



Welcome to



PAF WORKSHOP 2016

PHASED ARRAY FEED WORKSHOP - AUGUST 24-26, 2016 - CAGLIARI, ITALY

PAF2016 Workshop Organizers



INAF

ISTITUTO NAZIONALE
DI ASTROFISICA
NATIONAL INSTITUTE
FOR ASTROPHYSICS



**Osservatorio
Astronomico
di Cagliari**



PAF2016 Organizing Committees

Local Organizing Committee (INAF-OAC):

Tiziana Coiana

Alessandro Navarrini

Andrea Saba

Scientific Organizing Committee:

Mark Bowen (CSIRO, Australia)

Lisa Locke (NRC-DAO, Canada)

Alessandro Navarrini (INAF, Italy)

Wim van Cappellen (ASTRON, The Netherlands)

Bruce Veidt (NRC-DRAO, Canada)

Scope:

- engineering feedback from commissioning and early science observations;
- element and array design with ultra-wide bandwidth;
- analog and mixed-signal electronics;
- traditional beamforming and innovative solutions;
- beamformer calibration;
- array characterization and testing;
- sensitivity and field of view limits;
- cryogenic PAFs;
- systems integration;
- telescope optics for PAFs;
- imaging, and lessons learned from early PAF deployments;

24 August 2016

...in 2001 the Astronomical Station of Cagliari became **Astronomical Observatory of Cagliari** and entered the new founded **Istituto Nazionale di Astrofisica (INAF)** which now comprises 18 institutes across the country



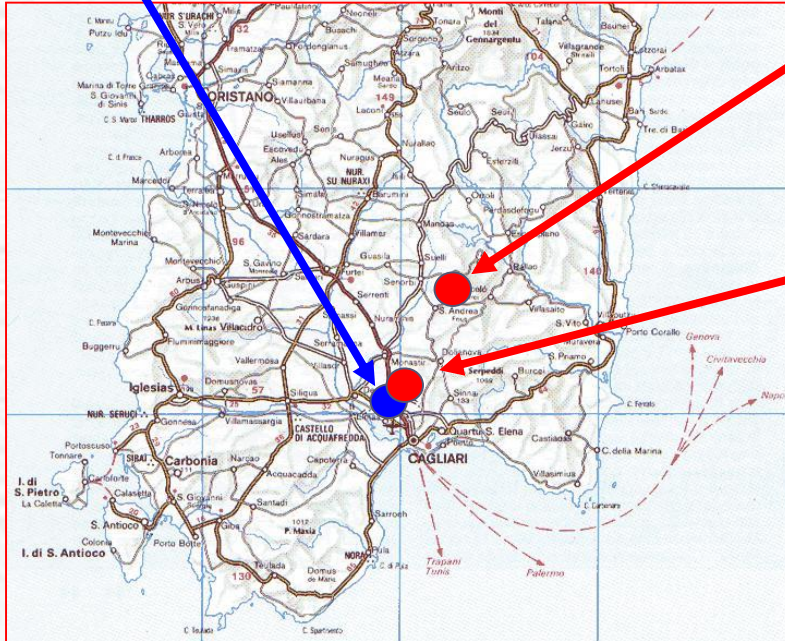
Andrea Possenti
Director INAF-OAC

The current geography of INAF in Sardinia

Physics Department of the
University of Cagliari

SRT (San Basilio / Gerrei)

New Headquarters (Selargius)



Two main sites

SRT: Full science operations since 2016

SRT inizia le osservazioni scientifiche

Terminata la fase di test e sviluppo, SRT si apre alla comunità scientifica con un programma di Early Science.



Sardinia Radio Telescope

Una delle domande più frequenti durante le visite guidate al Sardinia Radio Telescope riguarda l'inizio della sua operatività: *"Ma SRT quando inizierà a fare osservazioni e scoperte?"*.

