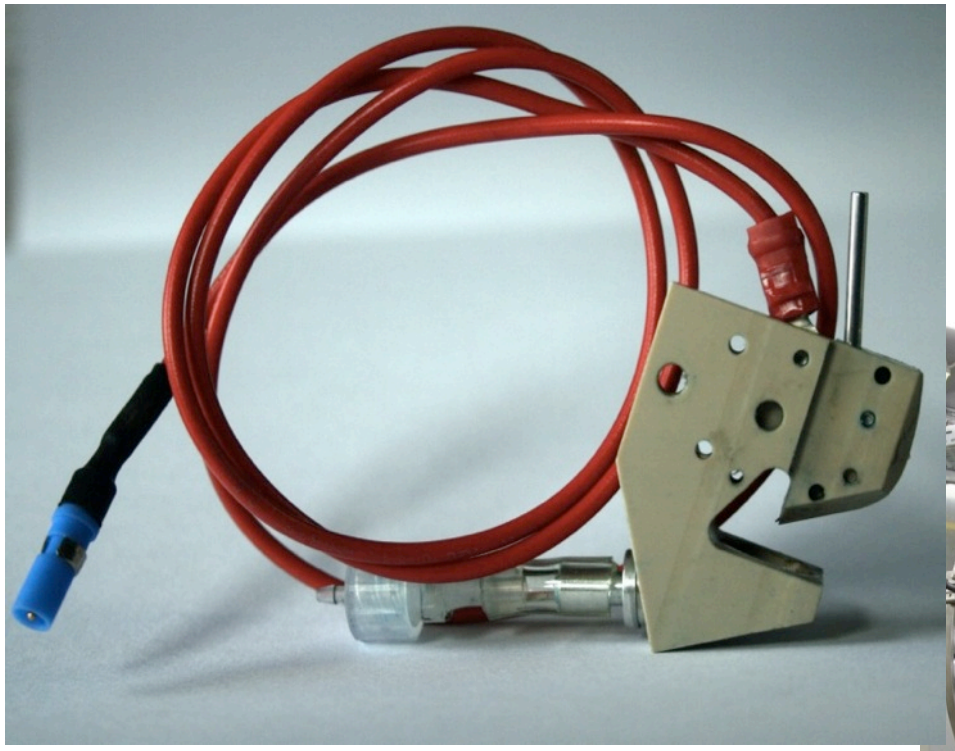
tonejet

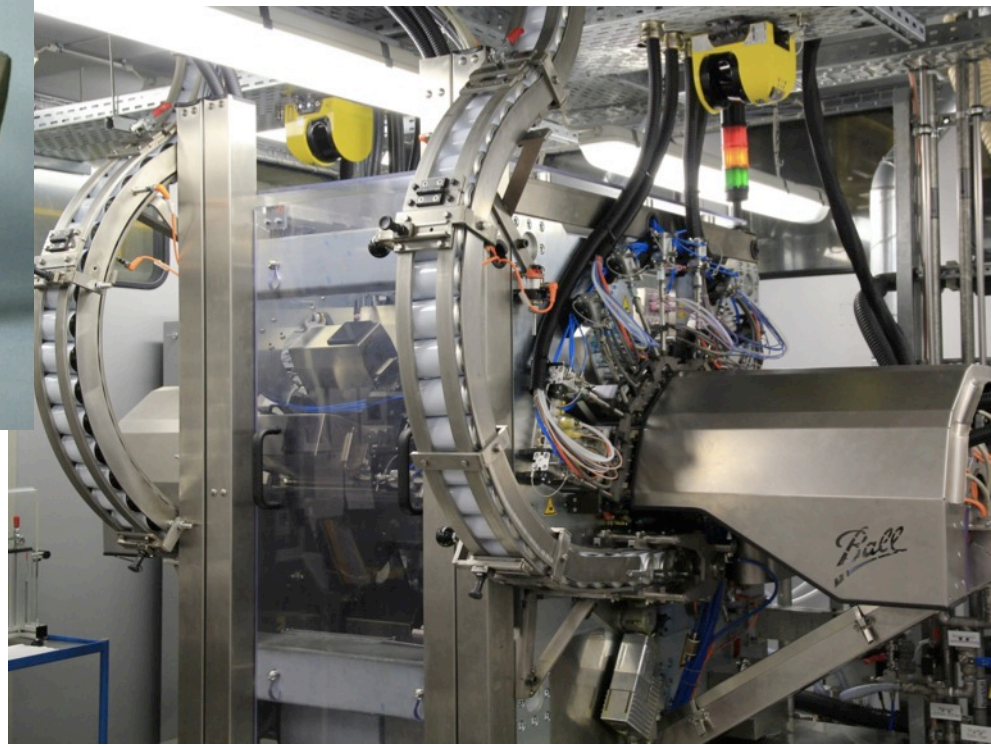
From invention to world's 1st industrial full colour, photographic quality, digital can printer.

10th Anniversary
High Value Manufacturing Conference 2012
14 November 2012 Cambridge
www.cir-strategy.com/events/

innovation to commercialisation

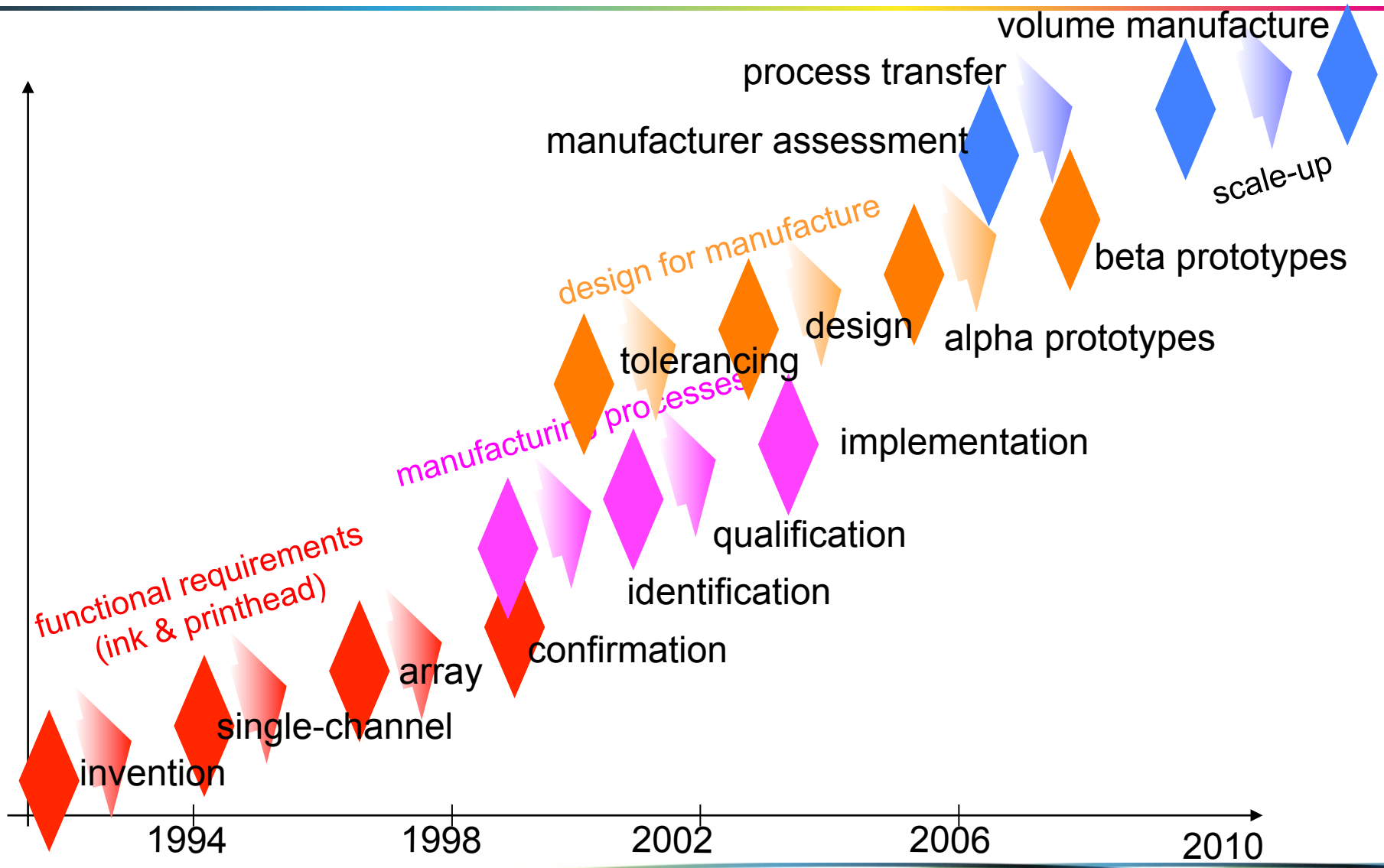
tonejet





innovation to commercialisation

tonejet



World’s 1st full colour digital can printer

tonejet

Ball

Ball Packaging Europe

Tonejet Limited

Tonejet

… owner, developer, licensor and supplier of digital print systems

World leading team

… print head fabrication

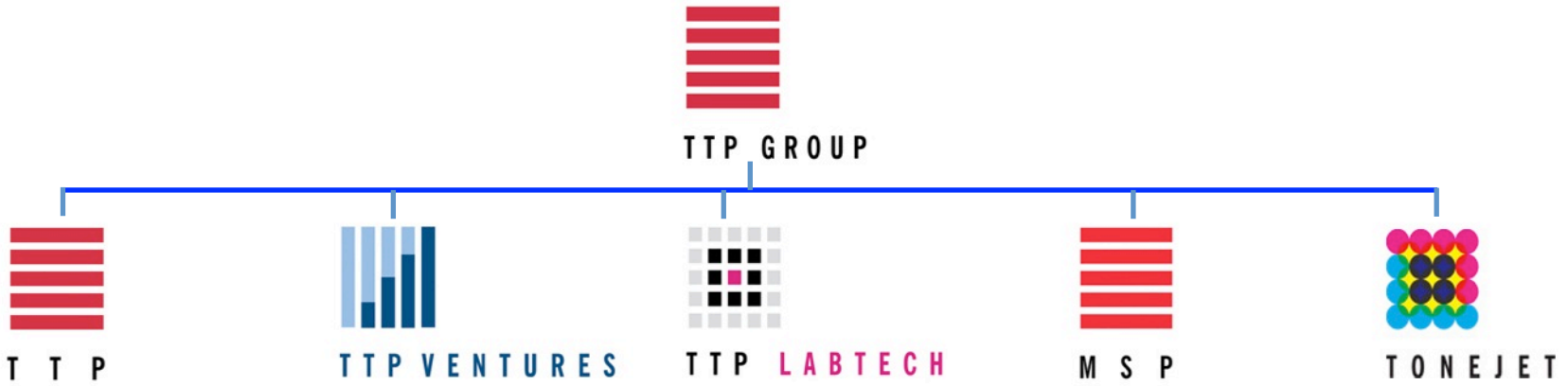
… electronic design and control

… micro-engineering

… ink chemistry

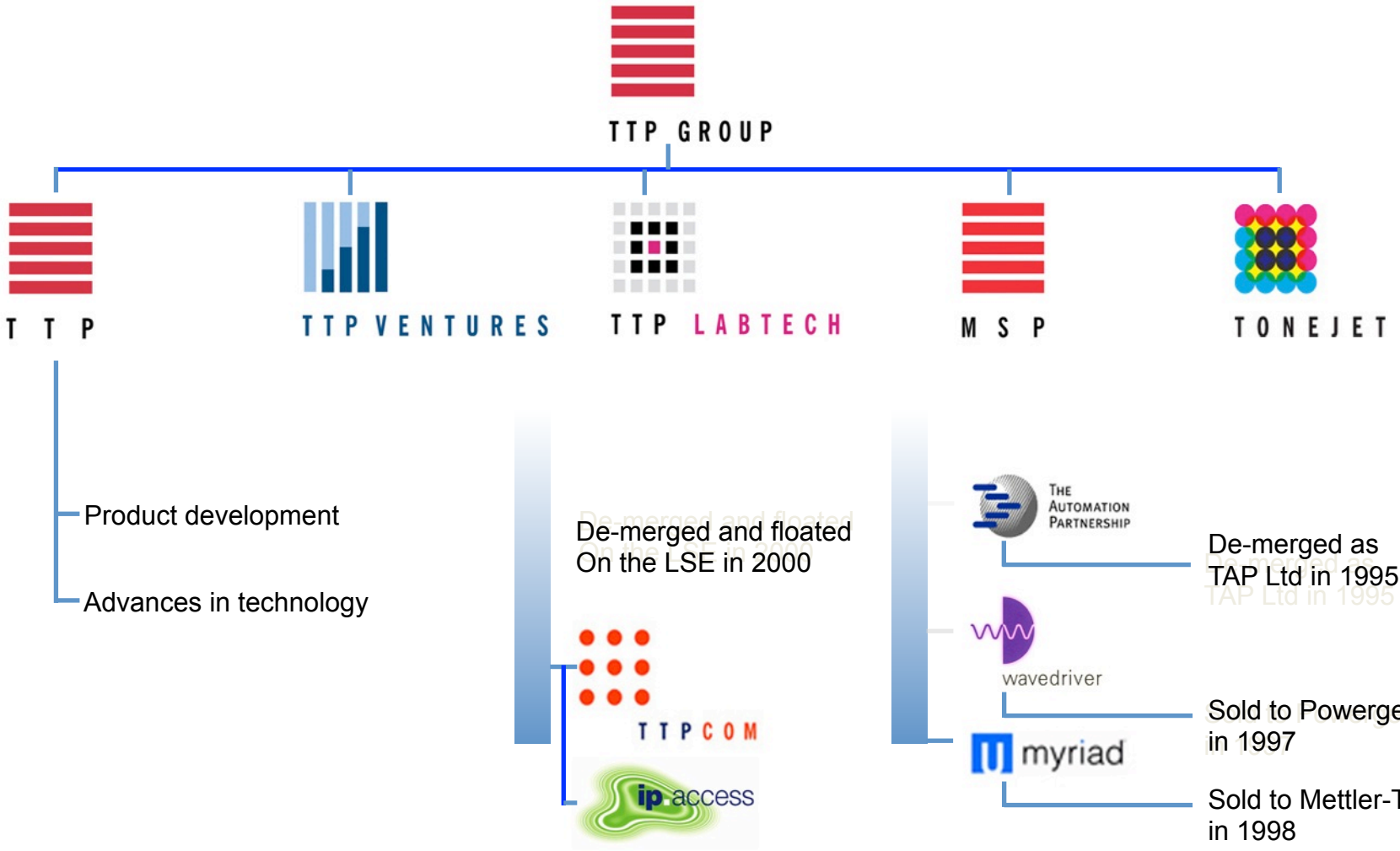
… system design and engineering

TTP Group of companies



- Product development
- Advances in technology

TTP Group of companies



industry awareness

tonejet

INK JET PRINTING - TECHNOLOGY ACCESS STUDY

This report has been compiled as a multi-client study but customised for

AB TETRA PAK

This report has been compiled using public domain material, and by interview with representatives of a number of companies in the field of ink jet printing. No confidentiality agreements have been signed, and no commercial negotiations entered into.

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Details of all contacts are available to purchasers of this report.

