

# BOLT + Helical: Powering Genomic Prediction in Global Cattle Breeding

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CEO & Managing Partner since January 2021  
USA  
[www.ThetaSolutionsLLC.com](http://www.ThetaSolutionsLLC.com)



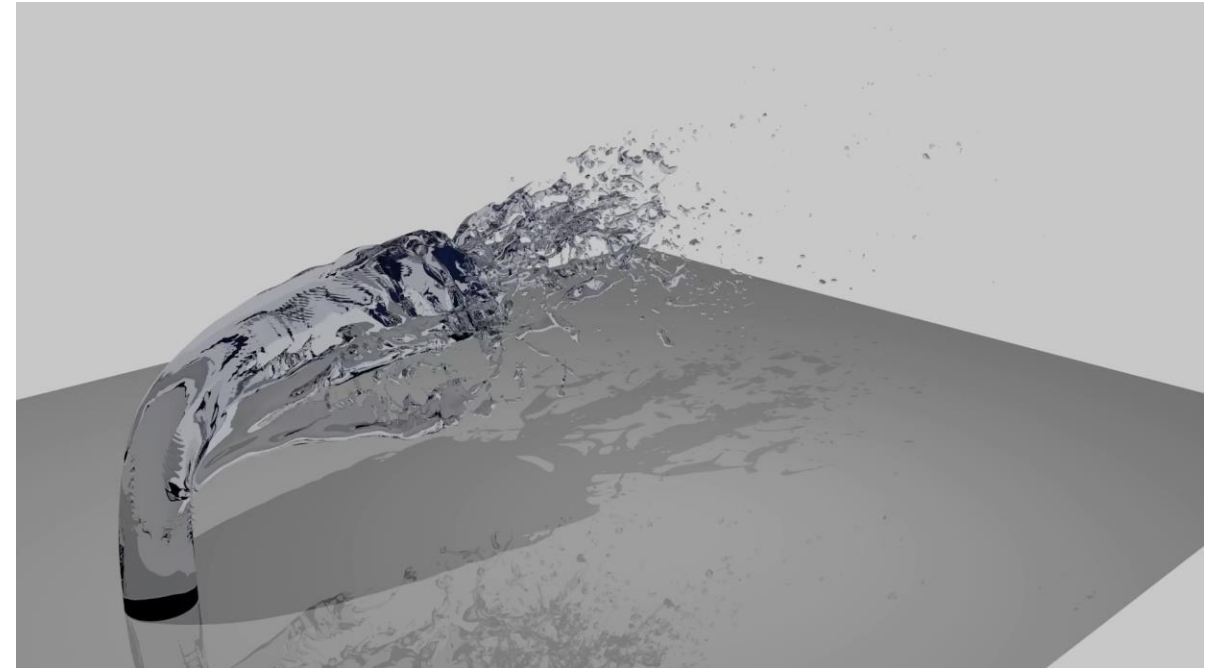
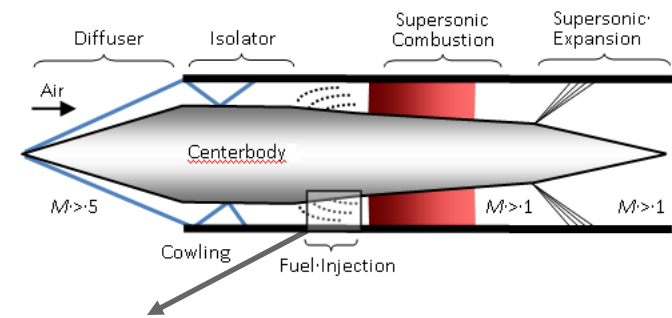
Adjunct Lecturer  
A.L. Rae Centre for Genetics & Breeding  
Massey University



# About me



  
**BOEING**  
V-22 Osprey




Fuel spray in supersonic flow (scramjet)



# What do Supersonic Combustion Ramjets and Genetics have in common?

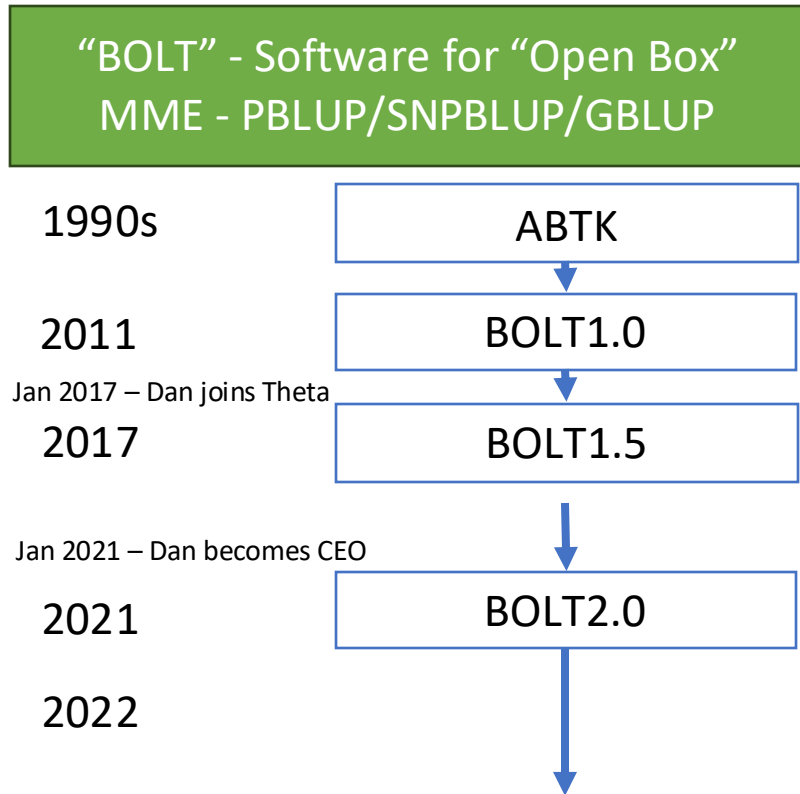


# Our Goal: Data to Business Value

- A complete solution for genetic improvement requires
  - A breeding objective
  - Field collection
    - of pedigree data
    - of performance data
    - of DNA samples
  - Assaying of genotypes from DNA samples (e.g. Illumina, Affymetrix, etc)
  - **IT / database / cloud / computing infrastructure**
  - **Data Analysis**  Our software
  - Interpretation of results
  - Informed decision making

