Dome P6: Novel algorithms

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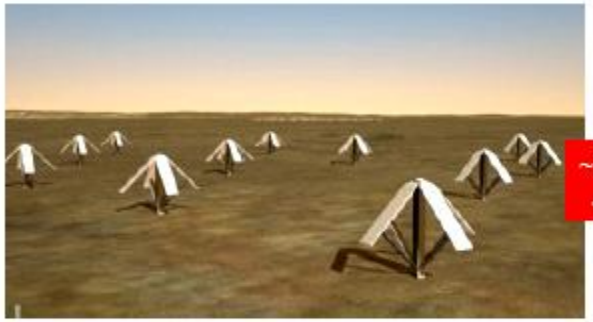
IBM Research

SKA: Massive amount of data



~250,000 antennas
.07GHz-0.45GHz.

~250,000 Antennas
.5GHz-1.7GHz.

~3,000 Dishes
3GHz-10GHz.

LOFAR:
One of the main SKA path finders

Low band antenna

High band antenna

DOME

Investigating novel ways for SKA exascale computations.

December 2012

Research Streams...

Sustainable Computing	Data & Streaming	Nanophotonics

...mapped to research projects:

System Analysis

Algorithms & Machines

Computing	Transport	Storage
-Microservers -Accelerators -P6: Novel algorithms	-Nanophotonics -Real-time communications -P6: Novel algorithms	-Access patterns

www.dome-exascale.nl

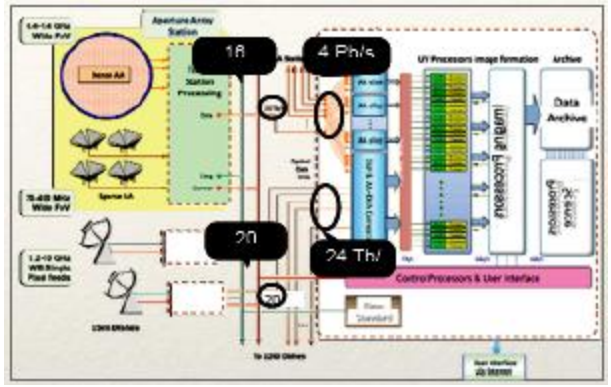
Contacts

Albert-Jan Boonstra (ASTRON)

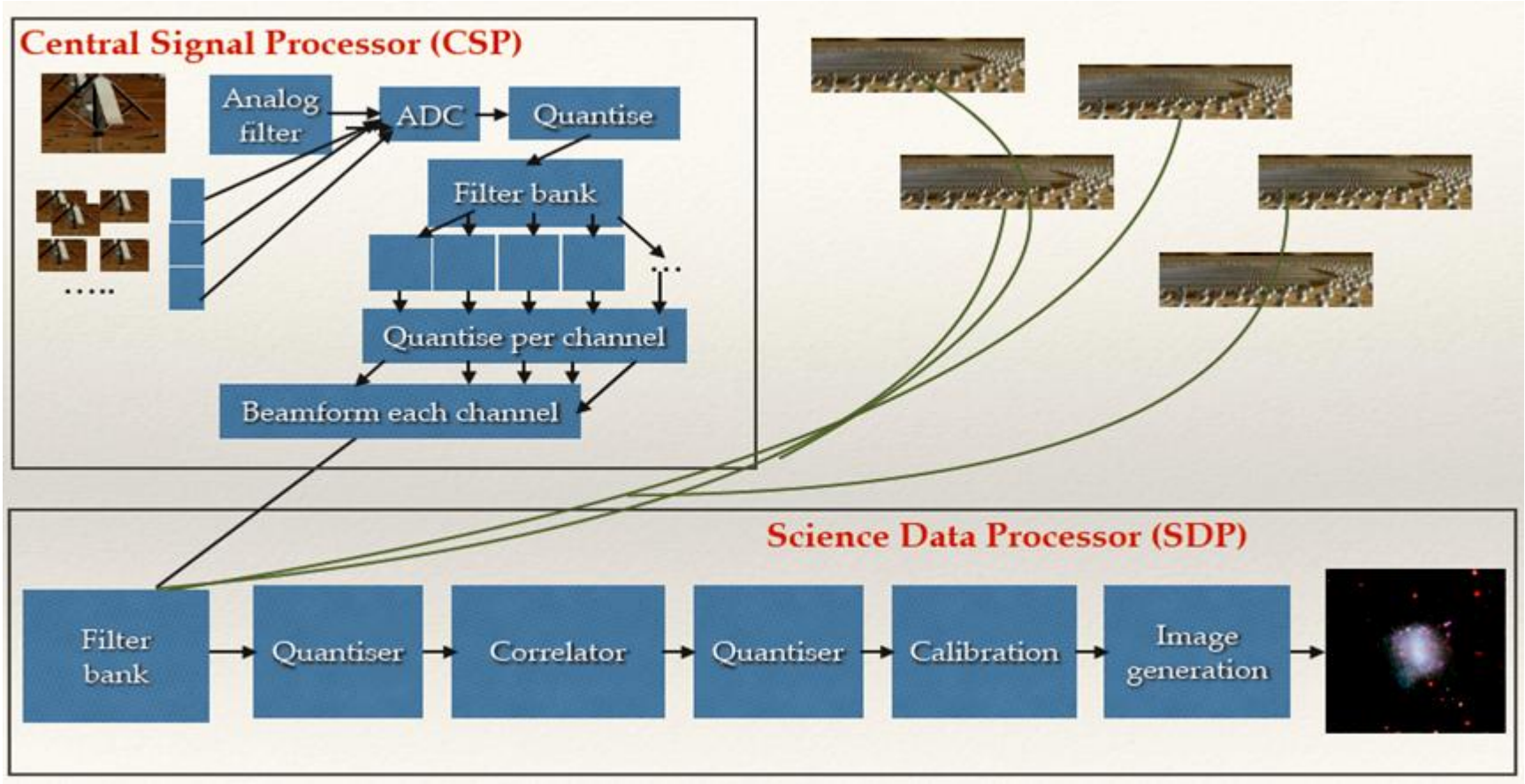
Ton Engbersen (IBM)

