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Genetics of body energy status of Holstein cows predicted by mid-infrared spectrometry

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Energy balance (EB)

Energy balance = energy intake – energy requirements

- ✓ growth, activity, maintenance
- ✓ lactation

- Negative EB in high-yielding cows in early lactation
- Important factor impacting health and fertility

Butler & Smith, 1989, J. Dairy Sci.
De Vries & Veerkamp, 2000, J. Dairy Sci.
Collard et al., 2000, J. Dairy Sci.

- Routine collection of EB data within milk recording schemes

➡ daily management decisions and breeding programs

Energy balance (EB)

- Direct measure of EB not feasible in commercial herds
- Potential of mid-infrared analysis of milk to predict body energy status (McParland et al., 2011, 2012, J. Dairy Sci.)
  - quick, easy, inexpensive
  - as a part of milk recording

✓ **Direct energy balance (dEB; MJ/d)**
R_{cv} = 0.68 R_{ev} = 0.65

✓ **Body energy content (EC; MJ)**
R_{cv} = 0.57 R_{ev} = 0.53

✓ **Effective energy intake (EEI; MJ/d)**
R_{cv} = 0.80 R_{ev} = 0.78

R_{cv} and R_{ev} = correlation coefficient of split-sample cross-validation and of external validation

McParland et al., 2012, J. Dairy Sci.
Banos & Coffey, 2010, Anim.

Objectives

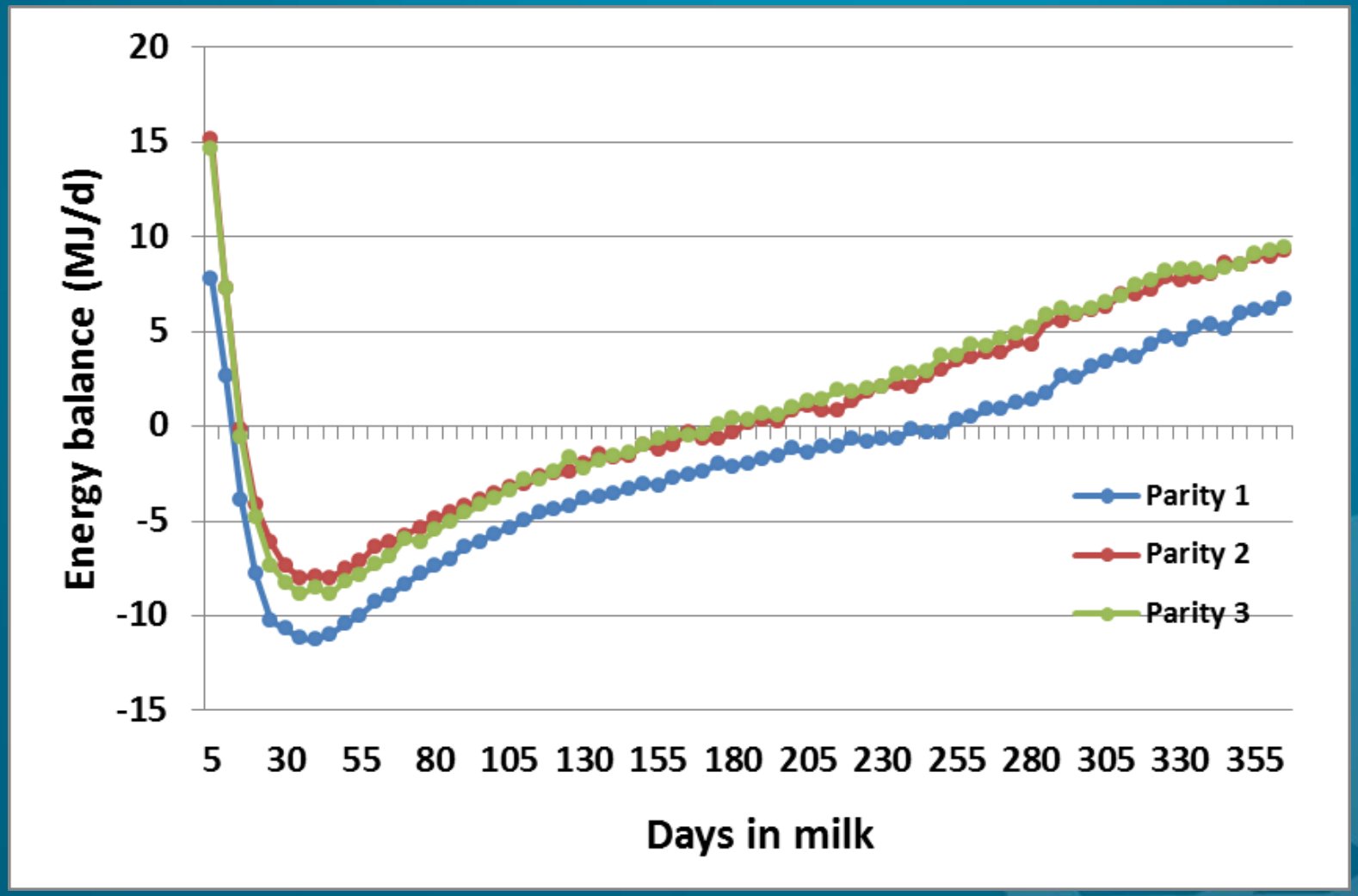
- ✓ **Genetic parameters for body energy status traits predicted by mid-infrared spectrometry**
  - **Walloon Holstein cows, parity 1 to 3**
- ✓ **Genetic correlations with fertility**

