



**Freedom from a lifetime of disease**

February 6, 2019

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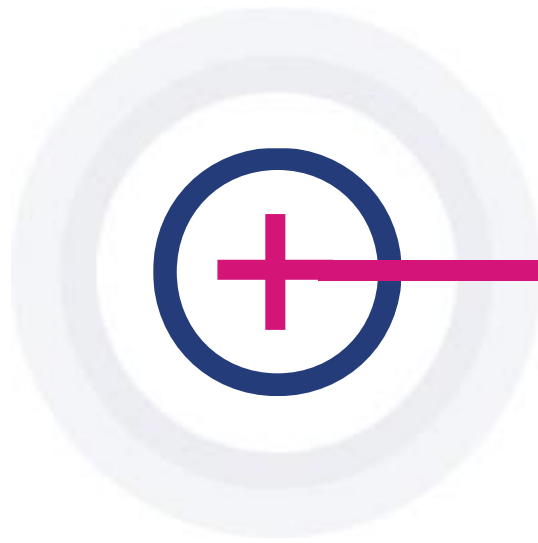
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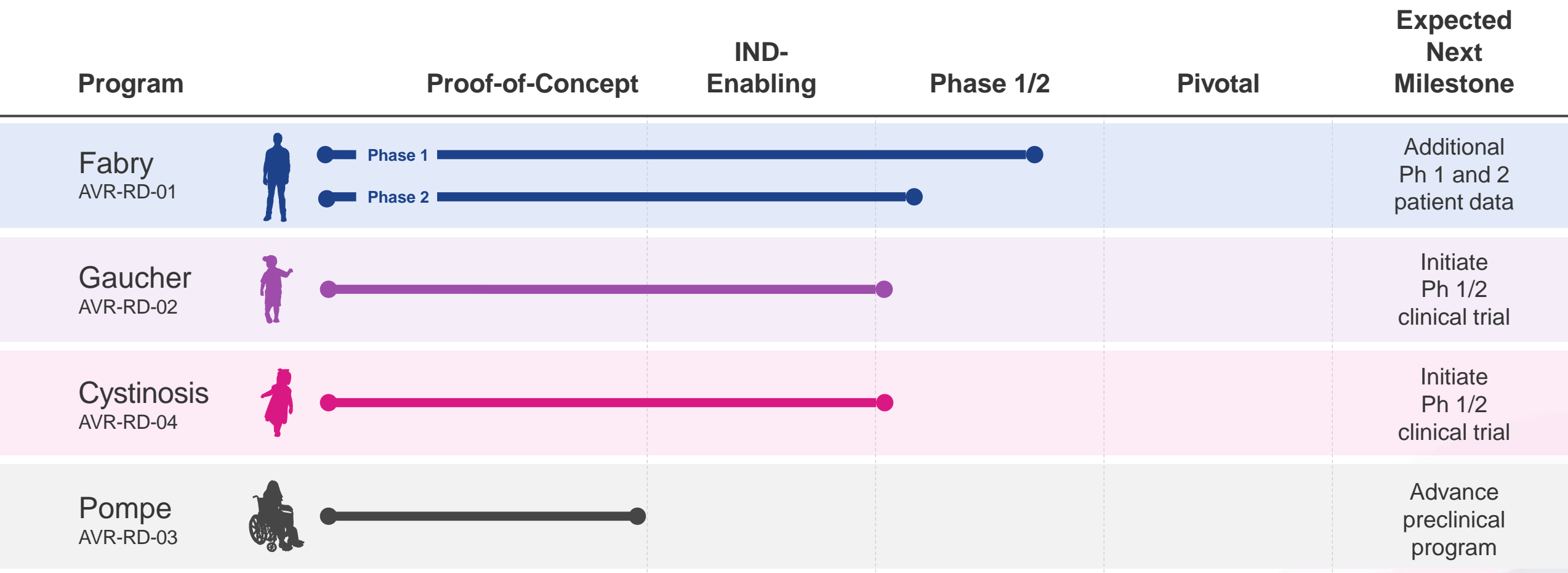


## Today's agenda

- Expanded leadership team
- Updated Fabry clinical data
- Introduce **plato**<sup>™</sup>
- Pipeline update

# Steady stream of clinical programs

Worldwide rights across portfolio



# Cell, gene and rare disease industry leaders



## AVROBIO expands and strengthens team

### MANAGEMENT TEAM



**Geoff MacKay**  
President and CEO



**Birgitte Volck, PhD, MD**  
President of Research and Development



**Kim Warren, PhD**  
Head of Operations



**Erik Ostrowski**  
Chief Financial Officer



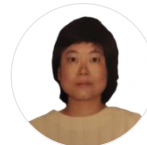
**Chris Mason, MD,**  
PhD, FRCS  
Chief Science Officer



**Steven Avruch, JD**  
General Counsel



**Deanna Petersen, MBA**  
Chief Business Officer



**Josie Yang, PhD**  
Head of Regulatory Affairs



**Kathryn McNaughton, PhD**  
SVP Portfolio & Program Management



### BOARD OF DIRECTORS

**Bruce Booth, DPhil**  
Chairman



**Ian Clark**



**Philip Vickers, PhD**



**Annalisa Jenkins,**  
MBBS, FRCP



**Phillip Donenberg**



**Chris Paige, PhD**



**Geoff MacKay**





# Patient focus groups December 2018

Significant unmet need and continued disease progression on ERT

*“I feel awful and there [are] so many, so many things that don’t show up on tests.”*

*“I have severe pain, severe exhaustion.”*

*“My reason for doing ERT is not so like I’ll feel better. I wish it was. It would be great if it lessened my pain or something. It is longevity of life, period.”*

*“The GI issues and pain, the infusions don’t really help with that.”*

*“[ERT] is not going to help a stroke.”*

*“My mother has Parkinson’s. My brother is 34 and 2 weeks ago because of his Gaucher’s, he just had a double hip replacement.”*

*“I have avascular necrosis in both my hips.”*

*“A day or two before I have my treatment, I don’t notice as much. My partner notices. You look white as a ghost. I’m exhausted. I’m snappy and I clearly had 8 hours of sleep, but no part of me feels that way.”*

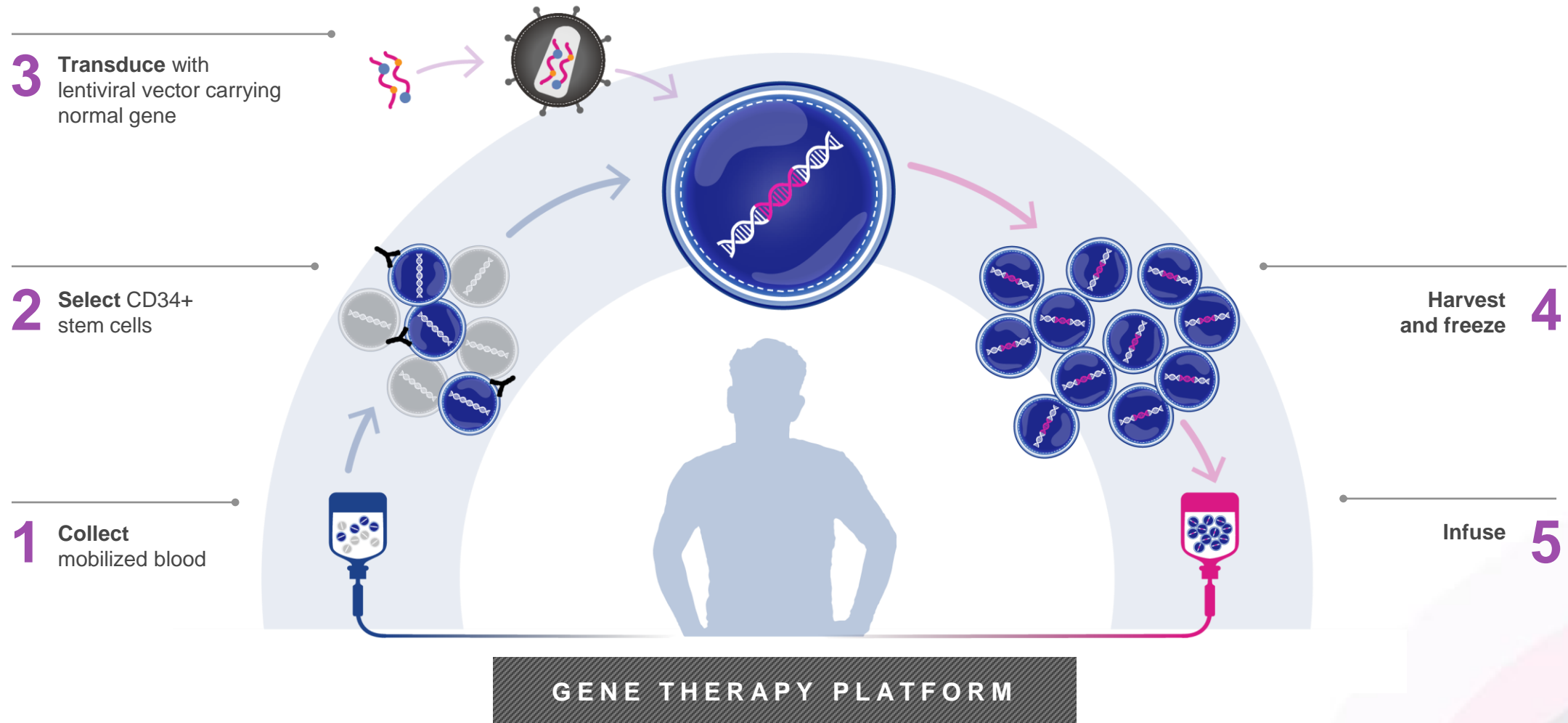
Patients with Fabry disease

Patients with Gaucher disease



## Our approach

# One platform applied across our portfolio





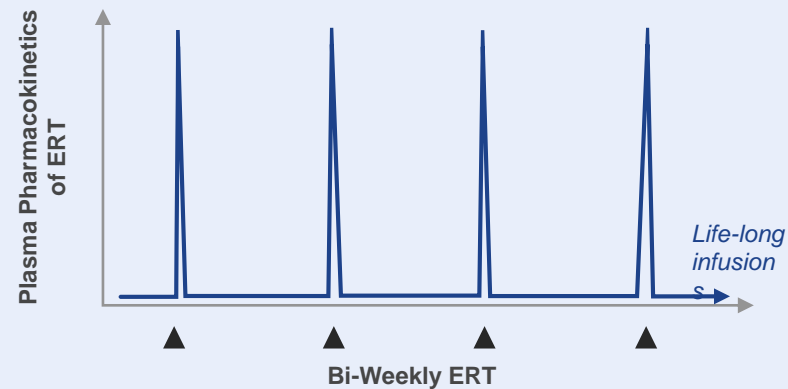
# Life-long treatments vs. Potential single dose cure



