



Burning Rock Biotech Limited

2Q 2024 results

23 August 2024

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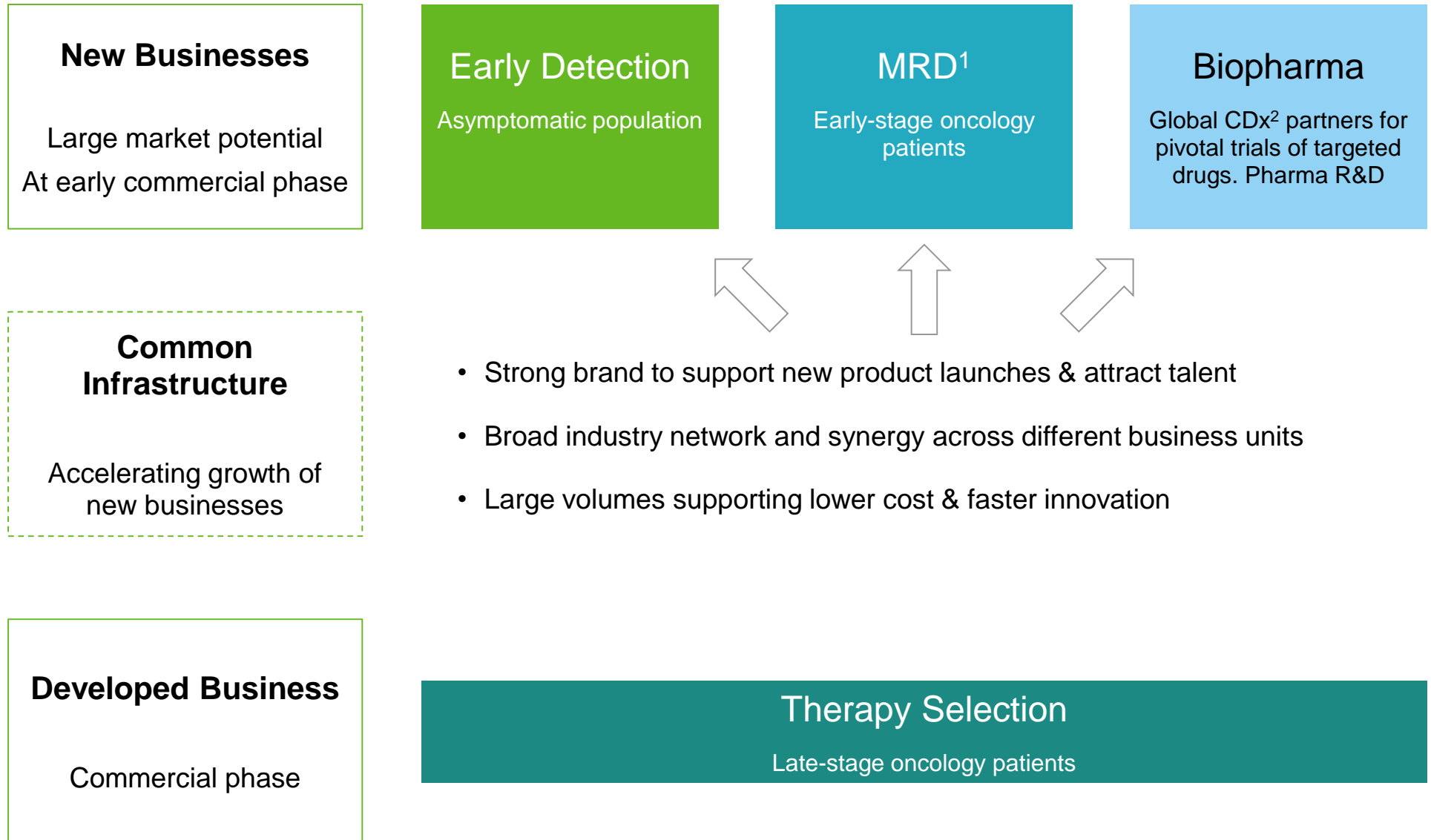
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Our value-building blocks

Extending leadership in NGS-based precision oncology from late-stage to earlier stage patients



Notes:

¹ Minimal residual disease of solid tumors

² Companion diagnostics

Recent progress

Continued efficiency gains, driving towards profitability

Delivering results on

1 Driving sales efficiency

- Increasing sales productivity per head
- Benefiting from more rational industry competition

2 Improving gross margin

- Leveraging our scale
- Delivering on margin improvement projects

3 Reducing G&A expenses

- Cutting overhead and lowering fixed cost-base

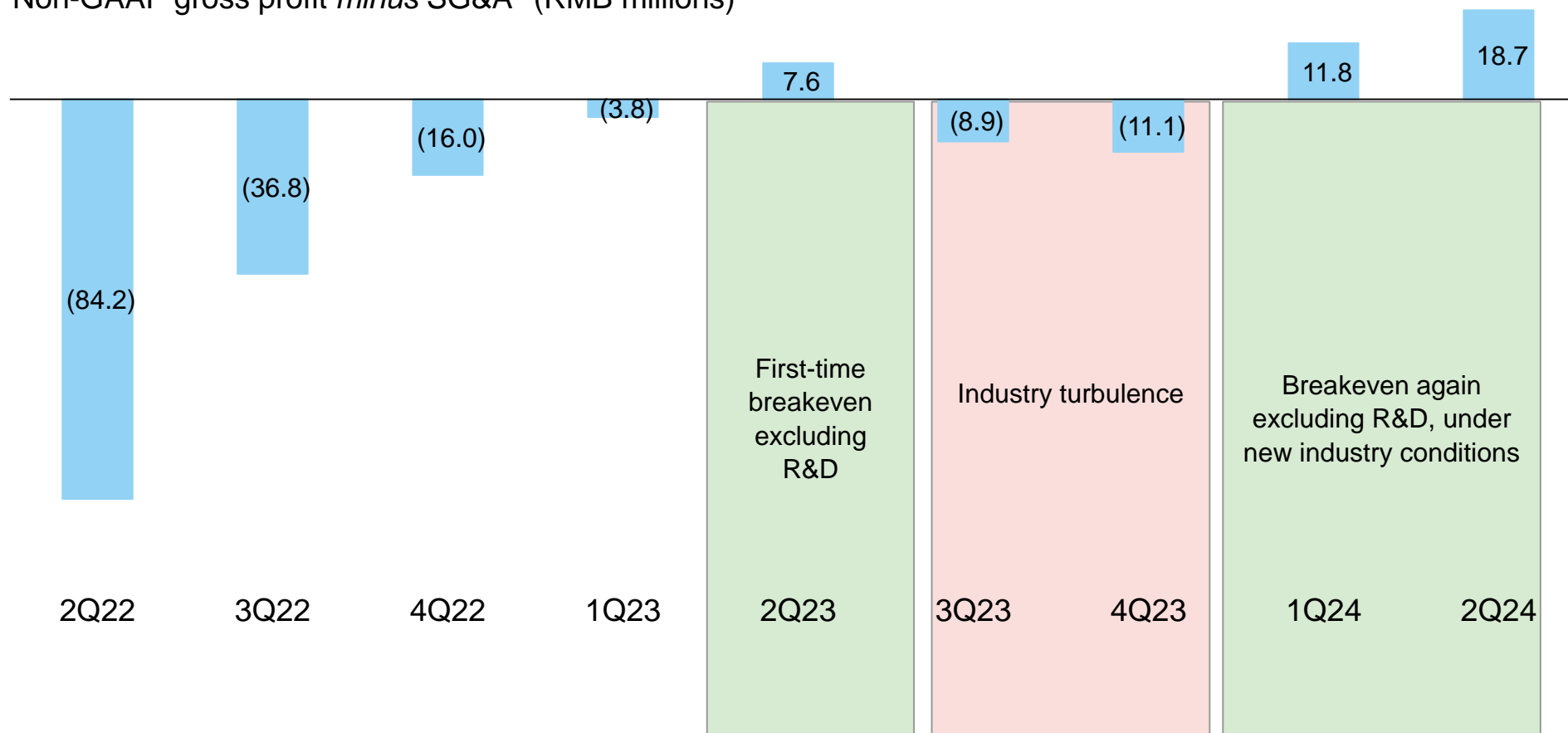
4 Reducing R&D expenses

- As clinical programs complete and run down
- Disciplined on new investment

2Q24 continues to get commercial breakeven under new industry conditions

Breakeven defined as Non-GAAP gross profit *minus* SG&A*

Non-GAAP gross profit *minus* SG&A* (RMB millions)



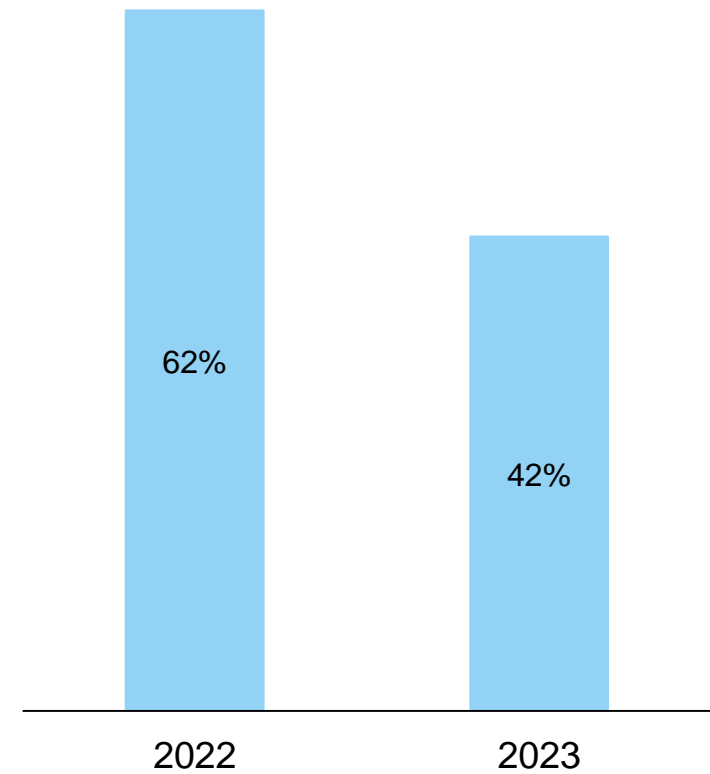
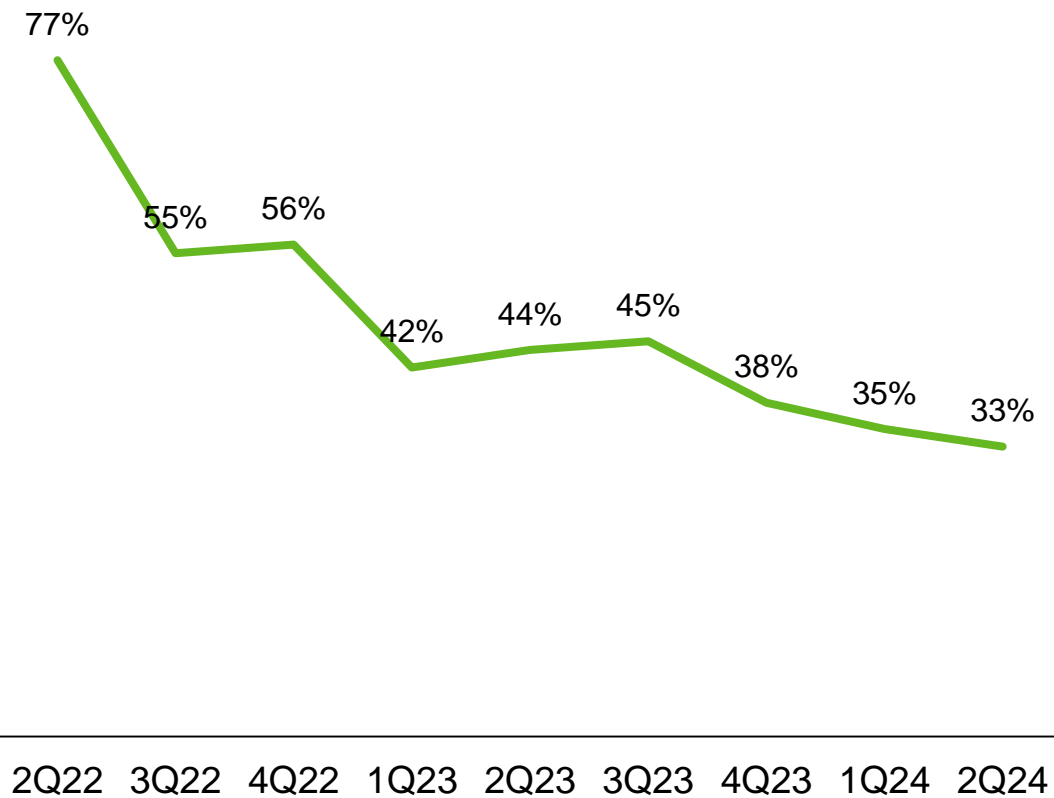
Notes:

* Non-GAAP gross profit, which is defined as gross profit excluding depreciation and amortization. Non-GAAP SG&A refers to selling and marketing expenses and general and administrative expenses, both excluding their respective share-based compensation and depreciation and amortization.

1 Driving sales efficiency

Expect below 40% selling expense going forward

Non-GAAP sales and marketing expenses as % of revenue*



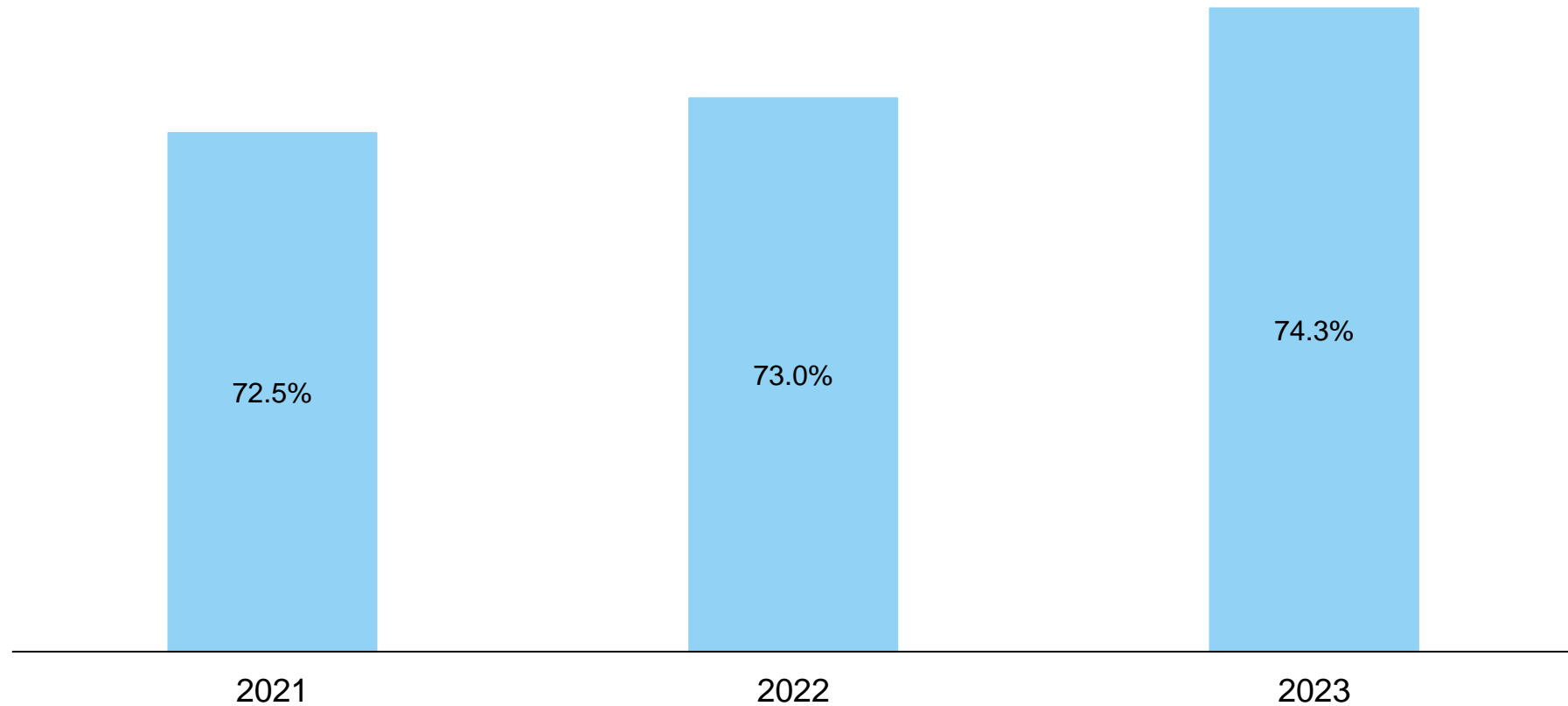
Notes:

* Excluding share based compensation (SBC) and depreciation and amortization (D&A)

2 Improving gross margin

Delivering on margin improvement initiatives

Non-GAAP gross profit as % of revenue*



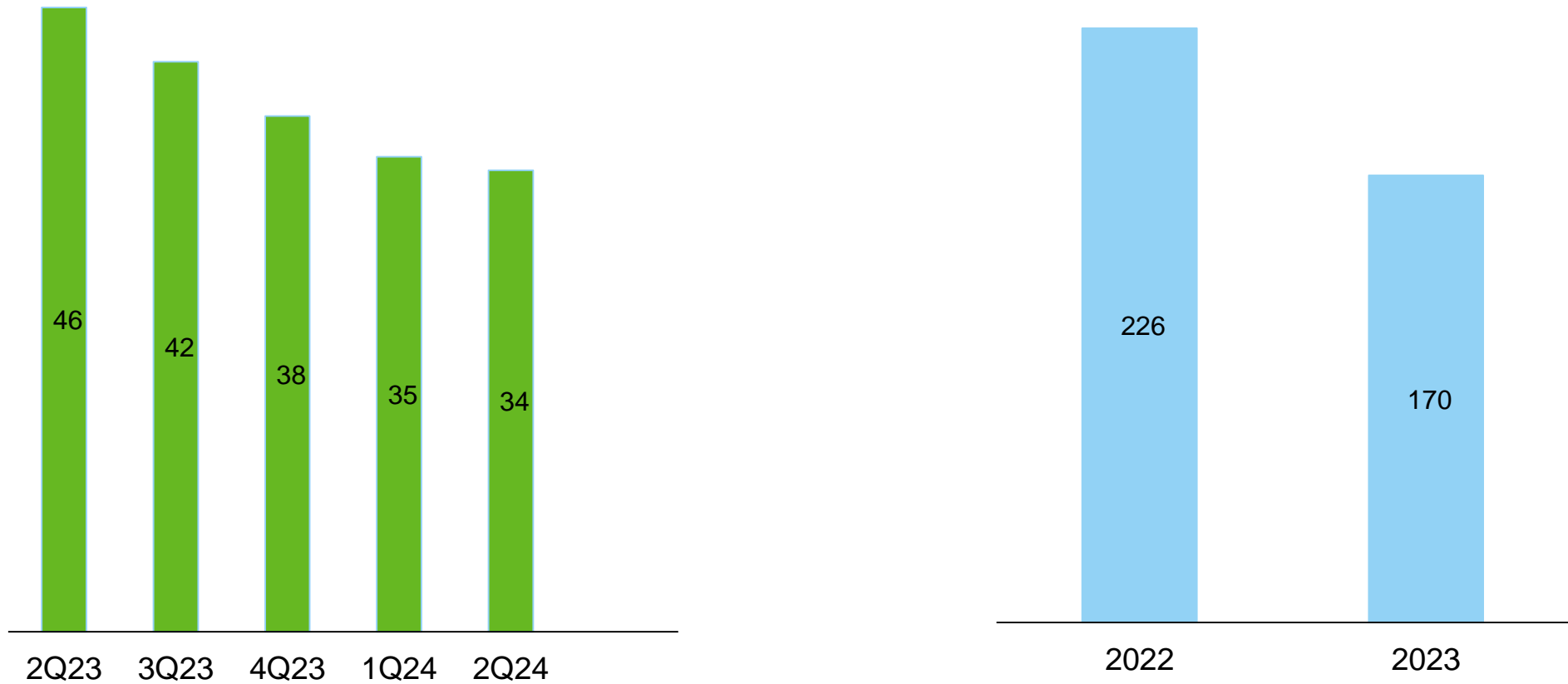
Notes:

* Non-GAAP gross margin, which is defined as gross margin excluding depreciation and amortization (D&A)

3 Reducing G&A expenses

Expect additional cost savings going into 2024

General and admin expenses *minus* noncash items * (RMB millions)



Notes:

* Excluding share based compensation (SBC), depreciation and amortization (D&A) and allowance for doubtful accounts.

Strong cash position to fund operations for the next 3 years

Commercial operation (excluding R&D expenses) reached profitability in 2Q24

On R&D spend, disciplined investment in R&D

RMBm	2022	2023	2024E ¹	1H2024
Operating cash outflow ²	457	256		81
Capex ³	75	9		4
Sum	532	265	c.150-200	85
Cash balance at period-end	925	615		533

Notes:

¹ Based on management's current estimate and subject to change

² Net cash used in operating activities

³ Purchase and prepayment of property and equipment and intangible assets, issuance of convertible loan, out of investing cashflows

Financials

Steady progress of improving margins, profitability and reducing cash outflows

RMB millions	2022	2023	YoY	1Q23	2Q23	3Q23	4Q23	1Q24	2Q24	2Q24 YoY	2Q24 QoQ
Revenues	563.1	537.3	-5%	142.6	146.2	127.6	121.0	125.6	135.6	-7%	8%
Central lab	314.8	232.8	-26%	61.8	66.2	53.5	51.3	47.6	48.8	-26%	3%
In-hospital ¹	175.3	188.6	8%	51.6	53.8	54.5	28.7	57.4	59.9	11%	4%
Pharma	73.0	115.9	59%	29.2	26.2	19.6	41.0	20.6	26.9	3%	30%
Non-GAAP gross profit²	411.0	399.4	-3%	107.9	109.4	95.1	87.1	93.0	101.9	-7%	10%
Total opex	1,360.5	1,032.4	-24%	287.2	236.1	264.7	244.4	211.6	206.7	-12%	-2%
R&D ³	344.4	264.8	-23%	74.0	73.1	64.2	53.5	49.0	50.8	-31%	4%
S&M ³	350.6	227.4	-35%	60.5	64.7	56.8	45.4	43.7	45.3	-30%	4%
G&A ³	250.5	188.3	-25%	51.2	37.1	47.2	52.8	37.5	37.9	2%	1%
SBC	325.1	258.4		77.8	37.2	72.7	70.7	68.8	67.6		
D&A	89.9	93.5		23.7	24.0	23.8	22.0	12.6	5.1		
Non-GAAP GP – SG&A	(190.1)	(16.3)		(3.8)	7.6	(8.9)	(11.1)	11.8	18.7		
Operating profit	(980.3)	(669.3)		(188.5)	(135.7)	(178.8)	(166.3)	(125.8)	(111.2)		
Net operating cash flows	(456.9)	(255.7)		(113.1)	(79.2)	(47.4)	(16.0)	(40.2)	(40.8)		
Margins											
Non-GAAP GP margin ²	73.0%	74.3%		75.7%	74.8%	74.5%	72.0%	74.0%	75.2%		
Opex ³ / revenue	168%	127%		130%	120%	132%	125%	104%	99%		
S&M ³ / revenue	62%	42%		42%	44%	45%	38%	35%	33%		

Notes:

¹ Within in-hospital segment, over 95% revenues are kit revenues, which are recurring in nature; the remaining are instrument revenues. In-hospital primarily through direct-sales model

² Non-GAAP gross profit or margin, which is defined as gross profit or margin excluding depreciation and amortization (D&A)

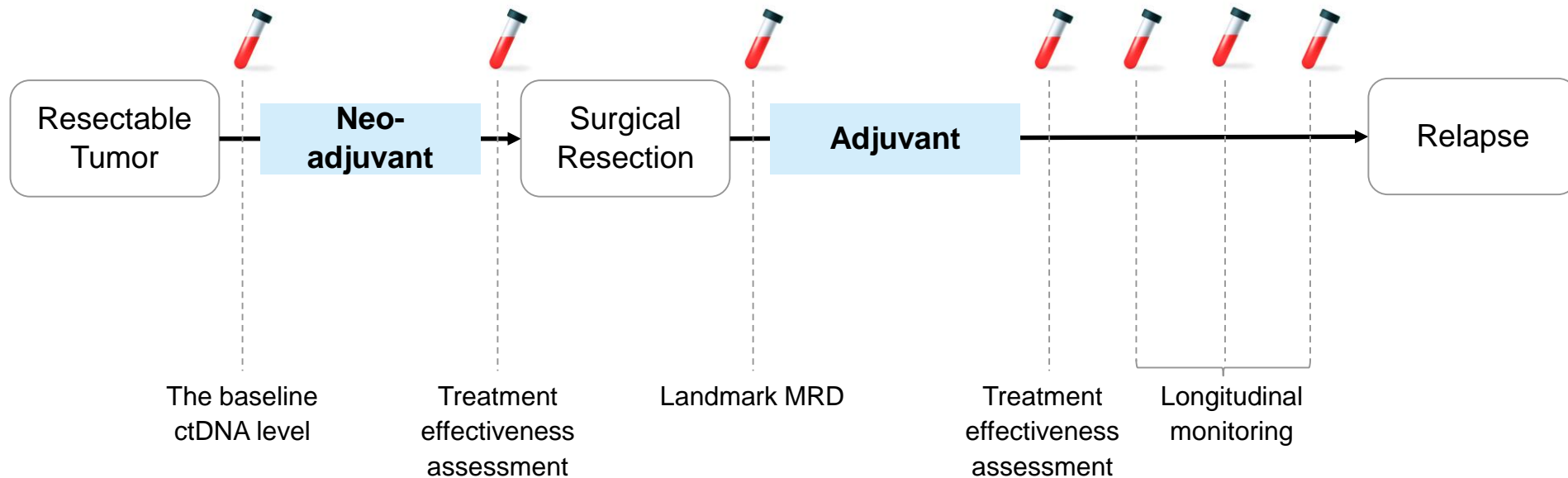
³ Excluding share based compensation (SBC) and depreciation and amortization (D&A)



Minimal Residual Disease (MRD)

Burning Rock's MRD clinical publications

Covering adjuvant and relapse settings in lung, colorectal, gastric and other cancers



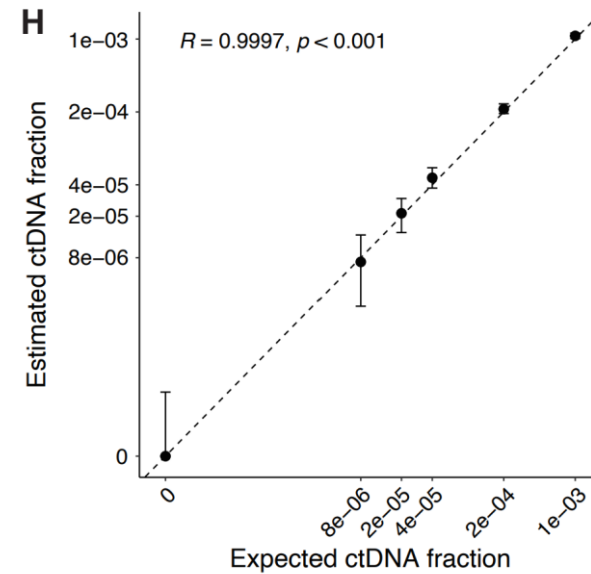
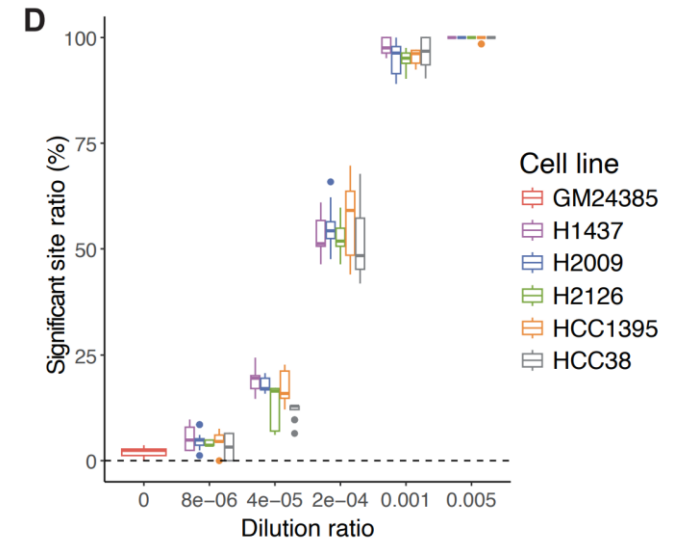
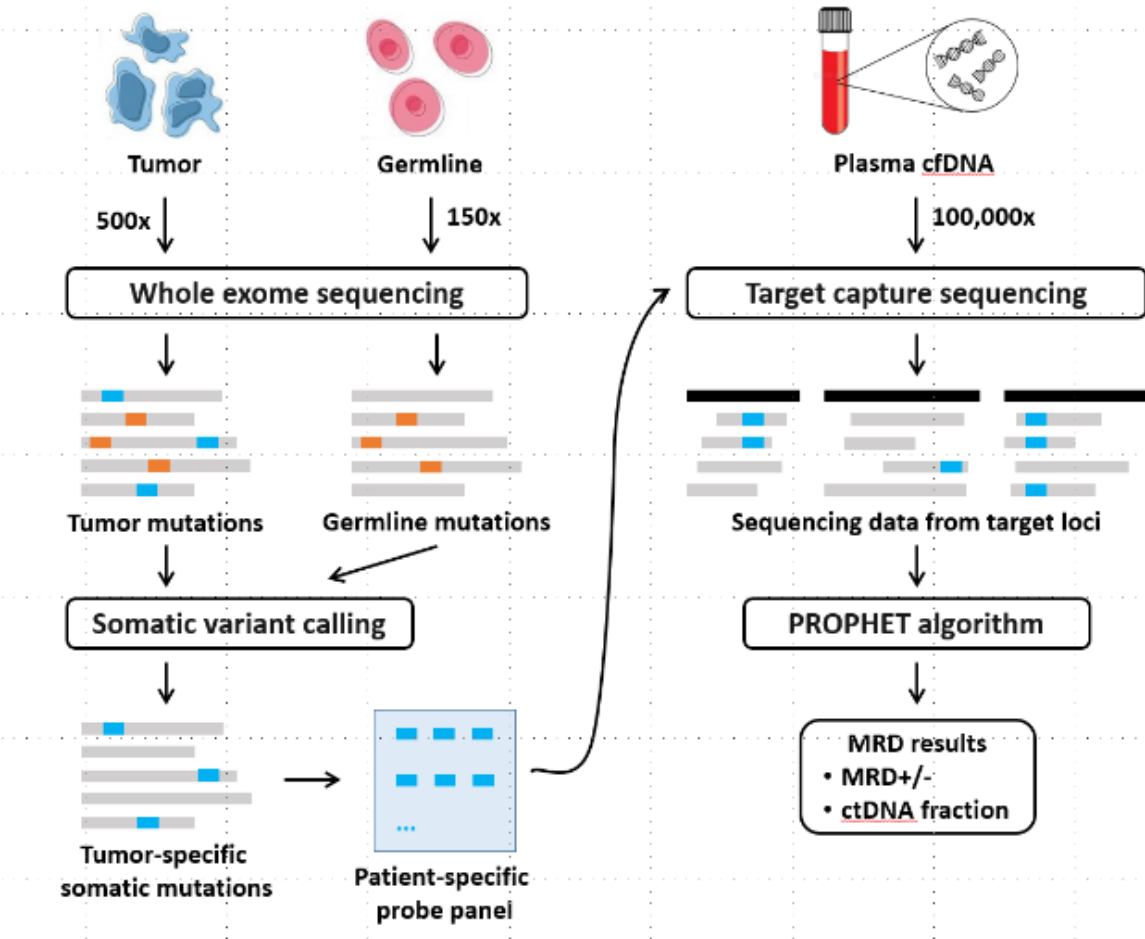
Non-small-cell lung cancer	Baseline, landmark and longitudinal monitoring timepoints completed AACR 2022 Abstract 5916, AACR 2023 Abstract 1039, MEDAL study publication
Colorectal cancer	Baseline and landmark timepoints AACR 2022 Abstract 5917, ASCO GI 2023 Abstract 213
Gastric cancer	Baseline and landmark timepoints AACR 2023 Abstract 6682
Pancreatic cancer	Baseline, landmark and longitudinal monitoring timepoints completed ASCO GI 2023 Abstract 744
Biliary tract cancer	Baseline and landmark timepoints AACR 2023 Abstract 6682

Cancer Cell

Overview of brPROPHET™

An ultrasensitive and quantitative MRD assay

Overview of the PROPHET assay



MEDAL study

Personalized MRD using brPROPHET™ on non-small cell lung cancer (NSCLC)

