



Updates on Gaia data processing for DR4

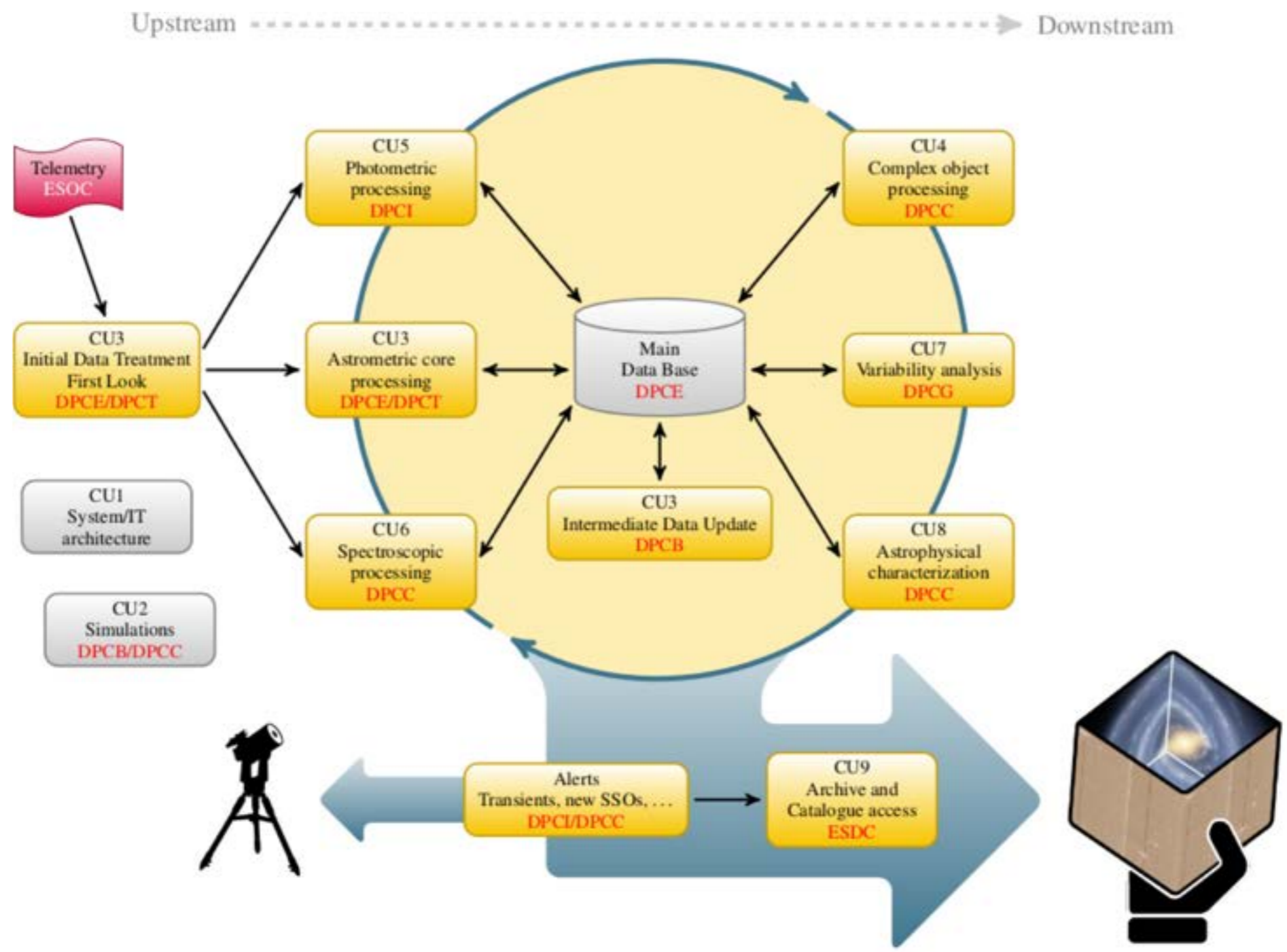
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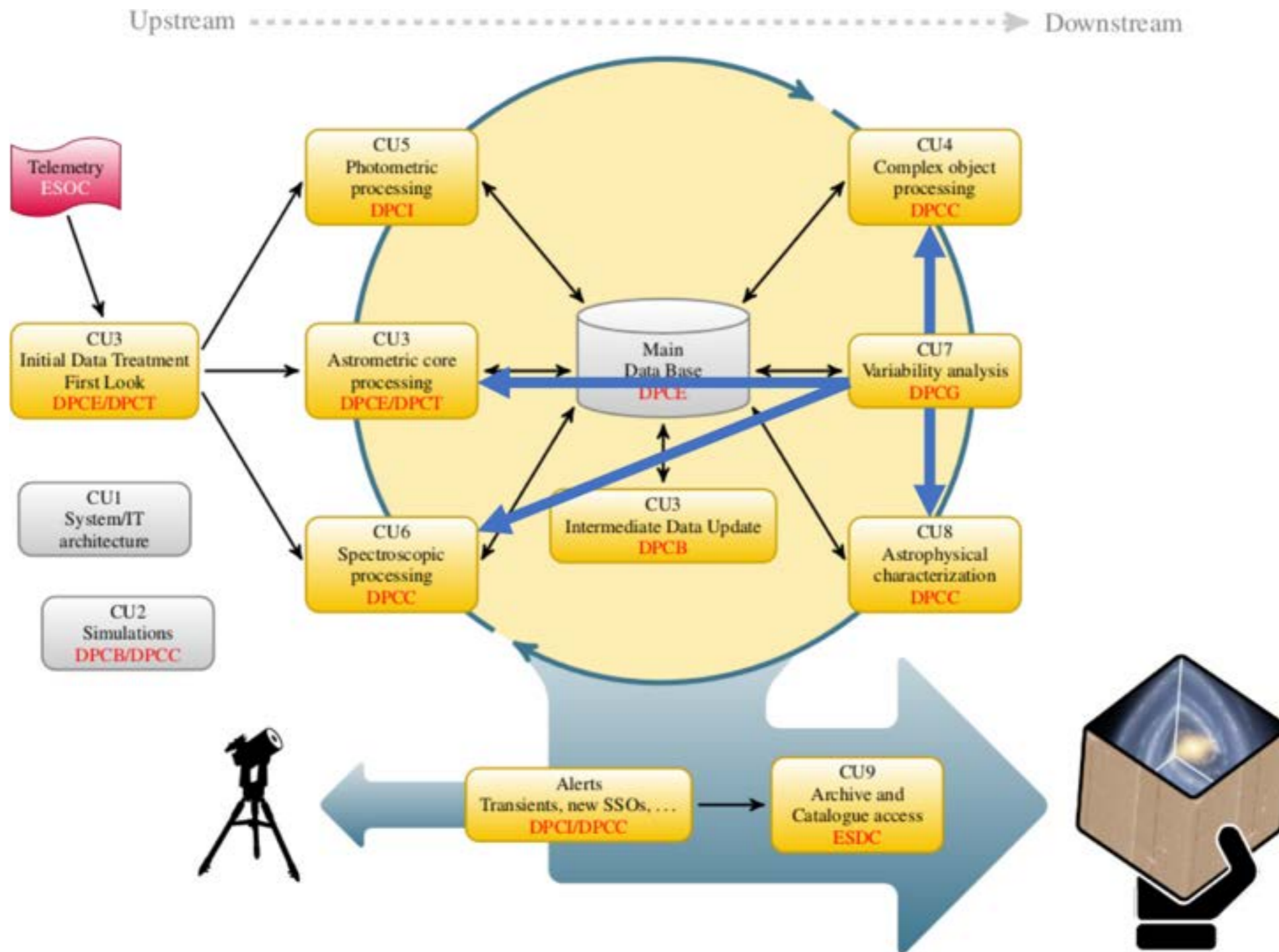
Gaia DPAC – CU7

