Photometric calibration in Astro-WISE

For the Astro-WISE consortium:

Gijs Verdoes Kleijn

OmegaCEN/Kapteyn

Groningen University

(and Philippe Heraudeau, Johannes Kopppenhoefer, John McFarland, Edwin Valentijn, Ronald Vermeij, etc…)

Overview

$$M_{STD} = -2.5\log(\text{countrate}) + ZPT - kX + (CT_0 * \text{color} - CT_1)$$

To cover full instrument FOV densely

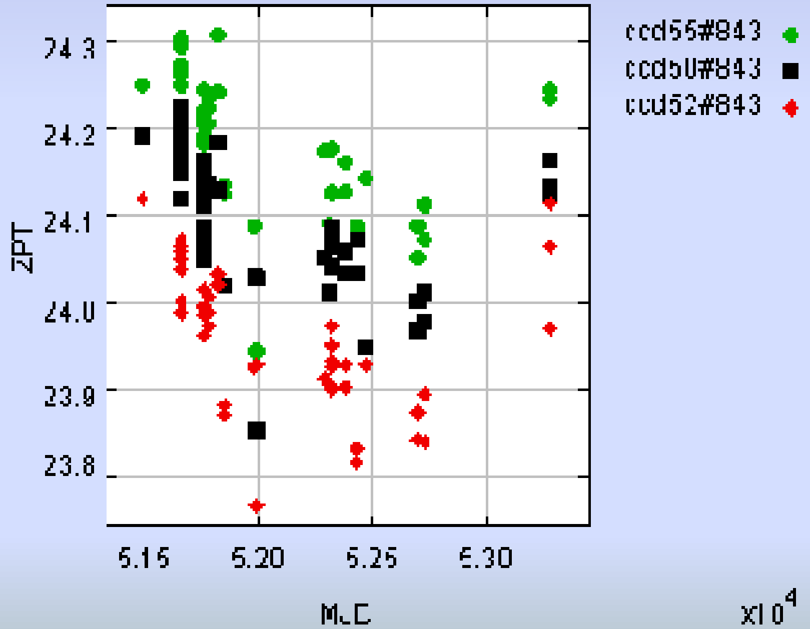
S/N limited, sigma clipped,
weighted mean of magnitudes of
(subset) of stars in 22 SA fields:

- Landolt standard stars
- Stetson standard stars
- DR5 (in SA fields) with no flags
- Preliminary Catalog from ugriz WFC for OmegaCAM secondary standards programme
- or your customized standard star catalog

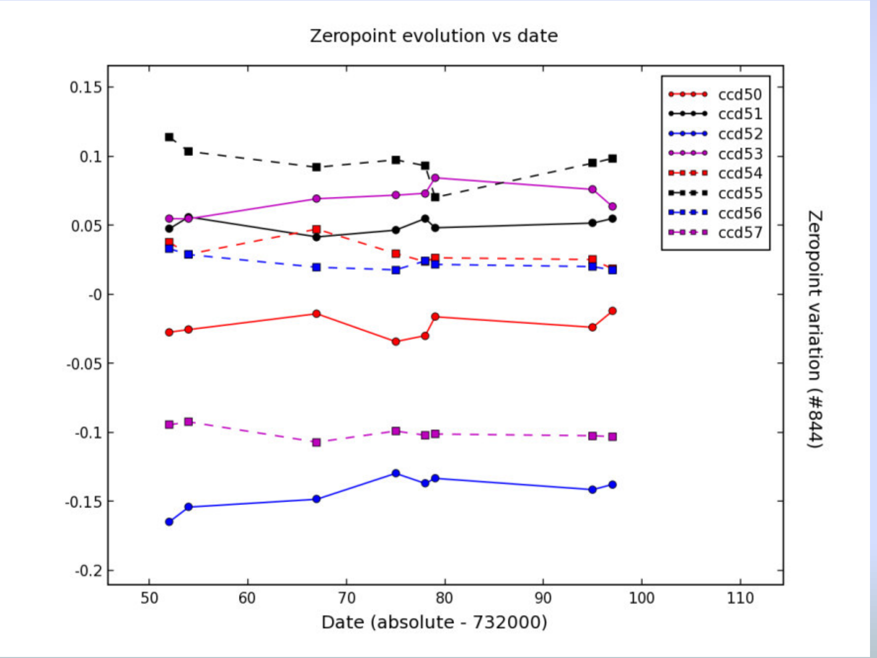
Astro-WISE:
photometric calibration chip-by-chip