Cancer Cell

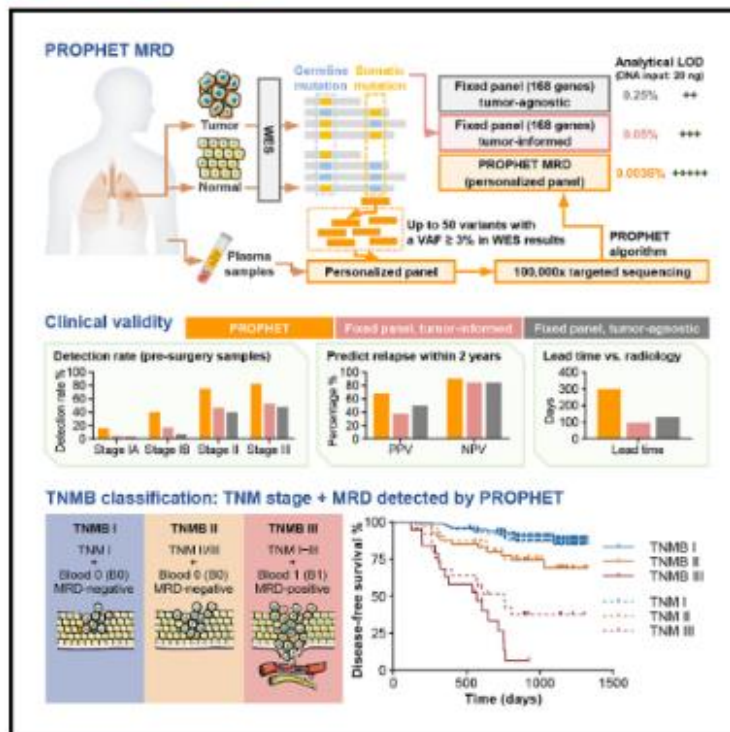
Article

Highlights

- PROPHET outperforms fixed-panel MRD assays in head-to-head comparison in NSCLC
- TNMB stage, integrating landmark ctDNA MRD and TNM, improves prognosis prediction
- PROPHET illustrates a median lead time of 299 days to radiological recurrence
- Post-relapse ctDNA status facilitates decision on later lines of treatment

Individualized tumor-informed circulating tumor DNA analysis for postoperative monitoring of non-small cell lung cancer

Graphical abstract



Authors

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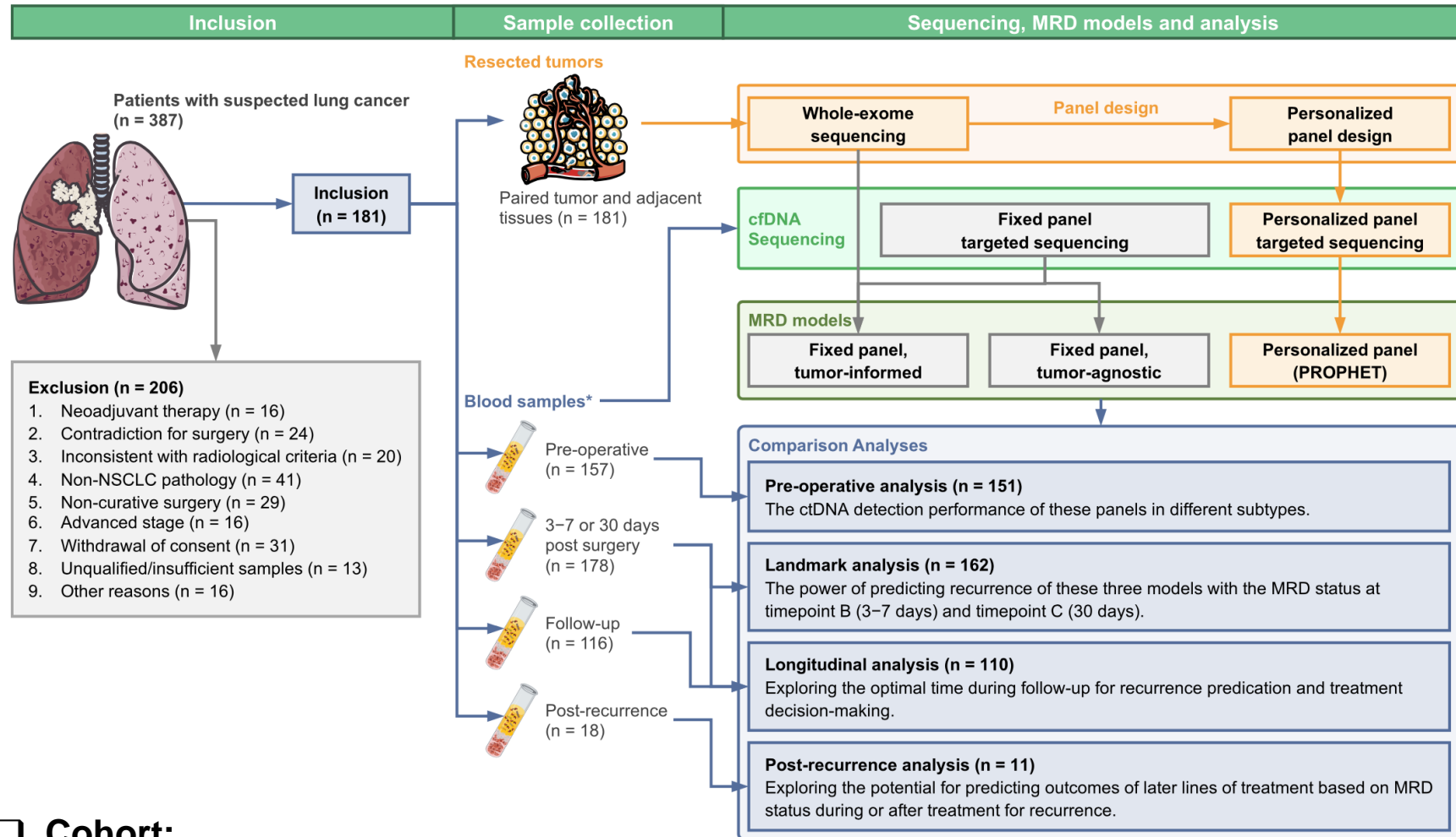
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Chen et al., 2023, Cancer Cell 41, 1–14
October 9, 2023 © 2023 Published by Elsevier Inc.
<https://doi.org/10.1016/j.ccell.2023.08.010>

In brief

Chen et al. introduced personalized Patient-specific pROgnostic and Potential tHERapeutic marker Tracking (PROPHET) for detecting molecular residual disease (MRD) in NSCLC, featuring a notably low limit of detection (LOD). It exhibits elevated sensitivity and extended lead time than radiologically confirmed recurrence. It also facilitates prognostic accuracy and postoperative treatment evaluation.

Study design



□ Cohort:

- 181 patients enrolled Stage I (63%), II (19%), and III (18%)

□ Sampling Time:

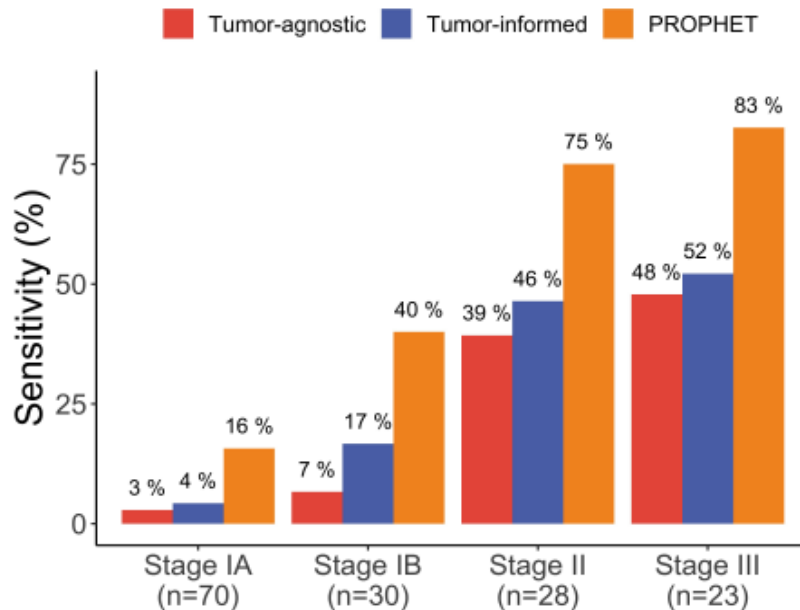
- Tumor and adjacent paired tissue collected at surgery
- Blood samples collected at Pre-operative, 3 days, and 30 days post-surgery
- Median Follow-up Time: 30 months

brPROPHET™ demonstrates superior sensitivity in ctDNA detection

Clinical validation with pre-operative plasma samples

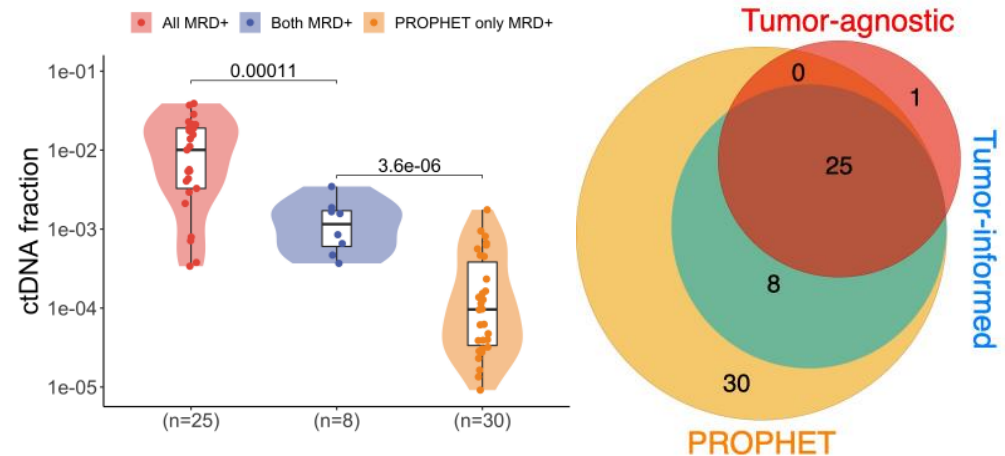
(a)

Sensitivity of pre-operative plasma



(b)

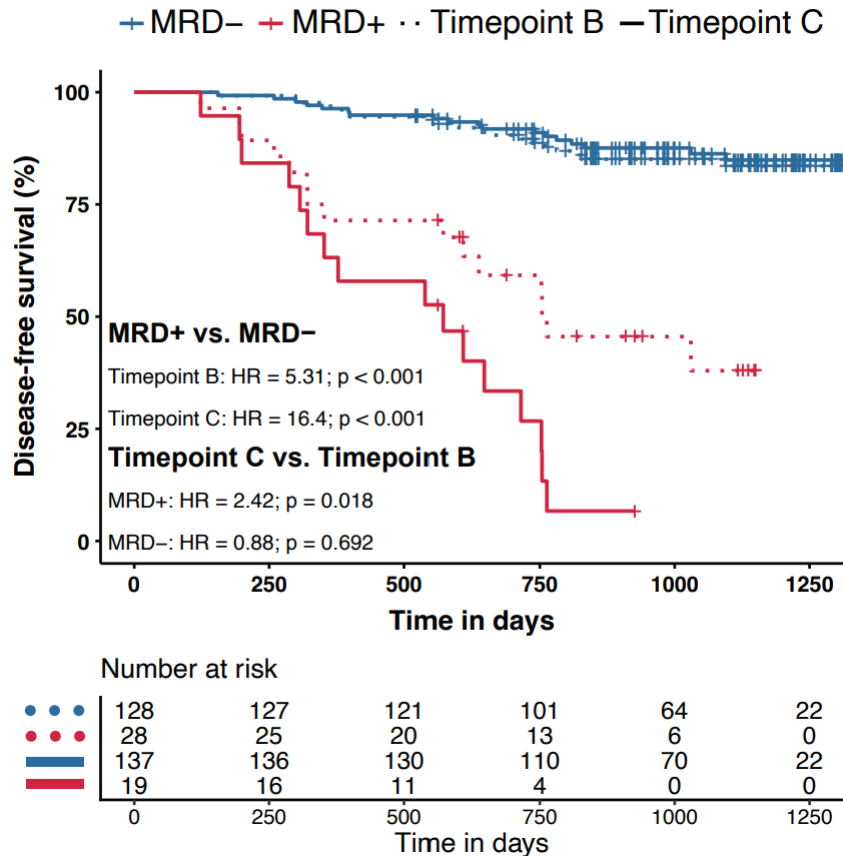
ctDNA fraction distribution of MRD (+) samples detected by different methods



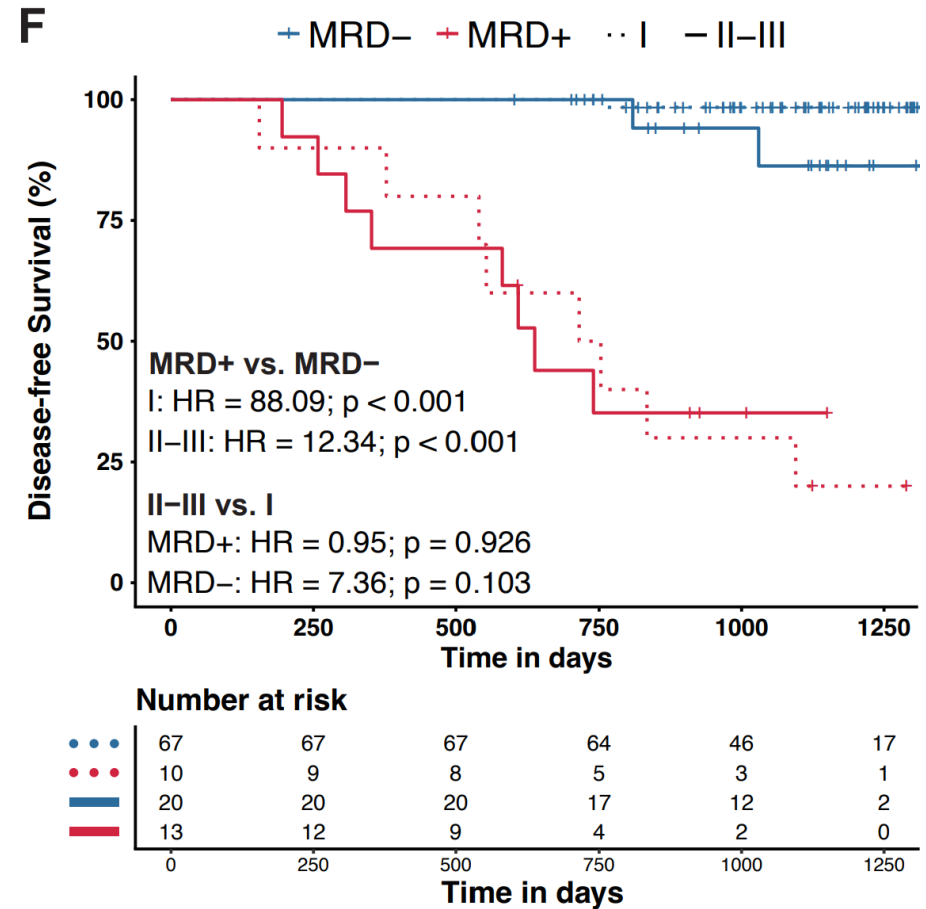
- For pre-operative plasma from patients with different clinical stages, brPROPHET has a higher sensitivity than the other two methods
- The median ctDNA fraction of the 30 patients detected by PROPHEt alone was significantly lower than the 25 patients detected by all three MRD assays

The patient-specific brPROPHET has a higher sensitivity than the two fixed panel detection methods

brPROPHET™ shows strong prognostic value in post-surgery NSCLC patients



Prognostic analysis at **Landmark** time points



Longitudinal MRD analysis

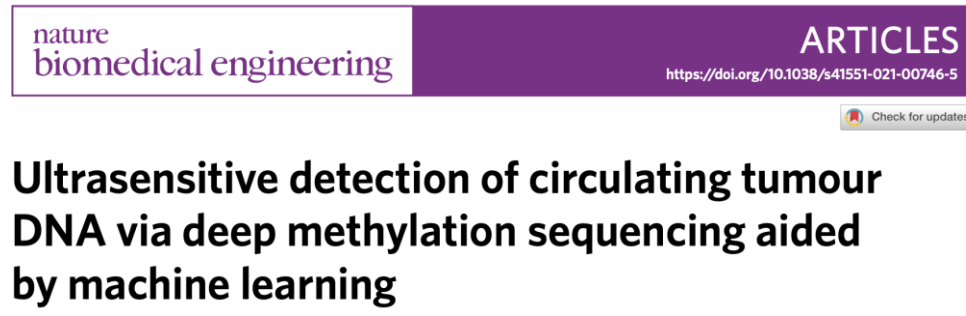


Early detection

Burning Rock's multi-cancer early detection technology

Competitive technology


Methylation + machine learning to overcome challenges of low ctDNA abundance




nature biomedical engineering ARTICLES
https://doi.org/10.1038/s41551-021-00746-5
Check for updates