ISSI team meeting – Bern, 4-7 December

Gaia DPAC



Cross-CUs processing



----- End of November 2023 DPAC operations report -----

Summary

- Final AGIS run for DR4, AGIS 4.8, on going, scheduled to finish by mid December
- PhotPipe operations continue
- CU6 Global operations, STAMTA bright sources run completed and being validated. Will be delivered early March after validation

Cep&RRL SOS WP: pipeline updates

High priority changes common to both Cepheids and RR Lyrae stars

1. Implementation of **photometry quality flags** to discriminate between good and problematic light curves and of a **radial velocity quality flag** to discriminate problematic radial velocity curves
2. **Improvement of the period determination** in the SOS pipeline when we re-derive the period(s) for all candidate RR Lyrae and Cepheids using the Lomb-Scargle algorithm, in order to reduce the number of spurious period detections particularly when several peaks of similar power are present in the power spectrum of the sources (3 peaks)
3. Increase to **more than 2** the number of **harmonics** for modelling the light curves of RR Lyrae stars and Cepheids with well-sampled light/RV curve
4. Addition of a **parameter that measures the skewness of the light curve** → **time of rise to maximum light** to distinguish RRab from RRc stars and to disentangle different types of Cepheids in the 1-2.5 d period range
5. Search for second-overtone Cepheids (single mode) and triple mode Cepheids; and Anomalous RRd stars (ARRd, both RR_{0.68} and RR_{0.61})
6. Calculation of **amplitude ratios** to detect binaries contaminating the Cepheids and RR Lyrae samples
7. Detection of Cepheids and RR Lyrae in **binary systems** using the **Gaia photometric, astrometric and radial velocity (RVS) time series** measurements

