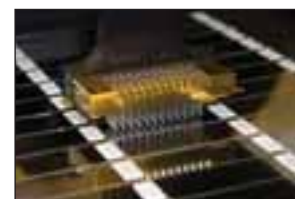


Product Survey: Microarray Spotters

Printing Biomolecules

Microarray printers are important tools for every lab doing microarray experiments. Basically you may choose between homemade or manufactured and contact or non-contact printers.



The first paper describing microarrays was published in 1989 by Roger Ekins but the real breakthrough for the microarray technology came a few years later when Pat Brown of the Stanford University built the first microarray printer in 1995. In contrast to Affymetrix' elaborate and expensive photolithographic process of the microarray generation, Brown's microarrayer was based on a rather simple contact printing technology that is still in use in some of today's microarray printers. His first printer was a kind of do-it-yourself construction. Brown's idea was to array spots of whole DNA-fragments onto glass slides with fountain pen-like tips that are moved to exactly defined positions across the slides by the arms of a robot.

Pick and place robot

Although a trained molecular biologist and physician, Brown obviously has some engineering skills too. He modified a standard "pick and place" XYZ axis gantry robot and came up with a microarray printer that picks up DNA samples from a 384 well microplate by placing the printing tips into the wells. Similar to a quill pen, the pins of Brown's microarray printer draw up the liq-

uid by capillary action and deposit it on the slide after the contact of the tips with the slide surface. The construction of a Brown-type microarrayer is rather easy. Actually, Brown and his former colleague, Joe deRisi, have posted a detailed list of the printer parts on Brown's Stanford website, together with a manual, describing how to put them together, to build a "homebrew" microarray printer. According to a paper published in 2006 by Tim Lenoir and Eric Gianella in the *Journal of Biomedical Discovery and Collaboration*, in the early days of microarrays, almost every second researcher doing microarray experiments used a homemade microarray system based on the plans from the Brown lab.

Contact printing microarrayers, like the one by Pat Brown, usually have solid, split, or microspotting pins that come into direct contact with the microarray slide surface. That's one of the main disadvantages of this microarray technique. While DNA fragments are rather robust and are not affected when the pins' tips touch the slide, delicate molecules like proteins may get damaged during the printing process. Another problem encountered with contact printers is the possibility that the pins carry over sub-

stances in multiple component reactions if they are not washed carefully between each single reaction step.

Shooting DNA drops

To avoid these problems, several manufacturers have developed non-contact printers based on the technology commonly used in piezo-driven ink-jet printers. Instead of ink on a sheet of paper, they shoot DNA, proteins or cells onto the surface of a substrate without having contact to the surface. To this end, the samples are transported to the tips of tiny glass capillaries used as print heads by micro-pumping devices or simple capillary force. The capillaries are connected to piezoelectric crystals that initiate the droplet ejection out of small nozzles on the tips of the capillaries after a piezoelectric impulse. With a few exceptions, the number of delivering mechanisms on non-contact printers is often limited to a range of one to 24. On the other hand, they can load large volumes and spot thousands of times with a single loading. Non-contact printers are therefore ideal if the number of samples to spot is low and the number of times to spot the samples is high.

