HOW TO CREATE DYNAMIC SPECTRA AND DE-DISPERSED TIME SERIES (DTS)
FROM BLINK PIPELINE IMAGES
(last updated 2025-08-26)

- **Testing in :** 20250825_BLINK_option_for_create_dynaspec.odt

- We assume that FITS files created by the blink pipeline are in the directory images/ and their names look like:
  start_time_**1508442485**_int_**00**_coarse_**109**_fine_ch**00**_image_real.fits

  The meaning of the numbers in FITS file name as as follows:
  - **1508442485** - unixtime second
  - int_**00** - 00 is the time integration within 1-second
  - **109** - coarse channel
  - ch**00** - fine channel within coarse channel

  ○ So in general FITS file names are :
    start_time_**UNIXTIME**_int_**TIMESTEP**_coarse_**COARSECHANNEL**_fine_ch**FINE CHANNEL**_image_real.fits
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- **Commands on Setonix to**
  ○ cd images/ # go to directory with the images here images/
  ○ salloc --mem 64g --time 02:00:00 --nodes=1 # request interactive session on CPU node
  ○ module use /software/projects/pawsey1154/msok/setonix/2025.08/modules/zen3/gcc/14.2.0
  ○ module load frb-search/main # load relevant module

  ○ Download METAFITS file with metadata for specific observation (obsID = 1192477696):
    - wget http://ws.mwatelescope.org/metadata/fits?obs_id=1192477696 -O 1192477696.metafits

  ○ Execute create_dynaspec program with the following parameters :

    create_dynaspec -p "(377,896)" -o 1192477696 -S 1508442485 -f start_time_%d_int_%02d_coarse_%03d_fine_ch%02d_image_real.fits -v 10 -N 10 -X 0.02 -I 1 -C 109 -T ./ -t 500 -d dynamic_spectrum -P > outout 2>&1

  ○ where :
    - -p "(377,896) : specifies which pixel to create dynamic spectrum for
    - -o 1192477696 : observation ID (obsID)
    - -S 1508442485 : first second from where to create dynamic spectrum (here 1st second of the observation)
    - -f start_time_%d_int_%02d_coarse_%03d_fine_ch%02d_image_real.fits : template for the FITS files names as explained above
    - -v 10 : high level of verbosity / debugging (set to 0 to make the program less "talkative")
    - -N 10 : number of fine channels per coarse channel (here for processing 120 kHz images -> 10 fine channels per coarse channel of 1.28 MHz)
    - -X 0.02 : time resolution of images in seconds
    - -I 1 : images from the MWA telescope

- -C 109 : first coarse channel
- -T ./ : not important
- -t 500 : total number of timesteps, which is the total size of the dynamic spectrum (i.e. number of seconds * number of images per second). Here 50 images/second * 10 seconds = 500
- -d dynamic_spectrum/ : name of output directory
- -P : specifies that these are images from BLINK pipeline

- **OUTPUT :**
  - **Dynamic spectrum is saved to FITS named with pixel coordinates :**
    - cd dynamic_spectrum/
    - ls -al 0377_0896.fits
    - ds9 0377_0896.fits &
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- **Example bash script is provided in :**
  - frb_search/scripts/dynamic_spectra/blink_dynamic_spectrum.sh
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- **De-dispersion and de-dispersed time series (DTS) :**
  - Go to directory with the dynamic spectrum :
    - cd dynamic_spectrum/
    - ls -al 0377_0896.fits
    - ds9 0377_0896.fits &
    - Download METAFITS file with metadata for specific observation (obsID = 1192477696) or copy from directory above :
      - wget http://ws.mwatelescope.org/metadata/fits?obs_id=1192477696 -O 1192477696.metafits

  - dynaspec_search 0377_0896.fits 0377_0896_series.fits -o 1192477696 -l 50 -m 65 -s 0.1 -n 7 -S 1 -A -T -C 0.120 -I 1 -B 138.94 -E 109 -P 0

  - where parameters are :
    - 0377_0896.fits - input dynamic spectrum FITS file
    - 0377_0896_series.fits - output de-dispersed time series (2D flux density vs. start time vs. trial DM)
    - -o 119247769 : Observation ID (GPS time)
    - -l 50 : start DM
    - -m 65 : end DM
    - -s 0.1 : DM step
    - -n 7 : threshold in sigmas for finding peaks
    - -S 1 : 1 - search for peaks, 0 - do not search
    - -A : get metadata from METAFITS file
    - -T : use global threshold (the same for entire DTS), without -T uses local threshold (based local sigma)
    - -C 0.120 : channel width, here 120 kHz
    - -I 1 : Telescope type (1-MWA [default], 2 - EDA2/AAVS2, 0 - unknown)
    - -B 138.94 : centre of the first frequency channel here 109*1.28 - 0.64 + 0.12/2 = 138.94 MHz
    - -E 109 : first coarse channel

- -P 0 : calculate dispersion sweeps starting before the start of dynamic spectrum. They are noisy and not worth using. Hence, disabled here [default = 1 -> enabled].
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