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Competitive Landscape & Differentiation

> **CERNAL is a B2B genetic-circuit design platform that starts from a biological state rather than from a pre-defined sensor or gate.**

Genetic-circuit design is already an established field. Commercial platforms such as `Asimov` provide biological-design software, `Cello` automates implementation of user-defined Boolean logic, and therapeutic companies including `Strand`, `Senti`, `ArsenalBio`, `Obsidian` and `MeiraGTx` demonstrate that conditional genetic control can be clinically relevant. The question is therefore not whether circuits can be designed - it is what you must already know before you can design one.

DESIGN SPECIFICATION	WHAT THE COMPILER IS HANDED
THE FIELD logic-first	`compile(logic_spec, characterised_host) → construct` *requires: you already know what to sense, and the host already has a parts library*
CERNAL state-first	`compile(state_A, state_B, host_name) → construct` *requires: two transcriptomes and the name of an organism*

AXIS 01 - SPECIFICATION

The trigger is discovered, not supplied

Existing tools begin once someone has decided what the circuit should sense. CERNAL derives that from measured expression, so the hardest upstream decision stops being a prerequisite.

AXIS 02 - HOST

The organism is an input, not a constraint

Because the logic is carried on RNA, no characterised parts library has to exist first. The host is a parameter the compiler adapts to, rather than a boundary on where the tool works.

Where CERNAL Differs

`// transcriptomics is already in the field - the difference is what it is used for`

This distinction matters because transcriptomic data is not new to the field. `ArsenalBio` has described using bulk RNA-seq and single-cell transcriptomic data in the development of programmable T-cell therapies. But in those workflows the data **informs a human decision** about what to go after; the circuit that results then senses something else entirely - a surface antigen, a promoter, an engineered regulatory element. In CERNAL the mRNA is not evidence used to choose a sensor. **It is the sensed**

species.

THE FIELD	RNA-seq → a person picks a target → *circuit senses an antigen / promoter*
CERNAL	RNA-seq → **compiler selects discriminating mRNAs** → **circuit senses those mRNAs**

↳ same data, different role: upstream evidence in one case, the trigger itself in the other

> WHITE SPACE
>
> **A reusable design layer that takes a new biological state and an organism as its inputs and returns a conditional circuit design - without anyone having to decide in advance what the circuit should sense, or which characterised parts it must be built from.** [10]

DESIGN QUESTION	TYPICAL EXISTING APPROACH	CERNAL
STARTING INPUT	A defined engineering objective - Boolean logic, a target, a payload or a construct	Target and control **transcriptomes**, plus the selected organism
WHAT THE CIRCUIT SENSES	Usually fixed in advance by the designer or the therapeutic programme	Selected computationally from **endogenous mRNAs** that differ between the two states
LOGIC IMPLEMENTATION	Depends on parts, gates or models already characterised in the implementation host	**RNA-level logic** generated within one common computational framework
HOST-SPECIFIC ELEMENTS	Supplied by host-specific parts systems, models or engineered platforms	Selected or adapted **computationally**, once the organism is named
OUTPUT	A construct that implements the stated objective	Endogenous **trigger candidates**, conditional logic, and a host-adapted circuit design

↳ evidence base: refs [5–13]

Competitors

// who else can do the design job, and what they would have to change to do ours

Direct competitors: genetic-design platforms

These tools compete most directly for the design task itself - converting a specification into a genetic construct. The question is what each one accepts as the specification.

	ASIMOV KERNEL	CELLO 2.0
CUSTOMER PROVIDES	A defined molecule, sequence or expression objective	A Boolean function, written as Verilog, plus design constraints
WHAT IT DESIGNS	Genetic constructs and expression systems; the Compiler designs expression vectors from antibody sequences	DNA circuits implementing the specified Boolean function
WHAT THE GATES ARE MADE OF	Not applicable - the public mammalian product optimises expression rather than implementing conditional logic	Repressor-protein NOT / NOR gates. One implementation, in *B. thetaiotaomicron*, uses sgRNA-based gates
A NEW HOST	Host-aware tools and engineered lines, including HEK293 and CHO	Extensible in principle, but each host needs its own characterised gate library and constraints file - described by the authors as an upfront cost
DIFFERENCE FROM CERNAL	The workflow begins from a **stated engineering objective**. Target-versus-control transcriptomes are not an accepted specification, and the shipped mammalian product does not implement conditional control. [5,6]	Automates the implementation of **logic someone has already defined**. It does not determine which biological state should be sensed, and the gate library must exist in the host first. [7,8]

↳ the gate chemistry differs between them; who decides what to sense does not

Indirect competitors: application-specific conditional regulation

These companies demonstrate sophisticated sensing and control. Their published products are therapeutic platforms and programmes, however, rather than general-purpose circuit-design software.