One of the most important assets for INAF

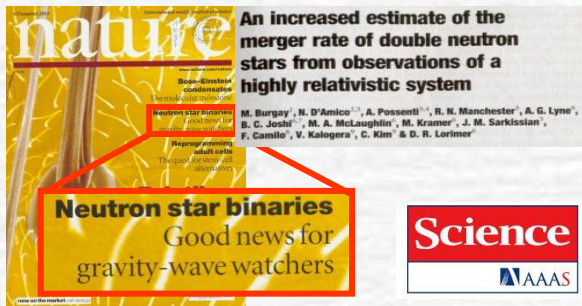
The headquarters of INAF-OAC since **2013**

about 25000 m² of which 3000 m² covered



42 permanent staff - **16** temporary staff - **7** PhD students, post-Docs, and other contracts

Twofold aims: SCIENCE



Detection of Gamma-Ray Emission from the Vela Pulsar Wind Nebula with AGILE

A. Pellizzoni,^{1,2} A. Trolis,² M. Tavani,^{1,2,3,4,5} M. Pilo,^{1,4} A. Giuliani,⁷ G. Pucella,⁸ P. Esposito,^{9,10} S. Sabatini,^{11,12} G. Piana,¹³ A. Argan,¹⁴ G. Barbattini,¹⁵ A. Bulgarelli,¹¹ M. Burgay,¹ P. Caraveo,¹ P. W. Cattaneo,¹ A. W. Chen,¹ V. Cocco,¹ T. Contesi,¹ E. Cota,¹ F. D'Ammando,^{2,3} E. Del Monte,² G. De Paris,² G. Di Cocco,² G. Di Persio,¹ I. Donnarumma,² Y. Evangelista,² M. Feroci,² A. Favaro,² M. Fiorini,² F. Fuschino,¹³ M. Gatti,¹² F. Gianotti,¹³ A. Hulan,¹³ C. Labanti,¹¹ I. Lashov,² F. Lazzarotto,² P. Lipari,¹⁴ F. Longo,¹⁶ M. Marisaldi,¹¹ M. Mastroiello,² S. Mereghetti,² E. Moretti,²⁰ A. Morrell,¹ L. Pacciani,² J. Palfreyman,¹⁵ F. Perotti,² P. Picazza,¹⁴ C. Pittori,¹⁸ A. Possenti,¹ M. Pevni,¹⁹ M. Raspanda,¹ A. Rappoldi,² E. Rossi,¹² A. Rubin,² P. Santolamazza,¹⁶ E. Scallie,² P. Soffitta,² E. Striani,¹⁴ M. Tringolo,²¹ E. Valzania,¹⁷ S. Verzelione,¹⁷ F. Verrecchia,¹⁴ V. Vittorini,¹ A. Zambra,⁷ D. Zanello,¹⁴ P. Giommi,¹⁴ S. Colafrancesco,¹⁴ A. Antonelli,¹⁴ L. Salotti,¹⁸ M. D'Amico,¹³ G. F. Bignami¹⁹

Detection of Gamma-Ray Emission from the Vela Pulsar Wind Nebula with AGILE
A. Pellizzoni *et al.*
Science **327**, 663 (2010);
DOI: 10.1126/science.1183844

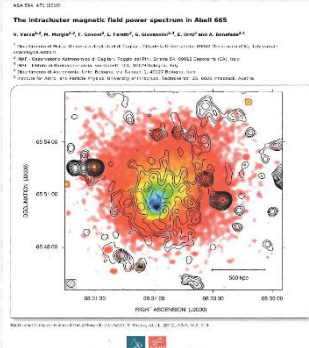


Nature **456**, 927-929 (18 December 2008) | doi:10.1038/nature07544;
Accepted 6 October 2008

A gravitationally lensed water maser in the early Universe

C. M. Violette Impellizzeri¹, John P. McKean¹, Paola Castangia^{1,2}, Alan L. Roy¹, Christian Henkel¹, Andreas Brunthaler¹ & Olaf Wucknitz³

1. Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany
2. INAF-Osservatorio Astronomico di Cagliari, Loc. Poggio dei Pini, Strada 54, I-09012 Capoterra (CA), Italy
3. Argelander-Institut für Astronomie, Auf dem Hügel 71, D-53121 Bonn, Germany



A Double-Pulsar System: A Rare Laboratory for Relativistic Gravity and Plasma Physics