  
Our “know how”

# What is BOLT?



- Biometric Open Language Tools
- Generalised software which can fit many different types of models, principally pedigree “PBLUP”, marker effects “SNPBLUP”, “ss-MEM”, and GRM “GBLUP”, “ss-GBLUP” models
- Takes advantage of modern Graphics Processing Units (GPUs) for faster computations



**BOLT powers weekly single-step evaluations on tens of millions of beef cattle globally starting in 2017**





## AMERICAN HEREFORD ASSOCIATION RELEASES BOLT GENETIC EVALUATION

December 6, 2017

- American Hereford Association, Canadian Hereford Association, Argentine Hereford Association, Uruguay Hereford Association
- >3.8 million pedigree and >200k genotypes across 17 traits



## IGS Releases Multi-breed Genetic Evaluation

04 May 2018

- Largest beef multibreed evaluation in the world
- Encompasses data from 20+ breed societies and counting
- >20 million pedigree and >500k genotypes across 14 traits



Business

Environment

People

Feed

Animal

Milking

Events

[Home](#) > [Animal](#) > [Animal Evaluation](#) > [The NZAEL 3.0 launch](#)

In December 2021, NZAEL launched the latest round of enhancements to its genetic evaluation system for dairy bulls.

This round of improvements, collectively referred to as NZAEL 3.0, includes new data filters and model updates based on research findings and farmer feedback, as well as significant investment in the software and systems used in the evaluation.

- New Zealand Multibreed Dairy Evaluation
- >34.4 million pedigree and >70k genotypes across 27 traits

# BOLT origins – starting in 1990's with “abtk”

- Animal Breeders Tool Kit (abtk)
- Developed by Dr. Bruce Golden
- Open source
  - No outside contributions except a Windows port
- Prior to ABTK
  - “Black box” models
  - Monolithic code for each trait evaluation
  - Inflexible and costly to upgrade and maintain
  - Duplicated effort and code
- With ABTK
  - Modular and flexible to fit a range of models
  - Sparse, dense and diagonal matrix types
  - Individual specialised tools with specific functions
    - pedigree handling – recode IDs, build A-inverse
    - Matrix addition and multiplication
    - Gauss-Seidel solver
    - tkblup to build the shell script for simple models

# Theta Solutions creates BOLT – first major revision of abtk circa 2011

- **Paid software licensing model to fund continuous research & development**
- Major improvements to take advantage of modern computing hardware
- Support for Graphics Processing Units (GPU) computing
- Innovations to support various genomic and single-step models
- Added a preconditioned conjugate gradient (PCG) solver (computes EPDs)
- Added a single-site Gibbs MCMC sampling tool
  - Enabled mixture models (some markers zero) and marker subset selection
  - Generates a Markov chain of plausible EPD values
  - Enabled calculation of PEV - Prediction Error Variances (and covariances)
- Amongst other innovations...



# BOLT – second major revision circa 2017+

- Updated PCG solver with expanded preconditioners
- New abstractions to enable more flexibility
- Extended functionality of some tools
- Introduction of model script builders
- Substantial reduction in model development effort
- Substantial reduction in production runtimes

# 2022+ - BOLT2 Release (Currently 2.3.6)

- Adds support for latest generation GPUs
- Adds support for latest Linux distributions - e.g. CUDA11 and Ubuntu22.04
- New and updated tools
  - impute - 2x faster for many problems
  - pcg - more than 10x faster for most problems
  - ssgibbsCuda - 2x faster for many problems
- Ever-growing to do list of opportunities for further enhancements
  - Adjusts to meet the most pressing need(s)
  - New types of phenotypes, new genotype data, new models



# TREE – a new product and business model

- There existed an industry need for efficient software to
  - manage SNP chip genotype data
  - process the data for parentage and single-step and other purposes
  - **no economical off-the-shelf solutions available**
- Developed a system using open source, BOLT, and new tools
- Genotype database as a real-time service
  - Simple one-off \$1 per genotype sample loaded
  - On demand web-based parentage analysis system
  - Imputation pipelines for evaluations and mate selection
  - Lots of automation
  - Used across 5 species and 4 continents