HARALD ZÄHRINGER

Microarray Spotters							
Company	Model	Short description	Applications	Spotting technology Washing & drying	Capacity Supported plates Throughput/Speed	Special features	Price [EUR]
Abbis bio process automation Wiesbaum, Germany www.abbis.de Contact: Berit Cleven Phone: +49-6593-998-0 info@abbis.de	ABBIS HDA	Non-contact Piezo Arrayer for industrial high throughput production of micro-arrays.	DNA microarrays Protein microarrays Customized microarrays.	Piezo Dispensing. Washing of Piezo dispensers in spotting unit. Drying in separate unit with VISION QC.	Customized capacity. Customized materials and formats. Customized throughput/speed.	- Vision QC Fully-autom. production - Modular design - Arbitrary batch sizes - Product flexibility - Individual configuration of software and hardware - Image store and LIMS connection	On request
Arrayjet Mayfield, Scotland - UK www.arrayjet.co.uk Contact: Product Manager: Karen Allison Phone: +44 131 654 5728 kallison@arrayjet.co.uk	Marathon	JetSpyder liquid-handling device allows aspiration of low quantities of biologic. samples into a piezoelectric print head which prints arrays to microscope slides on-the-fly with excellent spot quality, uniformity, and precise placement. Upgradeable platform.	DNA arrays; Cell lysate arrays; protein arrays; cell arrays.	Industrial-scale piezo-electric inkjet print head with 126 nozzles.	Prints from 6 microtitre plates to 100 slides in walkaway mode. More plates may be added by the user if required in relay mode - the Marathon will pause to allow swapover. Prints 1x384-well plate to 100 slides in 48 or 25 minutes, depending on JetSpyder selection.	- Robust, user-friendly inkjet technol. - High throughput on-the-fly printing capability - Multiple nozzles p. sample enables spot-on-spot printing on-the-fly - QC test slide allows interaction with the print head and virtually eliminates missing spots - Printing format flexibility makes max. use of avail. space and allows fast, easy print. of mini-arrays	135.000,- (approx.)
	Super-Marathon	As above	DNA arrays; Cell lysate arrays; protein arrays; cell arrays.	Industrial-scale piezo-electric inkjet print head with 126 nozzles.	Prints from 48 microtitre pl. to 100 slides in walkaway mode. More plates may be added if required in relay mode - the Super-Mar. will pause to allow swapover. Prints 1x384-well pl. to 100 slides in 48 or 25 min, dep. on JetSpyder selection.	As above	168.000,- (approx.)
	New product: Sprint	As above	DNA arrays; Cell lysate arrays; protein arrays; cell arrays.	Industrial-scale piezo-electric inkjet print head with 126 nozzles.	Prints from 2 microtitre plates to 20 slides in walkaway mode. Two more plates may be added if required in relay mode - the Sprint will pause to allow swapover. Prints 1x384-well plate to 20 slides in approximately 40 min or less.	As above	On request
BioFluidix Freiburg, Germany http://www.biofluidix.com Contact: Thomas Apel Phone: +49 761 203 7285 thomas.apel@biofluidix.com	TopSpot E	Personal bench top spotter for low and medium density arrays and small batch size.	Oligos, Plasmids, Proteins, Sugar, Viscose solution.	Parallel non-contact spotting. Based on reusable printhead-Topspot-Technology. After finish, cleaning of the printhead with detergent and water. Finally drying with nitrogen.	Printhead print 24 or 96 spots of 0.5-1 nl simultaneously. Pitch of 500 µm. 1-6 µl probe uptake in the printhead. Up to 6000 printing with one filling possible. 16 printings (24 / 96) on one slide 105 sec. incl. loading. 10 slides 1 printing 210-260 sec. incl. loading.	- Instrument ready-to-use - User-friendly self installing software - Highly reproducible - Consistent spot size - Custom size printhead possible - Printhead can be filled with an automatic pipetting system - No spot contamination	20.000,-
	TopSpot E Vision	Personal bench top spotter with integr. camera for spotting control.	See above	See above	See above	- See above - Integrated quality control during spotting	26.000,-
	TopSpot OEM	Print module for integration in a customize robotic system.	See above	See above	Printing depended on the automatic system. > 1 Hz	- See above - Full scal. (low t. high throughput) - Only the OEM module	12.000,-
Bio-Rad Laboratories www.bio-rad.com Contact: Marcus Neusser Phone: +49 89 31884 118 Marcus_neusser@bio-rad.com	BioOdyssey Calligrapher	Benchtop Spotter for low and mid size throughput of Protein and DNA Spotting.	Spotting of Proteins and Nucleic Acids.	Contact spotter. Static and flow through wash bath plus vacuum station for pin drying.	1-8 pins Supports 96, 384, 1536 well plates 384 samples on 16 slides in less than 2 hours	- Cooling Module for source plate and platen - Humidity Control - Backtraker files - SourceSelect mode for cherry pick. - Prints onto slides membranes and into 96well plates	29.000,- (approx.)
febit biotech Heidelberg, Germany www.geniom.com www.febit.com Contact: Philipp Habermeier Phone +49(0)6221-6510300 sales@febit.com	Geniom One	Fully automated microarray synthesis and detection device for lab benchtop use. Complete freedom of design. Highest level of confidentiality.	microRNA profiling, Gene expression profiling, SNP typing & genotyping, Pathogen & virus typing, Epigenetic profiling, Enzyme on Chip.	Light-activ. in-situ DNA synth. of oligo probes within microfl. biochip. Completely customizable array design. Straight forward digital-to-DNA workflow: Digital array design - overnight synthesis - ready to use microarray the next day. Fully automated washing and staining & drying processes through microfluidic biochip within one machine.	Geniom Biochip with 8 arrays with 6776 features (54208 per chip) (Upgrade to 15.000 features per array available late 2007). Geniom microfluidic biochip (proprietary format). 2 biochips per day / Overnight synthesis 8 hours / Hybridisation depending on application / Detection / With ready to go biochips from febit (prefabricated microarrays with validated content) no synthesis required.	- Microfluidic Biochip - Wash & Rehyb (up to 4 times reuse of the microarray) - Enzymatic reactions on Chip supported - Day-to-day array design - Researcher defined content	Please inquire

