(G)ASP/WAPP Data Analysis

- NANOGrav data:
  - Taken every ~month since ~2004
  - At AO: every pulsar at two frequencies, any of 327 MHz, 430 MHz, 1400 MHz and 2300 MHz
  - At GBT: 800 MHz and 1400 MHz
  - Integration times vary from ~10-30 min per pulsar per frequency

(G)ASP Analysis

- UBC software: ASP Fits Reader (AFR)
  - Developed by Rob Ferdman, Ingrid Stairs, Marjorie Gonzalez
  - Routines for calibration, timing and data handling

(G)ASP Analysis

- AFR routines:
  - Timing:
    - ***ASPFitsReader***: reads in (G)ASP FITS files and applies flux calibration, scan rejection, profile binning, polyco re-folding, polarization calibration, etc. Output file in AFR FITS format.
    - ***ASPStokes***: reads in AFR FITS file and outputs ascii profiles.
    - ***ASPToa***: reads in AFR FITS files and produces TOA file (also needs template).

(G)ASP Analysis

- AFR routines (cont'd):
  - Calibration:
    - ***ASPCal***: reads in (G)ASP FITS calibration files and outputs calibration file with Jy/count conversion. Uses continuum files or measured Tcals for each polarization.
    - ***ASPThetaBB***: calculate phase offset between the two polarizations using continuum file.

(G)ASP Analysis

- AFR Routines (cont'd):
  - Data handling:
    - ***ASPAdd***
    - ***ASPBinDown***
    - ***ASPMatch***
    - ***ASPRotate/ASPRotateAsc***
    - ***ASPTemplate***
    - ***ASPHead***

(G)ASP Analysis

- Other routines also used:
  - RFI rejection: IDL code, compares each dump/channel in an observation to a standard. Outputs list of scans to be rejected that is give as input to ASPFitsReader
  - Polarization calibration: more below...

(G)ASP Analysis

- Sample run

(G)ASP Pipeline

- NANOGrav data archive at UBC: pulsar and calibration files
  - Pulsar observations: 1 min dumps, average of 16 frequency bins across bandwidth
  - Calibration observations:
    - Pulsar calibration plus flux reference source (3 files)
    - 2x1min scans, matching frequency bins
- All ASP data to date

(G)ASP Pipeline

- Pipeline steps:
  - Find pulsar and calibration files for each epoch and frequency
  - Re-fold files using new par file (if desired)
  - Perform RFI rejection (if desired):
    - Compare profile for each dump/frequency with standard
    - Generate list of bad channels/dumps

(G)ASP Pipeline

- Pipeline steps (cont'd):
  - Perform calibration (if desired):
    - If continuum calibration files found: use for flux calibration (ASPCal) and phase offset between polarizations (ASPThetaBB)
    - Only pulsar calibration: use calibration file and list of Tcals (ASPCal)
  - Process data with given input (ASPFitsReader), in addition can:
    - Bin by specified amount in time, frequency, phase

(G)ASP Pipeline

- Pipeline steps (cont'd):
  - Repeat for all epochs and frequencies
  - Generate profiles (ASPStokes)
  - Create TOA file (ASPToa)