example: WFI@ESO/MPG2.2m

ΔZPT chip-to-chip: <=0.3mag



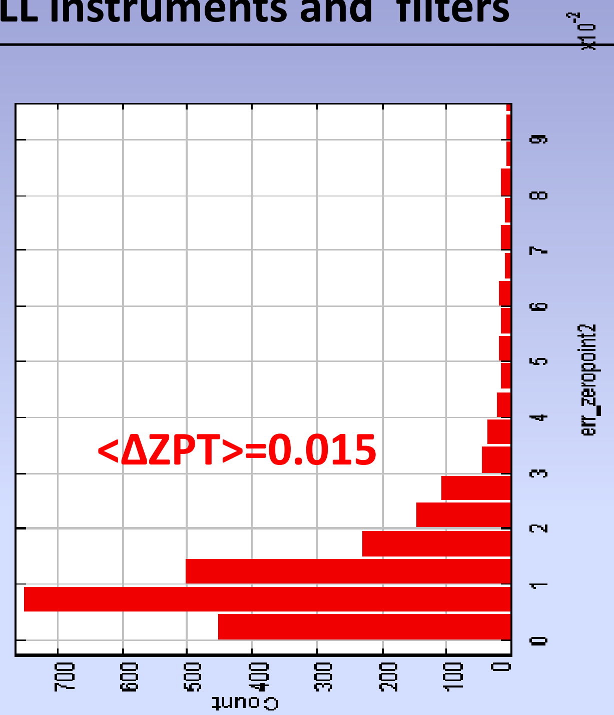
Δ(ΔZPT) vs time: <=0.05mag



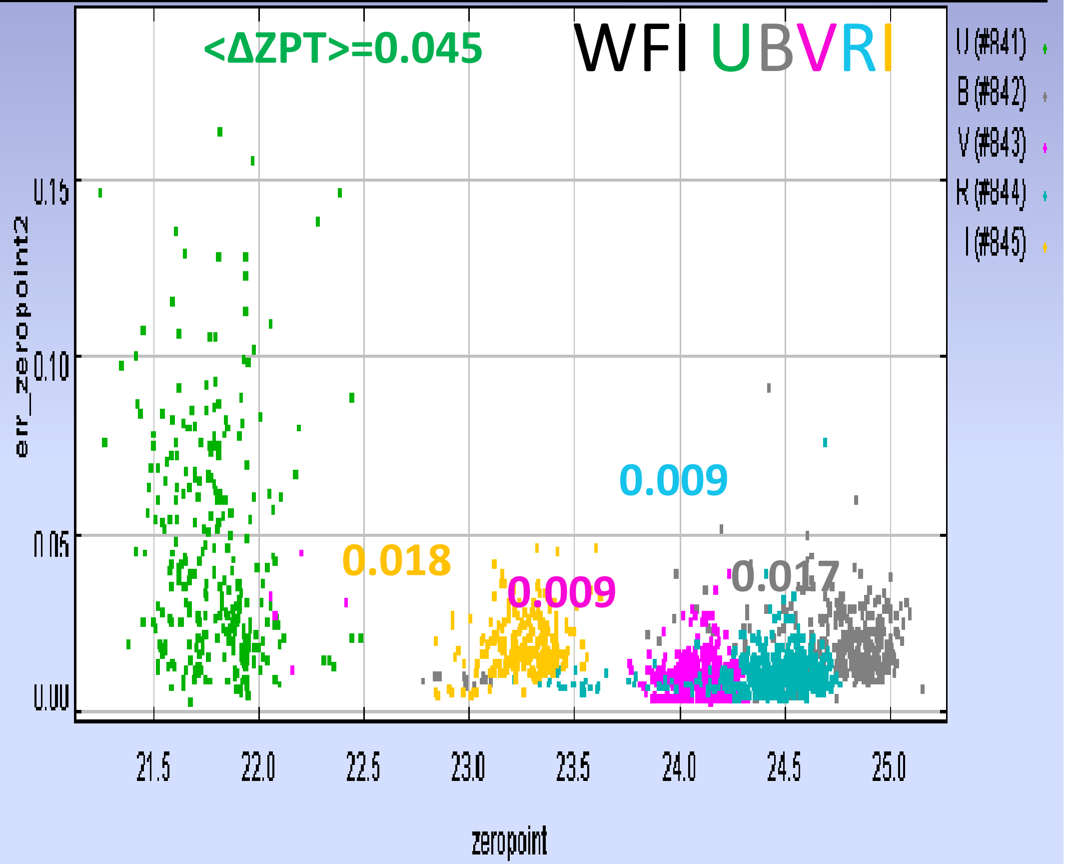
Random error in zeropoint

ΔZPT=estimated error on ZPT from unweighted scatter *(not formal error)*

ALL instruments and filters



WFI@MPG/ESO 2.2m



Typical ΔZPT can be improved. Most ZPTs:

- no illumination correction: with illum: <ΔZPT> =0.01
- no instrumental->standard transformation: with illum+transform: < ΔZPT> =0.007

Exclusion of "secondary /tertiary standards" does not decrease <ΔZPT>

Monitoring photometric calibration of instrument:

- Information sofar obtained with:

```
def get_photom(self):
    qpp=PhotometricParameters.instrument.name!='GIJS'
    for pp in qpp:
        pp.photcat.date_obs.toordinal(),pp.photcat.frame.AIRMEND,pp.instrument.name,pp.filter.name,pp.photcat.frame.EXPTIME,pp
```

(and Philippe Heraudeau, Johannes Kopppenhoefer, John McFarland, Edwin Valentijn, Ronald Vermeij etc…..)

Systematic error in zeropoint

- Example: dependence on calibrator set
  - WFC@INT: DR5 vs Sloan from Landolt+Jester transformations (2005, AJ, 130, 873)

filter	Median ΔZPT (DR5-Landolt)	uncertainty
Δu	0.07	0.02
Δg	0.02	0.01
Δr	-0.03	0.01
Δi	-0.04	0.02
Δz	0.00	0.04

Verdoes Kleijn et al, 2007, ASP Conf, Series 364, 103

Overall photometric stability

1σ variations photometric scale

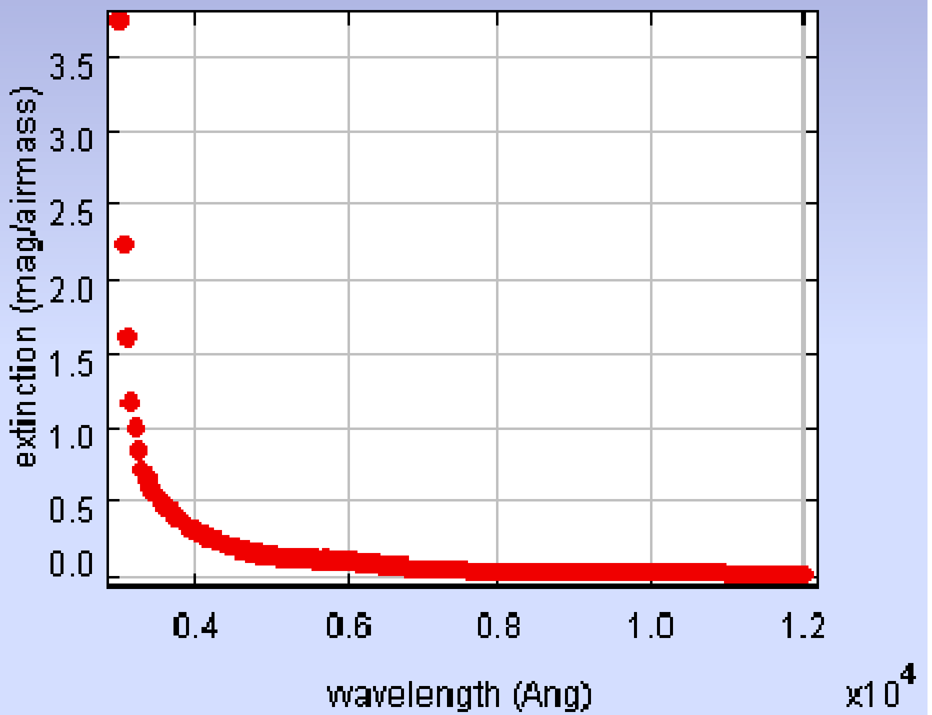
- Within a photometric night
  - WFC@INT: u~0.020, g~0.015, r~0.015, i~0.015, z~0.020
  - WFI@ESO/MPG: R<~0.03