PETER TAYLOR and KEITH GARDNER
THE TECHNOLOGY PARTNERSHIP LTD
MELBOURN SCIENCE PARK
CAMBRIDGE ROAD
MELBOURN
ROYSTON
HERTS. SG8 6EE

TEL: 0763 62666
FAX: 0763 61582

PJT/KG/WBH/2081
MAY 1989

BIS CAP International—Europe
Providers of Decision-Critical Information

BIS
A NYNEX Company

THE THIRTEENTH ANNUAL EUROPEAN IGC INK JET PRINTING CONFERENCE
APRIL 18 - 20, 1990
AMSTERDAM HILTON HOTEL

CONFERENCE CHAIRMAN:

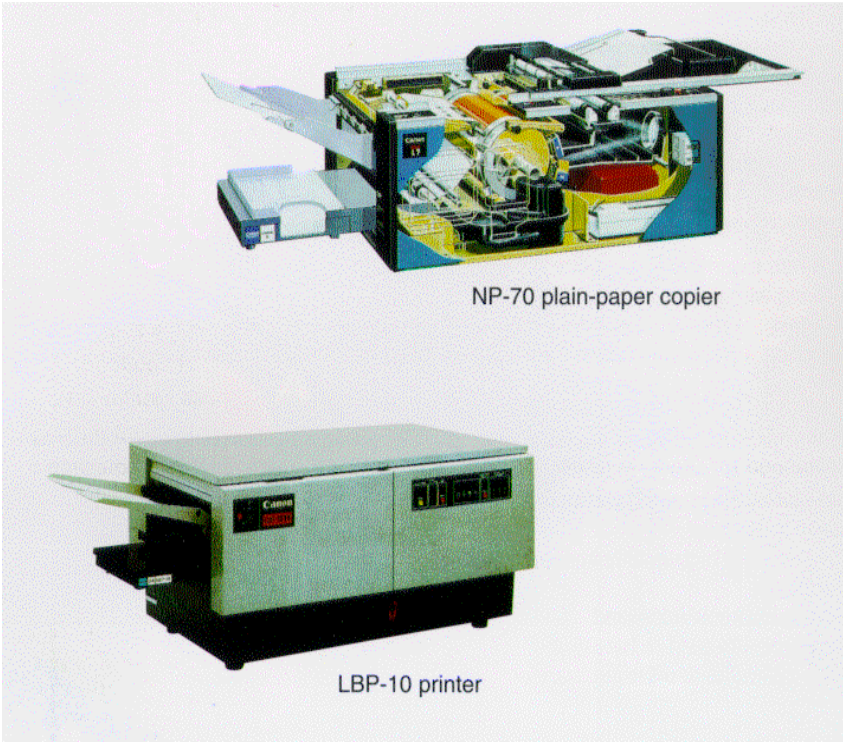
Skip Rung Research and Development Manager	Hewlett Packard Co. U.S.A

SPEAKERS:

Dr. Ross R. Allen Technical Staff	Hewlett-Packard Laboratories U.S.A.
Geoff Broad Managing Director	Elmjet Limited England
Mark Hanley Manager, Hard Copy Supplies Europe	BIS CAP Europe Limited England
J. Patrick Haxell Development Manager, Advanced Products	Coates Electrographics Limited England
Nathan Hine Manager, Printhead Technology	Spectra Inc. U.S.A.
Steven Hudson Group Services Manager	The Lettershop Group England
Hugh S. Laver Applications Chemist, Additives Div.	Ciba Geigy AG Switzerland
William J. Lloyd Deputy Director	Hewlett Packard Laboratories Japan

not invented here

tonejet



NP-70 plain-paper copier

LBP-10 printer

clear potential

tonejet

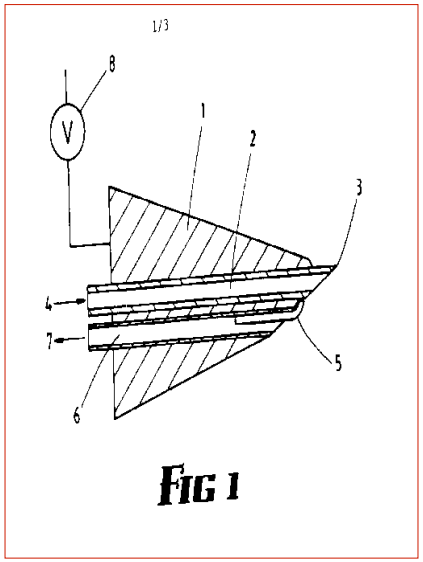
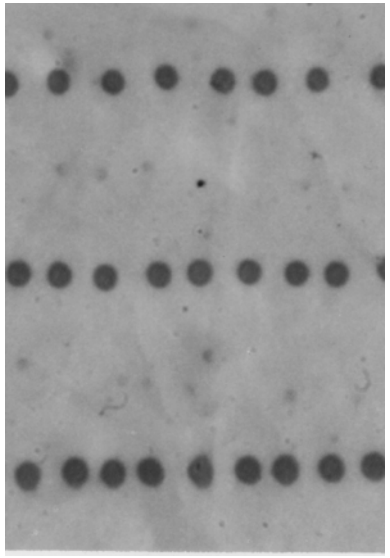
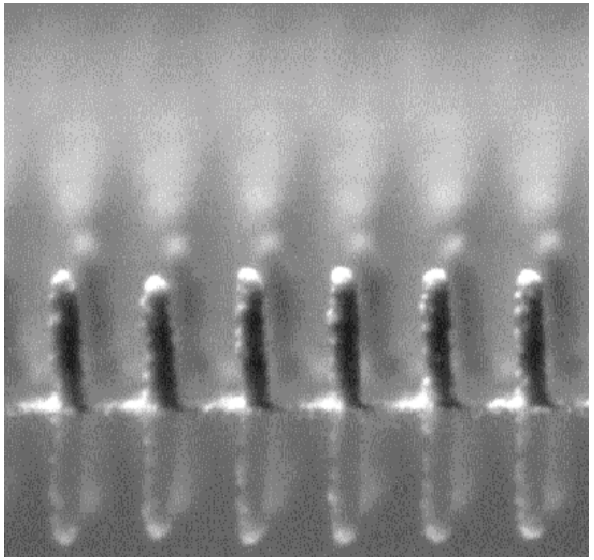


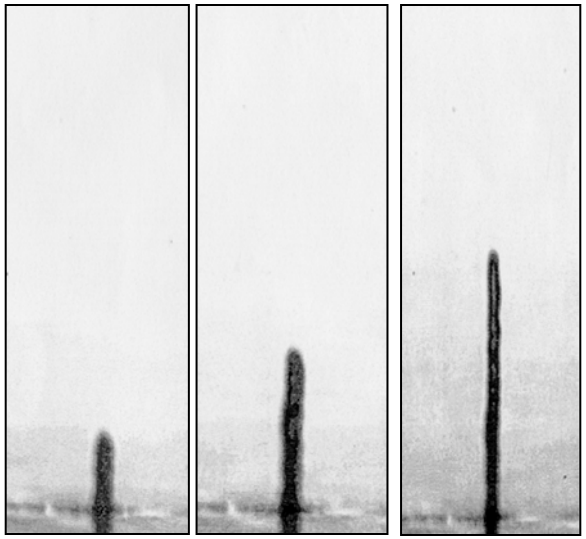
FIG 1





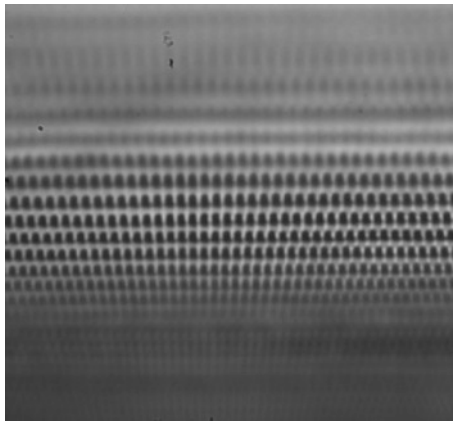
printing capabilities – non-absorbing substrates

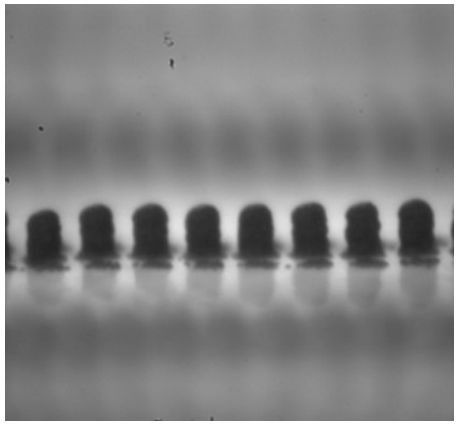
tonejet



(30 x 500 µm tower)

- excellent dot placement accuracy
- excellent reproducibility
- very high viscosity deposition

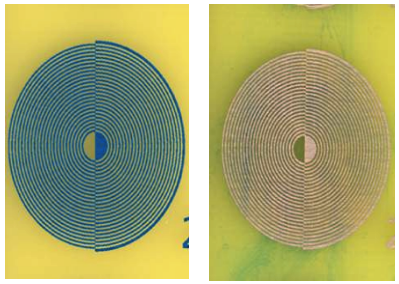




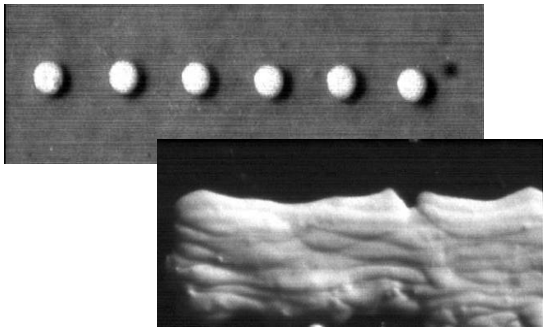
printing capabilities – other functional materials