Quality flags

- Uniformity index (UNIFX)
- rms of the time-series / rms of the residuals after fit (RMS/rms)
- Peak-to-peak amplitude / rms of the residuals after fit (AMP/rms)

Quality flags: Uniformity index

Uniformity index by Madore+2005

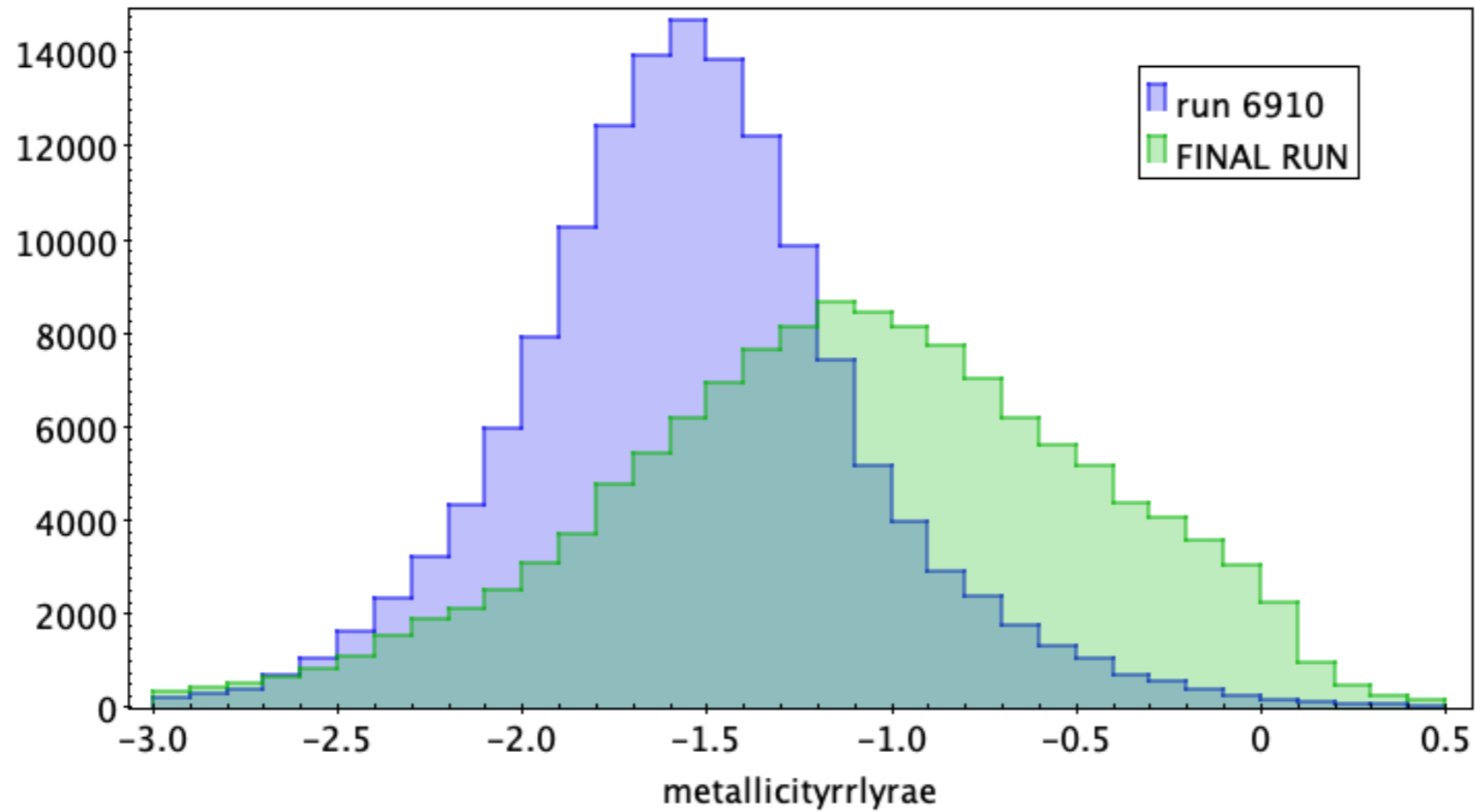
→ how well is sampled a LC (or RV)

$$U_N^2 = \frac{N}{(N-1)} \left[1 - \sum_{i=1}^N (\phi_{i+1} - \phi_i)^2 \right]$$

