The Pristine Survey

C. Allende Prieto (Instituto de Astrofisica de Canarias)
and the Pristine Collaboration

Metal-poor stars

Primordial nucleosynthesis: H, He, Li

Spallation in the ISM: B, Be

Nucleosynthesis in stars (and supernovae): all metals

Metal-poor stars

First metal-poor stars recognized early, in the 1950's (Chamberlain & Aller 1951)

Big picture complete with the B^2FH (1957) paper

Metal-poor stars then used to study the formation of the Galaxy

UV excess used as a proxy for metallicity and used in the ESL model of formation (Eggen, Sandage & Linden-Bell 1962)

Metal-poor stars

Large-scale search for metal-poor stars using Schmidt telescopes and objective prism observations: HK survey of Beers, Preston & Shectman (1985)

Medium-resolution follow-up observations to follow for about a decade

Hamburg-ESO survey (HES; Christlieb et al. 2002) used to select candidates, which brings the first stars at [Fe/H]<-5

SDSS enters the scene, with 1e6 spectra to date, from which several stars at -6<[Fe/H]<4 have been identified (e.g. Placco et al. 2015; Allende Prieto et al. 2015; Aguado et al. 2016, 2017)

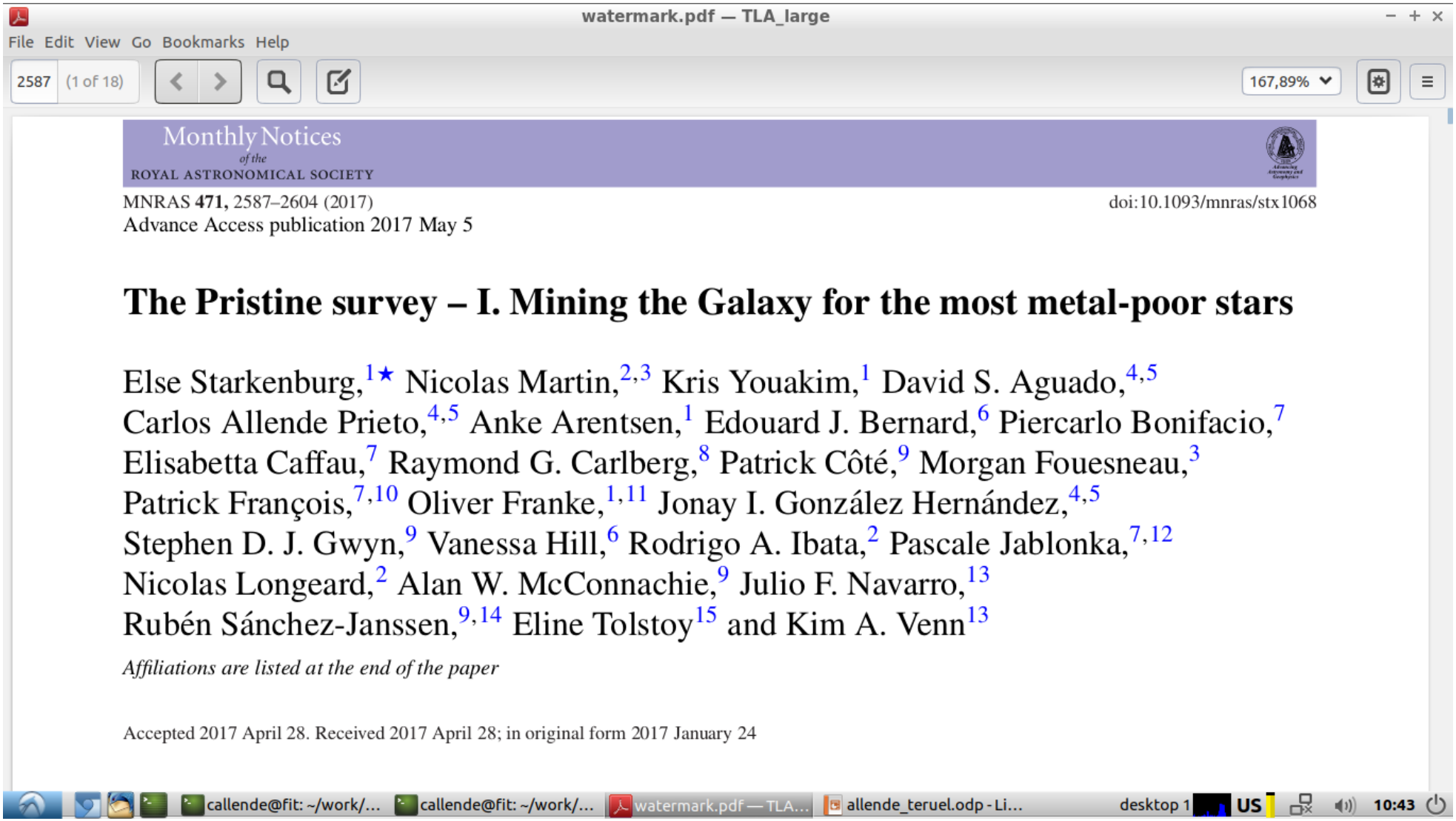
Metal-poor stars

Vast [C/Fe] enhacements are usual, but there are exceptions – see Caffau et al. (2014) which sets the record for non-carbon enhanced metal-poor stars at [Fe/H]~ -5

Narrow-band photometric surveys: Skymapper (1.35m at Side Spring), Pristine (3.6m CFHT at Mauna Kea) and J-PLUS (0.8m at Javalambre)

The iron-poor record holder sits at [Fe/H]<7 (Keller et al. 2014) identified from the follow-up of Skymapper candidates

Pristine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Monthly Notices
of the
ROYAL ASTRONOMICAL SOCIETY
MNRAS 471, 2587–2604 (2017)
Advance Access publication 2017 May 5
doi:10.1093/mnras/stx1068
The Pristine survey – I. Mining the Galaxy for the most metal-poor stars
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Accepted 2017 April 28. Received 2017 April 28; in original form 2017 January 24
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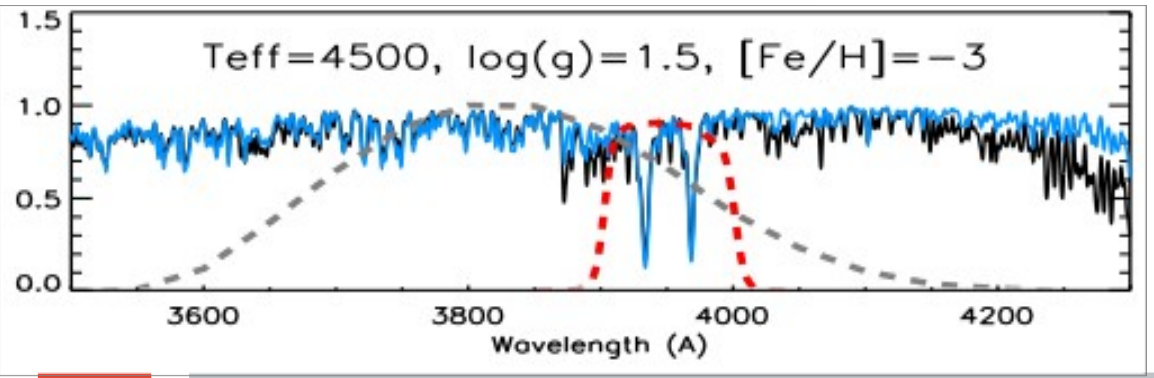
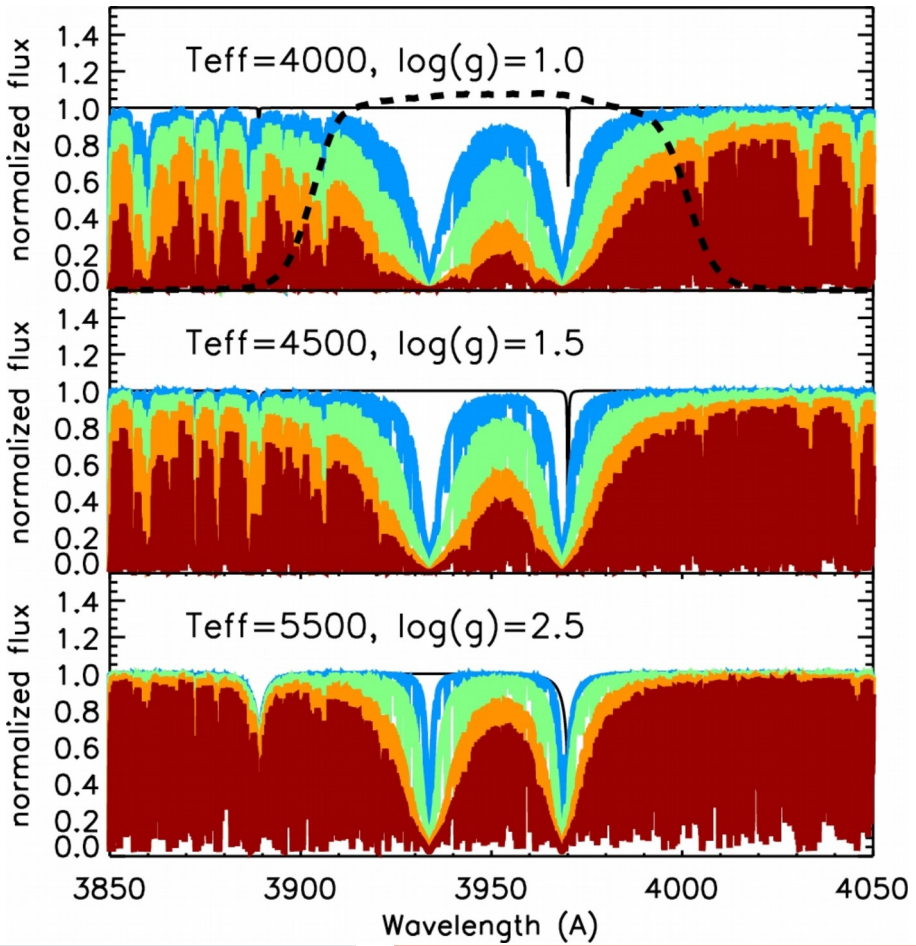
Pristine