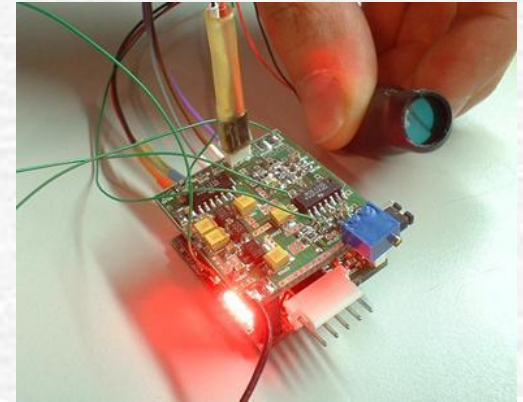
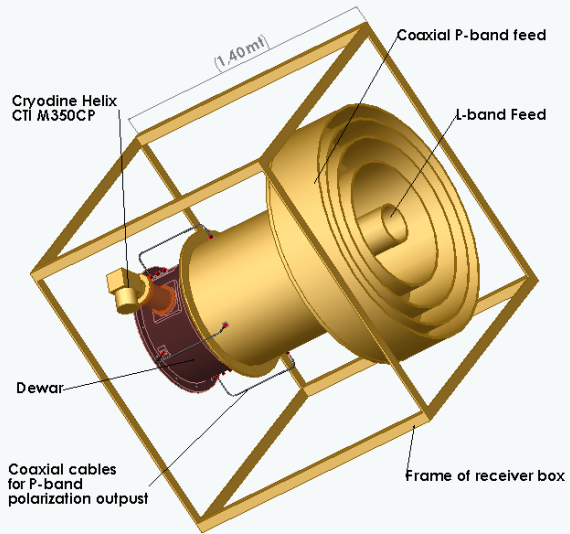
A. G. Lyne,^{1*} M. Burgay,¹ M. Kramer,¹ A. Possenti,^{1,2} R.N. Manchester,¹ F. Camilo,³ M. A. McLaughlin,⁴ D. R. Lorimer,⁵ N. D'Amico,^{1,6} B. C. Joshi,⁷ J. Reynolds,⁸ P. C. Freire⁹

The stochastic properties of pulsars moving in the gravitational fields of their unseen neutron-star companions have allowed unique tests of general relativity and provided evidence for gravitational radiation. We report here the detection of the 2.4-second pulsar PSR J-0737-3039a as the companion to the 2.3-millisecond pulsar PSR J-0737-3039b in a highly relativistic double neutron star system, allowing unprecedented tests of fundamental gravitational physics. We show that a short eclipse of PSR J-0737-3039a by PSR J-0737-3039b and orbital modulation of the flux density and pulse shape of PSR J-0737-3039b, probably because of the influence of PSR J-0737-3039a's energy flow on its magnetosphere, have effects that allow us to probe magnetospheric properties of a pulsar magnetosphere.

since 2009

54 papers/yr on refereed journals
for 22 science-devoted FTEs
among which
5 Science papers
4 Nature papers

Twofold aims: TECHNOLOGY



since **2009**



Modern workshop and well equipped labs of electronics and microwaves



Plus a lot of international involvements, e.g.

SKA: 1 chair of Science WG plus few contributors to previous WGs
and SKA meeting 2014 +

Technological cooperation for back-ends

LOFAR: 2 people involved, few past-students working in that

EPTA, IPTA and LEAP: 5 people involved

VAMDC EU project: 1 people chairing

FERMI, AGILE group: 5 people involved

HTRU survey: 3 people involved

AETHER: few people involved

Various collab with **IRAM:** few people involved

Collab with **CALTECH (Werthimer)** : 2 people involved

...

Fundamental support from the Regional Government



REGIONE AUTONOMA DELLA SARDEGNA

OAC construction

=

≈ 7 Meuro from the Region

+ Municipality of Selargius + INAF (10%) contribution

SRT construction

=

5 Meuro for construction of the SRT infrastructures before 2011

1.5 Meuro for completion and early science from 2012

Fundamental support from the Regional Government

since **2009**



REGIONE AUTONOMA DELLA SARDEGNA

Research grants for about 2 Meuro

Technology development grants for about 3 Meuro

Grants for high level formation and educational for about 0.5 Meuro

**Radio astronomy, space science and related technologies
are selected assets for Sardinian Region**

Given what reported ... the plan for the future is ...