Ultrasensitive detection of circulating tumour DNA via deep methylation sequencing aided by machine learning

Multi-cancer validation data



Annals of Oncology
Available online 26 February 2023
In Press, Journal Pre-proof ? What's this? >



Original Article

Unintrusive multi-cancer detection by circulating cell-free DNA methylation sequencing (THUNDER): development and independent validation studies

AACR 2022

Session OPO.CL11.01 - Biomarkers
5116 - Analytical performance of ELSA-seq, a blood-based test for early detection of multiple cancers

Session OPO.CL11.01 - Biomarkers
5109 - Development of cfDNA reference standards for methylation-sequencing tests

ESMO 2022

A multi-cancer early detection model based on liquid biopsy of multi-omics biomarkers: A proof of concept study (PROMISE study)

Regulatory breakthrough

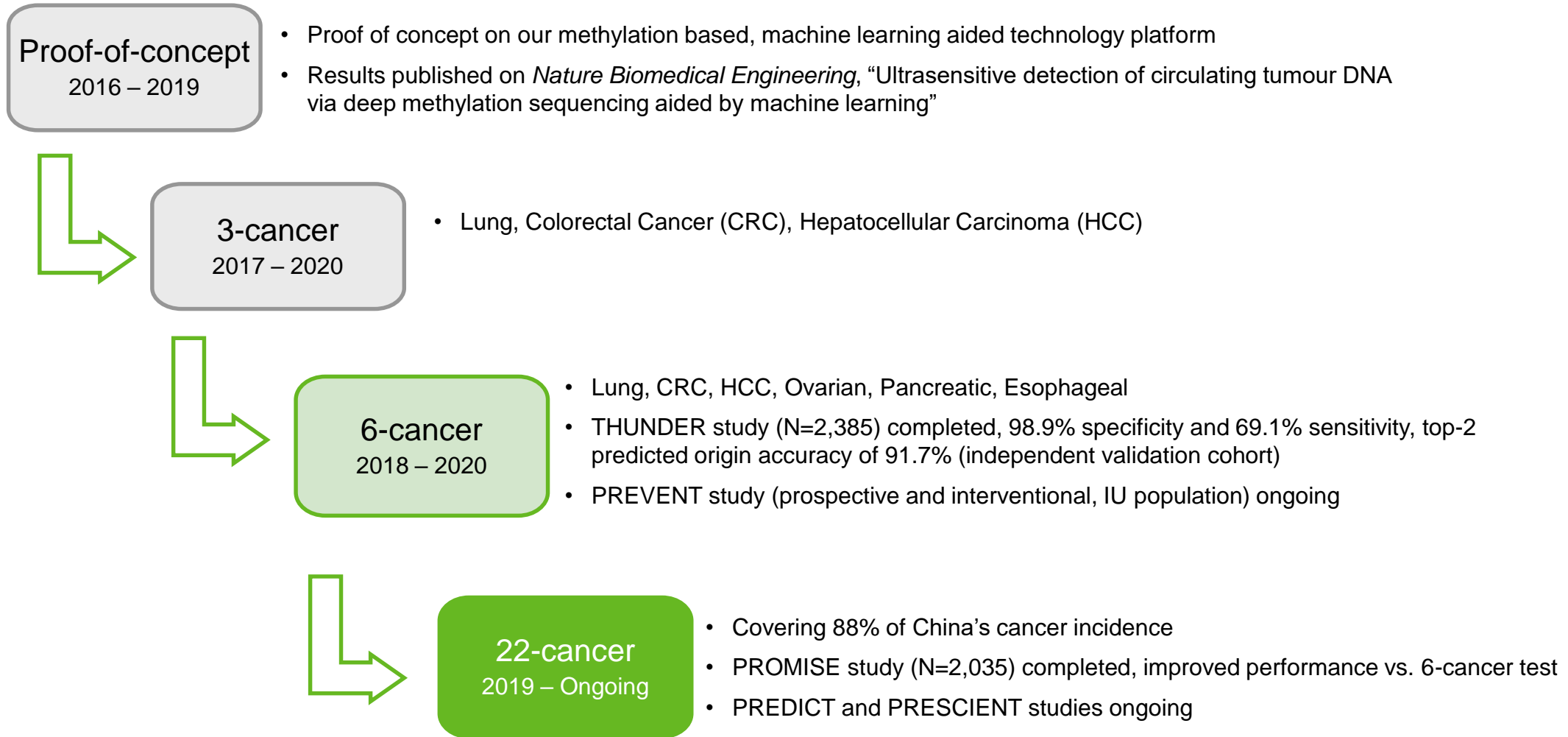
 breakthrough device designation granted



国家药品监督管理局
National Medical Products Administration

China NMPA breakthrough designation granted

Product development roadmap



Running the largest clinical programs in China supported by top physicians

PREDICT



- Leading site: Shanghai Zhongshan Hospital
 - One of China's largest comprehensive academic hospitals
 - Performs c.104,000 operations and serves c.169,000 inpatients and over 4,236,000 outpatients on an annual basis¹
 - Ranked top 5 in the 2019 China's general hospital rankings²

Principal Investigator: Prof. Jia Fan



- Fellow of the Chinese Academy of Sciences
- President of Shanghai Zhongshan Hospital

PRESCIENT



- Leading site: Cancer Hospital of the Chinese Academy of Medical Sciences³
 - The first and top cancer-specialist hospital in China
 - The National Clinical Center for Cancer Research, the National Center for Quality Control on Standardized Cancer Treatment and Diagnosis, the National Clinical Center for Drug Research

Principal Investigators

Prof. Jie He



Prof. Jie Wang



- Fellow of the Chinese Academy of Sciences
- President of CHCAMS
- Head of the Dept. of Medicine, CHCAMS

PREVENT



四川大学华西医学中心
WEST CHINA MEDICAL CENTER OF SICHUAN UNIVERSITY

- Leading site: West China Hospital
 - One of the largest hospitals in China, performed 196,000 surgeries and 7.8 million out-patient services in 2021
 - Ranked #2 in the Fudan Best Hospital in China Rankings (2009-2020)

Principal Investigator: Prof. Weiming Li



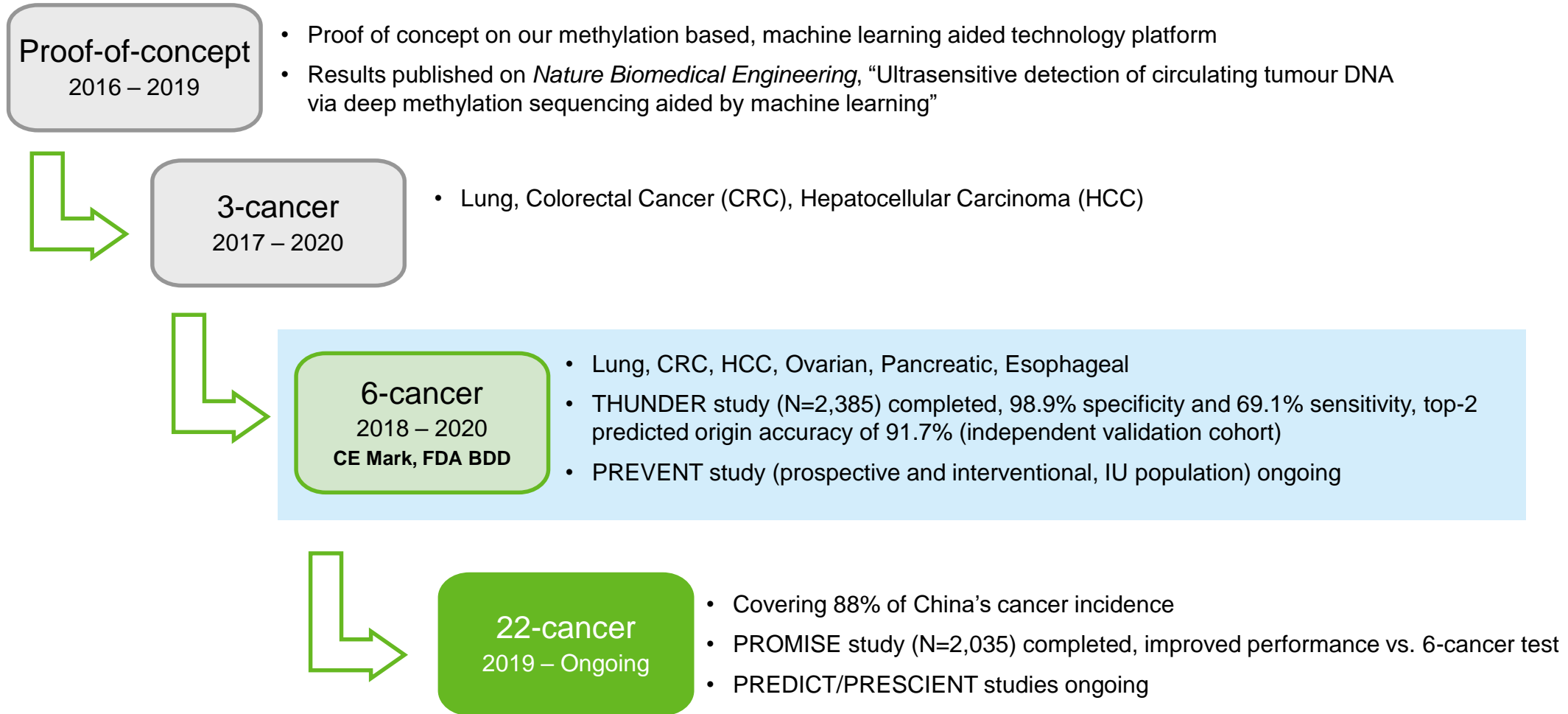
- President of West China Hospital

Notes:
¹ Based on 2018 statistics
² <http://rank.cn-healthcare.com/rank/general-best>
³ CHCAMS

Appendix 1

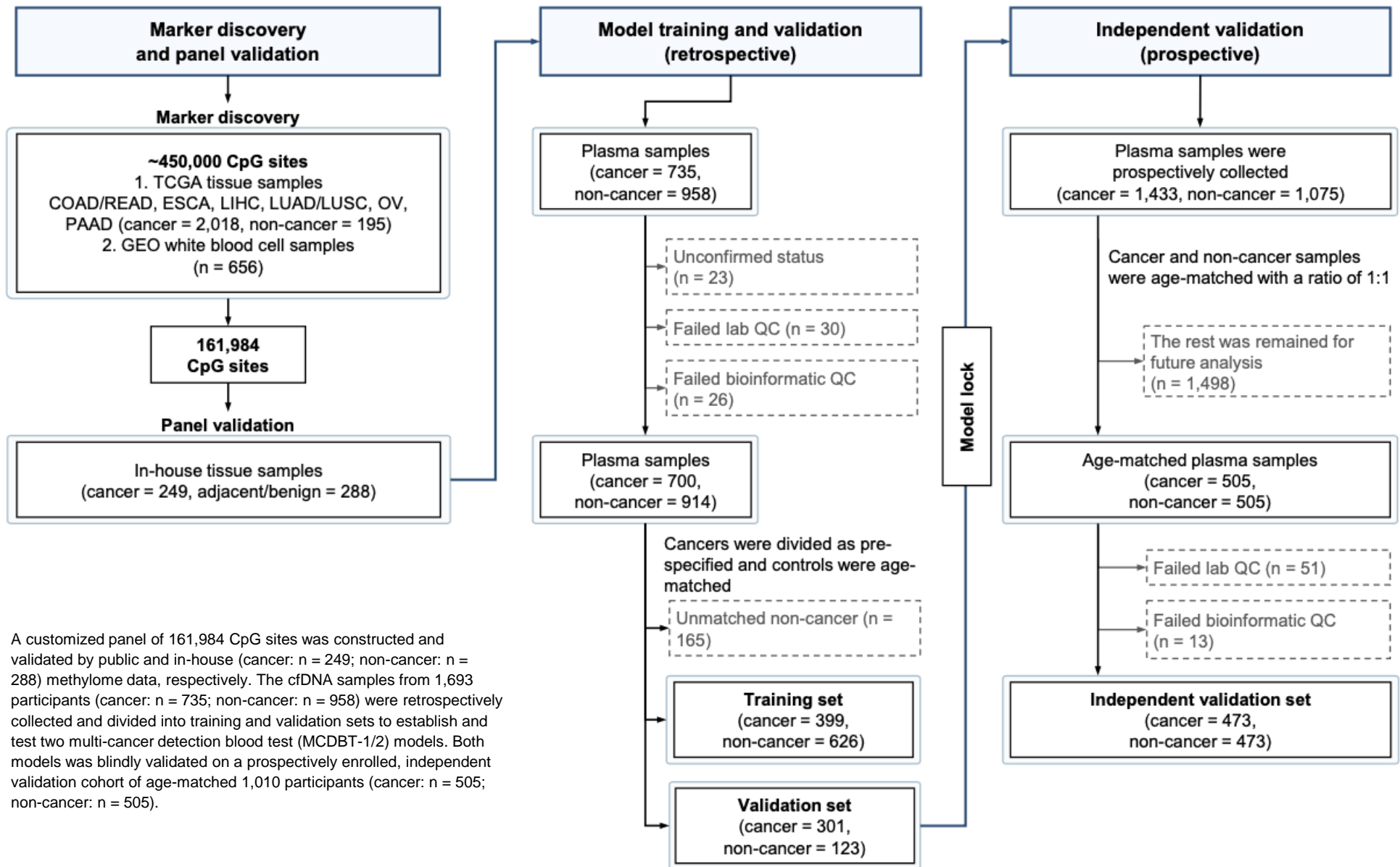
Early detection

Product Development Roadmap



6-cancer test marker discovery and model training

The THUNDER study, 2395 participants

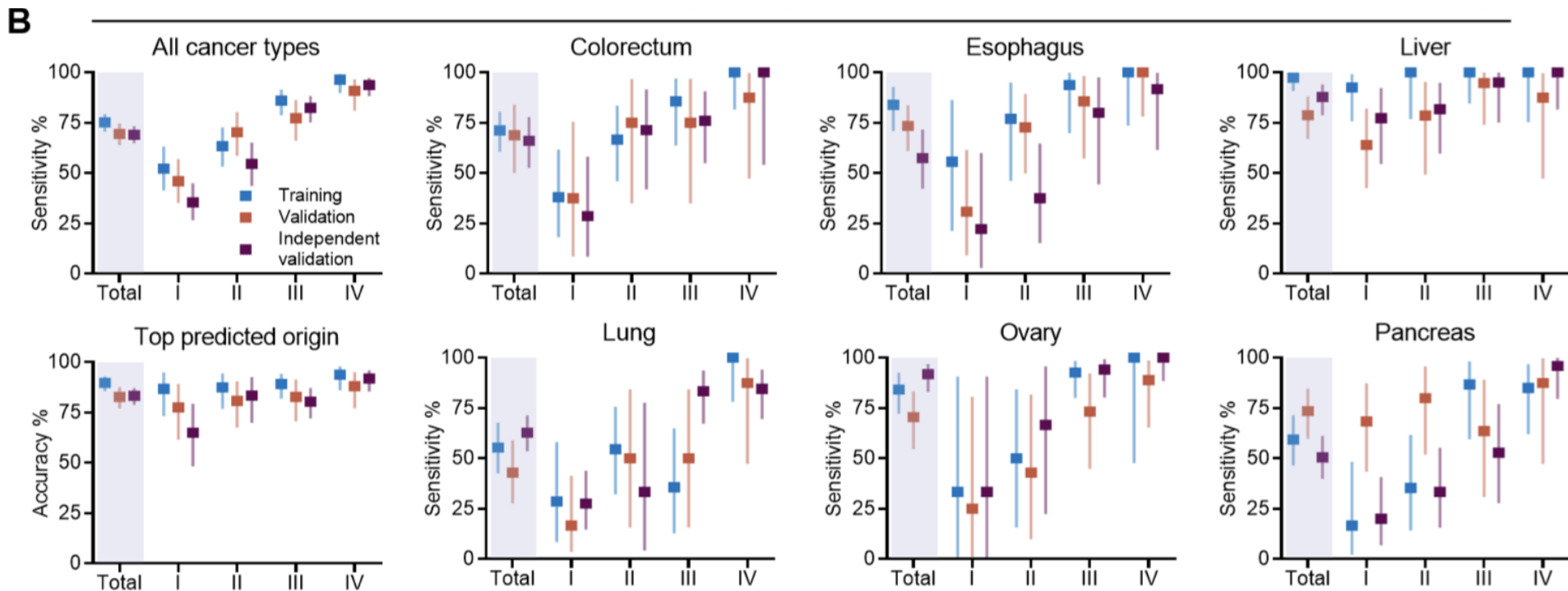


A customized panel of 161,984 CpG sites was constructed and validated by public and in-house (cancer: n = 249; non-cancer: n = 288) methylome data, respectively. The cfDNA samples from 1,693 participants (cancer: n = 735; non-cancer: n = 958) were retrospectively collected and divided into training and validation sets to establish and test two multi-cancer detection blood test (MCDBT-1/2) models. Both models were blindly validated on a prospectively enrolled, independent validation cohort of age-matched 1,010 participants (cancer: n = 505; non-cancer: n = 505).