tonejet

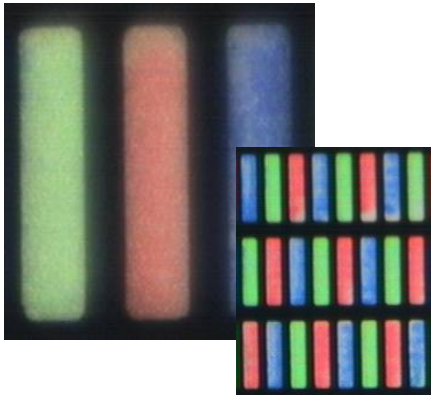
PCB resist



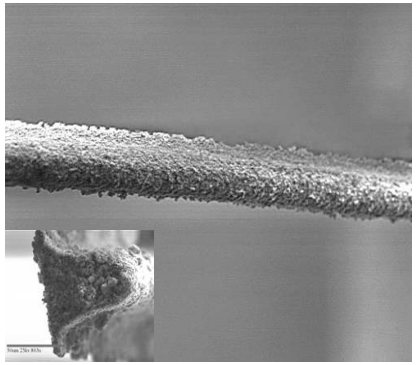
ceramics



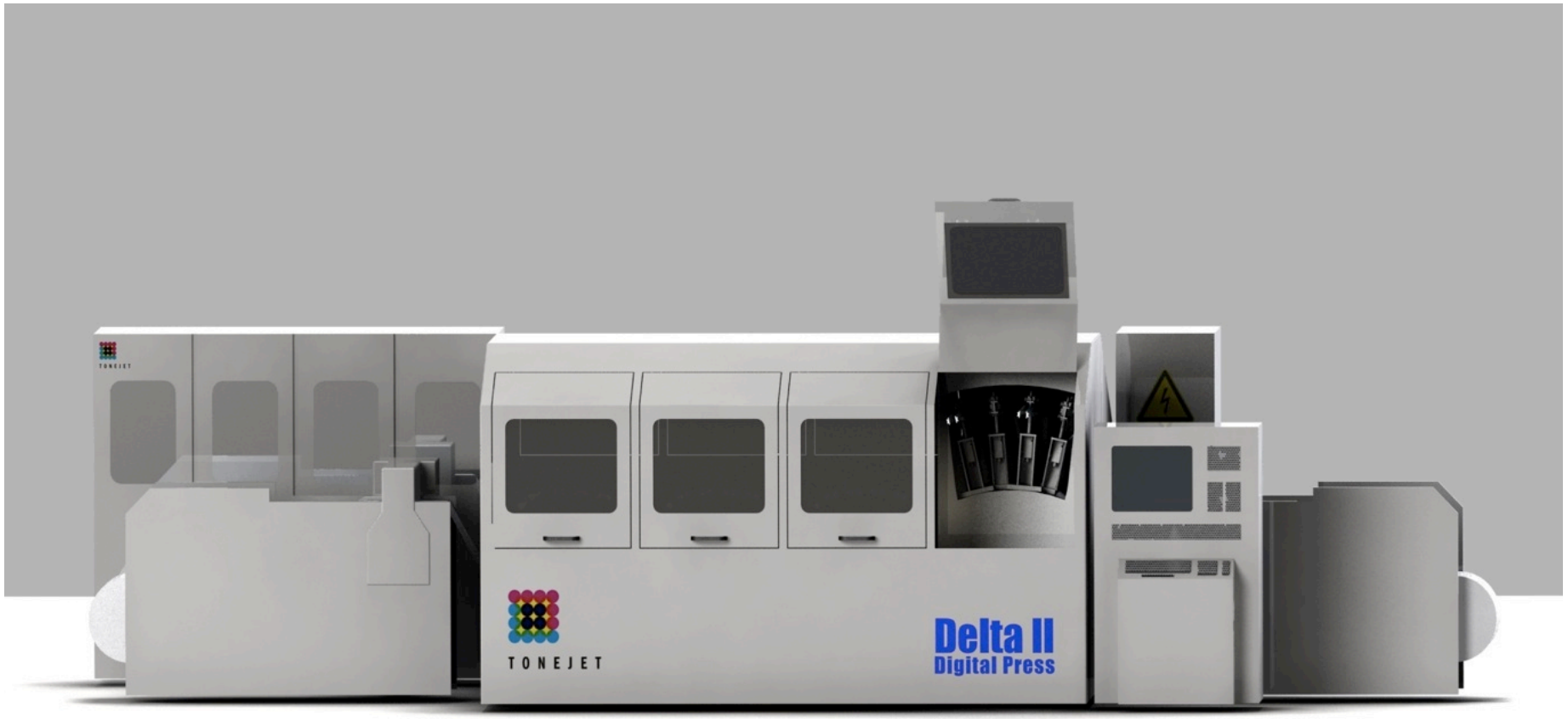
colour filters



free-standing wire



Tonejet Delta 2 Digital Printing Press



Speed of response & small batches

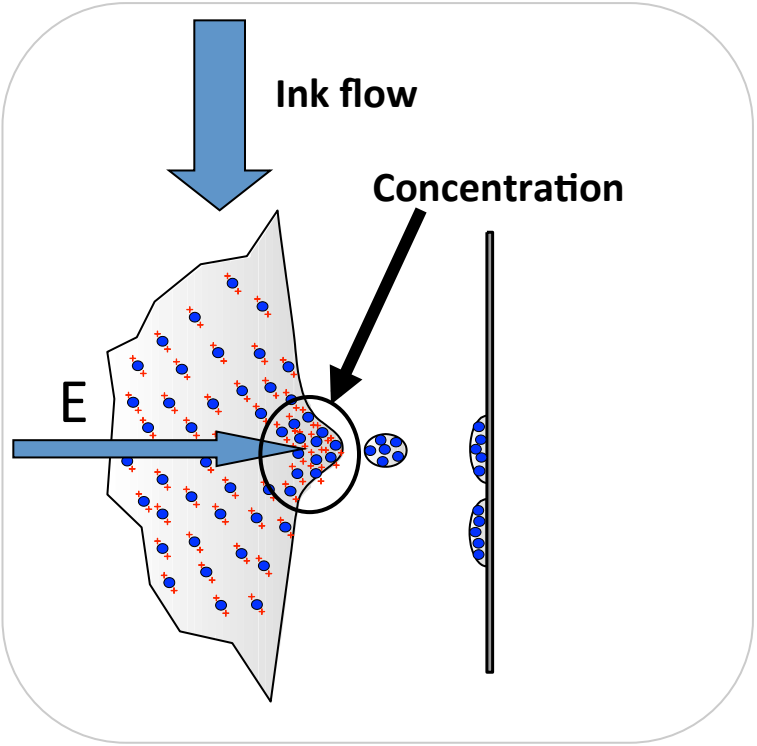
tonejet

various substrates

tonejet

the Tonejet process: science

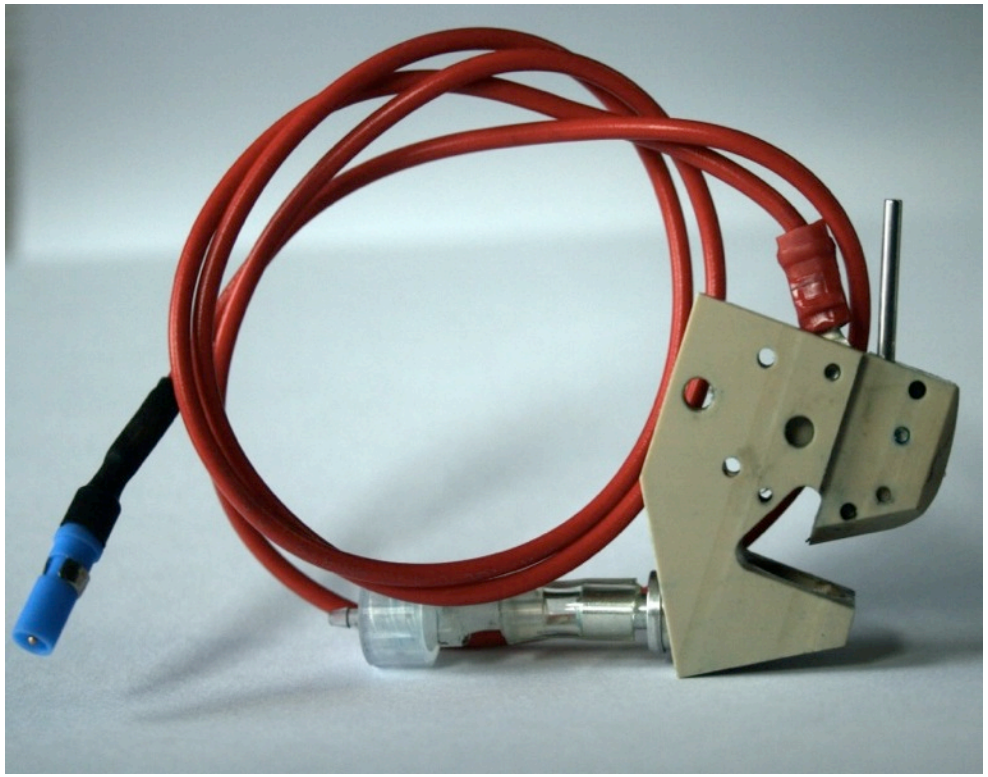
- **electrostatic concentration and ejection of particles from a fluid**
- the Tonejet printhead creates the meniscus shape and enables an electric field to be applied to the ink surface.
- the Tonejet ink is a key part of the ejection process, the force is applied direct to the charged particles.
- the electric field draws the particles into a fine concentrated jet. the longer the pulse the more ink is ejected.
- Tonejet ink flows continuously through the ejection region.



D-head

tonejet

- number of ejectors: 1
- print swathe: 42µm
- head dimensions: 10mm by 50mm by 40mm
- manufacturing method: Scalpel blade (hand cut)
- print frequency: 2kHz
- time to print a post card: 1 hour, 12 minutes



test bed

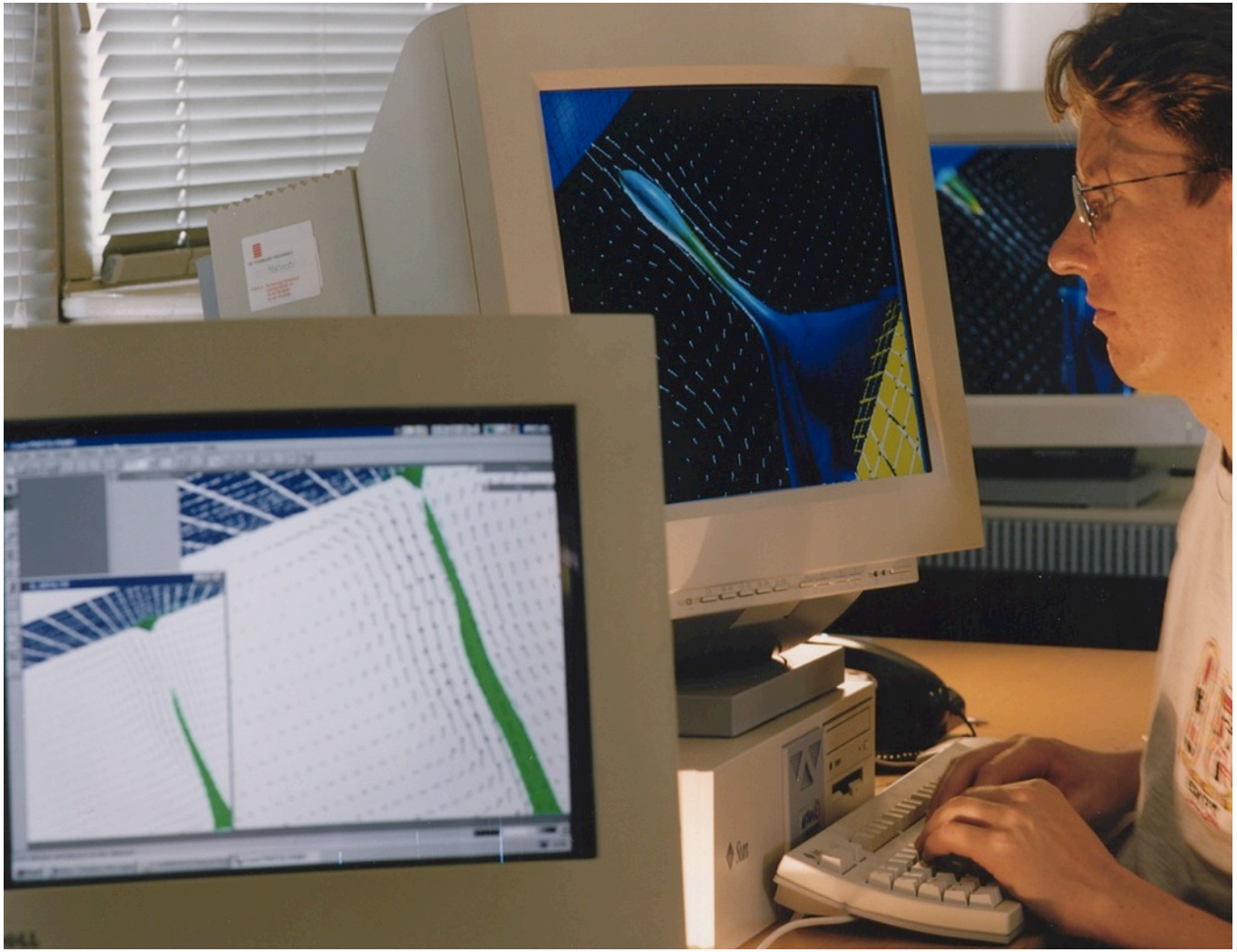
tonejet

early demonstration images

tonejet

simulation

tonejet

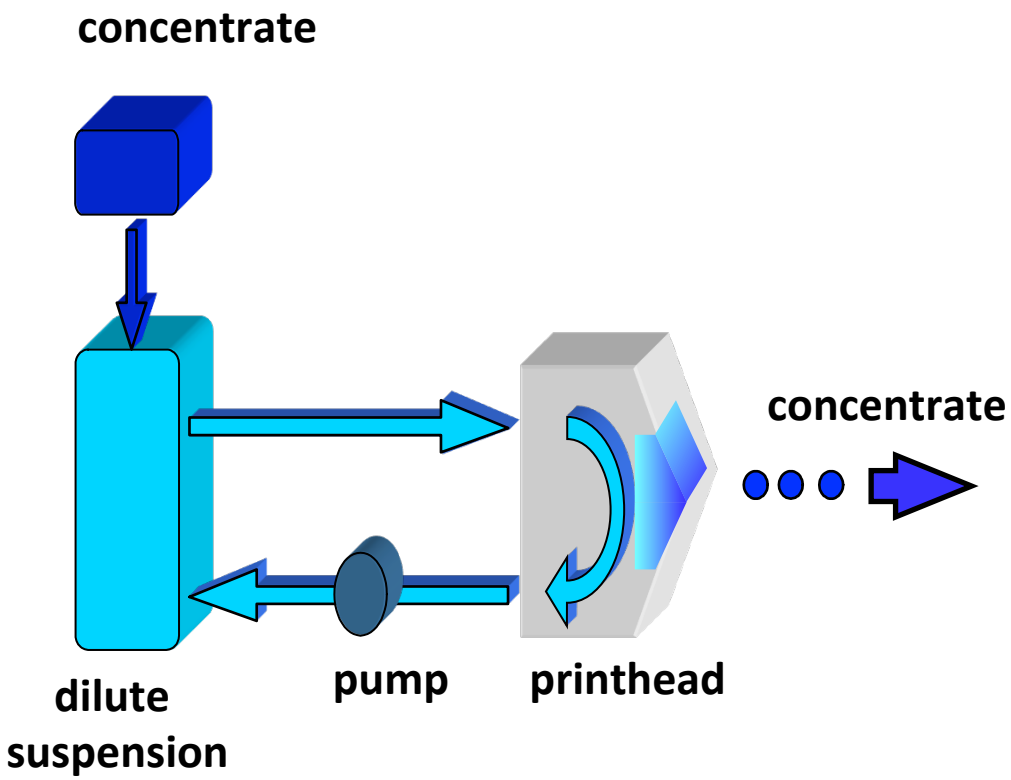


use of computer modelling

tonejet

- variety of models used:
  - 2D electrostatic modelling
  - 3D electrostatic modelling
  - computer fluid dynamics
  - all embracing 3D electro-fluidic model
- models developed in parallel with direct observation with:
  - high speed camera
  - strobe imaging

the Tonejet process

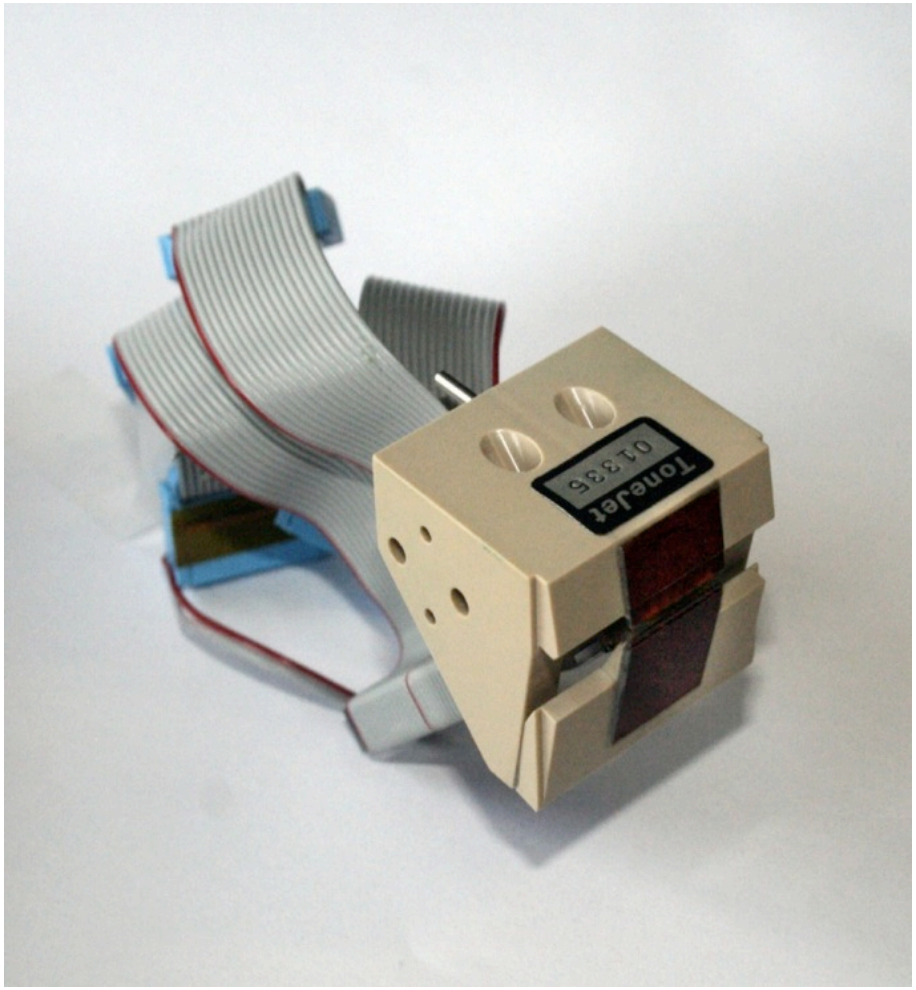


- non-contact
- prints concentrated ink
- no special substrate treatment
- continuous greyscale control
- ejects large range of materials

Verification: W-head

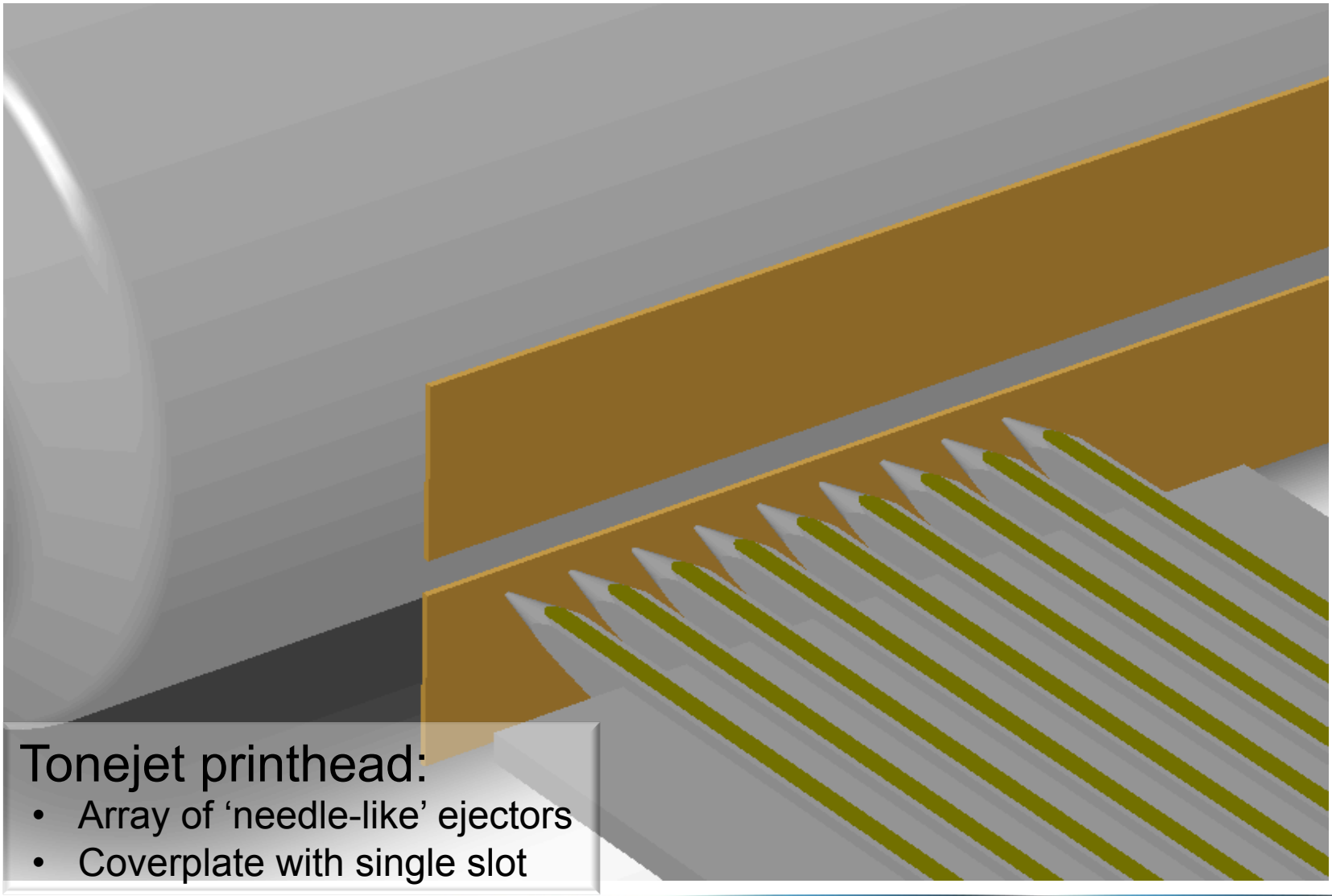
tonejet

- number of ejectors: 64
- print swathe: 10.5mm
- head dimensions: 40mm by 40mm by 60mm
- manufacturing method: machined ceramic (every feature individually machined)
- print frequency: 16kHz
- time to print a post card: 1 minute, 8 seconds