Narrow-band filter over the Ca II resonance doublet

Imaging on the 3.6m CFHT using MegaCam

Goal is to cover 3000 sqr. Deg (over 1000 done so far)





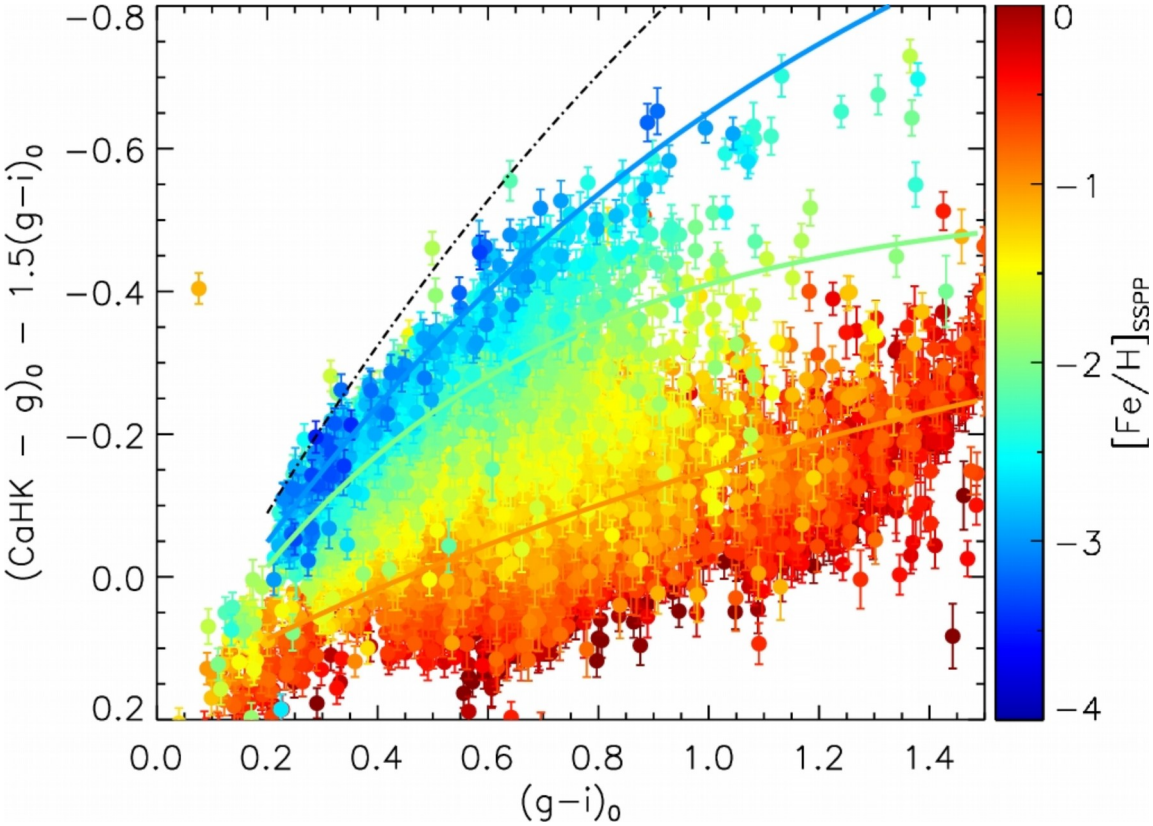
Calibration

Pristine footprint overlaps with SDSS *ugriz* imaging

100-200s exposures reaching down to g~ 21 mag

Relative calibration of the photometry

[Fe/H] scale tied to SEGUE



Pristine [Fe/H] estimates

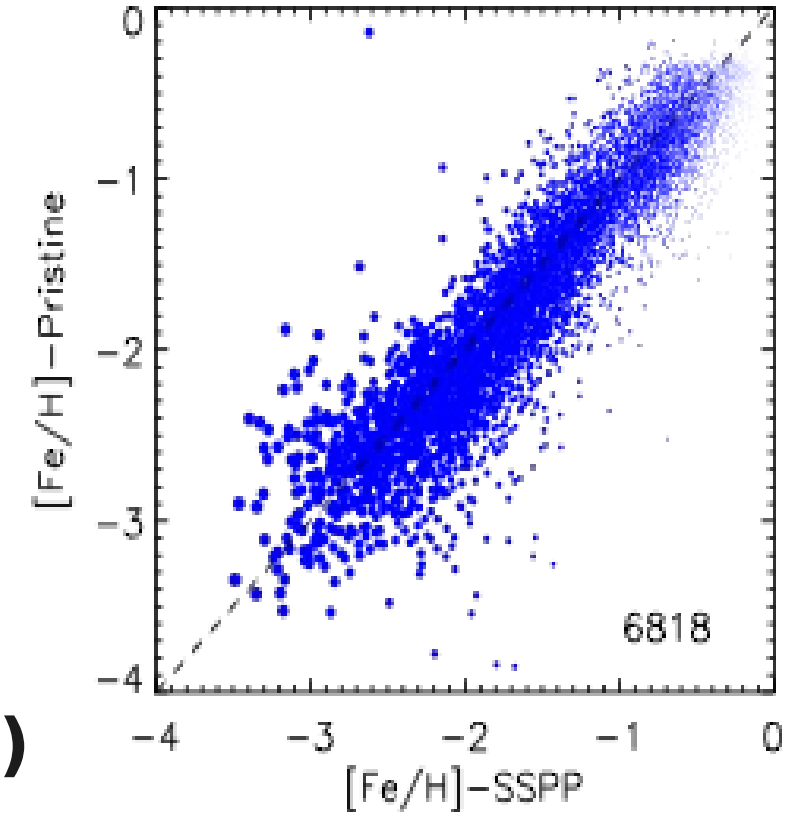
Good sensitivity down to [Fe/H]~ -3 or -3.5

Spectroscopic follow-up based on the 2.5m INT and the 4.2m WHT

Over 50 nights already executed

Reduction pipeline based on IRAF (K. Youachim)

Pristine Ca H&K



Analysis pipeline based on FERRE (D. Aguado)