© Gianni Alvito



...keeping (and possibly further improving) the **HIGH QUALITY** of the produced **SCIENCE** and **TECHNOLOGY** in the planetary context ...

... while enhancing the role of **GROWTH DRIVER** for technological and cultural development of **Sardinia**



© Alessio Putzu

... and the PAF 2016 meeting arrives at the perfect time !

THANKS for coming to Sardinia and
HAPPY meeting !

Internet access

A free wifi connection is available inside the hotel.

WiFi SSID: HRM

Internet connection requires to login with social credentials (like Google+, Facebook, Twitter, Instagram, etc.).

The local organizing committee is available for assistance.

- 
- Workshop Program and Abstract Book updated yesterday.
Updated versions are available online at:
<http://paf2016.oa-cagliari.inaf.it/>
 - A printed copy of the updated program is available in your cardboard folder;
 - PAF2016 Workshop numbers:
55 registered participants from 12 countries, 24 abstracts, 8 sessions;
 - Three presentations by videoconference;
 - Use microphone for questions.

Sala Villanova, Hotel Regina Margherita
Viale Regina Margherita, 44 – Cagliari, Italy
PAF2016 WORKSHOP AGENDA



Osservatorio
Astronomico
di Cagliari



INAF
ISTITUTO NAZIONALE
DI ASTROFISICA
NATIONAL INSTITUTE
FOR ASTROPHYSICS

PAF WORKSHOP 2016
PHASED ARRAY FEED WORKSHOP - AUGUST 24-26, 2016 - CAGLIARI, ITALY

Updated Agenda

Wednesday Aug. 24th, 2016:

08h00-09h00	Registration and Payment	
09h00-09h05	Welcome address from hosting Institution	
09h05-09h15	Logistic information	
09h15-09h30	PAFs and the future of radio astronomy, <i>S. Tingay (INAF, Italy)</i>	Session 1 Chair: E. Carretti
09h30-10h15	Introductory Talk: Mutual coupling analysis of line-feeds devoted to cylindrical reflectors, <i>C. Crayle (Univ. Louvain, Belgium)</i>	
10h15-10h45	High-Performance PAFs with CMOS LNAs, <i>B. Veidt (NRC, Canada)</i>	
10h45-11h05	Coffee break	
11h05-11h35	Early commissioning results from the Focal-plane L-band Array feed for the Green Bank Telescope (FLAG), <i>B. Jeffs (Brigham Young Univ., USA)</i>	Session 2 Chair: M. Bowen
11h35-12h05	Focal L-band array for the GBT: Instrumentation Upgrades and Performance Results, <i>Anish Roshi (NRAO, USA) – Videoconf</i>	
12h05-12h35	An update on APERITIF and future PAF activities at ASTRON, <i>W.A. van Cappellen (ASTRON, The Netherlands)</i>	
12h35-13h05	Online Calibration Scheme for APERITIF, <i>B. Hut (ASTRON, The Netherlands)</i>	
13h05-14h00	Lunch break	
14h00-14h30	Development of the L-band Phased Array Feed for the Five-hundred-meter Aperture Spherical radio Telescope, <i>Y. Wu (NAO, China)</i>	Session 3 Chair: L. Locke
14h30-15h00	Measuring PAFs at CSIRO, <i>A. P. Chippendale (CSIRO, Australia)</i>	
15h00-15h30	First astronomy with a modified Mark II ASKAP PAF on the 64 m Parkes radio telescope, <i>A. P. Chippendale (CSIRO, Australia)</i>	
15h30-15h50	Coffee break	
15h50-16h20	The development of a CSIRO MKIII wideband phased array feed, <i>A. Dunning (CSIRO, Australia)</i>	Session 4 Chair: A. Navarrini
16h20-16h50	High Polarisation Isolation Crossed-Ring Antenna Array for SKA-MFAA, <i>Y. Zhang (University of Manchester, UK)</i>	
16h50-17h20	A 160 channel Cryo Phased Array Camera for Radio Astronomy, <i>G. Cortes-Medellin (Cornell University, USA)</i>	
17h50-18h50	Bus transfer from Hotel Regina Margherita to Nora (free evening in Cagliari is an option). Meeting point in front of the hotel at 17h40	
19h00-19h45	Visit of Nora archeological site (guided tour for free)	
20h00-22h30	Social dinner in a seaside restaurant (cost 40 € per person, accompanying persons are welcome)	
22h30-23h30	Bus transfer from Nora to Hotel Regina Margherita	