The Tonejet process

tonejet

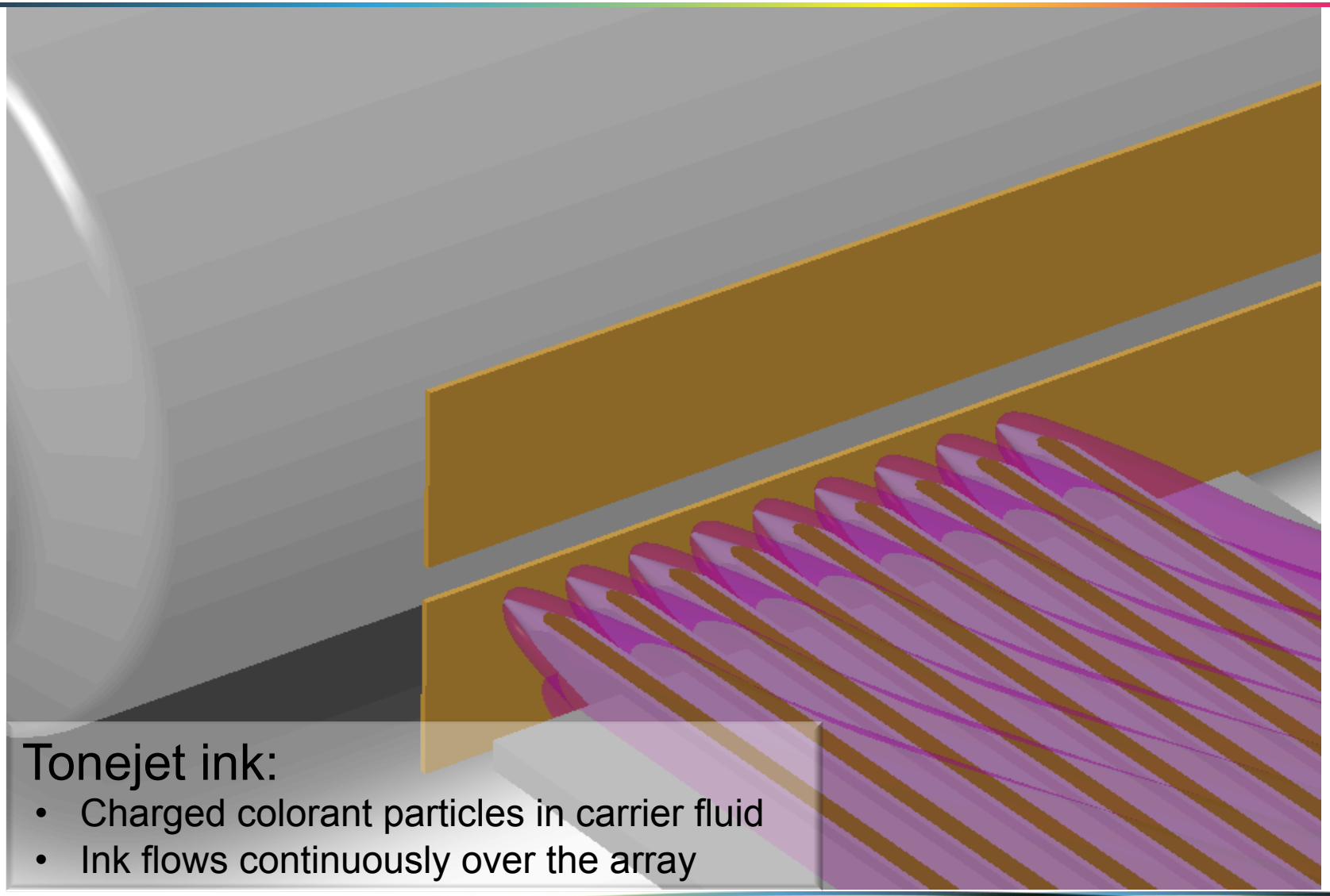


Tonejet printhead:

- Array of ‘needle-like’ ejectors
- Coverplate with single slot

The Tonejet process

tonejet

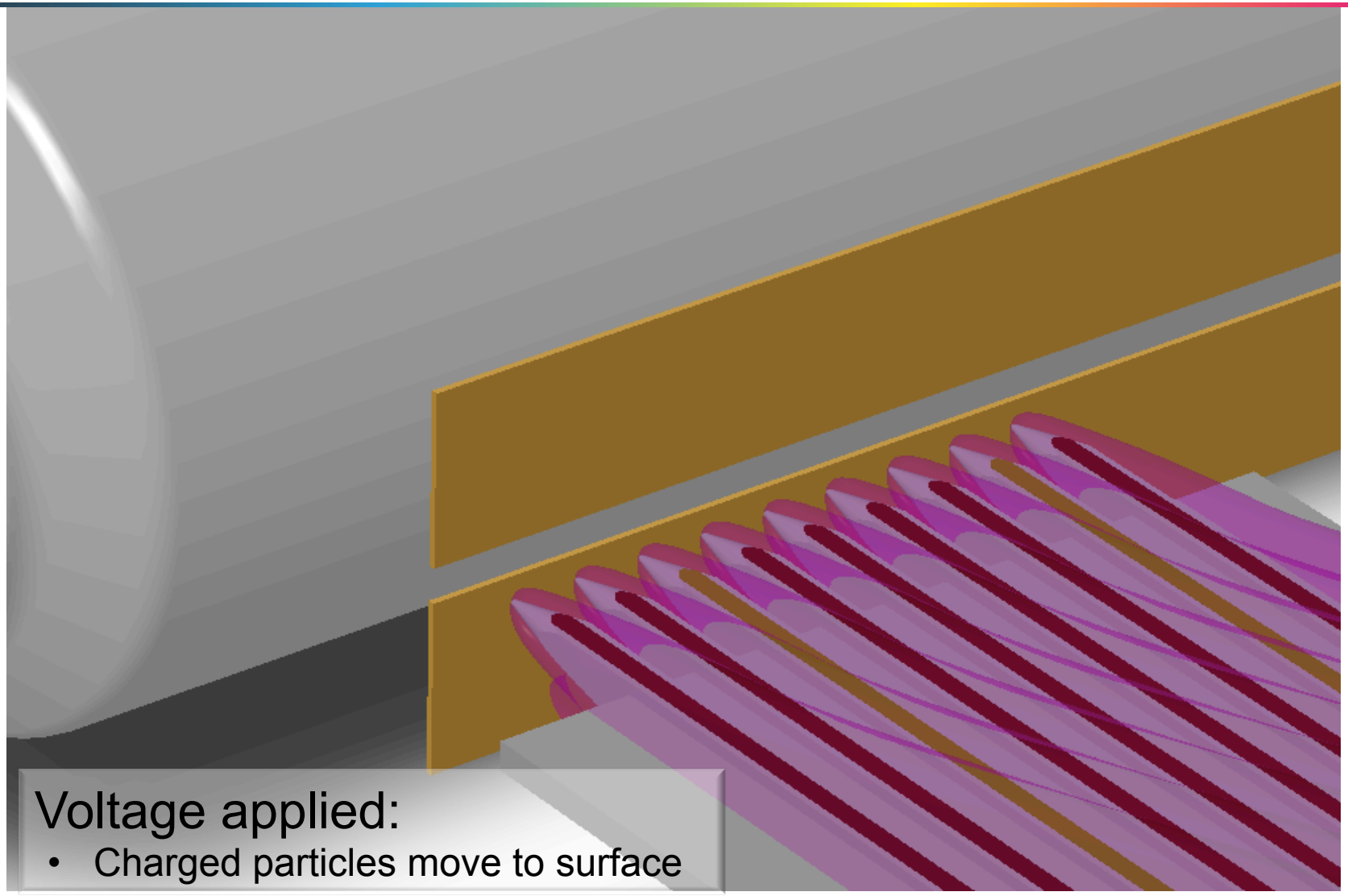


Tonejet ink:

- Charged colorant particles in carrier fluid
- Ink flows continuously over the array

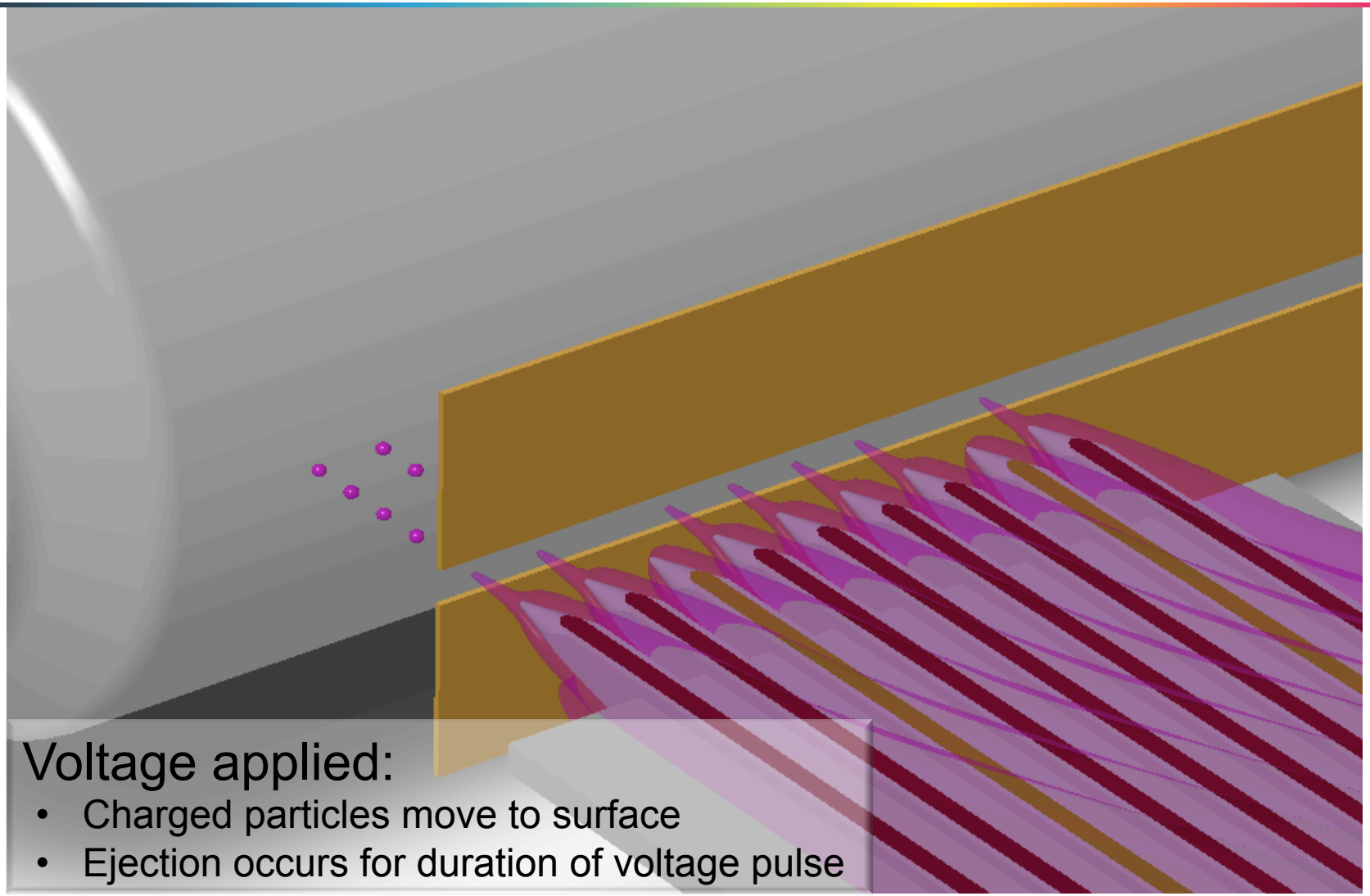
The Tonejet process

tonejet



The Tonejet process

tonejet

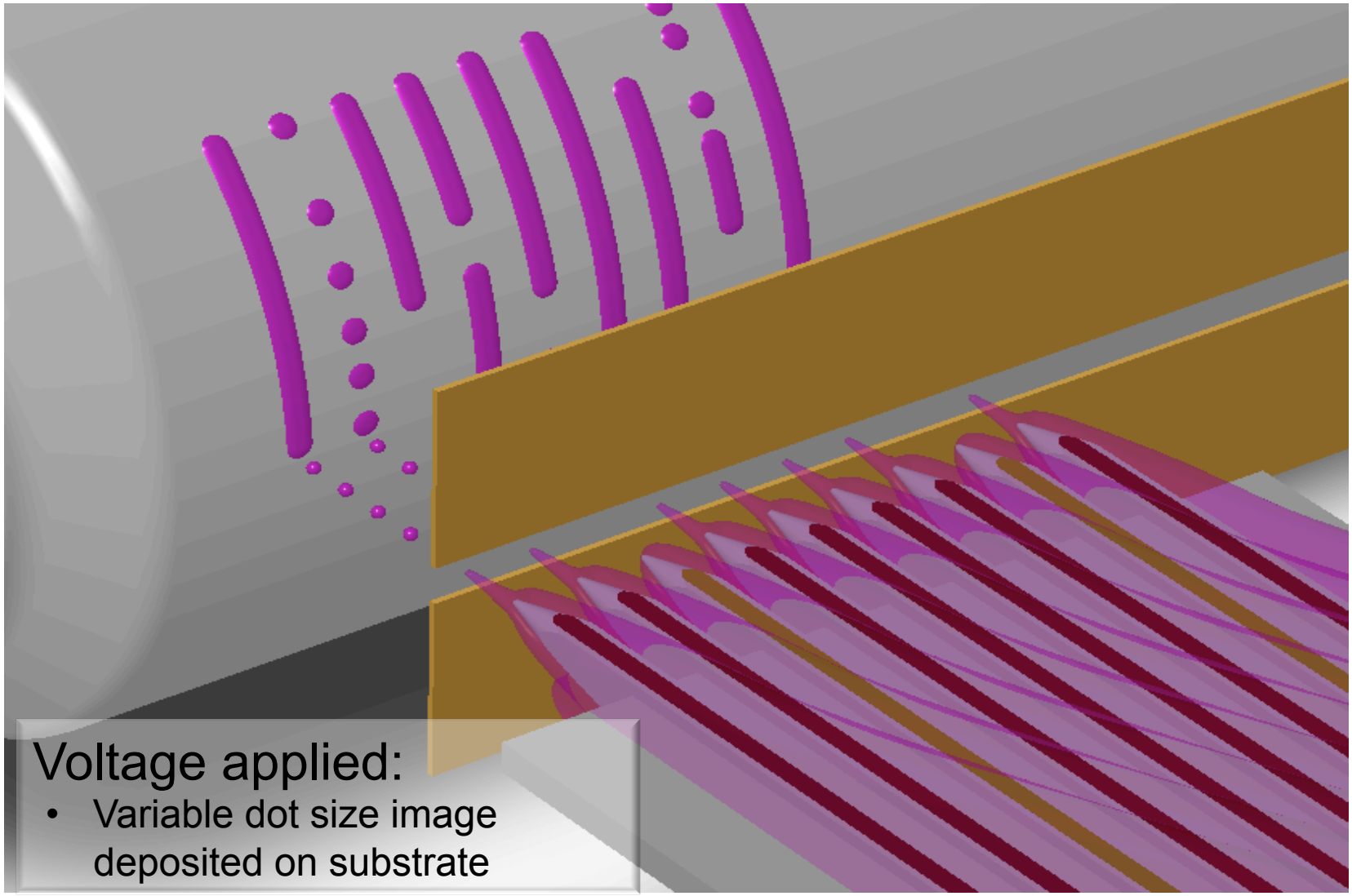


Voltage applied:

- Charged particles move to surface
- Ejection occurs for duration of voltage pulse

The Tonejet process

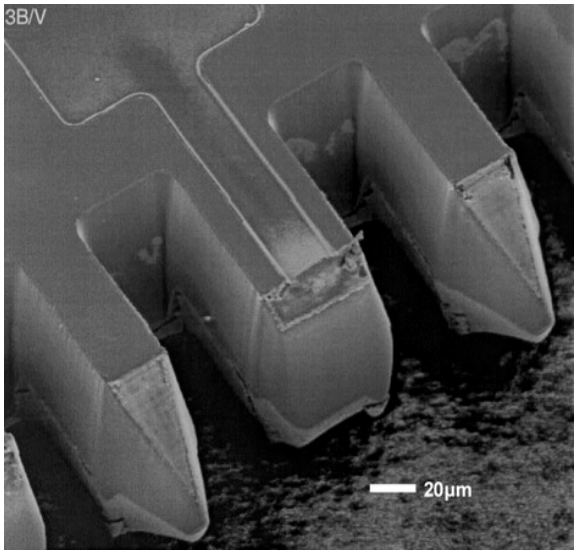
tonejet



printhead fabrication

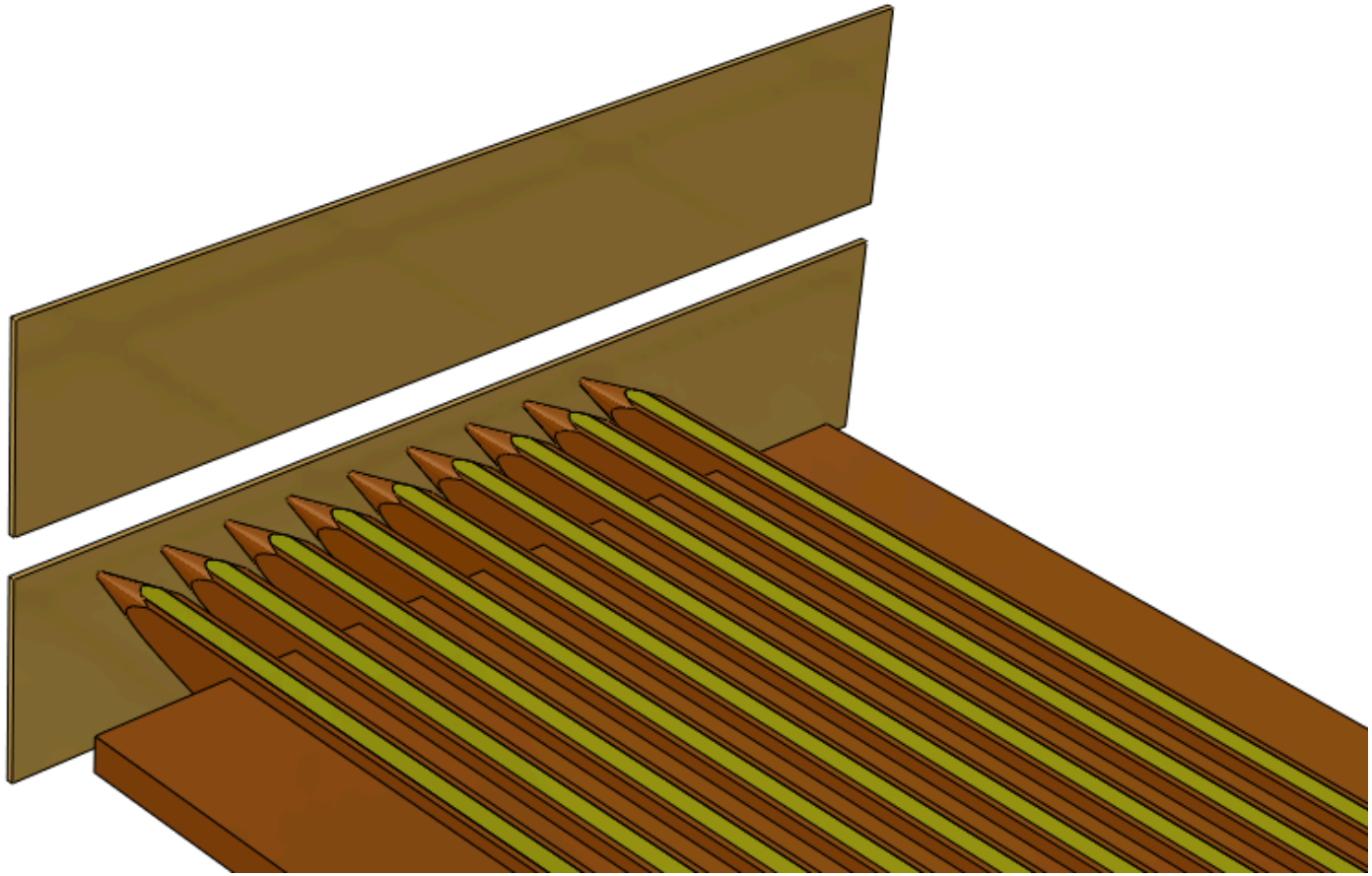
tonejet

- smallest feature: 5µm
- prototyping method reproduced features very well, but all features were individually machined
- replication methods investigated:
  - casting and lithography
  - laser machining
  - injection moulding and lithography
  - silicon processes
  - stereolithography
  - Embossing
- ...before adopting casting and lithography
- infrastructure investment made once manufacturing methods confirmed:
  - cleanroom
  - equipment