DOME P6: Novel Algorithms

- Started 02.2014 for 3 years
- Goal: (massively) reduce data/ increase fidelity for 1.5 billion euro SKA project
- Team of approx. 3-4 from IBM, 3-4 from ASTRON
- Collaboration also with SKA South Africa

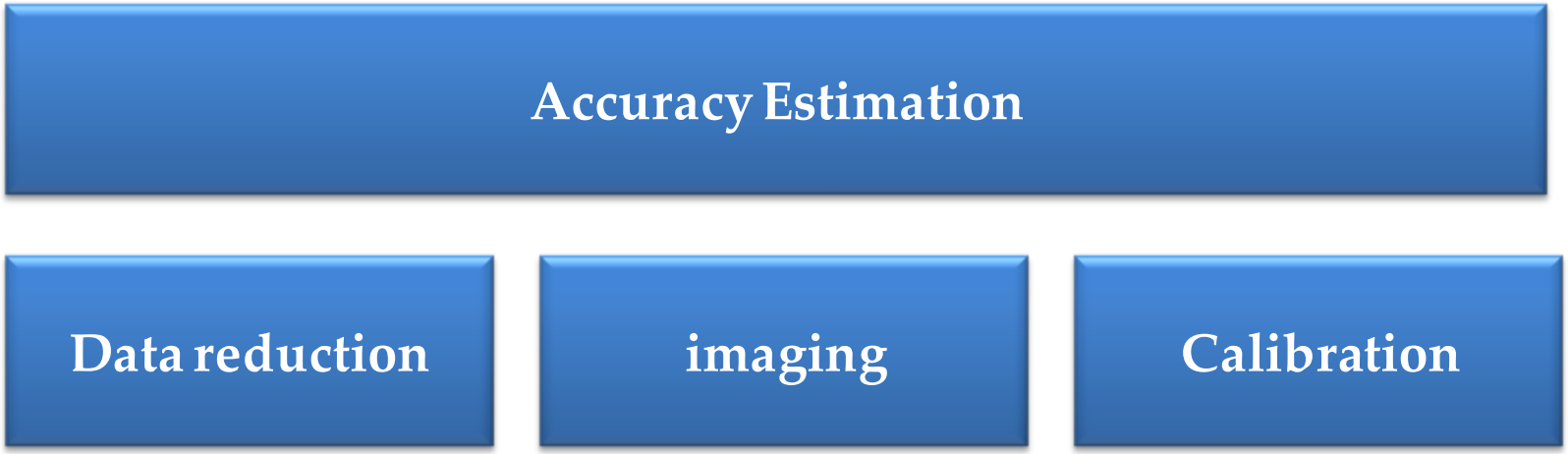


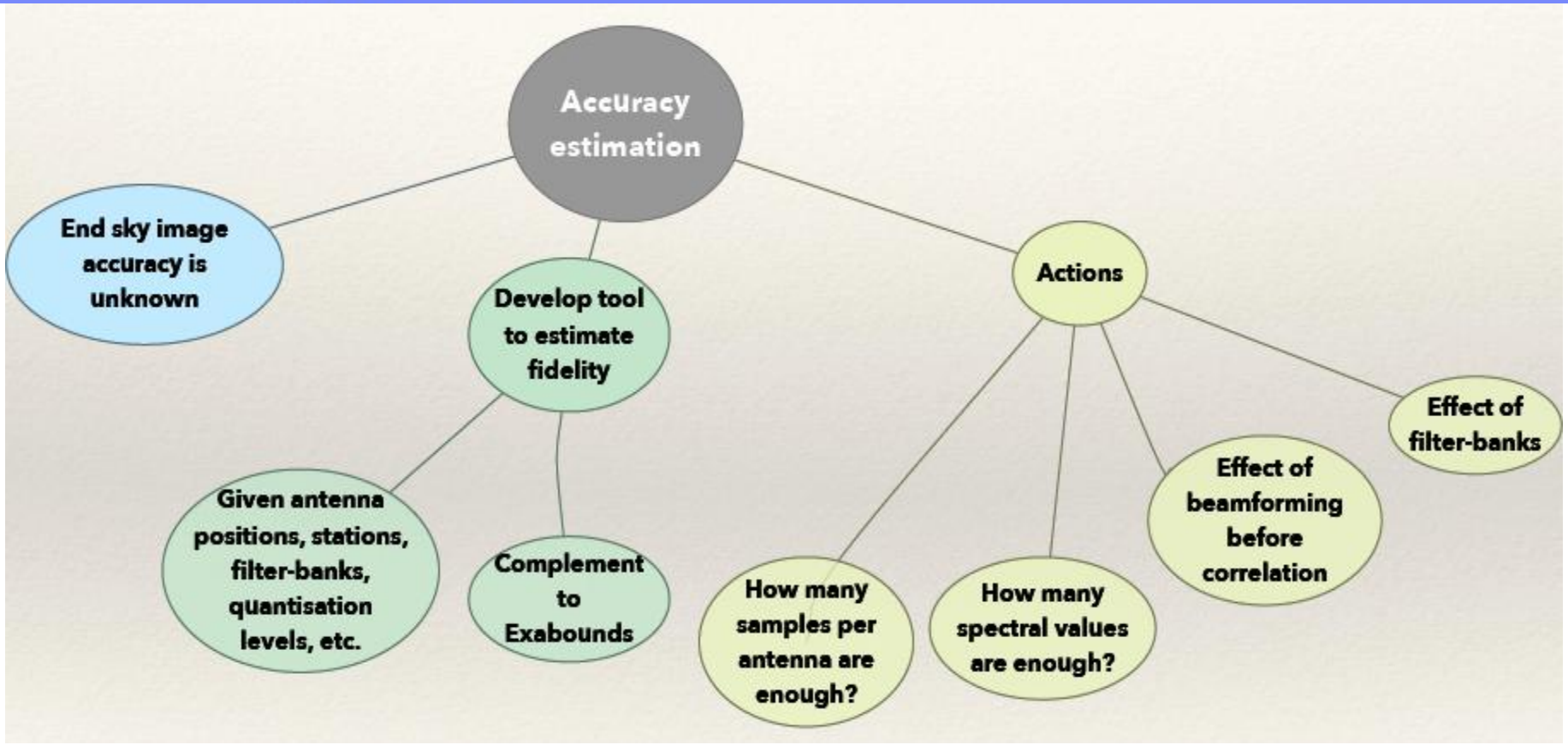
❖ We look at the whole chain, from antenna to image.