## DISEASE PROGRESSION CONTINUES

### Enzyme Replacement Therapy (ERT)

Temporary bolus of enzyme, not curative



Enzyme or protein level

Transient, intermittent elevation

Treatment burden

Bi-weekly IV infusions

## DISEASE PROGRESSION COULD HALT

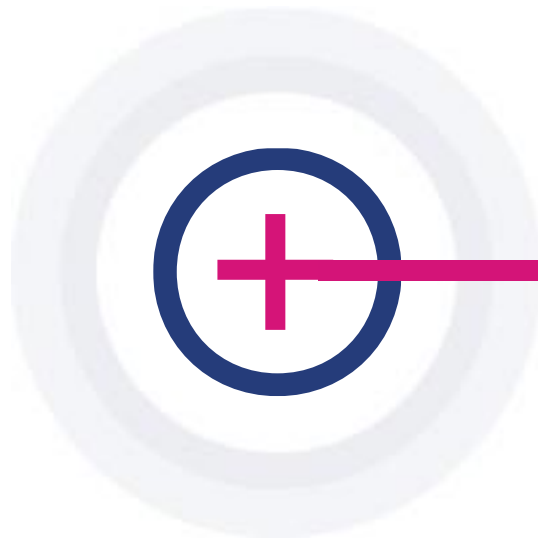
### AVROBIO Gene Therapy

24/7 expression of protein, curative potential



Long-term, continuous elevation

Single IV infusion



## AVRO-RD-01 in Fabry disease



# Goals for gene therapy in Fabry disease

## TO PREVENT OR IMPROVE:

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### Kidney function

**Unmet needs:** proteinuria, polyuria, kidney failure



### Cardiac function

**Unmet needs:** left ventricular hypertrophy, fibrosis, heart failure



### Neuropathic pain

**Unmet needs:** pain and burning sensations in hands and feet, pain crises



### Everyday burden of illness, and life expectancy

**Unmet needs:** fatigue, inability to sweat, joint pain, abdominal pain, diarrhea, vomiting, cloudy vision, hearing loss, tinnitus, rash, angiokeratomas, biweekly infusions, shortened lifespan



### CNS complications

**Unmet needs:** TIA/stroke, depression, mild cognitive deficiency, white matter hyperintensities

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# New clinical data

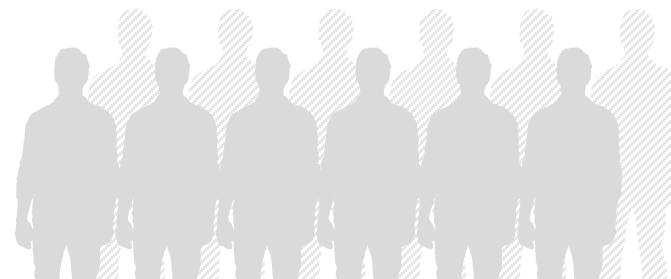
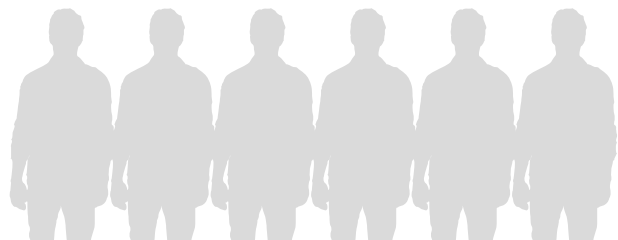
## Growing body of clinical data in Fabry

- + All patient data to-date demonstrated **AGA enzyme activity** above the diagnostic range
- + **Substantial reductions in substrate and metabolite levels** of patients on gene therapy alone observed across multiple measurements
- + Impact seen in **both** treatment-naïve patients and previously treated patients who have discontinued ERT
- + AVR-RD-01 observed to be **generally well tolerated**

# AVR-RD-01 Fabry clinical trials



6 patients dosed across Phases 1 and 2



## PHASE 1

Investigator-Sponsored Trial\*

### Patients

n = up to 6

On ERT > 6 months prior to enrollment  
18-50 year-old males

### Key Objective

Safety

## PHASE 2

AVRO – FAB-201 Trial

### Patients

n = 8-12

ERT-naïve  
≥ 16 year-old males

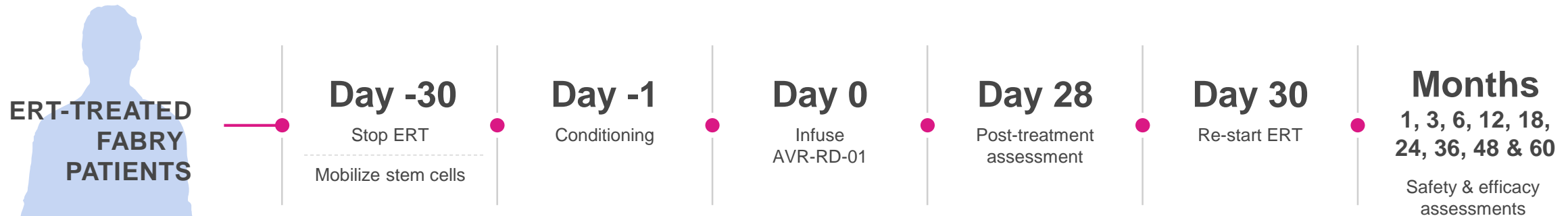
### Key Objectives

Safety and efficacy



# Phase 1: Investigator-sponsored study\* in ERT-treated Fabry patients

4 patients dosed to-date



*Clinical pilot study of autologous stem cell transplantation of CD34+ cells engineered to express AGA in patients with Fabry disease*

OBJECTIVES	PATIENTS	ASSESS
<ul style="list-style-type: none"><li>• Safety</li><li>• Preliminary efficacy</li></ul>	<ul style="list-style-type: none"><li>• Up to 6 patients</li><li>• 18-50 year old males</li><li>• Receiving ERT</li></ul>	<ul style="list-style-type: none"><li>• Plasma and leukocyte enzyme activity</li><li>• Presence of vector in peripheral blood and bone marrow cells</li><li>• Safety</li></ul>

\* **Note:** Protocol amendment allows for discontinuation of ERT 6 months after treatment with AVR-RD-01

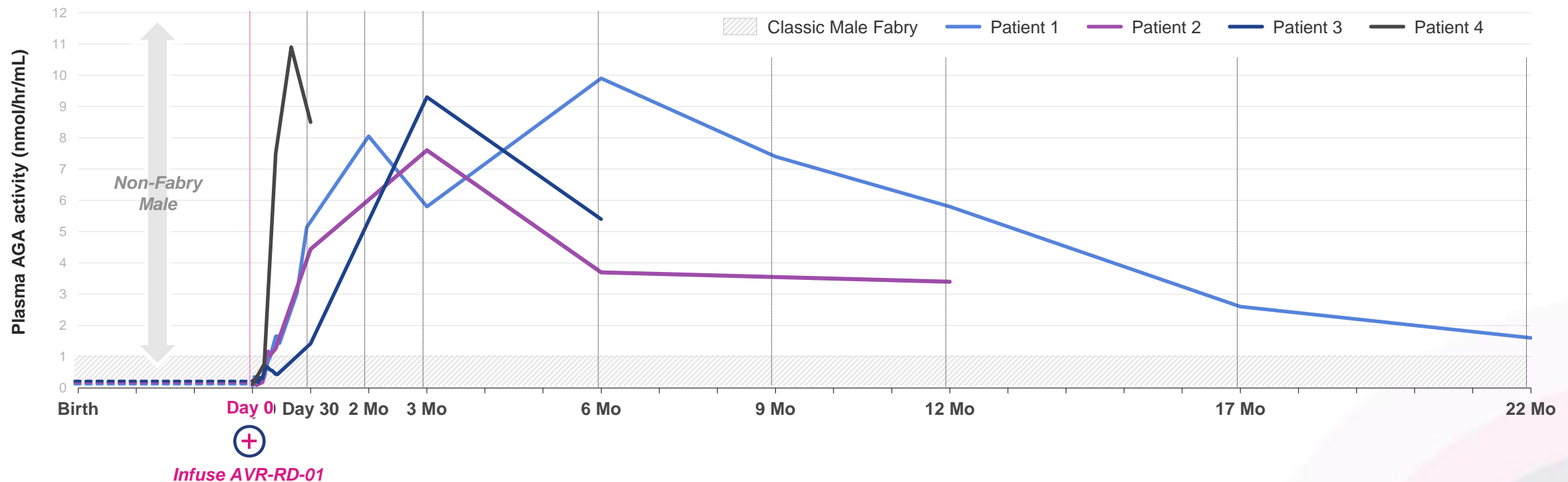
\* Sponsored by FACTs team (Fabry disease Clinical research and Therapeutics) in Canada

# Phase 1: Substantial enzyme activity elevation

Sustained at 22 Months



*Level of AGA enzyme activity rose from nearly undetectable levels to levels above the range for males with classic Fabry disease*



Source of reference bar: Tsukimura T et al, Mol Genet Metab, 2014

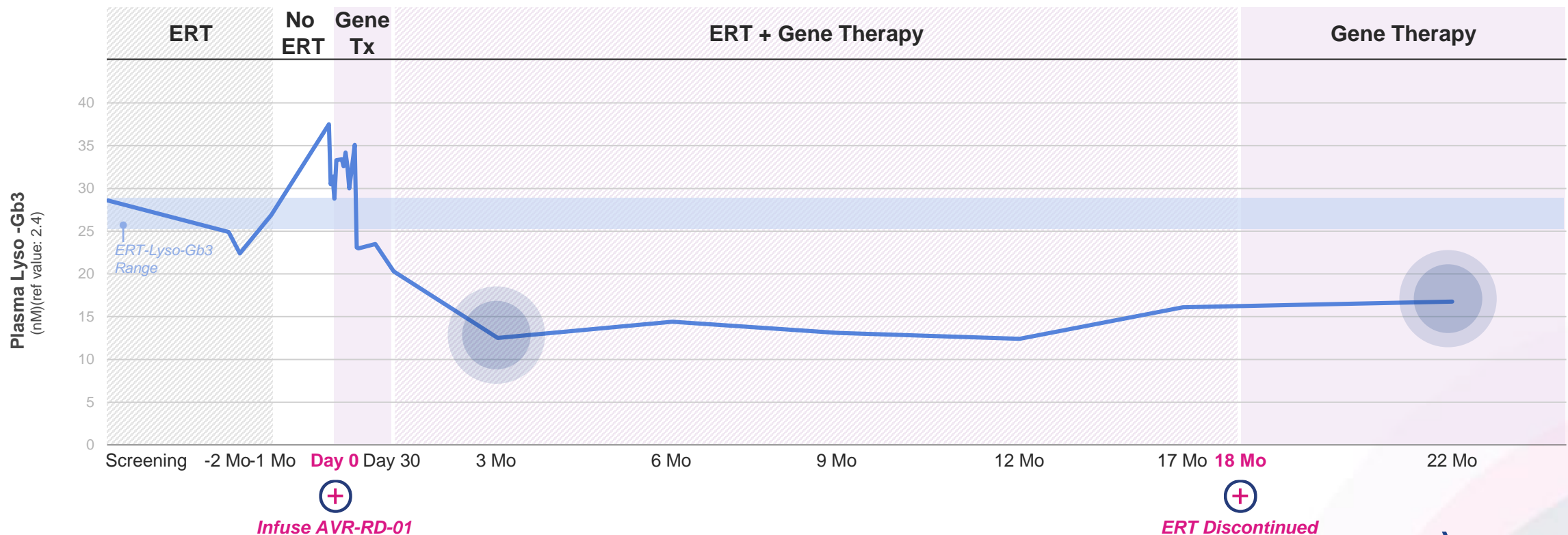
Note: Enzyme measurements are taken at ERT troughs