SOS Cep&RRL pipeline: updates already implemented

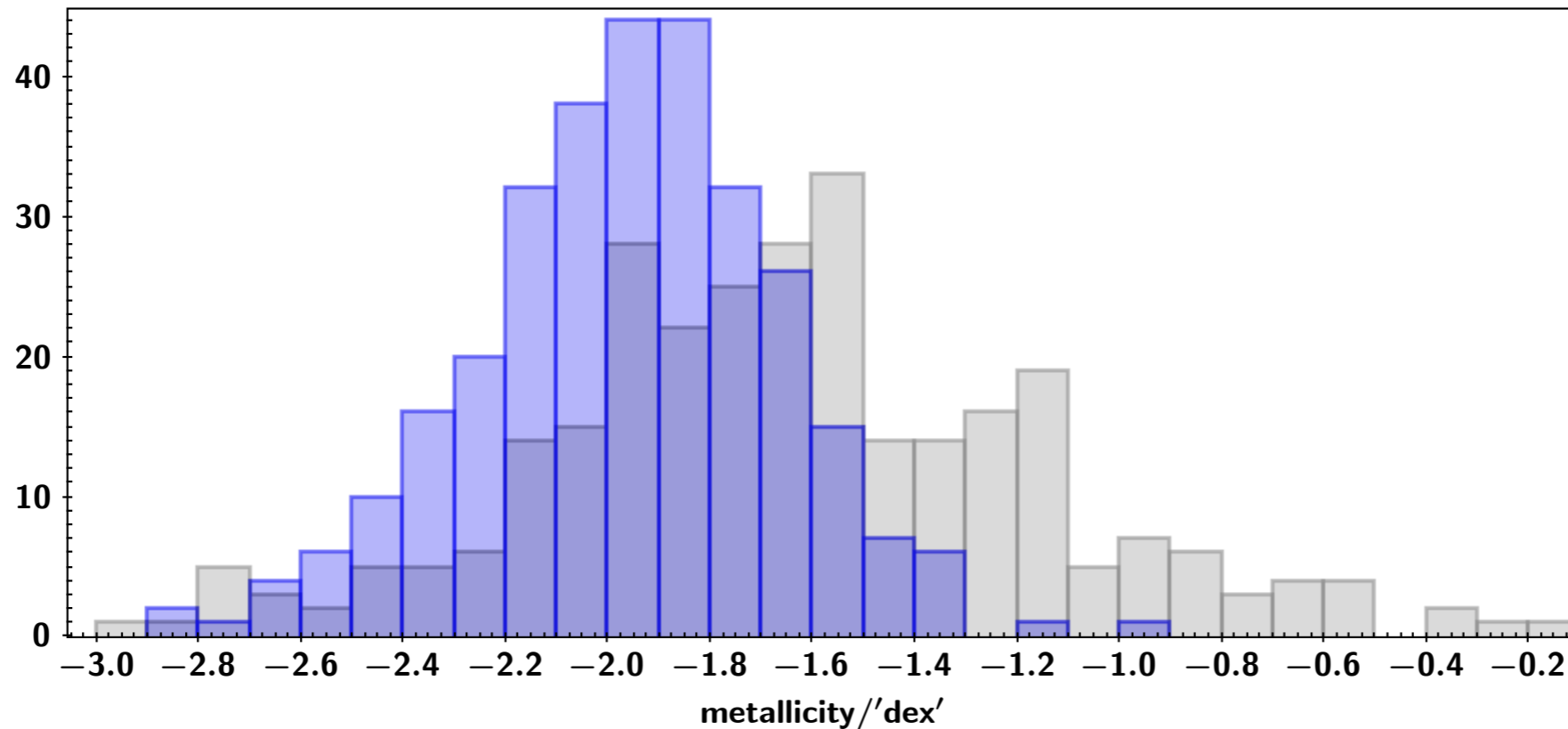
1. **Derivation of astrophysical parameters** (APs; metallicities, gravities, and T_{eff} values) and delivery to CU6 to best select the template spectra for the cross-correlation to measure radial velocities of RR Lyrae stars and Cepheids in DR4 (Jira C6AUXD-263)
2. Improvement of the **period determination** for RR Lyrae stars and Cepheids (three peaks)
3. Increase to **more than 2 the number of harmonics** for modelling the light curves for RR Lyrae stars and Cepheids
4. Addition of a parameter that measures the skewness of the light curve → **time of rise to maximum light** for RR Lyrae stars and Cepheids
5. **Revision of total error of the SOS metallicities** ($[\text{Fe}/\text{H}]_{\text{SOS}}$) for the RR Lyrae stars because errors published in Gaia DR3 were **overestimated**
6. Implementation of **new relations** ($[\text{Fe}/\text{H}] - \text{Fourier parameters} - P$) to estimate photometric metallicities from the Fourier parameters and the pulsation period of RR Lyrae stars and Cepheids directly from the Gaia G-band light curves
7. Adoption of Luminosity-metallicity (LZ) and PW and PW-metallicity (PWZ) relations in the Gaia bands, calibrated on Gaia parallaxes in the pipeline, in order to improve the classification of RR Lyrae stars