Microarray Spotters

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Genetix Queensway, New Milton, Hampshire UK www.genetix.com Contact: Steve Hawkins Microarray Business Manager Phone: +44(0)1425 624600 Steve.hawkins@genetix.com	QArray-Mini	Personal, high specification microarrayer with a large slide capacity. Designed around a highly accurate dual axis, linear system. Combines speed, precision and durability.	Gene Expression Arrays Comparative Genomic Hybridisation (CGH) Protein Arraying Reverse Transfection Microplate Arrays RNAi.	Solid and split pins. High pressure washer and vacuum drier.	100,000 spots onto 54 slides 96 and 384 well plates, the holder can be cooled. 48 split pins. Approx. 44 spots per sec / Approx. 3.5 hr (to print a full run of 54 slides with 10,000 spots) 48 solid pins / Approx. 12 spots per sec / Approx. 12.5 hr (to print a full run of 54 slides with 10,000 spots).	- Personal high-specification speed precision durability	From 58,000,-
	QArray2	Stand alone, high specification microarrayer with a high slide capacity, providing you with the optimum in microarraying technology. Designed around a highly accurate dual axis, linear system, the QArray2 combines speed, precision and durability with high throughput.	Gene Expression Arrays Comparative Genomic Hybridisation (CGH) Protein Arraying Reverse Transfection Microplate Arrays RNAi.	Solid and split pins. High pressure washer and vacuum drier.	100,000 spots onto 90 slides or a few 100 spots into 16, 96 or 384 well plates / 96 and 384 well plates, the holder can be cooled or a stacker used. 48 split pins. Approx. 50 spots per sec / Approx. 5 hr (90 slides with 10,000 spots) / 48 solid pins / Approx. 20 spots per sec / Approx. 12.5 hr (90 slides with 10,000 spots).	- Lab-scale high-specification speed precision durability	From 84,000,-
	QArray-Max	A sophisticated, ultra high-throughput system for production scale Microarraying, the QArrayMax combines speed, precision and durability with high throughput.	Gene Expression Arrays Comparative Genomic Hybridisation Microplate Arrays RNAi.	Solid and split pins. High pressure washer and vacuum drier.	100,000 spots onto 448 slides. 96 and 384 well plates. 48 split pins (spots per sec) Approx. 78 hr (448 slides with 40,000 spots) / 48 solid pins (single head) Approx. 13.5 spots per sec / Approx. 367 hr (448 slides with 40,000 spots) single head) / Approx. 68.2.	- Production-scale ultra high-throughput rapid precision	From 500,000,-
Gesim Grosserkmannsdorf, Germany www.gesim.de Contact: Hendrik Fiehn / Frank-Ulrich Gast Phone: +49(0)351-2595-322 info@gesim.de	Nano-Plotter NP 1.2	Quiet non-contact microarrayer for small/intermediate throughput, up to 8 pipettes, working area 260x270 mm, max. 2500 spots/cm ² at 50 µm accuracy.	All where non-contact dosage is required, plus all standard microarraying applications.	Piezoelectric (non-contact), arbitrary volumes from 60 pl onward. Wash station for inside and outside of tips, drying pad.	Max. 40 slides, 1 microplate (cooled, additional plates freely definable). 96-well and 384-well plates. Throughput depends on application, system configuration, and spotting mode (e.g. 20-40 min for 96 samples with 4 pipettes); please inquire.	- Graphic user interface to define targets and (sub)array layouts - Flexible open programming system (if needed at all; same for all Gesim spotters); - Arbitrary spot patterns - Stroboscope pipette check with automatic spot repair - Humidification - Cooled slide tray	On request
	Nano-Plotter NP 2.1	Robust non-contact microarrayer with small footprint for intermediate throughput, up to 16 pipettes, working area 280x331 mm, > 4000 spots/cm ² at 10 µm accuracy.	See above	Piezoelectric (non-contact), arbitrary volumes from 60 pl onward. Automatic wash station for inside and outside of tips plus drying pad, second wash bowl for different wash medium optional.	Max. 55 slides (with and without locating pins, cooled), 1 microplate (cooled; additional plates freely definable), holders for other target sizes and additional microplates on request, third-party plate handler for up to 56 plates (unattended run). 96-well and 384-well plates. Throughput depends on application, system configuration, and spotting mode (e.g. 20-40 min for 96 samples with 4 pipettes); please inquire.	- Arbitrary spot patterns - Extra fast mode for replica and line printing - Humidification - Automatic target identification via microscope - Alternative print heads - Customization	On request
	Nano-Plotter NP 2.1/E	Robust non-contact microarrayer for intermediate/high throughput, up to 16 pipettes, working area 656x331 mm, > 4000 spots/cm ² at 10 µm accuracy.	See above	See above	Max. 115 slides (cooled), 1 microplate (cooled; additional plates freely definable), holders for other target sizes and additional microplates (up to 12) on request, third-party plate handler for up to 56 plates (unattended run). 96-well and 384-well plates. Throughput depends on application, system configuration, and spotting mode (e.g. 20-40 min for 96 samples with 4 pipettes); please inquire.	- See above	On request