Sala Villanova, Hotel Regina Margherita
Viale Regina Margherita, 44 – Cagliari, Italy
PAF2016 WORKSHOP AGENDA



Updated Agenda

Thursday Aug. 25th, 2016:

08h30-09h20	Bus transfer from Hotel Regina Margherita to Sardinia Radio Telescope site. Meeting point in front of the hotel at 8h20.	
09h20-12h00	Visit of the Sardinia Radio Telescope and group photo	
12h00-12h30	Bus transfer from Sardinia Radio Telescope to restaurant	
12h30-14h10	Lunch in a countryside restaurant	
14h10-14h40	Bus transfer to Hotel Regina Margherita	
14h50-15h20	CryoPAF4 – a cryogenic phased array feed design, <i>L. Locke (NRC, Canada)</i>	Session 5 Chair: W. van Cappellen
15h20-15h50	Variable Dielectric Delay Lines in Liquid Crystals for Phased Array Feed, <i>L. Liu, (University of Manchester, UK)</i>	
15h50-16h05	Cryo-mechanical solutions for a cryostat equipped with large window: The PHAROS case, <i>S. Mariotti (INAF, Italy)</i>	
16h05-16h30	Coffee break	
16h30-17h00	PAF Aperture Array Tests: Analog and Digital Beamforming Compared, <i>D. B. Hayman (CSIRO, Australia)</i>	Session 6 Chair: B. Veidt
17h00-17h30	The ASKAP Phased Array Feed Digital Beamformer: Design Overview and Performance Characteristics, <i>J. Tuthill (CSIRO, Australia)</i>	
17h30-18h00	A[nother] beamforming strategy – an information theoretic look at beamforming with PAFs, <i>G. Hellbourg (CSIRO, Australia) - Videoconf</i>	
18h00-18h30	Spatial RFI mitigation with Phased Array Feeds, <i>G. Hellbourg (CSIRO, Australia) - Videoconf</i>	
19h00-20h30	Free evening. Possibility of guided walking tour of Cagliari city center: meeting point at the Hotel Regina Margherita at 18h50.	

Friday Aug. 26th, 2016:

09h00-09h30	Fast Numerical Method for the Simulation of Hexagonal Focal Plane Array, <i>R. Sarkis (Antonine Univ., Lebanon)</i>	Session 7 Chair: K. Grainge
09h30-10h00	SKA as Piggyback on Solar Power Towers?, <i>A. Roy (MPIfR, Germany)</i>	
10h00-10h30	PAFs for imperfect optics, <i>O. Wucknitz (MPIfR, Germany)</i>	
10h30-10h50	First astronomy results from PAFs, <i>P. Serra (CSIRO, Australia)</i>	
10h50-11h10	The CSIRO Astronomy and Space Science Phased Array Feed Development Program, <i>M. A. Bowen (CSIRO, Australia)</i>	
11h10-11h30	Coffee break	
11h30-12h30	Workshop summary	Session 8 All
12h30-13h00	Next workshop	
13h00-14h30	Lunch	

