French industry involvement in SKA

Auckland, SKA NZ Symposium, 16th February 2018

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Industry Relations CNRS-INSU
French ILO for SKA
Member of the SKA PSOW
French industry involvement in SKA

- SKA, France and SKA France
- Technology challenges
- 2 examples: Air Liquide and ATOS Bull
- The « Maison SKA France »
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Timeline of the SKA project

- 2010: ESFRI Project
- 2012: Creation of the Project Office
- 2015: Beginning of negotiations for IGO
- 2016: CDR closed
- 2018: IGO entry into force
- 2019: Construction approval
Timeline of the SKA project

- 2009: SKADS
- 2010: LOFAR
- 2011: AS SKA-LOFAR
- 2012: EMBRACE
- 2015: PrepSKA
- 2016: SKA FRANCE
- 2017: Revision of French roadmap
- 2018: P0 for France joining SKAO
- 2019: NenuFAR
The SKA France coordination

Workshops

Web page

Big events

Seminars

Monthly bulletins
The French SKA White Book

176 authors from

- 40 French research institutes

- 6 private companies

Editor in Chief:
C. Ferrand

Editors:
G. Lagache, J.-M. Martin, B. Semelin — Cosmology and Extra-galactic astronomy
M. Alves, K. Ferrière, M.-A. Miville-Deschenes, L. Montier — Galactic Astronomy
E. Josefín, N. Vilmart, P. Zarka — Planets, Sun, Stars and Civilizations
S. Corbel, S. Vongsi — Transient Universe
S. Lambert, G. Thummé — Fundamental Physics
S. Besse, A. Ferrari, S. Galfire — Technological Developments
G. Marquette — Industrial Perspectives and Solutions
France within the organisation of the SKA European Regional Data Centre

- J.-P. Vilotte (CNRS): member of the External Advisory Board (with I. Bird @ CERN & M. Zwaan @ ESO)
- C. Ferrari (OCA): chair of the General Assembly
SKA France factsheet

French contribution to the SKA:
• Observer at SKA Board and Strategy Committee
• Chair of AENEAS GA & 1/3 Members of Ext. Adv. Board
• Invitees to all SKA scientific and technological conferences
• 55 scientific experts in SWG (including 2 co-chair)
• French ILO in SKA Industry Liaison Group and member of PSOW
• Contributor to SKA tech. consortia: LFAA, MFAA, WSBF, DISH, SDP

SKA France actions in 2 years:
• 2 French industry days (> 50 organisations)
• 2 presentations to HC TGIR
• SKA France visits at SKA Office and SKAO visits in French companies
• 10 scientific and technology workshops: SP, Energy, HPC/Big data

French SKA community:
• 176 contributors to the French White Book
• > 250 scientists involved today, 400 by the end of 2017
• > 40 French labs involved
• > 50 experts from the industry
• 6 LE, 3 SMEs involved in RfI & collaborative projects for SKA
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Technological challenges
Building this fantastic machine

SKA1-MID

8.8 Tbps

~2 Pbs

SKA1-LOW

7.2 Tbps

5 Tbps

50 PFLOPS

100 PFLOPS

~300 PB/yr

Users
A wide variety of technical challenges

- Management of large data flows and complex problems of interferometric signal processing
  - *Interdisciplinarity through applications*: identify SKA signal processing and analysis issues that are in common with other application domains (geophysics, meteorology, particles physics, medical imaging, ...)
  - *Interdisciplinarity within the SKA project*: identify how to respond to the challenges of the entire data processing and analysis chain by integrating the technological and methodological components

- Distribution of uninterrupted electrical energy under strong constraints in a desert environment

- Minimising the costs, whilst maximising the reliability and ease of maintenance of all hardware components

- Accurate real-time control of a many elements large-scale infrastructure
Industrial perspectives and solutions

Scientific and technology workshops:
- Energy
- Energy and Cryogeny
- HPC/Big Data
- Signal processing
- System integration (AIV, ITF)

French companies involvement:
- Rfl Energy for SKA RSA (and Australia, to come): Engie, Air liquide
- French industry meetings with SKAO: ArianeGroup, Callisto, Air Liquide, Bull Atos, Thalès, Kalray, Fedd
Industrial perspectives and solutions
Industrial perspectives and solutions