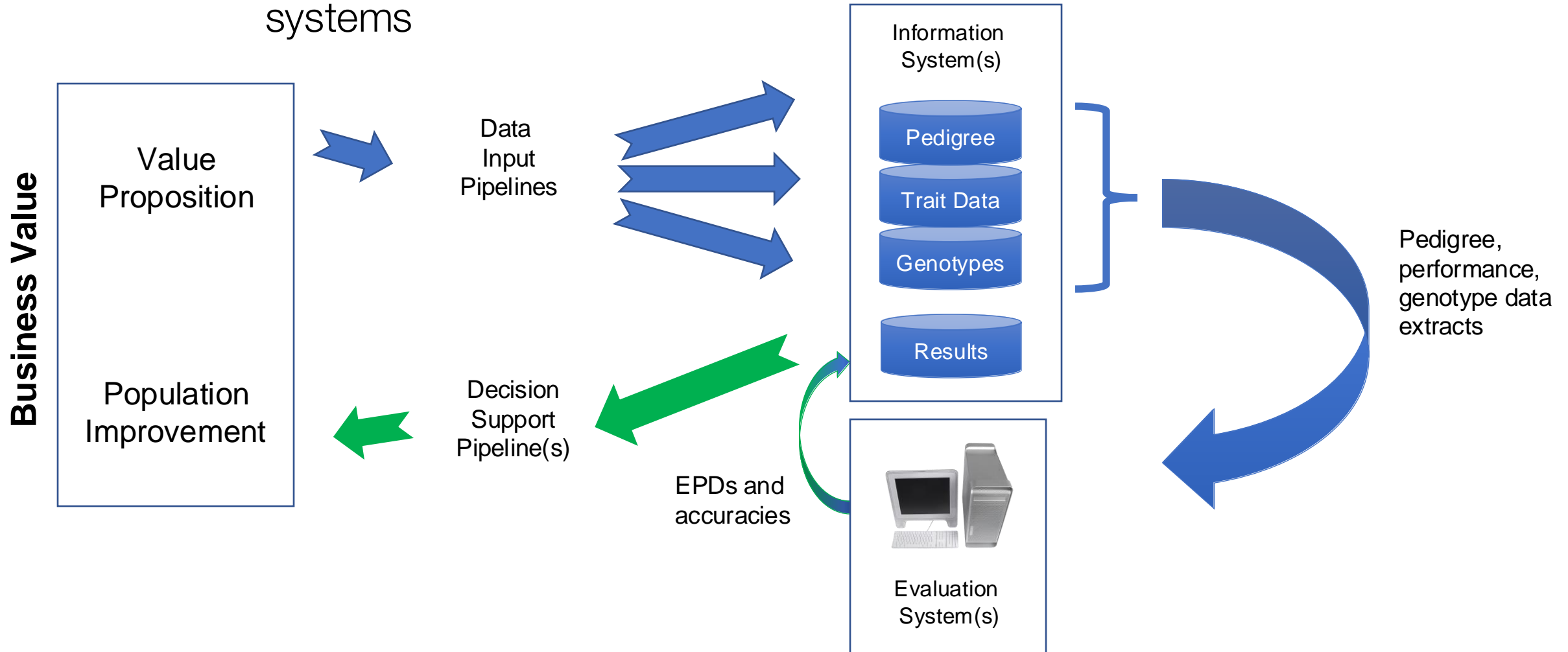
# Helical – another quantum leap

- **Command line toolset for Linux + Mac + Windows**
- **Modern web-based genotype management system**
- New tools for genotype manipulation, processing, and analyses
- Massive increases in flexibility and performance to complement BOLT analyses
- New tools for matrix algebra and model building –no GPU required
- **Additional modules for pedigree, genetic conditions, phenotypes, EPDs**

# Our Goal: Data to Business Value

We provide consulting assistance on all aspects of the genetic improvement systems

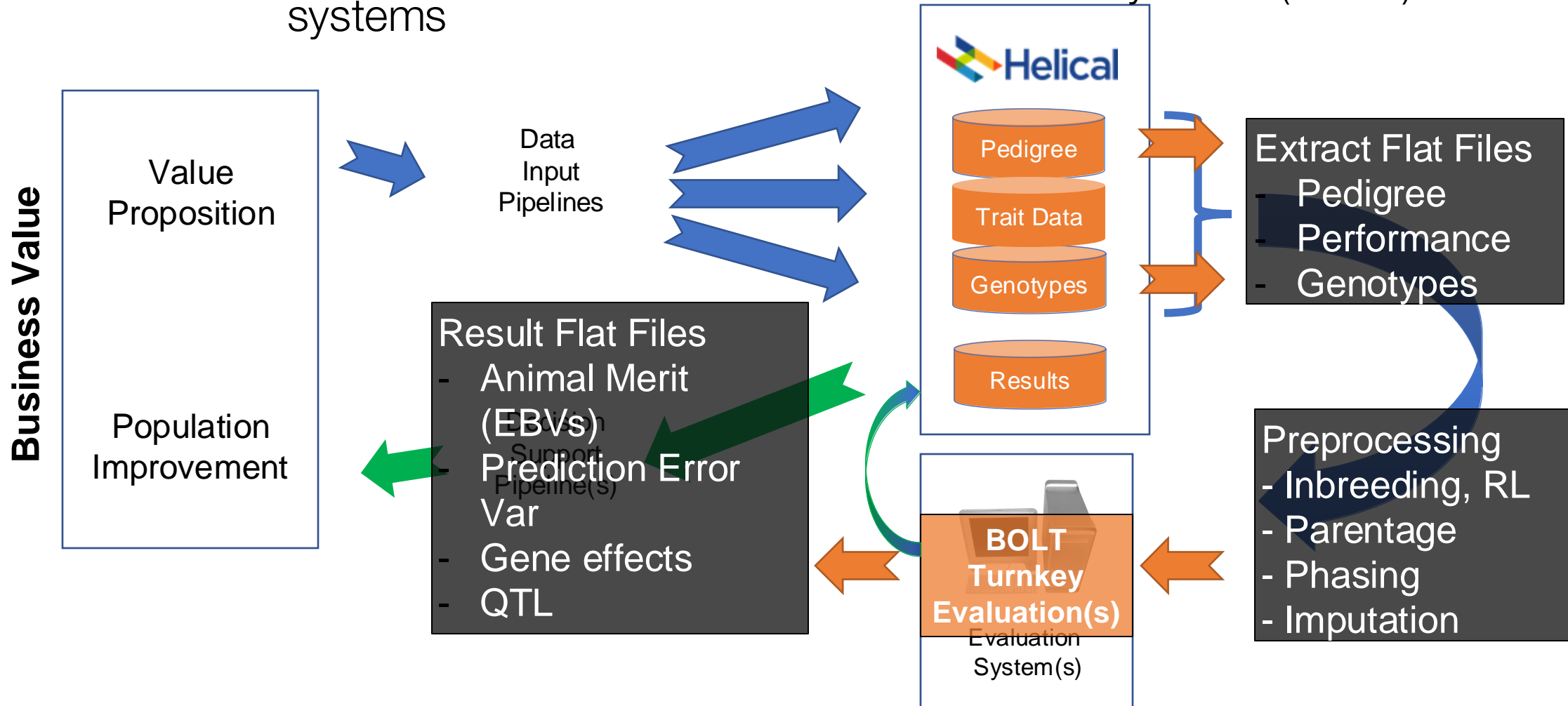
We license software on all aspects of the information and evaluation systems