COMPANY	CONDITIONAL-CONTROL	SPECIFICITY / INPUT	WHY INDIRECT

	APPROACH		
Strand Therapeutics	Programmable mRNA carrying SignalLock logic circuits	**Endogenous microRNA sensors** control where, when and how strongly a payload is expressed	The nearest neighbour in this table. Developed as part of Strand's genetic-medicine platform rather than as a general state-to-circuit design tool. [9]
Senti Bio gene-circuit programmes	Logic-gated engineered immune cells, including OR and NOT logic	Defined cell-surface biomarkers - CD33, FLT3 and EMCN in SENTI-202	Clinically advanced gene-circuit logic, but the sensing architecture is built around specific therapeutic programmes rather than offered as design software. [10]
ArsenalBio	Programmable T cells with multi-module logic gating	Pairs of tumour-associated surface antigens and other engineered modules	Uses extensive computation and omics for target selection, but develops proprietary cell therapies rather than a reusable external compiler. Announced a strategic shift toward in vivo CAR-T in 2026. [11]
Obsidian Therapeutics	cytoDRiVE drug-responsive domains	An FDA-approved small molecule regulates protein function	Externally controlled therapeutic regulation rather than endogenous state-to-circuit design. [12]
MeiraGTx	Synthetic riboswitch controlling transgene expression	An oral small-molecule inducer	Precise regulated expression, but the control signal is exogenous and the technology sits inside a genetic-medicine platform. [13]

↳ four of the five are controlled from outside the cell; one is not

Replacement and potential competitors

The most honest competitive question is not which company we beat, but what a customer does today instead of buying anything.

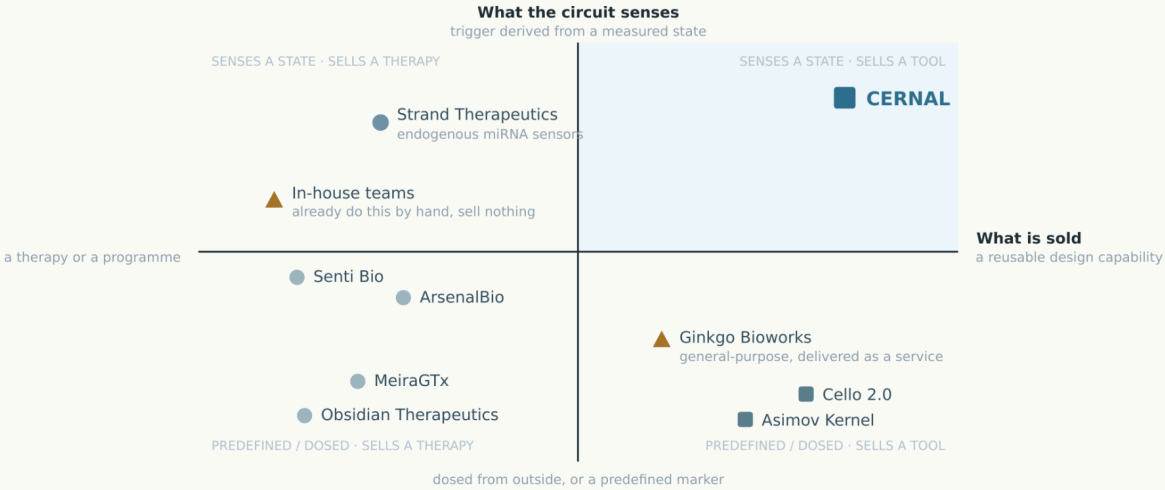
IN-HOUSE TEAMS the real default	A skilled computational and synthetic-biology team can already combine

	differential-expression analysis, biomarker selection, RNA design, construct design and experimental testing by hand. This is the most important present-day replacement for an integrated CERNAL workflow.
PUBLIC TOOLS	A low-cost workflow can be assembled from differential-expression tools, RNA-structure and design software and sequence utilities. The disadvantage is that it stays manual and expertise-intensive rather than becoming a product.
GINKGO BIOWORKS potential, not present	Ginkgo combines computational design, large-scale experimental infrastructure and Design–Build–Test–Learn workflows across diverse organisms. Its accumulated design and experimental data make it a credible platform competitor if it productises a state-to-circuit capability. [14]

↳ evidence base: refs [5–14] ·

// POSITIONING · competitors placed by what they sense and what they sell

The competitive white space



CERNAL · Direct — design platforms · Indirect — therapeutic programmes · Replacement & future risk

↳ Strand is one axis away: it senses an endogenous RNA species, but sells therapies rather than a design capability.
↳ Positions are qualitative. No scale is implied and no ticks are drawn, because none of this is measured.

