REPORT ON THE RADIONET3 NETWORKING ACTIVITY

TITLE: 3GC3 WORKSHOP & INTERFEROMETRY SCHOOL

DATE: *11-22 FEBRUARY 2013* **TIME:** (WHOLE DAY)

LOCATION: *PORT ALFRED, SOUTH AFRICA*

MEETING WEBPAGE *https://sites.google.com/a/ska.ac.za/3gc3/home*

HOST INSTITUTE: *RHODES UNIVERSITY*

PARTICIPANTS NO: *49*

Project supported by the European Commission
Contract no.: 283393

REPORT:

1. Agenda and/or programme of the meeting

A detailed program of the meeting is attached as a separate PDF file.

2. Scientific Summary

3GC3 was the third in a series of workshops on third-generation calibration (3GC) in radio astronomy. 3GC is catch-all term for calibration and imaging techniques and algorithms that are needed to deal with the problems and increased capabilities of the new crop of SKA pathfinder telescopes, and the SKA itself. The themes of the previous two workshops were DDE calibration techniques (Nancy, France, 2009) and beam shape-related problems (Albufeira, Portugal, 2011, also co-sponsored by RadioNet3).
The specific theme of 3GC3 was "The Elephants In The Room", by which we refer to possible fundamental or practical limits on the scientific performance of upcoming telescopes. With orders-of-magnitude increases in the sensitivities and fields-of-view of our instruments, some of these "elephants" may now be taking shape, and need to be clearly identified and taken into account in the SKA design process, so a workshop discussing these issues was timely. The second major aim of the workshop was to introduce a large number of South African (or SA-based) students and young researchers to 3GC concepts. With MeerKAT construction starting, and SKA looming on the horizon, it is becoming increasingly important to train up a local body of researchers skilled in new data reduction methods. To facilitate this, we also received a workshop grant from the SKA SA skills development program.

The first four days of the workshop (Feb 11-14) were structured as an advanced interferometry school for postgraduate students and post-docs looking to gain a deeper understanding of calibration and imaging problems. The aim of this was somewhat different from a regular synthesis imaging school – rather than learning about routine data reduction, the intent was to look at "difficult cases" that require new approaches, and lay the groundwork for 3GC. The school was structured as roughly 50% lecture time and 50% hands-on time (see program), with the hands-on tutorials serving to highlight and reinforce the theoretical concepts. After two introductory lectures by R. Perley, we had tutorials on the use of pyrap to access visibilities in Python, and on simulations in MeqTrees. This was followed by lectures on calibration, imaging, the radio interferometry measurement equation, deconvolution, AW-projection, LOFAR and the ionosphere, and solving for pointing errors, interspersed with tutorials on calibration and imaging. One particularly successful tool proved to be a “simulations buffet” prepared by I. Heywood, who could not attend physically, but contributed this website instead: http://www-astro.physics.ox.ac.uk/~ianh/3GC3_sims/. This is a series of increasingly complex but heavily documented exercises, which the school participants were able to do on their own time (and for the most part, did do, assiduously); this played a very important role as a source of reinforcing and supporting material. From the beginning, school participants were offered the option of staying on for the main “advanced” workshop, and in the end almost all of them did.

The first day of the main workshop (Feb 15) was dedicated to overviews of (a) SKA and pathfinder science (M. Jarvis, F. Abdalla, G. de Bruyn), and (b) current state-of-the-art in data reduction and dynamic range (R. Perley, G. de Bruyn). This was followed by open discussion, at which some urgent problems were identified, in particular the need for more studies of how future science surveys are likely to be affected (i.e. biased or limited) by the instrumental

response of SKA and the pathfinders. On the one hand this is still poorly understood, but on the other we now have the software tools to tackle the problem.

Feb 17-18 was dedicated to beam shape issues (side lobe confusion noise, pointing error and response to pointing error, PAF beam stability, beam modelling), followed by hands-on tutorials on direction-dependent calibration (SAGEcal, MeqTrees). Feb 19-20 focused on the ionosphere and LOFAR data, and included hands-on sessions using current ionospheric calibration tools (SAGEcal, SPAM, GPS models). One clear outcome of this was that while current DD-calibration tools can produce very deep and artefact-free maps even in the presence of the ionosphere and unstable primary beams, the increase in degrees of freedom in such calibration models is worrying and its effects are poorly understood. On the other hand, techniques such as CBFP (talk by A. Young) seem to allow for modelling of PBs with relatively few parameters, and their application to calibration needs to be explored. Likewise, better ionospheric modelling techniques need to be developed.