Note: Dotted line illustrative only

# Phase 1: Plasma Lyso-Gb3 reduction sustained after discontinuation of ERT



***PATIENT #1: Plasma Lyso-Gb3 remains below ERT levels with AVR-RD-01 gene therapy alone***

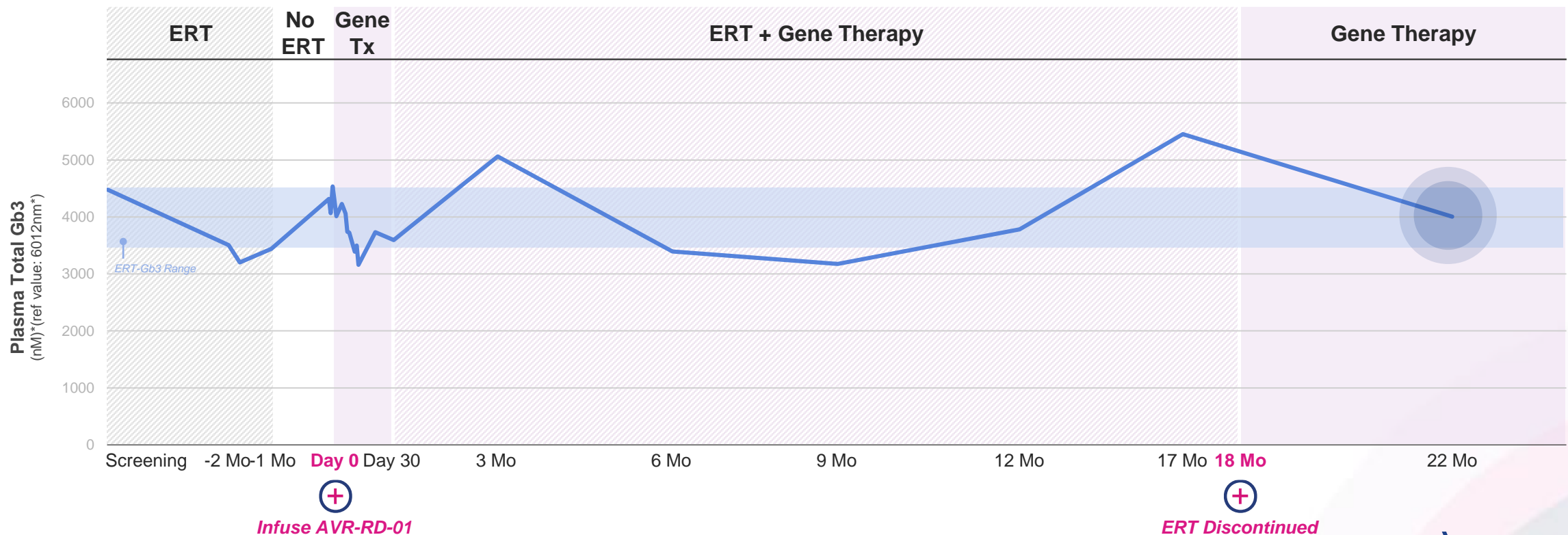




# Phase 1: Plasma Total Gb3 Levels sustained after discontinuation of ERT



*PATIENT #1: Plasma Total Gb3 remains at ERT levels with AVR-RD-01 gene therapy alone*

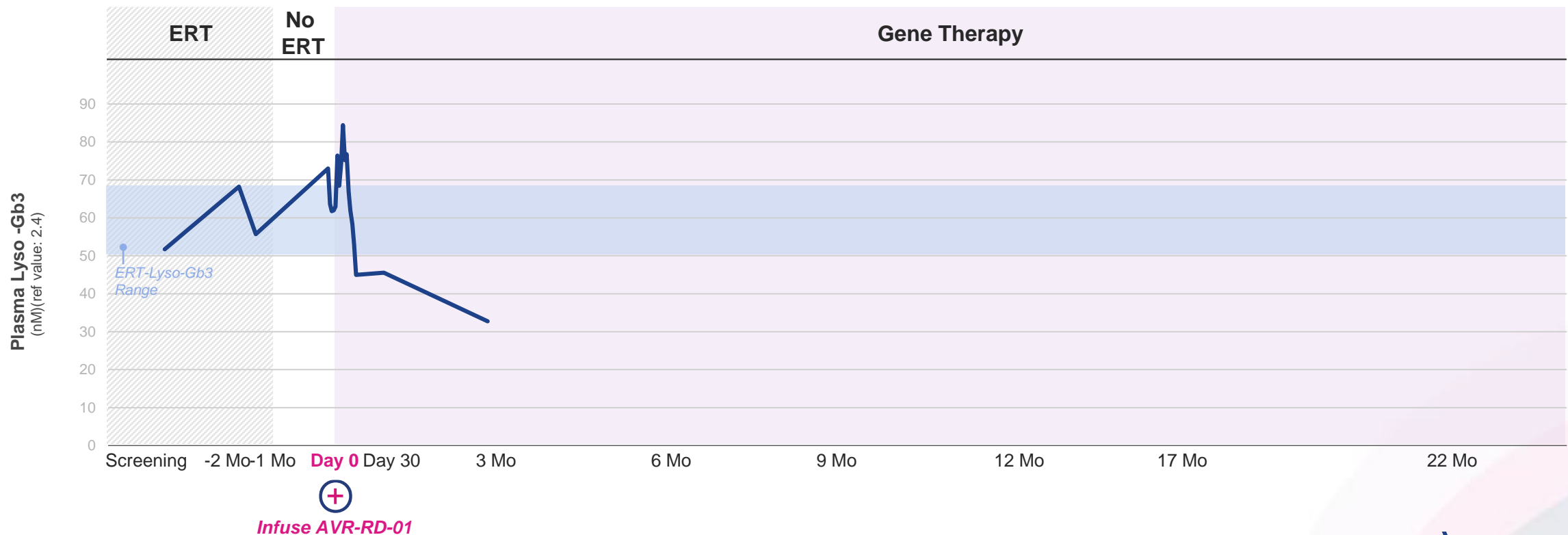


\* Ref value updated Aug. 2018 to 4961

# Phase 1: Plasma Lyso-Gb3 declines below levels on ERT with **gene therapy alone**



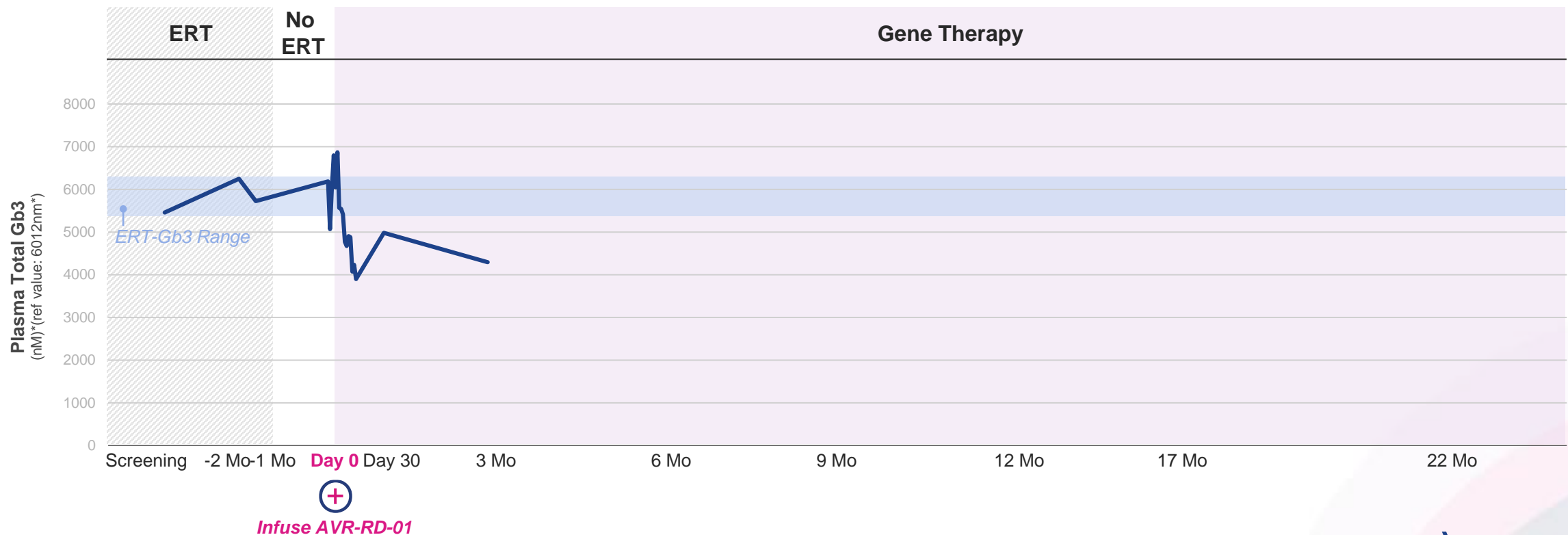
*PATIENT #3: Did not resume ERT treatment following AVR-RD-01 dosing*



# Phase 1: Plasma Total Gb3 declines below levels on ERT with **gene therapy alone**



*PATIENT #3: Did not resume ERT treatment following AVR-RD-01 dosing*



\* Ref value updated Aug. 2018 to 4961

# Phase 1: Vector Copy Number (VCN)



Drug Product VCN		Peripheral Blood VCN	Patient 1	Patient 2	Patient 3
Patient 1	0.7	1 Month	0.4	0.8	0.2
		3 Months	0.6	1.1	0.8
Patient 2	1.4	6 Months	0.4	0.4	0.5
		9 Months	0.3	-	
Patient 3	0.8	12 Months	0.2	0.4	
		17 Months	0.1		
Patient 4	1.4	22 Months	0.1		