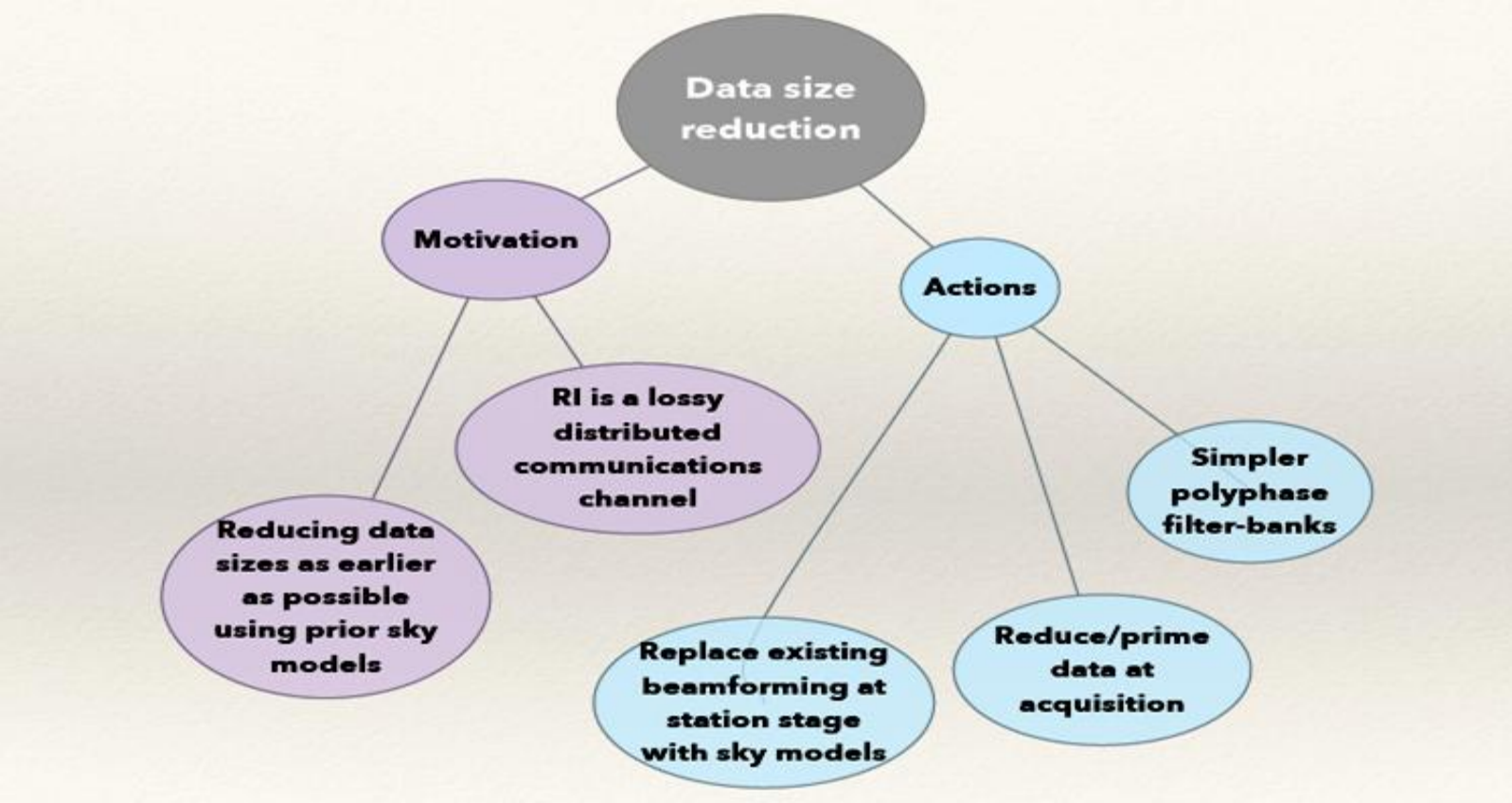
❖ We aim to reduce data + processing as early as possible!
while increasing resolution

Project topics:

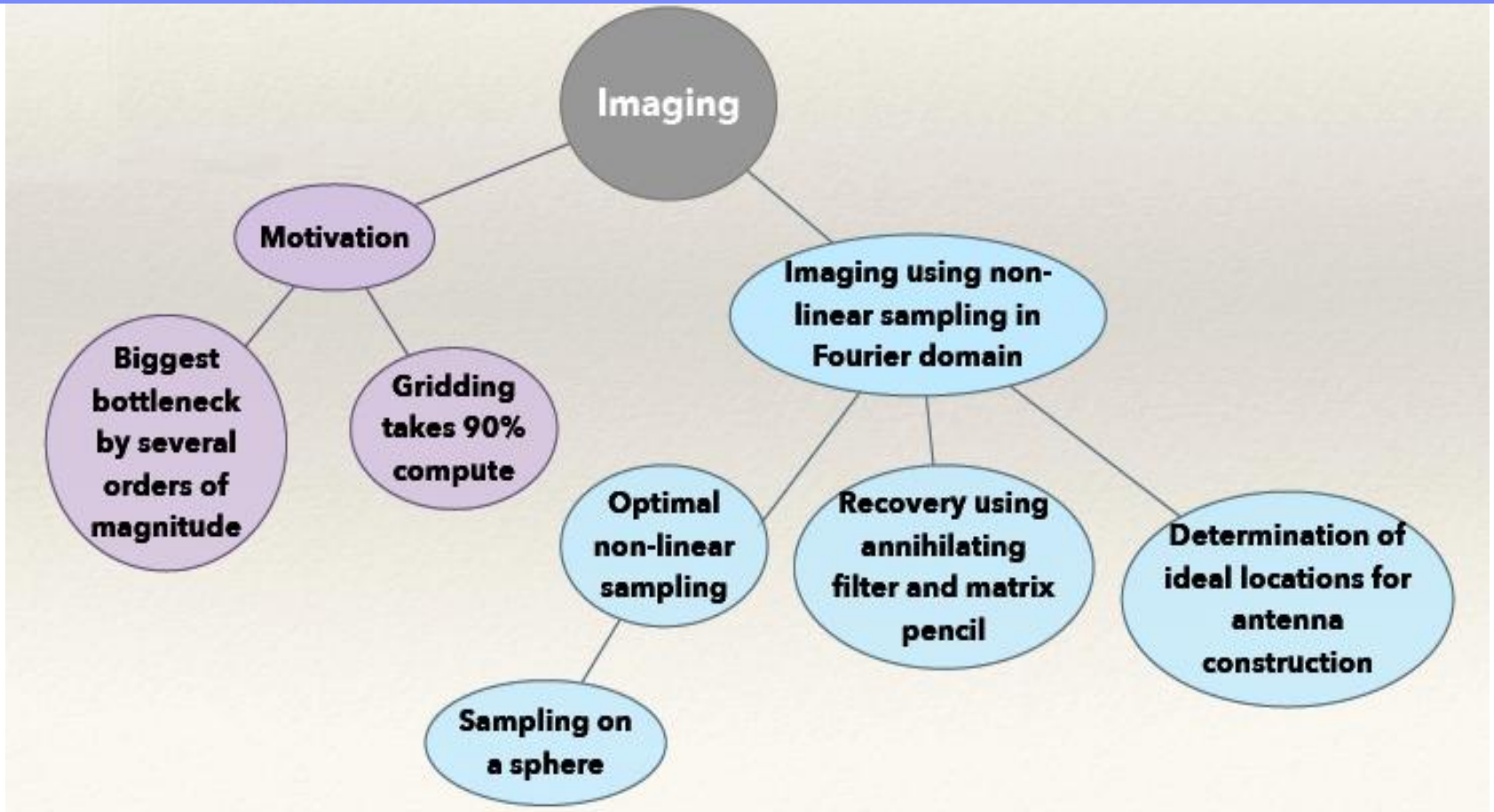




- ✓ Derivation of formulas for accuracy of estimators as a function of samples and filter
- ✓ Derivation of image quality of dirty image

