Session 20

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Responses of North American and New Zealand strains of Holstein Friesian to homeostatic challenges during early and mid lactation

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The Science of Farming and Food

Introduction

- **Genetic selection for milk yield:**
  - Increased partitioning of ingested nutrients to milk production
  - Increased mobilization of body reserves in support of milk
  - Greater energy deficits in early lactation

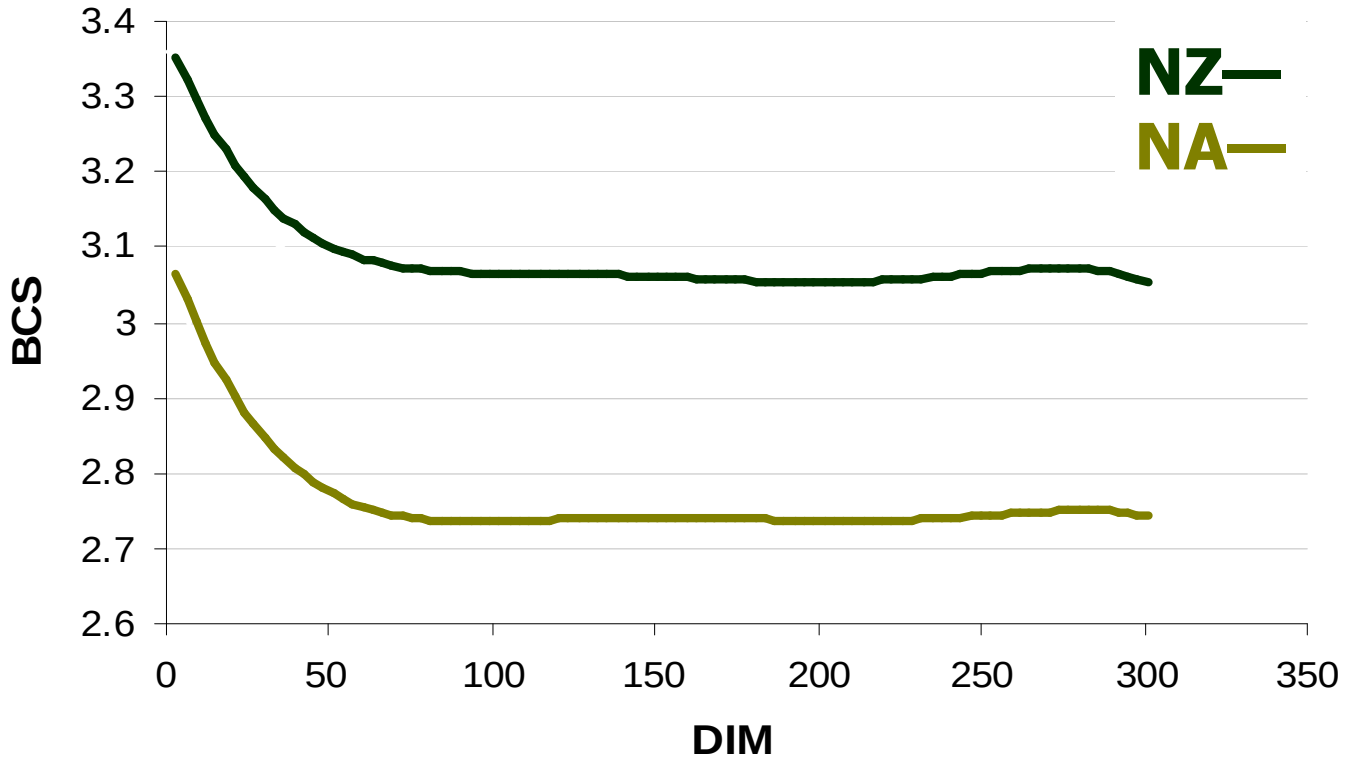
- *Greater nutrient partitioning likely involved in compromised fertility*

Moorepark Strain Study

- **North American (NA) Holstein Friesian**
  Genetically selected:
  - In a high concentrate system
  - For maximal milk volume
  - For increased body size and angularity

- **New Zealand Holstein Friesian (NZ)**
  Genetically selected:
  - In a pasture system
  - For milk production efficiency
  - For improved body condition score & fertility

Moorepark Strain Comparison Study



Body Condition Score (BCS) profiles for NA and NZ strains of Holstein Friesian 2001-05 (McCarthy et al, 2007)

Hypothesis

'Differences in nutrient partitioning between the HP and NZ genetic strains are the result of altered tissue responsiveness to homeostatic stimuli'

Objective

'To investigate the physiological differences in nutrient partitioning by comparing the responses of the strains to a series of metabolic challenges'

Metabolic challenges

- **Principle:** Animals that differ in their partitioning of nutrients will have different responses to infusions of metabolites and metabolic hormones

- **Methodology:**
  - Metabolite/metabolic hormone infused into bloodstream at a fixed concentration
  - Responses measured by monitoring changes in plasma concentrations of metabolites and hormones

Metabolic challenges

- **Glucose Tolerance Test**
  - Measures tissue response to glucose
    - (glucose disposal, insulin response)
- **Epinephrine Challenge**
  - Measures response to catabolic stimulus
    - (NEFA and glucose)
- **Insulin Challenge**
  - Measures response to anabolic stimulus
    - (glucose and NEFA)
- Response to each challenge measured as changes to blood glucose, NEFA and insulin profiles

Experimental Design

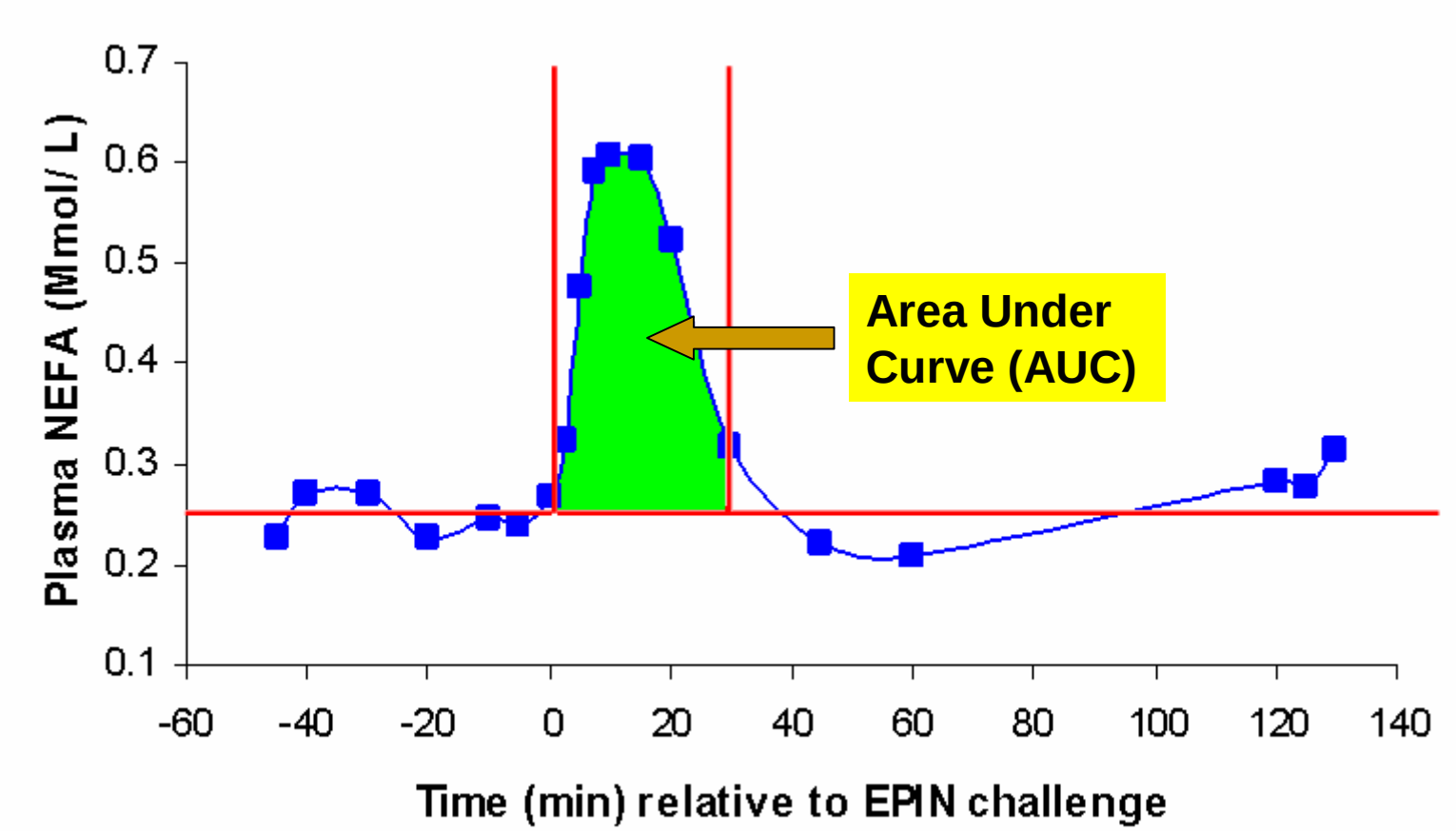
- 10 mature HP and 10 NZ cows
- Metabolic challenges carried out at 32 ± 0.48 (T1) and d137 ± 2.44 (T2) of lactation
- Indwelling jugular catheters fitted
- Infusion of glucose, epinephrine and insulin on consecutive days
- Frequent blood sampling from -45 to 180 min relative to infusion