SKA1-MID

Telecommunications

SKA1-LOW

Energy production and storage
Industrial perspectives and solutions

SKA1-MID

~2 Pb/s

8.8 Tb/s

7.2 Tb/s

SKA1-LOW

Data science for monitoring

Hardware and application integration

Data storage, distribution, preservation

100 PFLOPS

DDN®

STORAGE

Thales Alenia Space

Bull

Kalray

SKA France Day 2017
Industrial perspectives and solutions

SKA1-MID

8.8 Tb/s

SKA1-LOW

~2 Pb/s

7.2 Tb/s

50 PFLOPS

5 Tb/s

100 PFLOPS

ThalesAlenia Space

System engineering

arianeGroup

SKA France Day 2017
Industrial perspectives and solutions
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1st example: Air Liquide

Hydrogen Powering SKA,

A precursor of renewable Energy Storage & Distribution
From fundamental physics to Society: Air Liquide & Radio-Astronomy

Cosmology
Dark Energy
ExoPlanets discovery
Life emergence
Early 2000

Square Kilometer Array Telescope.
Integrated Cryogenics and distributed Power
Early 2020

Renewable Energy Storage & Hydrogen Mobility
Early 2030
Grid Power Supply baseline of SKA-MID1

1st example: Air Liquide

2,2MW Dish
No grid build yet

2,7MW Computing

6,5MW Max
1,8MW Grid loss

50km
1st example: Air Liquide
Concluding Statements

SKA will pave the way to the deployment of industrial systems for the production and storage of renewable energies

French breakthrough solutions proposed by Air Liquide can change the game:

- An innovative and competitive renewable energy storage system
- A cutting edge technology for the mechanical coolers

A participation in SKA will put the French industry at the forefront in the worldwide energy transition market
2nd example: ATOS Bull

Collaboration on DDFacet

In a nutshell

- **Context & Partnership**
  - Paris Observatory
    - DDFacet Imaging tool by Cyril Tasse & collaborators
    - The most advanced French code already widely used on radio astronomical data (e.g. LOFAR, MeerKAT, etc.)
  - Bull’s Center for Excellence in Parallel Programming (CEPP)
    - Expert in optimization of HPC applications and workflows
    - Industrial HPC systems and tools
  - Work launched by and performed within the SKA-France coordination
    - Coordinated scientific, technological and industrial preparation to the SKA project

- **First phase (done)**
  - Dive into DDFacet and its associated software stack
  - Test 2 compiler suites: GNU and Intel
  - Identify the different phases of processing and extract their respective part of the total execution time
  - First focus on Input/Output (IO) phase

- **Second phase (in progress)**
  - Multi-node execution of DDFacet
    - Reduce latency (time to solution)
    - Improve throughput (#image / hour)
  - Exploring different hardware architectures (Sequana Xeon Phi, Bullion, more...)
  - Contribution to SKA-France to improve chance of joining SKA Lowe
Collaboration on DDFacet

Results obtained by C. Tasse & collaborators on LOFAR Surveys Data

3rd generation calibration on the Bootes field:
8 hours integration with LOFAR@~150MHz

DDFacet:
the equivalent of adaptive optics for radioastronomy

Developed by C. Tasse

In collaboration with Rhodes University
(Tasse et al. 14; Smirnov & Tasse 15;
Tasse & Smirnov in prep.)

Adopted for LOFAR Surveys (Röttgering et al.)
2nd example: ATOS Bull

SKALLAS: SKA parallel Architecture & Software

**AAA approach:**
Complex methods of calibration and deconvolution
Design space exploration \(\rightarrow\) computing system best adapted in terms of dimension and energy consumption vs SKA needs
Test of different architectures and parallelisation of codes (MPPA 15W, GPU, FPGA) (Coll. AUT, Rhodes Univ.)

**Challenges:**
1/ Real time processing of raw data up to 9 Tb/s (CSP: 50 Pflops; SDP: 100 PFlops pour le SDP)
2/ Energy constraints \(\rightarrow\) FLOPS per watt
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From SKA France Coordination to the « Maison SKA France »

- SKA is a fantastic test bench and use case with a global perspective facing a huge worldwide competition

- One year after the creation of SKA France Coordination, the French partners decide to move because they need to increase:
  - direct contact with SKA Organisation
  - image/communication at global scale
  - expertise and technology developments necessary to reach SKA challenges through strong PPPs.
  - the financing capacity for preliminary studies with SKA:
    - direct contracting with SKA countries
    - through collaborative projects, thanks to:
      - regional and national programs: ANR, PIA3, DIM, FUI
      - at European level: H2020, EUREKA Clusters (ITEA3, EUROGIA...)
    - financial engineering: BPI, EIB, WB, AfDB