Data

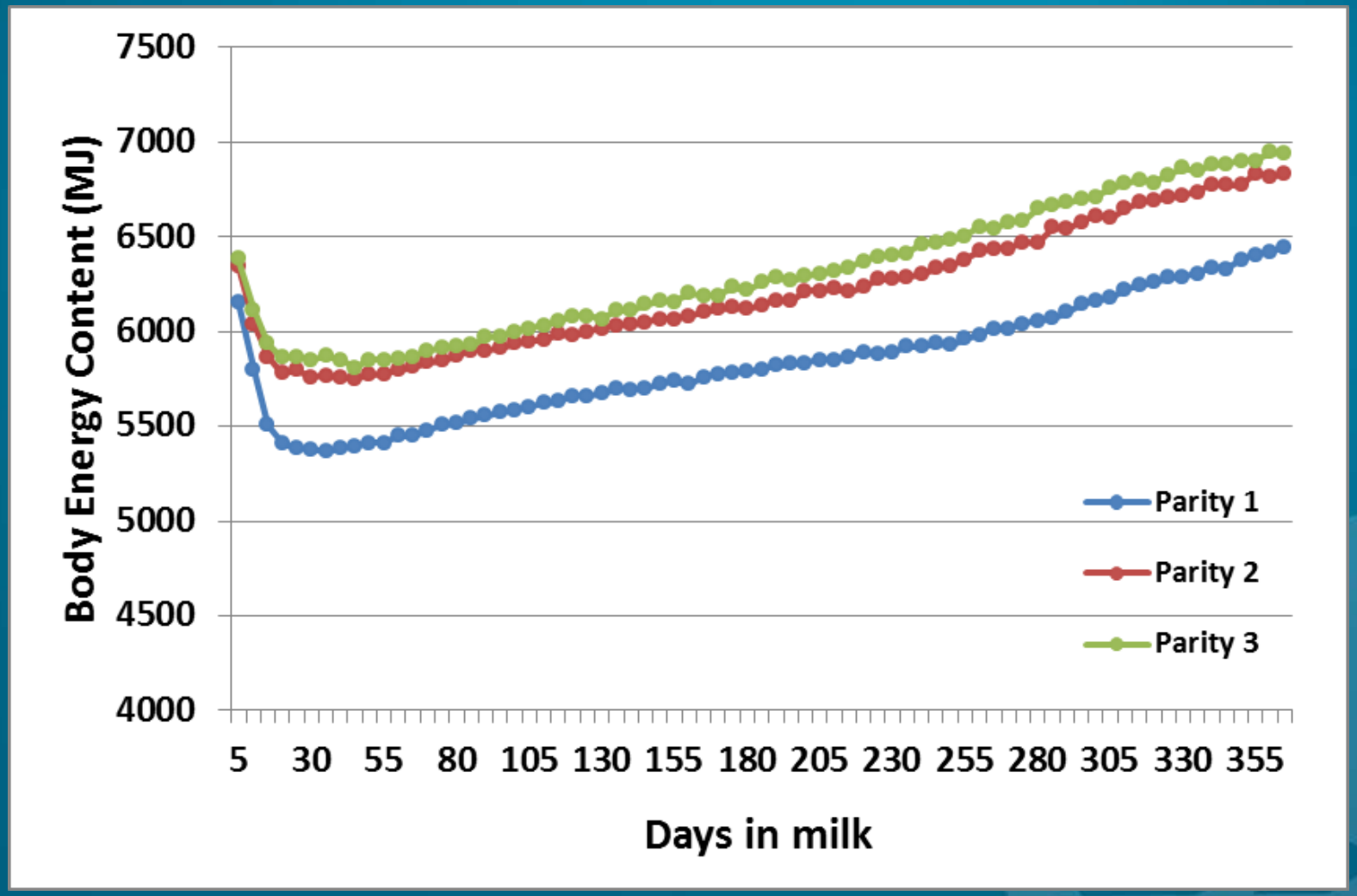
- The equations obtained by McParland et al. (2011, 2012) were applied on the Walloon spectral database.
- Only dEB, EEI, and EC predictions that encompassed the variability represented in the calibration dataset retained