***PATIENT #1: At 14 months, 13% of bone marrow mononuclear cells were vector positive***

Phase 1:  
AVR-RD-01  
**generally  
well tolerated**  
Safety and tolerability



**AEs reported as expected** for  
melphalan conditioning



**No SAEs related to AVR-RD-01**

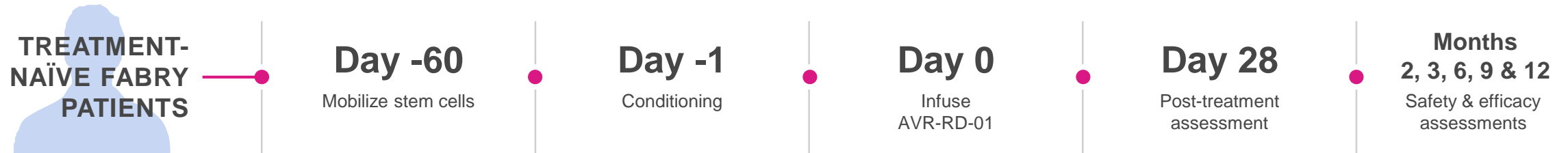


**No antibody elevation**, consistent  
throughout study for all patients



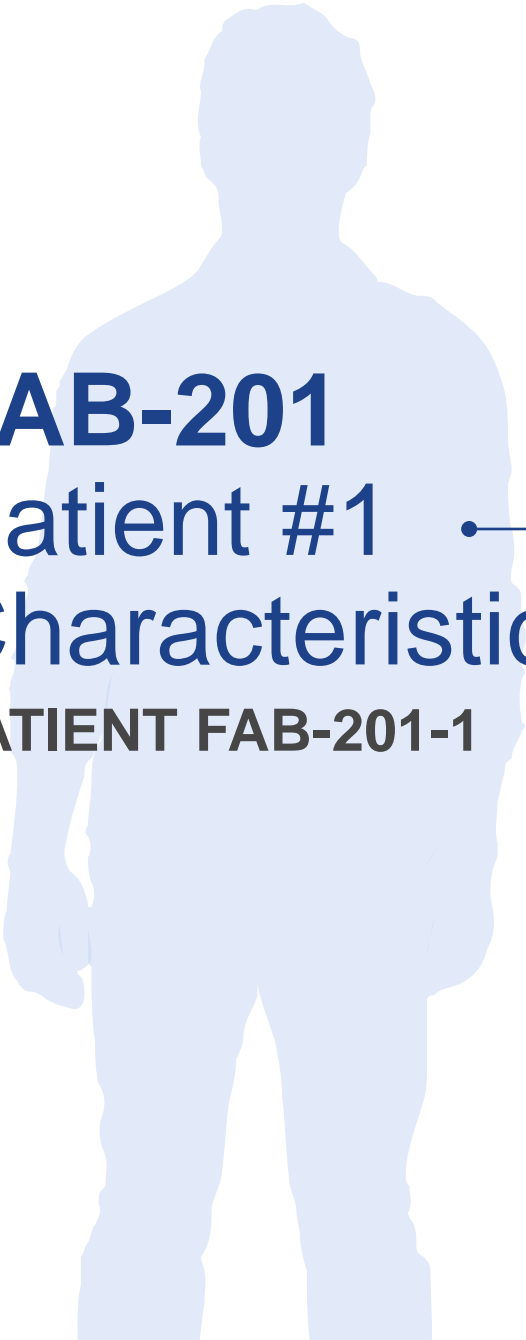
# FAB-201: AVROBIO Phase 2 study in Treatment-Naïve Fabry patients

2 patients dosed to-date



*Phase 2 open-label, multinational study of the efficacy and safety of ex vivo lentiviral-based vector gene therapy AVR-RD-01 for treatment-naïve subjects with classic Fabry disease*

OBJECTIVES	PATIENTS	ASSESS
<ul style="list-style-type: none"><li>• Safety</li><li>• Efficacy (functional endpoints and biomarkers)</li></ul>	<ul style="list-style-type: none"><li>• 8-12 patients</li><li>• Adult males (age <math>\geq 16</math> years)</li><li>• Treatment-naïve</li></ul>	<ul style="list-style-type: none"><li>• Primary efficacy endpoint: reduction of substrate in kidney biopsy</li><li>• Substrate reduction (Gb3 and/or lyso-Gb3) in urine, plasma, skin</li><li>• Enzyme (AGA) activity</li><li>• Kidney function</li><li>• Cardiac size</li><li>• Vector Copy Number (VCN)</li><li>• Chimerism</li><li>• Safety</li></ul>



# FAB-201 Patient #1

## Characteristics

PATIENT FAB-201-1

### GENERAL

- 21 year old male
- No prior treatment with ERT or chaperone therapy
- Family history of Fabry disease

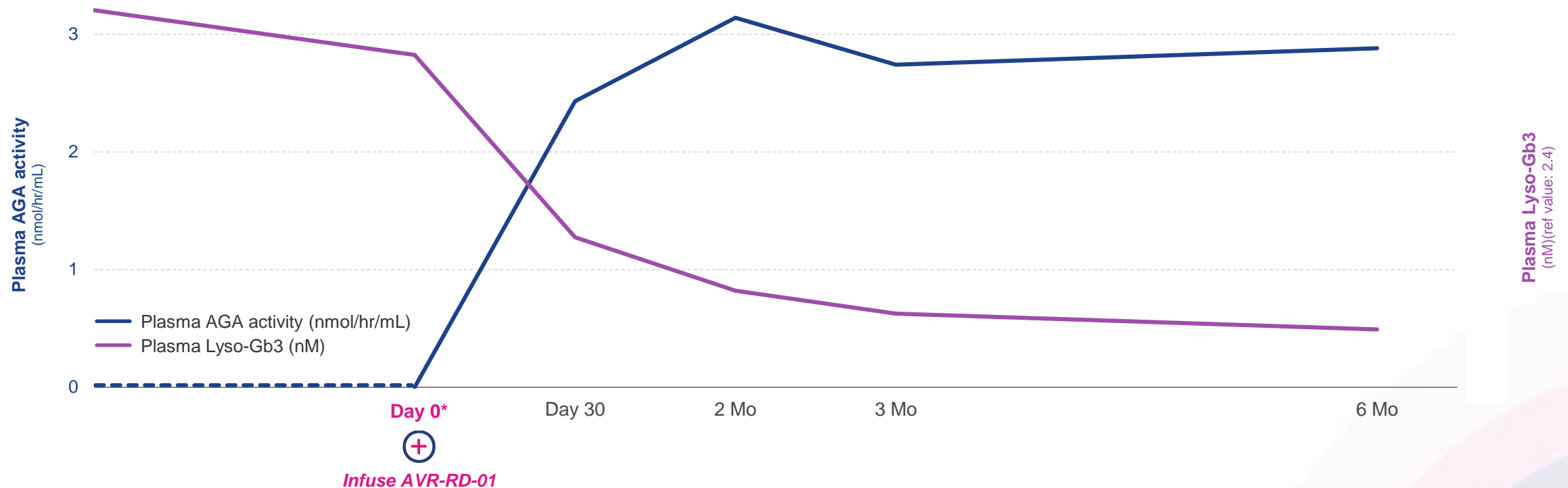
### FABRY DISEASE HISTORY

- Chronic acral pain and knee pain, onset age 10
- Gastrointestinal symptoms (intermittent diarrhea), onset age 15
- Diagnosed age 19
  - Umbilical keratoma
  - Decreased cold sensation



# FAB-201: Substantial increase in AGA enzyme activity with associated **reduction in Plasma Lyso-Gb3**

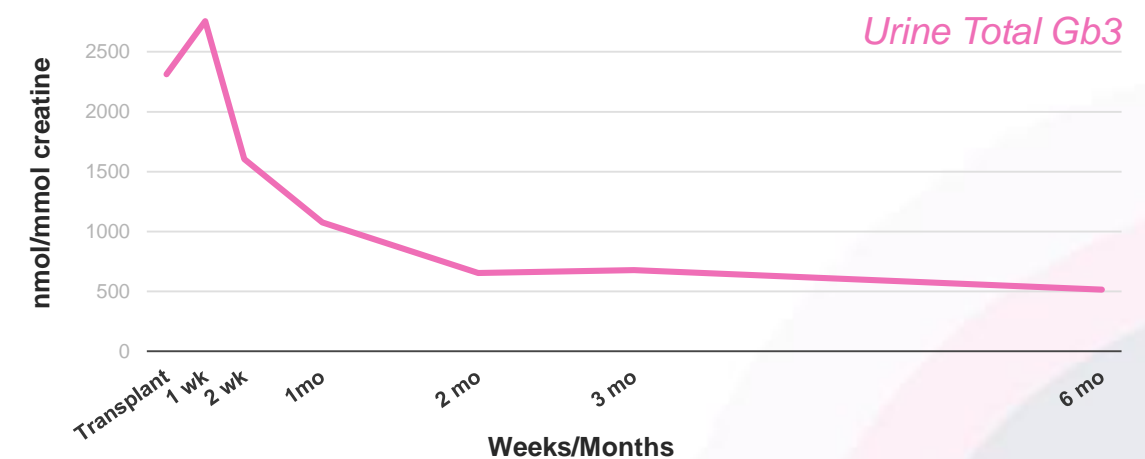
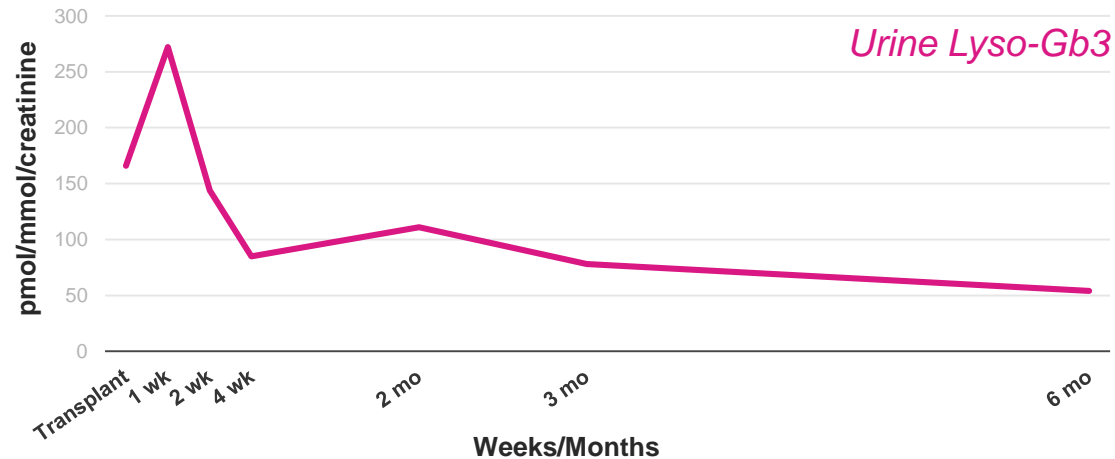
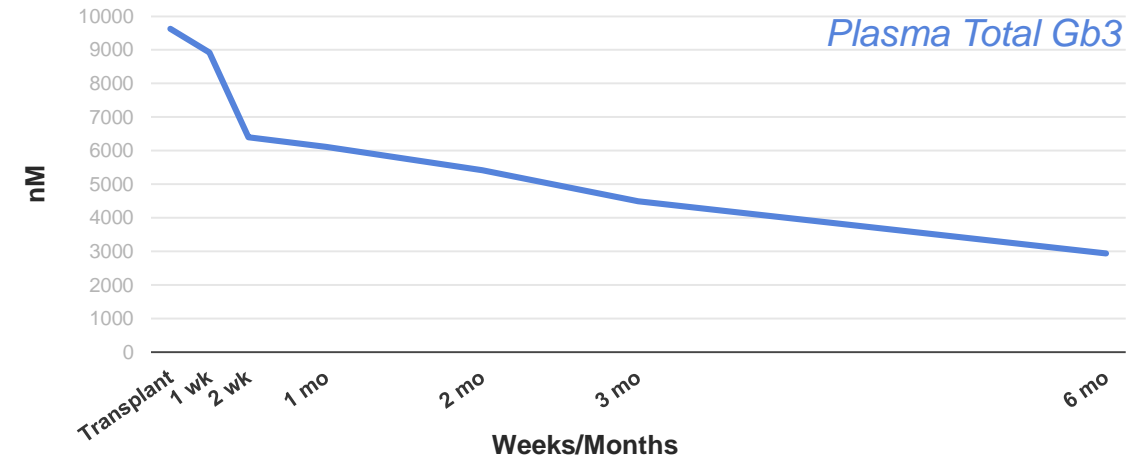
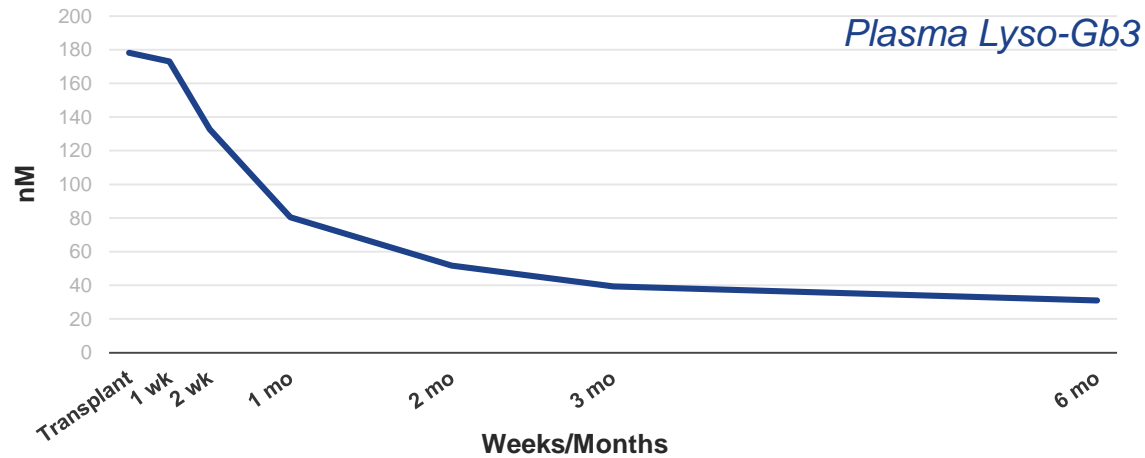
*Patient #1: 85% reduction in plasma lyso-Gb3 levels observed within 6 months*