Pristine follow-up

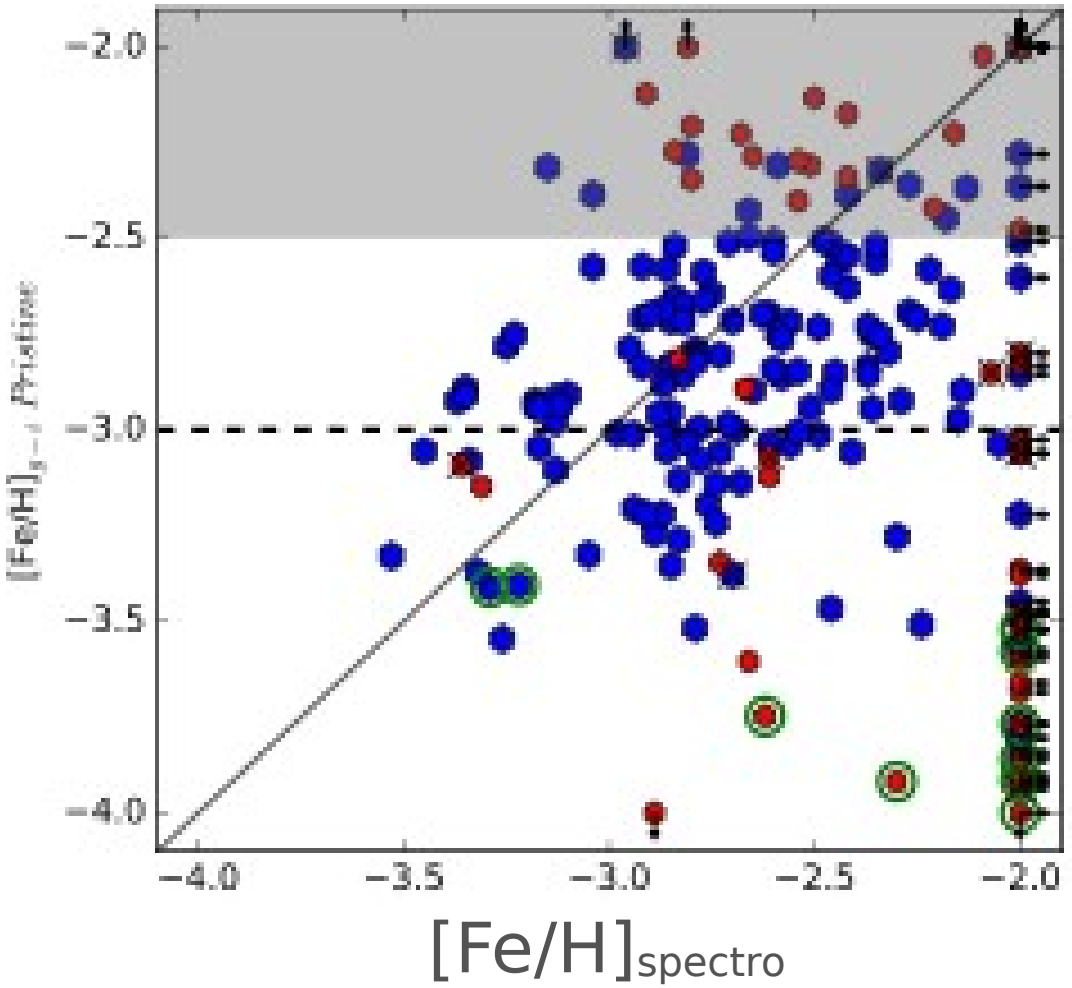
Efficiency

~80% at [Fe/H]<-2

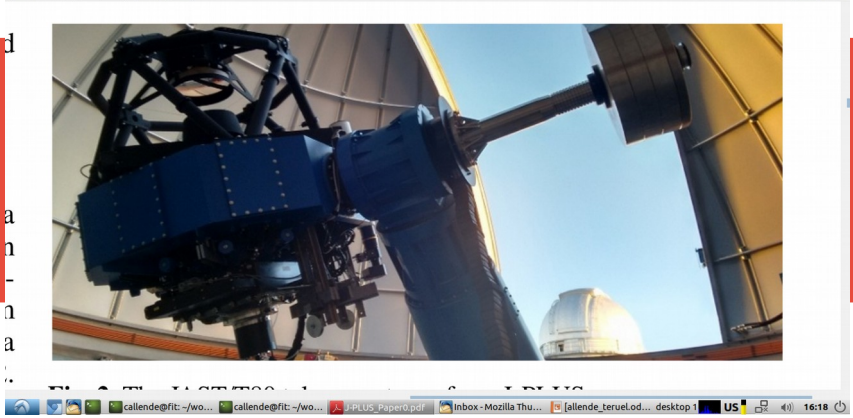
~20% at [FE/H]<-3

Already have some stars at [Fe/H]<-4

Follow-up will go on and piggy-back on the WEAVE surveys



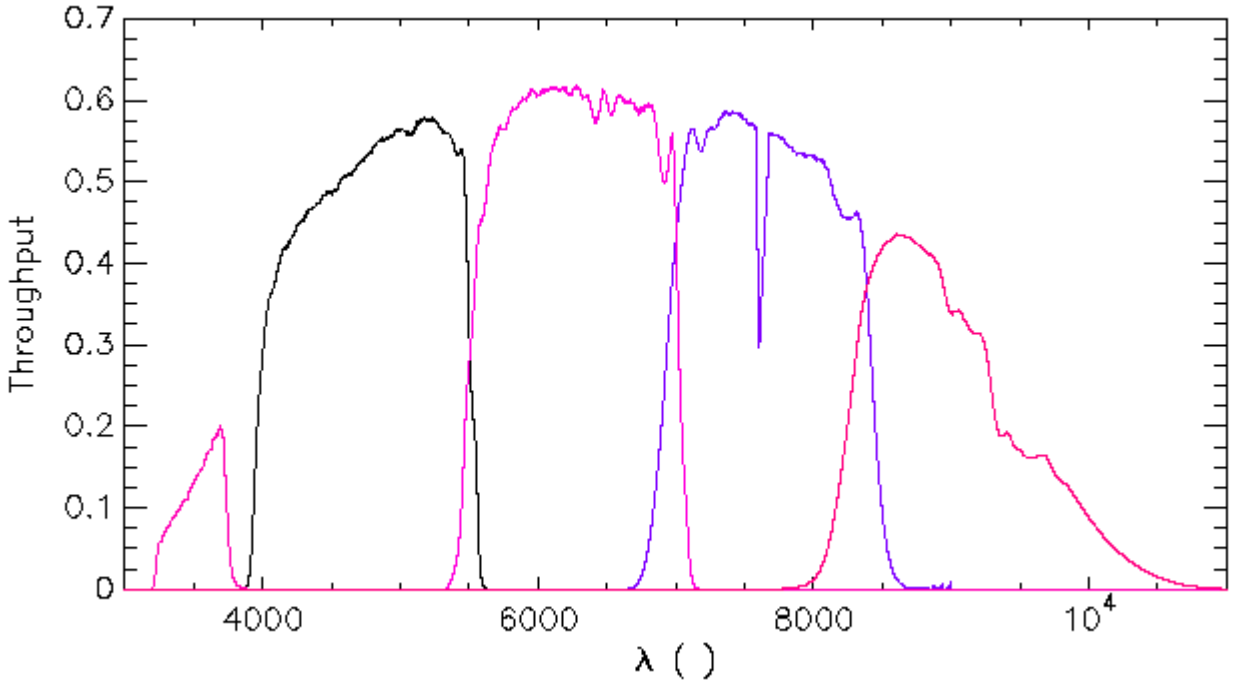
J-PLUS



Smaller telescope but

- wider area: 8500 deg² (idr201709 ~ 500 deg²)

- 12 passbands (including several narrow-band ones)

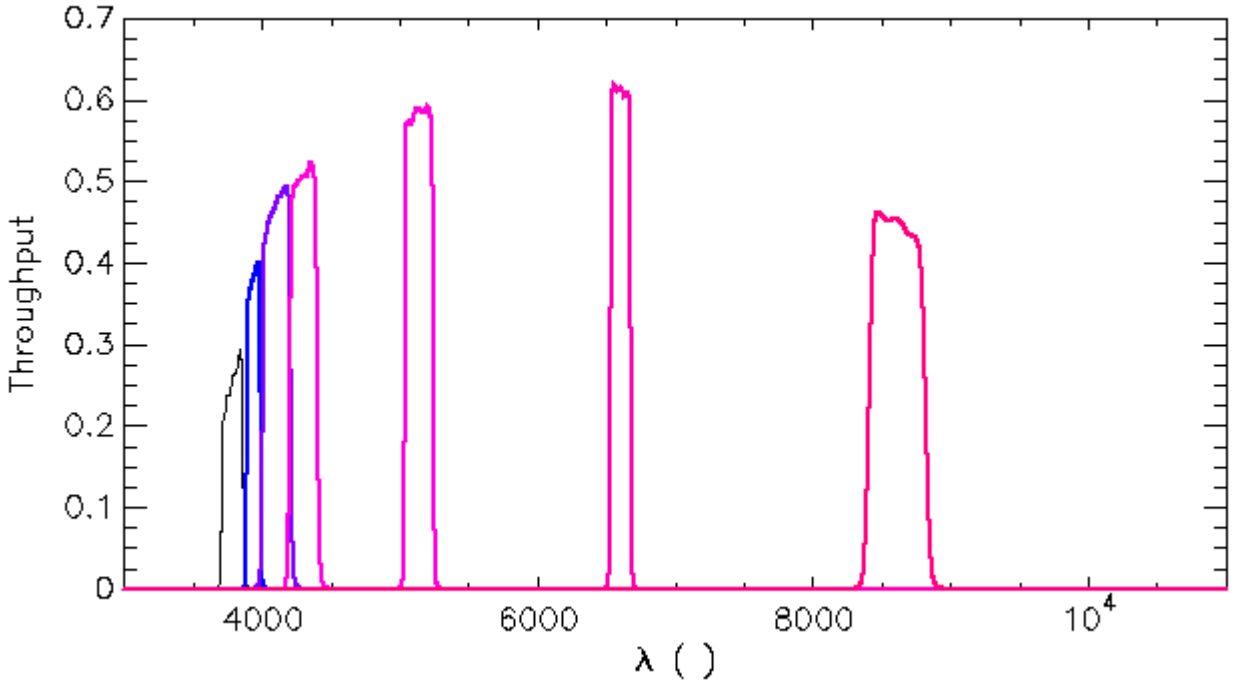


J-PLUS

Smaller telescope but

- wider area

- many colors (including several narrow-band ones)