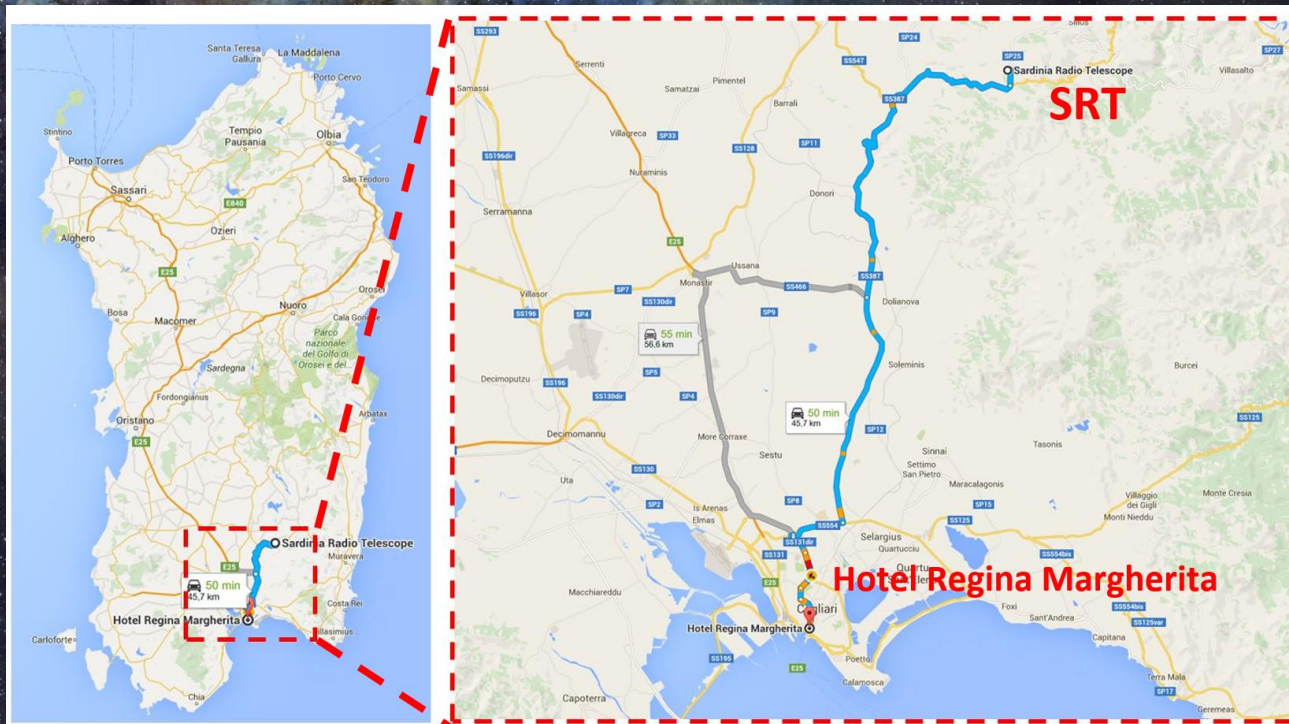
END of PAF2016 Workshop

SRT visit, tomorrow, Aug. 25th

1/2



- Meeting in front of the hotel tomorrow morning at 8h20 (bus leaves at 8h30);
- 50 min travel time;
- Group photo upon arrival at the site (9h20);



SRT visit, tomorrow, Aug. 25th

2/2

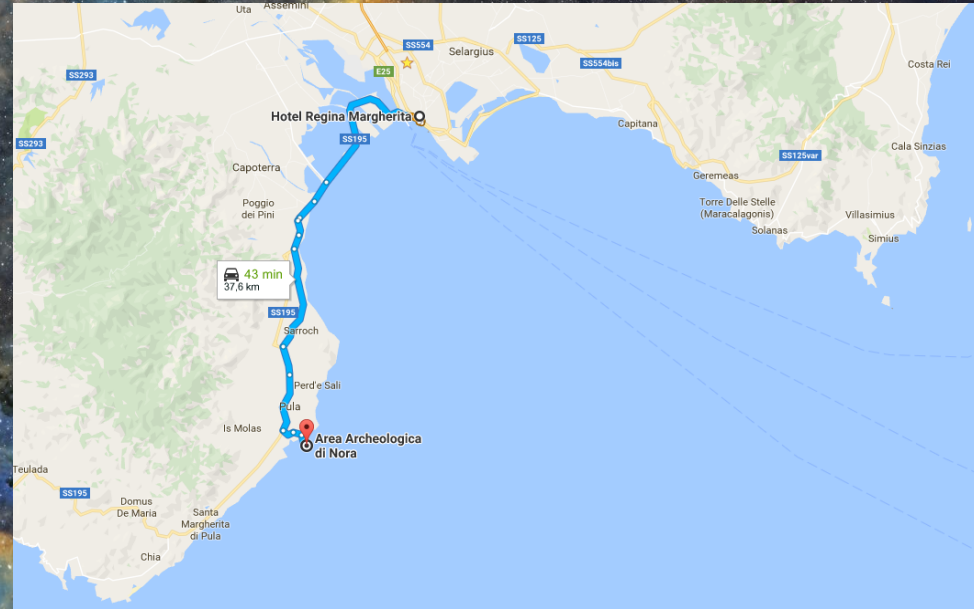
- Various parts of the SRT telescope and associated infrastructures will be accessible;
- Participants divided in four groups (Group A to D);
- **Important:** For safety reasons, participants wishing to tour the telescope **are required to wear suitable shoes** with anti-slip outsole, possibly with safety grooves to improve grip (do not wear open-toed shoes, sandals, or leather-soled shoes);
- A vertical ladder will have to be climbed to access the upper parts of the telescope;
- Sunscreen and sunglasses suggested;
- Bus leaves from the SRT site at 12h00;
- Lunch in a countryside restaurant on the way back to Cagliari (choice between traditional Sardinian meat food or vegetarian);