- Q1 2018: Creation of the Maison SKA France
SKA France private and public partners have proposed to organize themselves within a light but efficient legal structure to:

- Acknowledge the capacity and power of academic and industry partners to help achieve SKA's goals
- Be an attractor of the French competencies and expertise to strengthen the potential of SKA
- Be a recognized body to interface with the ministries in France and with the organization SKA
- Be a force of proposition to evolve the SKA program in the best interests of the international astro community.
Objectives

• Demonstrate to the French Research Ministry public-private mobilization to bring France into the Project Office SKA as soon as possible, aiming at 2018

• Promote and recognize the excellence of French scientific teams and industry to be at the fore-front of the science to be developed in SKA

• Develop the expertise and technologies needed to meet the challenges of SKA through strong Private-Public Partnerships. Implementation through theses/postdocs and collaborative research projects on public, private, shared cost or own funds.
The added value of the Maison SKA France for industry

1. Access for companies to SKA in making industry expertise/competence known and acknowledged

2. Get a better insight of SKAO and SKA structure and operations

3. Have industry experts working for and with SKAO in technological consortia

4. Optimize resources engagement for technological solutions preparation corresponding to SKA needs

5. Media impact of the Maison SKA France partners in France and in SKAO.
SKA, a new paradigm of research-industry relations in France

Maison SKA France:
- A MoU, strong real equilibrated PPP, between research organisations and their industry partners
- A means to participate to the SKAO Board works
- A science and technology roadmap
- A forum to develop fundamental research and R&D projects
- A 3-year action, until France becomes SKA country

A precursor of a new business model for Large Research Infrastructures:
- Public-private financing, for both CAPEX and OPEX
- Unique interface between industry partners and SKAO
- Long term, multi-partners, interdisciplinary relationships

A new collaboration scheme for Large Research Infrastructures in France: astro, HPC, energy
- Interdisciplinary and systemic approach
- Full cost evaluation, procurement rules, IP, exploitation of results
Maison SKA France

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- A science and technology roadmap
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- A precursor of a new business model for Large Research Infrastructures

SKA France Day 2017
The “Maison SKA France” is ready to put into action this unique opportunity for France and SKA
Thank you!
Integrative approach and socio-economic impact

• Integration of all costs, from research to industrialization
• Development of a new relationship model with the industry by associating industry partners since the design phase:
  • R&D costs optimization
  • Better positionning to prepare bids proposals
• Setting an innovative business model leading to long term investments
  • Minimization of losses due to bids failures
  • ROI calculation taking into account marketing aspects, impact, image, market(s), long term contracts, etc.
  • Private-public funding for large infrastructures
• Sharing different cultures et constraints with stakeholders (ministries, IGO...):
  • Procurement rules, full costs computation, company strategy...
Collaboration on DDFacet

Other examples of DDFacet results on LOFAR Surveys Data (Röttgering et al.)

Without DDE correction

DDE correction estimated by Wirtinger-Kalman filter

Tasse et al.
First phase outcome

- Two technical meetings
  - 5th Oct. 2017 @ Bull (Échirolles) with OBSPM and DDN
  - 16th Oct. 2017 @ SKA France Day - OBSPM Paris with Bull, DDN, INSA-Rennes and Rhodes University

- Outcomes and new goals from the technical meetings
  - Multi-node parallelization should be studied
  - Why not exploring different hardware architectures (Sequana Xeon Phi, Bullion, more...)?
  - Transfer of a bigger test case to enable asynchronism (overlap IO and computational phases) and intensify computational part such as Gridding

Second phase preparation

- SKALLAS: SKA parallel Architecture & Software
  - Umbrella project to fund face to face meetings and a special session at IEEE SIPS 2018 conference

- New bigger test case from OBSPM sent to Bull

- Internship @ Bull Rennes dealing with inter-node parallelization
  - Mentoring in collaboration with INSA Rennes
  - From 19th Feb. to 3rd Aug. 2018 (6 months)
  - Mission:
    - Identifying parallelism opportunities in DDFacet
    - Develop a prototype to make a proof of concept
    - Study the impact of a hierarchical storage system
    - Propose improvements and optimizations on different specific hardware environments

- Dissemination: conference paper at the SIPS special session