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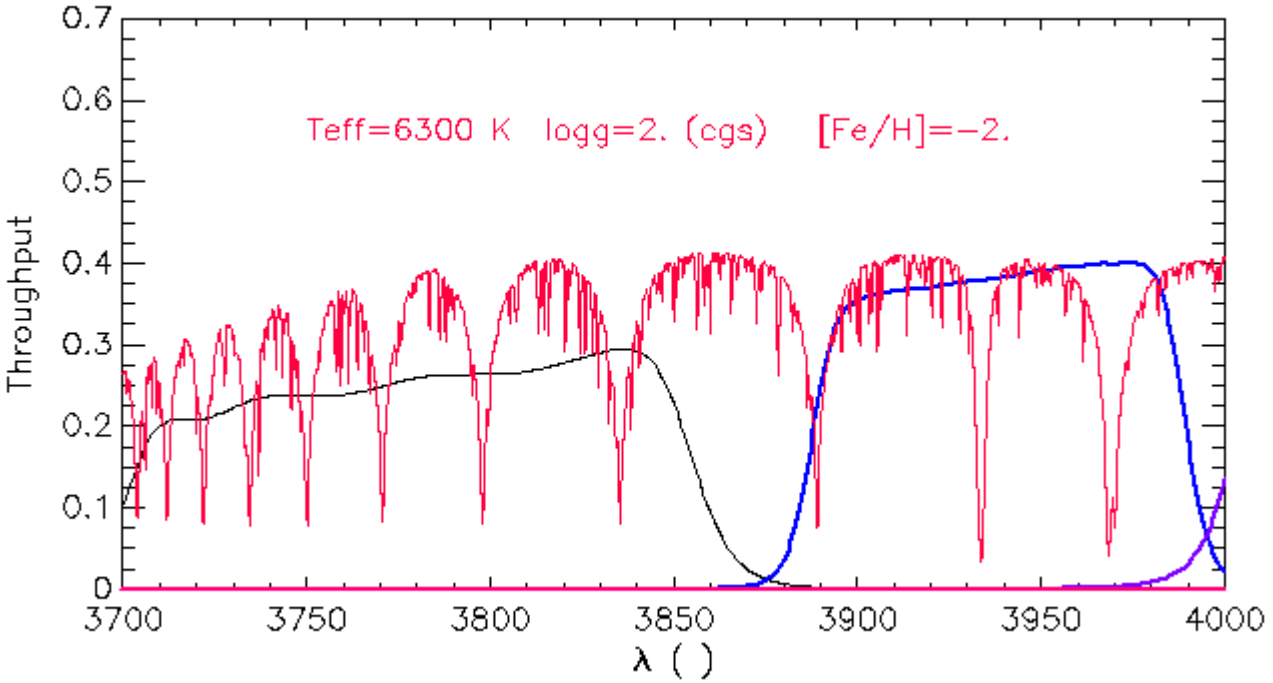
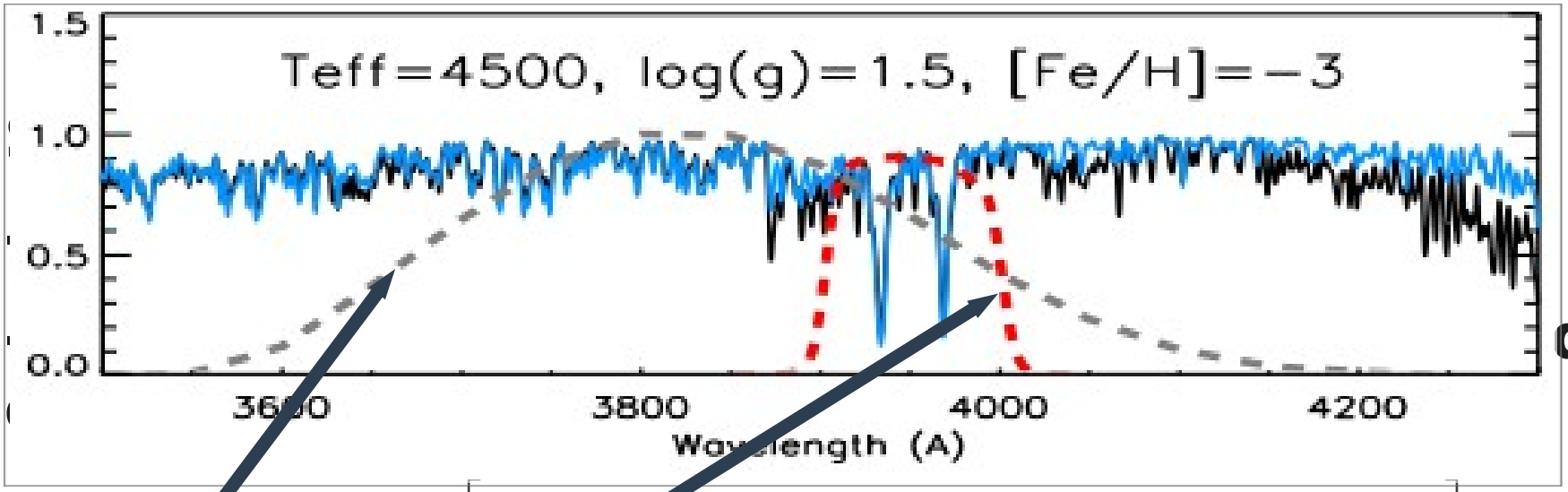


J-PLUS



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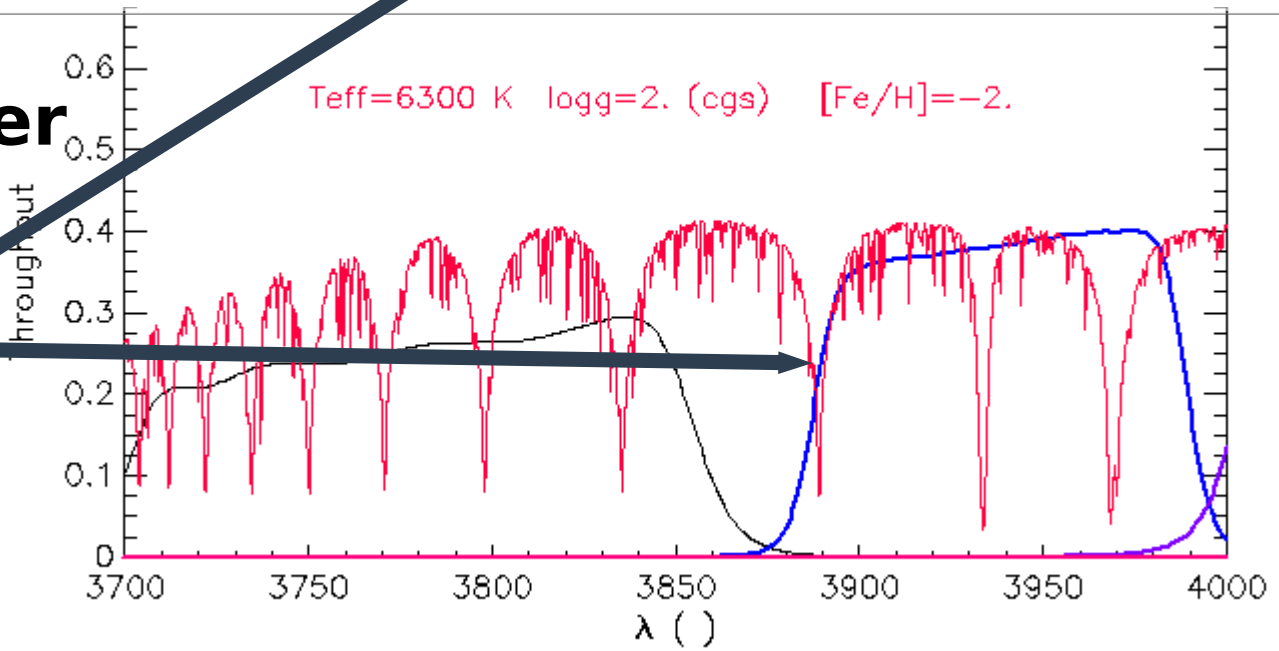
Skymapper

Pristine

J-PLUS



J-PLUS simulations

Based on ATLAS9 model atmospheres (Meszaros et al. 2012) and the ASSET spectral synthesis code (Koesterke 2009)

