

Sweden in SKA

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Swedish national infrastructure for Radio Astronomy

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Very short - two slides per topic + some extra pictures.

(1) Timeline – Sweden in SKA

- 2012 - Sweden joins SKA Organisation
- 2014 - Work begins on SKA design via international consortia involving OSO
- 2015- 2019 Sweden involved in negotiation of SKA international convention
- 2019 - VR proposal for SKA ([Conway](#), [Mellema](#) and [Zackrisson](#) main authors) submitted– very highly rated
- 2020 - **Funding secured for Swedish long term membership at 1.5% share.** Includes Construction funding of 175 Mkr (from VINNOVA + VR) expected to come back to Swedish companies -plus Operations funding (via OSO budget, requiring re-prioritization of activities)
- 2021 –Chalmers -SKA Observatory collaboration agreement signed. Construction/operation contribution payments to SKA Observatory start.

Inter-Governmental Organisation Convention and Final Record signed: 12 March 2019





October 2021 – Chalmers Rektor and SKAO Director General sign bilateral cooperation agreement.

Completing Membership Process

Application to Swedish government to sign SKA Observatory convention is currently being processed.

Parliamentary time needed to modify some Swedish laws related to the the SKA Observatory privileges and Immunities.

Current status for Sweden is fully equivalent to being a convention signee w.r.t industrial return, **scientific access, etc** –All assured long term given the secured funding- Only one practical difference - no vote in SKA council.

Hope for good news on completing convention formalities soon!

(2) SKA Pathfinder science involvement + Onsala LOFAR station

- Several SKA Precursor/Pathfinder radio telescopes have been built over last 10 years.
- Several invited talks today describing these telescopes- all now fully operational- allowing preliminary SKA-type science to be carried out already **now**.



MeerKAT 64
antennas
South Africa



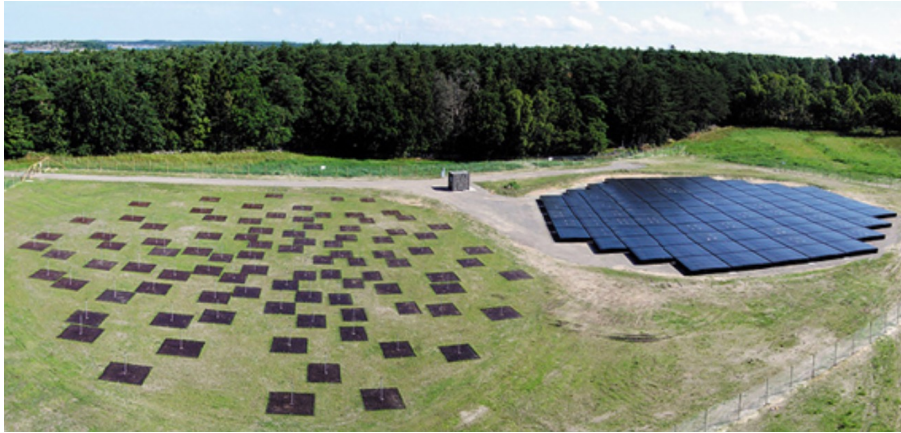
MWA
array
Australia

ASKAP 32
dishes
Australia



Westerbork-APERTIF, Netherlands

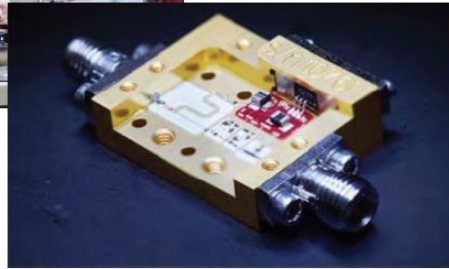
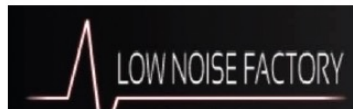
Onsala LOFAR station and Swedish Involvement