6-cancer test, detection-of-cancer performance in case-control cohorts

The THUNDER study

Fig 3. Performance of the MCDBT-1/2 models. A. Sensitivity, specificity, accuracy of top predicted origin, and accuracy of top two predicted origins. **B.** The overall sensitivity, accuracy of top predicted origin, and sensitivity stratified by cancer types reported by tumor stage.

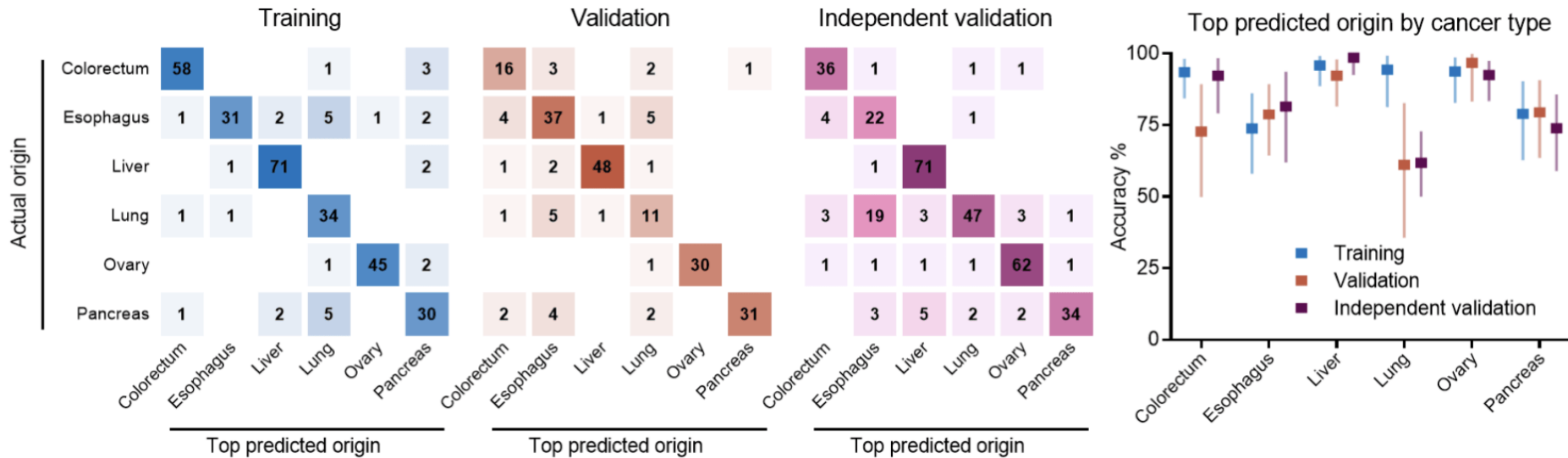


Data set	Specificity (%)	Sensitivity (%)	Accuracy of top predicted origin (%)	Accuracy of top two predicted origins (%)
Training set	99.7 (98.9-100.0)	75.2 (70.6-79.4)	89.7 (85.7-92.9)	94.7 (91.5-96.9)
Validation set	100.0 (97.0-100.0)	69.4 (63.9-74.6)	82.8 (77.0-87.6)	89.4 (84.5-93.3)
Independent validation set	98.9 (97.6-99.7)	69.1 (64.8-73.3)	83.2 (78.7-87.1)	91.7 (88.2-94.5)

6-cancer test, top-predicted-origin performance in case-control cohorts

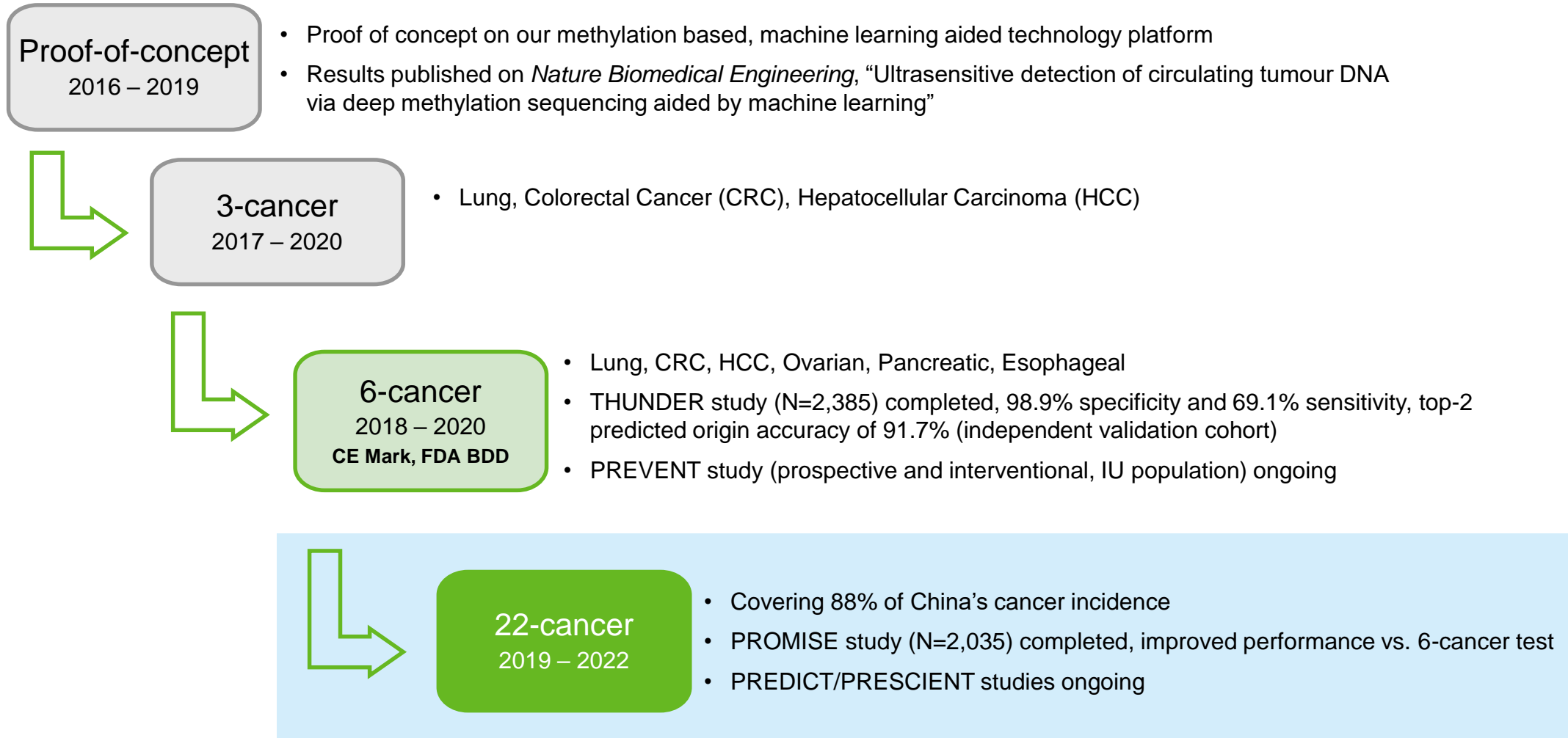
The THUNDER study

Fig 4. Top predicted origin for the MCBDT-1 model. Confusion matrices representing the predicted origin in the training, the validation, and the independent validation sets.



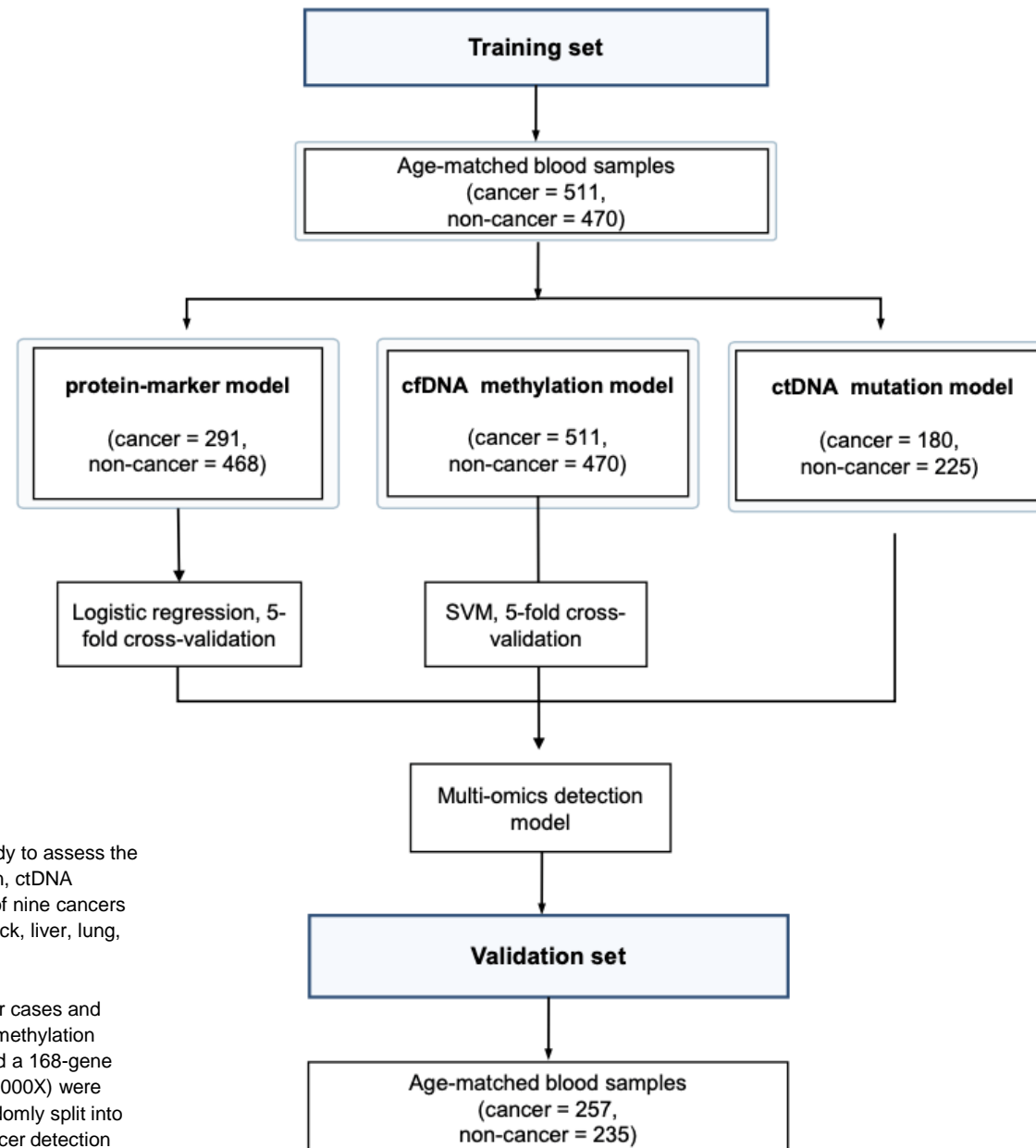
Data set	Specificity (%)	Sensitivity (%)	Accuracy of top predicted origin (%)	Accuracy of top two predicted origins (%)
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Independent validation set	98.9 (97.6-99.7)	69.1 (64.8-73.3)	83.2 (78.7-87.1)	91.7 (88.2-94.5)

Product Development Roadmap



9-cancer test, multi-omics model

The PROMISE study



PROMISE is a prospective multicenter case-control study to assess the performance of multi-omics including cfDNA methylation, ctDNA mutation and protein biomarkers in the early detection of nine cancers in the biliary tract, colorectum, esophagus, head and neck, liver, lung, ovary, pancreas and stomach.

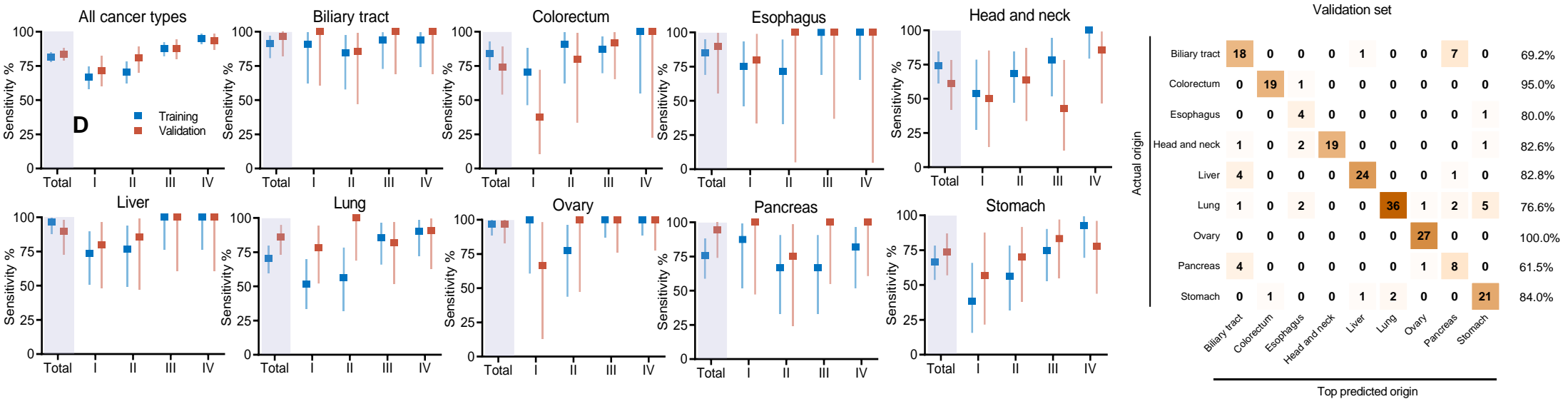
Blood samples were prospectively collected from cancer cases and non-cancer controls. A targeted cell-free DNA (cfDNA) methylation panel of ~490,000 CpG sites (1,000X) by ELSA-seq and a 168-gene mutation panel (35,000X, matched white blood cells:10,000X) were sequenced. Age-matched cases and controls were randomly split into training (n = 981) and test sets (n = 492). The multi-cancer detection blood test (MCDDBT) models were developed in the training set and then validated in the test set.