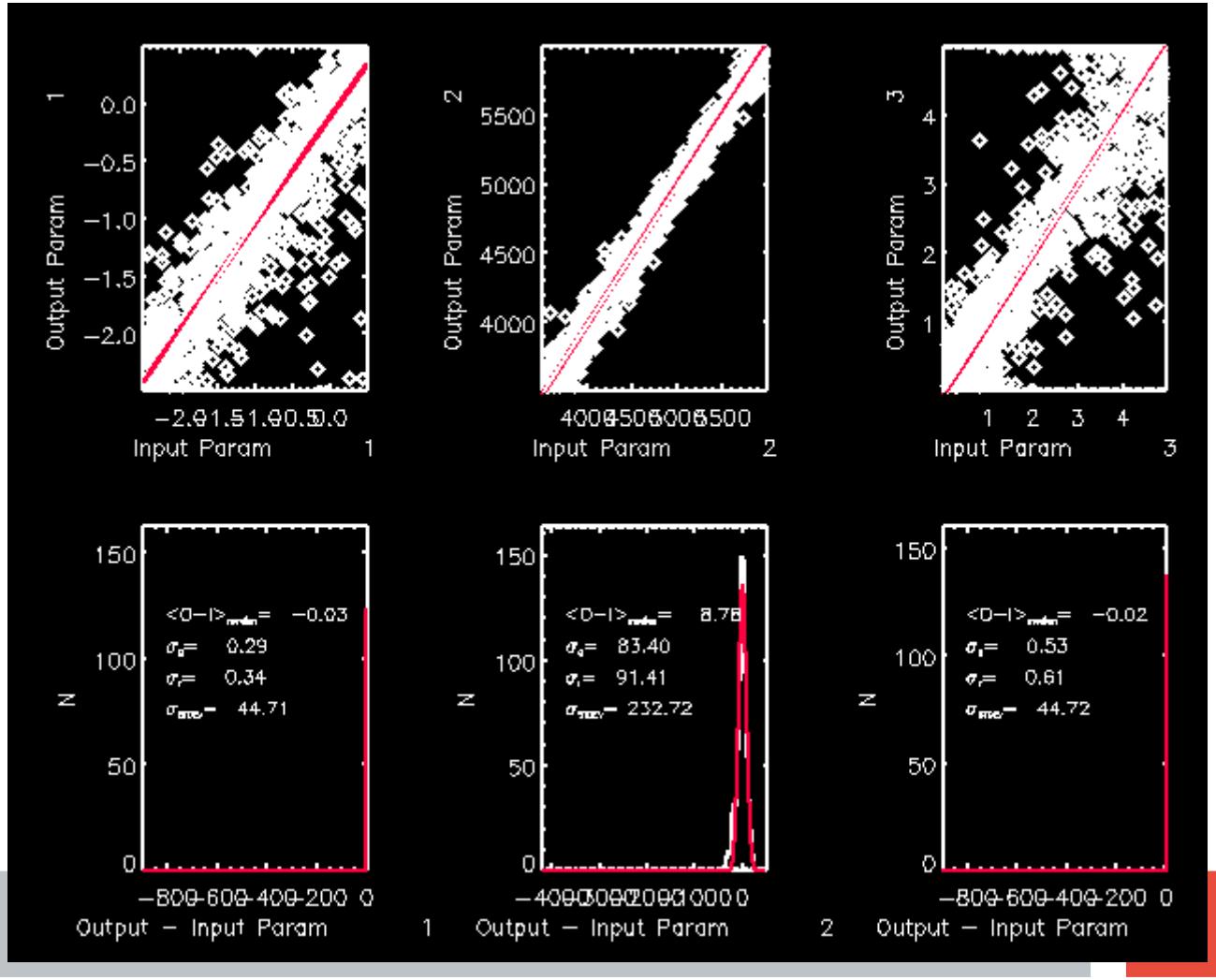
Convolved stellar spectra, inject noise and attempt to recover the stellar parameters using FERRE (Allende Prieto et al. 2006)

The search optimizes the agreement between model and observed colors using the Boender-Timmer-Rinnoy Kan global algorithm, interpolating in a precomputed grid held in memory

E(B-V) *known* from the Schlegel et al. 1998 maps

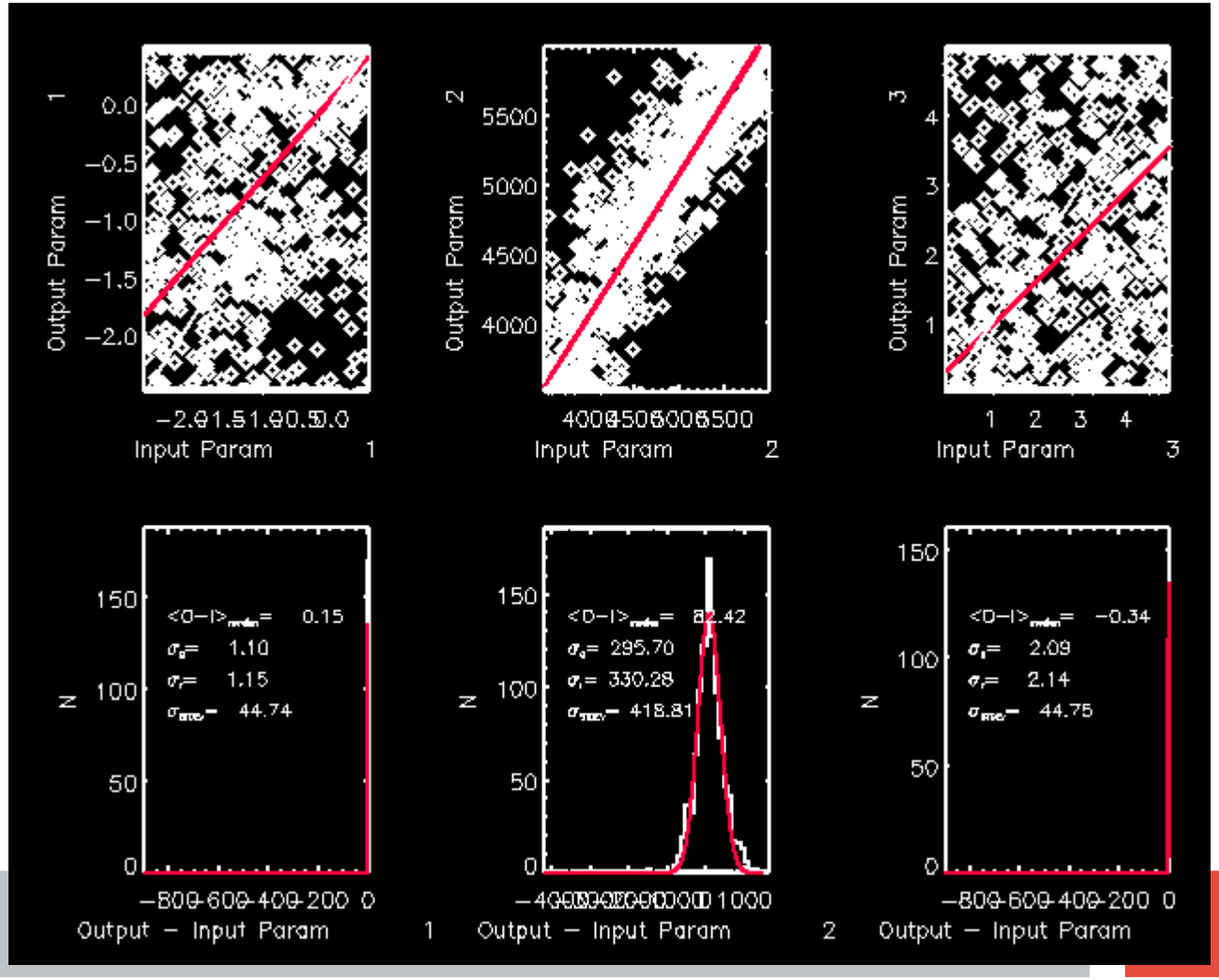
J-Plus simulations

Very good results at high s/n (=80)