# Our Goal: Data to Business Value

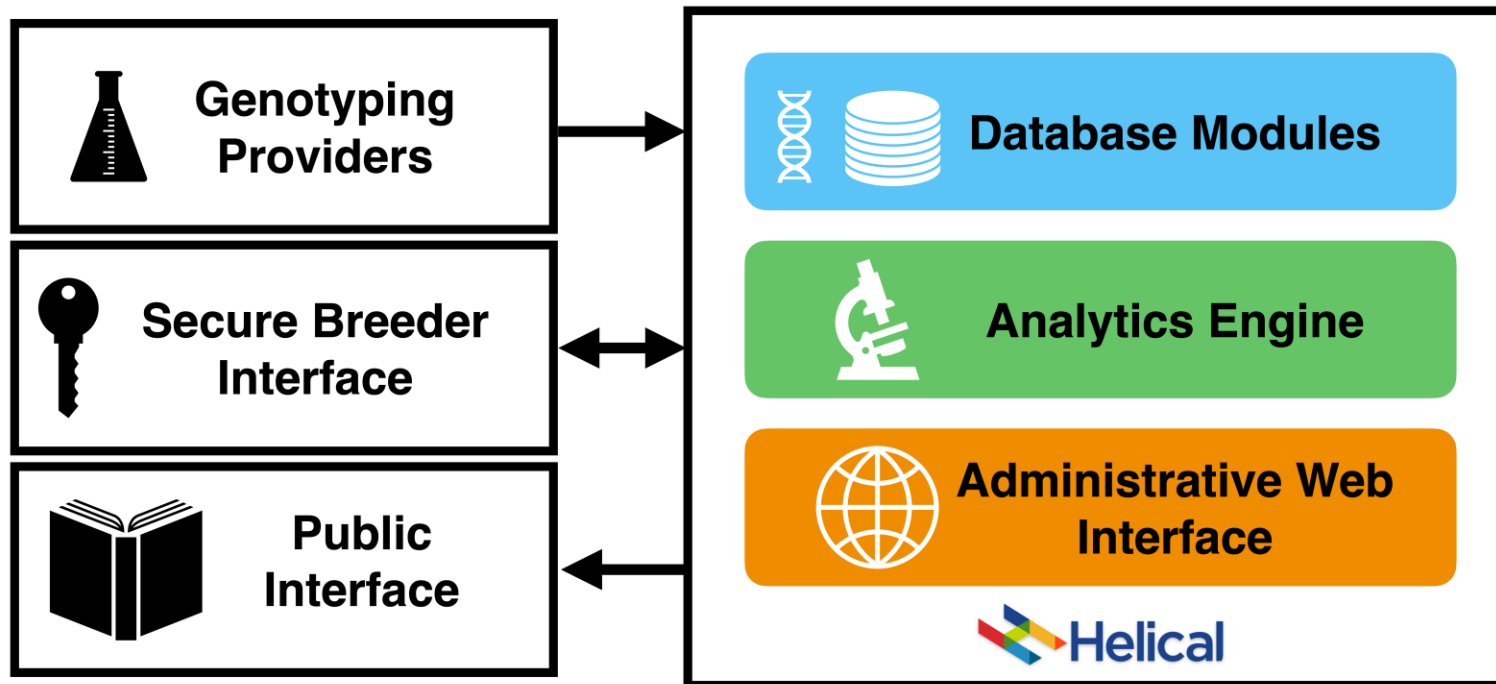
We provide consulting assistance on all aspects of the genetic improvement systems

We license software on all aspects of the information (**helical**) and evaluation systems (**BOLT**)





# Helical Platform Schematic



- Lab agnostic - aggregate and analyze data from any number of genotyping providers
- Parent verification and discovery
- No technical skills required



# The new system - Helical

“One-stop DNA shop”

Allows members to view and download all DNA test request results including:

- Parentage analysis results
- Genetic condition results
- Genotype call rates (including failed samples and samples needing recollection)
- Samples with quality control issues (ie: low quality, differing genotype predicted sex to nominated test request sex)
- Crossbred Wagyu Test (CWT)
- Wagyu Feeder Check results (WFC)