9-cancer test multi-omics model performance

The PROMISE study

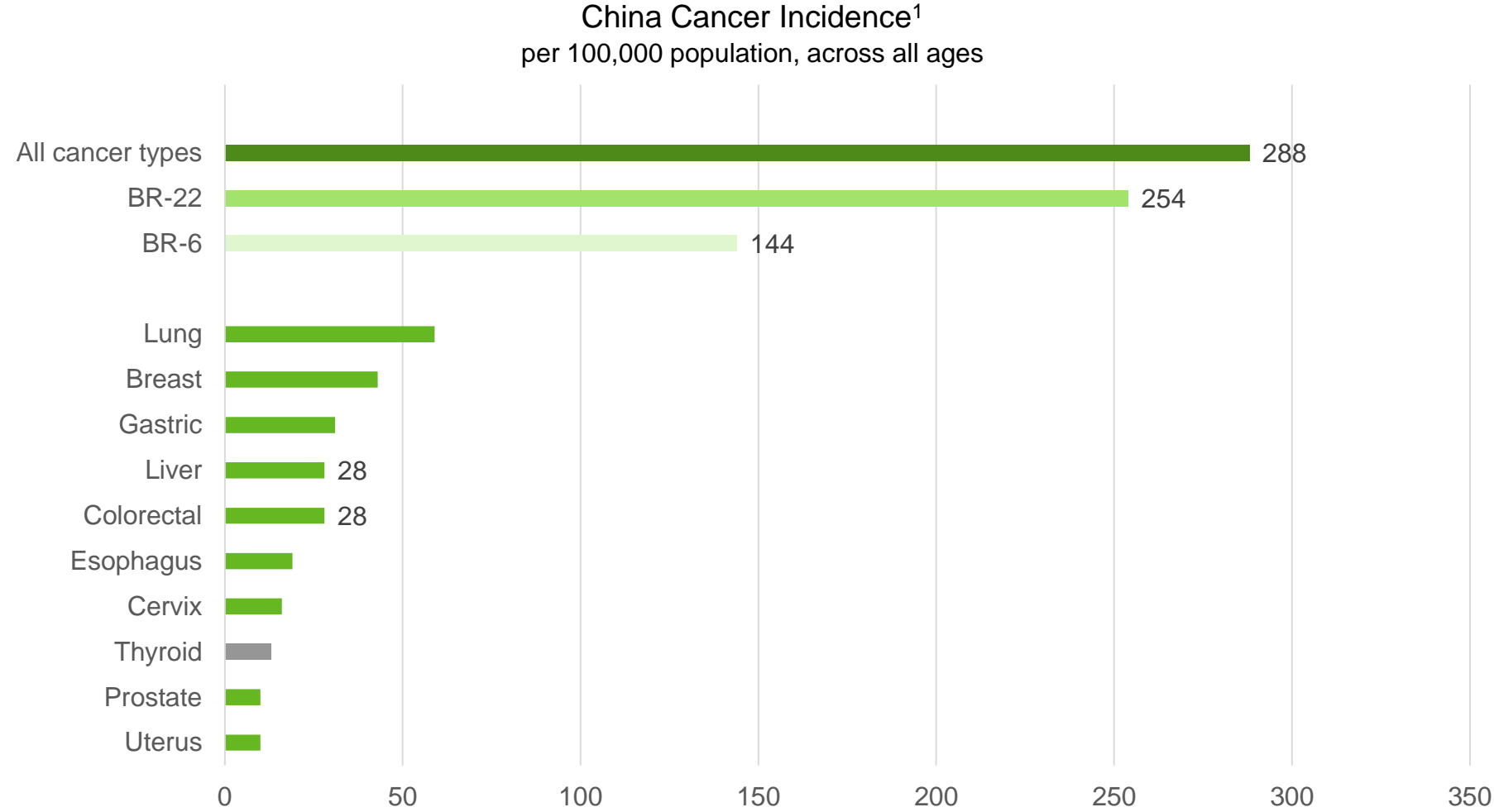
	Cancer (n)	Non-cancer (n)	Specificity (%)	Sensitivity (%)	Accuracy of top predicted origin (%)
Training	470	511	97.9% (96.1%-99.0%)	81.7% (78.1%-84.9%)	86.6% (83.0%-90.0%)
Validation	257	235	98.3% (96.6%-99.4%)	83.7% (79.0%-88.0%)	81.9% (76.0%-87.0%)

	Multi-omics	Methylation	Mutation	Protein
Specificity (95% CI)	98.3% (96.6%–99.4%)	99.1% (97.3%–99.8%)	99.6% (97.9%–100.0%)	99.6% (98.7%–100.0%)
Sensitivity (95% CI)	83.7% (78.6%–88.0%)	79.0% (73.5%–83.8%)	49.4% (41.9%–57.0%)	47.8% (40.8%–54.9%)



- PROMISE demonstrated 83.7% sensitivity and 98.3% specificity for 9 cancers
- Methylation contributed >90% of the total sensitivity, while protein and mutation collectively provided <10% additional positive detections

Burning Rock's 22-cancer test covers 88% of China's cancer incidence



Notes:

¹ Incidence data per "2018 China cancer registry annual report ", J He et al., ISBN 978-7-117-28585-8

² Final number of cancer types subject to development progress

Leadership in multi-cancer early detection

First-in-class, high entry-barrier, multi-year efforts

Challenges

BNR position

1

Technology

Low amount of cancer signal
in the circulating bloodstream, much more
challenging compared to tissue

Proprietary chemistry and algorithm

- On par with global leader, competitive sensitivity in earlier stages for certain cancers
- Multi-year lead vs. China peers (most showing liver-cancer and colon-cancer data only)

2

Clinical

Large, multi-year studies required
from case-control to intend-to-use population, from
observational to interventional (e.g. CCGA study:
15,254 participants, 8,584 with cancer, 6,670
without cancer)

Sponsorship from top physicians

- Catching up with global leader, to improve specificity and tissue-of-origin performance through large clinical studies
- Multi-year lead in China as the only company that has launched studies with over 10,000+ subjects

3

Regulatory

First-in-class
with no established regulatory pathway

Leading regulatory capability in China

- Exploring possible pathway, leveraging experience through the country's first NMPA-approved NGS kit

4

Commercial

Unprecedented product

Multi-pronged approach

- Initially working with hospitals' health check-up departments, leveraging synergy from in-hospital therapy selection business

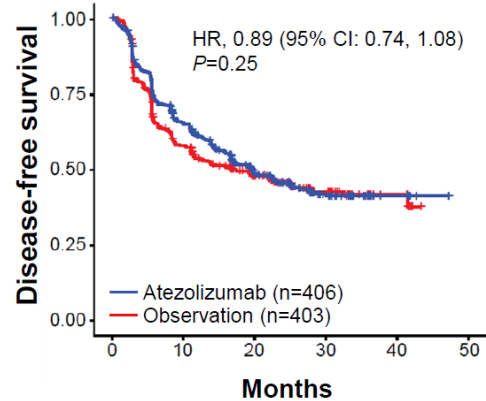
Appendix 2

MRD

How do MRD studies advance utility

Example 1: IMvigor010, enrich the high-risk group and "tune-up" adjuvant treatment

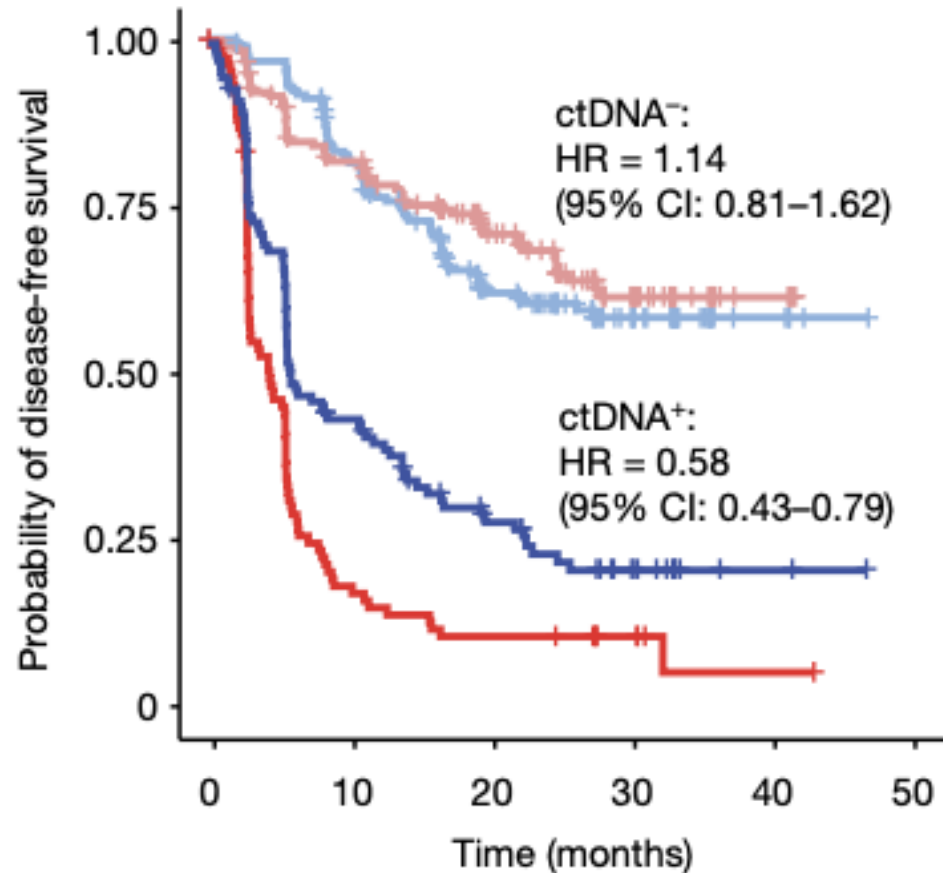
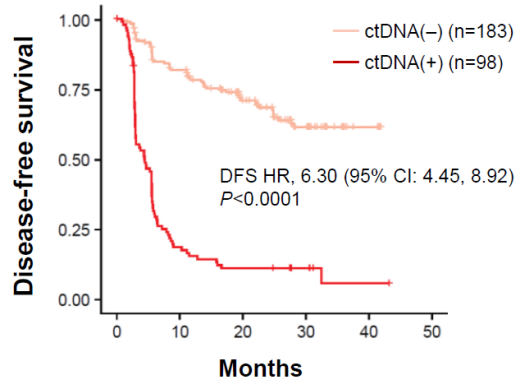
ITT



Atezo, MIUC Adjuvant Therapy
"All comers" demonstrated NO efficacy
TMB/PD-L1 showed NO prediction



Observation arm



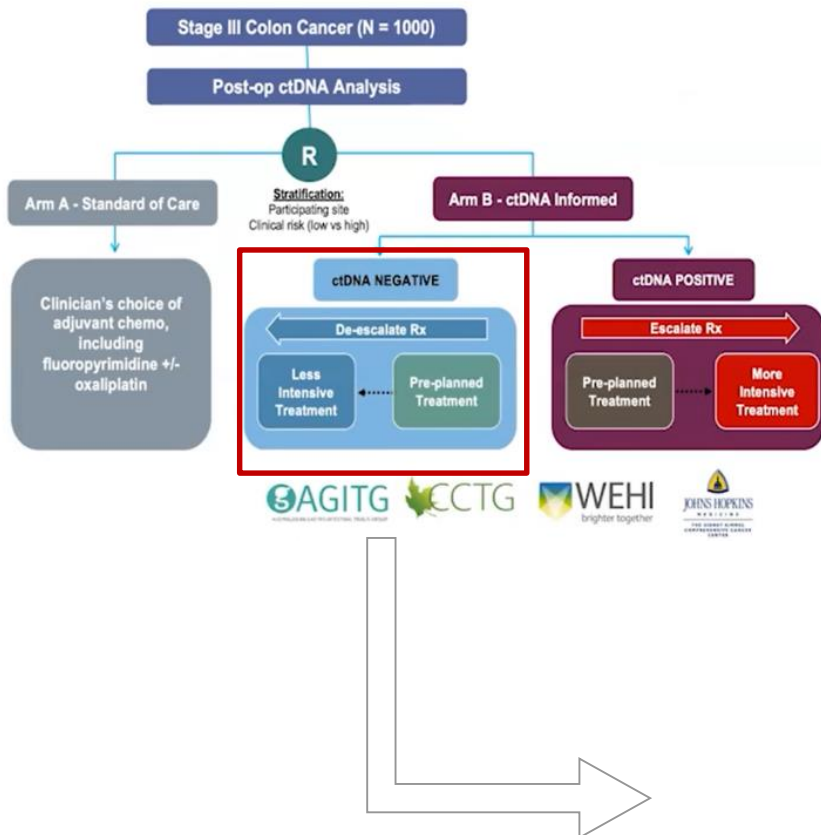
Indeed, only baseline MRD+ pts showed benefit

Landmark MRD+ pts (39%) had worse prognosis
Maybe only those patients can benefit?

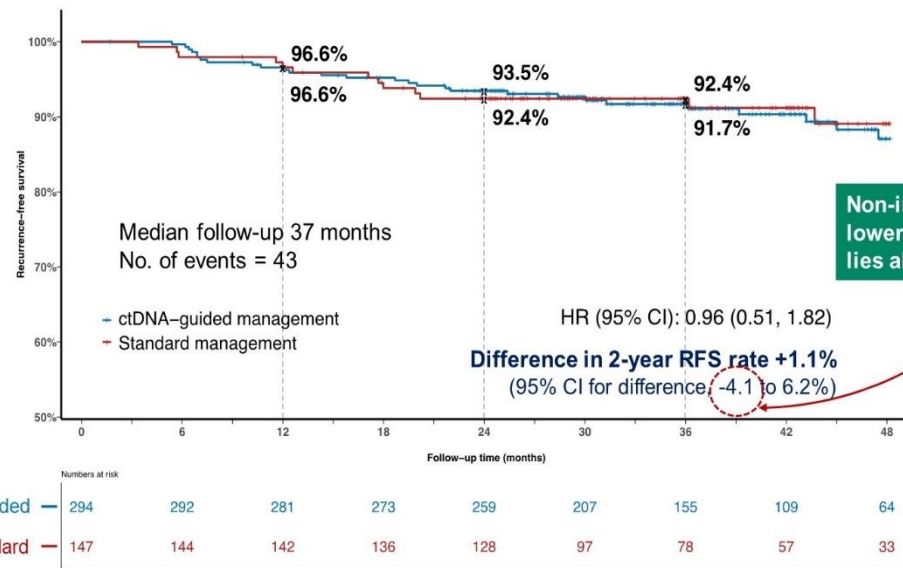
How do MRD studies advance utility

Example 2: Dynamic, identify low-risk patients and “tune-down” adjuvant treatment

DYNAMIC-III

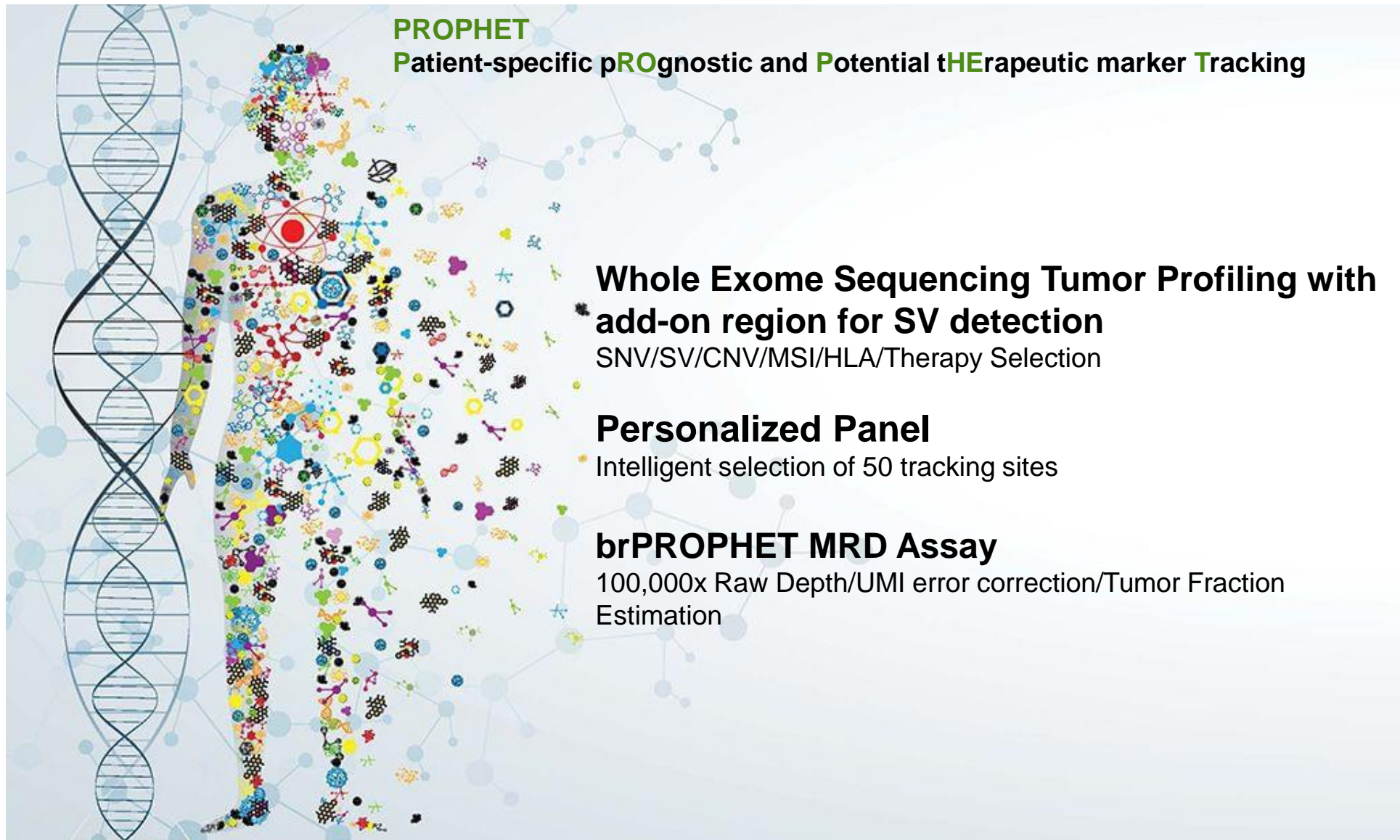


ctDNA-guided vs standard



The ctDNA-guided MRD- group had fewer patients with adjuvant chemotherapy than the standard group (15% vs. 29%) with non-inferiority of 3-year RFS (92.4% vs 91.7%)

brPROPHET™ – Burning Rock's MRD solution



PROPHET
Patient-specific pROgnostic and Potential tHERapeutic marker Tracking

Whole Exome Sequencing Tumor Profiling with add-on region for SV detection
SNV/SV/CNV/MSI/HLA/Therapy Selection

