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on behalf of
the SKA Japan Consortium VLBI sub-Working Group (Since 2020)
SKA-JP VLBI sub-WG (SKA-J-VLBI) short history

- One branch of the SKA-JP Science Working Group (SWG) since 2020
- Merging two groups (since 2009) in SKA-JP (since 2008)

a. SKA-JP Astrometry sub-WG
   - Extensive applications from astrometry with VERA (VLBI Exploration of Radio Astrometry)
   - Science cases in collaboration with JASMINE (Japan Astrometry Satellite Mission for INfrared Exploration)
   - Demonstrations of VLBI astrometry in OH masers (corresponding to SKA1-MID Band-2)
   - Collaboration in GASKAP (Galactic SKA Spectral Line Survey, Dickey et al. 2013)
   - Collaboration in SPLASH (Southern Parkes Large-Area Survey for Hydroxyl, Dawson et al. 2014)

b. VLBI sub-WG (one branch of SKA-JP Engineering Working Group)
   - Development of wide-band feed and receiving system in NICT
   - Study on use cases in SODP (SKA Observatory Development Program)
   - Synergy with SKA1 AIV(Australia) and VLBI (with JIVE)
SKA-JP VLBI sub-WG members

- **Co-chairs**
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- **Members**
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Current action items: discussion issues

❖ SKA-VLBI operation plan: how to operate in the Global VLBI Alliance?
  ➢ Reference document: WP10: VLBI with the SKA
    ■ 10.2 Operational Model for inclusion of SKA in Global VLBI
      (existing VLBI arrays)
    ■ 10.3 Portfolio of SKA-VLBI Science Cases
  ➢ Possible Japanese contributions to SKA-VLBI operation
    ■ VLBI backend on site, VLBI signal transfer, etc.

❖ SKA-VLBI science cases
    ■ Breakdown from the white paper about SKA science case consideration
      issued by NAOJ VLBI Observatory
  ➢ Scientific demonstrations using VERA and East Asia VLBI Network (EAVN)
  ➢ Will they match those in the white paper on the white paper of the future projects
    issued by Japan VLBI Consortium (2021 March)?
Current action items: discussion issues (continued)

❖ New international VLBI experiments for SKA-VLBI pathfinding
➢ P-band, SKA1-LOW band with Iidate, GMRT and MWA
➢ L-band with GMRT, ASKAP (phase-up) and FAST
  ■ L-band VLBI using Usuda 64m and VERA telescopes (currently in Mizusawa & Ishigakijima)
  ■ Drafting FAST-VLBI White Paper (proposed in East Asia VLBI Workshop 2019)

★ Issues:
  ○ What is the key targets requesting the ultimate capability of SKA-VLBI (MID) in the science cases (currently) demonstrated with VERA/EAVN (L−K bands) ?
  ○ What is the first targets in P-band VLBI in pathfinding with Iidate-MWA-GMRT
Japanese-lead science cases in SKA-VLBI (still TBD)

- **Transients** in the evolutions of stars and blackholes captured in VLBI
  - Flares in massive star forming regions linked to mass accretion and jet formation
  - Flashes in pulsars, blackholes, and other transients, and resulting jet formation

- **Origins** of exotic stellar objects and super-massive black holes
  - OH megamasers at z~4, radio relics of γ-ray bursts
  - Pulsars born in supernovae, wisps in pulsar winds, radio bursts from exoplanets

- **Ultimate accuracy** of space-time measurement
  - Trigonometry (σ~1 μas) of radio sources towards the Galactic Center (within a few 100 pc) and other exotic objects
  - Geodesy (σ~10 ps/measurement) for detecting Earth's fluid-core and free inner-core nutations
Current action items: engineering developments

- L-band receiving system in VERA
  - Receiver installing high temperature superconducting filters (Figure 1)
  - Development of RFI mitigation technique
- Spectroscopic water vapor radiometers in VERA (Figure 2)
  - Comparison with GPS measurement
  - Planning VLBI astrometry demonstration with VERA
- Designing a UHF receiver with multi-band high temperature superconducting filters
- Designing / developing a 15—60 GHz receiving system for multipurpose application (meteorology, geodesy, astrometry, and spacecraft navigation)
Figure 1: Performance of the developed high temperature superconducting filters
Figure 2: Spectroscopic water vapor radiometer, which is developed as an application of the AD sampler, OCTAD, is installed in VERA Iriki 20 m antenna, receives radio frequency signals (18—26 GHz) from the antenna beam, and performs digital sampling (32 Gbps) and spectroscopy (256 channels) (developed by Elecs Industry Co. Ltd.)
Current action items: scientific demonstrations

- VLBI fringe tests in P-band using Iidate@Fukushima and Toyokawa@Aichi stations
- RFI investigations
  - In NICT Kashima Station on 2017 August 28 (100—3000 MHz)
  - In NAOJ Mizusawa Station on 2018 August 23 (100—3000 MHz) (Figure 3)
  - In Iidate Station (Planet Plasma and Atmospheric Research Center) on 2021 March 27 (100—500 MHz)
- VLBI follow-ups of flares of 6.7 GHz methanol masers associated with possible recurrent mass accretion in massive young stars and reported to M2O (Maser Monitoring Organization)
- OH maser trigonometry with the VLBA (Orosz et al. 2017, AJ, 153, 119)
Figure 3: RFI environment in VERA Mizusawa Station in 2018 August.