



TECHNOLOGY & PLATFORM LANDSCAPE

Spatial Biology

Integrating a functional-substrate technology into the leading spatial biology platforms — instruments, resolution, economics and collaboration routes.

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EXECUTIVE SUMMARY

Project Background

To guide strategy on what growth applications for functional substrates to pursue, monitor, or move away from, the manufacturer wants to develop a clear understanding of individual technologies under the Spatial Biology umbrella — including, but not limited to, Mass Spectrometry Imaging, Multispectral Imaging and In situ hybridization — and the working principle of individual instruments leveraging them.

A breakdown of individual instruments, including:

- The material used for the substrates
- Functionalization of the slides/substrates
- Average sale price (ASP) of the functionalized slides/substrates
- Unique selling point (USP) of the instrument
- ASP of the instrument

Project activities will focus on an assessment of:

- Spatial Biology sub-technologies
- The working principles of individual instruments leveraging spatial biology technologies
- Instruments using or having the potential to use functional substrates
- Substrate materials including type, function, sales price, value proposition, and price of complete instrument

EXECUTIVE SUMMARY

Research Approach

Ezassi followed a qualitative approach — directly interviewing subject matter experts with experience in Spatial Biology.

Ezassi's quantitative research included investigation into the technology and market landscape of Spatial Biology.

- **Data Sources explored:** News, web-monitoring, patents, publications, supplier/vendor databases, startup databases, grants
- **Geographic regions covered:** Global



Qualitative interviews validated against the quantitative landscape.

PLATFORMS 1-5 OF 10

Platform Analysis Matrix - Technology & Performance

Feature	Nanostring GeoMx (Bruker)	10x Genomics (Visium) & Visium HD	BGI STOmics	Lunaphore	Akoya
Omics Technology	Transcriptomics/ Genomics/ Proteomics	Transcriptomics	Transcriptomics/ Genomics/ Proteomics	Proteomics, some transcriptomics	Proteomics, transcriptomics
Underlying Technology	Microdissection	In Situ Sequencing	Microarray	Microfluidic-based sequential IF	Cyclic immunofluorescence
Protein/RNA/Both	Both	RNA	Both	Both	Both
Signal Intensity	High	Moderate	High	High	High
Spatial Resolution	Min. UV illumination area: 10µm diameter	Visium: 55 µm Visium HD: with 2µm pixel	>500nm	>250 nm	>250 nm (subcellular)
Plex	Whole transcriptome, Proteomics: 60 plex possible	Whole transcriptome (up to 20k)	Whole transcriptome	40+	100+
Tissue Compatibility	FFPE & FF	FFPE & FF	FF	FFPE & FF	FFPE & FF
Re-usability	Yes	No	No	Yes	No
Sequencing Compatibility	Yes	Yes	Yes	Yes	Yes

PLATFORMS 6-10 OF 10

Platform Analysis Matrix - Technology & Performance

Feature	Miltenyi	Vizgen MERSCOPE	Curio Bioscience SEEKER	Standard Bio Tools HYPERION	Ionpath MIBIscope
Omics Technology	Proteomics, transcriptomics	Transcriptomics	Transcriptomics	Proteomics, Transcriptomics	Proteomics, Transcriptomics
Underlying Technology	MACSima Imaging Cyclic Staining (MICS)	smFISH	Slide-Seq (similar to Visium, but higher resolution)	Time-of-Flight Mass Spec, Imaging Mass Cytometry	Time-of-Flight Mass Spec
Protein/RNA/Both	Both	RNA	RNA	Both	Both
Signal Intensity	High	High	Moderate	High	High
Spatial Resolution	Down to 0.25 µm/pixel (subcellular)	~0.5 µm (subcellular)	10 µm	≥1 µm	Down to 250 nm
Plex	Hundreds of protein markers, 20+ RNA targets	Hundreds to thousands of genes	Whole transcriptome	40+	Up to 40 protein markers per tissue section
Tissue Compatibility	FFPE & FF	Fresh frozen, FFPE	Fresh frozen	FFPE & Fresh frozen	FFPE & Fresh frozen
Re-usability	Yes	No	No	N/A	N/A
Sequencing Compatibility	Yes	Yes	Yes	N/A	N/A

