

Engineering Forum Workshop

Report

Title	4th Engineering Forum Workshop <i>Photonics in Radio Astronomy</i>	
	http://www.radionet-eu.org/fp7wiki/doku.php?id=na:engineering:ew:4thew	
Date	2 – 3 September 2010	
Location	Aveiro, Portugal	
Host institute:	Instituto de Telecomunicações University of Aveiro	
Participants		
	<i>Number</i>	19
	<i>Countries</i>	DE, ES, NL, PT, UK, ZA
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PARTICIPANTS LIST

	Last Name	First Name	Affiliation	COUNTRY
1.	Barbosa	Domingos	Instituto Telecomunicação	Portugal
2.	Bedoe	Gerlinde	Nokia Siemens Networks	
3.	Berenz	Thomas	MPIfR	Germany
4.	Bergano	Miguel	Instituto Telecomunicação	Portugal
5.	Camacho	Caludia	Instituto Telecomunicação	Portugal
6.	Drummond	Miguel	Instituto Telecomunicação	Portugal
7.	Gallego Puyol	Juan Daniel	OAN	Spain
8.	Keller	Reinhard	MPIfR	Germany
9.	Maat	Peter	ASTRON	The Netherlands
10.	McCool	Rosheen	SPDO	UK
11.	Monteiro	Paulo	Instituto Telecomunicação	Portugal
12.	Nelson	Silva	Instituto Telecomunicação	Portugal
13.	Nogueira	Rogério	Instituto Telecomunicação	Portugal
14.	Oliveira	Arnaldo	Instituto Telecomunicação	Portugal
15.	Spencer	Ralph	University of Manchester	UK
16.	Szomoru	Arpad	JIVE	The Netherlands
17.	Terra	Domingos	Instituto Telecomunicação	Portugal
18.	Venkatasubramani	T. L.	SKA, National Research Foundation	South Africa
19.	Wernz	Horst	Ericsson GmbH	

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	Name	Address	Signature
1.	Barbosa Domingos	Instituto Telecomunicações, Portugal	
2.	Berenz Thomas	MPIFR Bonn, USA Germany	
3.	Drummond Miguel	Instituto Telecomunicações, Portugal	
4.	Gallego Puyol Juan Daniel	OAN, Spain	
5.	Keller Reinhard	MPIFR-Bonn, Germany	
6.	Matt-Peter PETER KRAAT	ASTRON, The Netherlands	
7.	Spencer Ralph	University of Manchester, United Kingdom	
8.	Szomoru Arpad	JIVE, The Netherlands	
9.	Venkatasubramani T. L.	SKA, National Research Foundation, South Africa	
10.	Wenz Horst	Ericsson GmbH	
11.	Claudia Camacho	Instituto Telecomunicações, Portugal	Claudia Camacho
12.	Miguel Bergano	Instituto Telecomunicações, Portugal	
13.	Gerlinde Bedoe	Nokia Siemens Networks	
14.	Domingos Terra	Instituto Telecomunicações, Portugal	
15.	Nelson Silva	Instituto Telecomunicações, Portugal	
16.	Rosheen McCool	SPDO	
17.	Rogério Nogueira	INSTITUTO DE TELECOMUNICAÇÕES / NSN	
18.	Gerlinde Bedoe	Nokia Siemens Networks	
19.	ARNAUDO OLIVEIRA	INSTITUTO DE TELECOMUNICAÇÕES / UA, PORT.	
20.	Paulo Monteiro	IT/UA/NSN	

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PHOTO



Participants of the 4th Engineering Forum Workshop, 2 – 3 September 2010, Aveiro (Portugal)

