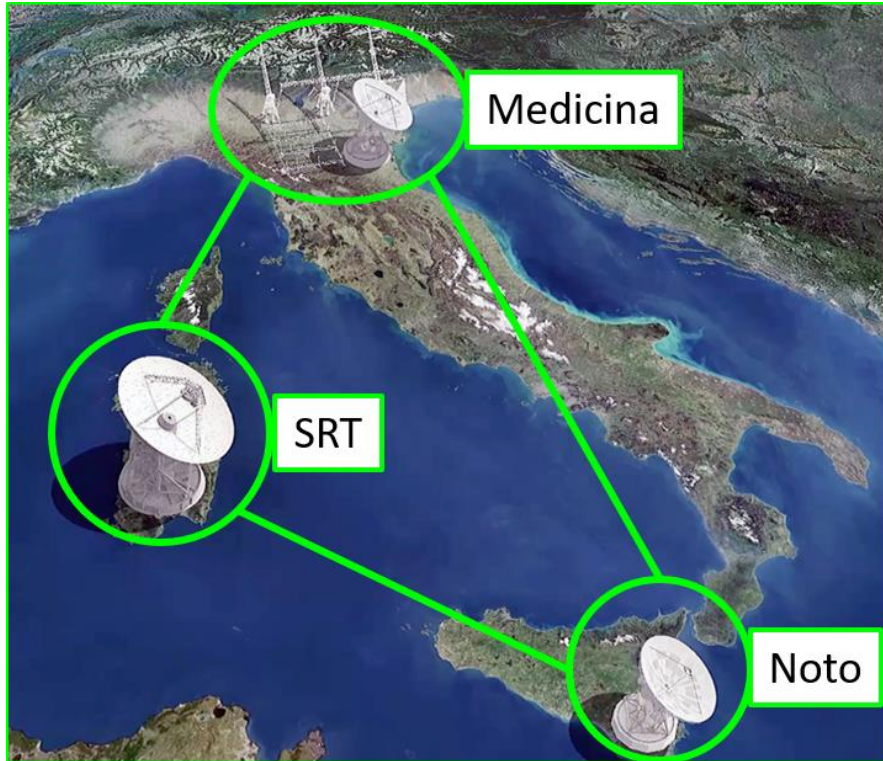


INAF radio telescopes: ObsCore mapping of SD data

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IVOA Radio Interest Group Meeting, March 8th, 2022

INAF radio telescopes



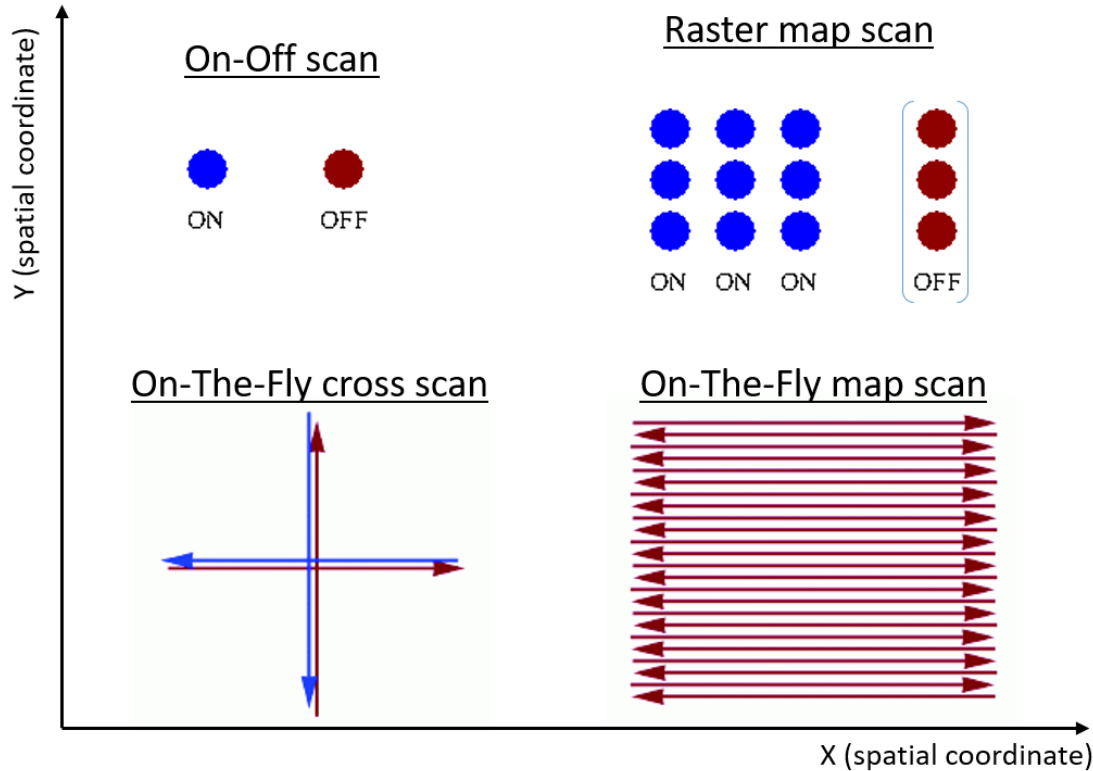
Observing modes:

SD

Pulsar

VLBI

Single-dish scan types (main/current)



Measured quantity:

raw counts(x,y,lambda,Pol).

at a given sampling rate
 δt

Single-dish data format

```
tyrann:~/home2/escs/archivioDati/extendedata/20190415-120831-19-18-0528+134> ls
20190415-120831-19-18-0528+134_023_002.fits 20190415-121134-19-18-0528+134_023_011.fits
20190415-120851-19-18-0528+134_023_003.fits 20190415-121154-19-18-0528+134_023_012.fits
20190415-120911-19-18-0528+134_023_004.fits 20190415-121215-19-18-0528+134_023_013.fits
20190415-120932-19-18-0528+134_023_005.fits 20190415-121235-19-18-0528+134_023_014.fits
20190415-120952-19-18-0528+134_023_006.fits 20190415-121255-19-18-0528+134_023_015.fits
20190415-121012-19-18-0528+134_023_007.fits 20190415-121316-19-18-0528+134_023_016.fits
20190415-121033-19-18-0528+134_023_008.fits 20190415-121366-19-18-0528+134_023_017.fits
20190415-121053-19-18-0528+134_023_009.fits Sum_20190415-120831-19-18-0528+134.fits
20190415-121113-19-18-0528+134_023_010.fits
tyrann:~/home2/escs/archivioDati/extendedata/20190415-120831-19-18-0528+134>
```

One Scan: folder containing...

1 Summary FITS file

n subscan FITS files

```
fv: Header of Sum_20190415-120831-19-18-0528+134_00.../19-18/data/20190415/20190415-120831-19-18-0528+134/
File Edit Tools Help
Search for: Find Case sensitive? No
SIMPLE = T / file does conform to FITS standard
BITPIX = 32 / number of bits per data pixel
NAXIS = 0 / number of data axes
EXTEND = T / FITS dataset may contain extensions
CREATOR = 'DISCOS' / Software (incl. version)
FITSVER = 'V 1.11' / FITS version
PROJID = '19-18' / ProjectID
TELESCOP = 'Medicina' / Telescope name
HIERARCH ScheduleName = '19-18 K_a_scd' / Name of the schedule
DATE-OBS = '2019-04-15T12:08:32.123' / Observation time
LST = 8914.6269 / Local sidereal time
HIERARCH RightAscension = 1.44399990196576 / Target right ascension (radians)
HIERARCH Declination = 0.23617954379873 / Target declination (radians)
EQUINOX = 2000.00 / Equinox of Ra, Dec
OBJECT = '0528+134' / Target source name
SCANATYPE = 'CROSSSCAN' / Scan astronomical type
EXPTIME = 229.71998 / Total integration time (seconds)
HIERARCH ReceiverCode = 'FKC' / Receiver name
HIERARCH BackendName = 'TotalPower' / Backend name
NUSECOND = 2 / Number of sections
FREQ1 = 23500.000000 / Start frequency of the Nth section (MHz)
BWID1 = 1200.00000000 / Bandwidth of the Nth section (MHz)
HIERARCH POLATYPE1 = 'LCP' / LCP, RCP, HLP, VLP, stokes type of the Nth sect
HIERARCH FREOBINS1 = 1 / Number of spectral bins of the Nth section
HIERARCH FREQRESOL1 = 1200.0000 / Frequency resolution of the Nth section (MHz)
HIERARCH RESTFREQ1 = -999.000 / Rest frequency of the Nth section (MHz)
FREQ2 = 23500.000000 / Start frequency of the Nth section (MHz)
BWID2 = 1200.00000000 / Bandwidth of the Nth section (MHz)
HIERARCH POLATYPE2 = 'RCP' / LCP, RCP, HLP, VLP, stokes type of the Nth sect
HIERARCH FREOBINS2 = 1 / Number of spectral bins of the Nth section
HIERARCH FREQRESOL2 = 1200.0000 / Frequency resolution of the Nth section (MHz)
HIERARCH RESTFREQ2 = -999.00000 / Rest frequency of the Nth section (MHz)
QMAXDEG = -999.000000000 / Scan start x coordinate (degree, optional)
YMAXDEG = -999.000000000 / Scan start y coordinate (degree, optional)
VMAXIPA = -999.000000000 / Scan end x coordinate (degree, optional)
HIERARCH ScheduleName = '19-18 K_a_scd' / Name of the schedule
```