Market Analysis & Commercial Entry Strategy

Existing tools begin after someone has decided what a circuit should sense. CERNAL proposes to make that decision the input. Given transcriptomes of a target and a non-target state plus a host, it selects endogenous RNA signals, designs the conditional logic, and adapts the circuit to the organism. The commercial bet is that removing the upstream decision saves more time than optimising the sequence afterwards.

> HOW TO READ THE NUMBERS
>
> **1,089** are published figure. **553–731** is calculated from published category totals. **166–219** applies a 30% assumption. **15** is a commercial target.

WORKING DECISION	CURRENT RECOMMENDATION
Initial chassis	HEK293 / HEK293T for first mammalian design and proof-of-function work.
Initial buyer hypothesis	CGT developer R&D, synthetic-biology, cell-engineering or construct-design teams. Validate through interviews and paid pilots.
Commercial model	Paid design-partner engagements first. Test conversion to annual access or licensing afterwards.
Expansion hypothesis	T and NK cells, then other hosts

1 Market Measurements

All counts are commercial private and public entities in ARM's Q2 2026 developer dataset. [1]

TAM - 1,089 commercial CGT developers. 740 private plus 349 public.

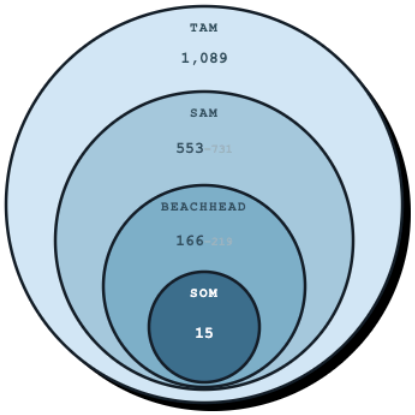
SAM - 553 to 731 organisations.

ARM CATEGORY	CALCULATION	COUNT
Gene therapy	`203 + 103`	**306**
GMCT & CBIO	`268 + 157`	**425**
Category union	`731 − (max overlap 178)`	**553–731**

Developers may appear in more than one category. ARM reports 1,089 commercial developers against 1,267 commercial category entries across all four approaches[1].

Beachhead proxy: 166 to 219 accounts.

Most of this pool already depends on HEK293: AAV, lentiviral and adenoviral vectors account for 390 of 462 vector-specified trials, or 84% [1]. Examples include Zolgensma, produced in HEK293 [3], and the HEK293/293T platforms run by Oxford Biomedica, Lonza and AGC Biologics. The host is therefore not the filter. Our 30% assumes that roughly one in three of these programmes designs constructs in-house rather than outsourcing to a CDMO - 84% × 35% ≈ 30%, giving 166–219 accounts. We plan against the lower end and will test the assumption by asking ten companies who designs their construct.



rings are schematic — see the bar chart for true proportions

TAM Total addressable market — SOURCED

1,089

Commercial cell and gene therapy developers worldwide.
740 private + 349 public · ARM Q2 2026 developer dataset [1]

SAM Serviceable available market — CALCULATED

553–731

Developers using **genetic modification**, where a circuit has something to act on. 306 gene therapy U 425 GMCT and CBIO; at most 178 companies are double-counted, which bounds the union [1]

BEACH Beachhead — ASSUMED

166–219

HEK293 / 293T programmes that design constructs **in-house**.
84% × 35% — 84% of vector trials use a HEK293-produced vector class; the 35% in-house share is our assumption [1]

SOM Serviceable obtainable market — TARGET

15

Paying accounts within **five years** · 9% of the 166 planning case.
Set below the 25+ partnerships Asimov reports after years of operation [4]

2 HEK293 first

CERNAL can serve a wide market. To choose where to start, our advisory board helped us decide. Oren Bogin, a biotech entrepreneur, and Yair Sakov, who has helped launch startups out of Tel Aviv University, told us what matters in a first market: be specific, stand apart from our competitors, fit our vision and mission, and choose a host where we can prove it fast. That points to mammalian cell engineering, starting with HEK293.

Link to full host analysis.

A peer-reviewed review reports that most therapeutic viral vectors are produced in HEK293 [3]. The chassis and the customer are therefore treated as separate questions. HEK293/293T is where the workflow is validated; the intended customer is a cell and gene therapy R&D or construct-design team. Contract manufacturers remain a channel hypothesis that has not yet been tested

3 In vivo engineering:

Recent transactions show substantial strategic interest in engineering cells inside the body. ASGCT and Citeline counted 4,487 gene, cell and RNA therapies in development in Q2 2026, including 2,217 gene therapies [2] - programmes, not buyers, and therefore context rather than market size.