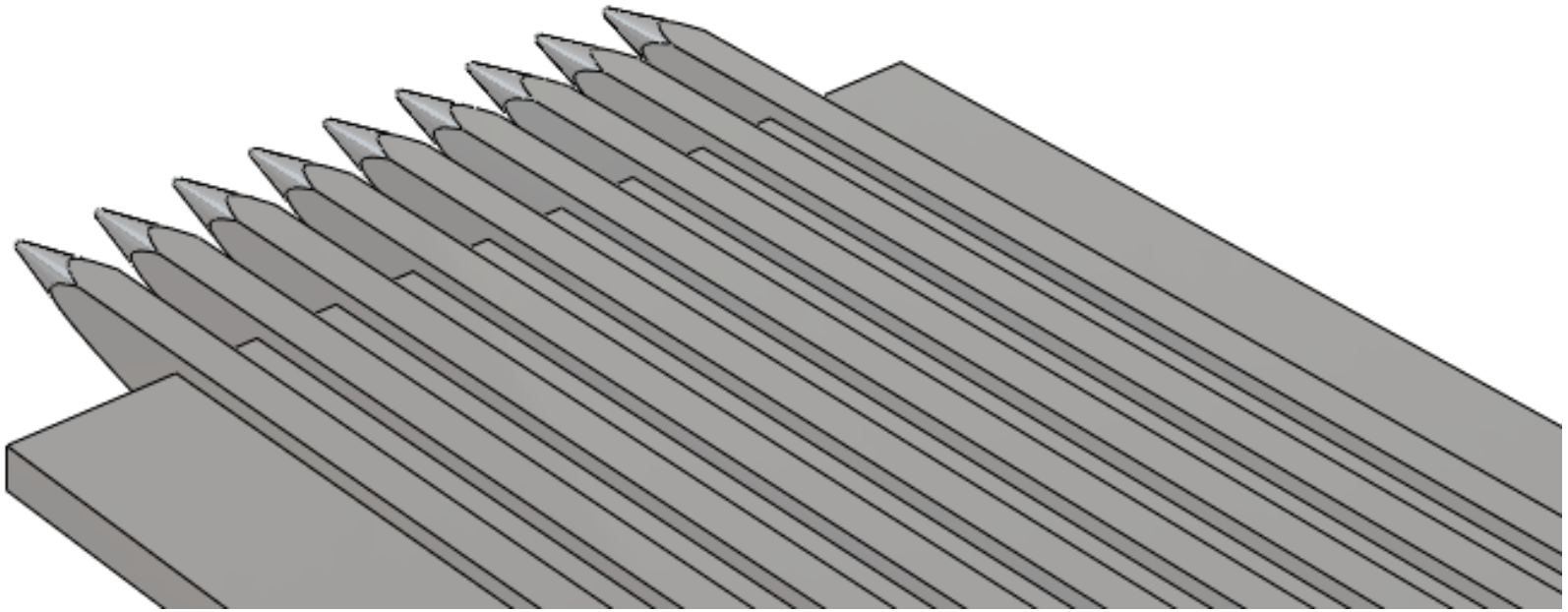
Scalable Fabrication Processes

tonejet



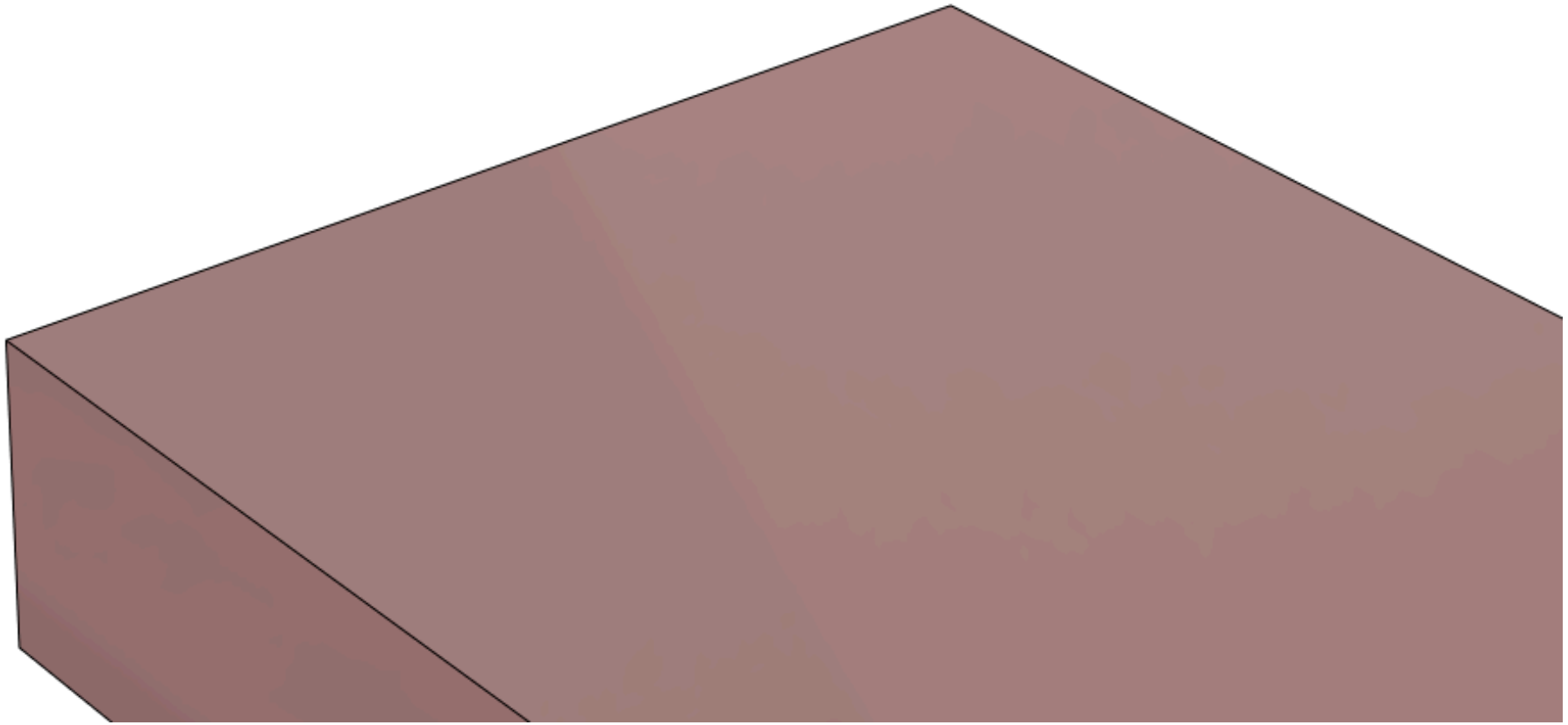
Master

tonejet



Moulding

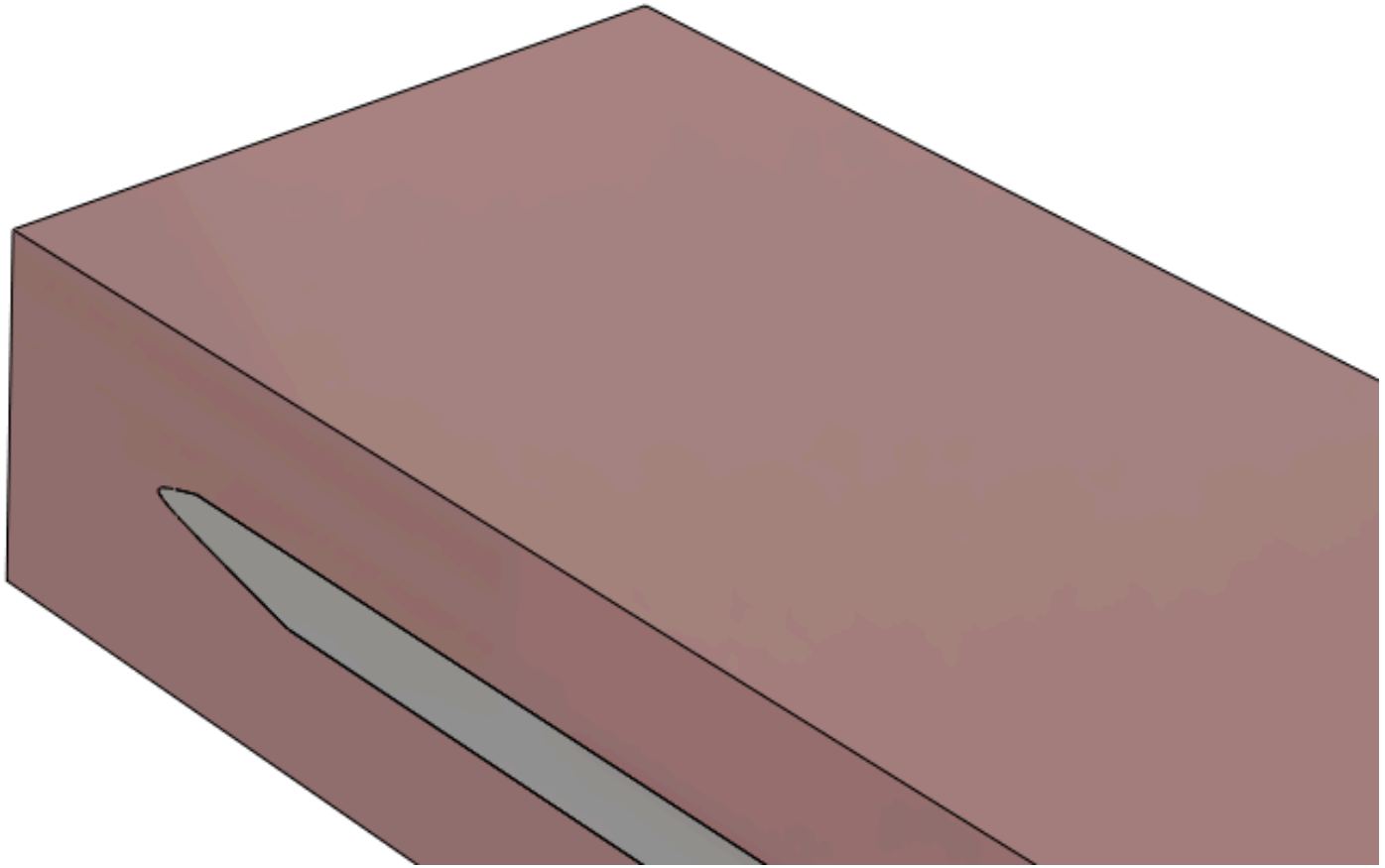
tonejet



Moulding

tonejet

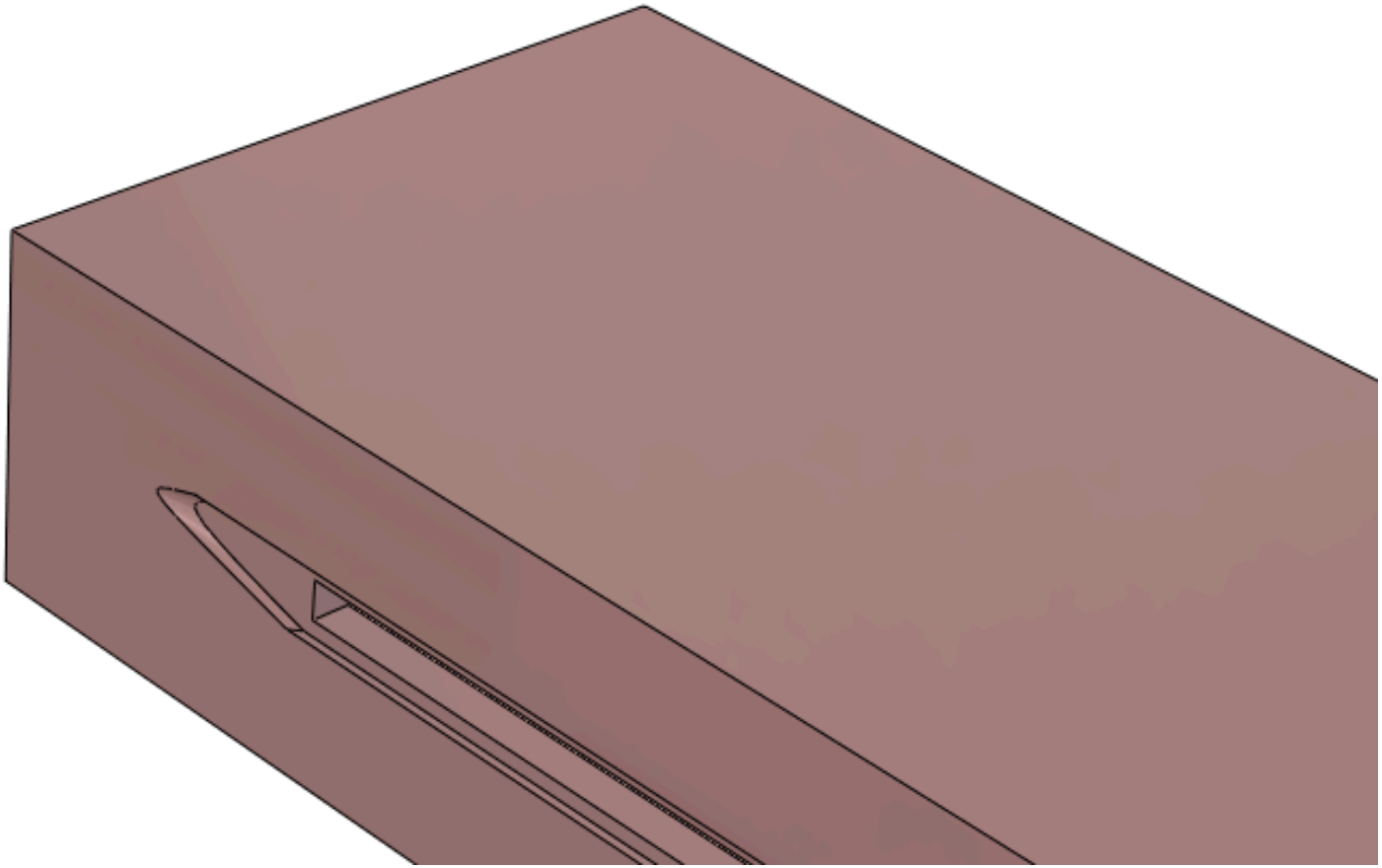
Sectioned View



Moulding

tonejet

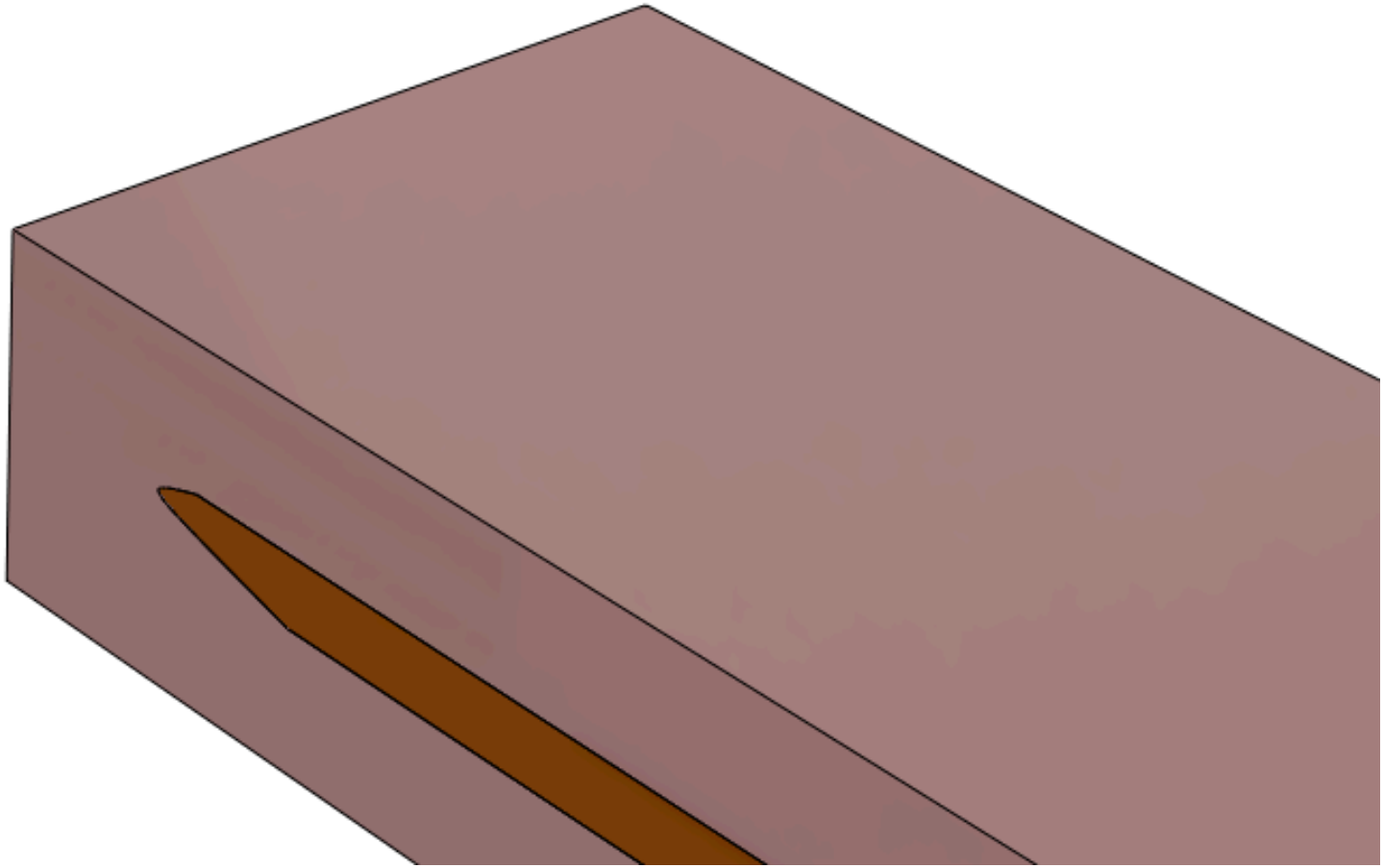
Sectioned View



Moulding

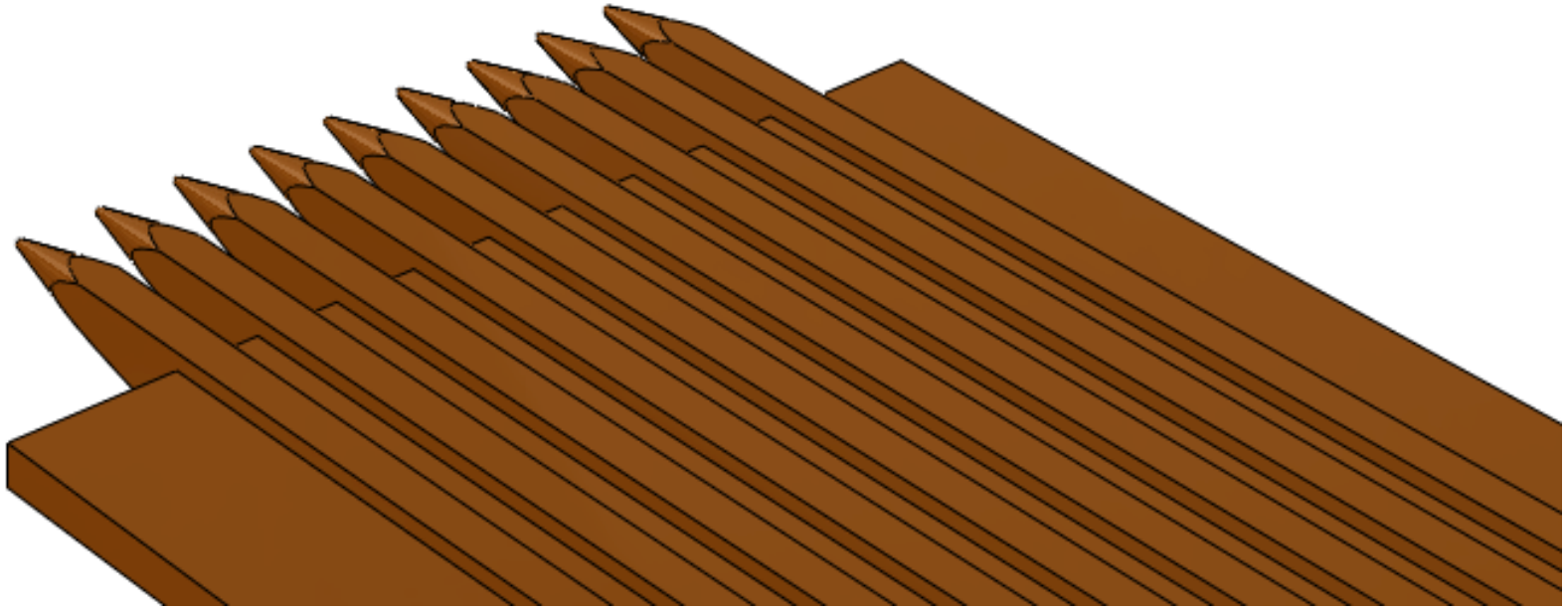
tonejet

Sectioned View



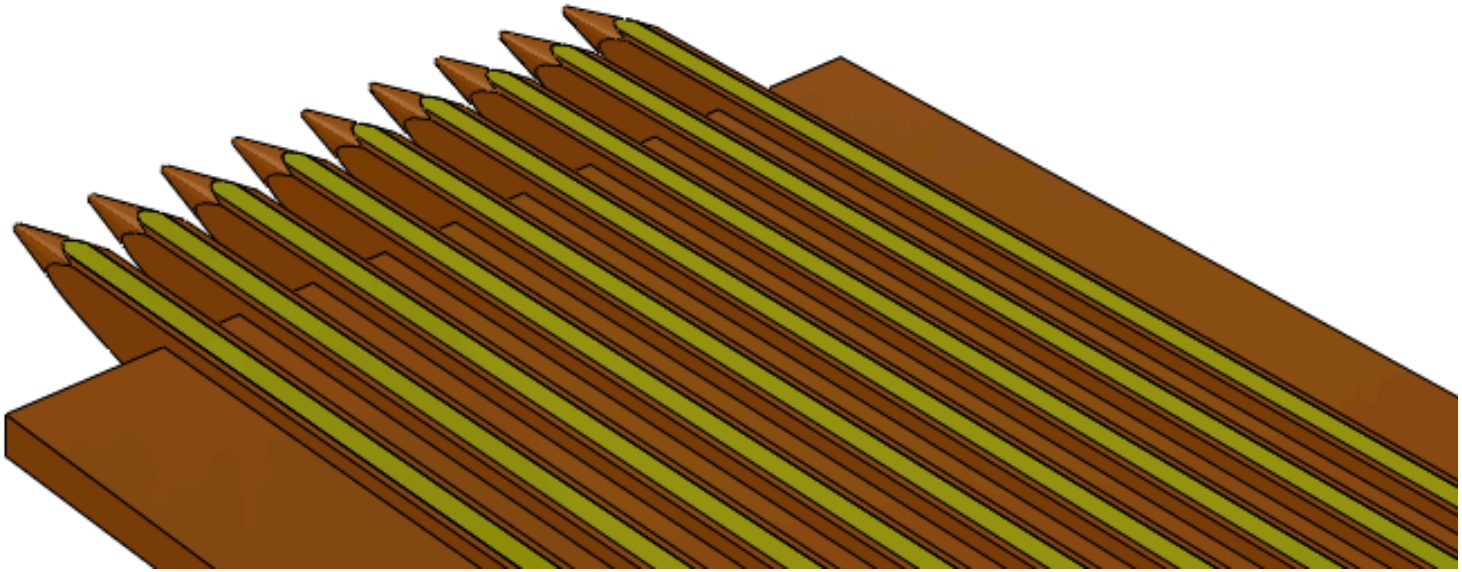
Moulded Ejector Component

tonejet



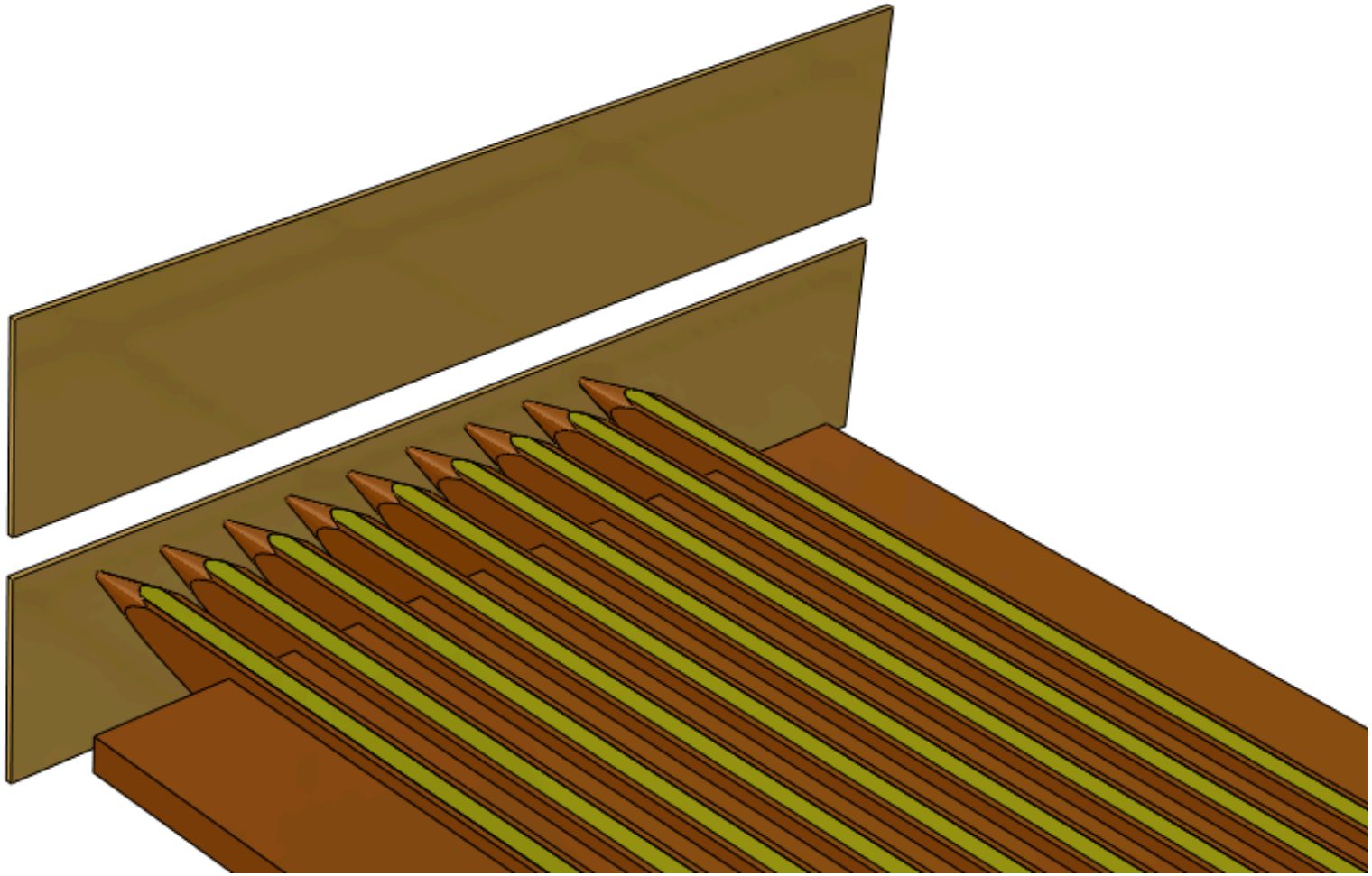
Electrodes

tonejet



Electrodes and Coverplate

tonejet



Manufacturing Process Flow

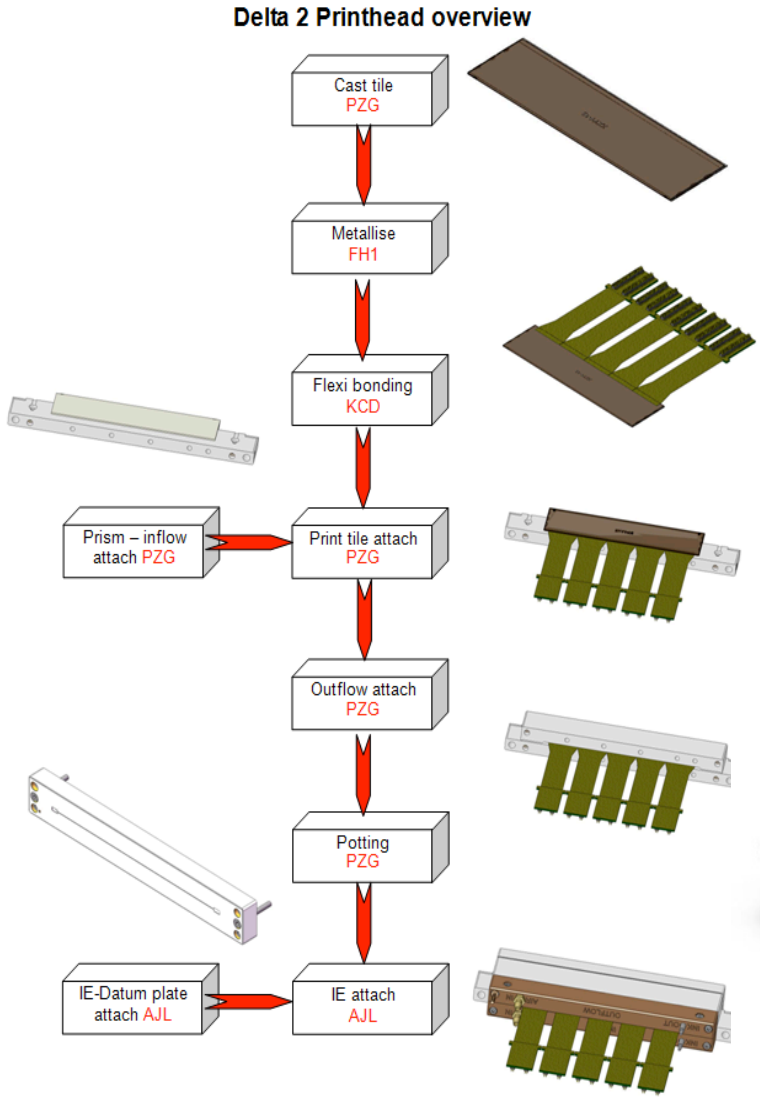
tonejet

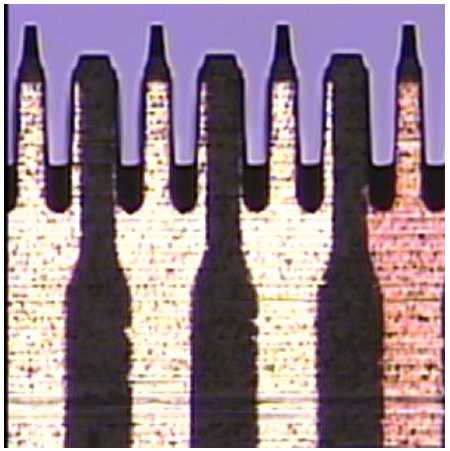
Casting

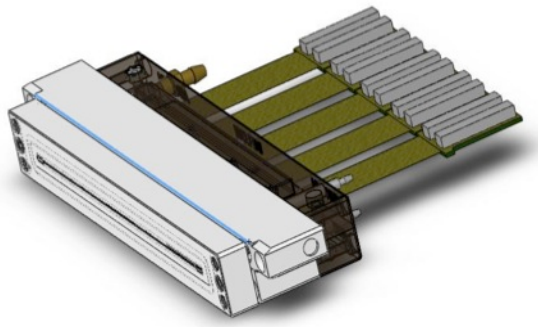
Metallisation

Flexi bonding

Assembly



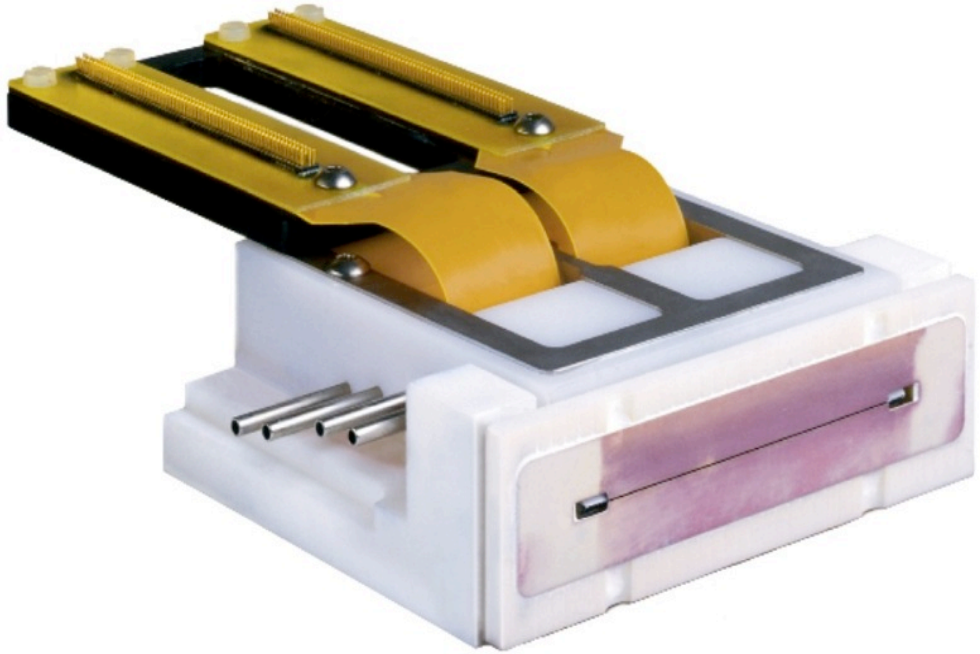




Delta 1 head

tonejet

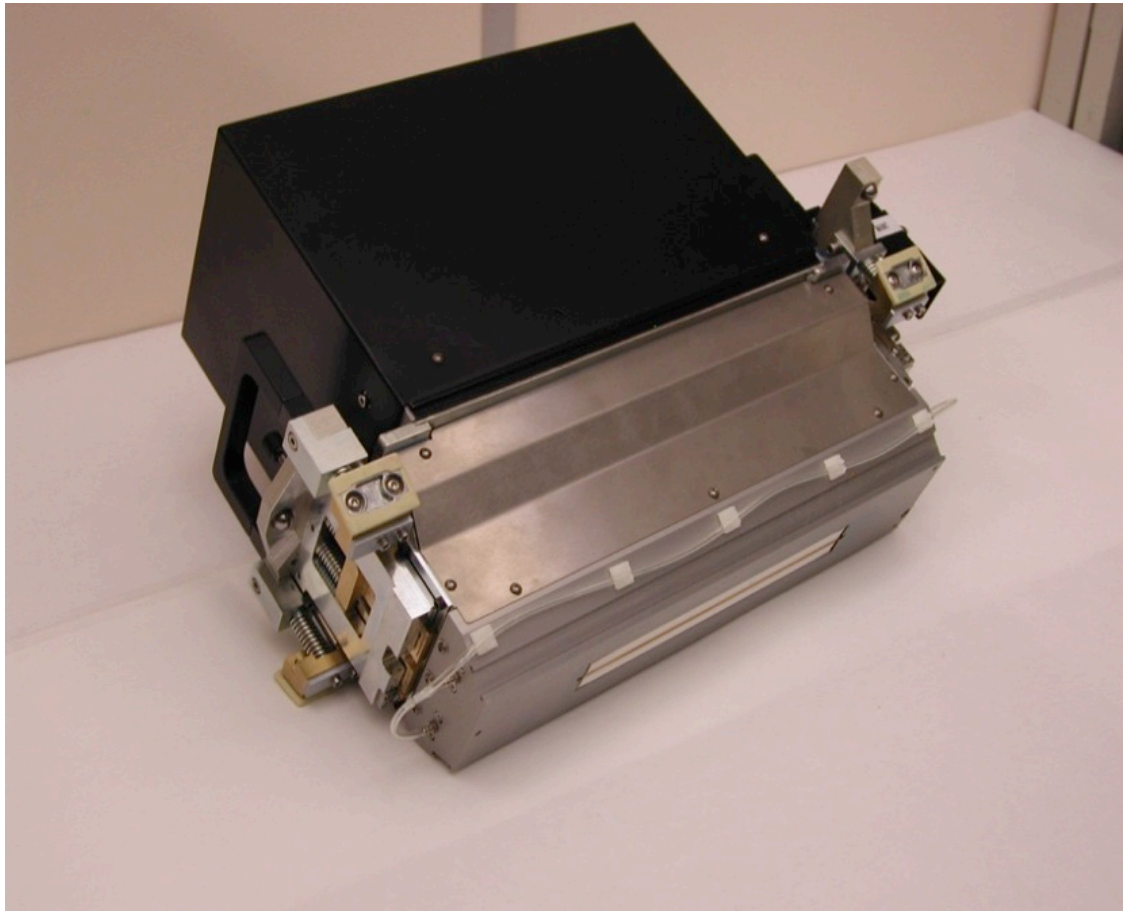
- number of ejectors: 252
- print swathe: 42mm
- head dimensions: 75mm by 25mm by 65mm
- manufacturing method: replication from a master and lithography
- print frequency: 24kHz
- time to print a post card: 12 seconds



Chiron head

tonejet

- number of ejectors: 1024
- print swathe: 170mm
- head dimensions: 300mm by 150mm by 150mm
- manufacturing method: replication from a master and lithography
