Tianlai Collaboration meeting held at Observatoire de Paris

June 5th, 2014

Attendance :
R. Ansari, J.E. Campagne, X. Chen, P. Colom, J. Hao, C. Magneville,
J.M. Martin, M. Moniez, J. Peterson, H. Shi, A. Stebbins, P. Timbie, F. Wu

List of items discussed with the corresponding discussion leaders:
A- Science - X. Chen
B- Instrument configuration - Albert Stebbins
C- Calibration strategies - J. Peterson
D- Reflector + feed - P. Timbie
E- Site, construction, planning - Fengquan Wu
F- Data processing & analysis - C. Magneville
G- Collaboration organization - X. Chen

A- Science - X. Chen

- large scale structure: BAO, RSD, non gaussianity, cross correlation
Non gaussianity more sensitive to imperfect foreground subtraction
- for cross correlation, need to operate at lower frequencies, around 1200 MHz
===> Check available catalogs and corresponding regions of sky around delta ~ 40 deg (SDSS, 6dF …)
- for dishes, 3 set of filters 700-800 MHz, 1200-1300 MHz, 1300-1400 MHz are available
- 21 cm absorbers : Need higher spectral resolution 0.1 km/s is more than enough,
but 10 km/s might be enough
- Milky way, supernovae remnants, ISM, magnetic field
- quasars, radio galaxies-variation, sensitivity , multi-wavelength analysis
- time domain variation, sensitivity, real time processing ?
- pulsars, fast radio bursts : will need upgrade for high sampling rate & dedispersion
- radio afterglow,
- Gravitational waves , MOU with aLIGO (Advanced LIGO), but maybe also with advanced VIRGO (LAL is involved in VIRGO)

B- Instrument configuration - Albert Stebbins

Tianlai Pathfinder configuration and survey strategy :
Design/strategy follows from science goals
it is important to keep the main thing the main thing: 21 cm
Deployment schedule? cylinders vs dishes
Basic Constraints: Transit telescope
---- Cylinders:
ganging together feeds ?
uniform or non uniform spacing ?
Proposal to start with uniform spacing, integrate for 3 months analyze data and
then decide to change spacing if necessary.
feed size : diameter 20 cm (decreased from 30 cm) , 42 cm spacing

--- Dishes:
- lo-z: cross-correlation w/ optical LSS
- hi-z: BAO, prove foreground subtraction
- hi-z: BAO , outriggers to cylinders ?

Prefered option for the dish configuration:
- movable dishes over an area of about ~ 50 m x 50 m
- Consider the possibility to have dishes on a series of tracks
- task to be done within a month: (A. Stebbins, R. Ansari, J. Zhang)
  come up with one or two configurations, to survey the zenith
  and possibly the NCP (North celestial pole)

C- Calibration strategies - J. Peterson

C.1) sources on sky
one feed ~ 1mK / Jy
transit time ~ 20 min (?)
100K / sqrt(1 MHz * 1200 s) ~ 3 mK
need sources > 10 Jy
sources:
Sun … 100 000 Jy variable, extended
Nearby SNR , CasA… 1000-5000 Jy , 5 of these
10 Jy extragalactic

C.2) noise injection
C.2.a) via noise ports on LNA - try this on few channels to monitor stability
C.2.b) via antenna near dish surface
Use this for relative gain/phase calibration

is this an accurate / stable gain measurement ?

3) satellites ?
Few tracks across sky. Far field, need to separately measure flux

4) Thethered balloon or RC helicopter
Not easily feasible

D- Reflector + feed - P. Timbie

1- Cylinder and Dish antennas designed
2- Remaining simulations
a- cross-coupling between cylinder feeds (due to feeds themselves)
b- cross-polarization
c- provide realistic simulated patterns to simulators
3- Tspill computed
4. Feed spacing ?

5. Anticipate beam pattern measurements
  a. Dishes
   dishes will be equipped with feeds which are similar, but made
   by the dish manufacturer
   ---> try to measure one dish beam precisely before installation
   ---> foresee 16-dish beam measurement with artificial source on site
   ---> don't need to do this measurement at the beginning
  b. Cylinders
  c. Bright sources
    i. Sun
    ii. CasA
    iii. Tau A (polarized ~10%)
    iv. Satellites?
6. Holography using dishes to check cylinders
7. Other

  feed tests at Wisconsin - copy of coffee can feed made at UW.
  Good agreement between simulation and measurements

  Tspill (Tsys = Trec + Tspill + Tsky)
  Coffee can feed used in all computations @900 MHz
  Tspill ~ 22 K for D=6m dishes

E- Site, construction, planning - Fengquan Wu

 - Site infrastructure
   july: finish the road
   building the living area : takes >~ 2 months
   pedestal for antenna (cylinders) : takes >~ two weeks
   September: finish testing the instrument system
     (electronic, correlator, acquisition software)
    analog electronic: ready, digital electronic & correlator
    finish testing the 32 channel system in september

   January: reception of the full 192 channel system
   Feb: install

- Try to install the 16-dish array during the summer, and make it work
with the 32-channel correlator system
- check the full analog system with 6.5 km fibre before going to Xinjiang

F- Data processing & analysis - C. Magneville

 - Data acquisition and QLA (Quick Look Analysis)
    ADC ---> FFT (FPGA) -- (switch) --> XCor (DSP) --(Gb-ethernet ethernet)--> Computer
  Data rate with 1 s averaging time for visibilities
  1000 freq channels   , 1 Vis = complex<float> = 2 x 32 bits = 64 bits

N=32 channels -> N*(N+1)/2 --> 16x33 = 528 visibilities
1 sec ---> 528 * 1000 * 8 bytes = 4 MBytes / sec
(or 400 MBytes/sec at 0.01 s averaging time)

1 day @ 0.5 sec visibility averaging time ---> 700 GB/day for the 32 channel correlator

further compression can be achieved during RFI cleaning, binning visibilities
Going to 5-20 seconds averaging (--> 1'-4' arcmin on sky) ---> 70 GB/day
Compute rates for the 192 channel correlator

make sure to track the data during transfer (identify data losses),
get the housekeeping data (temperature …)
write data to a well supported format (FITS suggested)
===> A definition and requirement document for the data acquisition will be written
(C. Magneville +J.E.Campage (+ Reza) will prepare a 3-4 pages document)

Notes :
- RA suggest to consider to have a copy of the data, possibly after the first
cleaning and compression step in a second computer center, in addition to NAOC.
A computing infrastructure could be setup at Fermilab, with some help from an IT engineer.
- The data processing pipeline has to be developed and contributions from collaboration members are expected.

- RFI cleaning
- Calibration
- Sky map reconstruction
- Foreground subtraction and power spectrum estimation

G- Collaboration organization - X. Chen

- A simple scheme will be defined to start with
Full membership = data access right = authorship
Associate membership might be considered for scientists interested in
exploiting Tianlai data for particular science analysis
A collaboration charter and structure (members, board …) has to be written

- Funding strategies
Search for funding sources or in kind contribution to complete and extend the instrument. Help needed for tests, and data analysis.
JMM: In France, we will try to apply for specific France-China programs through ANR