

Nano-Plotter™

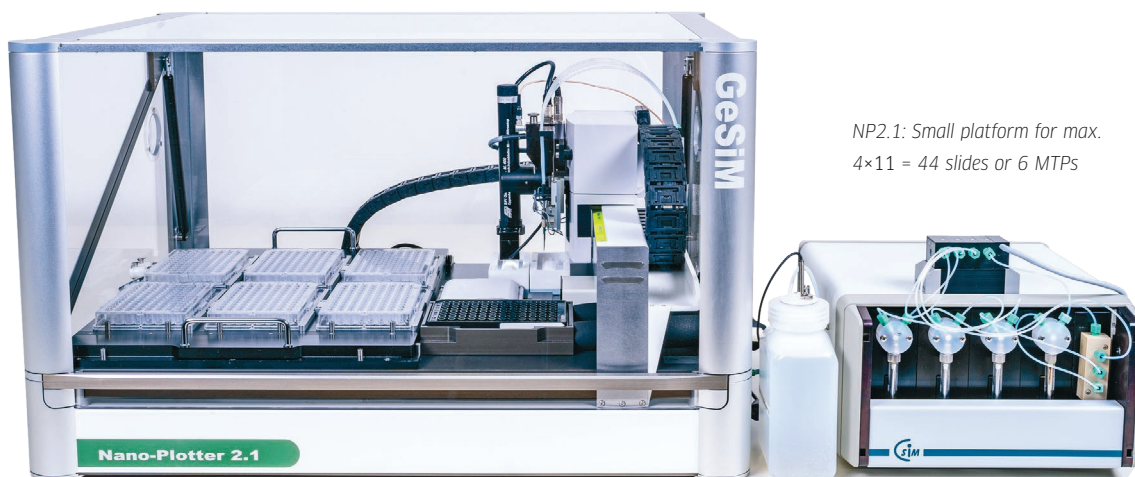
Microarraying and Picolitre Pipetting



Your indispensable, robust, field-tested companion for the fabrication of biochips – in research *and* production



MICROARRAYING



NP2.1: Small platform for max. 4x11 = 44 slides or 6 MTPs



NP2.1/E: Large platform for max. 4x24 slides (standard; here 5x24) or 12 MTPs

The GeSiM Nano-Plotter™ is not just another non-contact microarray spotter. Modular hardware and an open software guarantee high flexibility to tackle even the most demanding print job.

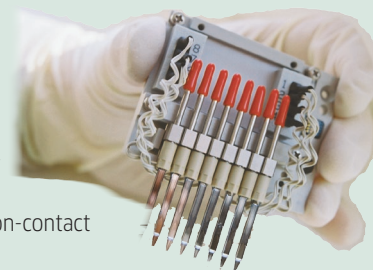
GeSiM's piezoelectric tips are micromachined from silicon and glass. They produce droplets as small as 50 picolitres and can handle a wide range of liquids, not only protein and DNA in standard buffers. Alternative dispensing methods, e.g. piezo valve dispensers and pipettes for displacement dispensing, can be added so that even difficult substances can be printed.

Microscope-based pattern recognition makes precise printing onto microelectrodes or other small features easy. Missing spot detection and repair is also possible. **Live spot detection** on backlit slides is optionally available.

Customised versions, e.g. for integration into automated production lines, are available on request.

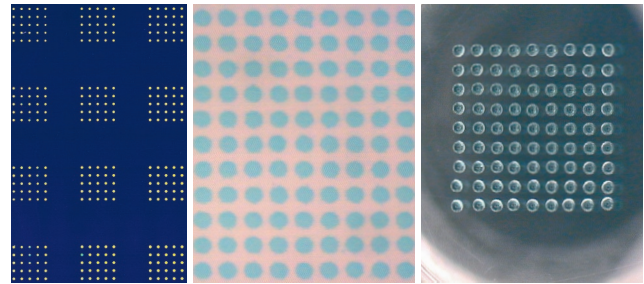
Key Features

- Small footprint
- Dust cover included
- Z-sensor for height profile measurement
- 'Drop on demand' technology (non-contact spotting)
- 1 - 16 independent piezoelectric pipetting tips with full fluidic control
- GeSiM's piezo tips are more robust than glass capillary dispensers!
- Tip layouts on the pipetting head (pitch in parentheses): 1x8 (4.5 mm), 1x6 (9 mm), 2x8 (9 and 4.5 mm) and special (custom) tools
- Sample aspiration from 96-well or 384-well microtitre plates (MTPs)
- Functional test in stroboscope of each pipette tip before/after spotting
- XY repetition accuracy better than $\pm 10 \mu\text{m}$ (encoder-controlled)
- Step width 2 μm , travel speed up to 500 mm/s
- Removable target tray
- Dew point pipetting (humidifying/slide cooling)
- Array density up to 3000/cm²
- **Spotting on the fly** (spotting without stopping)
- Spotting into microtitre wells
- Dispensers for large volumes or viscous media / adhesives (e.g. VERMES)
- Automatic spotting onto small features via image recognition
- Countless accessories