Metallicity distribution of the DR3 SOS RR Lyrae



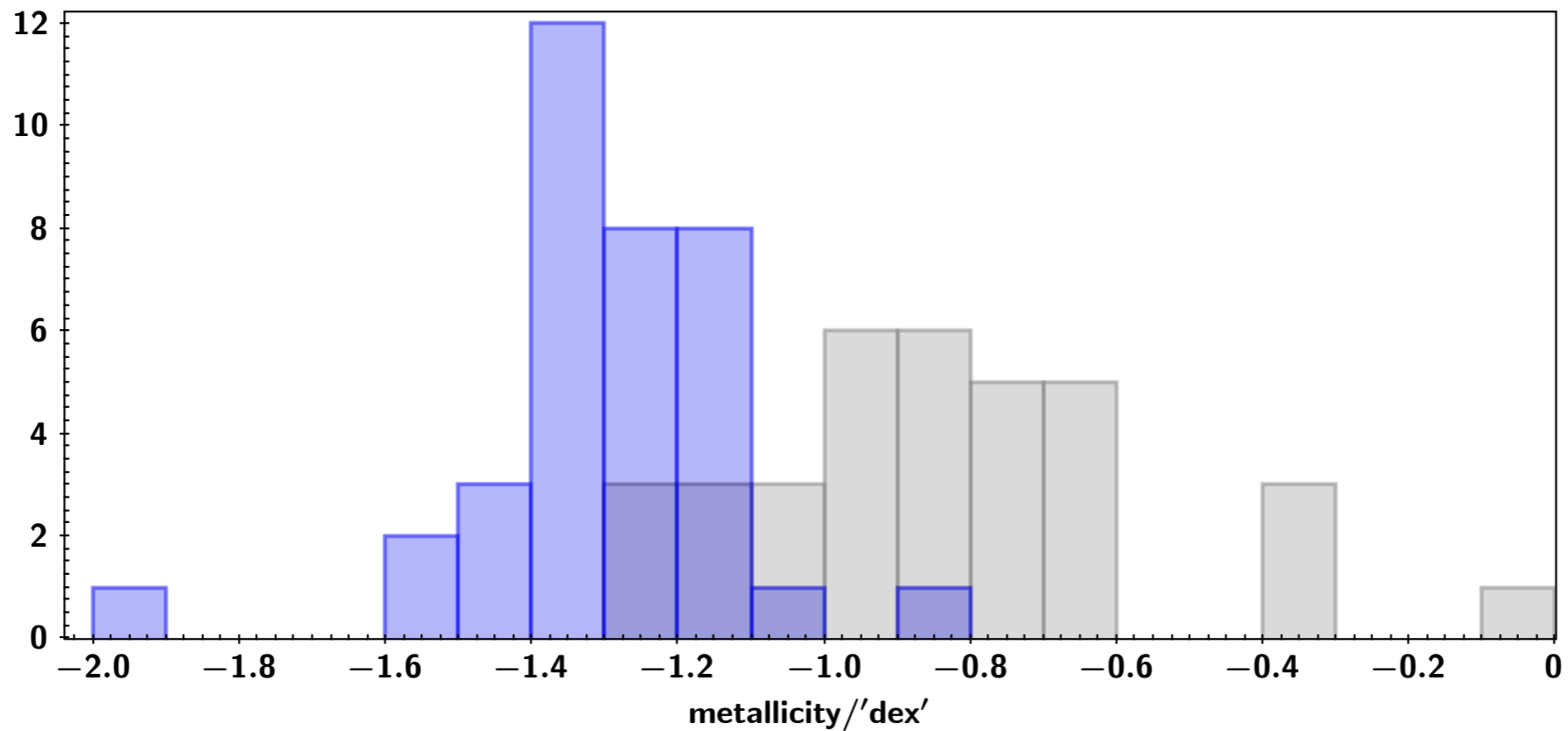
DR3 SOS RRLs, whole sample with an [Fe/H] estimate (135K RRLs)