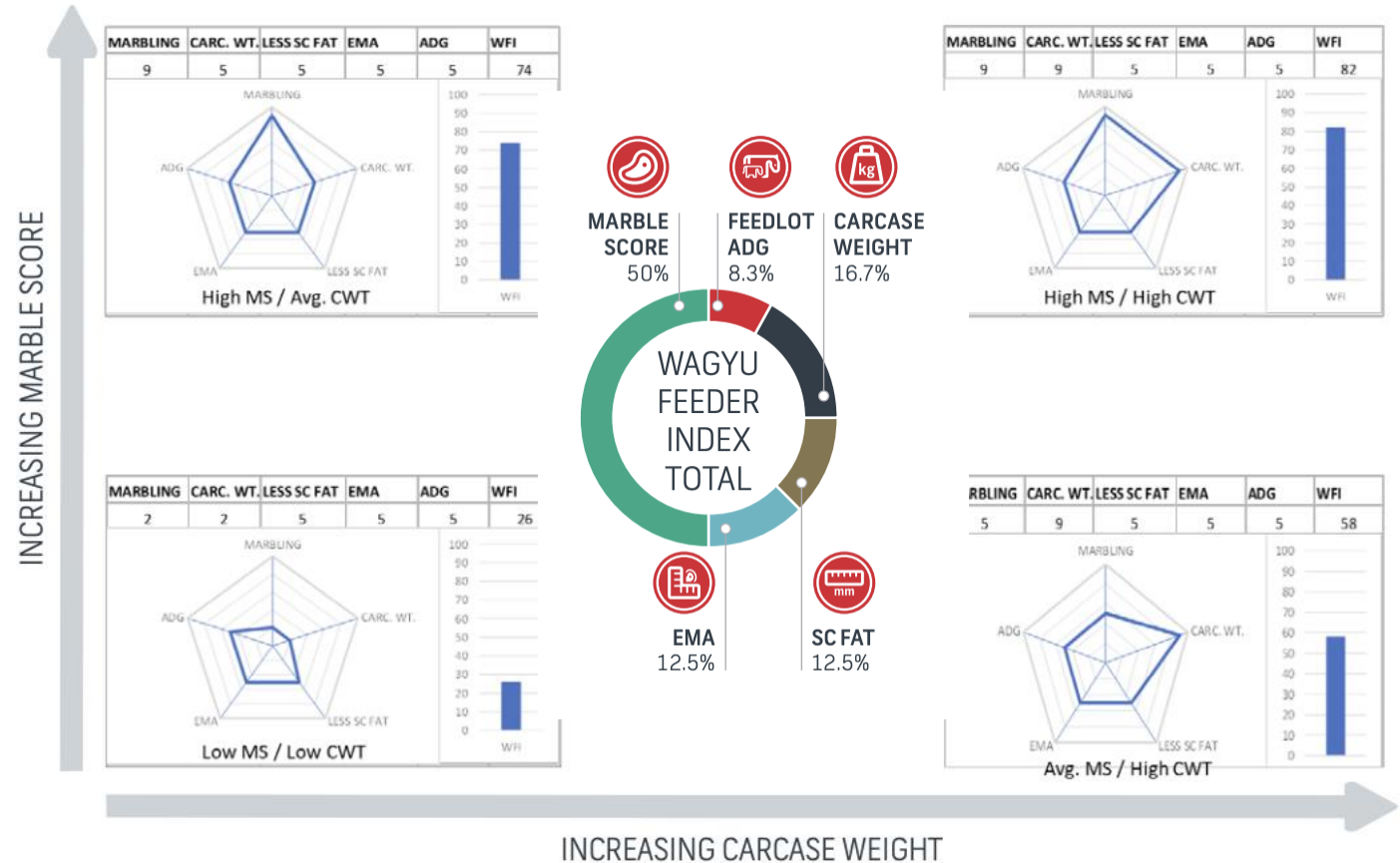
# Wagyu Feeder Check

- A **data flywheel** to unlock value for both breed society and commercial cattle producers
- Huge growth of data collection **and genotyping** of commercial cattle to identify poor performing animals (and sires)
- **Parent discovery unlocks pedigree linkages to registered bulls**
- Commercial producers are incentivized to **provide carcass data back to the society**
- **Carcass analysis enables further improved carcass trait predictions**



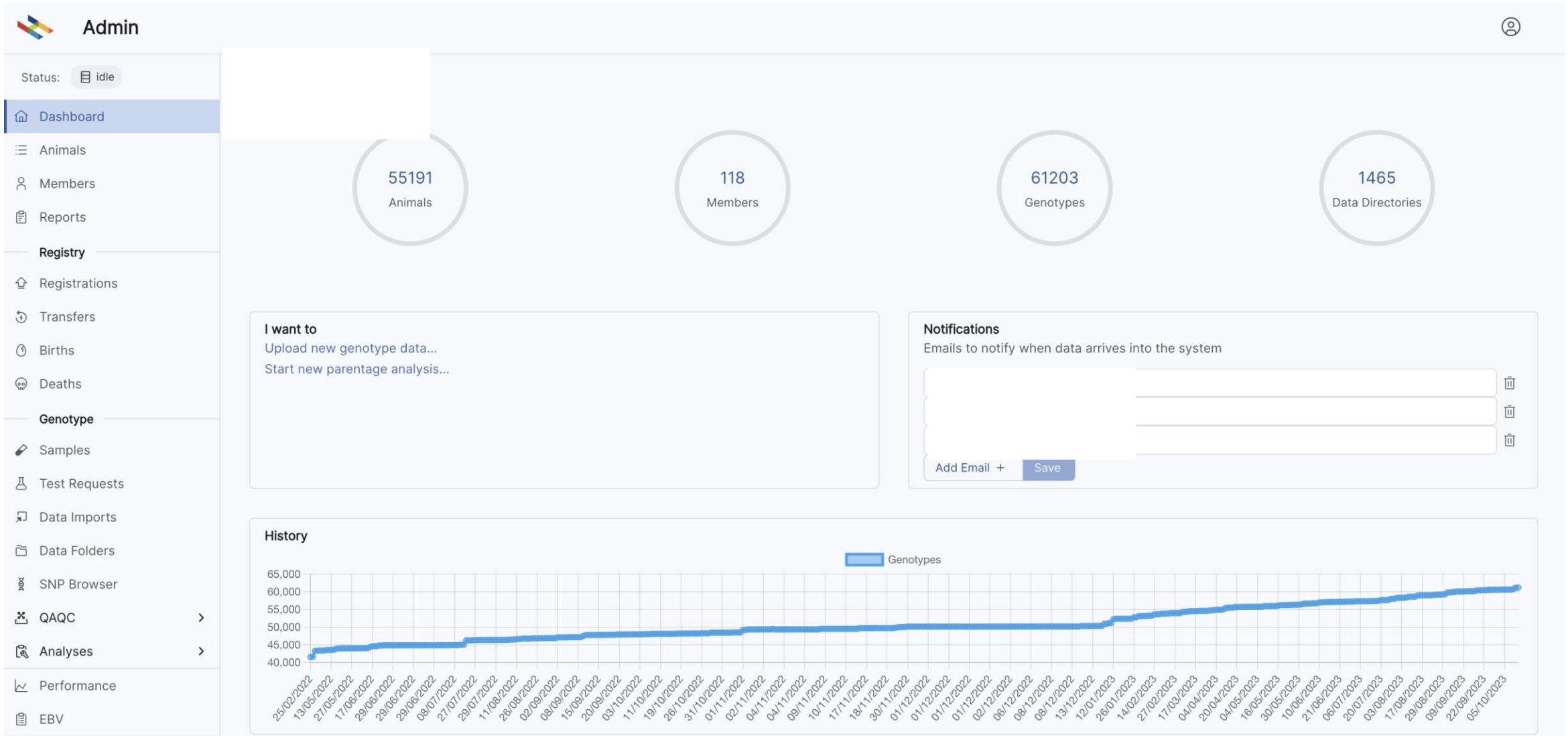
# Wagyu Feeder Check

- Farmer origin test request workflow
- Automated submission of test request files to lab and invoicing and reporting of results to farmers
- Automated MBV loading and reporting module with visualisations
- View sire summaries