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AGENDA

2nd September 2010

08.45 – 09.15	Registration
09.15 – 09.30	Welcome and Introduction <i>R. Keller (MPIfR, DE), D. Barbosa IT, PT)</i>
09.30 – 10.15	Optical Fibres and e-MERLIN <i>R. Spencer et al (Manchester University, UK)</i>
10.20 – 10.40	Fibre networks for the SKA <i>R. McCool (SPDO)</i>
10.45 – 11.05	Broadband analogue RF transmission via optical fibre <i>T. Berenz (MPIfR, DE)</i>
11.10 – 11.30	Coffee Break
11.30 – 12:00	The LOFAR data transport system <i>P. Maat (ASTRON, NL)</i>
12.05 – 12.35	Optical Fibre Network for a radio astronomy receiver <i>T. L. Venkatasubramani (SKA-SA)</i>
12.40 – 13.10	EXPreS and NEXPreS: the future of European VLBI <i>A. Szomoru (JIVE, NL)</i>
13.10 – 14.30	<i>Lunch</i>
14.30 – 15.00	<i>Optical solutions for astronomical data rates</i> <i>G. Bedö (Nokia Siemens Networks)</i>
15.05 – 15.35	Photonic true-time delay antenna beamformer based on a tunable polarization-domain interferometer <i>M. V. Drummond (Instituto de Telecomunicações, PT)</i>
15.40 – 16.10	Analog optical signal transport and signal processing for the SKA telescope <i>P. Maat (ASTRON, NL)</i>
16.15 – 16.40	<i>Coffee Break</i>
16.40– 17.10	Current state and future aspects of high data rate optical transmission <i>H. Wernz et al (Ericsson GmbH, DE)</i>
17.15 – 17.30	The GEM project – the R&D status <i>D. Barbosa (Instituto de Telecomunicações, PT)</i>
17.35 – 17.50	Conclusions <i>R. Keller (MPIfR, DE)</i>
18.00 – 18.30	Lab Visit
20.00 -	<i>Social Dinner</i>

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3rd September 2010

09.00 –	<i>Departure from the hotel</i>
09.45 – 12.30	Visit at the radio astronomy station in the Portuguese interior <i>Guiding Tour</i>
12:35 –	<i>Lunch at Fajão</i>
13.00 – 14.00	<i>Departure from the site</i>

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SUMMARY

Ralph Spencer (University of Manchester) gave an overview of the e-MERLIN data link infrastructure. He stressed the differences between standard telecom applications and radio astronomy application. This is mainly the one-way data flow. In the case of e-MERLIN a total of 39Gbps is used with three-bit resolution on three optical links combined optically on one fibre. Regenerators on the way recover the signal on the long optical links. On the latest link a fibre of 412 km length is used without any regeneration as a test for future application. Data loss can be accepted in radio astronomy, which makes this data link possible.

Another important data link for phasing the e-MERLIN array is the phase transfer system for locking the local oscillators at the various stations. The original RF pulse operated phase locking system has been replaced by optical links. After measuring and verifying carefully the optical link the existing RF-link will be modulated on the optical carrier. This was realized for the nearest telescopes, the other longer links would follow soon.

Roshene McCool (SPDO) presented the basic layout of the SKA and the corresponding needs for data links. There are still analogue and digital links consider to be used for the different array configurations. Data rates from 80Gbps for the WBSP dishes up to more than 16Tbps for the dense phase arrays are required. This results in a variety of different components and systems needed. She also stressed the importunateness of high phase stability for the LO and clock oscillators. At the end of her talk a vivid discussion on the very important spec on dynamic range, specified for the astronomical image of 70dB. One of the big questions is how to translate it into engineering requirements.

Thomas Berenz (MPIfR) presented results of measurements made in the 100m Effelsberg telescope on analogue optical fibre links. Environmental influences as well as the movements of the telescope have significant influence on the signal quality. He demonstrated that temperature of the fibre sections is correlated to the RF performance in phase and amplitude. The bending and twisting of the fibre due to telescope movements in elevation and azimuth is also correlated with the RF performance but are lower than in the standard coaxial cables used so far.

Peter Maat (ASTRON) gave an overview on the LOFAR telescope in the Netherlands and Northern Europe. The rate of the astronomical data is 3Gbps and for M&C 100Mbps is provided. The latency is at 10ms relatively relaxed due to the reduced bandwidth of the stations compared to SKA requirements. After a sophisticated cost investigation a 10GbE net was decided. The data transport system is Ethernet based with jumbo frames to combine high data rate with the advantage of having COTS hardware. The data net structure is divided into virtual local area networks (VLAN) to achieve maximum system reliability. The switching topology turned out to be an important point to provide access from all the correlation, storage, M&C to the remote stations and can act as a valuable model for the SKA topology.