Sculptor dSph

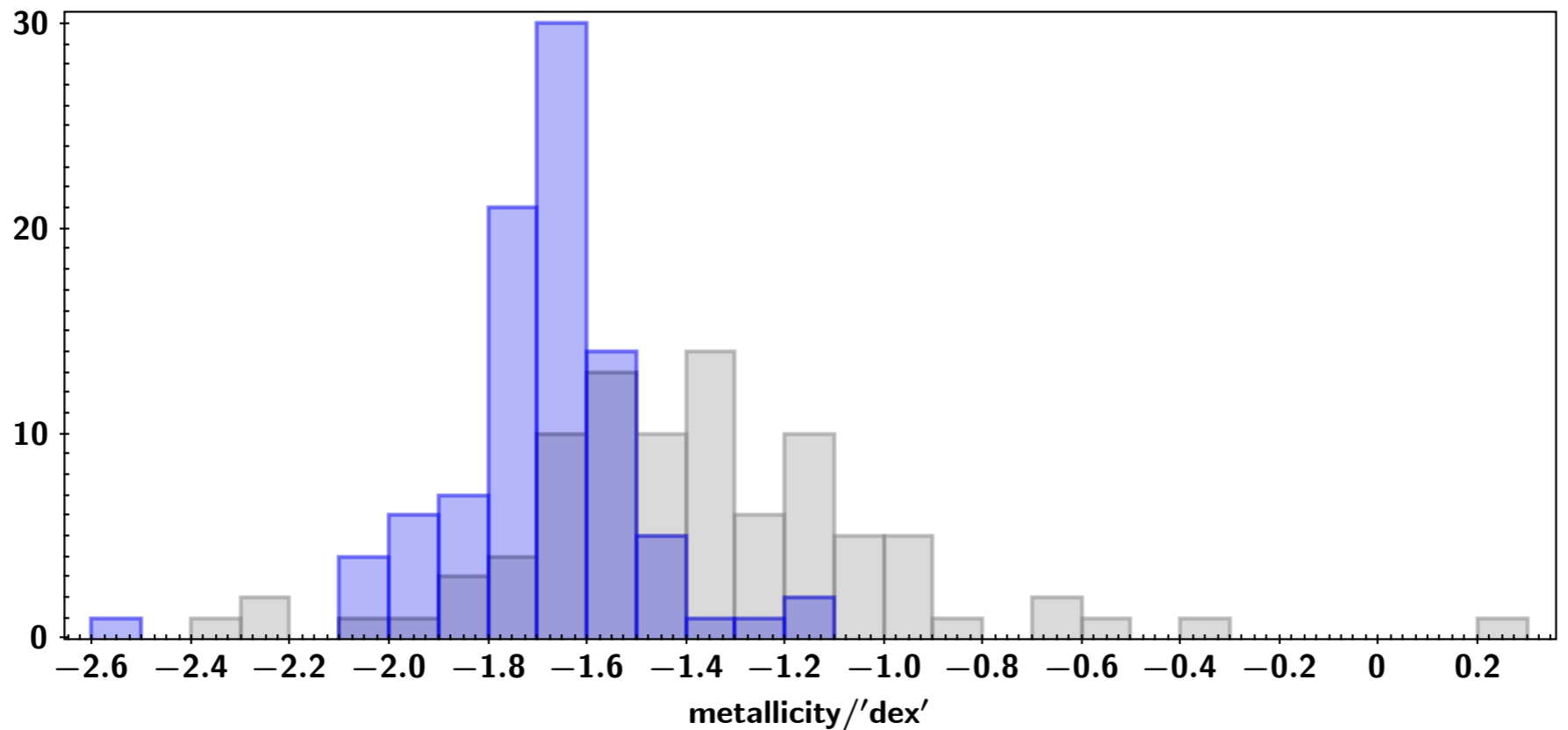


DR3 SOS RRLs with an [Fe/H] value in the Sculptor dSph

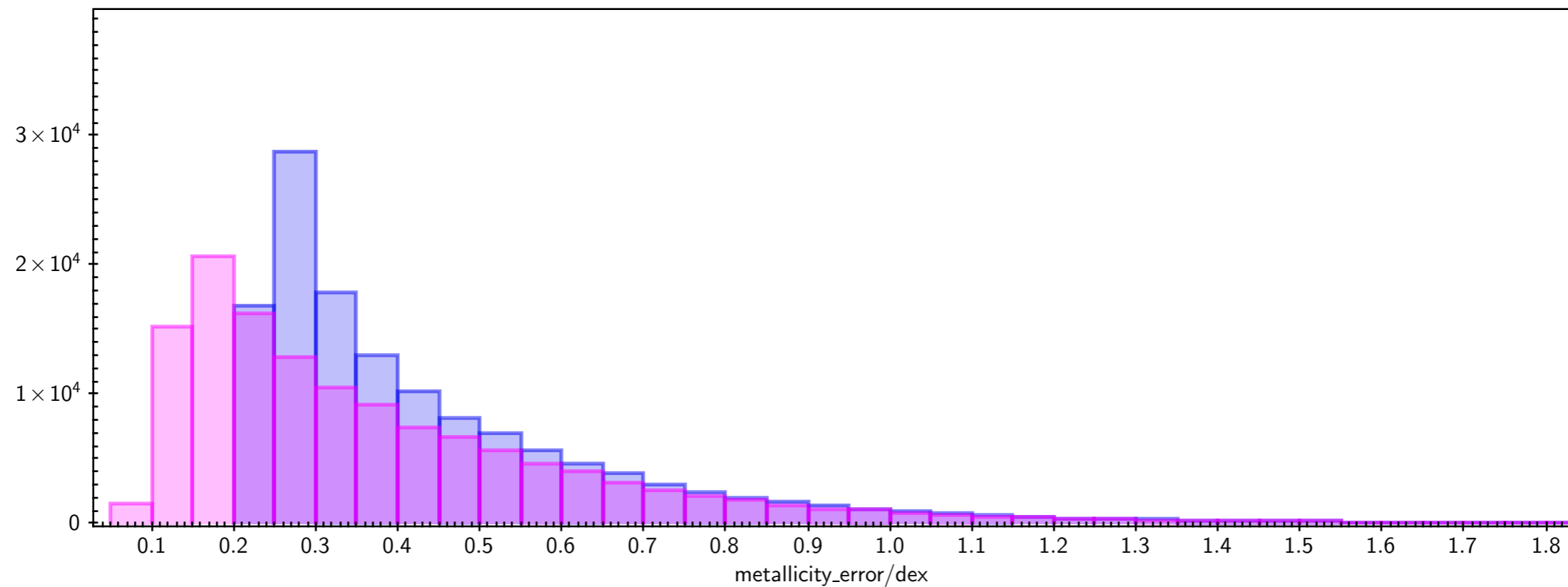