Trait	N	Mean	SD
Direct energy balance (dEB, MJ/d)	777,303	-1.30	11.48
Body energy content (EC, MJ)	791,502	6012	753
Effective energy intake (EEI, MJ/d)	791,502	172.07	56.67

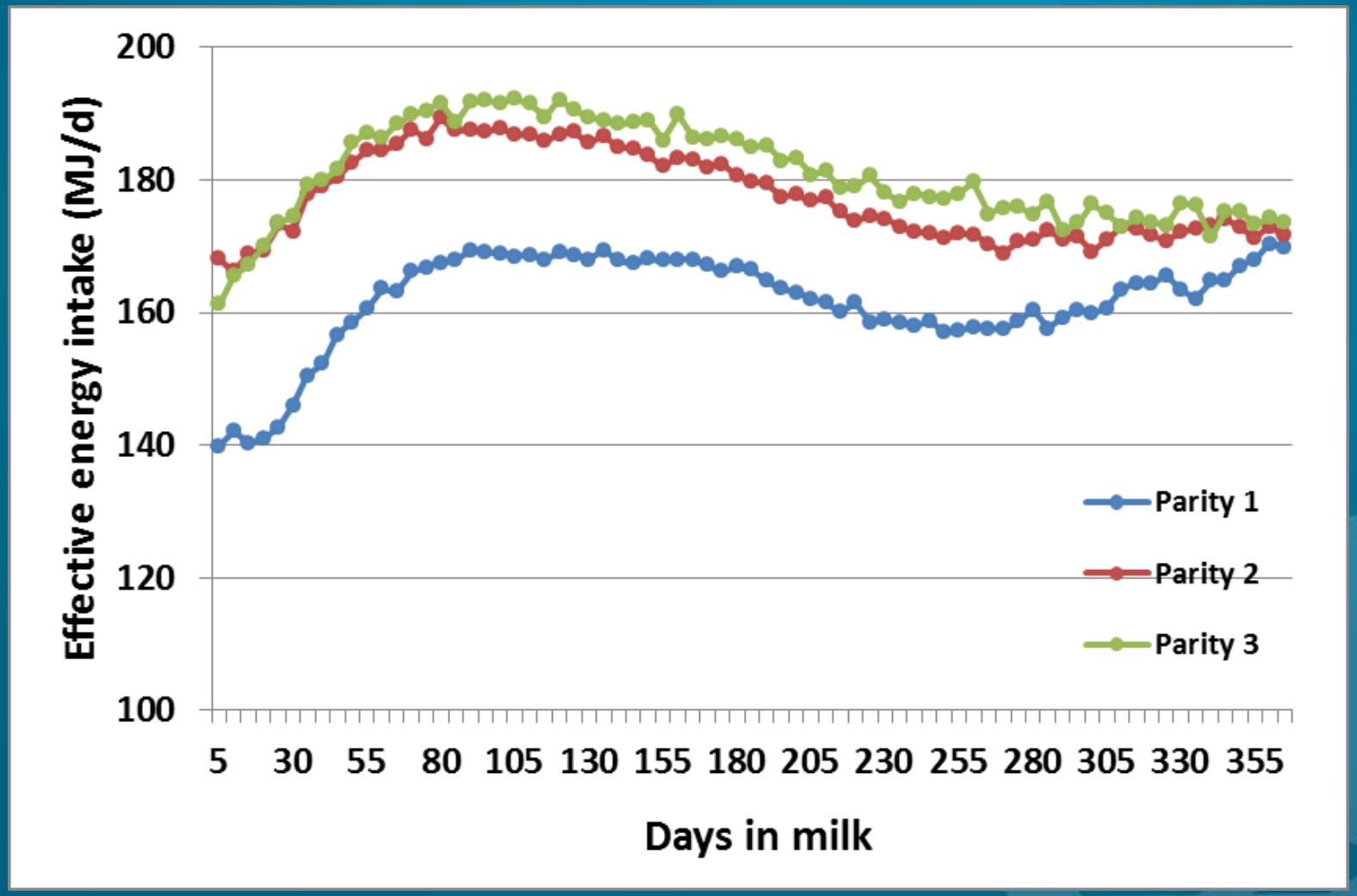
Data – dEB over lactation



Data – EC over lactation



Data – EEI over lactation



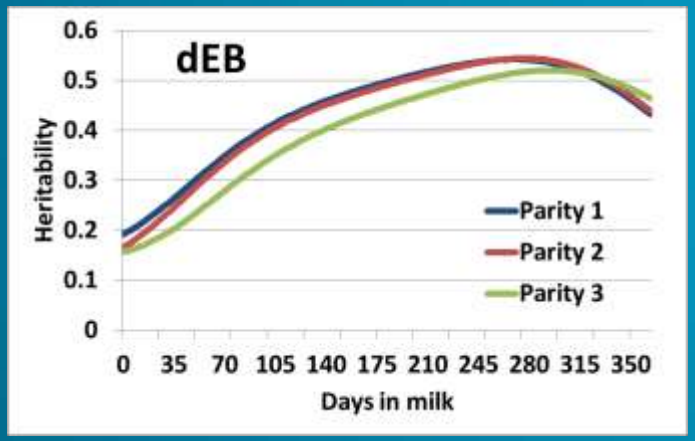
Genetic parameters

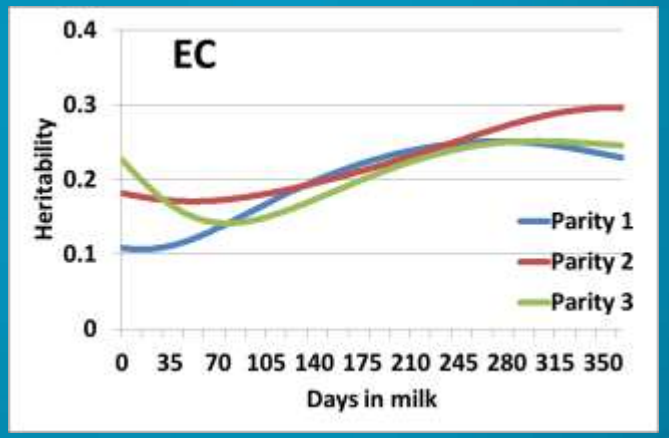
- Data after edits
  - parity 1 to 3
  - 336,142 dEB records from 36,694 cows in 580 herds