# FAB-201: Patient #1 – Decline in multiple substrate/metabolite levels following gene therapy

## Gb3 and lyso-Gb3



# FAB-201: Vector Copy Number (VCN)



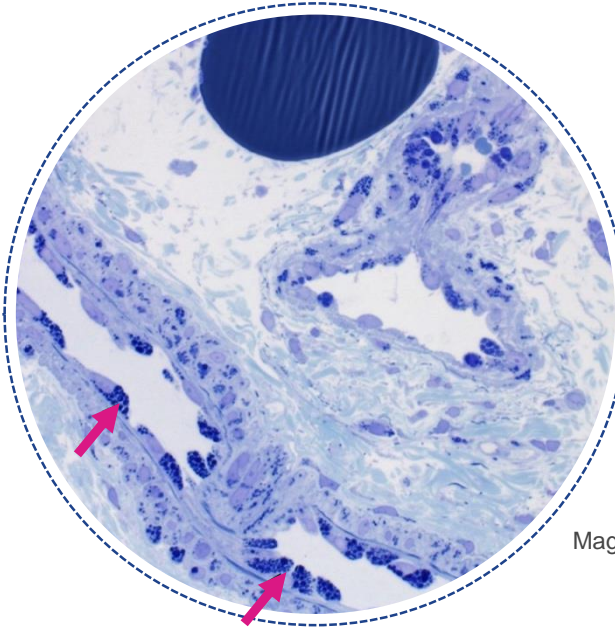
Drug Product VCN		Peripheral Blood Average VCN	Patient FAB-201-1
Patient FAB-201-1	0.7	1 Month	0.2
		2 Months	0.2
		3 Months	0.5
		6 Months	0.2

# FAB-201: Reduction in substrate inclusions in skin endothelial cells



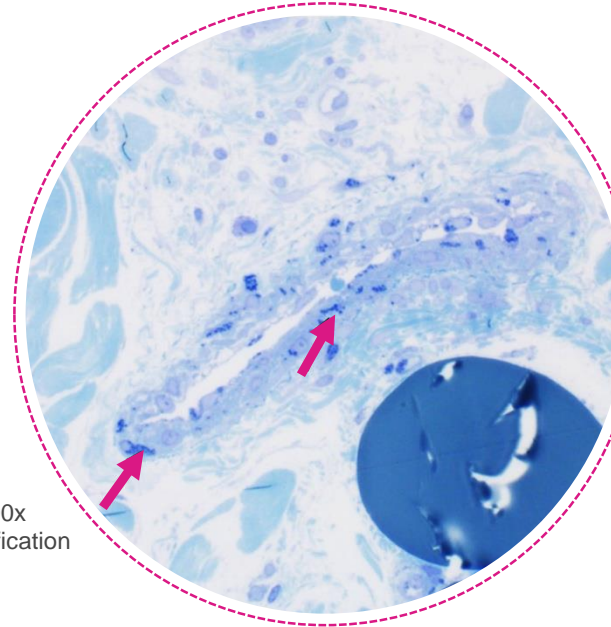
*Patient #1 achieved reduction in skin biopsy score from 3 to 2 within 6 months*

**Baseline  
Biopsy Score: 3**  
*Severe accumulation*



400x  
Magnification

**6-Month  
Biopsy Score: 2**  
*Moderate accumulation*



## **Skin Biopsy Scoring:**

3 = Large accumulations of inclusions, with some clusters at the juxtanuclear region and around cytoplasmic borders, and bulging of the vessel lumens

2 = Multiple vessels with multiple sites of single or multiple inclusions

1 = Majority of vessels with a single endothelial inclusion

0 = None or only trace microvascular endothelial deposits of GL-3 (normal or nearly normal)

Source: Thurberg B et al, J Investigative Dermatology, 2004

Phase 2:  
AVR-RD-01  
**generally  
well tolerated**  
Safety and tolerability



**AEs reported as expected** for  
melphalan conditioning



**2 serious adverse events reported**

- one pre-treatment and one post-treatment (dehydration, nausea and vomiting) potentially related to conditioning, but not considered to be related to AVR-RD-01



**No antibody elevation**

- Baseline and 4-week values negative



# FAB-201 SUMMARY

**PATIENT FAB-201-1  
at 6 months**

## FAB-201: Phase 2 in treatment-naïve Fabry patients

- Substantial enzyme increase
- Associated with substrate reduction
- Generally well tolerated
- Awaiting long-term follow-up

# Significant advances in Fabry clinical program

## Growing body of clinical data in Fabry

- + 6 patients dosed across 2 active clinical trials
- + All patient data to-date demonstrated **AGA enzyme activity** above the diagnostic range
- + **Substantial reduction in substrate and metabolites** observed in both ERT-treated and ERT-naïve patients
- + AVR-RD-01 observed to be **generally well tolerated**

INTRODUCING

plato<sup>+</sup><sup>TM</sup>

Gene therapy.  
Evolved.

AVROBIO



# Introducing plato™

AVROBIO's foundation for worldwide commercialization



A **vector system** and cell **manufacturing solution** designed to support commercialization

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**Automated, closed manufacturing system** for CD34+ gene therapy

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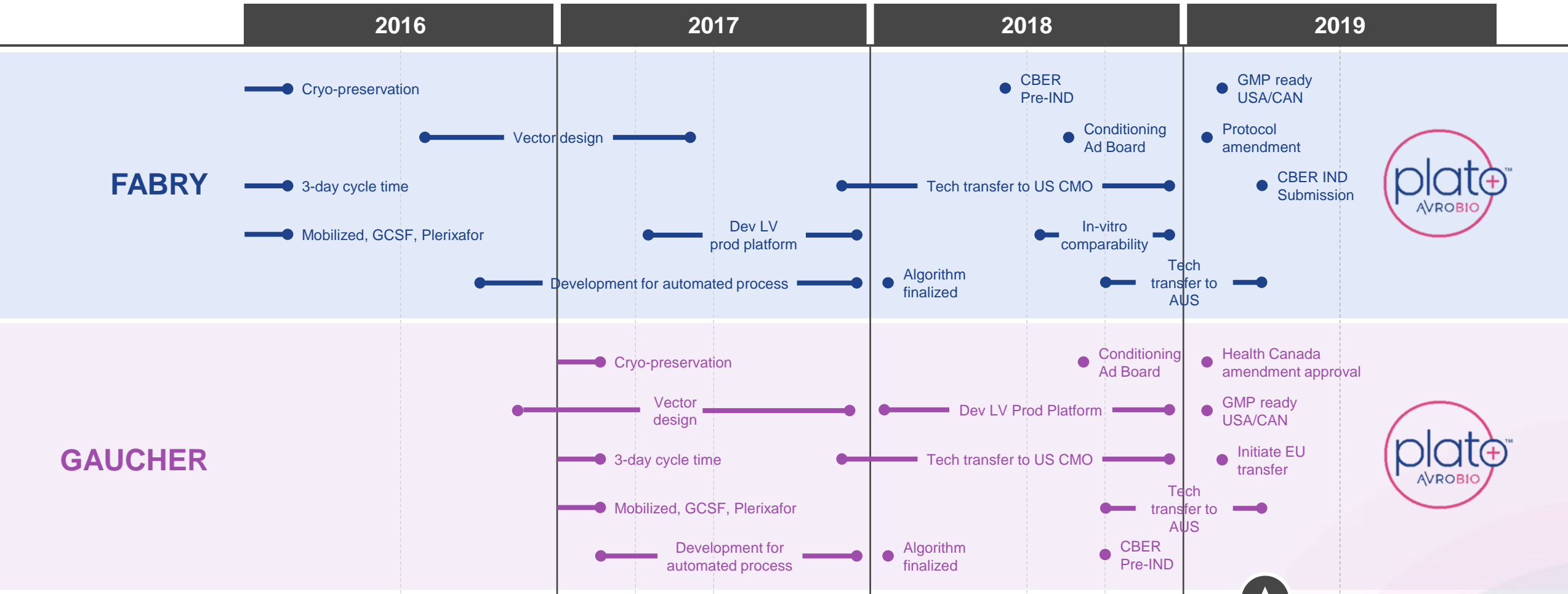


Designed to safely deliver **long-term efficacy** and **durability**



# plato™: Commercial platform over 3 years in the making

Clinical trials 2H 2019, regulatory milestone obtained



# plato™ overcomes historical bottlenecks to enable commercialization



## Expanded Scale

Potential to reach thousands of patients per year



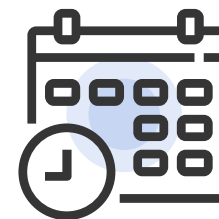
## Broader Reach

Portable platform for flexible global production using low grade clean rooms



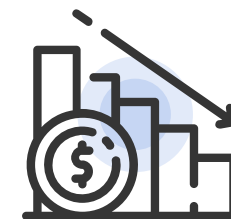
## High Quality

Automated, closed system designed to improve quality and consistency



## Longer Shelf-Life

Cryopreservation simplifies logistics and patient scheduling












## Lower Costs

Efficiencies in vector design / scalable cell and vector production

# plato™: Three 2019 upgrades designed to optimize **potency, safety, and durability**



 UPGRADES	Increased enzyme activity	Increased transduction efficiency	Increased VCN	Increased marrow space / engraftment	Increased consistency and safety
			 *		 **
					
					
<i>Upgrades designed to increase Vector Copy Number (VCN), chimerism and durability</i>					

\* Average VCN per cell  
\*\* TDM (therapeutic drug monitoring)