M4 NGC6121



M3 NGC5272



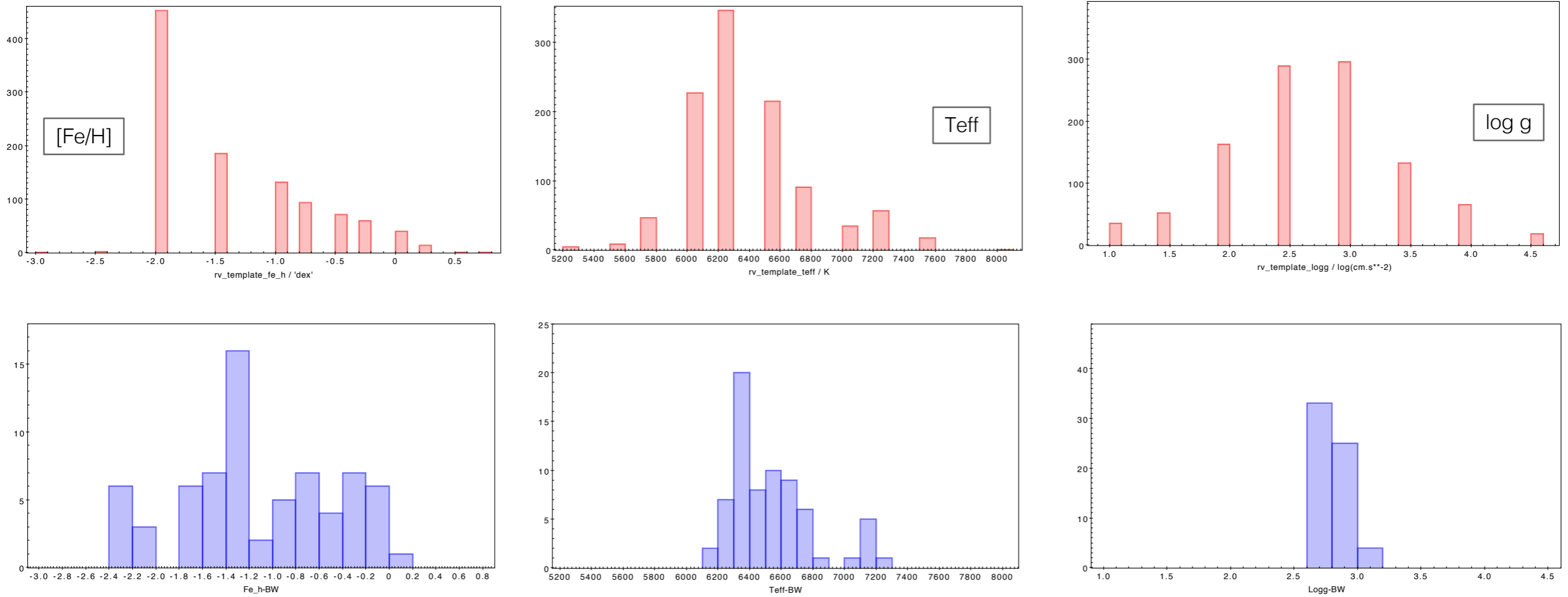
Correct metallicity errors of RR Lyrae stars



