Big Science Business Forum 2022

General introduction of DIAGNOSTICS, DETECTORS, SENSORS, OPTICS AND INSTRUMENTS of all involved big science organisations.

Luca Stringhetti SKAO Head of Engineering

4th October 2022 Granada

SKAO CERN esa ESO ess FUSION FOR ENERGY European XFEL

What is diagnostic?

Def: investigation or analysis of the cause or nature of a condition, situation, or problem. (Webster Dictionary)

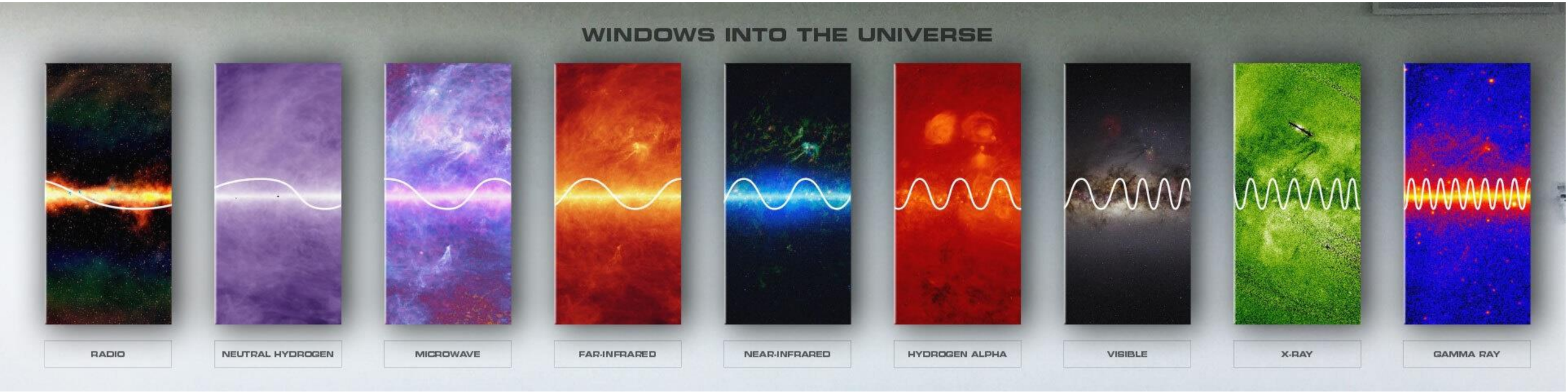
Diagnostic

Instrument

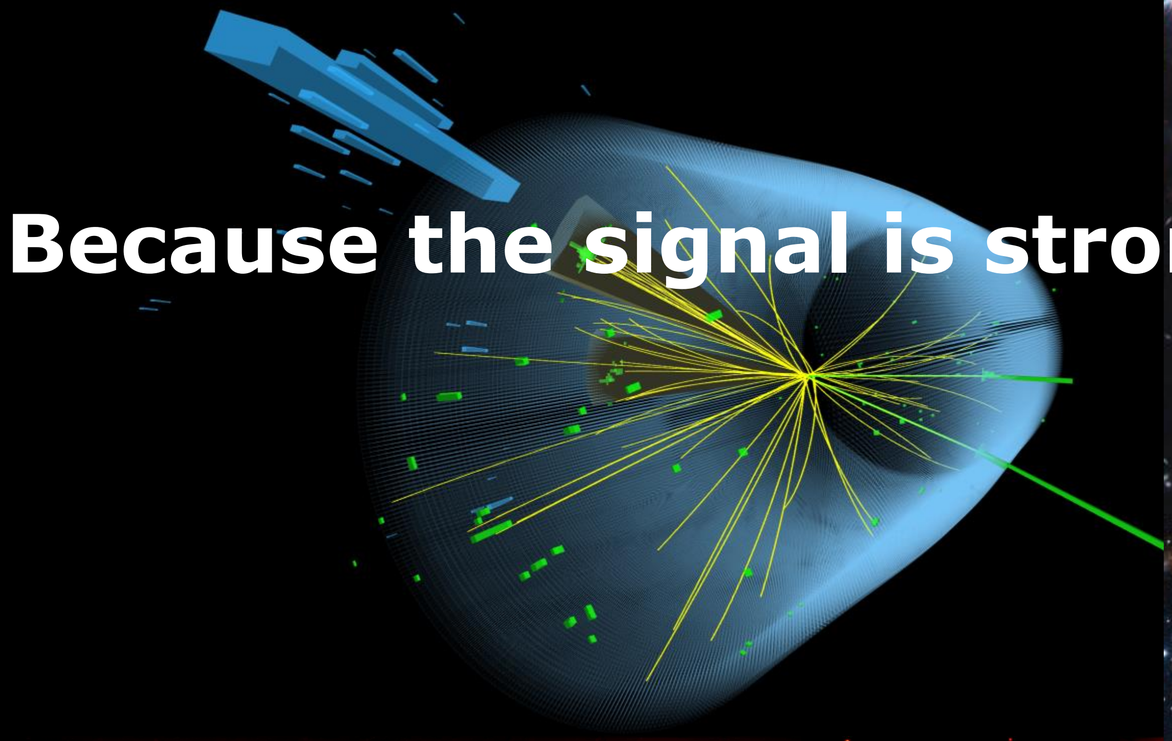
Detector

Big Science organisations have a specific need for a range of diagnostics, detectors, and instruments for the scientific exploitation of the facility.

Because the signal spans quite some frequency range



....and in some cases a multiplicity of energetic particles.