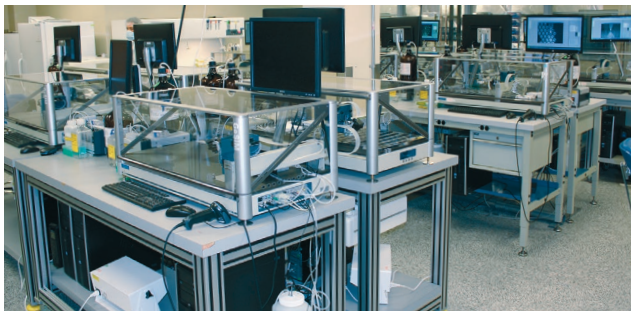


Arrays for DNA, proteins and much more

One to 16 individually addressable GeSiM piezo dispensers provide high spot homogeneity and are perfect for typical buffers such as 3× SSC, phosphate-buffered saline (PBS) or Tris, but also fluids as viscous as 40% glycerol. Typical samples are DNA and proteins in standard buffers, but as pipetting parameters can be adjusted to samples, various other molecules, in aqueous buffers or organic solvents, can be spotted as well (e.g. liquid crystals, nanoparticles, photo-resist, MALDI matrix). 'High-viscosity' and heatable tips are also available. The spotting pitch depends on the surface; hydrophobic substrates allow grid sizes down to 150 µm.



Spots on a commercial slide (PolyAn, fluorescence scan), a membrane (2.5 nl, 0.4 mm pitch) and in a 96-well microtitre plate (0.3 mm pitch)



Large-scale chip production

The Nano-Plotter is being used to print multi-parameter assays for immunology, cancer diagnostics, respiratory diseases and others. It works with slides, well plates, nitrocellulose membranes, chips, microfluidic cartridges and many other targets (e.g. silicon chips) and it is well suited for **24/7 operation**.

A growing number of companies worldwide rely on the Nano-Plotter for bulk biochip production. We have therefore developed live spot detection and a production line for ultra-high throughput.

Accurate spotting onto micro-needle arrays

The pictures show an example of the spotting of pharmaceuticals (here: insulin) onto 3D-printed micro-needle arrays for transdermal drug delivery. This also requires a microscope camera for tip adjustment before printing (see below). Left picture: spotting onto micro-needle arrays; right picture: SEM image of spotted insulin on needles (pyramid base 1 mm). Pictures courtesy University of Greenwich.

Ref.: Pissinato Pere, C.P., et al., *Int. J. Pharm.* 544, 2018, 425-432

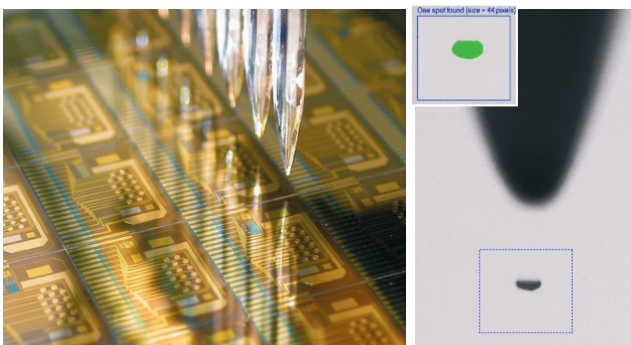
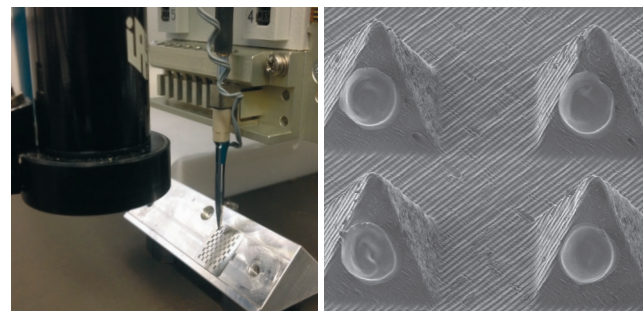


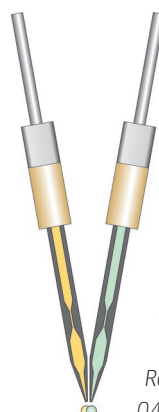
Image recognition

Many labs worldwide use the Nano-Plotter to spot probes onto microelectrodes, optical structures, nano-wells, microcantilevers or into microfluidic channels. Precise positioning is aided by microscope image processing. The left picture shows tips above a 300 mm wafer with microelectrodes, developed by Fraunhofer ISIT, Itzehoe, for quick diagnostic tests. Image processing can also be used for **post-spotting repair of missing spots** in regular microarrays. DXF and bitmap files can be imported and printed with or without image recognition. Another option is droplet detection on a **light table** while printing (right picture, green pixels).