Feb 21 was dedicated to source extraction and deconvolution, and included a hands-on pyBDSM tutorial. The highlight of the day was a session on compressive sensing (CS) techniques, which seem to offer a mathematically robust approach to the deconvolution problem. In particular, the SARA imaging algorithm presented by R. Carrillo looks very promising, and should incorporated into a production-level imager software soon.

The final day, Feb 22, was dedicated to a summing up of telescope performance limitations, drawing both on practical experience (G. de Bruyn, R. Perley) and analytic considerations (R. Braun, S. Wijnholds). In the end, we found that while specific figures for such limitations (“the elephants in the room”) were not produced at the workshop, the elephants' outlines, as well as the tools and strategies for dealing with them, were clearly identified. Even more importantly, 3GC3 really drove home the point of how many new algorithms and software tools had become available over the past couple of years (even by comparison with 3GC-II in 2010); with the talks and especially the tutorials allowing the participants to acquire hands-on knowledge of these new tools. In the end this point was probably the most important outcome of the workshop.

3GC3 can be considered an unqualified success, with the participants' feedback being overwhelmingly positive: “... one of the best events I have been to.” (D. Smith, ASTRON); “I have to admit that workshop was one of the best ones I've ever been to. It was good seeing the advances that have been made with regards to calibration in the past few years, as well as to get a glimpse of what it still to come.” (S. Muchovej, Caltech); “It was a rare opportunity to find all the top scientists in this field from around the globe in one location, along with students in the field. It created a very productive environment for experts and a perfect place for students to learn.” (F. de Gasperin, U. Hamburg); “The third 3GC workshop ... was a sparkling success. It showed that there is great progress in finding how these new and exciting new instruments can be made to do great new science. New concepts, and new approaches, were vigorously discussed and debated. I am sure that all who participated will return to their institutions, ready to experiment with and to implement these new ideas.” (R. Perley, NRAO). This is a very gratifying result: We have been experimenting with the formula for three workshops, trying to combine talks on the current state-of-the-art with hands-on sessions more befitting a synthesis school, and with 3GC3 it appears the right balance has finally been struck.

Conference pictures are available here: https://sites.google.com/a/ska.ac.za/3gc3/photos-media. There is further coverage of the meeting in the March 2013 SKA SA newsletter (http://www.ska.ac.za/newsletter/print/19_ska_newsletter_mar2013.pdf, see page 12).

Of the 49 participants, 8 were women, 13 were PhD/MSc students, and a further 14 were young post-docs. The geographical distribution was as follows:

South Africa:	23
The Netherlands:	11
Australia:	5
UK:	4
USA:	4
Germany:	2

3. Attendance list (incl. participant names, affiliation and country) signed by the participants and confirmed by the organizer

A separate PDF is attached.

4. Financial Report / RadioNet3 contribution

A maximum budget of 7000 euro was allocated by RadioNet3 for this meeting; however we were encouraged to reduce costs if possible, so the final RadioNet3 expenditure was 5260 euro. This was used to fund the travel costs of three participants, and the accommodation costs of a further four participants:

5	Griffin Foster	UK	airfare	GBP	717.00	**€ 831.93**
			airfare	ZAR	1,703.00	**€ 142.94**
	Sarod Yatawatta	NL	airfare			**€ 1,079.30**
			train & taxis NL			**€ 48.00**
			car rental			**€ 165.00**
	Stefan Wijnholds	NL	accommodat	ZAR	4,500.00	**€ 377.69**
	David Smith	NL	accommodat	ZAR	6,500.00	**€ 545.56**
	Khan Asad	NL	accommodat	ZAR	6,500.00	**€ 545.56**
	Francesco de Gasperin	Germany	accommodat	ZAR	6,500.00	**€ 545.56**
	Jan Noordam	NL	airfare			**€ 978.70**
	TOTAL					**€ 5,260.23**