J-Plus simulations

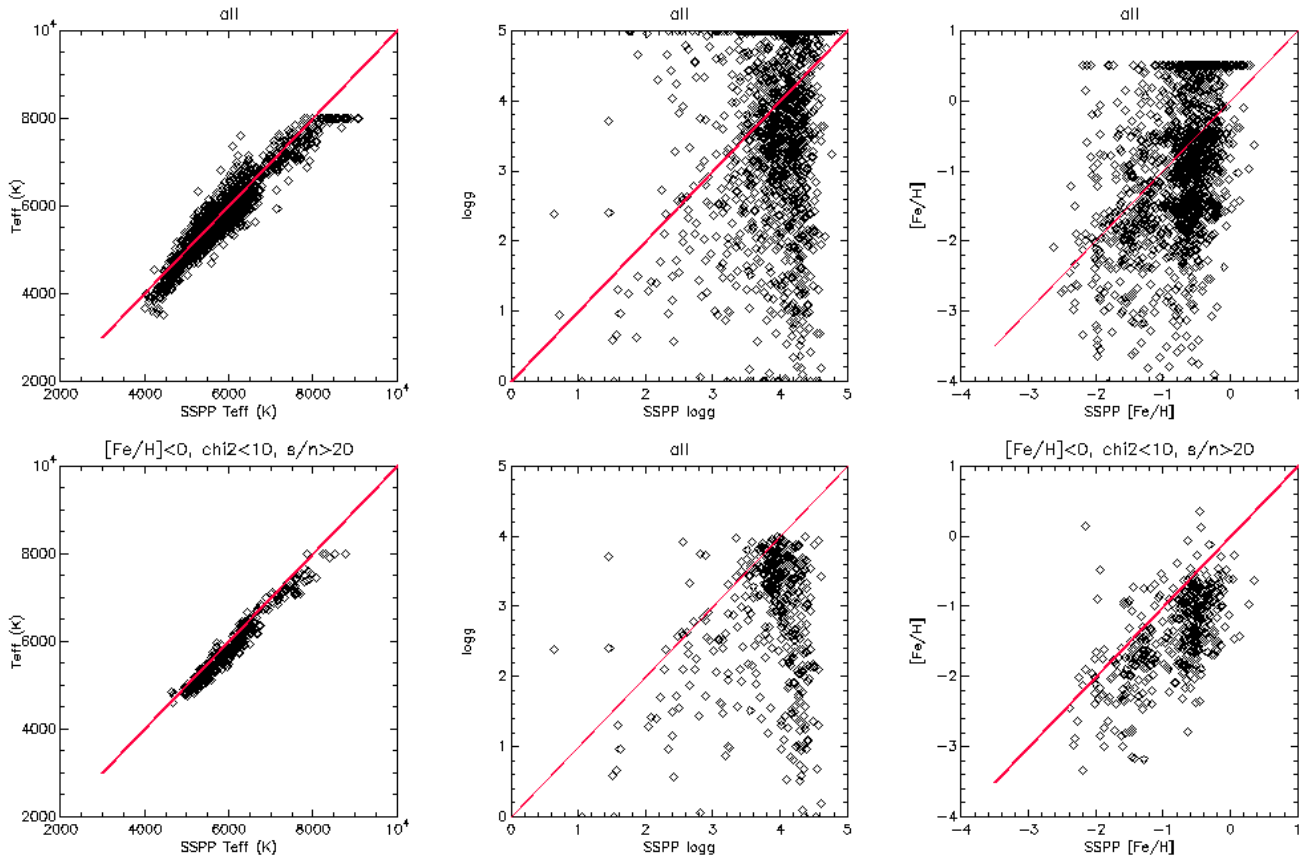
Which degrade significantly at S/N~10



Real EDR data for stars with SEGUE results

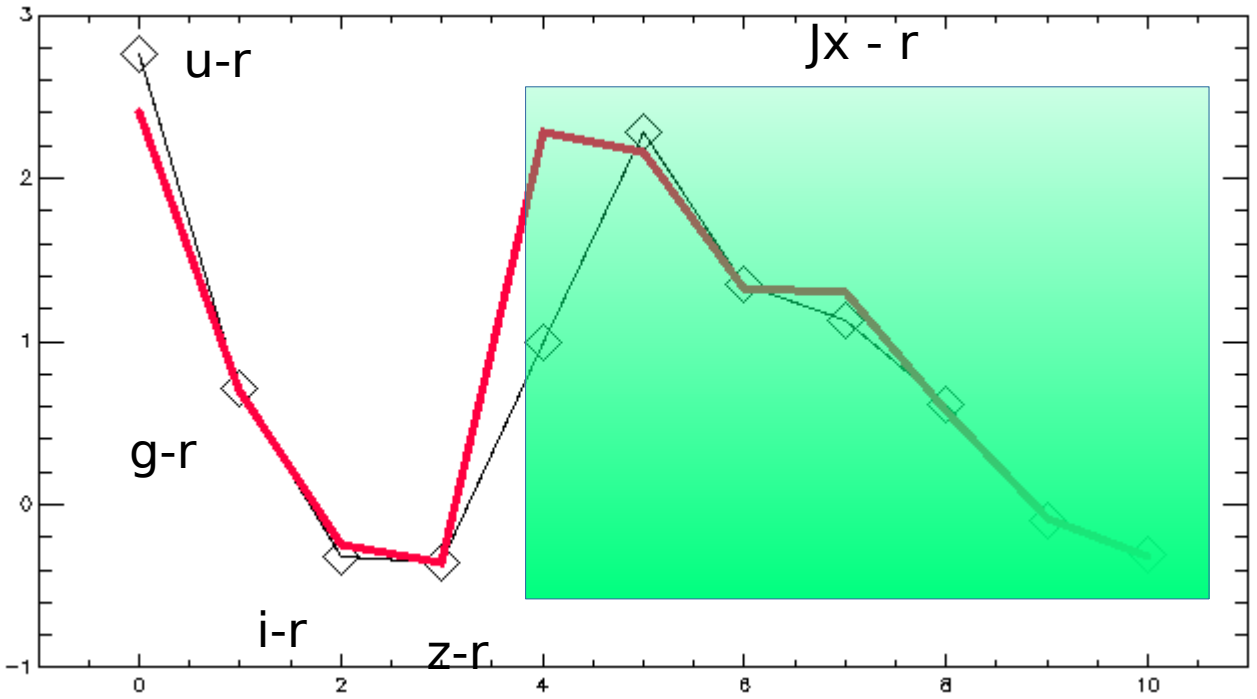
Rms scatter between the spectroscopic and photometric parameters (g<18):

150 K for Teff, 0.5 dex for [Fe/H]



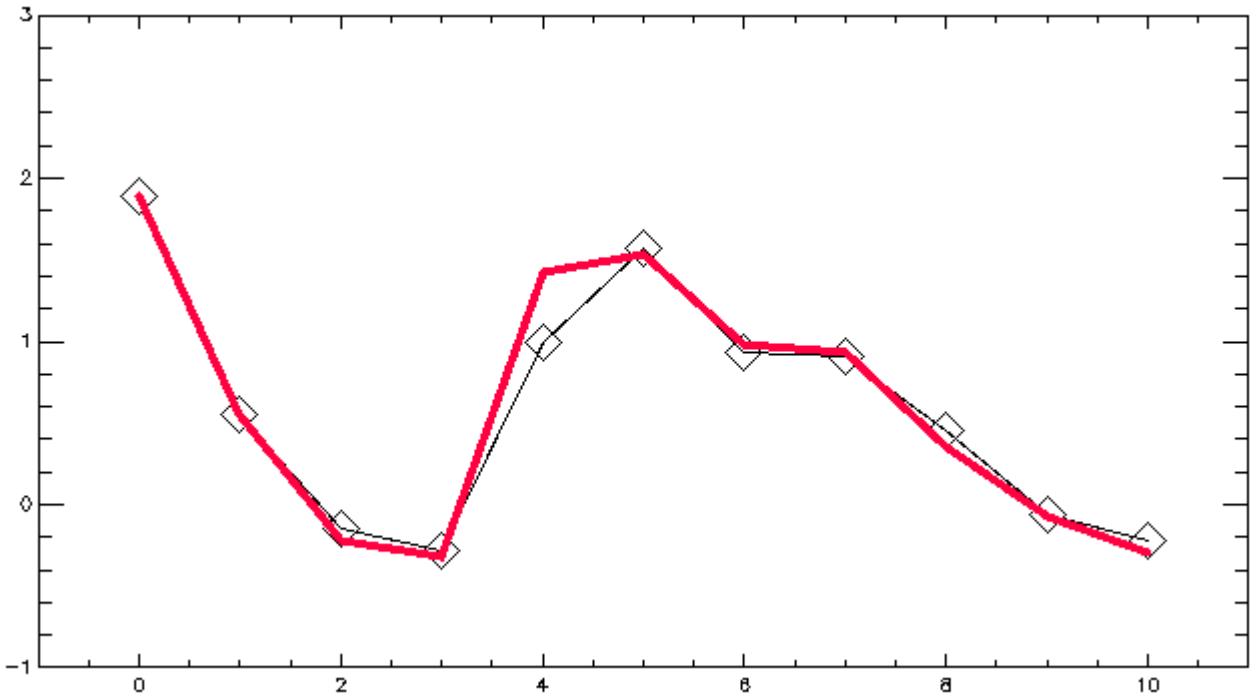
Real EDR data for stars with SEGUE results