Statistical Analysis

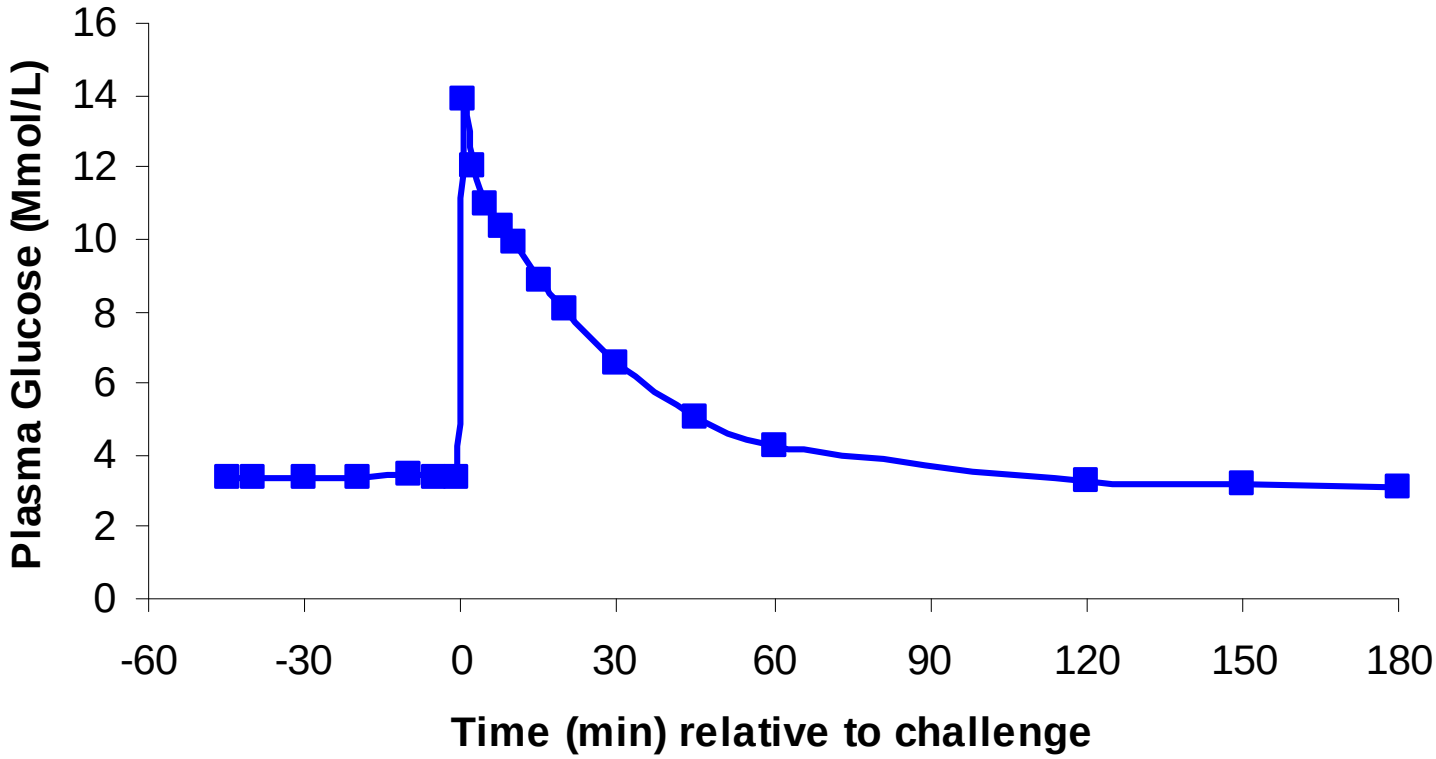
- **Responses calculated as:**
  - Area under response curve (AUC)
  - Clearance rate (CR)
  - Half life ($t_{1/2}$)