# Administrative system

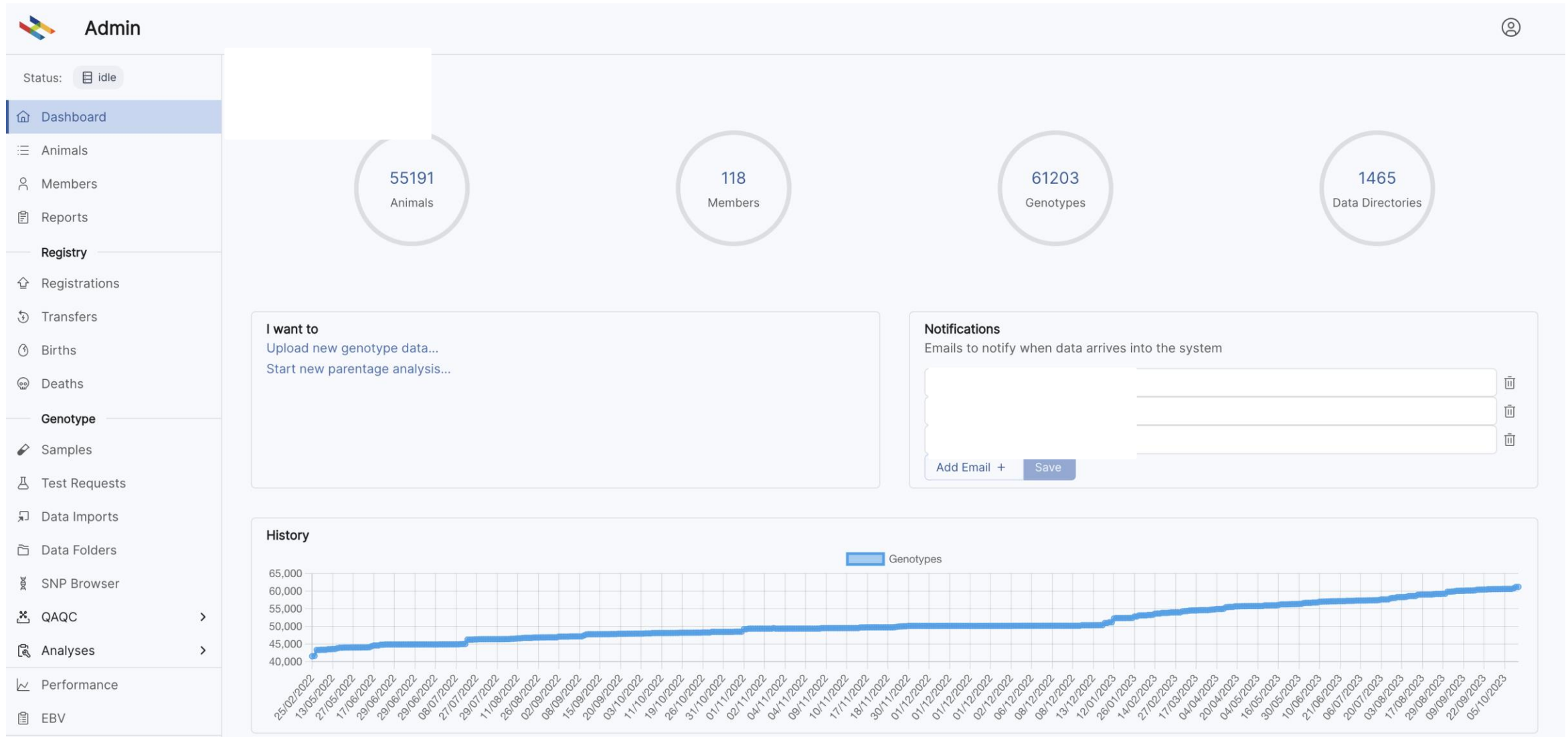
<https://organisation.helicalco.com>





# Administrative system

<https://organisation.helicalco.com>







# 0049220089

♂ bull Parent Verification: sire dam mating

Name:	RISSINGTON 220089	Tattoo:	L89	NAIT ID:	None	ICAR ID:	SIMNZLM000049220089
DOB:	2022-08-30	Sire:	1667190488	Dam:	0049200213	Breeder:	0049
Owner:	0049	Grade:	A (pure)	Colour:	None	Horned Status:	Polled
Num In Birth:	1	Animal Type:	NZ Born	AI Approved:	None		

Pedigree Progeny EBV Performance Genetic Tests

Textual Animals EBVs

0049220089  
RISSINGTON 220089

1667190488  
KERRAH HUMDINGER H488

0049200213  
RISSINGTON 200213

1312AC0004  
GLENSIDE CRUMPY C4

1667AF0188  
KERRAH F188

1614AC0001  
LEAFLAND CAPTAIN C1

0049AB5207  
RISSINGTON AB5207

0049AU0158  
RISSINGTON NEW STANDARD AU158

1312AW0820  
GLENSIDE AW820

1667AX0187  
KERRAH XFACTOR AX187

1667AD0188  
KERRAH D188

US2616685  
ELLINGSON KLONDIKE Y123 (IMP USA)

1614AZ0041  
LEAFLAND Z41

1455AW0063  
WAIKITE AW063

0049AW0155  
RISSINGTON AW155

# Breeder cloud app – 3GP Interface

<https://app.helicalco.com/organisation>



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♂ bull Parent Verification: sire dam mating

Name:	RISSINGTON 220089	Tattoo:	L89	NAIT ID:	None	ICAR ID:	SIMNZLM000049220089
DOB:	2022-08-30	Sire:	<a href="#">1667190488</a>	Dam:	<a href="#">0049200213</a>	Breeder:	<a href="#">0049</a>
Owner:	<a href="#">0049</a>	Grade:	A (pure)	Colour:	None	Horned Status:	Polled
Num In Birth:	1	Animal Type:	NZ Born	AI Approved:	None		

[Pedigree](#)
[Progeny](#)
**[EBV](#)**
[Performance](#)
[Genetic Tests](#)

[Documentation ?](#)

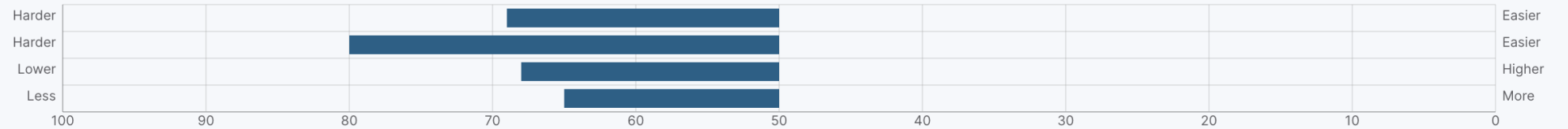
Reference: [2022 born calves](#)