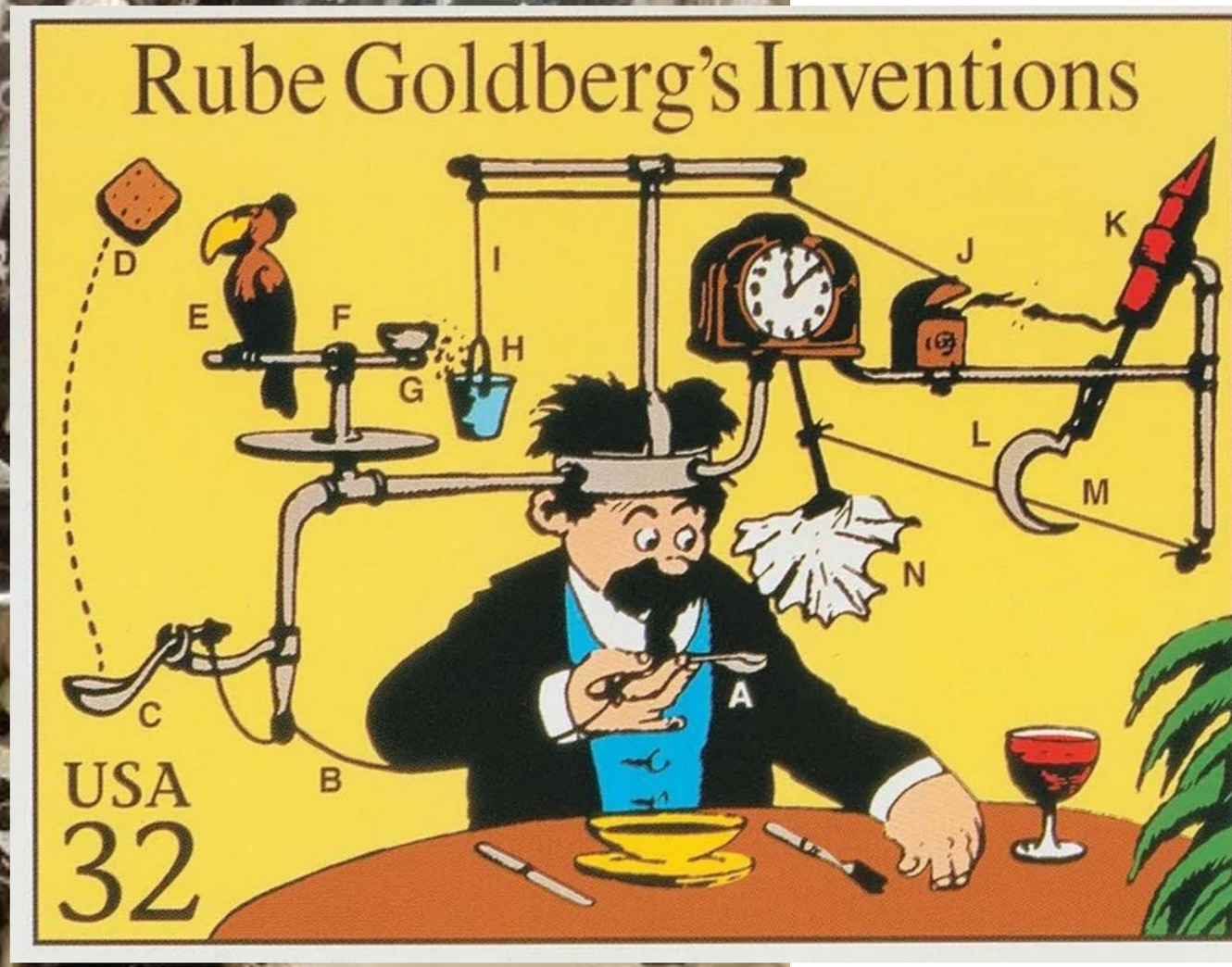


Because the signal is strong……

From ITER web site entry page

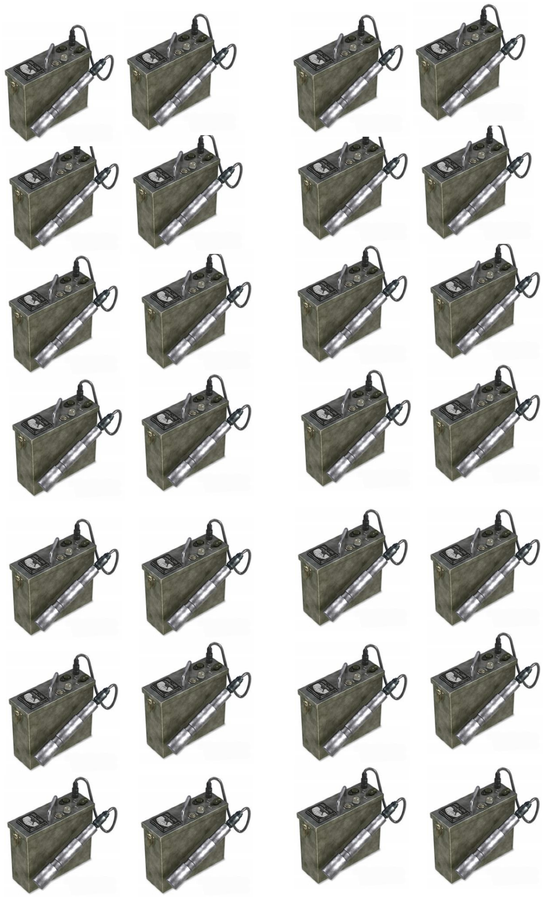
Because the signal is weak……

....we need different technologies



and we need complex systems
Big modern projects are pushing technology to the limit.