- Over months (from WFI repeated fields) :
  - Photom nights only: R~0.05 in R
  - All nights (so variation largely atmospheric) : R~0.1

4 way to model atmospheric extinction in Astro-WISE

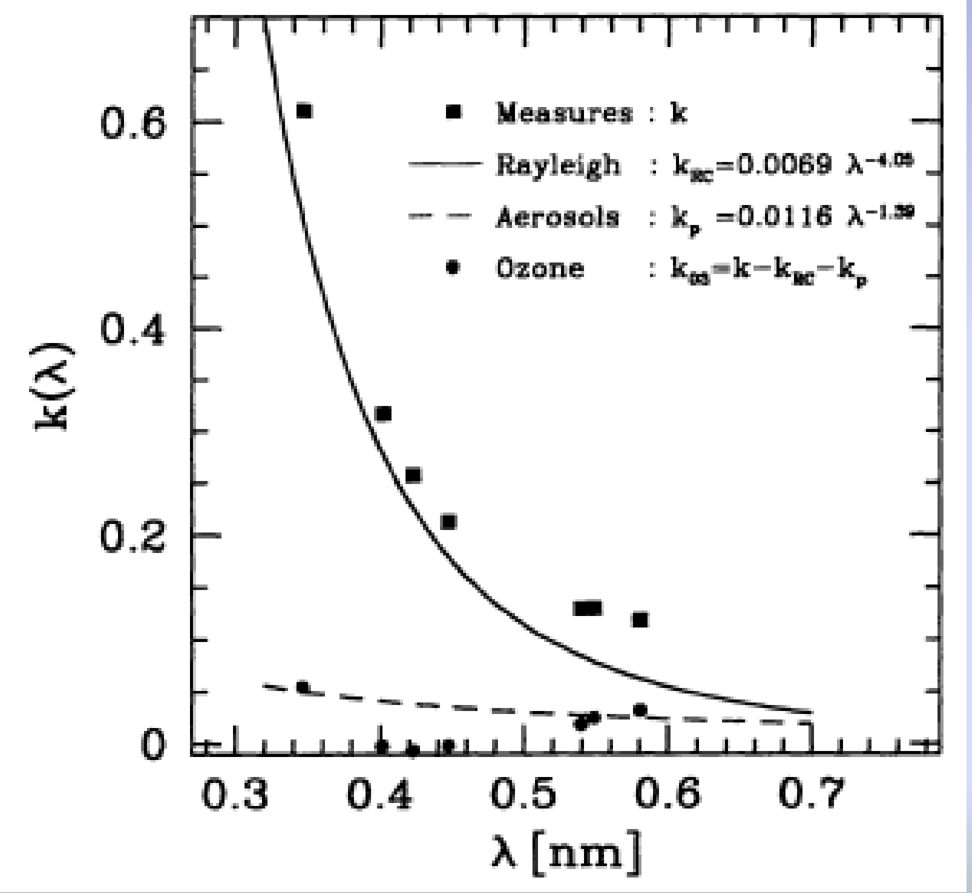
1. observations of standard fields at 2 airmasses
2. Standard extinction curve: coefficient stored in the database
3. standard field plus known zeropoints
4. Combination standard extinction curve and extinction report (OmegaCAM calibration plan)