Social events

1/2

Tonight, Aug. 24th: Visit to Nora archeological site and workshop dinner



- Meeting in front of the hotel today at 17h40 (bus leaves at 17h50);
- ≈1 hr travel time by bus;
- Free organized visit of Nora archeological site, 19h00-19h45;
- Workshop dinner (choice between seafood or vegetarian) not included in registration fee: cost 40 Euro per person (to pay at the restaurant);
- Bus back to Cagliari leaves Nora at 22h30 (arrival around 23h30);
- If interested, please register to the event during the upcoming coffee break;
- Otherwise, free evening in Cagliari is an option.

Social events

2/2

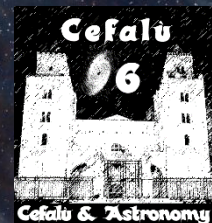
Tomorrow, Aug. 25th: Free guided walking tour of Cagliari historical city center

- Meeting in front of the hotel tomorrow at 18h50;
- ≈1h30 walking tour of city center between 19h00 and 20h30;
- Check tour guide info on abstract book;
- If interested, please register to the event during the upcoming coffee break;
- Free time for dinner after the walking tour. Selection of some possible restaurants available in your folder;
- For information: city is open tomorrow night (shops opened until midnight, *blue night*).

PAF WORKSHOP 2016
PHASED ARRAY FEED WORKSHOP - AUGUST 24-26, 2016 - CAGLIARI, ITALY

Session 1

09h15-09h30	PAFs and the future of radio astronomy <i>S. Tingay (INAF, Italy)</i>	Chair: <i>Ettore Carretti (INAF, Italy)</i>
09h30-10h15	Introductory Talk: Mutual coupling analysis of line-feeds devoted to cylindrical reflectors <i>C. Craye (Univ. Louvain, Belgium)</i>	
10h15-10h45	High-Performance PAFs with CMOS LNAs <i>B. Veidt (NRC, Canada)</i>	



PAF WORKSHOP 2016
PHASED ARRAY FEED WORKSHOP - AUGUST 24-26, 2016 - CAGLIARI, ITALY

Session 2

11h05-11h35	Early commissioning results from the Focal-plane L-band Array feed for the Green Bank Telescope (FLAG) <i>B. Jeffs (Brigham Young Univ., USA)</i>	Chair: <i>Mark Bowen</i> (CSIRO, Australia)
11h35-12h05	Focal L-band array for the GBT: Instrumentation Upgrades and Performance Results <i>Anish Roshi (NRAO, USA) – Remote presentation</i>	
12h05-12h35	An update on APERITIF and future PAF activities at ASTRON <i>W.A. van Cappellen (ASTRON, The Netherlands)</i>	
12h35-13h05	Online Calibration Scheme for APERITIF <i>B. Hut (ASTRON, The Netherlands)</i>	