- Data analyzed as repeated measures using PROC MIXED in SAS

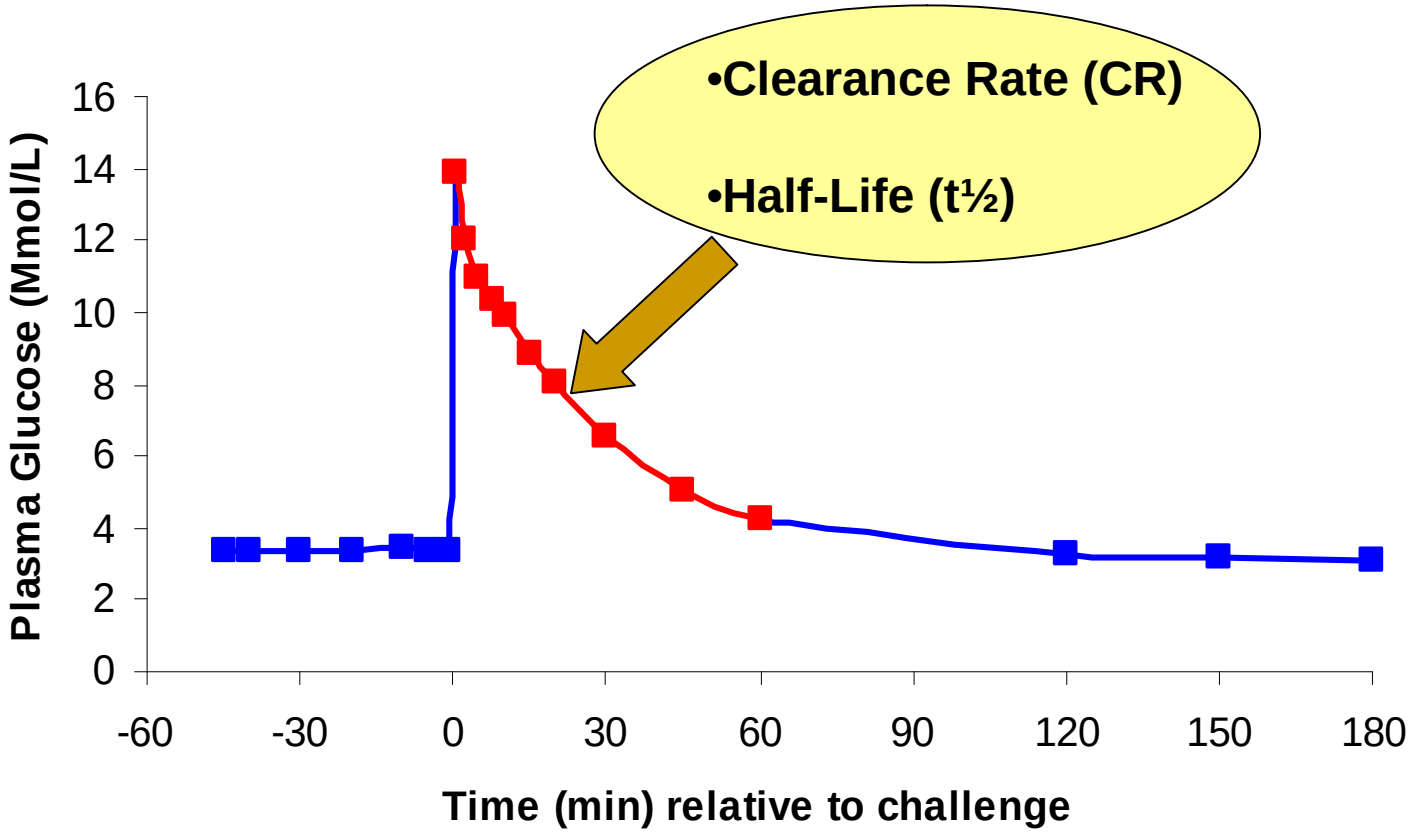
Area Under Response Curve



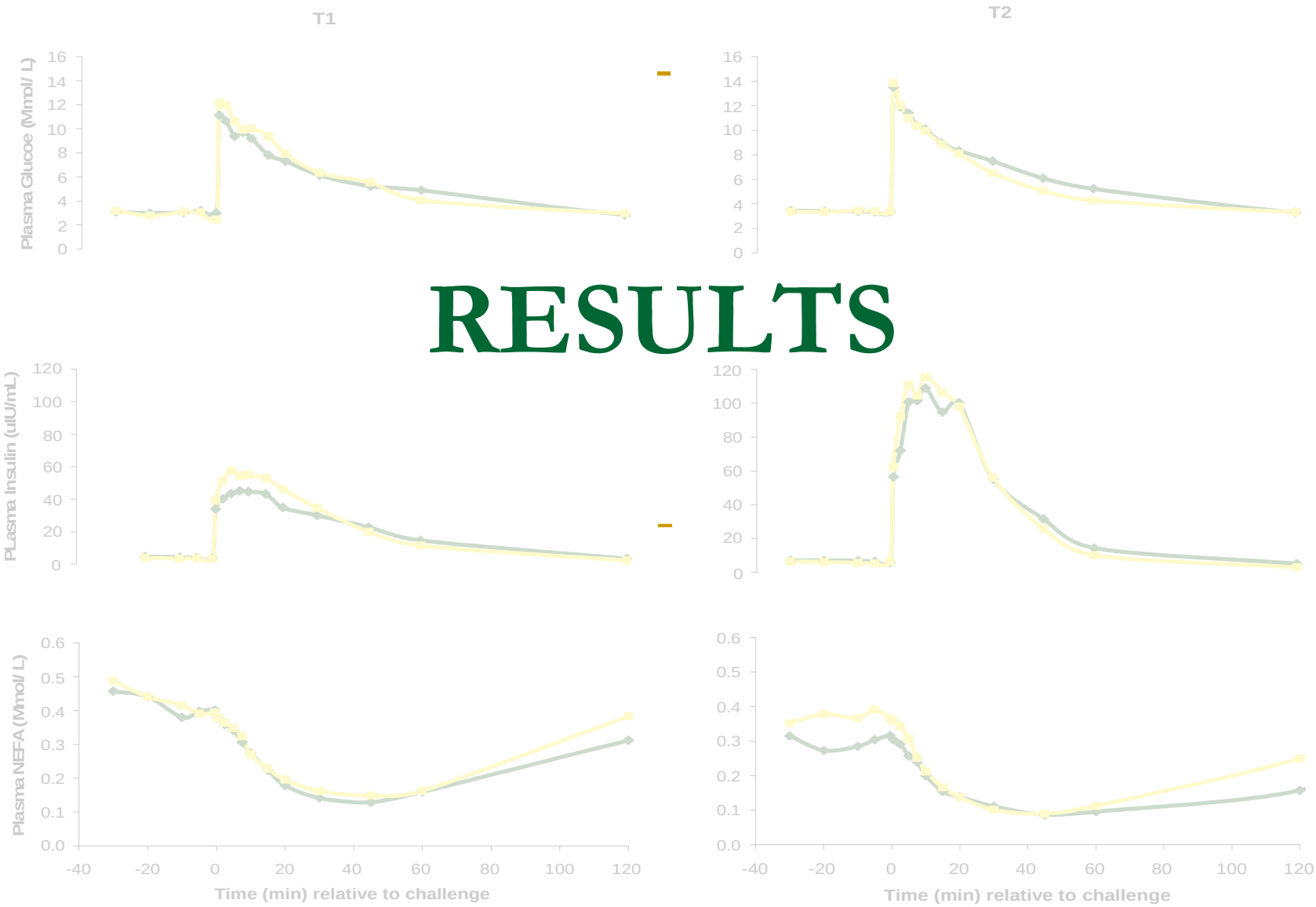
Response Curve



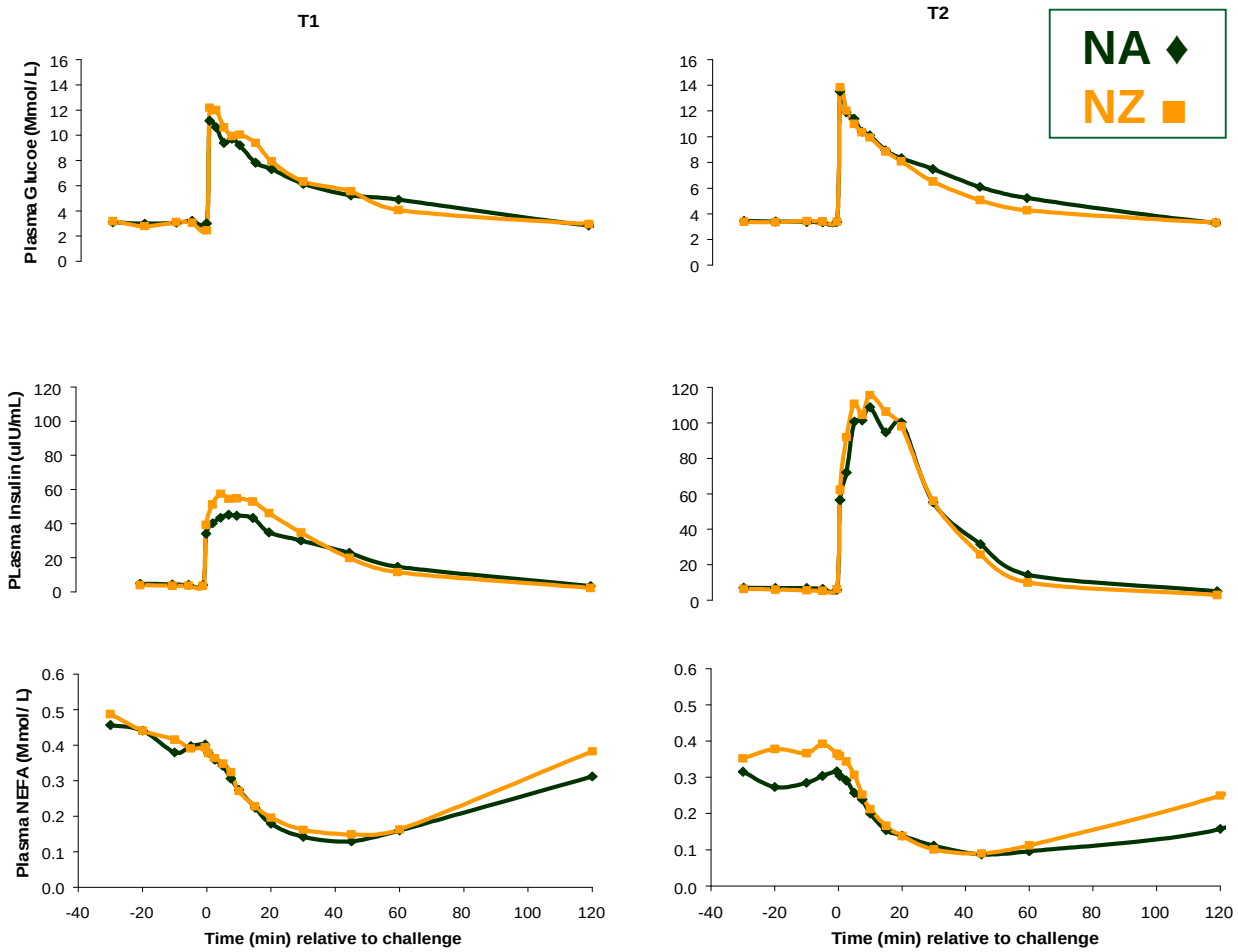
Response Curve



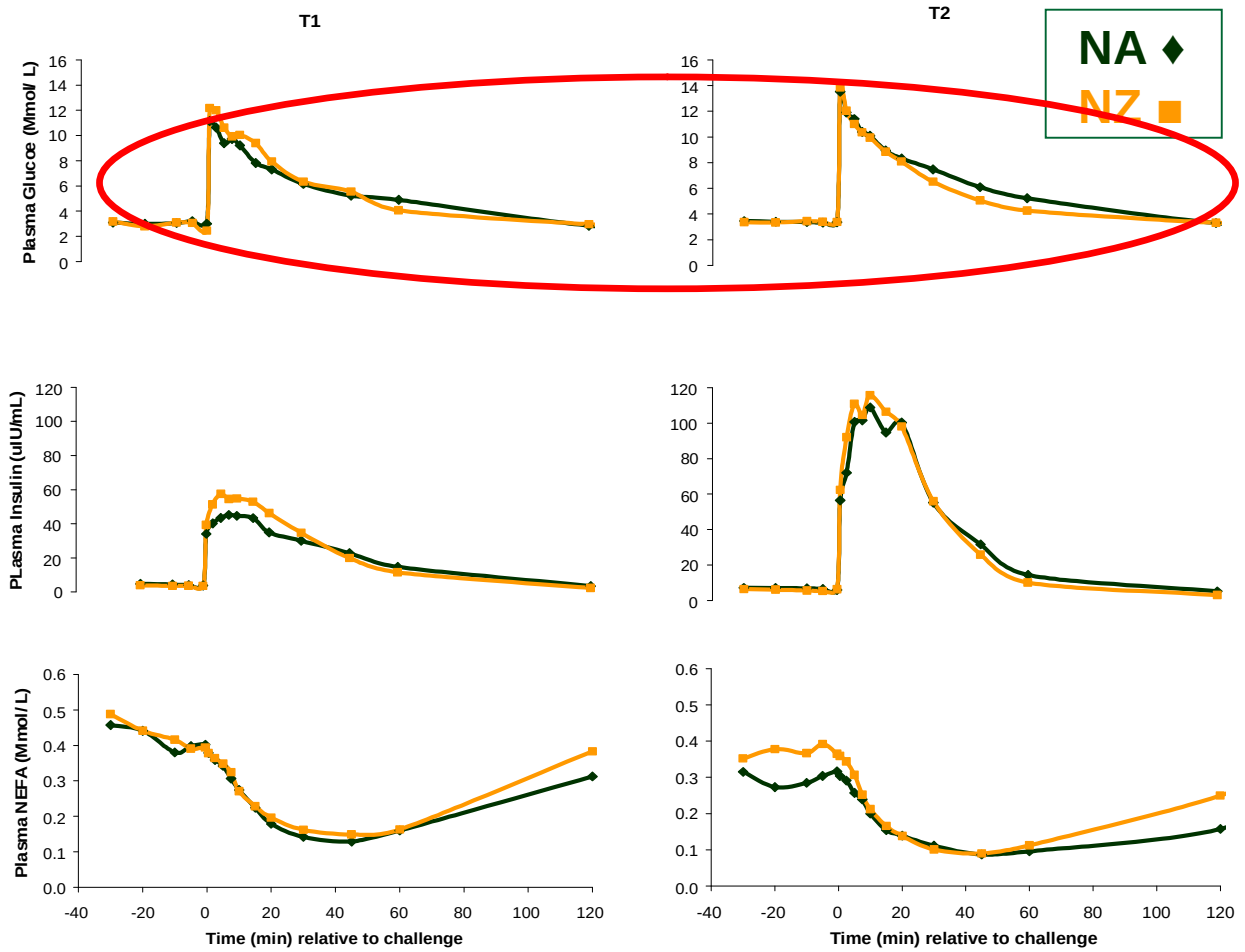
RESULTS


T1
T2
Plasma Glucoe (Mmol/ L)
PLasma Insulin (uIU/mL)
Plasma NEFA (Mmol/ L)
Time (min) relative to challenge
Time (min) relative to challenge