Blue= metallicity errors for RR Lyrae stars published in DR3
Magenta= correct metallicity errors

[Fe/H], Teff, and log g values of the CU6 templates vs <Teff>, <log g>, and [Fe/H] values from B-W

[Fe/H], Teff, and log g values of the CU6 templates for RR Lyrae in DR3



[Fe/H], Teff, and log g values of RR Lyrae with B-W

Developments underway: Cepheids

Updated *PL/PW* relations in the Gaia bands based on DR3

Search for 3rd periodicity for Cepheids

Search for second-overtone (single mode) and triple-mode Cepheids

New metallicity – Fourier parameters' relations based on Hocde+23's work

Improved **validation tools based on ML** to speed up the validation process

Further developments: RR Lyrae

Flagging potential Blazhko RR Lyrae stars

Add PW , PWZ relations to improve RR Lyrae classification

Use CMD diagram to improve RR Lyrae classification

New metallicity – Fourier parameters' relations to improve metallicity

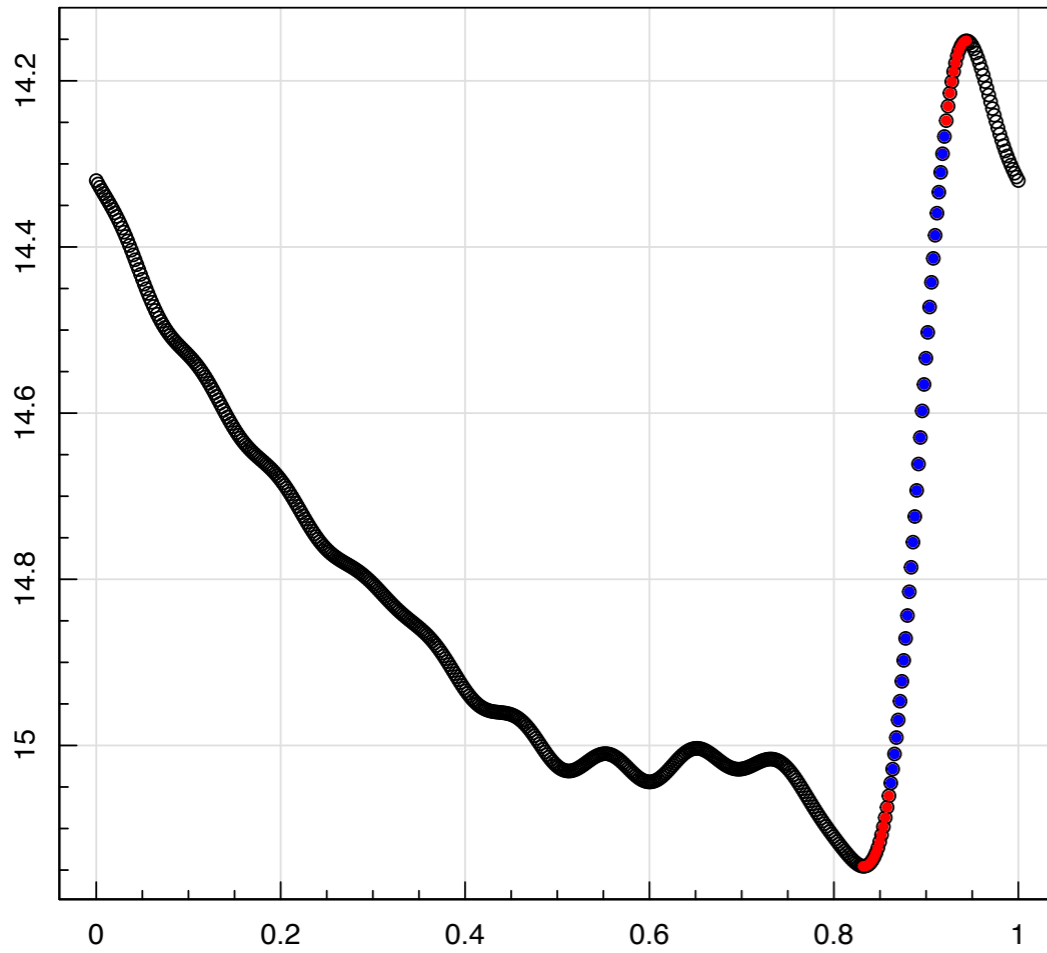
Develop validation tools based on ML to improve validation process



Thank you

ISSI team meeting – Bern, 4-7 December

4. Addition of a parameter that measures the skewness of the light curve → time of rise to maximum light
DONE & TESTED



rise time in V (RRab) $\sim 0.1 - 0.2$
 rise time in V (RRc) ~ 0.4