1 Scan = 1 ObsCore entry

Mapping SD data into ObsCore

OK

calib_level

obs_collection

obs_id, obs_publisher_did

access_url, access_format

access_estsize

target_name, s_ra, s_dec

t_min, t_max, t_exptime

(*pol_states*), pol_xel

(*facility_name*), instrument_name

Under discussion

dataprodct_type / subtype

s_fov, s_region, s_xel1, s_xel2

t_resolution, t_xel

s_resolution

em_res_power, em_min, em_max

dataprodect_type

Extend the concept of *measurement* according to the preliminary description in <http://www.ivoa.net/rdf/product-type> as of 2021-11-18 ?

Use `dataprodect_subtype` to improve the description.

Geometry: s_{fov} , s_{region} , s_{xel1} , s_{xel2}

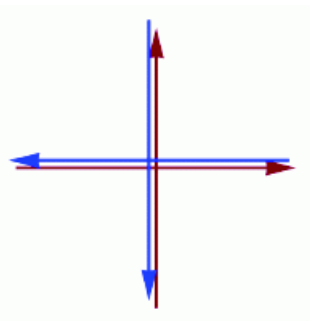
Peculiar cases in the radio domain [not a typical (x,y) image]

ON-OFF: two fixed positions



OTF Cross Scan: axes lengths have not the same geometrical meaning as in a typical image.

$s_{region} = s_{fov}$



Multi-feed receivers (typically used for mapping and nodding): non-contiguous sky coverage. s_{fov} as the instantaneous footprint.

s_{region} may not be extremely accurate (requires computations on the feed geometry during mapping)

Time in SD data

t_resolution is defined as the temporal resolution FWHM, not meaningful for SD?

SD: (x,y) positions measured at a fixed sampling rate delta_t. Sampling rate does not vary in a scan. Measured: raw counts(x,y,lambda,Pol)

(btw: looking at the description in ObsCore v1.1 Sez 4.16 “The t_resolution column is the minimal interpretable interval between two points along the time axis” Is it a FWHM or a minimal value?)

t_xel: to be discussed accordingly

Multiple spectral windows:

Many spectral windows in the same scan. Each spectral window is fixed within a scan and different spectral windows may differ in bandwidth and spectral resolution.

Example: each window centered on a different frequency, or all windows at the same frequency but with increasing resolution.

Spectral multiplicity affects `em_min`, `em_max`, `em_res_power` but also `s_resolution`, `s_region` and `s_fov`

`em_res_power`: it is defined as the optical resolving power (adimensional, $\Delta\lambda/\lambda$). The radio domain uses the frequency resolution (in units of frequency): new parameter `em_resolution`?

To be discussed

Some kind of ObsCore extension could be useful to:

- fully describe the *spectral multiplicity* of the data, expressed in: em_min, em_max, em_xel, em_res_power (or its equivalent for radio)
- fully describe the spatial properties/scanning strategies (which are related to the spectral ones): s_resolution, s_region and s_fov

Additional discussion:

- em_res_power vs em_resolution?
- (*access_estsize in kbytes: is it still a meaningful unit?*)