**

Italian SKA Book

- **Editorial Board:** 16 members from 13 INAF institutes
- **Contributions**: ~80 astronomers from all INAF Institutes + 10 Universities
- **Delivery**: July 2013, Printed 2014



SKA International Conference

- Naxos, June 9-13, 2014
- Scope: new Science Book

- **152 chapters** submitted
- **1/3** involving Italy (**17% PI**)
- **114 selected** speakers
- **17 speakers from Italy (15%)** [12 Institutes represented]

Adapted from R. Braun

- Final Chapters due by August 22nd
- March 2015: Final decision on SKA1 Design

Conclusions

- Transformational science expected in all phases to the full SKA:
  - from Pathfinders to Precursors to SKA1 & SKA2

- Previous phases will provide valuable constraints (both scientific & technological) to better fine-tune following phases
  - Better sky modeling + technology advances

- Need to address some critical issue in SKA1 design that may limit science applications ➔ Inputs from Community are important
  [Focus of next SKA-Italy meeting]

- IMPORTANT TO INCREASE INVOLVEMENT IN PREPARATORY / PRECURSORS' SCIENCE [SKA included in INAF PhD Thesis Programme]