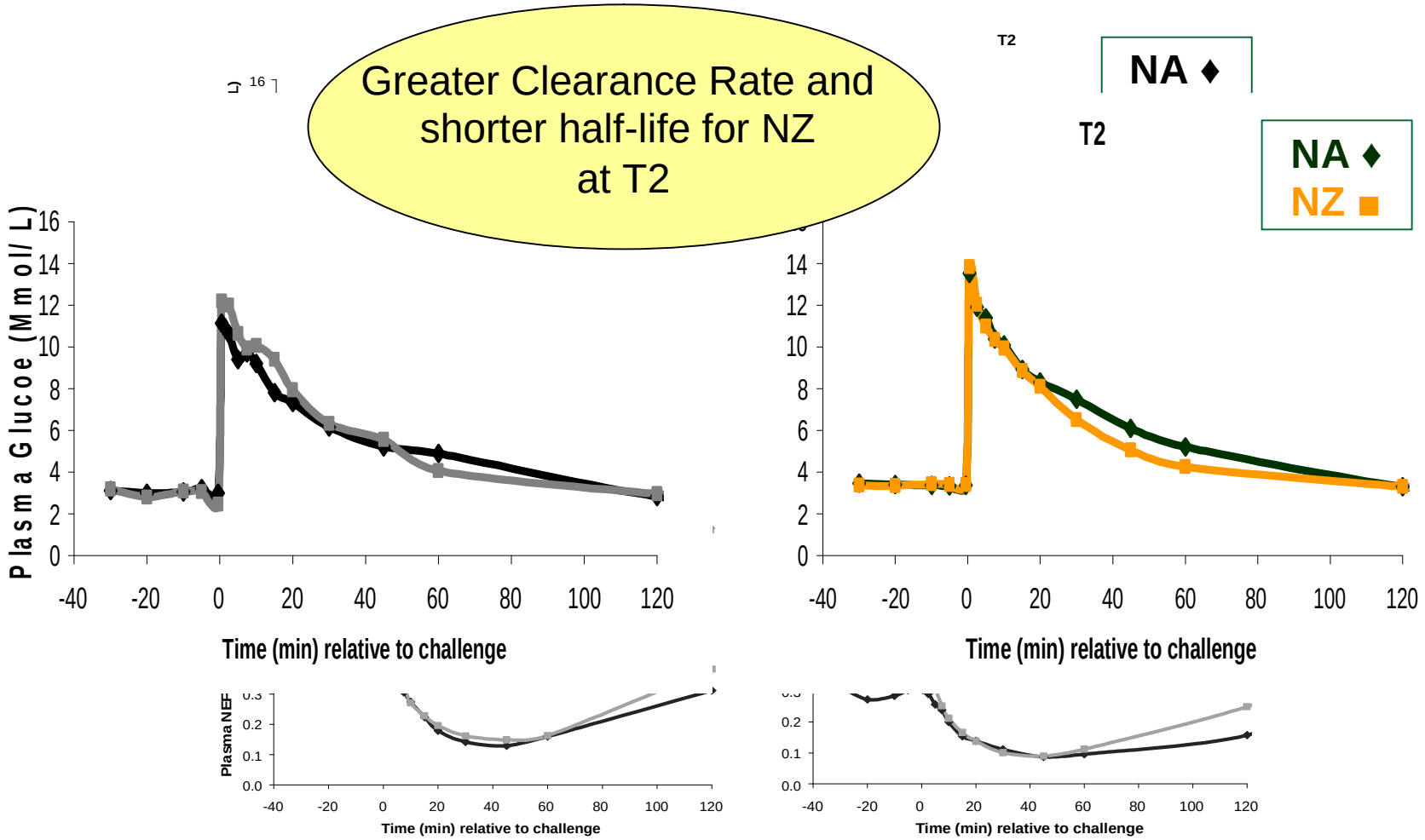
Glucose Tolerance Test



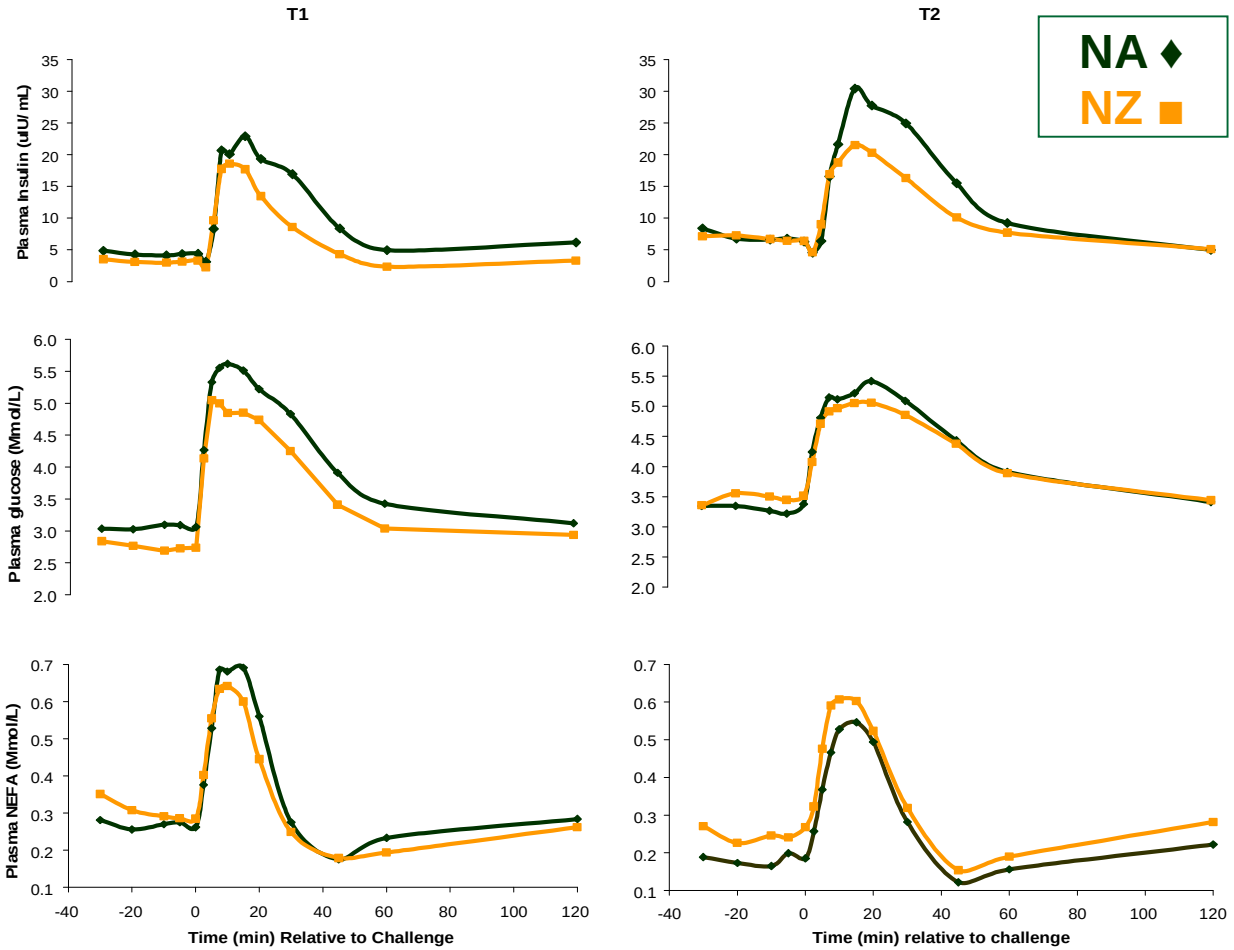
Glucose Tolerance Test



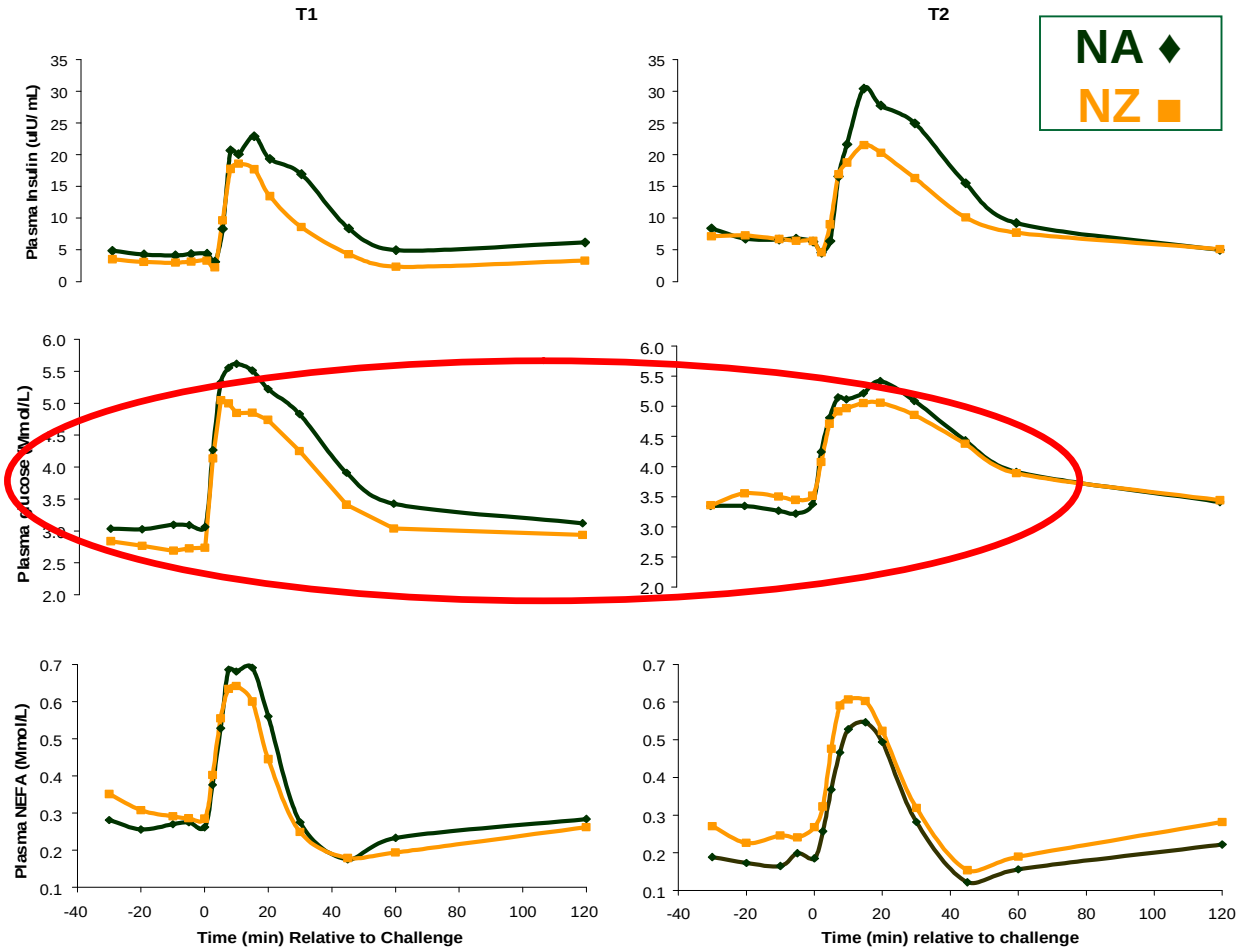
Glucose Tolerance Test



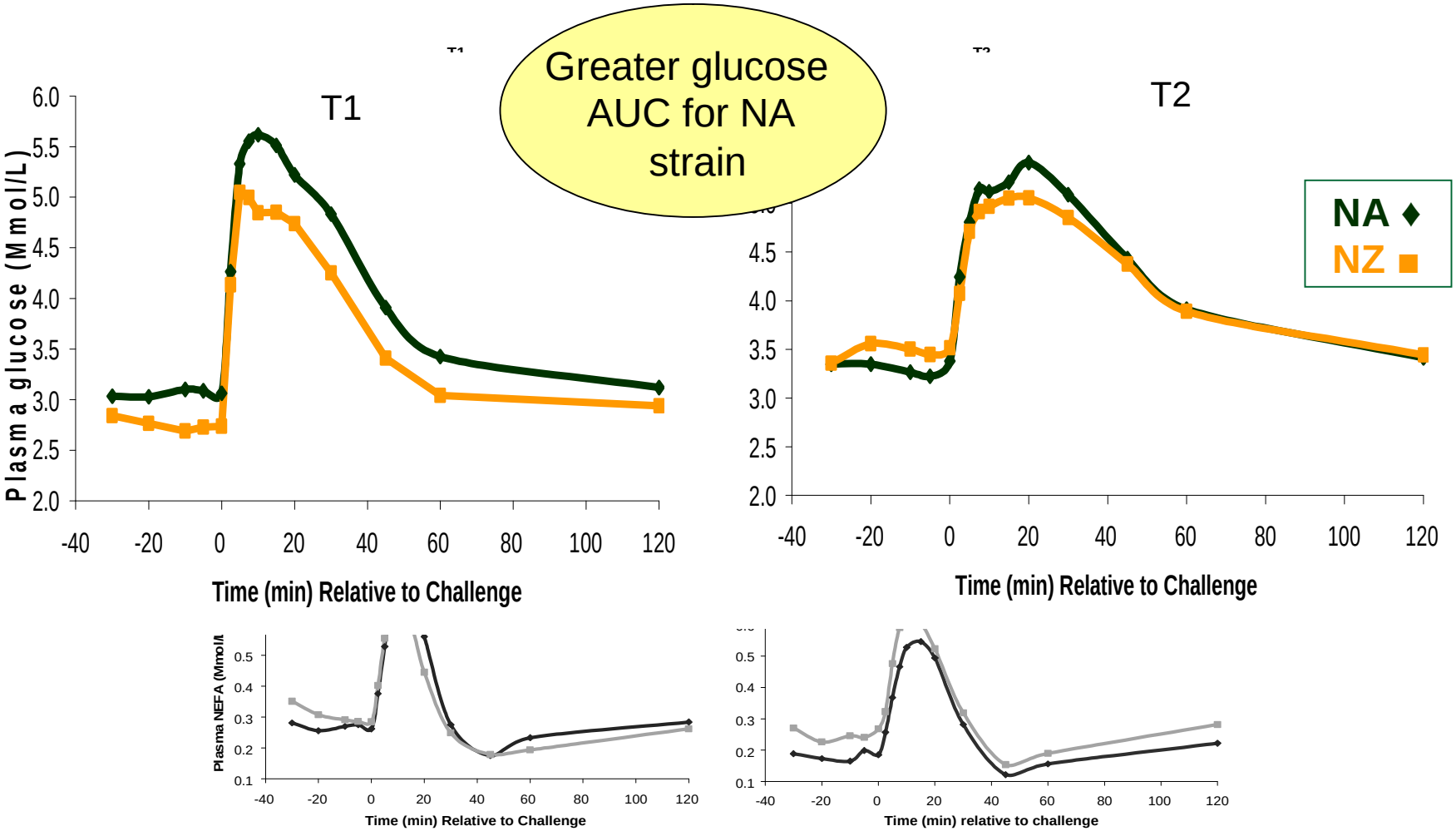
Epinephrine Challenge



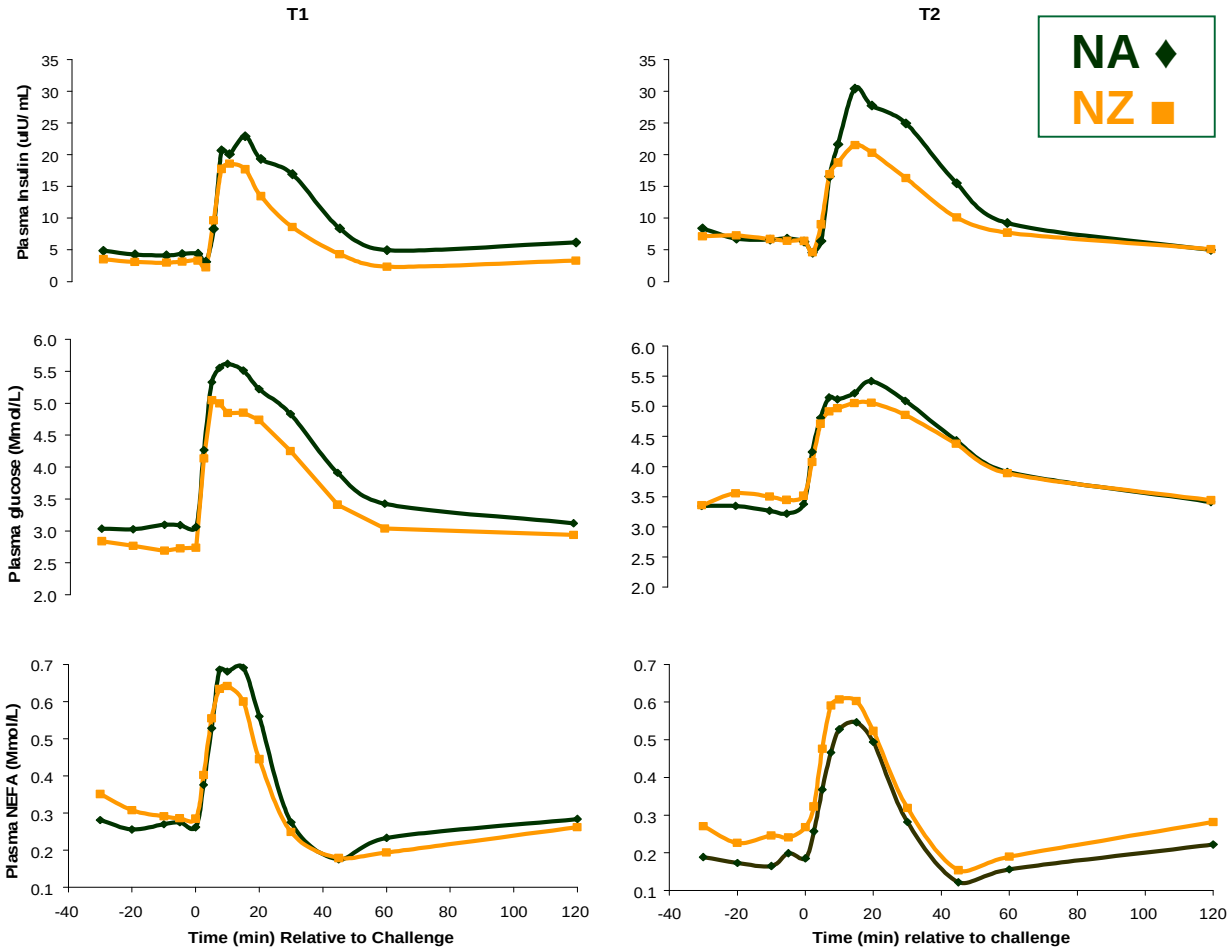
Epinephrine Challenge



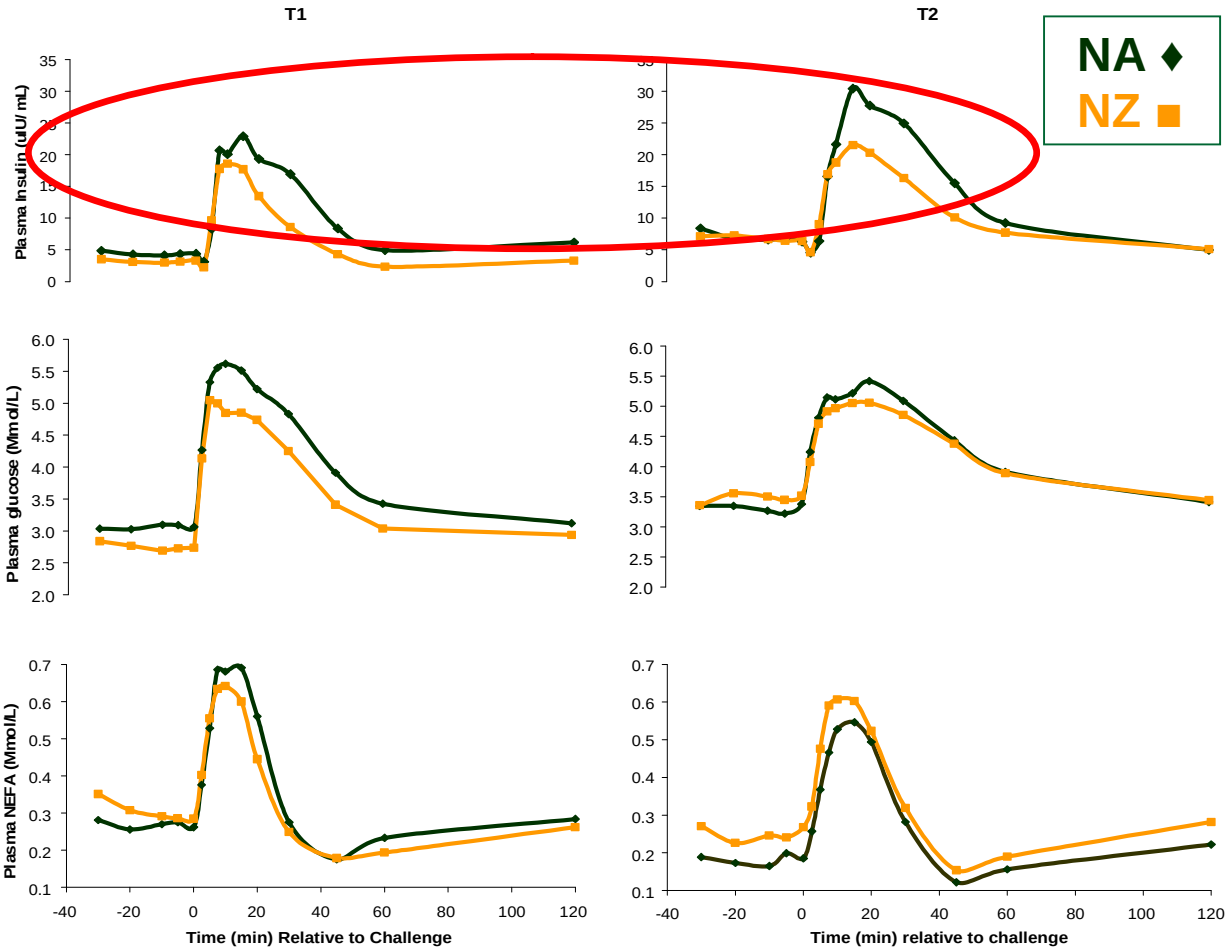