Personalized Panel
Intelligent selection of 50 tracking sites

brPROPHET MRD Assay
100,000x Raw Depth/UMI error correction/Tumor Fraction Estimation

Gastric cancer cohort publication at AACR 2023



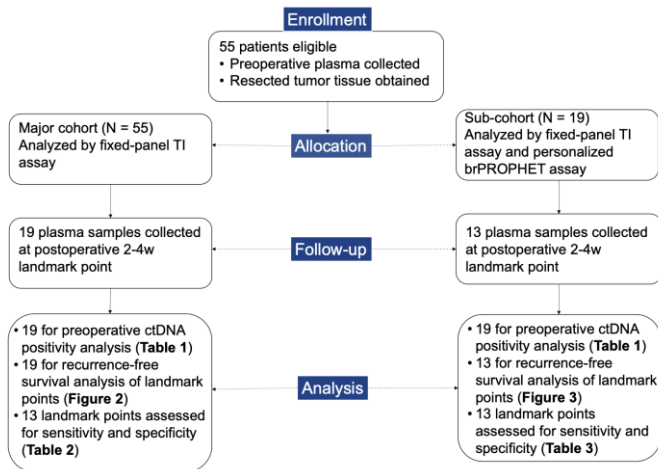
Circulating tumor DNA - based molecular residual disease predicts relapse in patients with resectable gastric cancer

Pei Xue¹, Yanfei Shao¹, Xueliang Zhou¹, Haiyan Li², Yang Wang², Chenyang Wang², Hao Zhang², Bing Li², Shuo Shi², Haiwei Du², Jing Sun¹
 1. Department of General Surgery, Ruijin Hospital, Shanghai Jiao Tong University, Shanghai, China
 2. Burning Rock Biotech, Guangzhou, China

2023 AACR
 #1037



Study cohort



Personalized assay significantly out-performs fixed panels

The ctDNA+ rate of preoperative samples detected by fixed panel and personalized brPROPHET™ assays

ctDNA+ rate	Stage I	Stage II	Stage III	Overall
Fixed panel	0% (0/4)	0% (0/3)	58.3% (7/12)	36.8% (7/19)
brPROPHET	100% (4/4)	66.7% (2/3)	91.7% (11/12)	89.5% (17/19)

Postoperative prognosis

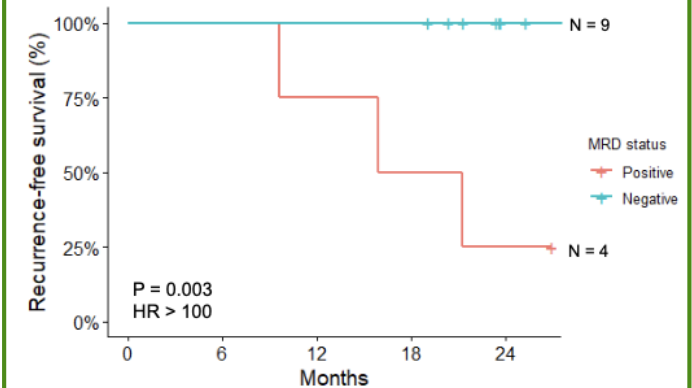


Table 3. The performance of MRD status detected by brPROPHET in predicting tumor recurrence.

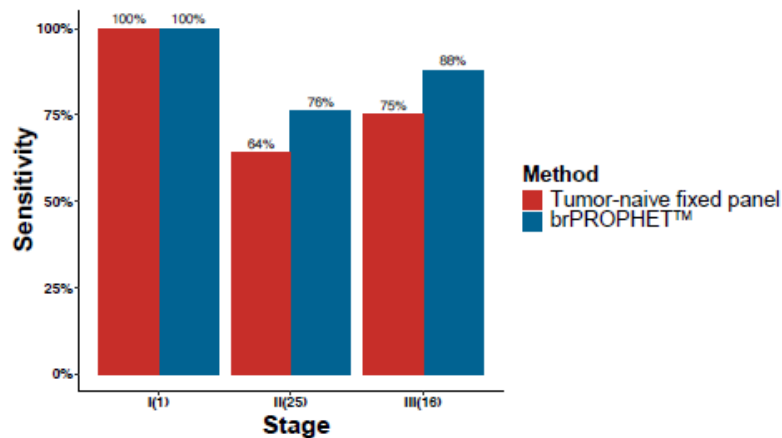
MRD status	Tumor recurrence		PPV=75%
	+	-	
+	3	1	NPV=100%
-	0	9	
		Sensitivity=100%	Specificity=90%

PPV, positive predictive value; NPV, negative predictive value.

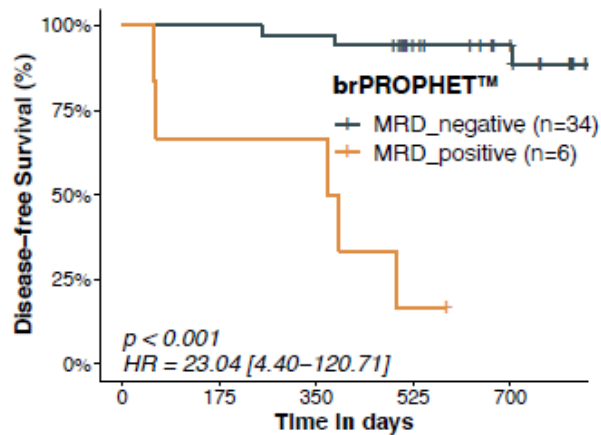
Colorectal cancer cohort publication at AACR 2022

Session OPO.PR02.01 - Clinical Prevention, Early Detection, and Interception

5917 - Patient-specific tumor-informed circulating tumor DNA (ctDNA) analysis for postoperative monitoring of patients with stages I-III colorectal cancer (CRC)

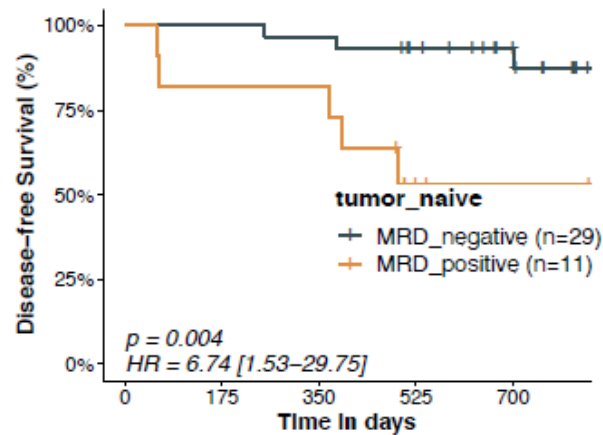


brPROPHET™ demonstrated superior sensitivity and specificity to fixed panel in pre-operative ctDNA detection and post-operative MRD calling among relapsed patients



Number at risk

Time (days)	0	175	350	525	700
MRD_negative (n=34)	34	34	33	25	17
MRD_positive (n=6)	6	4	4	1	0



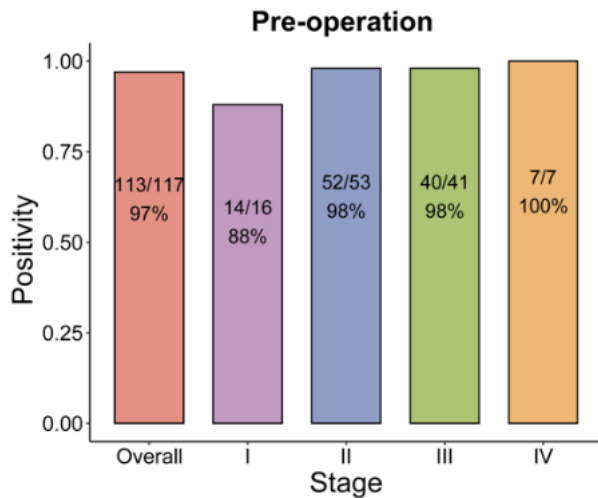
Number at risk

Time (days)	0	175	350	525	700
MRD_negative (n=29)	29	29	28	24	16
MRD_positive (n=11)	11	9	9	2	1

Second colorectal cancer cohort publication at ASCO GI 2023

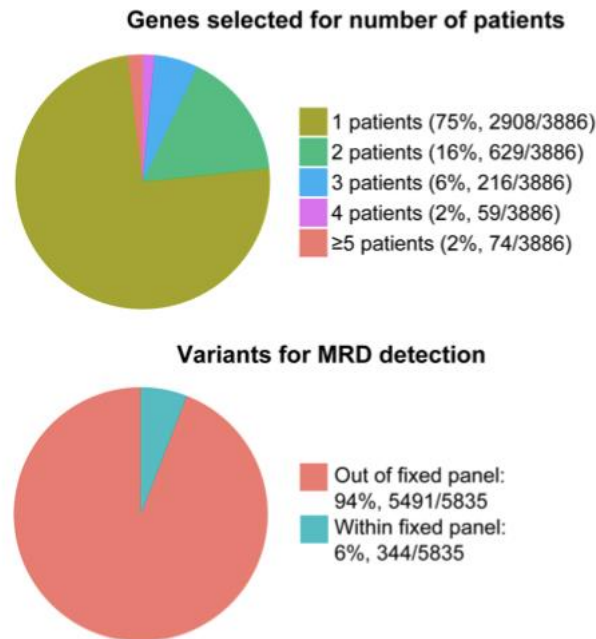
brPROPHET™ has high detection sensitivity

Preoperative ctDNA was detected in 97% (113/117) of the patients with 88% (14/16), 98% (52/53), 98% (40/41), and 100% (7/7) in stage I, II, III and IV, respectively



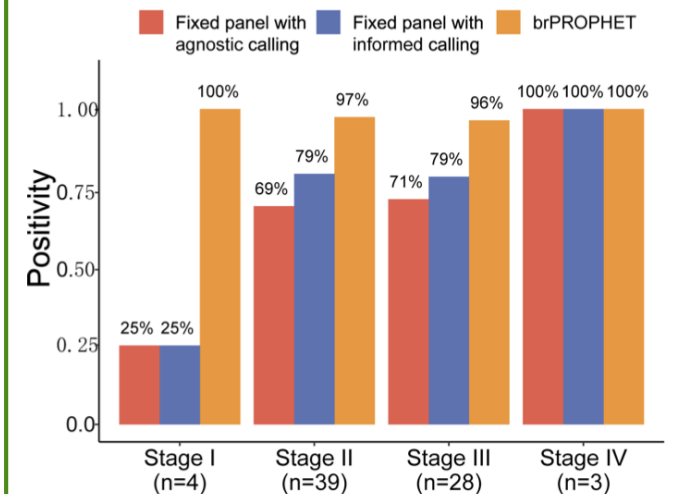
Most mutation variants fall outside of fixed panels

Only 6% of designed variants were included in the fixed panel. 75% of genes selected for panel design were private to a specific patient.



brPROPHET™ significantly out-performs fixed panels

Preoperative ctDNA was detected in 97% (113/117) of the patients with 88% (14/16), 98% (52/53), 98% (40/41), and 100% (7/7) in stage I, II, III and IV, respectively



Patients: A total of 117 patients (stage II/III 53 [45.3%] / 41 [35.0%]) who received surgery were analyzed. A subset of 74 patients were analyzed for comparisons of different methods.

Samples: Tumor tissue samples were collected at the surgery. Plasma samples collected at baseline, landmark 7-day and 1-month, and longitudinal points were analyzed.

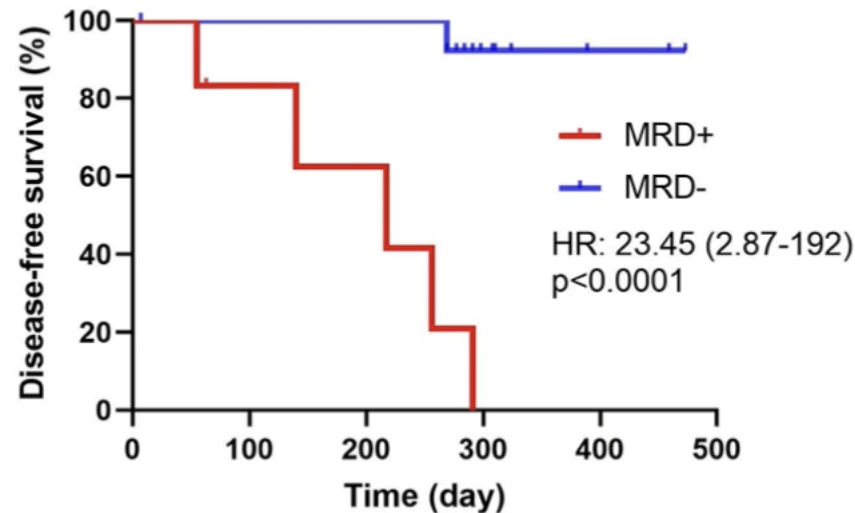
Source: Cao et al., Patient-specific tumor-informed circulating tumor DNA analysis for molecular residual disease detection in surgical patients with stages I-IV colorectal cancer, ASCO GI 2023

Pancreatic cancer cohort publication at ASCO GI 2023

Table 1: ctDNA detection at serial timepoints

	Baseline (Day 0)	Timepoint A (Day 7)	Timepoint B (Day 30)	Timepoint C (During AT)	Follow-ups
Positive	20	2	1	2	4
Negative	0	16	9	12	5
Positive Rate	100%	11.1%	10%	14.3%	44.4%

Figure 1: Longitudinal MRD detection is associated with shorter disease-free survival



Patients: A total of 20 patients (stage I/II 10 [50.0%] / 9 [45.0%]) were analyzed. 13 (65.0%) patients were treated with adjuvant therapy (AT) after surgery.