Date	Day	Theme	Session 1 9h30-11h00	Break 11h00-11h30	Session 2 11h30-13h00	Lunch 13h00-14h00	Session 3 14h00-15h30	Break 15h30-16h00	Session 4 16h00-17h30
11-Feb-2013	Mon	School	P. Clayton: opening remarks (20m); R. Perley: Intro I		C. Tasse: pyrap Tutorial		R. Perley: Intro II		O. Smirnov, I. Heywood: Simulations tutorial
12-Feb-2013	Tue	School	R. Perley: Calibration		O. Smirnov, RIME		R. Perley: Imaging		U. Rau, Deconvolution (30m, skype); O. Smirnov, I. Heywood: Simulations tutorial
13-Feb-2013	Wed	School	R. Perley: Polarimetry		C. Tasse: AW-projection		**game drive + braai**		**game drive + braai**
14-Feb-2013	Thu	School	O. Smirnov, 3C147 Tutorial		C. Tasse: LOFAR, Ionosphere		O. Smirnov: QMC Project		S. Bhatnaghar, Pointing selfcal (30m skype); Simulations tutorials
15-Feb-2013	Fri	Mixer Day	B. Fanaroff: welcoming remarks (20m, skype); M. Jarvis: Science Overview + discussion (70m)		R. Perley: High-fidelity Imaging (45m); F. Abdalla: Cosmology & Radio Astronomy (45m)		G. de Bruyn: Science Context + Low Frequency Astronomy (45m + 45m)		Open discussion (M. Jarvis lead): SKA challenges, etc.
16-Feb-2013	Sat	Elephants	Day trip to Addo		Day trip to Addo		Day trip to Addo		Day trip to Addo
17-Feb-2013	Sun	Beamshapes	O. Smirnov, B. Frank: BeamSims + tutorial	Coffee Break	D. Mitchell: MWA calibration & imaging + tutorial	LUNCH	A. Young: CBFM + tutorials	Coffee Break	Tutorials, open discussion and experiments
18-Feb-2013	Mon	Beamshapes / DDEs	R. van Weeren: LOFAR calibration		A. Young & S. Wijnholds: PAF Beams		S. Yatawatta, E. Orru: SAGEcal + tutorial		S. Yatawatta, E. Orru: SAGEcal + tutorial
19-Feb-2013	Tue	Ionosphere	M. Mevius: Ionosphere Intro (30m); H. Intema: SPAM (30m); J. Noordam: MIM (30m)		M. Mevius: LOFAR data (45m); S. Daiboo: Tomography (20m)		Parallel tutorials: SAGEcal, LOFAR data, SPAM, GPS models		Parallel tutorials: SAGEcal, LOFAR data, SPAM, GPS models
20-Feb-2013	Wed	Ionosphere (half day)	Open discussion, Ionosphere (G. de Bruyn chair)		Open discussion, ionosphere; G. de Bruyn: The Future		**game drive + braai**		game drive + braai, J. Noordam: Communication & Community (dinner talk)
21-Feb-2013	Thu	Source modelling	D. Rafferty: Source finding + tutorial		Advances in source modelling and deconvolution (various speakers)		L. Schwardt: Fundamentals of Compressive Sensing (45m); R. Carrillo: SARA (45m, skype)		J. Riding: shapelets, MWA (20m);Open discussion and experiments
22-Feb-2013	Fri	DR & performance limits	R. Perley (45m), G. de Bruyn (45m): High-DR Imaging		R. Braun: DR Limits (90m)		S. Wijnholds, The Dust Under The Carpet (45m); O. Smirnov, BeamSims Tutorial (45m)		O. Smirnov, BeamSims Tutorial (45m); Closing Discussion (45m)