  - 354,900 EC and EEI records from 38,531 cows in 607 herds
- Single-trait 3-lactation random regression model
  - fixed effects: herd x test day, lactation stage (classes of 5 days), gestation stage, age at calving x season of calving x lactation stage
  - random effect: herd x year of calving, permanent environmental, additive genetic

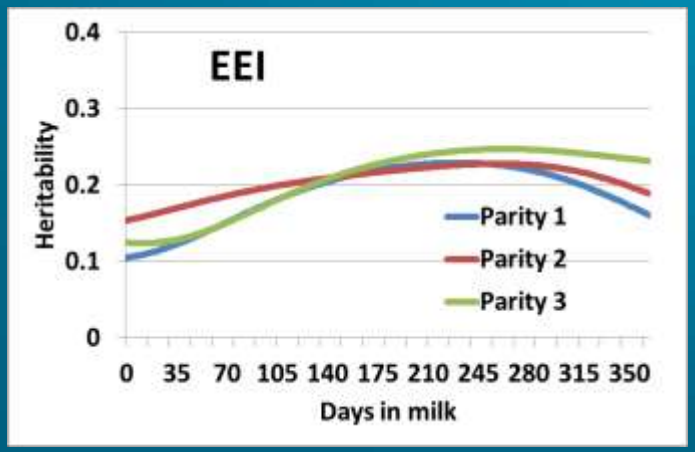
    → regression curves modelled with 2nd order Legendre polynomials