PLATFORMS 1-5 OF 10

Platform Analysis Matrix - Commercial & Operational

Feature	Nanostring GeoMx (Bruker)	10x Genomics (Visium) & Visium HD	BGI STOmics	Lunaphore	Akoya
Instrument ASP	350k€	80k€	NA	225k€	275k€
Slide ASP (average sale price)	3-4k€	10k€	9-11k€	1-3k€	N/A
Functionalization of the slides/substrates	N.A.	Bin coating (hydrogel)	Nanoballs	N.A. (some: ITO coating)	N/A
Reagents — material used for substrates	Oligos	Oligos	Oligos	Off-the-shelf antibodies	Barcoded antibodies
Target Group	Research/Translational/Clinical (?)	Research	Research	Research, Clinical, Translational	Research, Clinical, Translational
Speed	1 day	2-3 days	1.5 days	Up to 30 min per cycle	0.5-1.5 days per run
Material Collection (Tissue)	UV-based microdissection	Spatially-barcoded beads	In situ capture	Microfluidic	Iterative imaging
Slide array size	1x1cm	6.5x6.5cm	0.5x0.5cm / 1x1cm / 6x6cm / 13x13cm	1.5x1.5cm	N/A
Cycling Time	1 day	2-3 days	1.5 days	Up to 30 min	N/A
Throughput (Scalability)	Up to 8 slides per day (with 12 ROIs per slide)	1 slide/cycle	4 slides	Up to 300 slides/week	One sample at a time, 0.5-1.5 days per run

PLATFORMS 6-10 OF 10

Platform Analysis Matrix - Commercial & Operational

Feature	Miltenyi	Vizgen MERSCOPE	Curio Bioscience SEEKER	Standard Bio Tools HYPERION	Ionpath MIBIScope
Instrument ASP	300k€	450k€	N/A	800k€	1m€
Slide ASP (average sale price)	N/A	N/A	N/A	N/A	N/A
Functionalization of the slides/substrates	N/A	N/A	Spatially barcoded beads	N/A	Metal-tagged antibodies
Reagents — material used for substrates	Recombinant antibodies	Oligos	Oligos	Metal-tagged antibodies	Metal-tagged antibodies
Target Group	Research, Clinical, Translational	Research	Research	Research, Translational, Clinical	Research, Translational, Clinical
Speed	Multiple cycles, each up to 30 min	0.5-1.5 days per run	Fast	200 pixels/sec (400 pixels/sec for Hyperion+)	20 mm ² per hour in high-throughput mode
Material Collection (Tissue)	Iterative imaging	Sequential imaging	Spatially-indexed beads	Laser Ablation	Laser Ablation
Slide array size	N/A	N/A	3x3 mm or 10x10 mm	≥15 mm x 45 mm (addressable sample size)	Up to 2 cm ² per scan
Cycling Time	Multiple cycles, each up to 30 min	N/A	N/A	N/A	N/A
Throughput (Scalability)	Up to 300 slides/week	One sample at a time	8 tiles (3x3 mm) or 4 tiles (10x10 mm)	≥1 mm ² /2 hr (@200 Hz), ≥1 mm ² /1 hr (@400 Hz for Hyperion+)	Up to 40 slides in 24 hours

Market Segment Needs

Clinical applications

The most immediate opportunity lies in platforms moving toward clinical adoption, particularly those using standardized workflows that require consistent, validated substrates.

Diagnostic development

- Platforms like GeoMx and PhenoCycler are being validated for clinical diagnostics
 - These require highly reproducible, clinically-validated substrates
- Critical need for FDA-compliant manufacturing and quality control

Clinical testing

- Opportunity for “clinical-grade” premium substrates
- Growing adoption in pathology labs requires standardized consumables

Research applications

The research market presents opportunities for innovation and specialized solutions:

High-performance research

- Advanced applications requiring superior optical properties
- Ultra-high-resolution imaging needs specialized surface chemistry
- Complex multi-omic experiments demand sophisticated substrate properties

Method development

- New spatial techniques requiring novel surface modifications
- Platform developers seeking competitive advantages
- Custom solutions for specific applications

EXECUTIVE SUMMARY

Recommended Actions

Pursue

Offer the most promising opportunities for integration, given their market leadership and the significant improvements the substrate technology could bring to their platforms.

- **10x Genomics Visium**
- **BGI STOmics**
- **NanoString GeoMx (Bruker)**

Monitor

Present strong collaboration potential due to their established market presence and the complementary nature of their technologies.