PAF WORKSHOP 2016
PHASED ARRAY FEED WORKSHOP - AUGUST 24-26, 2016 - CAGLIARI, ITALY

Session 3

14h00-14h30	Development of the L-band Phased Array Feed for the Five-hundred-meter Aperture Spherical radio Telescope <i>Y. Wu (NAO, China)</i>	Chair: <i>Lisa Locke</i> (NRC, Canada)
14h30-15h00	Measuring PAFs at CSIRO <i>A. P. Chippendale (CSIRO, Australia)</i>	
15h00-15h30	First astronomy with a modified Mark II ASKAP PAF on the 64 m Parkes radio telescope <i>A. P. Chippendale (CSIRO, Australia)</i>	

PAF WORKSHOP 2016
PHASED ARRAY FEED WORKSHOP - AUGUST 24-26, 2016 - CAGLIARI, ITALY

Session 4

15h50-16h20	The development of a CSIRO MKIII wideband phased array feed <i>A. Dunning (CSIRO, Australia)</i>	Chair: <i>Alessandro Navarrini (INAF, Italy)</i>
16h20-16h50	High Polarisation Isolation Crossed-Ring Antenna Array for SKA-MFAA <i>Y. Zhang (University of Manchester, UK)</i>	
16h50-17h20	A 160 channel Cryo Phased Array Camera for Radio Astronomy <i>G. Cortes-Medellin (Cornell University, USA)</i>	

PAF WORKSHOP 2016
PHASED ARRAY FEED WORKSHOP - AUGUST 24-26, 2016 - CAGLIARI, ITALY

Session 5

14h50-15h20	CryoPAF4 – a cryogenic phased array feed design <i>L. Locke (NRC, Canada)</i>	Chair: <i>W. Van Cappellen</i> (ASTRON, The Netherlands)
15h20-15h50	Variable Dielectric Delay Lines in Liquid Crystals for Phased Array Feed <i>L. Liu, (University of Manchester, UK)</i>	
15h50-16h05	Cryo-mechanical solutions for a cryostat equipped with large window: The PHAROS case <i>S. Mariotti (INAF, Italy)</i>	

PAF WORKSHOP 2016

PHASED ARRAY FEED WORKSHOP - AUGUST 24-26, 2016 - CAGLIARI, ITALY

Session 6

16h30-17h00	PAF Aperture Array Tests: Analog and Digital Beamforming Compared <i>D. B. Hayman (CSIRO, Australia)</i>
17h00-17h30	The ASKAP Phased Array Feed Digital Beamformer: Design Overview and Performance Characteristics <i>J. Tuthill (CSIRO, Australia)</i>
17h30-18h00	A[nother] beamforming strategy – an information theoretic look at beamforming wit PAFs <i>G. Hellbourg (CSIRO, Australia) – Remote presentation</i>
18h00-18h30	Spatial RFI mitigation with Phased Array Feeds <i>G. Hellbourg (CSIRO, Australia) – Remote presentation</i>

Chair:
Bruce Veidt (NRC, Canada)

PAF WORKSHOP 2016

PHASED ARRAY FEED WORKSHOP - AUGUST 24-26, 2016 - CAGLIARI, ITALY

Session 7

09h00-09h30	Fast Numerical Method for the Simulation of Hexagonal Focal Plane Array <i>R. Sarkis (Antonine Univ., Lebanon)</i>	<p>Chair: <i>Keith Grainge (The Univ. of Manchester, UK)</i></p>
09h30-10h00	SKA as Piggyback on Solar Power Towers? <i>A. Roy (MPIfR, Germany)</i>	
10h00-10h30	PAFs for imperfect optics <i>O. Wucknitz (MPIfR, Germany)</i>	
10h30-10h50	First astronomy results from PAFs <i>P. Serra (CSIRO, Australia)</i>	
10h50-11h20	The ASKAP Phased Array Feed Digital Beamformer: Design Overview and Performance Characteristics <i>J. Tuthill (CSIRO, Australia)</i>	

PAF WORKSHOP 2016

PHASED ARRAY FEED WORKSHOP - AUGUST 24-26, 2016 - CAGLIARI, ITALY

Session 8

11h40-12h00	The CSIRO Astronomy and Space Science Phased Array Feed Development Program <i>M. A. Bowen (CSIRO, Australia)</i>	
12h00-13h00	Workshop summary	
13h00-13h30	Next workshop	All
Lunch – END OF WORKSHOP		