Genetic parameters

Trait	dEB	EC	EEI
Heritability (averaged across DIM and parities)	0.43	0.21	0.20





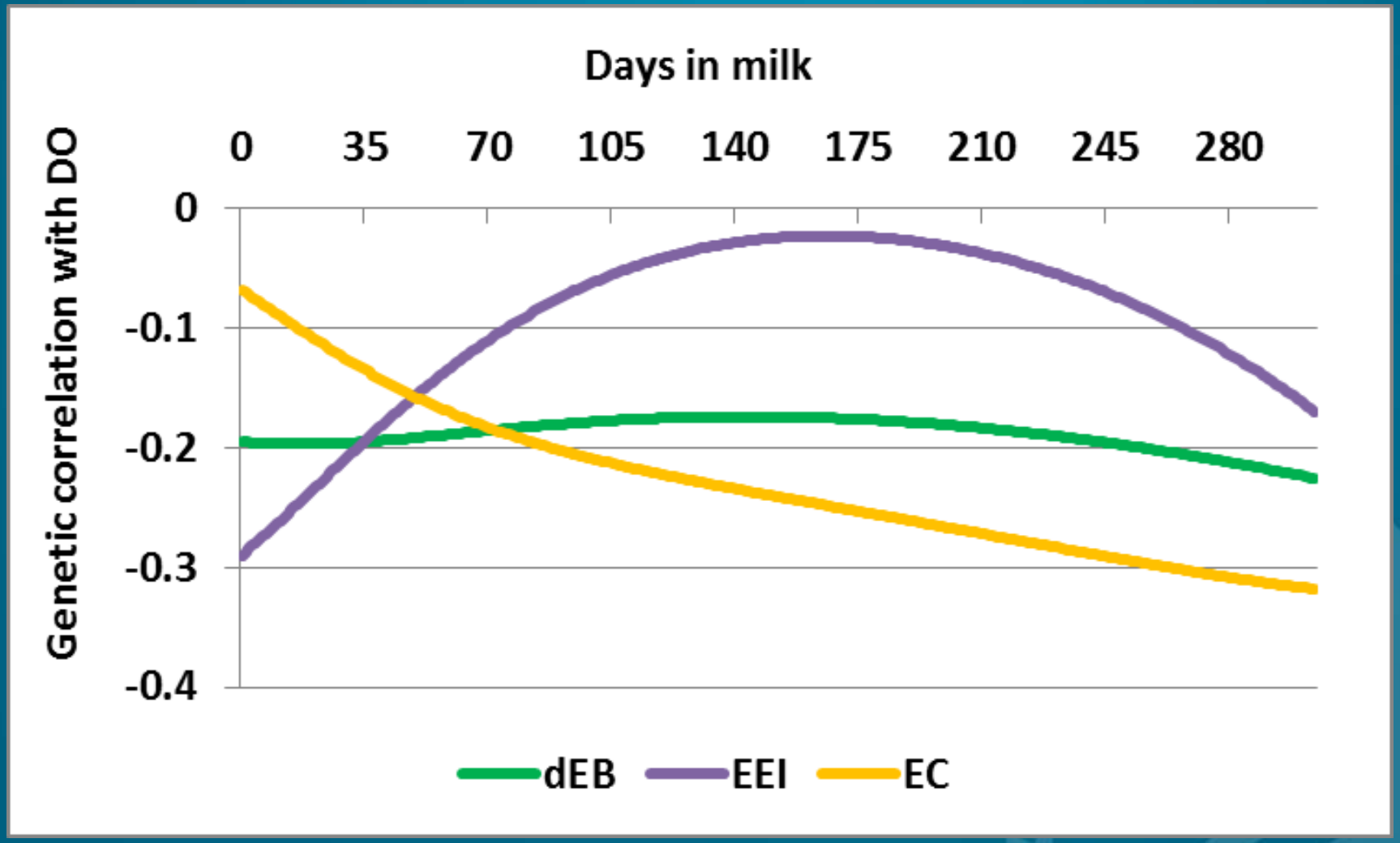


Genetic correlation within traits across lactation > 0.85

Correlation with fertility

- Data after edits
  - 124,921 dEB, EC and EEI records
  - 24,419 days open (DO) records for fertility
  - 24,419 first-parity cows in 361 herds
- Bivariate model including random regressions for body energy status traits
  - dEB, EC, EEI: same model than above
  - DO:
    - fixed effects: year of calving x month of calving, season of calving x age at calving, herd
    - random effects: herd x year of calving, non-genetic animal, additive genetic

Correlation with fertility



Summary

- Mid-infrared prediction of body energy status traits
  - "indicator" of body energy status
  - variability of the data should be represented in the calibration data set
- Heritable traits
  - h^2 from 0.10 to 0.55, dEB more heritable
  - h^2 higher in mid to late lactation
- Genetic correlation with DO
  - favorable, low to moderate
- Mid-infrared prediction of body energy status traits could be considered in selection programs.

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