**CONDITIONING UPGRADE:****plato™** transitions to busulfan TDM for anticipated advances in **safety and efficacy**

**WHAT** Switch from 100mg/m<sup>2</sup> melphalan to **busulfan** with **Therapeutic Drug Monitoring (TDM)**

**WHY**

Busulfan **used successfully** in many gene therapy indications

TDM intended to **elevate safety profile** while permitting higher intensity

Potential to **impact CNS manifestations** which affect many LSD patients

**SAFETY TRACK RECORD**

Busulfan in **non-malignant** conditions

- Literature shows >700 patients with **NO reports** of t-MDS / t-AML
- **Isolated case** of t-MDS in a sickle cell patient in bluebird bio's gene therapy trial

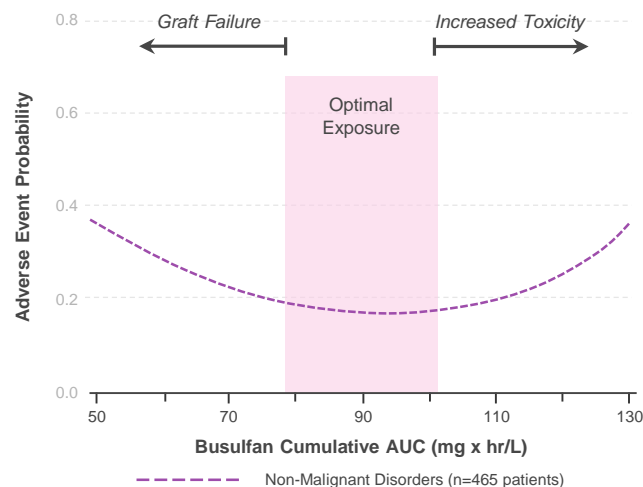
*t-MDS = Treatment-related myelodysplastic syndrome  
t-AML = Treatment-related acute myeloid leukemia  
References available upon request  
bluebird bio is a registered trademark of Bluebird Bio, Inc.*

## CONDITIONING UPGRADE:

## Busulfan intended to balance engraftment with enhanced safety

## Optimized Dosing

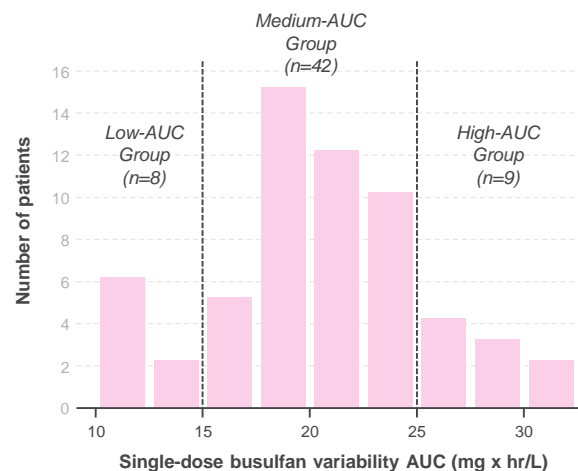
Designed to Enhance Tolerability



Lowest rate of complications in the Bu90 range

## Optimized Monitoring

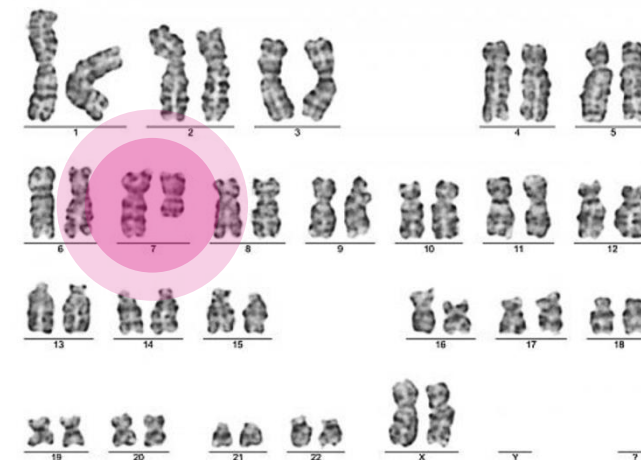
Designed to Enhance Safety



TDM via area under the curve (AUC) intended to eliminate out-of-bounds toxicity

## Optimize Screening

Designed to Reduce Patient Risk

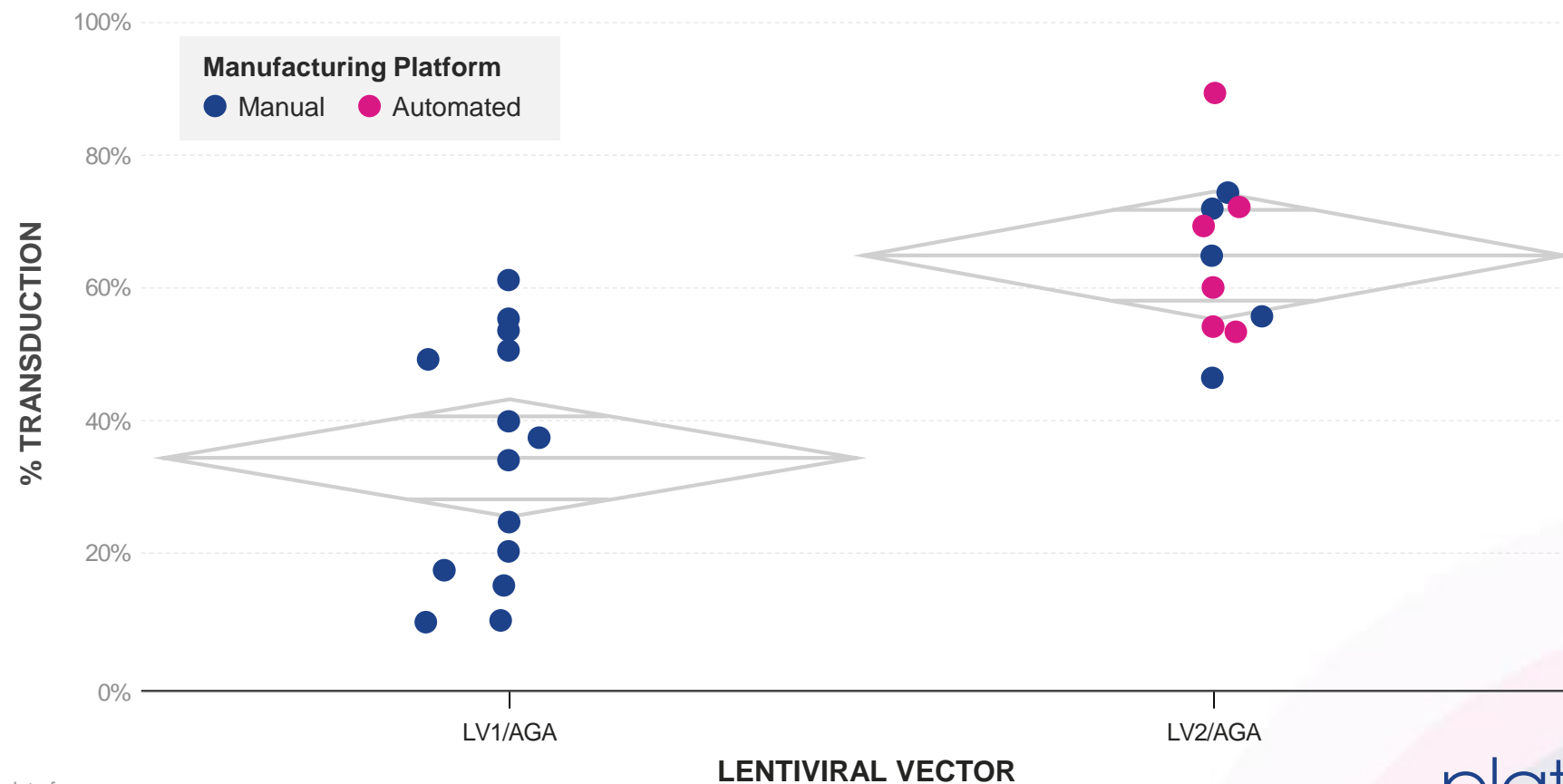


Pre-screening for molecular and cytogenetic abnormalities has potential to further reduce risk

# VECTOR & AUTOMATION UPGRADES: plato™ designed to enhance potency and long-term durability



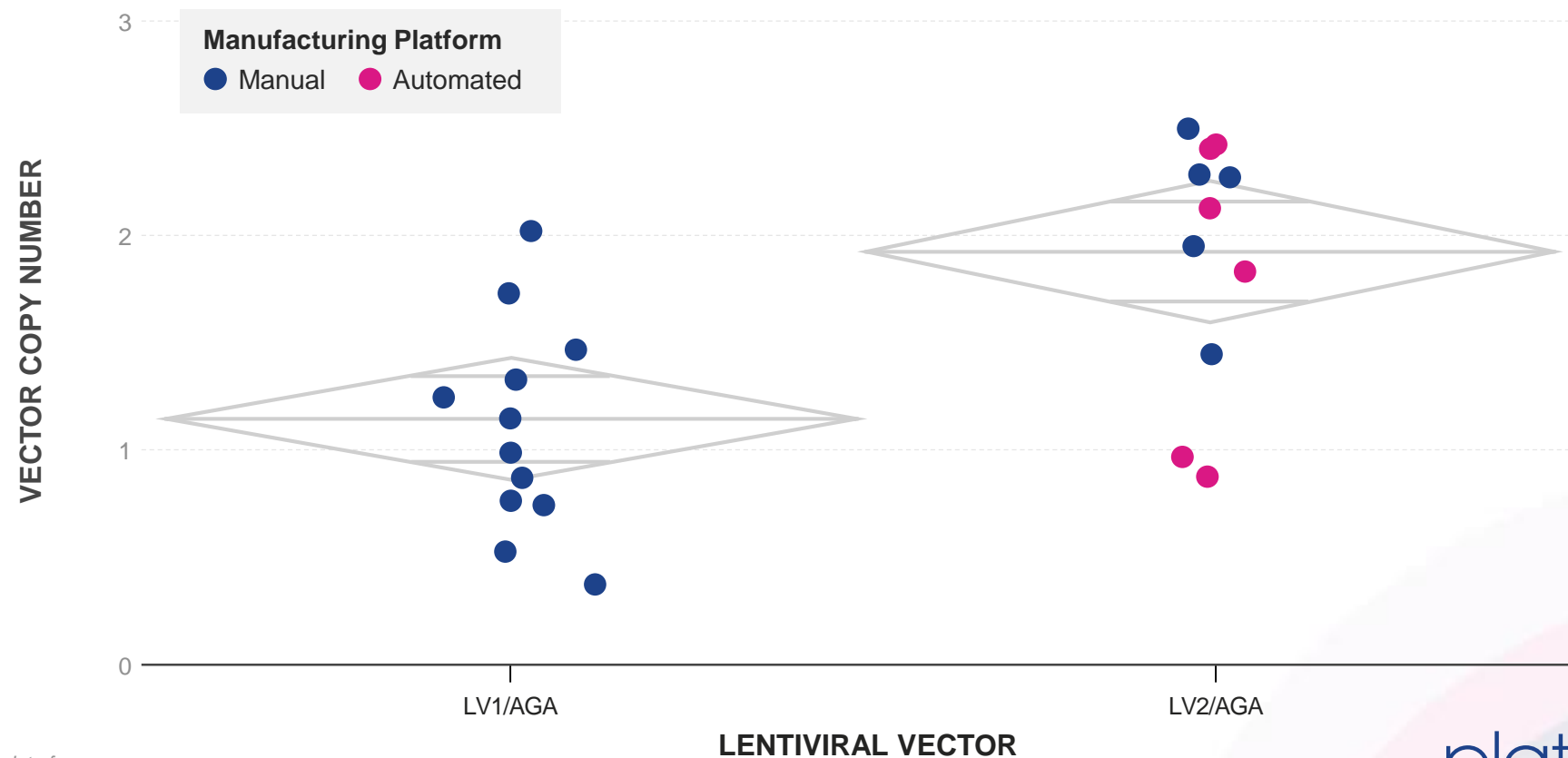
—  
*Increased  
% Transduction*  
—



*Note: Data from all development runs using normal donor cells and data from four Fabry patients Drug Products are included, as of Oct 2018*