Group Traits

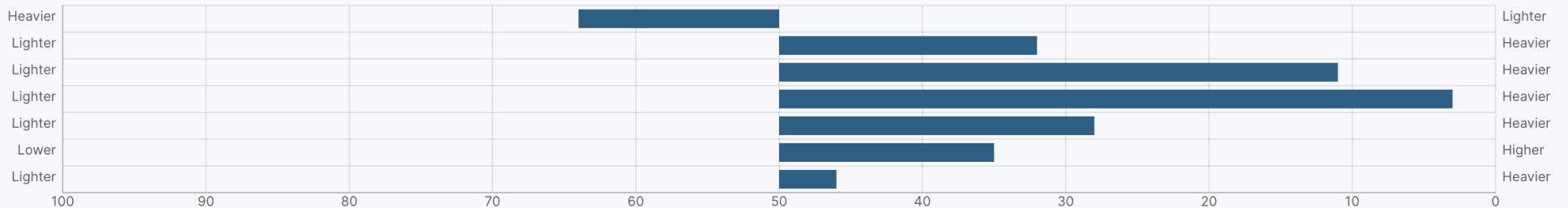
## Maternal

	Trait	EBV	Rel
IGS Calving Ease Dir. (%)		11.80	79%
IGS Calving Ease Mat. (%)		6.60	54%
IGS Stayability (%)		29.60	67%
IGS Docility (%)		25.20	77%



## Growth

	Trait	EBV	Rel
IGS Birth Wgt. (kg)		4.99	82%
IGS Weaning Wgt. (kg)		78.83	80%
IGS Yearling Wgt. (kg)		125.74	81%
IGS Post Weaning Gain (kg)		0.29	81%
IGS Mat. Weaning Wgt. (kg)		63.78	61%
IGS Milk (kg)		24.49	45%
600 Day Wgt. (kg)		135.22	61%





ID, Name, Tattoo or NAIT ID:

Sire ID:

Status:

Colour:

Sex:

Dam ID:

Born Between:

Horned Status:

Filter EBVs

Trait	Min	Max	Average
IGS Birth Wgt. (kg):	Min...	Max...	4.31
IGS Weaning Wgt. (kg):	Min...	Max...	75.58
IGS Yearling Wgt. (kg):	Min...	Max...	111.29
IGS Post Weaning Gain (kg):	Min...	Max...	0.22
IGS Mat. Weaning Wgt. (kg):	Min...	Max...	60.72
IGS Milk (kg):	Min...	Max...	23.01
IGS Calving Ease Dir. (%):	Min...	Max...	15.78
IGS Calving Ease Mat. (%):	Min...	Max...	11.07
IGS Stayability (%):	Min...	Max...	31.78
IGS Docility (%):	Min...	Max...	29.33
IGS Carcass Wgt. (kg):	Min...	Max...	24.90
IGS REA (sq cm):	Min...	Max...	11.20
IGS Back Fat (mm):	Min...	Max...	-0.54
IGS Marbling Score:	Min...	Max...	-0.02
IGS USDA Yield Grade Score:	Min...	Max...	-0.93
600 Day Wgt. (kg):	Min...	Max...	132.45
Gestation Length (days):	Min...	Max...	-0.47

# Public cloud app – Animal Search

<https://app.helicalco.com/public/organisation>



Animal Search Stud Search Sale Catalogs Semen/Embryo Catalogs

ID, Name, Tattoo or NAIT ID:

Sire ID:

Status:

Colour:

Sex:

Dam ID:

Born Between:

Horned Status:

Filter EBVs ▶

Search

Table view:

Animal ID	Birth Wgt. (kg)	Weaning Wgt. (kg)	Yearling Wgt. (kg)	600 Day Wgt. (kg)	Mat. Weaning Wgt. (kg)	Milk (kg)	Post Weaning Gain (kg)	Calving Ease Dir. (%)	Calving Ease Mat. (%)	Stayability (%)	Docility (%)	Carcass Wgt. (kg)	REA (sq cm)	Back Fat (mm)	Marbling Score	USDA Yield Grade Score
US2641380	-6.35 98%	54.79 97%	76.02 97%	80.78 22%	55.07 95%	27.76 92%	0.14 97%	47.20 95%	26.60 89%	54.20 87%	30.40 96%	10.70 91%	6.32 88%	-0.11 87%	1.40 90%	-0.39 84%
US2524956	-4.90 99%	62.69 99%	94.71 98%	- 98%	45.18 98%	13.88 97%	0.20 98%	35.80 97%	25.40 93%	28.60 91%	20.20 97%	24.22 93%	1.29 92%	-0.16 91%	0.96 94%	-0.07 87%
1312222205	-4.35 85%	49.80 84%	74.21 84%	101.98 60%	49.80 70%	24.95 60%	0.15 84%	41.20 83%	27.80 64%	36.80 71%	24.20 83%	-0.09 79%	9.81 78%	-0.25 75%	0.62 79%	-0.80 73%
1501XA0537	-4.35 81%	39.19 73%	66.41 72%	97.80 78%	38.74 39%	19.23 0%	0.17 72%	36.60 53%	21.60 37%	7.80 28%	22.40 0%	27.49 47%	1.81 39%	-0.08 0%	0.62 0%	0.01 34%
200000096	-3.90 47%	-12.25 37%	-17.69 37%	90.84 68%	9.07 54%	15.24 47%	-0.04 37%	31.00 24%	17.00 24%	8.00 14%	11.80 0%	-4.45 14%	1.68 20%	-0.07 14%	-0.10 0%	-0.26 14%
CA794268	-3.63 100%	58.88 99%	90.81 99%	85.55 68%	55.07 98%	25.76 98%	0.20 99%	37.80 99%	18.40 95%	32.80 92%	26.20 97%	30.75 93%	9.81 89%	-0.51 84%	-0.26 91%	-0.79 84%
US2977098	-3.54 98%	64.05 97%	97.25 97%	68.55 73%	58.42 89%	26.49 84%	0.21 97%	41.40 94%	21.80 84%	42.40 80%	26.00 94%	15.42 88%	11.61 87%	-0.36 81%	0.94 89%	-0.86 81%
US2320695	-3.27 100%	71.58 100%	108.95 100%	89.04 0%	57.70 100%	21.77 100%	0.24 100%	35.80 100%	22.80 100%	31.40 99%	27.00 100%	41.19 99%	0.77 99%	0.30 100%	0.92 100%	0.56 94%
AUIMU1Q274	-3.18 100%	67.49 100%	104.42 99%	109.70 71%	57.79 95%	24.13 92%	0.23 99%	34.60 98%	21.00 93%	37.80 86%	22.20 99%	16.87 94%	9.68 94%	-0.11 87%	1.12 95%	-0.51 87%
US2499571	-3.18 99%	58.42 99%	90.36 99%	- 98%	63.41 98%	34.29 96%	0.20 99%	40.20 98%	19.40 93%	25.80 90%	33.40 97%	16.96 92%	7.74 91%	-0.52 84%	0.30 91%	-0.82 84%