fittings



Real EDR data for stars with SEGUE results

fittings



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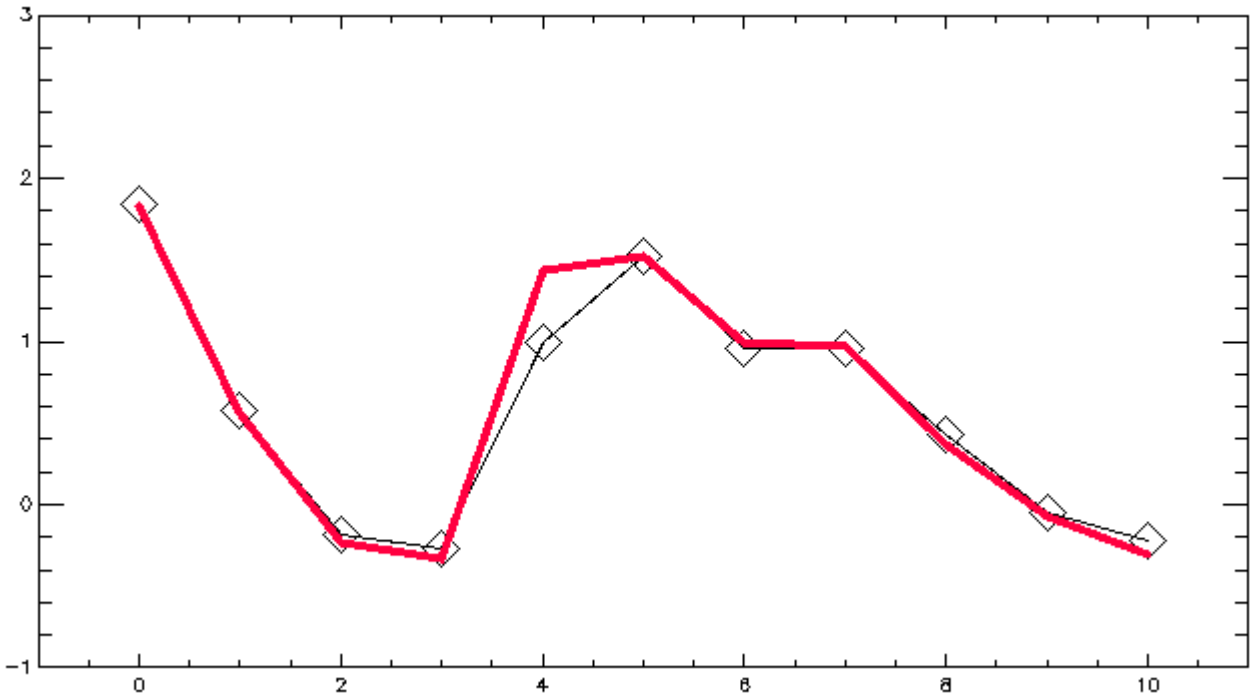
fittings



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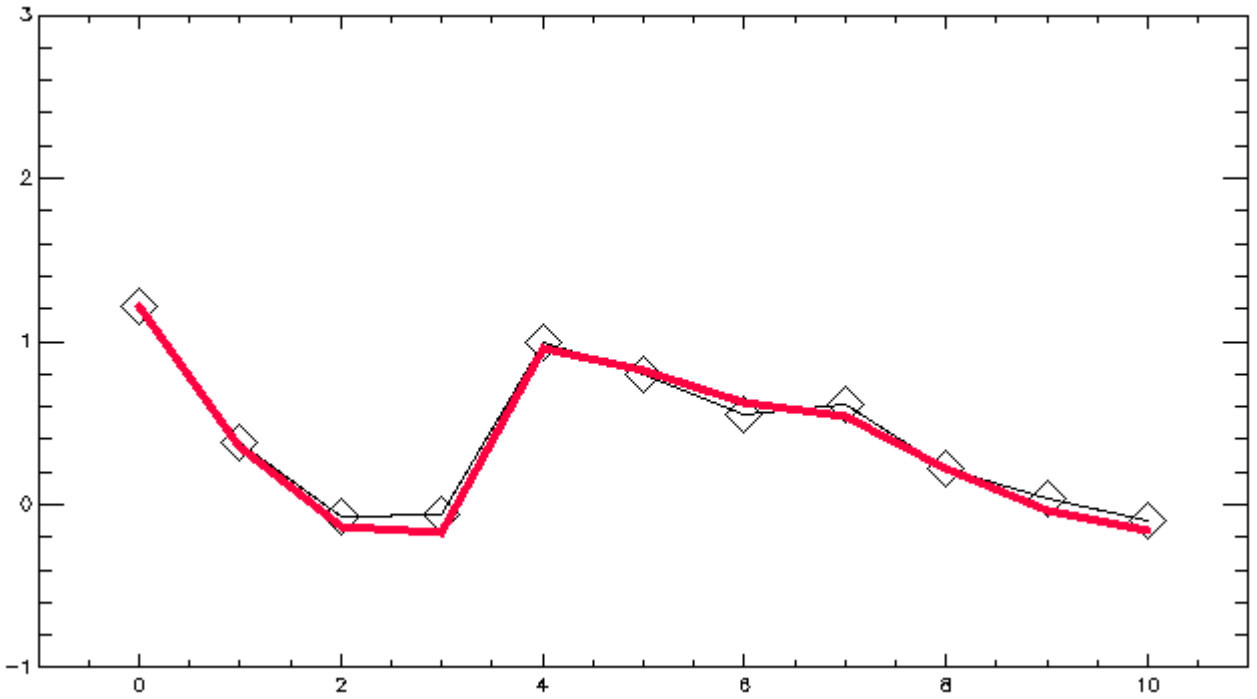
fittings



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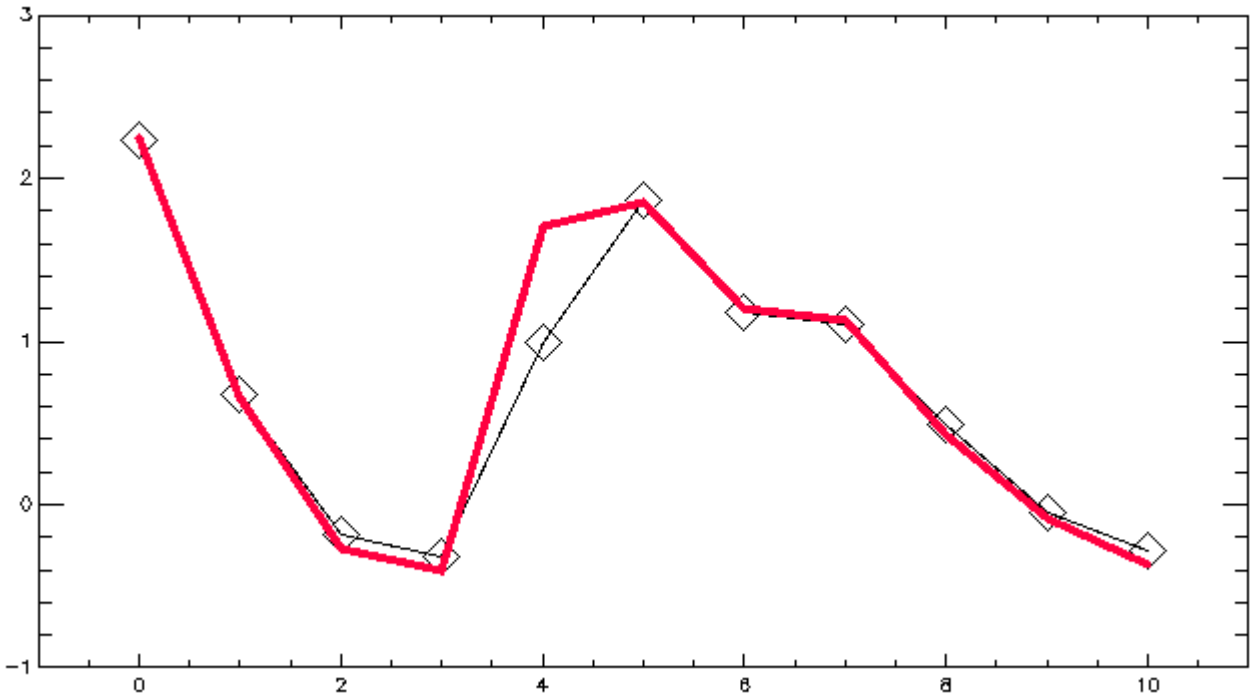
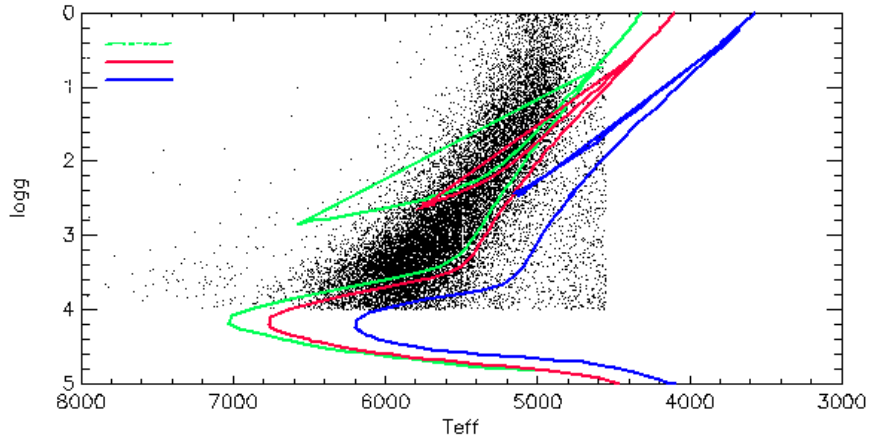
fittings