Standard extinctioncurve

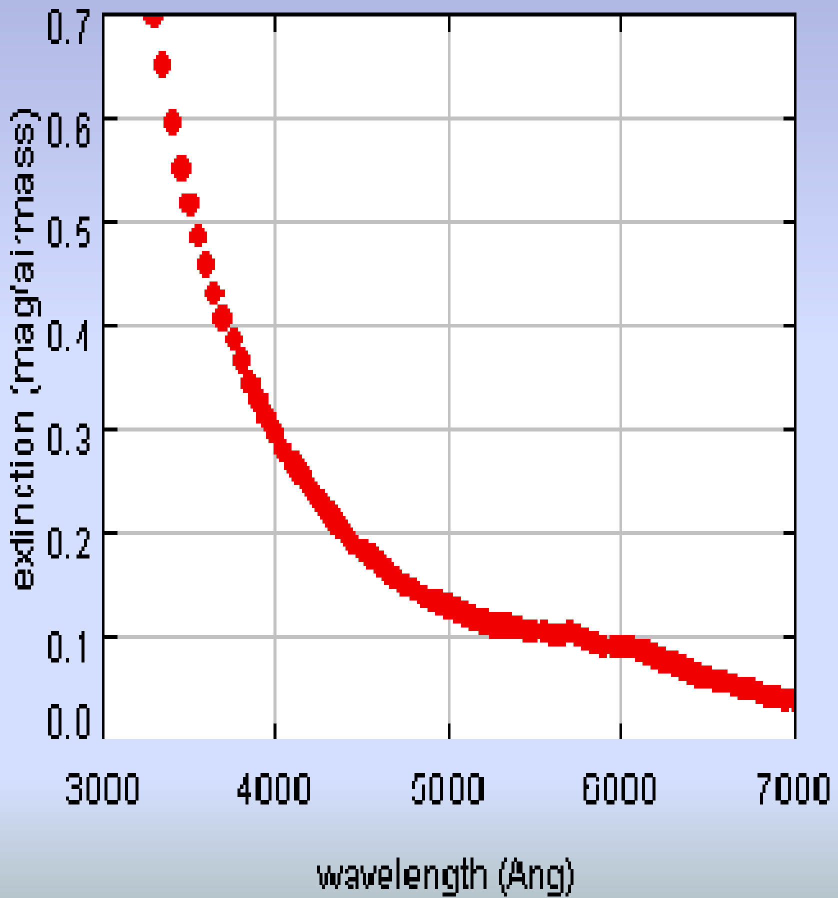


Extinction Curves

La Silla measurements 1995A&AS112_383 Burki etal



Extinction Curve in use in Astro-WISE (La Palma Extinction Curve)



Variation in Extinction Curves

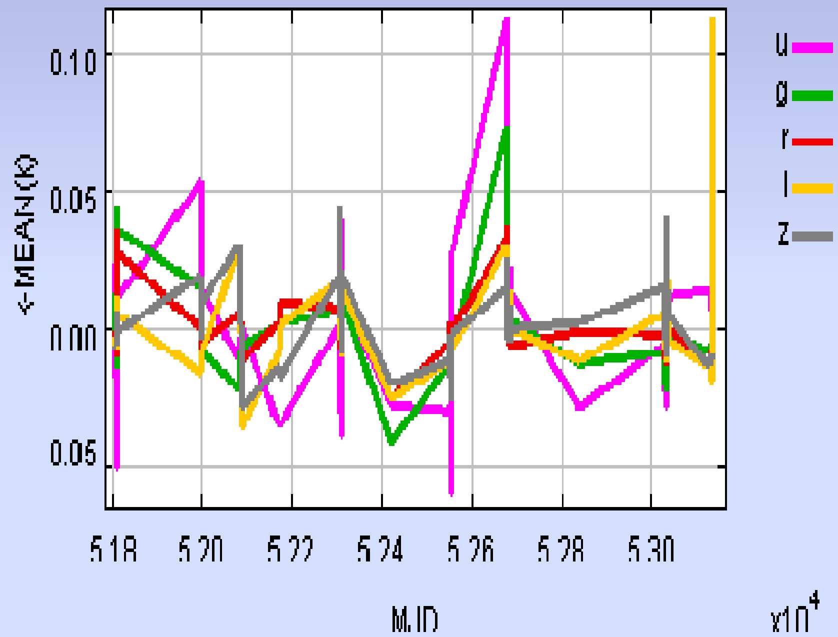
La Silla (UBV)

(variation due to volcanic activity)

Table 6. Variation of the extinction $\Delta k(\lambda)$ in the U, B and V bands and of the exponent α_p of the extinction law $k(\lambda) \sim \lambda^{\alpha_p}$ due to aerosols from The Pinatubo

HJD	$\Delta k(U)$	$\Delta k(B)$	$\Delta k(V)$	α_p
2448670	0.072	0.075	0.077	$+0.15 \pm 0.03$
2448800	0.072	0.079	0.083	$+0.19 \pm 0.08$
2448870	0.076	0.082	0.087	$+0.28 \pm 0.03$
2449000	0.058	0.066	0.072	$+0.41 \pm 0.04$
2449200	0.033	0.040	0.044	$+0.54 \pm 0.06$
2449260	0.024	0.031	0.036	$+0.85 \pm 0.07$