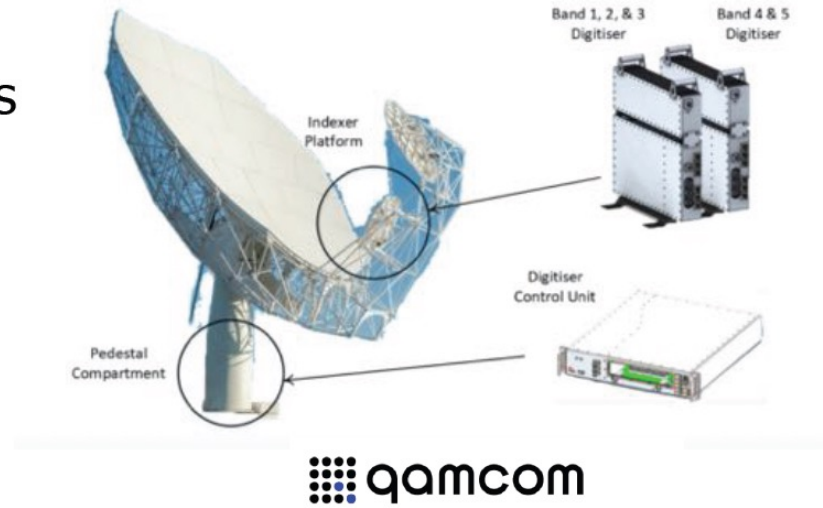
- LOFAR low frequency array. Has re-invented deep, wide angle radio interferometry – Algorithms ready for SKA (!)
- Swedish involvement in LOFAR EoR ([Mellema](#)), Continuum Surveys ([Conway](#)), Magnetism ([Horellou/Piras](#)), Fast Radio Bursts ([Kirsten](#)), Exoplanet search ([Jansson](#)), long baseline imaging ([Varenius/Conway](#)), Recombination Lines ([Toribio](#)).
- LOFAR overlaps SKA1-low but also unique capabilities; very low frequencies, long baselines. LOFAR 2.0 upgrade exploits these ([Hessels, Morabito](#)). Onsala applied for and received VR funding to upgrade station to LOFAR 2.0.
- Good that there will remain a wide-field interferometry testbed in Europe into the SKA era; doing unique science/technique development.
- Also In Europe cm wavelength dishes of EVN, including those at Onsala, will carry out VLBI using SKA-mid in SA as new large element - greatly improving VLBI sensitivity.

(3) Technical Contributions/Industrial return

Low Noise Amplifiers

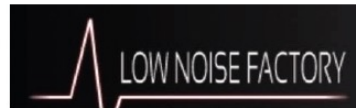


Digitizers

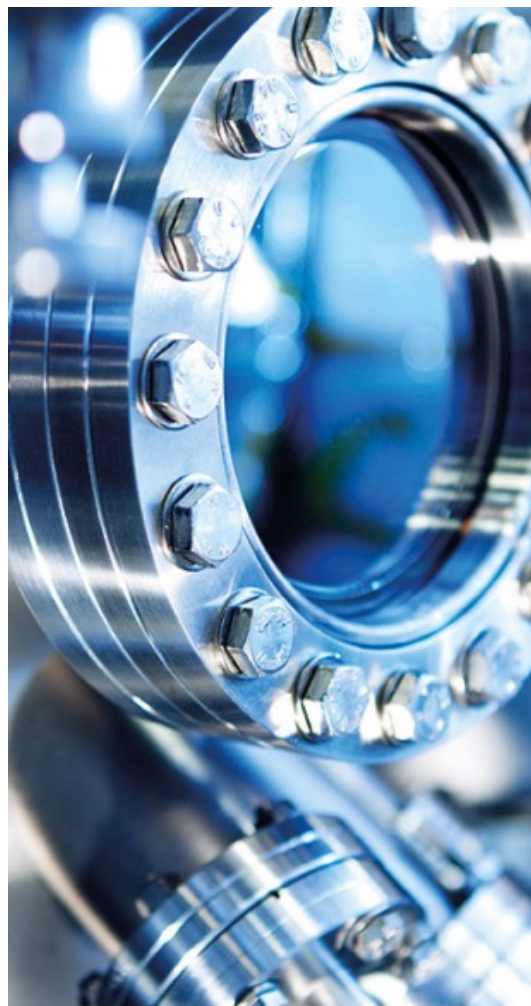


So far 15M€ of Swedish industrial contracts assured.

Band 1 Receiver
350 .-1050 MHz



Major design and prototyping effort by OSO- Future High frequency receivers – AL/ML method development with industry



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Big Science Sweden is funded by:



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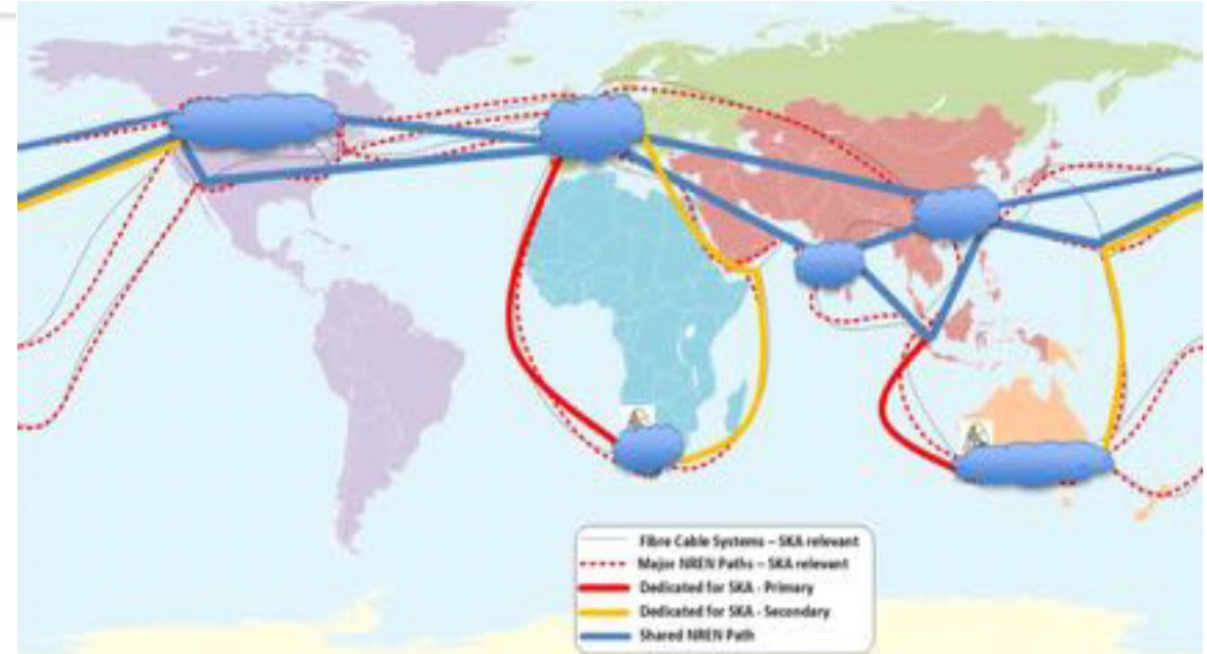
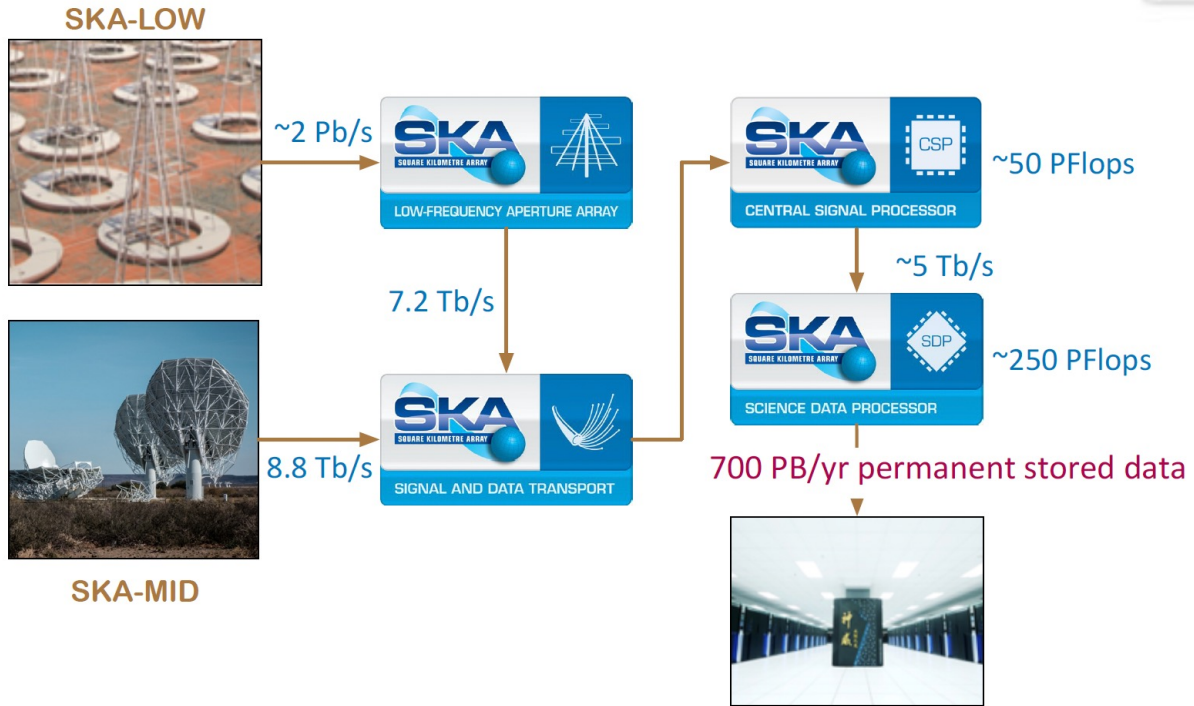


<https://www.bigsciencesweden.se>

For funding Swedish involvement in new international Science Infrastructures industrial return is important nowadays.