# VECTOR & AUTOMATION UPGRADES: plato™ designed to enhance potency and long-term durability

—  
*Increased  
Vector Copy  
Number (VCN)*  
—

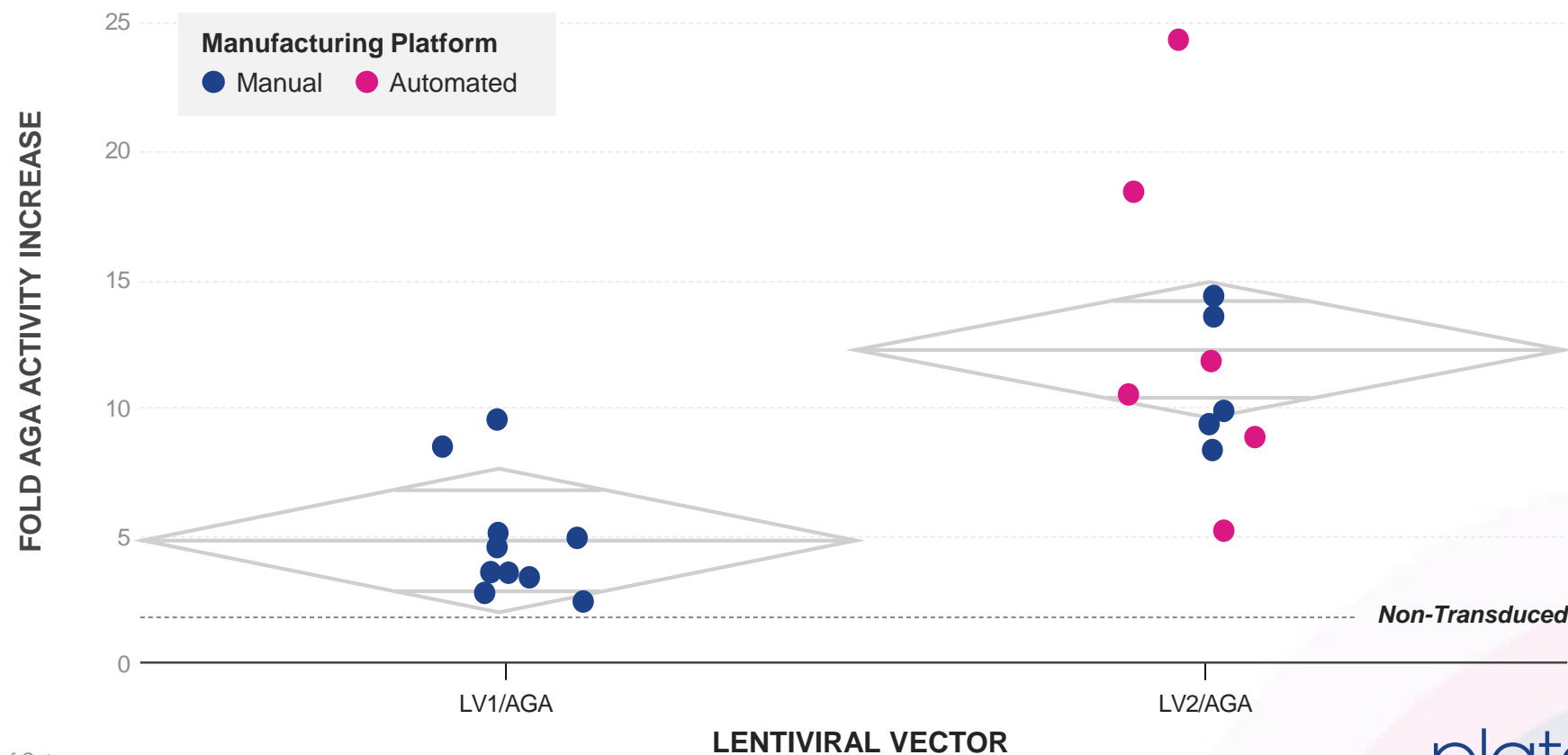


*Note: Data from all development runs using normal donor cells and data from four Fabry patients Drug Products are included, as of Oct 2018*

# VECTOR & AUTOMATION UPGRADES: plato™ designed to enhance potency and long-term durability



—  
*Increased  
AGA Enzyme  
Activity*  
—



*Note: Data from all development runs using normal donor cells, as of Oct 2018*



# Introducing plato™

AVROBIO's foundation for worldwide commercialization



Expanded Scale



Broader Reach



High Quality



Longer Shelf-Life



Lower Costs



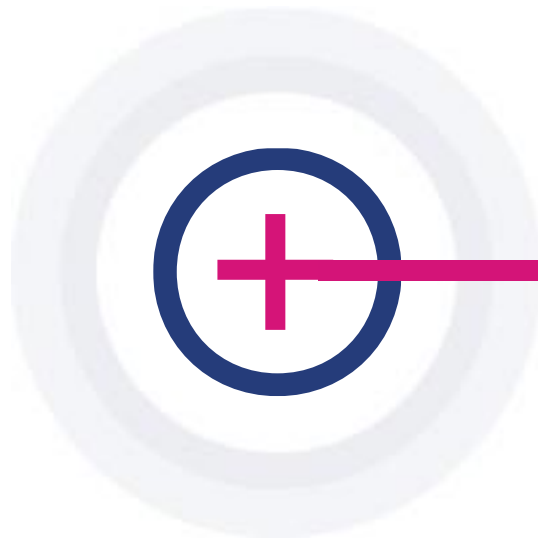
A **vector system** and cell **manufacturing solution** designed to support commercialization



**Automated, closed manufacturing system** for CD34+ gene therapy



Designed to safely deliver **long-term efficacy** and **durability**



## AVRO-RD-02 in Gaucher disease



# Goals for gene therapy in Gaucher Type 1 Disease

## TO PREVENT OR IMPROVE:



### Bone-related manifestations

**Unmet needs:** bone pain, avascular necrosis, bone crisis, osteoporosis, fractures, joint destruction, skeletal abnormalities



### Hemoglobin levels and platelet counts

**Unmet needs:** anemia, thrombocytopenia, easy bruising, bleeding



### Hepatosplenomegaly

**Unmet needs:** enlarged liver, enlarged spleen



### Everyday burden of illness, and life expectancy

**Unmet needs:** fatigue, pain, lung disease, biweekly infusions, shortened lifespan



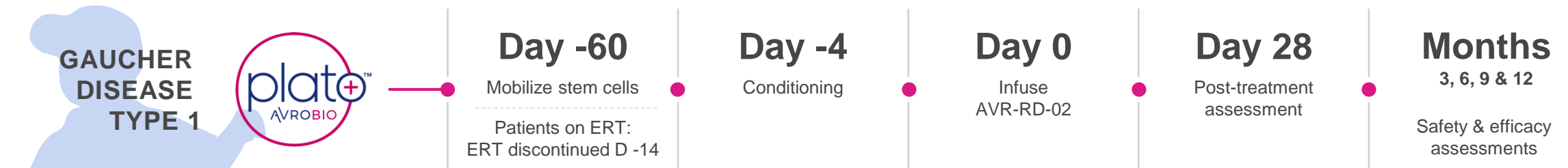
### CNS complications

**Unmet needs:** GBA-Parkinson's disease



# GAU-201: AVROBIO Phase 1/2 study in Gaucher Type 1 patients

ERT-stable and treatment-naïve patients



*An adaptive, open-label, multinational phase 1/2 study of the safety and efficacy of ex vivo, lentiviral vector mediated gene therapy AVR-RD-02 for subjects with Type 1 Gaucher disease*

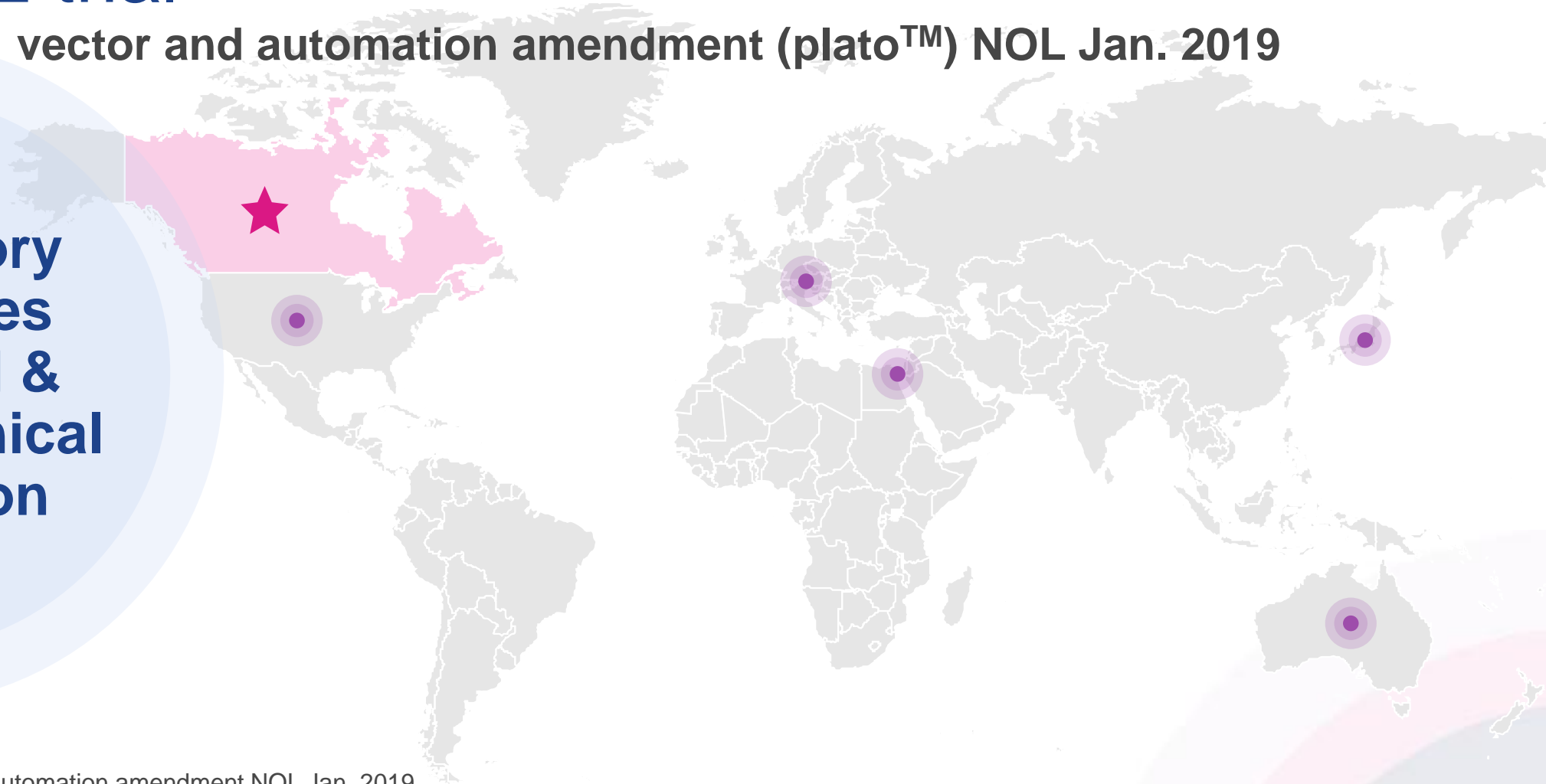
OBJECTIVES	PATIENTS	ASSESS
<ul style="list-style-type: none"><li>• Safety</li><li>• Engraftment</li><li>• Efficacy (functional endpoints and biomarkers)</li></ul>	<ul style="list-style-type: none"><li>• 8-16 patients</li><li>• 16-35 year old males and females</li><li>• Two arms<ul style="list-style-type: none"><li>– Treatment naïve</li><li>– Stable receiving ERT</li></ul></li></ul>	<ul style="list-style-type: none"><li>• Vector Copy Number (VCN)</li><li>• Chimerism</li><li>• GCase activity, including in CSF</li><li>• Efficacy<ul style="list-style-type: none"><li>– Hematologic values</li><li>– End-organ volumes and BMD</li><li>– Biomarkers and QoL</li></ul></li><li>• Safety</li></ul>