- **Lunaphore COMET**
- **Akoya PhenoCycler**

Lower priority

Offer valuable capabilities in spatial biology, but present less compelling integration opportunities than the higher-ranked platforms:

- **Miltenyi MACSima**, with its current high resolution (down to 0.25 μm /pixel) and established cyclic immunofluorescence approach, may see only incremental benefits from integration
- **Vizgen MERSCOPE**, focused solely on RNA detection with its $\sim 0.5 \mu\text{m}$ resolution, limits the full potential of the technology's dual RNA/protein capabilities
- **Curio Bioscience SEEKER**, while potentially benefiting significantly from enhanced resolution beyond its current 10 μm , is constrained by its limited market presence and fresh-frozen-only sample compatibility



APPENDIX

Appendix

- Platform analysis by technology
- Company profiles
- Subject matter experts
- Resources

TECHNOLOGY BREAKDOWN BY PLATFORM

Platform Analysis by Technology

In situ sequencing / RNA analysis

- 10x Genomics Xenium: In situ sequencing
- 10x Genomics Visium: Microarray-based spatial transcriptomics
- ACDBio RNAscope: Single-molecule FISH (smFISH)
- Resolve Biosciences Tissue Cartography: smFISH
- Vizgen MERFISH: smFISH
- Nanostring nCounter: scRNA-seq
- Nanostring CosMx: smFISH
- Spatial Genomics GenePS: seqFISH
- BGI STOmics: Microarray

Cyclic immunofluorescence / protein analysis

- Akoya PhenoCycler: Cyclic restaining
- Akoya PhenImager: Multispectral imaging
- Lunaphore COMET: Cyclic restaining
- Lunaphore COMET + RNAscope: Combined cyclic restaining + smFISH
- Miltenyi MACSima: Cyclic restaining
- Leica Cell Dive: Cyclic restaining
- Canopy Biosciences CellScape: Cyclic restaining, chip cytometry
- Rarecyte ORION: Narrow-band optical filters

Mass spectrometry based

- Standard Bio Tools Hyperion: ToF mass spectrometry, IMC
- Ionpath MIBIScope: ToF mass spectrometry
- Bruker FLEX series: MALDI imaging
- AmberGen Miralys: Mass-tags and fluorophores for MSI

Platform Analysis by Technology

Novel / hybrid approaches

- Alpenglow 3Di: 3D spatial biology with open-top light-sheet microscopy
- Singular Genomics G4x: In situ sequencing + proteins + FL H&E
- Ultivue InSituPlex: Conjugated DNA barcoding
- Genoskin MANTIS: 3D multiplex imaging platform for skin
- Omicsvue NanoVIP: Stainer only, no imaging

Software solutions

- Aspect Analytics Weave: Cloud/browser-based
- Enable Medicine Platform: Cloud/browser-based
- Fraunhofer IIS MIKAIA: Cell analysis suite (segmentation, characterization, etc.)
- Leica Aivia: Image analysis
- Miltenyi MACS iQ View: Analysis software
- Nanostring AtoMx: Cloud/browser-based
- Lunaphore Horizon: Analysis software

Key technology features

- Protein analysis capability: 18 platforms
- RNA analysis capability: 16 platforms
- Combined protein & RNA: 7 platforms

Analysis methods

- FISH-based methods (various types)
- Cyclic immunofluorescence
- Mass spectrometry
- Microarray-based approaches
- In situ sequencing
- 3D imaging approaches
- Cloud-based analysis platforms

This landscape shows a diverse range of approaches to spatial biology, with many platforms offering complementary capabilities.



APPENDIX

Company Profiles

The following companies were selected based on:

- Alignment with the scope of work set by the manufacturer, and understanding of substrate integration opportunities
- Information gathered by direct discussion with subject matter experts (SMEs) and direct analysis of quantitative information from the sources cited in this report

NanoString GeoMx (Bruker)

Why collaborate?

- Offers high-plex spatial analysis of RNA and proteins, aligning well with the substrate technology's potential to enhance both
- Current 10 μm minimum ROI could be significantly improved by a high-density microchannel array
- Compatible with both FFPE and fresh frozen samples, expanding market reach

Value proposition

- The substrate technology could provide GeoMx with a competitive edge in spatial resolution and processing speed
- Potential to increase throughput beyond current 12 ROIs per slide
- Enhanced sensitivity for detecting low-abundance targets

NanoString GeoMx (Bruker)

- Spatial resolution limited to 10 µm minimum ROI
- Processing time constraints due to UV-based microdissection
- Potential for signal loss during microdissection and collection
- Scalability limitations in ROI selection process
- Balance between high-plex capability and spatial resolution
- Need for improved sensitivity in detecting low-abundance targets