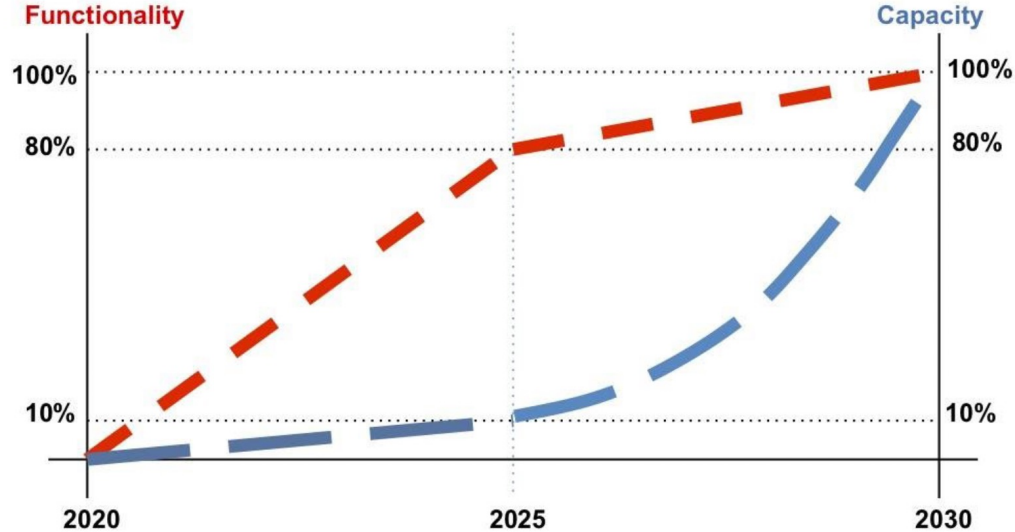
SKA provides a possible template for other Swedish infrastructure investments in astronomy (including ESO instrumentation).

(4) Swedish SKA Regional Centre Node



- Image cubes and other observatory data products produced at SKA telescope sites in Australia and South Africa will be distributed across global network of SKA Regional Centre nodes for user access and further processing.
- Sweden's SRC node is expected to provide 1.5% of total storage (i.e. to permanently store every year an extra 10 PB) by 2028 - and to provide associated computing.

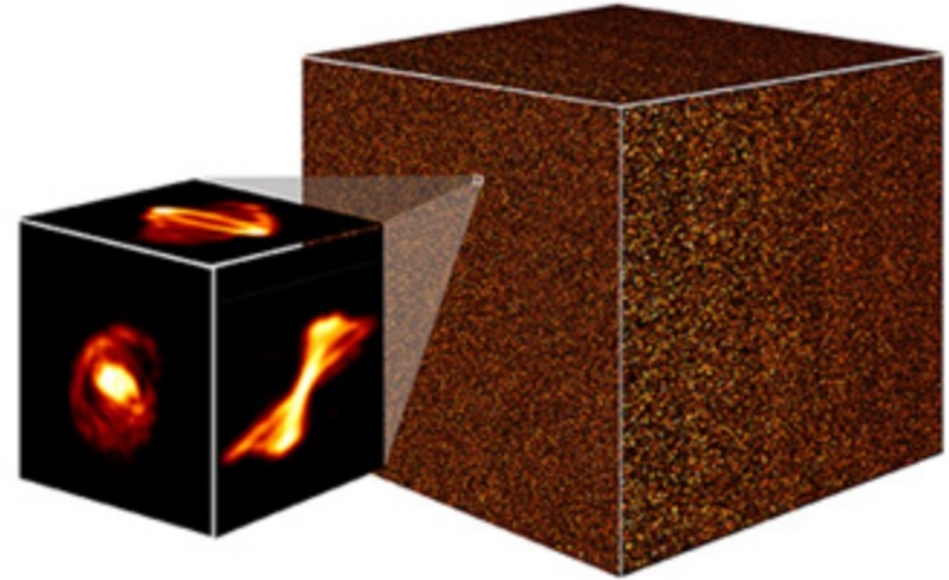
SRC Development



Three people recently hired at Chalmers to form core of Swedish SRC proto node.

Proto-node already supporting SKA pathfinder science use (LOFAR Magnetism, [Sara Piras](#) – Long baselines – [Deepika Venkattu](#) with HI Surveys – [Kelley Hess](#) - to be added during 2023).

Storage Capacity of SRC proto-node at Chalmers likely to approach 1 PB by end 2023/early 2024.



Above - simulated SKA HI data cube data set

Stored data at SRC is almost all **images** (not visibility data) – i.e just like other wavebands. **Possibility to use Swedish SRC node resources for large survey processing from other bands, optical/IR etc.**

Processing includes using ML/AI for source detection – as in SKA Data Challenge 2 – (see ([Henrik Håkansson](#) talk).