- print frequency: 24kHz
- time to print a post card: 2 seconds



Delta 2 head module

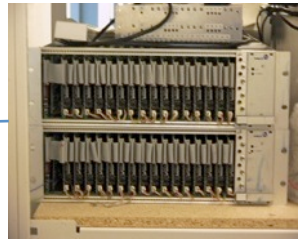
tonejet

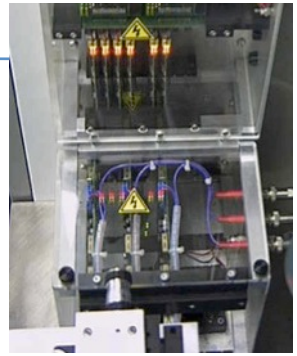
- number of ejectors: 2560
- print swathe: 105mm
- head dimensions: 210mm by 120mm by 300mm
- manufacturing method: replication from a master and lithography
- print frequency: 24kHz
- time to print a post card: 0.1 seconds

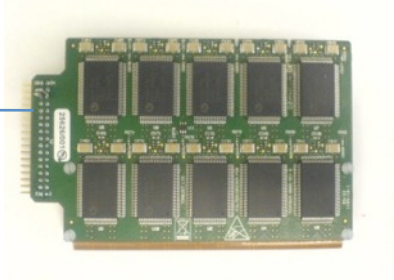
drive voltage

tonejet

Year	Hardware	Pulse voltage (V)
Pre1994	Valve amp – one ejector	1000
1994	One drive card per ejector	800
1996	Big 64 channel drive cards	600
1998		500
2002	Miniature 64 channel drive cards	400
2007		250-300
2009	Miniature 640 channel drive card	250-300







World’s 1st full colour digital can printer

tonejet

Ball

Ball Packaging Europe

Tonejet printing systems

Systems being commercialised

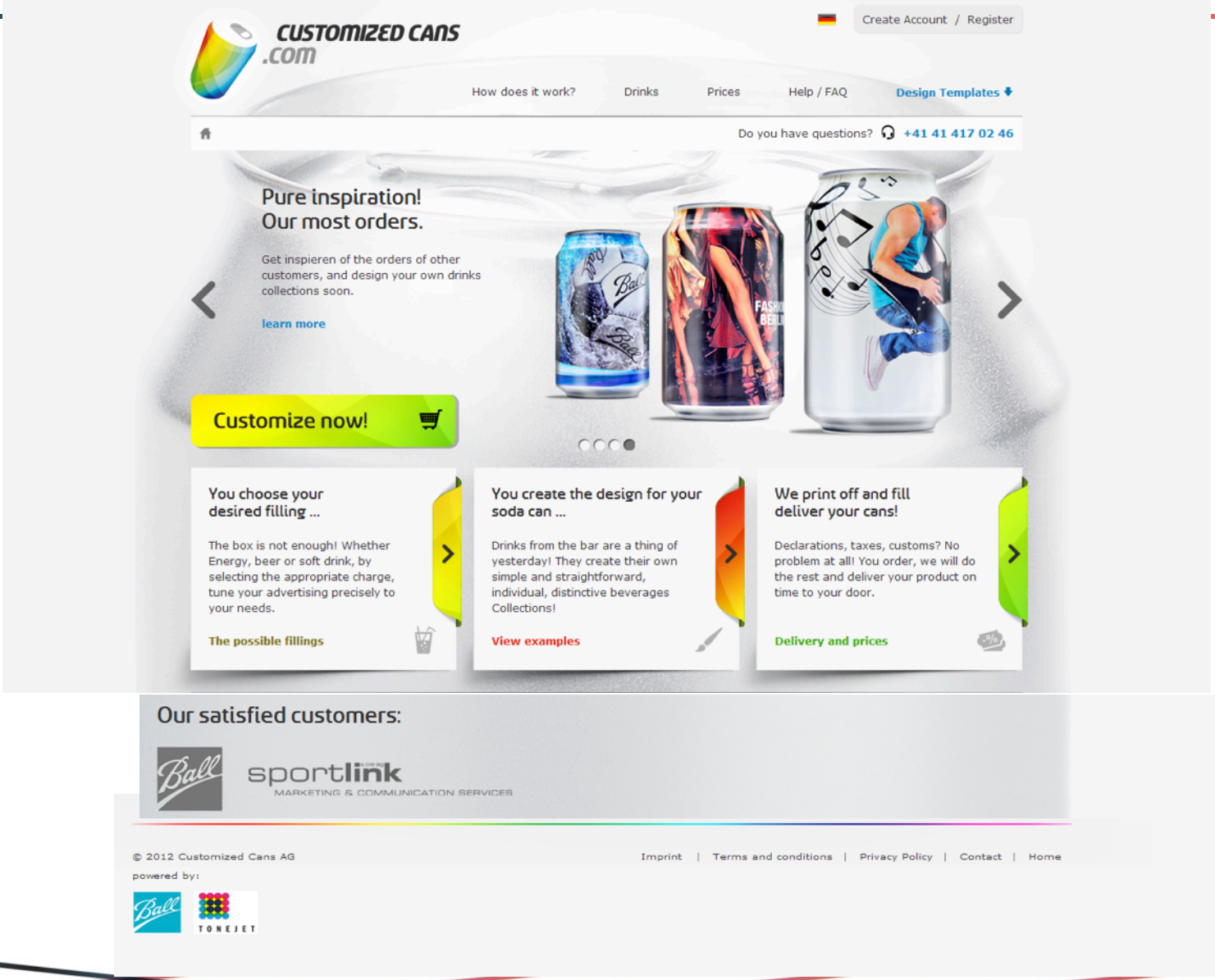
cans/cylinders/tubes/caps

sheet metal

flexible webs

Adding value to the customer

tonejet



Value of manufacturing for Tonejet

tonejet

- You will put more product down the process pipe in the first week of full commercial operation than in the entire development program

- A successful new process will be as good as its predecessor in all key respects, and better in some.