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Intavis Bioanalytical Instruments Cologne, Germany www.intavis.com Contact: Christian Behn Phone: +49-221-502 94 86-0 behn@intavis.com	SSR 223	Direct spotting, low volume liquid handling robot.	Spotting of low density arrays on microscope slides.	Direct contact spotting of metered volumes. Active flow-through needle rinse. Air drying of slides.	27 slides with up to 800-1000 spots each. 2 source plates (96 or 384 wells). Speed depends on number of spots, up to 6h.	- Free grid definition - Direct contact spotting - All liquids possible - Reliable deposition - Low source volume allowed	18.800,-
Perkin Elmer Rodgau, Germany www.perkinelmer.com/ proteomics Contact: Hans-Peter Steffens Phone: +49 6106 6100 or 0800 181 0032 Hans-peter.steffens@perkinelmer.com	Piezorray	Non contact spotting system.	Spotting of DNA and Proteins Antibody arrays Small molecule printing Targeted oligo arrays Very flexible Array layout.	Piezo spotting using glass capillaries. Inert glass capillaries allow low sample take up (< 1µl). Washing from inside using system liquid (HPLC grade water), washing from outside, ultrasonic wash bowl, sonication inside the tips. Additional wash solutions on the deck according to application. Low carryover.	Four Piezo elements at 9 mm spacing. Printing from 96 or 384 well source plates. Up to 25 slides, 5 destination plates or equivalent printing holders for custom substrates.	- Accurate and precise CV 2 % - 5 % - Error recovery option - Unique pressure control system - Printing on slides and into microplates - Targeting of microstructures	Typical System at around 95.000,- (Depending from options: On request
Scienion Berlin/Dortmund, Germany www.scienion.com Contact: Peter-Paul C. Henze Phone: +49.30.6392.1700 henze@scienion.com	sciFLEX-ARRAYER S3	Non-contact piezo dispenser for automated ultra-low volume handling from picoliters to microliters. Engineered robustly for the most delicate surfaces. Acclaimed user-friendly software facilitates flexible use for a wide range of applications.	DNA-, Protein-, Reverse Phase Protein-, Glycan-Microarrays, Cell Transfection, Spotting of living cells, Microarrays in MTPs, MALDI sample preparation, General low volume liquid handling applications.	Piezo Electric Dispenser Intensive external & internal rinsing. Optional station for additional solvents/cleaning agents. Passiv drying. Internal ultrasonification.	Nozzles: Up to 8 Slides: 20 MTPs (target): 2 Customized holders on request. Any 96-, 384- well MTP may be used. Settings for commercial MTPs most commonly used are pre-installed. Customizable to any target. Throughput/speed largely depends on sample number, array layout, number of features/sub arrays, and number of slides. Realistic estimates are gladly provided based on your requirements.	- Versatile tool for novice users	62.500,-
	sciFLEX-ARRAYER S5	See above	See above	Piezo Electric Dispenser Intensive external & internal rinsing. Optional station for additional solvents/cleaning agents. Passiv drying.	Nozzles: Up to 8 Slides: 24 MTPs (target): 4 Customized holders on request. See above See above	- Reliable machine for flexible use	95.000,-
	sciFLEX-ARRAYER S11	Non-contact piezo dispenser for automated ultra-low volume handling from picoliters to microliters. Engineered robustly for the most delicate surfaces. Acclaimed user-friendly software facilitates flexible use for a wide range of applications. Workhorse for production.	DNA-, Protein-, Reverse Phase Protein-, Glycan-Microarrays, Cell Transfection, Spotting of living cells, Microarrays in MTPs, MALDI sample preparation, General low volume liquid handling applications.	See above See above	Nozzles: Up to 8 Slides: 60 MTPs (target): 10 Customized holders on request. See above See above	- Workhorse for reliable production	145.000,-
Shimadzu Duisburg, Germany www.shimadzu.de Contact: Marcus Mreyen Phone: +49-203-7687-0 mm@shimadzu.de	ChIP-1000	Device for delivering reagents on a micro-scale.	On-membrane peptide mass fingerprint, nano western blot, MALDI tissue imaging Micro derivatisation.	Non-contact piezo-electric printing device dispensing pico to nanoliter volumes of samples or reagents in fixed or random arrays.	Stage for two sample sets in MTP plate format. Microscopy glass slide adapter available.	- Scanner included - Easy selection of area of interest - Export of X,Y coordinates	--