# Public cloud app – EBVs

<https://app.helicalco.com/public/organisation> 



### Glen Anthony 36th Annual Bull Sale

Submitted By: 0299  
Date: 13 Jun 2024, 20:30  
Website: <http://www.glenanthony.co.nz>

Location: 825 Farm Road Waipukurau 4284  
Contact Email: [glenanthony1@yahoo.co.nz](mailto:glenanthony1@yahoo.co.nz)

Tony Thompson Ph: 027 280 6148

**Overview** EBV Table Sire EBV Table

#### 0299220009

Lot: 1

An excellent clean polled son of St John Gatton. What a good bull to start the sale. London shows soundness of legs and feet, great length and excellent muscle expression, depth and width. Birth weight in the top 15% and calving ease in the top 20%, figures that are supported by the easy calving confirmation (smooth shoulder and good neck extension). London typifies the excellent temperament of all the bulls in this catalogue.



#### 0299220020

Lot: 2

Executive sons are becoming rare. Don't miss this opportunity. Laird is the boss of the Glen! Great length, depth and width. Second best actual EMA of 116. DNA tested Polled, now lightly scurred.



#### 0299220027

Lot: 3

Another excellent dark red polled son of St John Gatton. A very smooth deep muscled bull, DNA tested and clean polled at birth, now lightly scurred.



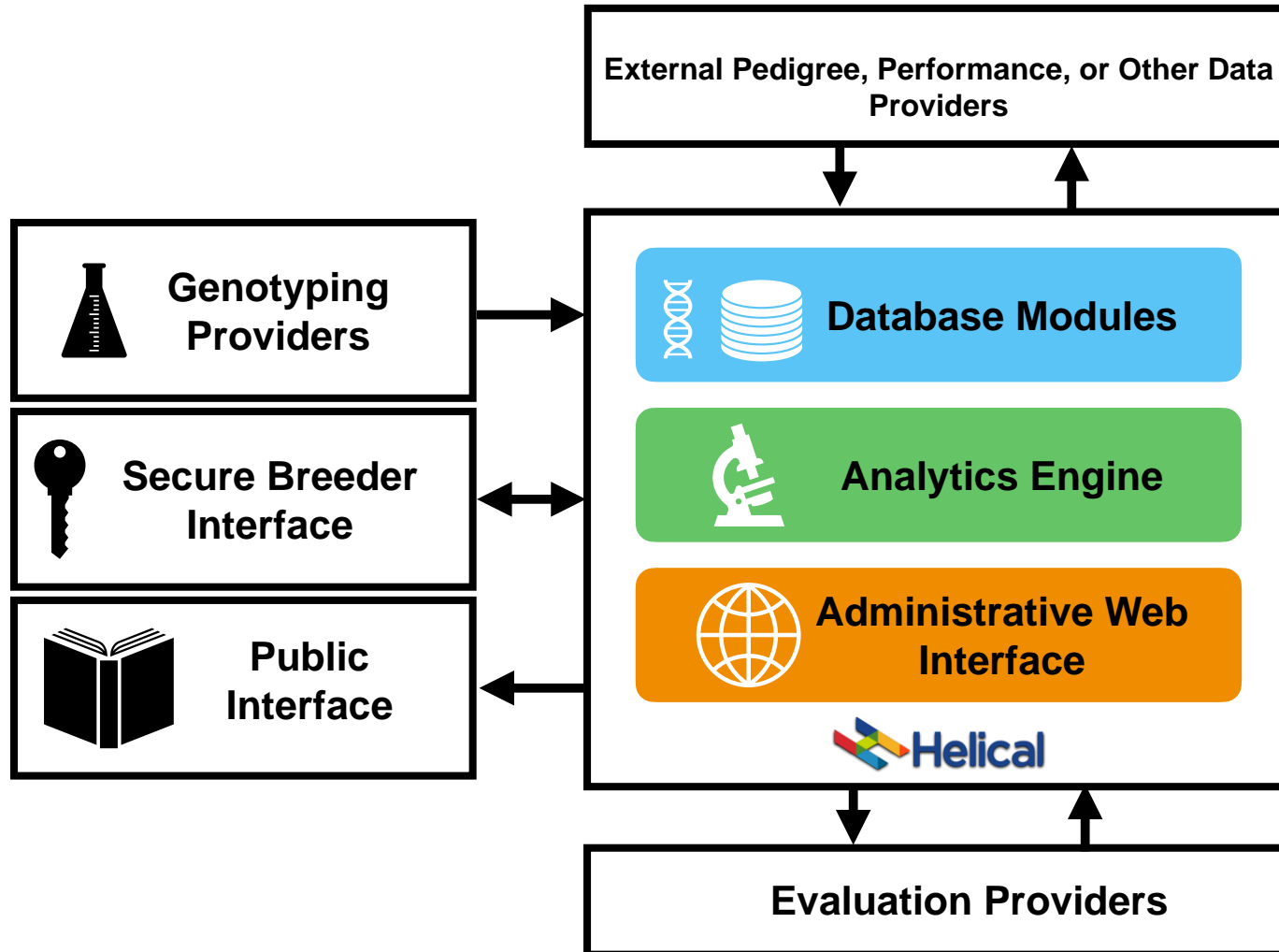
#### 0299220042

Lot: 4

The first of the Homozygous polled bulls. By our Gold Creek purchase from 2021, Lebron is out of one of our best first calving Democrat daughters. Beautiful temperament, a powerful bull with great capacity.



# Our focus is innovative software for genetic improvement



**Continuous integration of new technologies and data pipelines including genomic prediction, selection support tools, data collection, and AI assistants, requires flexible and agile information system(s)**



# Thanks for your attention!

- **BOLT** - software for genetic and genomic evaluations
- **Helical** - software for information systems for genetic improvement, and for genetic and genomic evaluations