Complex (aka big) is better……



Work with the signal

Understand the instrument

Understand the results

Work with the signal

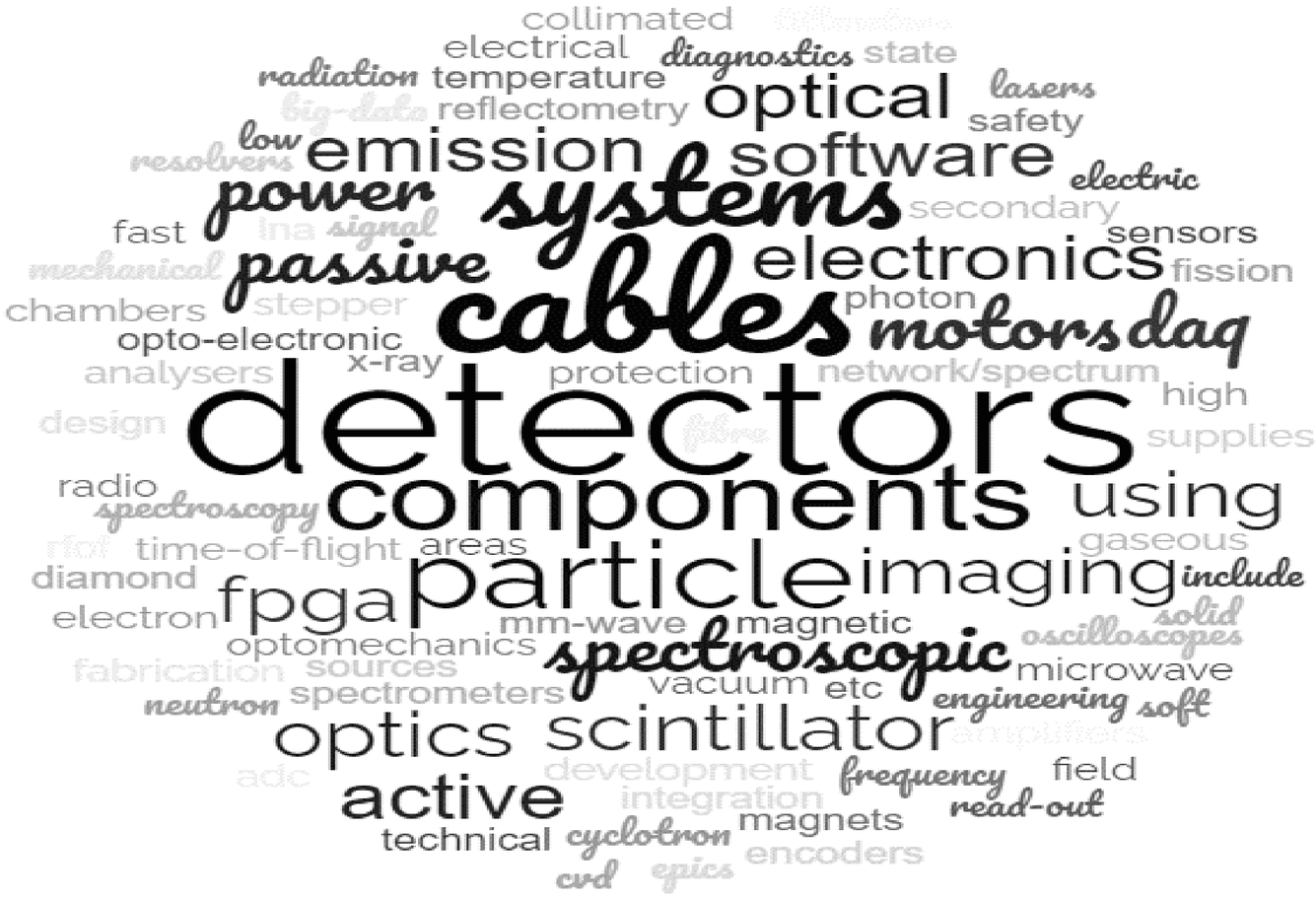
Complicated problems need complex instrumentation, using technology that in some case does not exist (yet), high multiplicity (e.g. redundancy or need for sensitivity) that work for long time (long integration) and that are reliable (in harsh environment)

Understand the instrument

Complex systems need accurate self diagnostic system to minimise unwanted signal (instrumental systematics) or in case of safety critical systems to avoid downtimes.

Understand the results

Complex systems need fast and reliable algorithm to guarantee long operation and detect emergent behaviours, and heavy power hungry data analysis to interpret the results.



The technical areas include optical components, imaging components, sensors, spectroscopic, microwave, electric & magnetic field diagnostics, particle detectors, opto-electronic detectors & components, and fast read-out electronics, etc.

Work with the Signal

Today's agenda covers most of the electromagnetic spectrum and many order of magnitudes of energy are involved. Difficult to have a complete and thorough list

- Photodiode
- Scintillators
- Gas detectors
- Semiconductor detectors
- Photomultipliers
- CCD
- Amplifiers
- Low Noise Amplifiers
- Bolometers
- Analog to Signal Converters (ADC)
- FPGA
- GPU
- ……
- New?