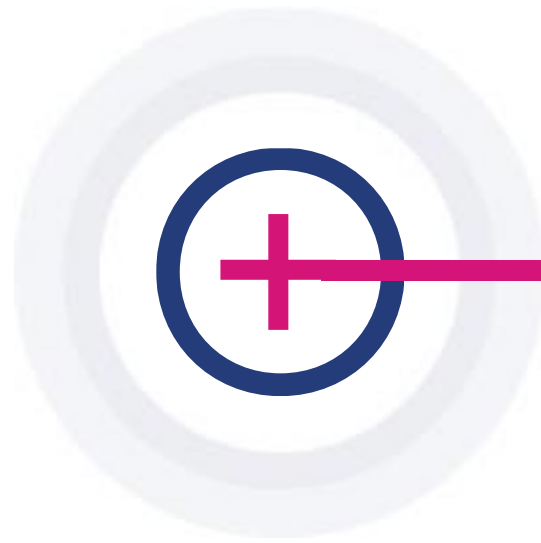
# GAU-201: Regulatory milestones for Phase 1/2 trial

CTA NOL 2018; vector and automation amendment (plato™) NOL Jan. 2019

**Regulatory  
Milestones  
Achieved &  
Future Clinical  
Expansion**



- ★ CTA NOL 2018; vector and automation amendment NOL Jan. 2019
- Planned expansion



## AVRO-RD-04 in Cystinosis



# Goals for gene therapy in Cystinosis

## TO PREVENT OR IMPROVE:



### Kidney function

**Unmet needs:** renal Fanconi syndrome, proteinuria, chronic kidney disease, kidney failure



### Vision

**Unmet needs:** corneal cystine accumulation, photophobia, involuntary eyelid closure



### Neuromuscular disorders

**Unmet needs:** myopathy, hypotonia, tremors, difficulty swallowing, neurodevelopmental issues (speech and walking delay and cognitive impairment)



### Endocrine disorders

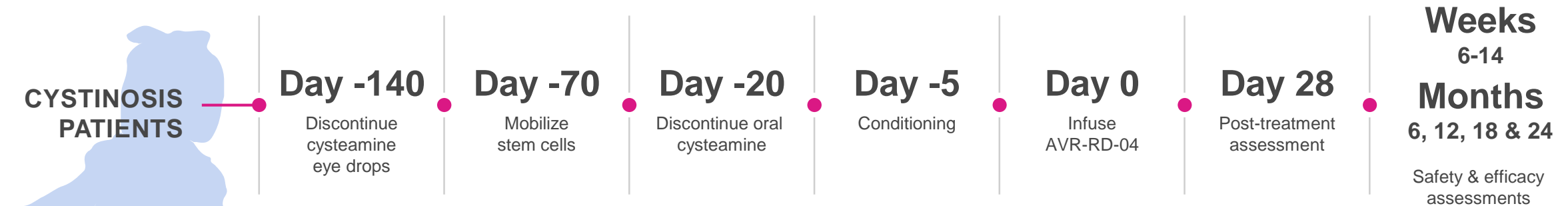
**Unmet needs:** softening/weakening of bones, bone pain, rickets, long bone deformations, hypophosphatemia, delayed growth, hypothyroidism, pancreatic insulin insufficiency, diabetes, infertility



### Everyday burden of illness, and life expectancy

**Unmet needs:** medications multiple times per day that cause GI discomfort and acid sulfur body and breath smell, shortened lifespan

# CYS-201: Investigator-sponsored\* Phase 1/2 study in Cystinosis patients



*A Phase 1/2 study to determine the safety and efficacy of transplantation with autologous human CD34+ Hematopoietic Stem Cells (HSC) from Mobilized Peripheral Blood Stem Cells (PBSC) of patients with Cystinosis modified by ex vivo transduction using the pCCL-CTNS lentiviral vector*

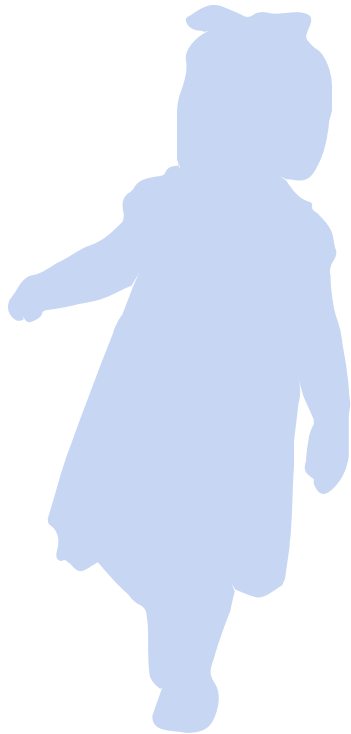
OBJECTIVES	PATIENTS	ASSESS
<ul style="list-style-type: none"> <li>Safety</li> <li>Efficacy</li> </ul>	<ul style="list-style-type: none"> <li>6 patients</li> <li>adults and potentially adolescents 14–17 years old</li> <li>Using oral and ophthalmic cysteamine</li> </ul>	<ul style="list-style-type: none"> <li>Cystine levels in granulocytes</li> <li>Vector Copy Number (VCN)</li> <li>Chimerism</li> <li>Renal, respiratory and endocrine function, ophthalmologic findings, muscle strength, growth, bone density, neurologic and psychometric measures</li> <li>Safety</li> </ul>



# CYS-201: IND approved by FDA

## December 2018

First patient planned ~2H 2019



**USA FDA CBER** Pre-IND meeting

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**Ethics approval**

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**USA FDA IND approval**



## AVRO-RD-03 in Pompe



# Goals for gene therapy in Pompe Disease

## TO PREVENT OR IMPROVE:



### Pulmonary function

**Unmet needs:** respiratory insufficiency, chronic respiratory infections, sleep apnea, artificial ventilation



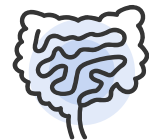
### Physical endurance and strength

**Unmet needs:** proximal myopathy, progressive muscle weakness in diaphragm, trunk and lower limbs, wheel-chair bound



### CNS complications

**Unmet needs:** neuromuscular control, reduction in executive function, cognitive impairment



### GI complications

**Unmet needs:** macroglossia (childhood onset), difficulty chewing and swallowing, GI symptoms, including irritable bowel-like symptoms



### Everyday burden of illness, and life expectancy

**Unmet needs:** fatigue, hepatomegaly, independent living, biweekly infusions, shortened lifespan



# Pompe preclinical program advancing

## Integrated 3-part solution

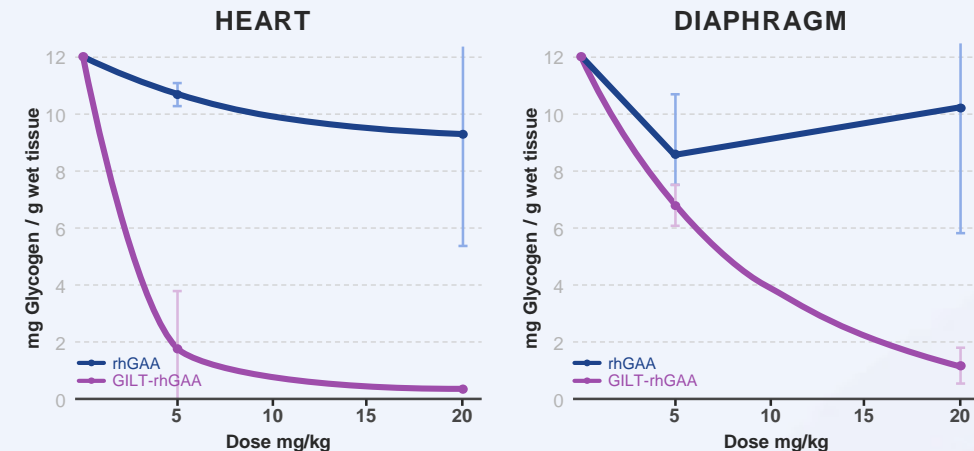
### THE CHALLENGE

- Pompe requires **20x more ERT** than Fabry or Gaucher
- Requires GAA activity restored to **muscle and CNS**

### AVROBIO's SOLUTION

1. Potent transgene promoter
2. GILT uptake tag
3. plato™ for CNS impact

**GILT-tagged Recombinant Human (rh)GAA** impacts levels of stored glycogen compared to non GILT-tagged Recombinant Human (rh)GAA in a Pompe mouse model



*GILT: Glycosylation-Independent Lysosomal Targeting*

*Sources: Burton B et al, J Pediatr, 2017; Aulsems M et al, Eur J Hum Genet, 1999; Gungor D et al, Orphanet J Rare Dis, 2011; Maga JA et al, J of Bio Chem, 2013*

Foundation for  
growth and future  
commercialization

## Substantial progress on all fronts

- + Compelling Fabry data across 2 clinical trials
- + Gaucher program in clinic 2019
- + Cystinosis program in clinic 2019
- + **plato™** in clinic 2019
- + Pompe preclinical program advancing
- + Strengthened leadership team

# Multiple 2019 milestones anticipated




## FABRY

- Phase 1 recruitment set to complete 1H 2019
- FAB-201 Phase 2 trial continues recruitment
- **plato™** incorporated in FAB-201 2H 2019 
- Additional trial sites to open in Canada and USA
- Additional readouts throughout the year



## GAUCHER

- First patient dosed in GAU-201 Phase 1/2 trial 2H 2019
- **plato™** incorporated in GAU-201 2H 2019 



## CYSTINOSIS

- First patient dosed in CYS-201 Phase 1/2 trial 2H 2019



## POMPE

- Preclinical program advances



## Momentum in 2019

- **Compelling Fabry data** across 2 clinical trials
- Substantial **platform and pipeline advances**