EDR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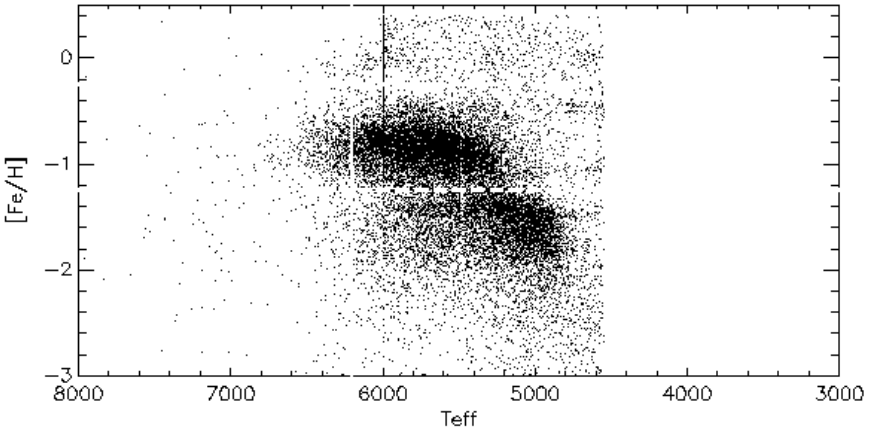
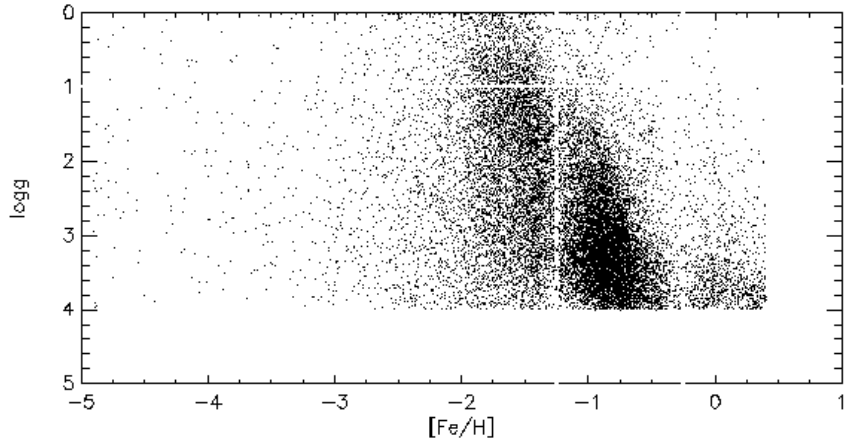
Teff
8000
7000
6000
5000
4000
3000
0
1
2
3
4
5


[Fe/H]
Teff
8000
7000
6000
5000
4000
3000
0
−1
−2
−3


logg
[Fe/H]
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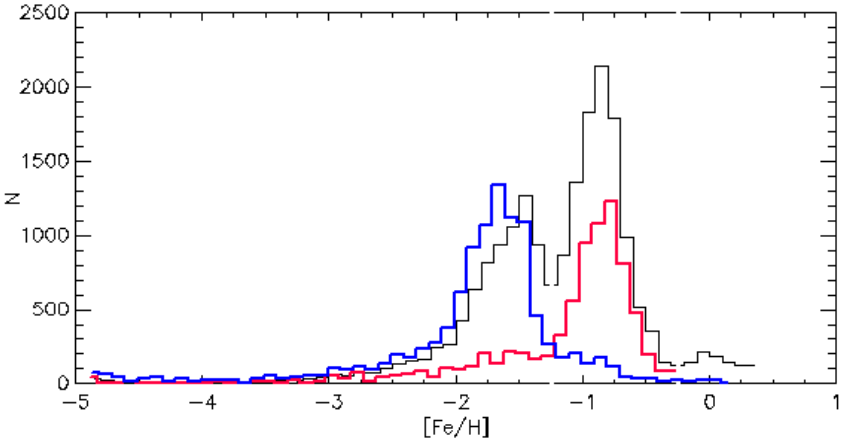
−4
−3
−2
−1
0
1
0
1
2
3
4
5


N
[Fe/H]
2500
2000
1500
1000
500
0
−5
−4
−3
−2
−1
0
1

Spectroscopic follow-up of metal-poor candidates

ISIS on the 4.2-m WHT

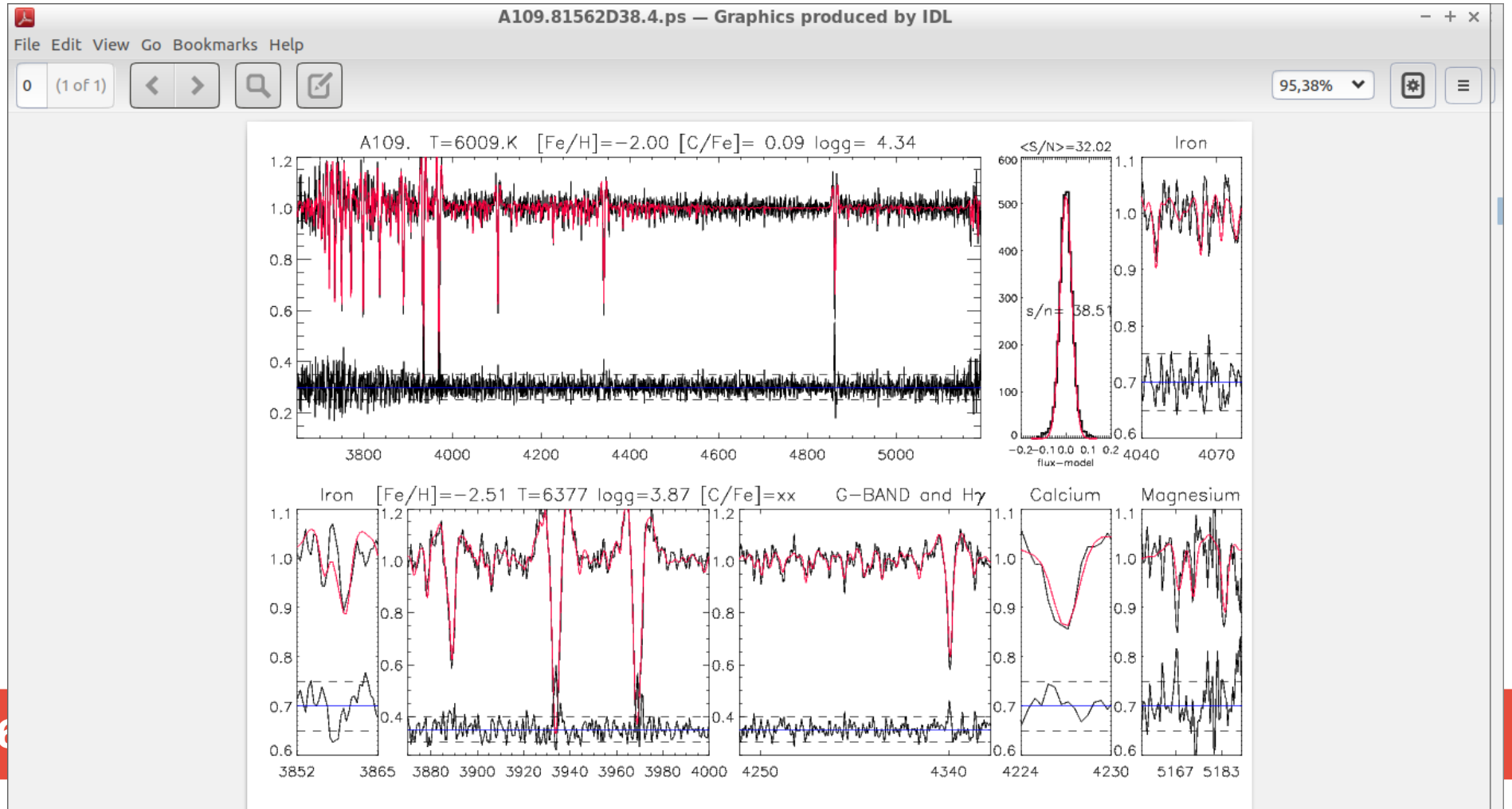
Short exposures (S/N~10-30) to check the photometric metallicities for a few targets

Targets identified a week ago, spectra taken immediately by D. Aguado

	ISIS		JPlus	
	Teff	[Fe/H]	Teff	[Fe/]
A108.82201D38.6826	5245	-2.05	5247	-2.44
A109.81562D38.4683	6009	-2.0	6377	-2.51
A110.22458D39.1538	5299	-2.0	4995	-2.5
A115.74627D41.6721	5236	-2.09	5055	-2.4

Spectroscopic follow-up of metal-poor candidates

ISIS on the 4.2-m WHT



Conclusions

Photometric narrow-band searches for extremely metal-poor stars work

Pristine is targeting 3000 deg² using MegaCam on the 3.6m CFHT

Pristine has a narrower passband than Skymapper, 10 nm-wide. J-Plus's J395 filter has a similar width

(Significant) Spectroscopic follow-up required, but a few stars at [Fe/H]<-4 have already been found

J-PLUS is in good shape to carry out similar work, and EDR data already allows for a clean separation between thick disk and halo stars