CTIO ugriz



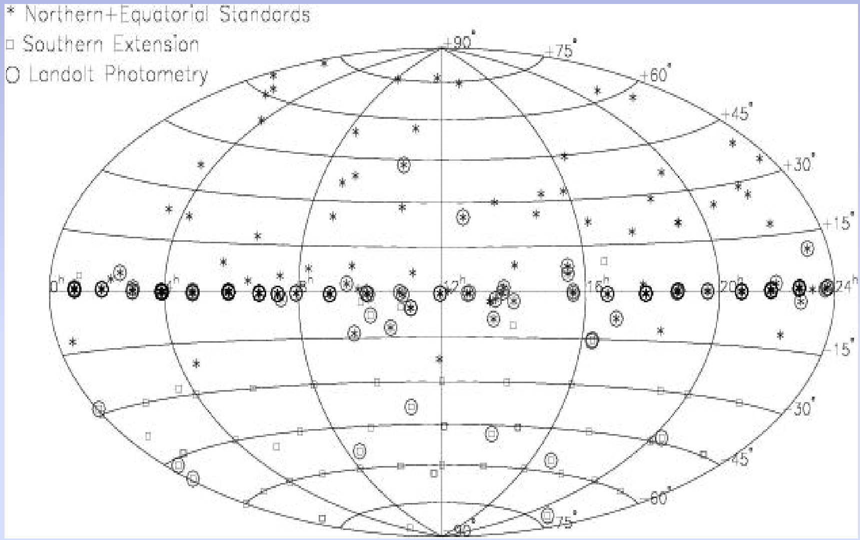
Burki et al, 1995, A&AS, 112, 383

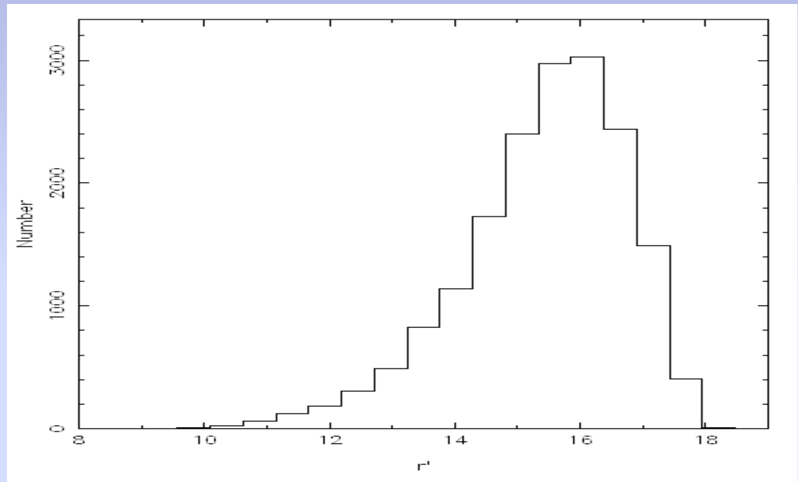
adapted from Smith et al, 2008, AJ, submitted

Wavelength independent shift of extinction coeff (within~0.025)

Up-coming Southern Sloan Standards

- Extension of Sloan standard work via CTIO 0.9m telescope
  - 58 Southern fields (16000 stars)
  - Smith et al, 2008, AJ (revising for referee comments)





In future

- SkyMapper project (PI Brian Schmidt)
  - tied to Tycho-2 catalog (BV)+transformations
- OmegaCAM secondary standards programme
  - tied to Landolt (plus Sloan South?)
- Global photometry

Global photometry

- Full data lineage back to raw data for magnitudes of stars in Southern Hemisphere will increase monotonically automatically

```
awe> pp.photcat.get_source_data(columns)
awe> pp.photcat.get_content_of_catalog()

awe> qsl=(SourceList.ulDEC<-10.0 and
SourceList.ulDEC>-20.0)
awe> len(qsl)
     … 25793
```

Summary

- Chip-by-chip
- ZPT accuracy in AstroWISE
  - random: ~0.01mag
  - Systematic: no quote: too much instrument/filter dependent
- Global photometry conceptually within reach with Astro-WISE