Cell lysate microarrays

In reverse phase protein arrays (RPPA), cell lysates are spotted and the binding of antibodies to certain proteins studied. Using antibodies with different fluorescent labels allows multiplex assays, enabling one to study a multitude of small amounts of cell lysates in parallel. Possible applications are the identification of disease-relevant marker proteins in tissues and body fluids including urine, drug screening and quantification of changes in cell signalling, e.g. phosphorylation.

Many other Nano-Plotter applications (e.g. glycoproteins, micro-western arrays) have been published, but there is not enough space to show them all. Please inquire if you'd like to know more.



Mixing of droplets in flight

Sometimes it is necessary to start chemical reactions immediately, e.g. to 3D-print hydrogels at high resolution e.g. using maleimide cross-linking. For this we invented the 'twin tip' that can mix two micro-droplets right on the surface. To use many substances, the pipettes can swivel between an inclined position for printing and an upright position for washing and sample uptake.

Ref.: Zimmermann, R., et al., *Biofabrication* 11, 2019, 045008



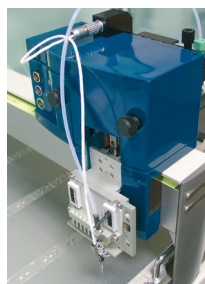
Accessories (Selection), Technical Data



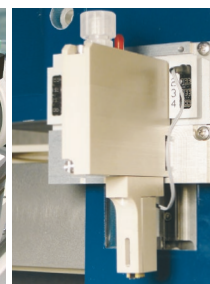
Two-row pipette head for up to 16 dispensers (option)



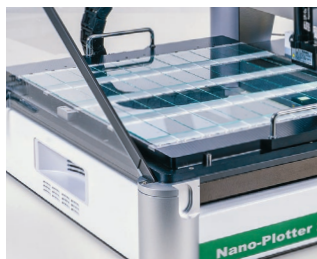
Flow sensors (8-fold on a diluter box) for droplet volume measurement



Heatable dispenser with temperature sensor



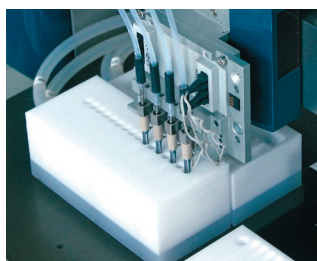
Cartridge piezo dispenser, Solenoid valve dispenser for volumes > 40 nl



Removable target tray for both slides **and** MTPs on a cooling chuck. Customized decks available.



Ultrasonic humidifier to prevent evaporation and for dew point pipetting



Second wash bowl for more efficient washing, with e.g. solvents



Microscope for optical target recognition / spot adjustment



Plate hotel for thousands of compounds, with MTP lid handler (inquire)

Non-contact dispensers with different droplet volumes (selection)	
Nano-Tip J	0.35 ... 0.4 nl
Nano-Tip A-J	0.25 nl, ideal for most spotting applications
Pico-Tip J	0.06 nl
Nano-Tip A-Gr-J (also other tips)	0.25 nl, sharpened point to reduce tip wetting
Nano-Tip R-J (also versions with Nano-Tip A, Pico-Tip)	0.35 ... 0.4 nl, slim design (tip and shaft), for array printing into 96-well plates
Nano-Tip HV-J (also versions with Nano-Tip A, Pico-Tip)	0.35 ... 0.4 nl, for highly viscous samples; also heatable and slim versions
Nano-Tip J-H (also other tips)	0.35 ... 0.4 nl (heater unit required)
Solenoid valve dispensers	ca. 20 ... 400 nl drops, with glass capillary

Technical Data	Nano-Plotter™ NP2.1	Nano-Plotter™ NP2.1/E
Dispensing area / slide tray (width×depth, outer dimensions)	302 mm × 400 mm	645 mm × 400 mm
Traversing range in XY-direction (width×depth)	427 mm × 341 mm	777 mm × 341 mm
Footprint main unit	623 mm × 509 mm	973 mm × 509 mm
Weight (incl. cover)	30 kg	50 kg
Height (incl. cover)		375 mm
Height (cover fully open)		880 mm
Max. pipetting height		50 mm
Pipetting channels		1 ... 16
Power supply		110 ... 240 V, max. 200 W

Manufactured by GeSIM, distributed in the UK and Ireland by **analytik**.