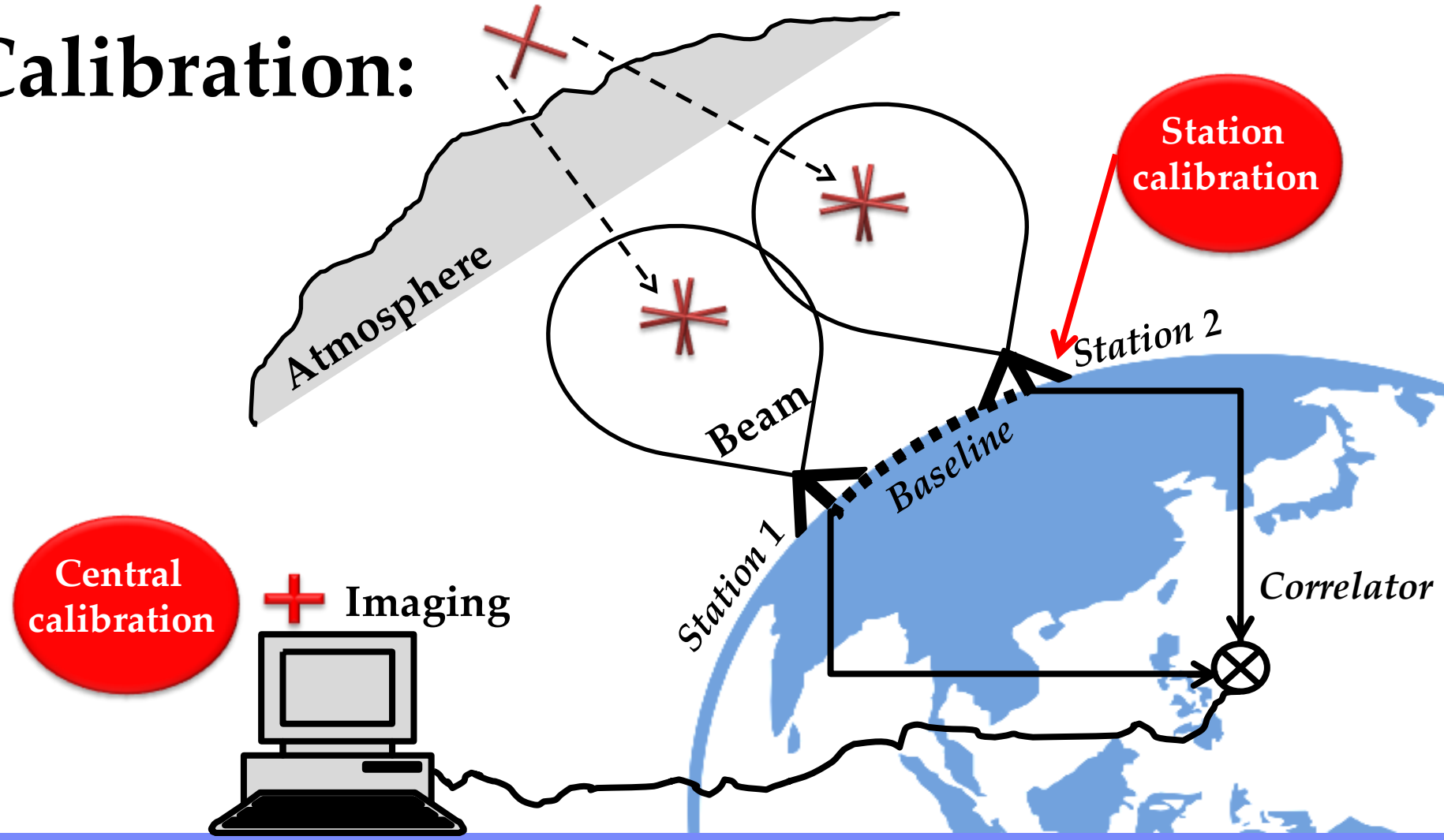


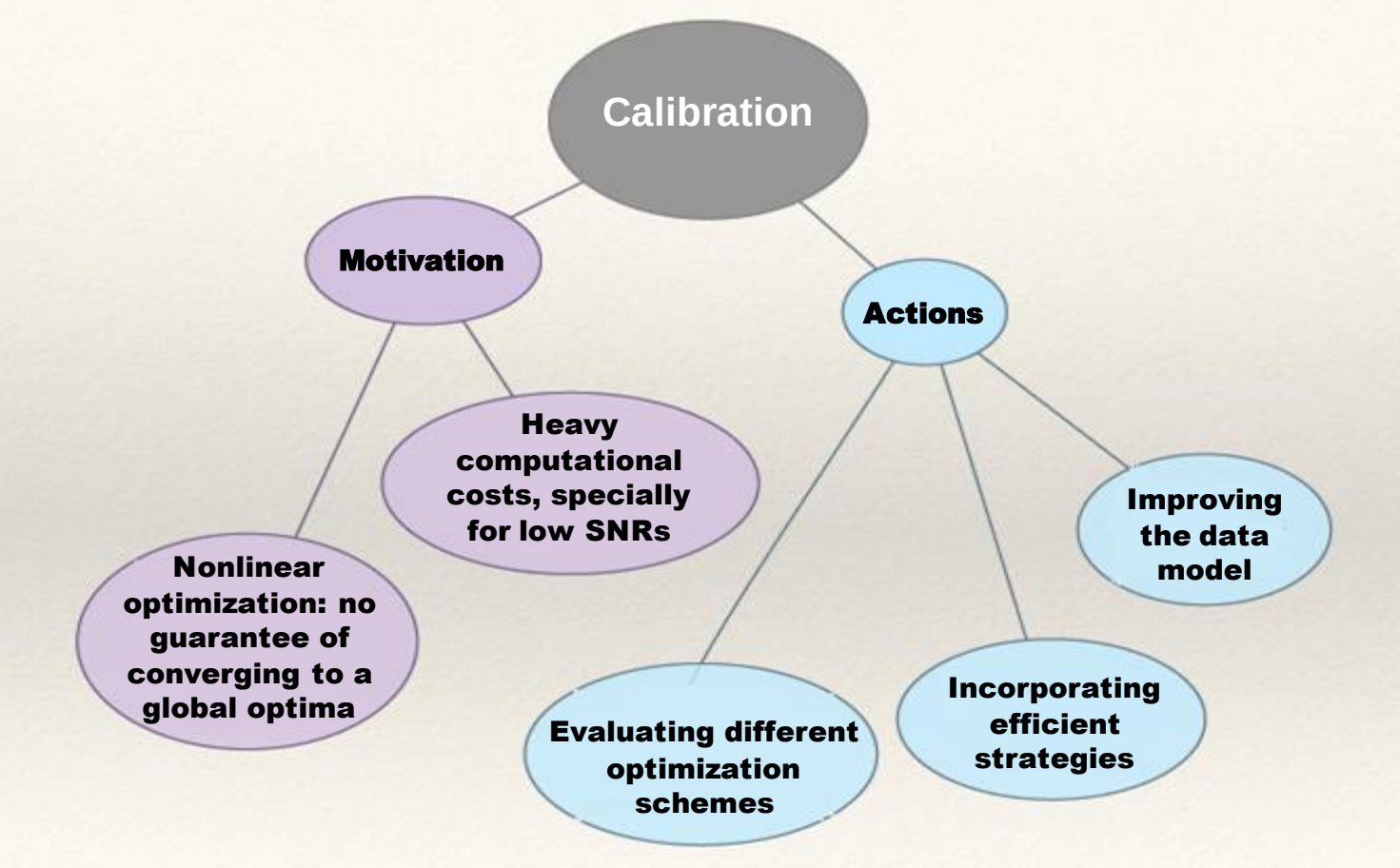
- ✓ Development of beamforming algorithms which increase up to 66% in information rate
- ✓ Showing conceptual change of filter



✓ **Initial development and successful testing of graph-based probabilistic imaging**

Calibration:

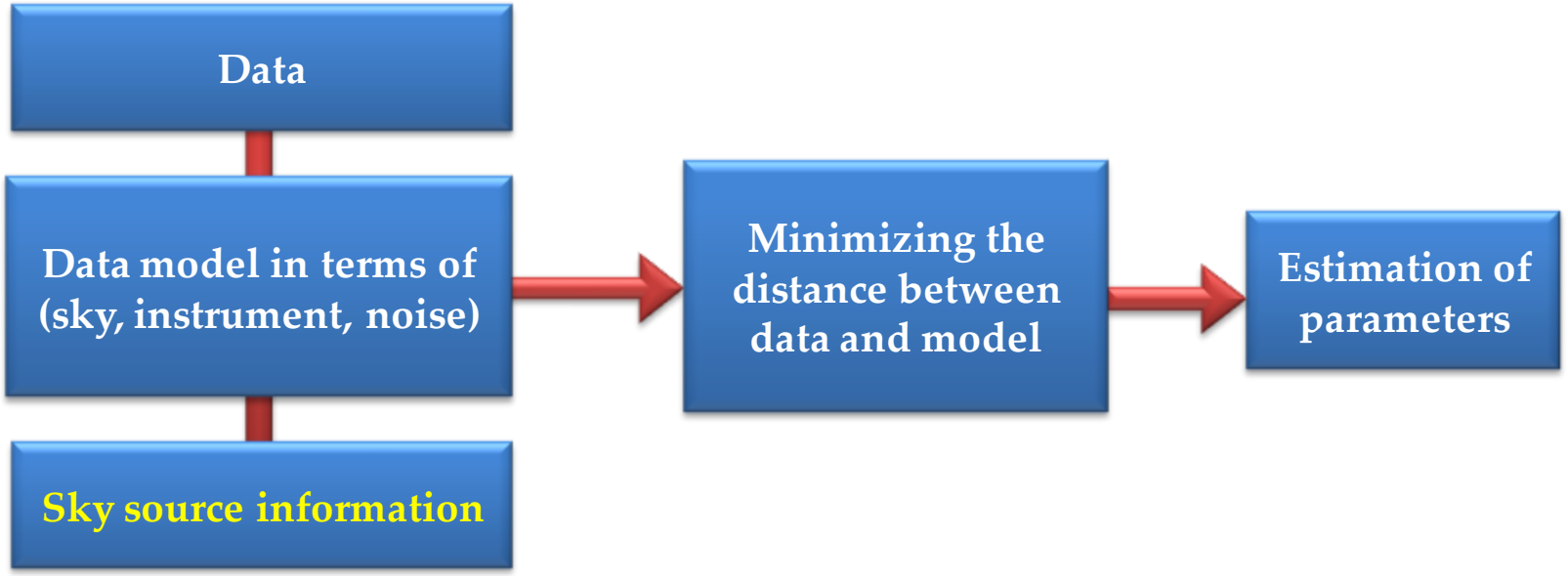




- ✓ Central calibration: Successful implementation of StefCAL in LOFAR pipeline
- ✓ Station calibration: Development and initial successful testing of Blind calibration