Very different technologies with a common requirements:

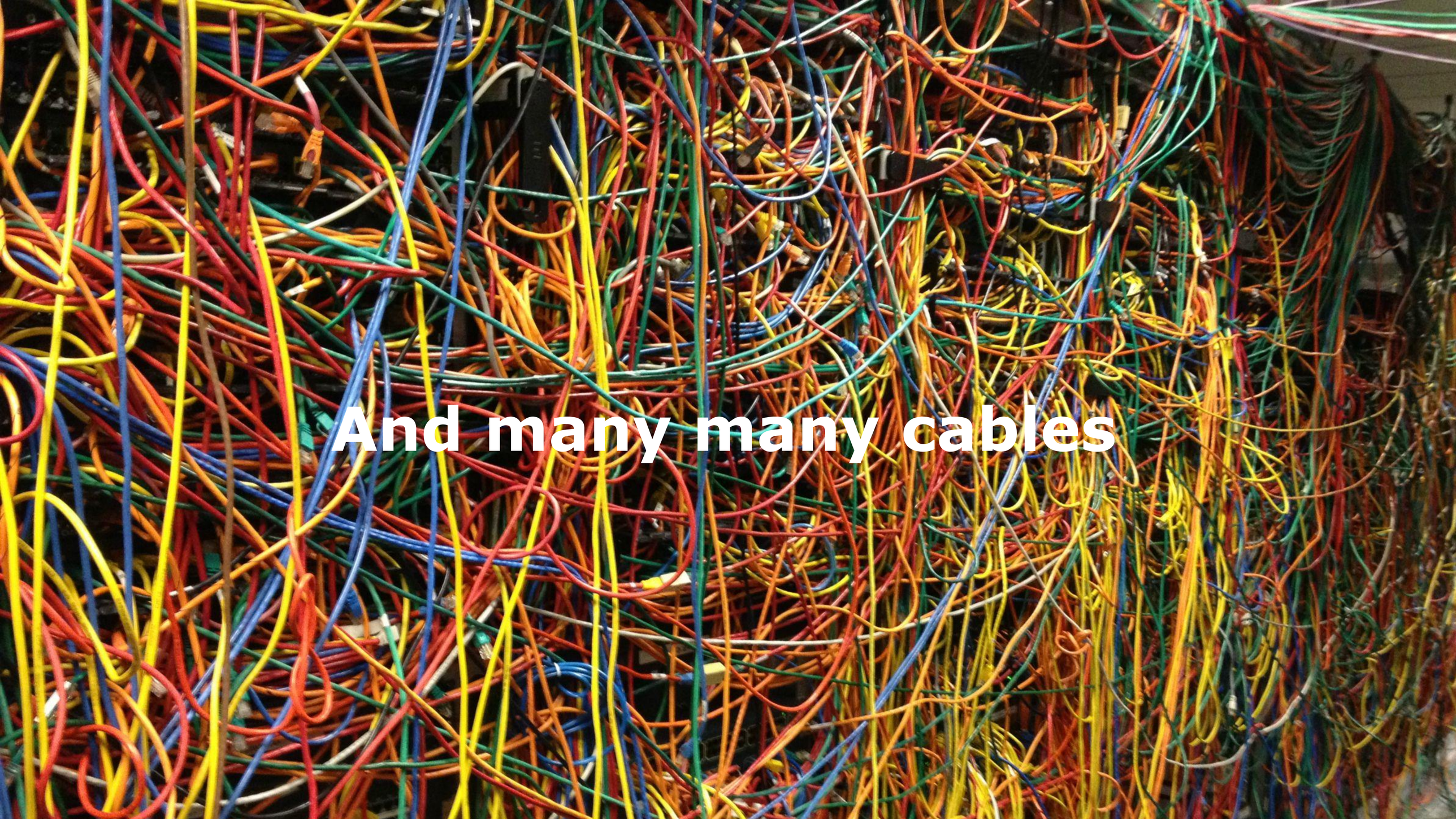
- fast, precise, accurate, low power, and reliable. (if you ask to an engineer)
- Max sensitivity and max dynamic range (if you ask to a scientist)

Understand the instrument

To keep the instrument in a known status is paramount for all the big (and small) projects.

High precision and reliable (and in some cases even redundant or safety-critical) sensors, diagnostic systems for real time feedback or conditioning analysis are needed.

Sensors measure the instrument and the environment around it: pressure, volt, current, temperature, gas analysers, vibration, tiltmeters, positioning, strain, fire, rain, humidity, radiation…


And many many cables

Understand the results

Big instruments and many sensors equals **big data,** and typically no time to analyse them.