Venkatasubramani (SKA, NRF) gave an overview on the analogue optical links at GMRT in India and KAT-7 in South Africa. The KAT-7 system with 2-4GHz bandwidth has several analogue included with different boundary conditions. This system, being situated at on of the possible sites of SKA with the real environmental conditions is a perfect demonstrator for the problems coming up and to be resolved for the final SKA design. Many challenging developments for the next iteration on

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MerKAT are needed and as a first result the hardware of a riser cable system from the pedestal to the dish developed together with a local company was presented.

Arpad Szomoru (ASTRON) gave an overview over the VLBI activities using Ethernet data transmission instead of storing and shipping data via tape or disc. The EC projects EXPReS and NEXPReS gave the opportunity to complete the connections to the stations in the European VLBI Network to correlate in almost real time at attractive data rates of a maximum of 1GbE. Data reliability charts show that the online data transmission provides even more stable operations than with the old style data acquisition via disc recording. Furthermore in NEXPReS distributed correlation and high bandwidth on demand operation up to 10GbE is investigated.

Gerlinde Bedö (Nokia Siemens) gives an industry view on the SKA data transport challenge. Industry is prepared for the 100Gbps data rate; the distance has been overcome in first tests. Besides the technical issues the infrastructure will be a big question. Number of fibres, maintaining it will have to be resolved. 40GbE is kind of established on the market using QPSK with coherent detection on the optical carrier. In a new, simpler coherent transmission the usually used DCM module for de-dispersion can be omitted having lower time delay and ending up in a cheaper system. 400GbE systems are under investigation but far away from market roll out. She stressed the infrastructure cost being about 75% of the total budget. This includes civil works, planning, management and material, the latter with about 30% of the infrastructure cost. Industry offers contribution in the decision process towards an optimal system for SKA. The discussion followed was mainly concentrated on availability of COTS equipment in the SKA timescale and 40GbE was announced to be in that schedule.

Miguel Drummond (IT) gave an overview of beam forming theory and compared it to the process of filter design. Phase shifting is compared with true time delay, the latter providing frequency independent array phasing. Delaying an optical carrier via different propagation length the modulated RF signal is true time delayed. Various approaches have been investigated in the past and based on the coupled ring optical pulse delay filters in an Mark Zender interferometer a quasi ideal TTD delay line can be realized. Together with cheap polarization controllers an affordable antenna beam former was realized theoretically and verified in first tests.

Peter Maat (ASTRON), in his second talk, showed an investigation on the intermodulation and thus dynamic range properties of analogue optical links. With external modulation and high optical power the IM products are reduced and dynamic range increases. Unfortunately this comes with high price and high power consumption. Further investigations with low cost components showed sufficient dynamic range behaviour but much higher noise level.

Horst Wernz (Ericsson) gave an overview of the works of the basic development group of Ericsson in Backnang, Germany, on the 120Gbps demonstrator. Main interest in this work is the upgrade of existing infrastructure with larger bandwidth. The upgraded link has to fit into the 50GHz bandwidth given by the infrastructure. This leads to increased complexity of the systems, i.e. due to digital pre-distortion, coherent detection and higher order modulation schemes. However measurements show that coherent detection provides clear advantage to low data rate errors, compact system design and system robustness.

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The last talk of the day was given by the organizer Domingos Barbosa (IT) on the GEM project in Portugal and introduced into the observatory visit of the following day. The Galactic Emission Mapping project will help to map the foreground to be subtracted from CMB measurements and as a side effect will map the sky at 5 GHz. The dish is a refurbished telecommunication dish with a fast drive system to overcome atmospheric fluctuations and $1/f$ noise in the LNAs.

In various vivid discussions besides the presentations it was strongly recommended to continue the discussion on this topic and to coordinate the various activities more than done so far. Due to the small group of participants very intensive and fruitful discussions came up and people agreed to cooperate on their work on photonics. The future will show how intensive these cooperation will be and what will be the outcome for the community and SKA. All participants agreed in a continuation of this discussion with another Engineering Workshop on photonics in the near future.

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FINANCIAL REPORT

4th Engineering Forum Workshop organised in Aveiro (Portugal) on 2 – 3 September 2010 was supported by the European Community Framework Programme 7, Advanced Radio Astronomy in Europe, grant agreement no.: 227290.

The organisation costs covered from the RadioNet-FP7 WP3: Engineering Forum were at the level of ~900€. Additionally travel expenses of several participants were supported from the project in the total range of ~4400€.