Epinephrine Challenge



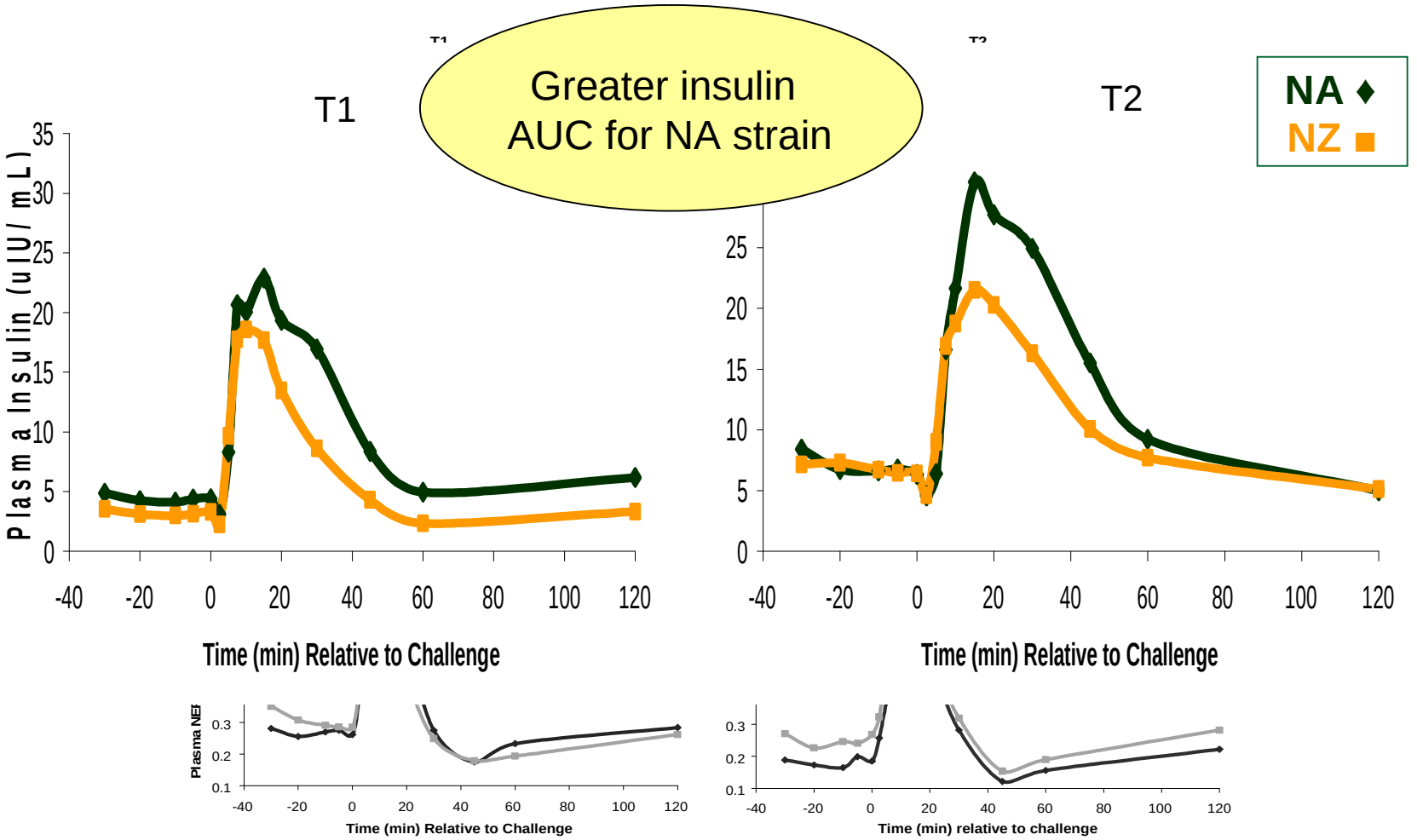
Epinephrine Challenge



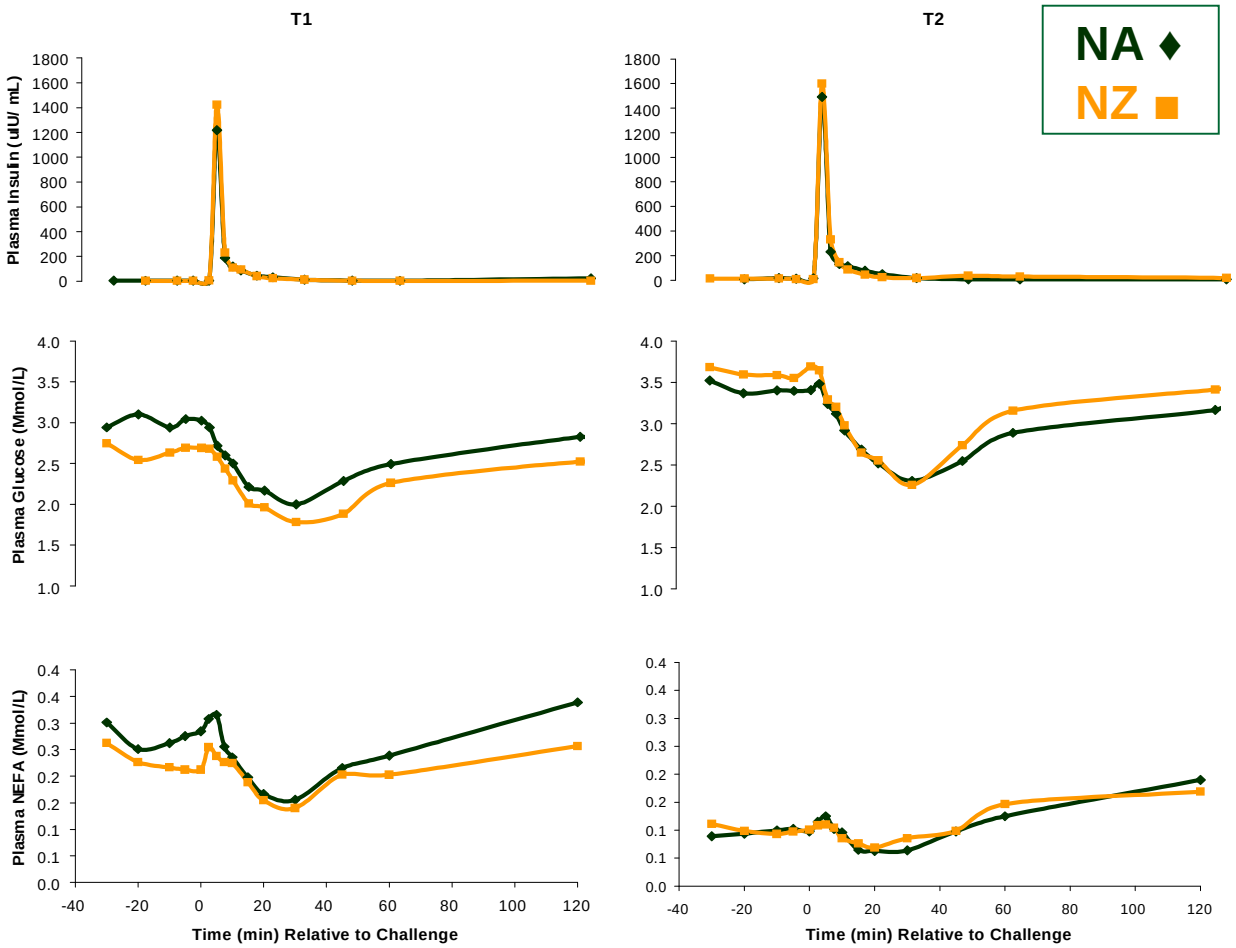
Epinephrine Challenge



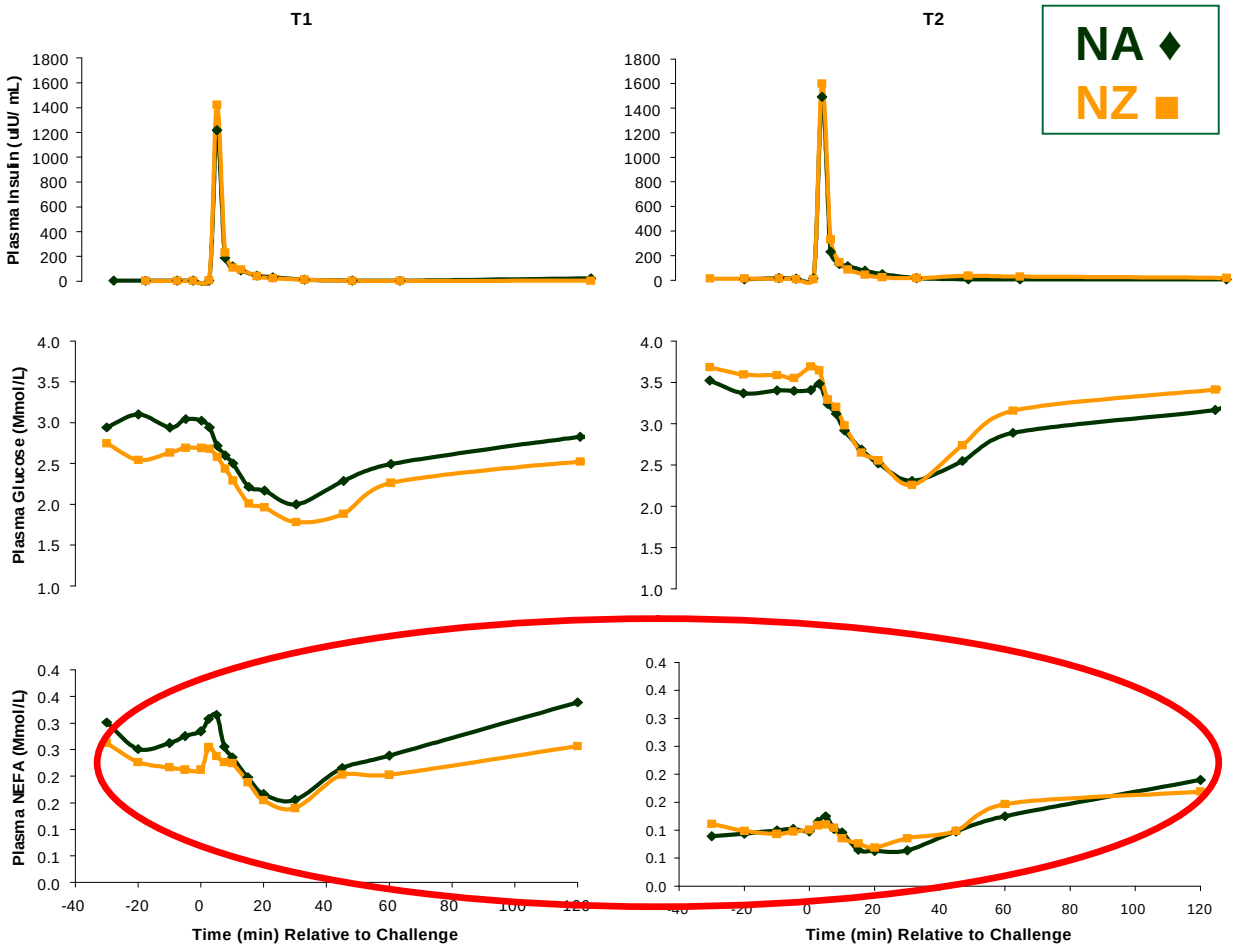
Epinephrine Challenge



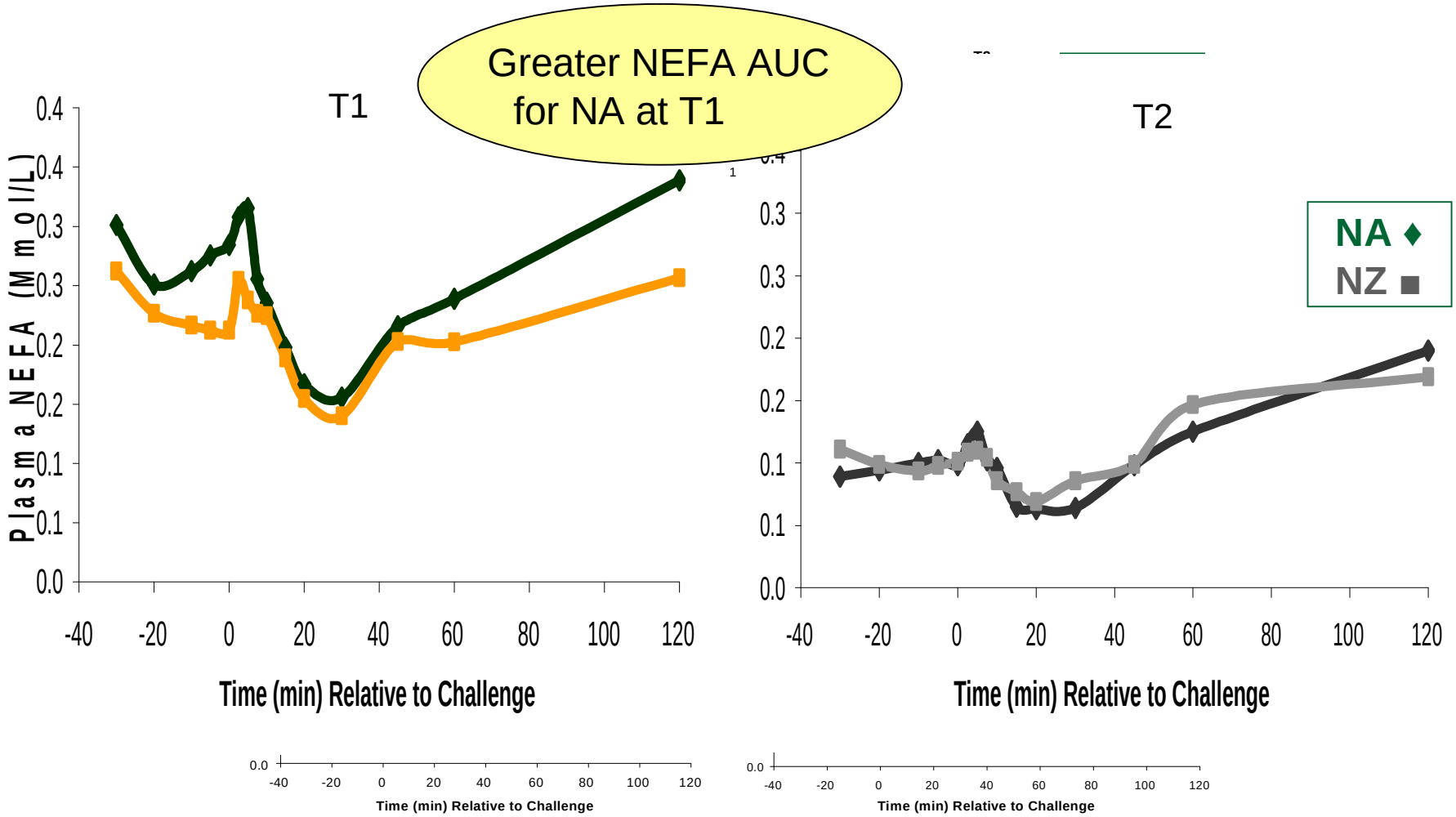
Insulin Challenge



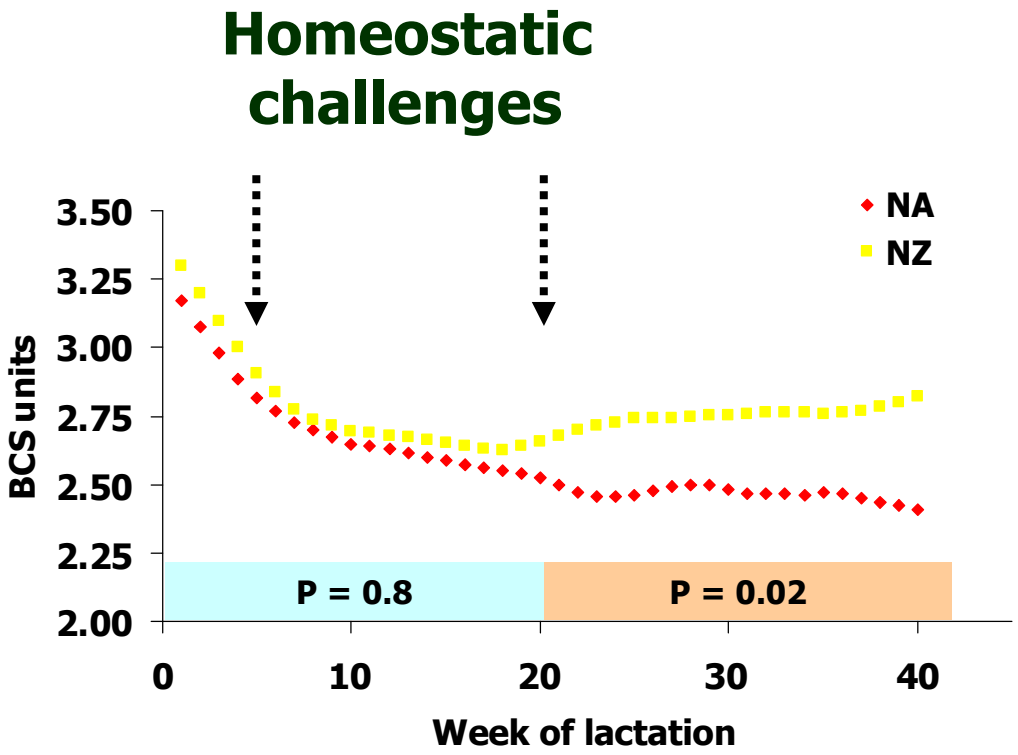
Insulin Challenge



Insulin Challenge