Samples: Tumor tissue samples were collected at the surgery. Plasma samples collected at baseline (n=20), landmark 7-day (n=18) and 1-month (n=10), and longitudinal points (n=23) were analyzed. Patients were followed for a median of 302 days. 39

Appendix 3

Therapy selection

NMPA approved NGS panels

NMPA approved testing kits by major NGS-focused companies¹

	First NMPA-approved kit	Second NMPA-approved kit
	EGFR, ALK, BRAF, KRAS Approved in Jul 2018 <u>First approved NGS kit in China</u>	EGFR, KRAS, MET, ERBB2, BRAF, PIK3CA, ALK, ROS1, RET Approved in Mar 2022
Novogene 诺禾	EGFR, KRAS, BRAF, PIK3CA, ALK, ROS1 Approved in Aug 2018	
Geneseeq 世和	EGFR, ALK, ROS1, BRAF, KRAS, ERBB2 Approved in Sep 2018	
BGI 华大	EGFR, KRAS, ALK Approved in Aug 2019	
Gene+ 吉因加	EGFR, KRAS, ALK Approved in Dec 2019	
Genetron 泛生子	EGFR, KRAS, BRAF, ERBB2, PIK3CA, ALK, ROS1, MET Approved in Feb 2020	
Genecast 臻和	KRAS, NRAS, BRAF, PIK3CA Approved in Mar 2021	
3DMed 思路迪		

Highlights on our second NMPA-approved kit

- Only 30ng DNA input required, applicable to small tissue samples
- First NMPA approved NGS kit with CNV² mutation type, with MET exon14 skipping

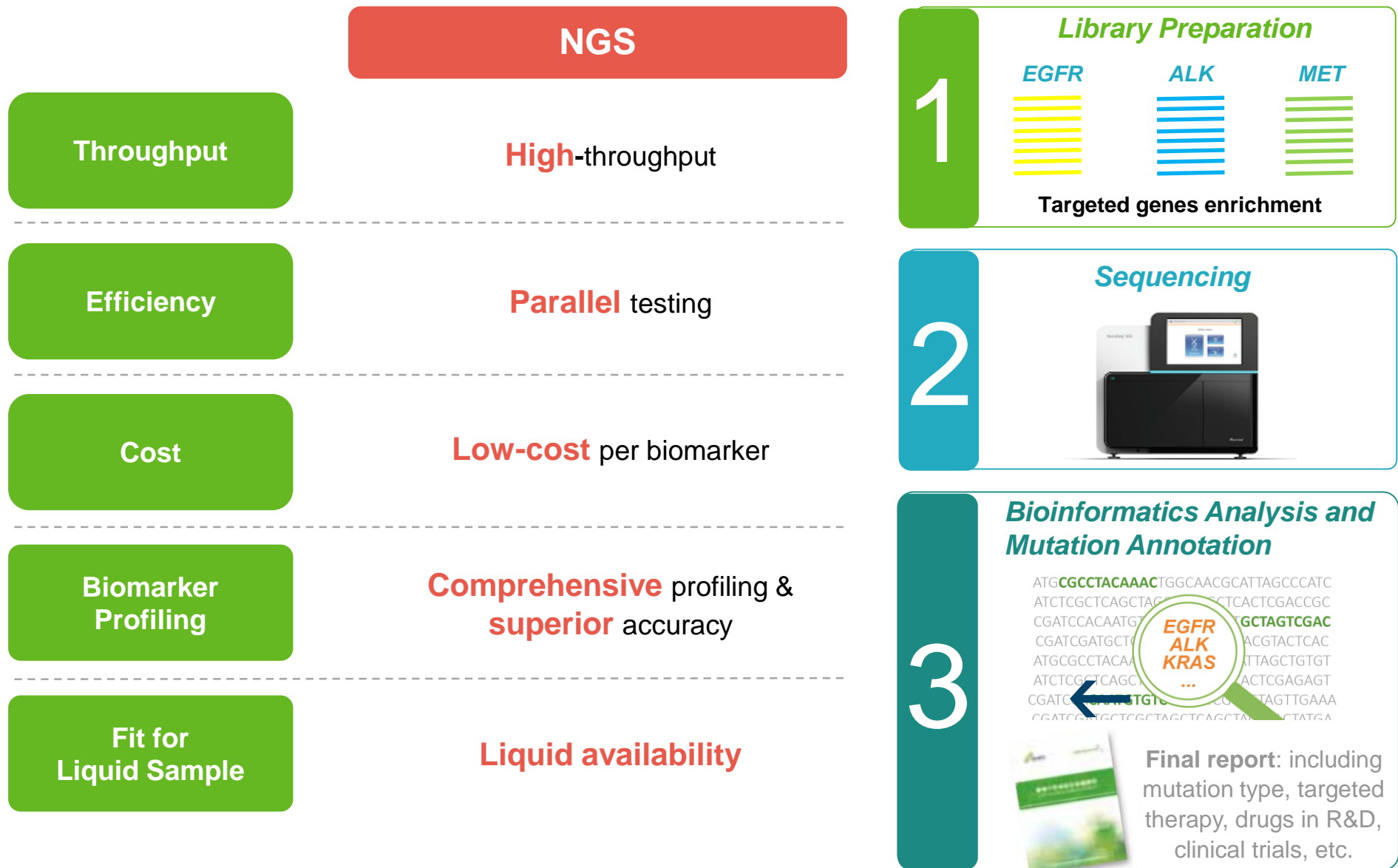
Notes:

¹ The list is not exhaustive. A total of 13 kits have been approved by the NMPA as of the date of this presentation

² Copy number variation

NGS testing

Diagnostics companies focus on steps 1 and 3



Leading liquid-biopsy product in China, with globally competitive performance

Demonstrated in high-impact analytical validation study

SEQC2
Study
Overview

MAQC/SEQC Consortium Projects – An Overview

- An FDA-led community-wide consortium effort to assess technical performance and application of emerging technologies (e.g., genomics).



Issues and Study Objectives

- FDA approved several NGS tests with sensitivity for AF ~5%
- Hundreds lab developed tests (LDT): sensitivity ~ 2-10%
- FDA approved ctDNA tests with sensitivity for AF ~0.3%



Evaluating the analytical validity of circulating tumor DNA sequencing assays for precision oncology

- False positive rate estimate through known negatives
- All of them by VAF ranges:
 - 0.1 - 0.5%, 0.5 - 2.5%, >2.5%
 - Finer VAF ranges for sensitivity: 0.1 - 0.2%, 0.2 - 0.3%, 0.3 - 0.5%
- Evaluate the impact of DNA input amount
 - Three levels of input for Ef: 10ng, 25ng, 50ng
- Evaluate the impact of synthetic plasma (DNA extraction)
 - Qubit HS calibration and quantification
 - Calculate extraction yield

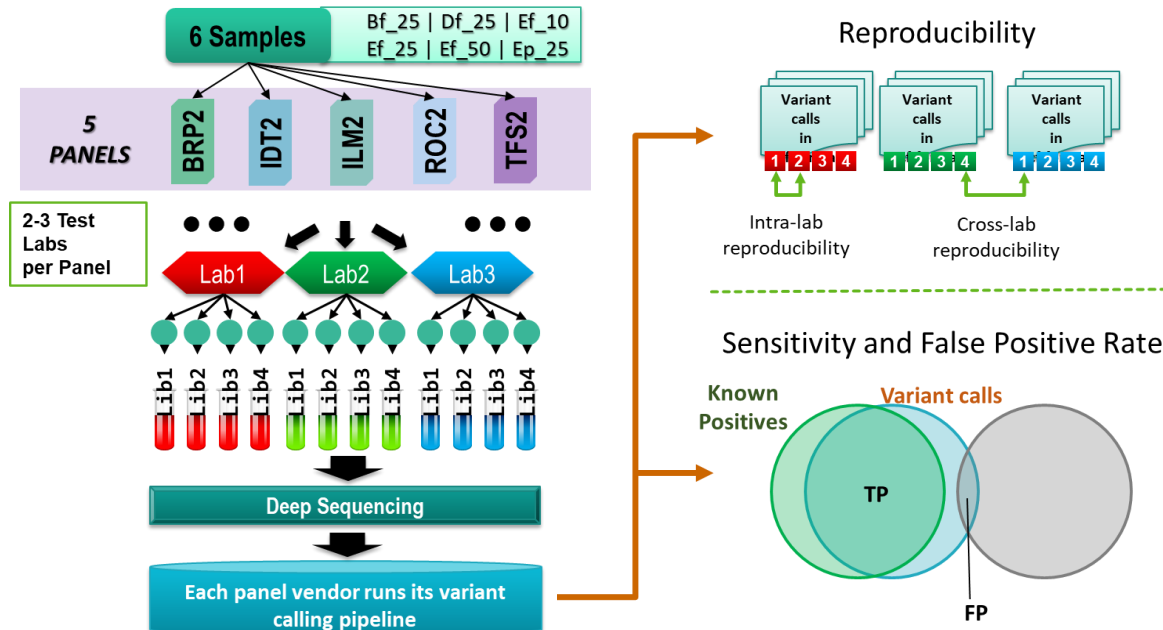
- Enzymatic fragmentation
 - better ligation efficiency
- Gel-based size selection (160bp-180bp) to mimic cfDNA
- 1ng/ul to mimic concentration after DNA extraction from plasma
- Ep: 40ng/ml Ef in synthetic plasma

BRP2: Burning Rock Dx LungPlasma v4
IDT2: IDT xGen Non-Small Cell Lung Cancer
ILM2: Illumina TruSight 170 with UMI
ROC2: Roche AVENIO ctDNA Expanded Kit
TFS2: Thermo Fisher Oncomine Lung cfDNA Assay

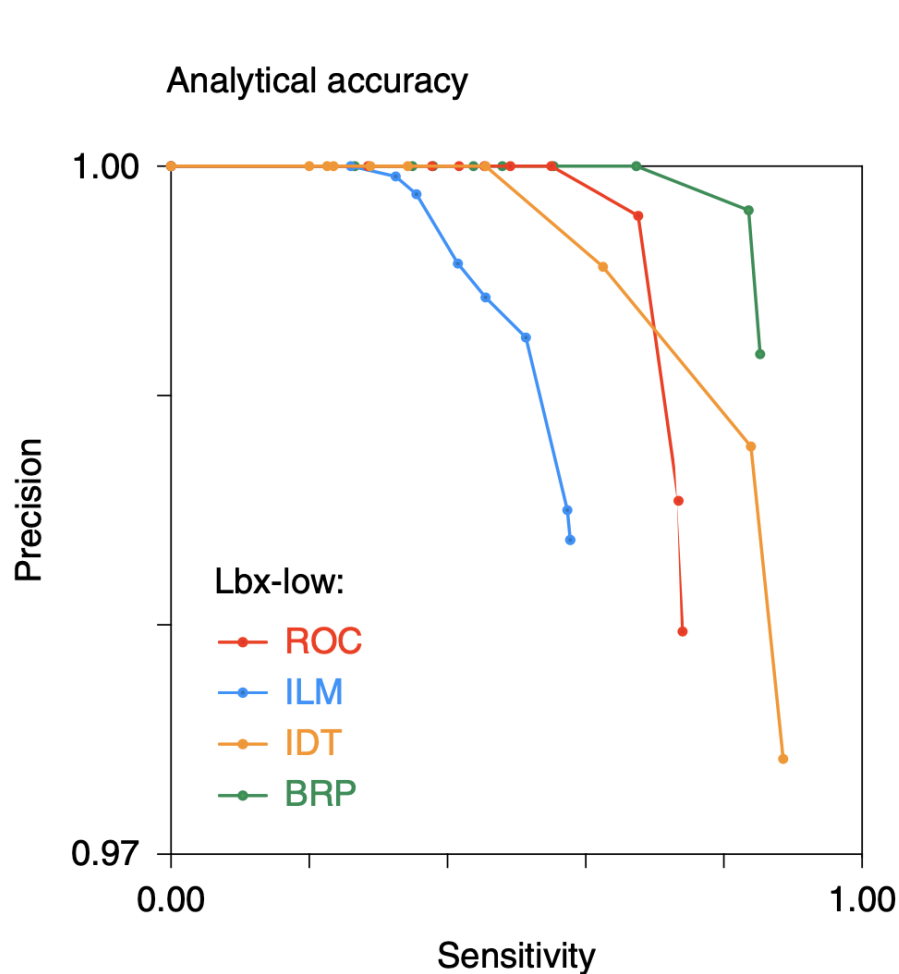
Liquid
Biopsy

Participating assays and study design

Name	Vendor	ctDNA assay	Sequencing platform	Target genes	Reportable region (kb)	Coding (kb)	CTR (kb)	Negatives (× 1,000)	Variants
ROC	Roche Sequencing Solutions	AVENIO ctDNA (Expanded Kit)	Illumina NextSeq	77	161.7	140.2	103.8	47.1	189
ILM	Illumina	TruSight Tumor 170 + UMI	Illumina NovaSeq	154	501.0	390.1	338.4	133.0	574
IDT	Integrated DNA Technologies	xGen Non-small Cell Lung Cancer	Illumina NovaSeq	24	110.1	93.2	76.5	39.3	130
BRP	Burning Rock Biotech	Lung Plasma v4	Illumina NovaSeq	168	226.9	148.5	125.1	53.4	229
TFS	Thermo Fisher Scientific	Oncomine Lung cfDNA assay	Ion Torrent S5 XL	11	1.9	1.6	1.3	0.8	5



Overall analytical accuracy and specificity

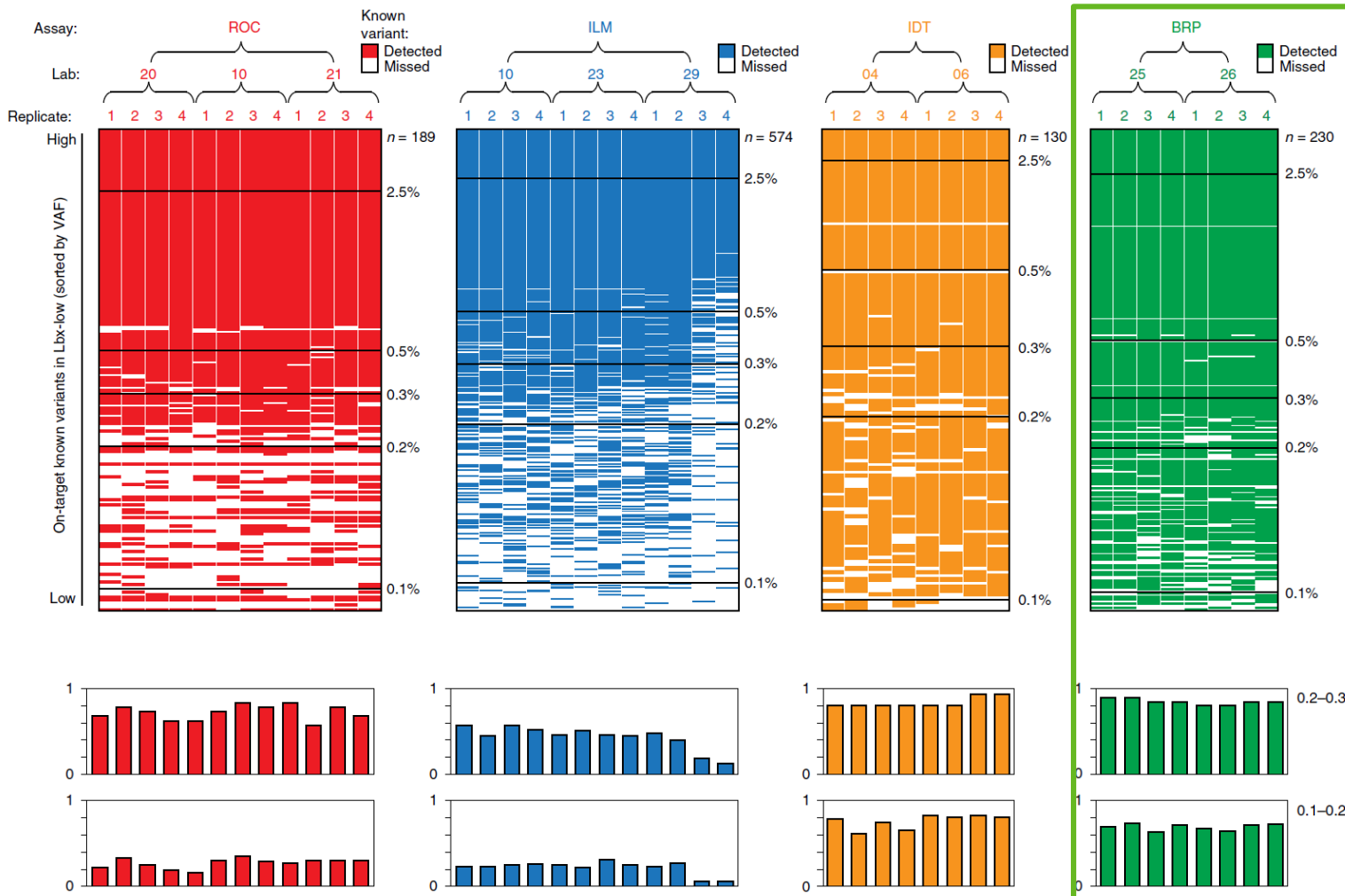


Assay	Known negatives (kb)	FPs per replicate (mean [range])	FP-rate (FP / kb) at specified VAF threshold		
			> 0%	> 0.1%	> 0.5%
ROC	47.1	2.91 [1-6]	0.061	0.044	0.000
ILM	133	5.25 [2-10]	0.039	0.039	0.008
IDT	39.3	2.75 [0-6]	0.070	0.057	0.000
BRP	53.4	1.65 [0-5]	0.030	0.007	0.000

The analytical accuracy was measured by **Precision-Sensitivity** plot (25ng Lbx-Low)
 The false positive rates were computed by FP/kb region.
 Once different VAF threshold increases, FP rates dropped further.

“To compare the accuracy of the participating ctDNA assays, we generated precision recall curves, ranking known variants and FPs according to their observed VAFs. **For Lbx-low samples at 25ng input, BRP was the most accurate assay, with roughly equivalent sensitivity but superior precision to IDT** (Fig. 4b and Supplementary Fig. 4c).”

Performance – Sensitivity



- LBx-low (25 ng input) replicates in each participating assay in different expected VAF bin.

“The most sensitive assays (IDT and BRP) achieved sensitivity greater than 0.90 for variants with 0.3–0.5% VAF; however, no assays reached this mark for variants with 0.2–0.3% or 0.1–0.2% VAF (Fig. 4a).”

“The performance characteristics of the assays evaluated here were broadly similar to what has been reported by several ctDNA sequencing providers (based on internal testing) that did not participate in this study. **During validation of the Guardant360 CDx hybrid capture assay, variants were detected with high sensitivity (~94%) at VAF ≥ 0.4%, declining to ~64% among variants with VAF ranging from 0.05% to 0.25%.** **FoundationACT showed ~99% sensitivity for SNVs with VAF > 0.5%, ~95% for 0.25%–0.5% VAF and ~70% for 0.125–0.25% VAF.**”