3GC3 Workshop & Interferometry School, Port Alfred, South Africa, 11-22 Feb 2013

List of Participants

	First name(s)	Surname	Institution	Country	Arrival	Departure
1	Filipe	Abdalla	UCL	UK	14-Feb-2013	21-Feb-2013
2	Richard Paul	Armstrong	UCT	South Africa	14-Feb-2013	23-Feb-2013
3	Khan Muhammad Bin	Asad	Kapteyn Astronomical Institute	The Netherlands	10-Feb-2013	23-Feb-2013
4	Marcellin Teufack	Atemkeng	Rhodes University	South Africa	10-Feb-2013	23-Feb-2013
5	Bruce	Bassett	AIMS/UCT/SAAO	South Africa	14-Feb-2013	23-Feb-2013
6	Robert	Braun	CSIRO	Australia	19-Feb-2013	23-Feb-2013
7	Soobash	Daiboo	Kapteyn Astronomical Institute	The Netherlands	10-Feb-2013	23-Feb-2013
8	David	Davidson	Stellenbosch University	South Africa	16-Feb-2013	22-Feb-2013
9	Ger	de Bruyn	ASTRON	The Netherlands	14-Feb-2013	23-Feb-2013
10	Francesco	de Gasperin	Hamburg University	Germany	10-Feb-2013	23-Feb-2013
11	Griffin	Foster	University of Oxford	UK	14-Feb-2013	23-Feb-2013
12	Bradley	Frank	UCT	South Africa	13-Feb-2013	23-Feb-2013
13	D.K. Emmanuel	Gazoya	Rhodes University	South Africa	10-Feb-2013	23-Feb-2013
14	Abhik	Ghosh	Kapteyn Astronomical Institute	The Netherlands	10-Feb-2013	23-Feb-2013
15	Trienko	Grobler	Rhodes University	South Africa	10-Feb-2013	23-Feb-2013
16	Jasper	Horrell	SKA SA	South Africa	17-Feb-2013	23-Feb-2013
17	Matt	Jarvis	University of Oxford & UWC	UK & South Africa	14-Feb-2013	21-Feb-2013
18	Justin	Jonas	SKA SA & Rhodes University	South Africa	20-Feb-2013	23-Feb-2013
19	Henrik	Junklewitz	MPA Garching	Germany	18-Feb-2013	24-Feb-2013
20	Ermias	Kassaye	UCT/SKA/AIMS	South Africa	10-Feb-2013	23-Feb-2013
21	Slava	Kitaeff	ICRAR/UWA	Australia	10-Feb-2013	23-Feb-2013
22	Sphesihle	Makhathini	UKZN	South Africa	10-Feb-2013	23-Feb-2013
23	Kim	McAlpine	UWC	South Africa	10-Feb-2013	23-Feb-2013
24	Maajike	Mevius	ASTRON	The Netherlands	16-Feb-2013	21-Feb-2013
25	Daniel	Mitchell	University of Melbourne	Australia	14-Feb-2013	23-Feb-2013
26	Stephen	Muchovej	Caltech	US	14-Feb-2013	23-Feb-2013
27	Iniyan	Natarajan	UCT	South Africa	10-Feb-2013	23-Feb-2013
28	Jan	Noordam	ASTRON	The Netherlands	18-Feb-2013	23-Feb-2013
29	Chuneeta Devi	Nunhokee	Rhodes University	South Africa	10-Feb-2013	23-Feb-2013
30	André	Offringa	ANU (RSAA Mt Stromlo Obs)	Australia	14-Feb-2013	23-Feb-2013
31	Patrice	Okouma	AIMS/UCT/UWC/SAAO	South Africa	10-Feb-2013	23-Feb-2013
32	Nadeem	Oozeer	SKA SA	South Africa	10-Feb-2013	23-Feb-2013
33	Emanuela	Orru'	ASTRON	The Netherlands	16-Feb-2013	23-Feb-2013
34	Prina	Patel	UCT	South Africa	10-Feb-2013	23-Feb-2013
35	Adriaan	Peens-Hough	SKA SA	South Africa	10-Feb-2013	15-Feb-2013
36	Rick	Perley	NRAO	US	10-Feb-2013	23-Feb-2013
37	David	Rafferty	Leiden University	The Netherlands	14-Feb-2013	23-Feb-2013
38	Laura	Richter	SKA SA	South Africa	10-Feb-2013	23-Feb-2013
39	Jennifer	Riding	University of Melbourne	Australia	14-Feb-2013	23-Feb-2013
40	Ludwig	Schwardt	SKA SA	South Africa	10-Feb-2013	23-Feb-2013
41	Hemant	Shukla	LBNL/University of Sussex	US	16-Feb-2013	23-Feb-2013
42	Oleg	Smirnov	Rhodes University	South Africa	10-Feb-2013	23-Feb-2013
43	David	Smith	ASTRON	The Netherlands	10-Feb-2013	23-Feb-2013
44	Cyril	Tasse	Rhodes & SKA SA	South Africa	10-Feb-2013	23-Feb-2013
45	Reinout	van Weeren	CfA	US	16-Feb-2013	22-Feb-2013
46	Stefan	Wijnholds	ASTRON	The Netherlands	14-Feb-2013	23-Feb-2013
47	Laura	Wolz	UCL	UK	10-Feb-2013	18-Feb-2013
48	Sarod	Yatawatta	ASTRON	The Netherlands	16-Feb-2013	21-Feb-2013
49	Andre	Young	Stellenbosch University	South Africa	14-Feb-2013	23-Feb-2013

(Note: Invited speakers are highlighted in yellow.)

I confirm that the above list of participants is complete and correct.

Conference organizer: _____ (O. Smirnov, SOC Chair)