New algorithm and new infrastructure (and diagnostic of that…) is needed to handle the huge amount of data that the instruments (and their diagnostic) create every second.

Data analysis needs to be **fast** and **reliable**, and be able to find emergent behaviours (especially if destructive, especially in fail-safe systems)

AI, Machine learning…

Storing and transportation is no more a negligible problem

Status of the technology

New questions, new problems, new technology…..

- **Research and Development is needed.**

All projects need labs and these need instrumentation (e.g. network analysers, signal generators…)

- **but also COTS (components off the shelf) are needed too.**

Where one projects needs cutting edge technology (or even not existing yet) another project needs a consolidated one.

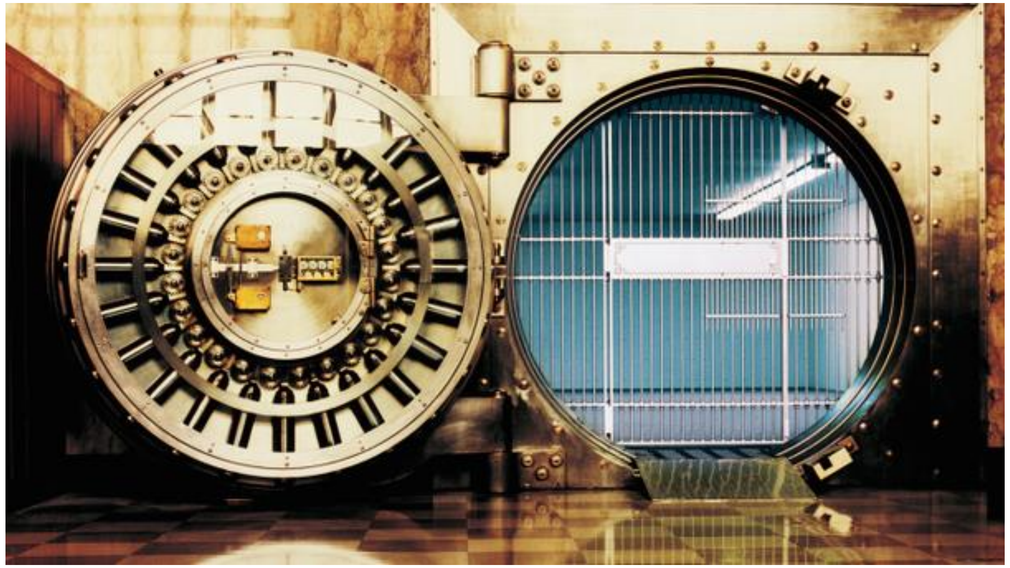
The instruments are often designed by scientific and academic laboratories and universities, but the construction of these require the input from a multitude of specialized companies. (**communication is key**)

Need up to 2026

All the organisations/ projects in today's agenda needs to handle and support the above three needs.

This is an large investment

As an overall envelope among the organisations in agenda there could be a cumulative investment between **40 and 60 Meuro/y**



Contracts can be: from small <200Keuro to large>10Meuro

Beyond 2026

- Many of the projects and organisation have already development plans and upgrades, beside normal operation.
- This means long relationships and collaborations are important for the future

- Being IGOs or ERICs means that the organisations have their own processes for procurements (but overall competitive tender is the preferable choice)
- Different examples of contracts types from New Engineering Contract (NEC4) to Framework contracts.
- Fair work return (pre-allocation of countries where to run the procurement process) is a common standards for several organisations

Path to contracts

Three main ways to get a contract

1) **Direct contract with the organisation** that is running the big science project. Direct contracting works also with consortium and join ventures.

2) **Contracted by a partner organisation** (e.g. universities, research institutions…)

3) **Contracted by somebody that is contracted directly** by the organisation (as subcontractor or suppliers)

Communication is key

All organisations have procurement offices and web portals to facilitate communication.

Moreover, cutting edge technology requires collaboration between several companies (institutions, organisation).

Let’s start here at the BSBF 2022!

Big Science Business Forum 2022

We recognise and acknowledge the Indigenous peoples and cultures that have traditionally lived on the lands on which our facilities are located.

SKAO

www.skao.int