- Reduction in BOM costs

- Increases in printed throughput

- Growth of I.P. Portfolio

- Speedier response to changes in market needs

Manufacturing Process Flow

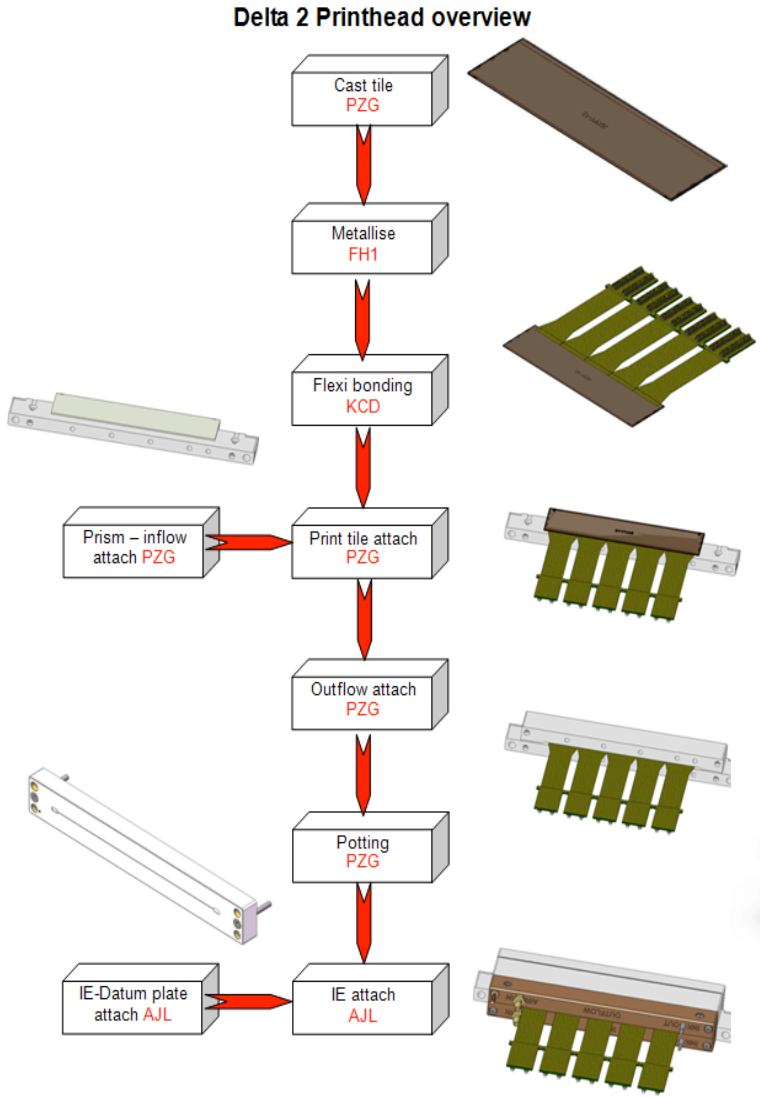
tonejet

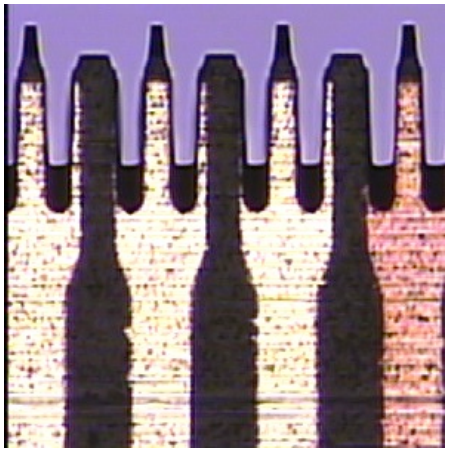
Casting

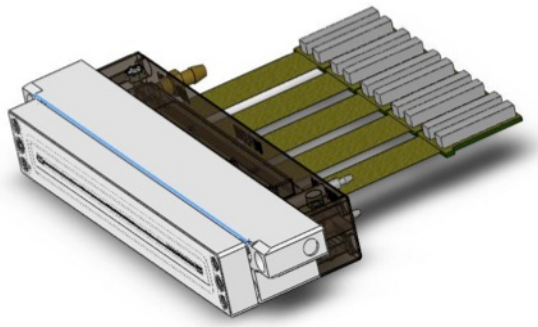
Metallisation

Flexi bonding

Assembly







Value of manufacturing for Tonejet

tonejet

- You will put more product down the process pipe in the first week of full commercial operation than in the entire development program

- A successful new process will be as good as its predecessor in all key respects, and better in some.

- Reduction in BOM costs

- Increases in printed throughput

- Growth of I.P. Portfolio

- Speedier response to changes in market needs

Printhead evolution

tonejet

printhead	no. ejectors	m'f'g method	BoM/ejector vs today	print frequency	time to print a postcard
D-head	1	scalpel, hand cut	12.5 X	2kHz	1hr 12 min
W-head	64	machined ceramic	2 X	16kHz	1 min 8 secs
Delta 1 head	252	cast & lithography	2.5 X	24kHz	12 secs
Chiron head	1024	cast & lithography	2 X	24kHz	2 secs
Delta 2 module	2560	cast & lithography	1 X	24kHz	0.1 secs

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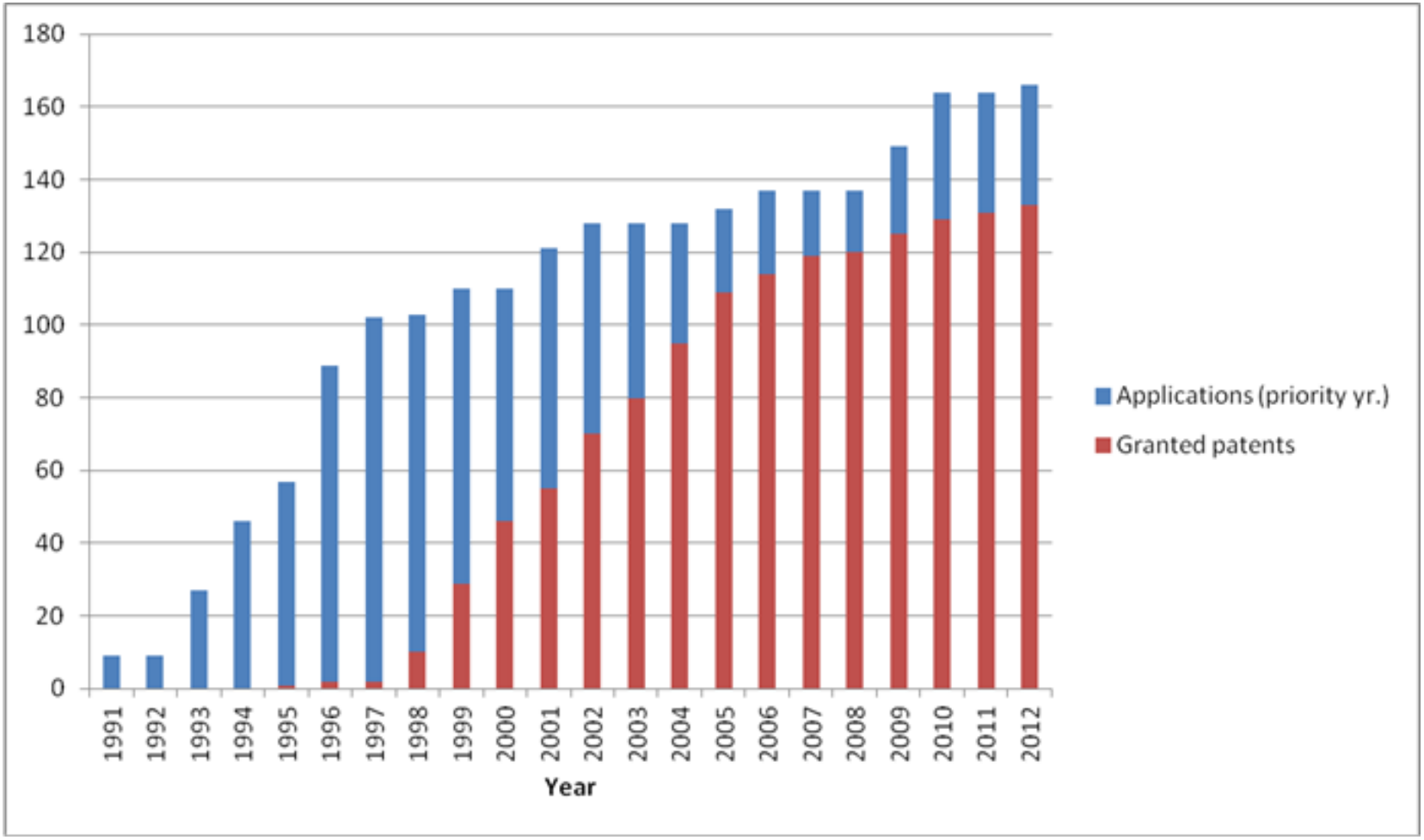
Patent activity

tonejet



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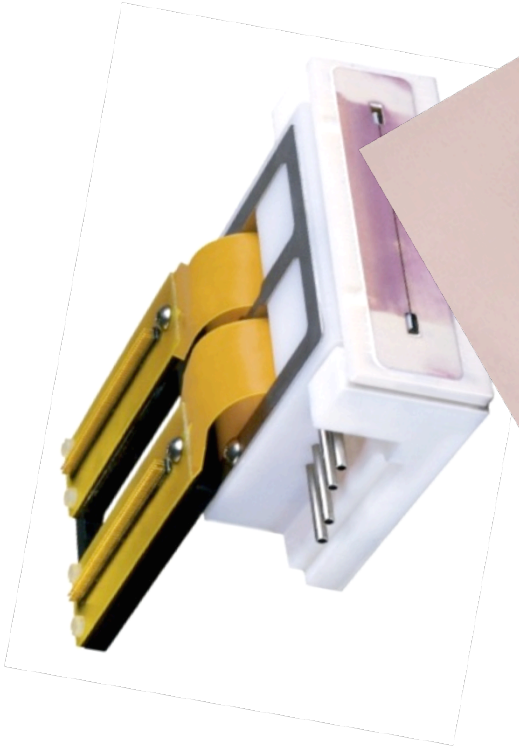
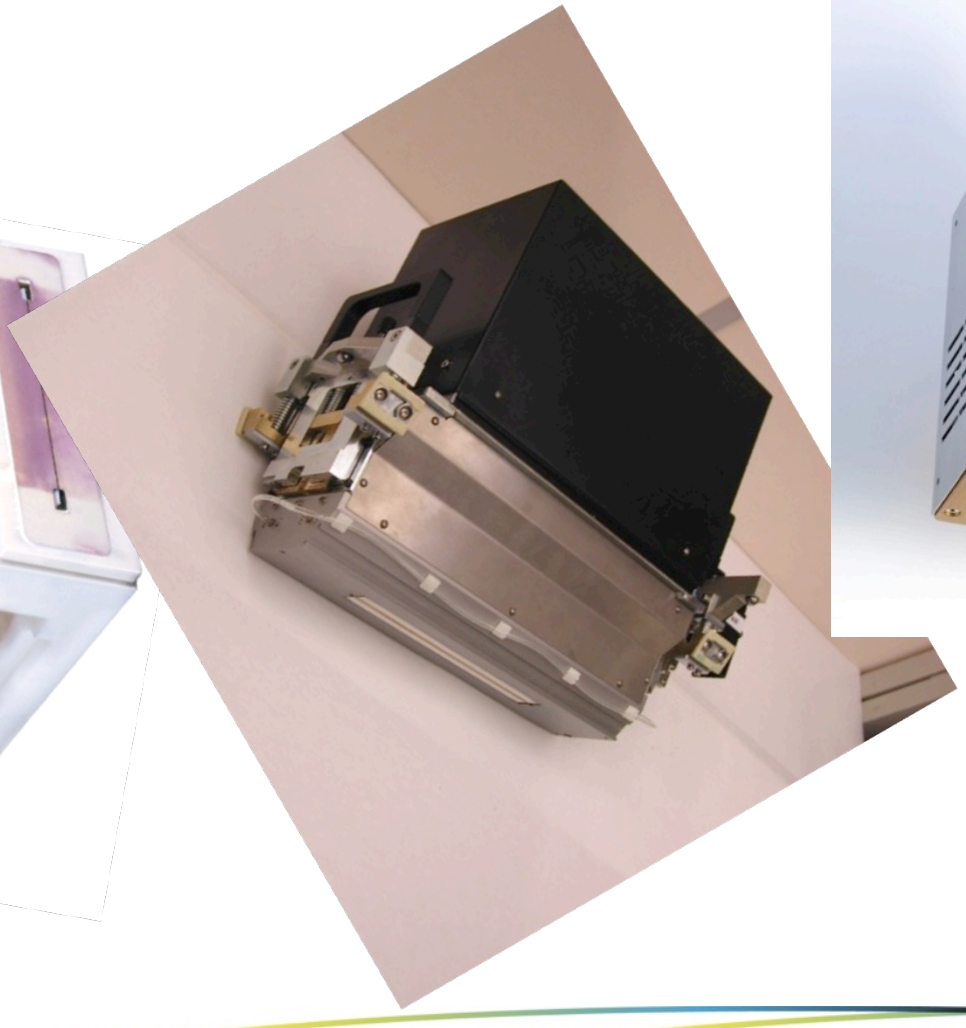
Responsive to market needs

tonejet





Value to the economy

tonejet

- Employment :  50% in 5 years

  feeding on Cambridge expertise

- Supply Partnerships – expanding their capabilities

  Work with key partners able to produce high specification components to enable sub-contract manufacturing of proven components

  Part of TSB funded consortium of UK businesses

- Enhancing Cambridge (and wider) expertise

  Tonejet staff being targeted by others!

tonejet

Leading the way
in digital printing