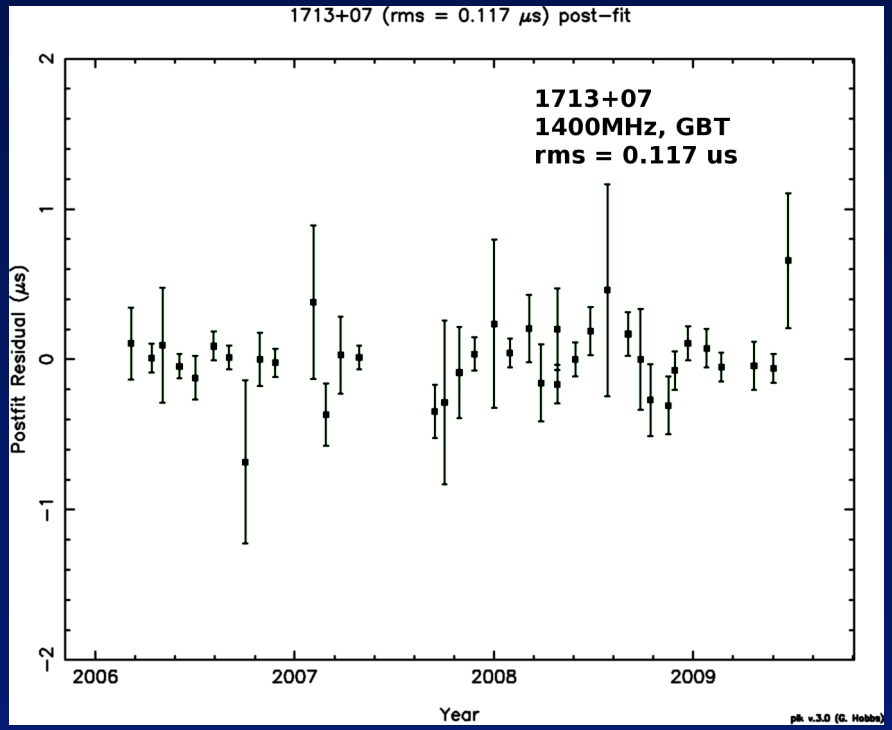
- Running pipeline:
  - Python script
  - Setup appropriate directories/files

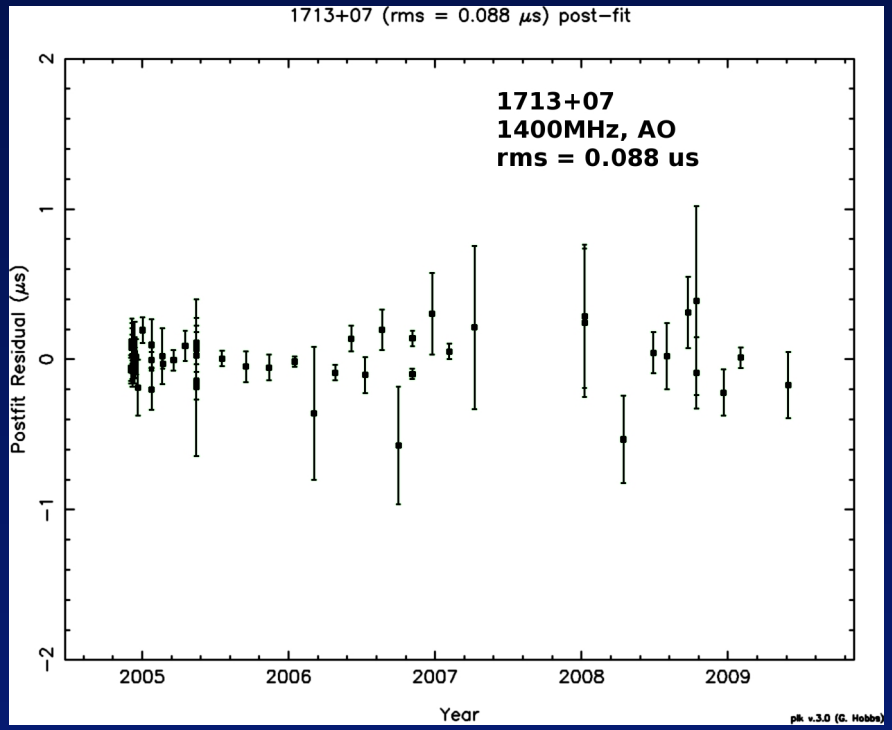
(G)ASP Pipeline

- Needs
  - Par file
  - Tcal file
  - Standard file
  - Mueller matrix
  - Pulsar/calib files
- Creates
  - Polycos
  - Cal file
  - ThetaBB file
  - Profiles
  - Toas

(G)ASP Pipeline

- Example: J1713+07, 1400 MHz at GBT and AO





(G)ASP Analysis

- Polarization calibration:
  - IDL code: match observed Stokes parameters to those of well-calibrated calibrated profile. Solve matrix describing the required transformation.
  - Once matrix is found, feed into ASPFitsReader to correct data taken with similar setup

(G)ASP Analysis

- Sample results: 800 MHz, GBT