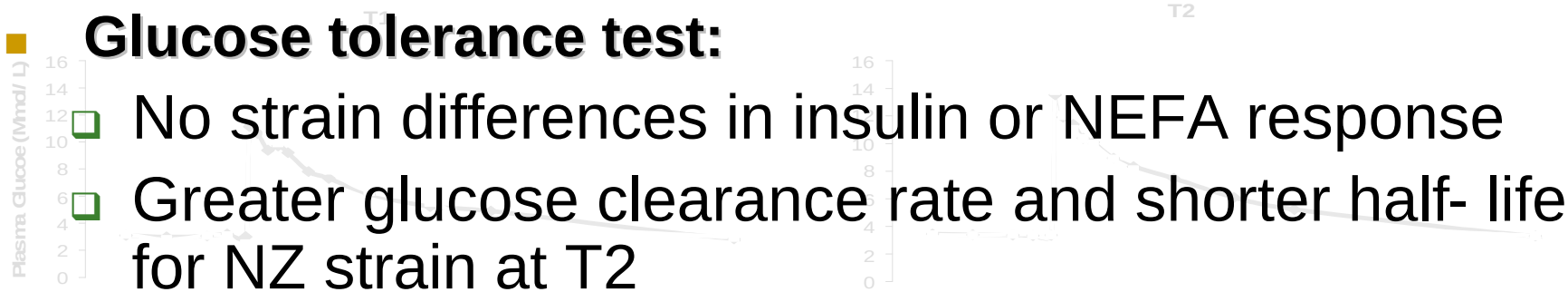


BCS at time of homeostatic challenges

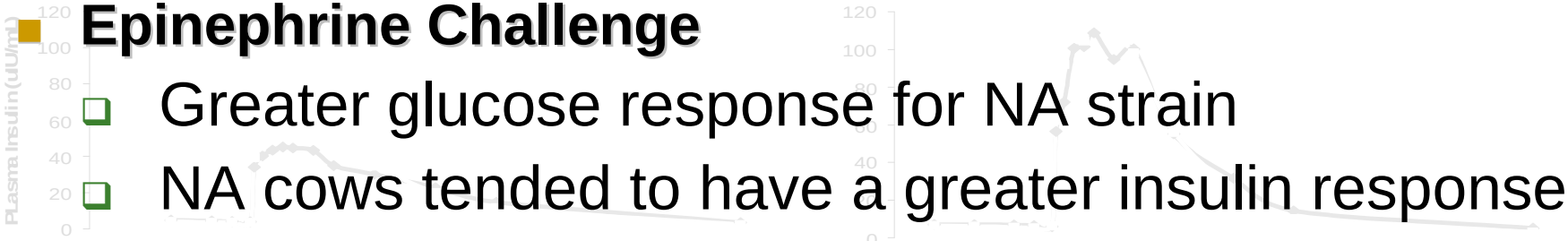


Results Summary

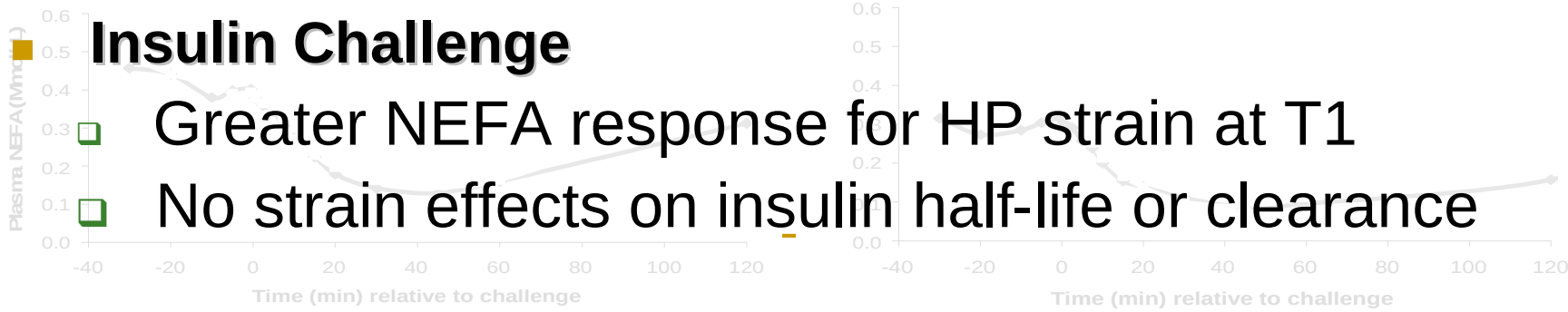
- **Glucose tolerance test:**
  - No strain differences in insulin or NEFA response
  - Greater glucose clearance rate and shorter half- life for NZ strain at T2



- **Epinephrine Challenge**
  - Greater glucose response for NA strain
  - NA cows tended to have a greater insulin response



- **Insulin Challenge**
  - Greater NEFA response for HP strain at T1
  - No strain effects on insulin half-life or clearance



Conclusions

- Results suggest that NA cows have enhanced hepatic glycogenolysis but similar lipolytic responses to a catabolic stimulus.
- Indications that higher basal circulating NEFA concentrations in the NA genotype during early lactation are not due to diminished adipose tissue responsiveness to insulin
- Glucose clearance rate greater for NZ cows in mid-lactation……likely plays a role in the increased body tissue accretion in this genotype

This data is in press (Animal)

Thank you……Questions?