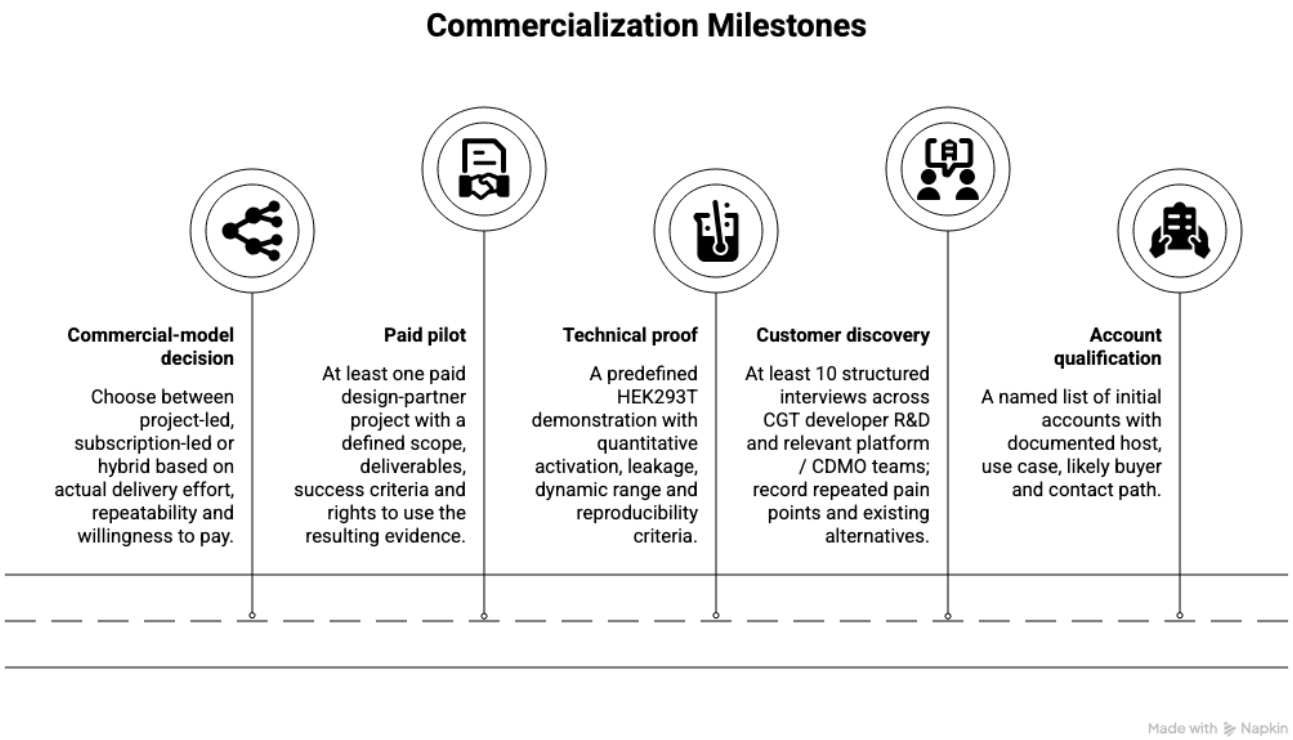
TRANSACTION	REPORTED TERMS	WHAT IT SIGNALS
AbbVie / Capstan 2025	Acquisition completed; targeted LNP delivery of RNA payloads to engineer cells in vivo [7]	Strategic interest in in vivo cell engineering.
AstraZeneca / EsoBiotec 2025	Up to $1B: $425M initial plus up to $575M contingent [8]	Investment in targeted lentiviral delivery to immune cells.
Lilly / Kelonia 2026	Up to $7B total, including $3.25B upfront [9]	Interest in selective in vivo T-cell engineering. .
J&J / Sail Biomedicines 2026	$785M initial payments; a further $2.58B if the option is exercised [10]	Investment in nanoparticle and RNA-based in vivo CAR-T.

> THE LIMIT OF THIS ARGUMENT
>
> Reviews of in vivo CAR-T identify delivery specificity, off-target transduction, expression control, persistence and immunogenicity as translational challenges [11]. Conditional expression can add a second layer of control *after* delivery. Investment in in vivo engineering creates a future application area where cell-state-dependent expression is valuable - when we can show reliable conditional control in the specific cells.

CHANNEL PRECEDENT

Asimov licensed LV Edge to AGC Biologics and announced an in vivo lentiviral-vector collaboration with Lonza [12,13]. This shows a synthetic-biology platform can reach market through manufacturing partners.

Milestones for the next 6–12 months



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