Blind Station Calibration

Station calibration: Supervised

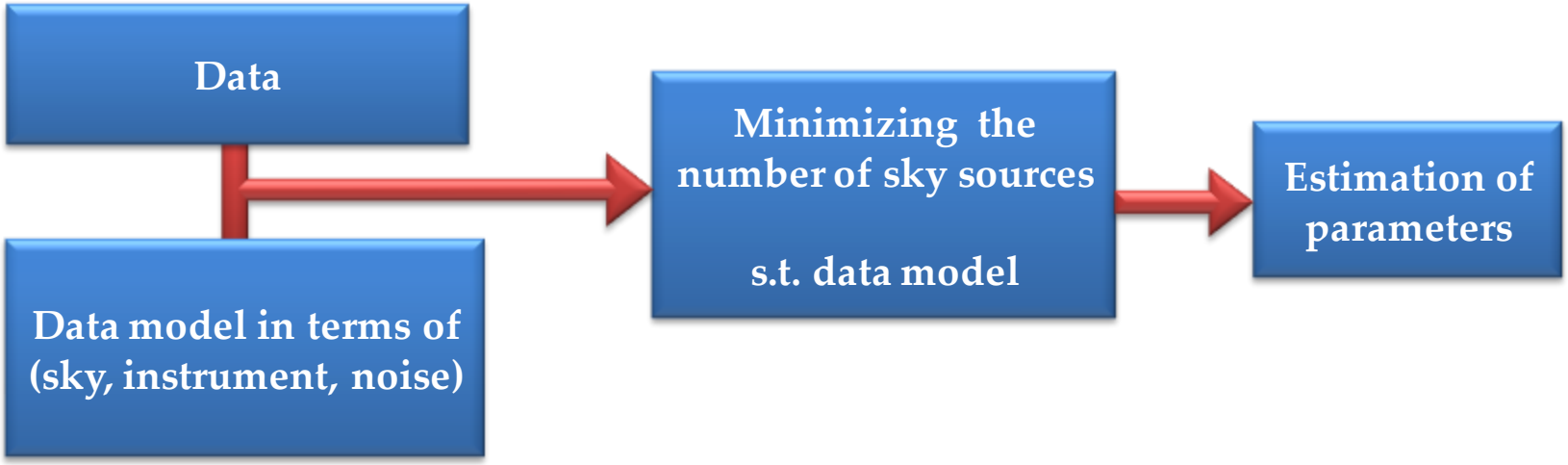


✓ Fast speed of convergence

X Performance sensitive to the sky source information

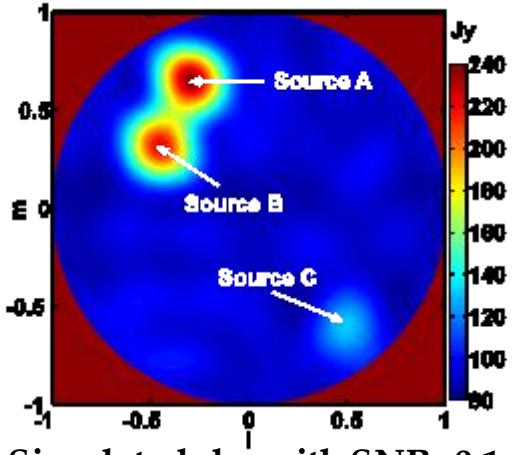
What if the sky source information is either inaccurate or missing???

Unsupervised/Blind

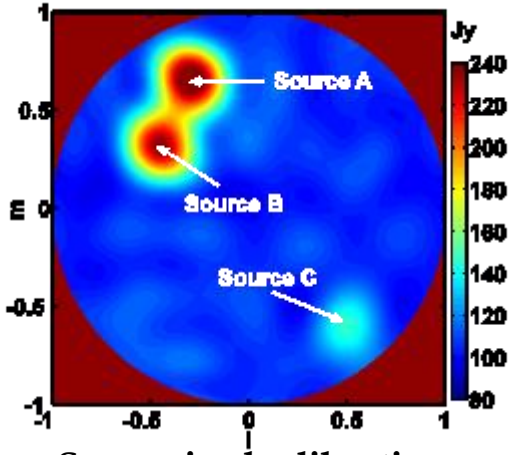


✓ Accurate parameter estimation without using any prior knowledge of the sky sources

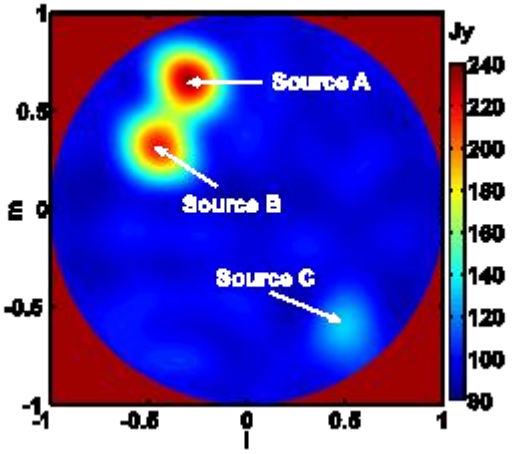
X Heavy computational cost



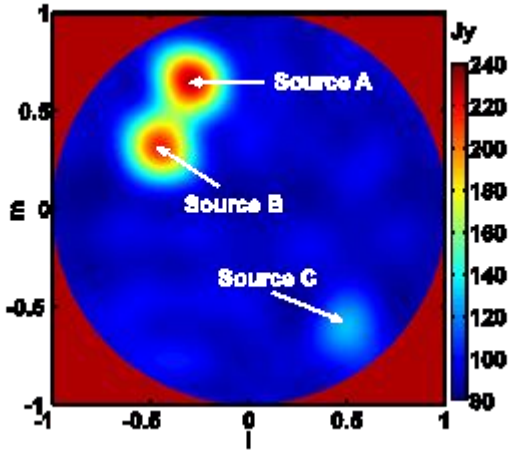
Simulated sky with SNR=0.1.



Supervised calibration.



Target image with perfect parameters.



Blind calibration on 1/5 of data.

Summary:

DOME P6 aims to evaluate the whole RI chain, and to suggest for a way forward

This includes evaluation of:
- Antenna sampling, beamforming, and filtering schemes
- Calibration algorithms
- Imaging techniques

Contributions over period:
- Introduction of more efficient beamforming and filtering techniques
- Development of StefCAL as a central calibration
- Development of a blind station calibration
- Application of graph-based probabilistic imaging methods to the filed