SST

STEIGERWALD STRAHLTECHNIK GMBH

Steigerwald Strahltechnik GmbH
located near
Munich in Germany
provides
Electron Beam Technology
with an experience since more than
50 years

Marko Wittig, Steigerwald Strahltechnik GmbH

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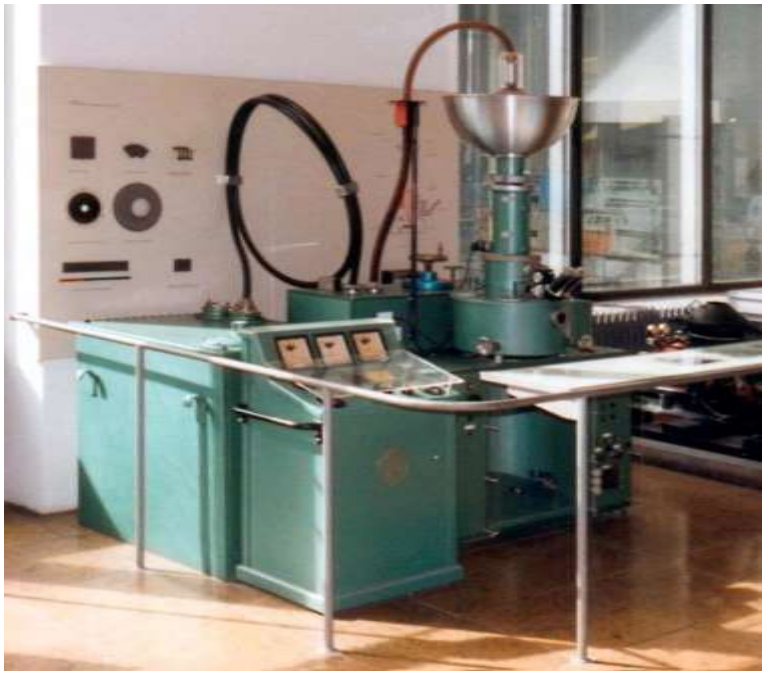
History & Group

2 Electron Beam Technology
Advantages & Applications

3 EB – Generator
The tool for this process

4 Machines, Future developments and Innovations

The Company
History & Group

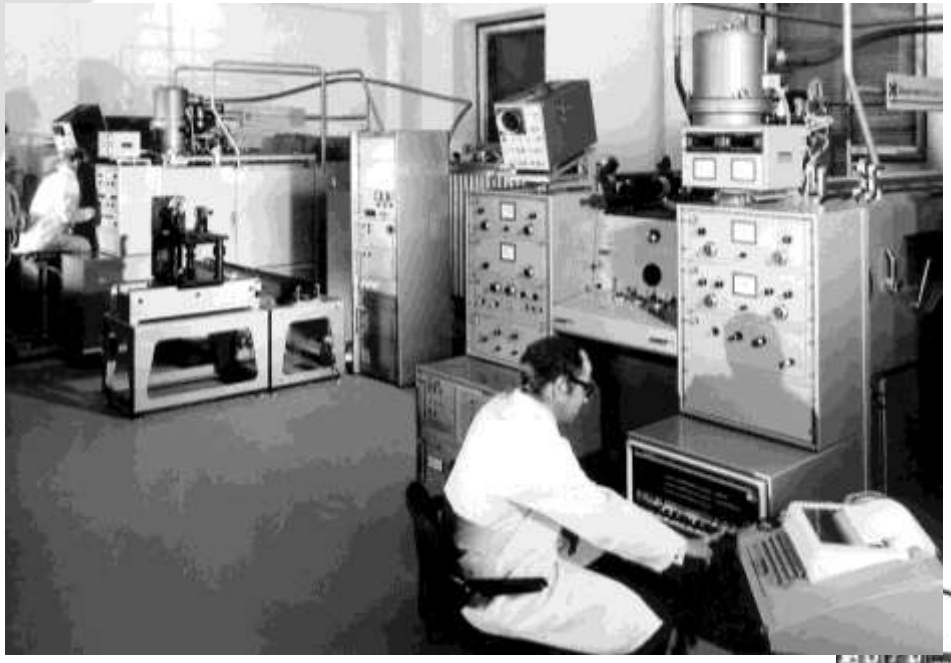


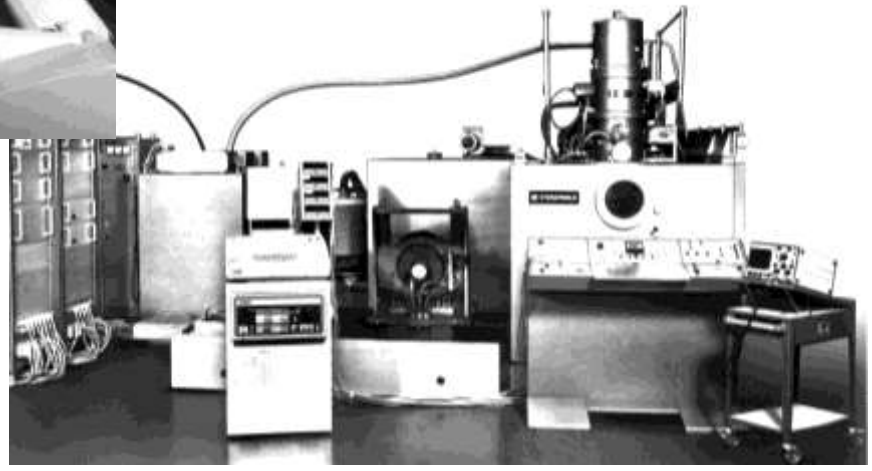
1958: The first electron beam welding machine (55kV) manufactured by Karl-Heinz Steigerwald.

1952 **Dr. h.c. Karl-Heinz STEIGERWALD builds the first EB processing machine for drilling of watch jewels. The birth of electron beam technology for materials processing applications.**

1963 **Dr. STEIGERWALD setting up his own company STEIGERWALD STRAHLTECHNIK GmbH. In only few years, the company established its reputation as the foremost specialist in developing and industrial application of EB technologies.**

The Company
History & Group

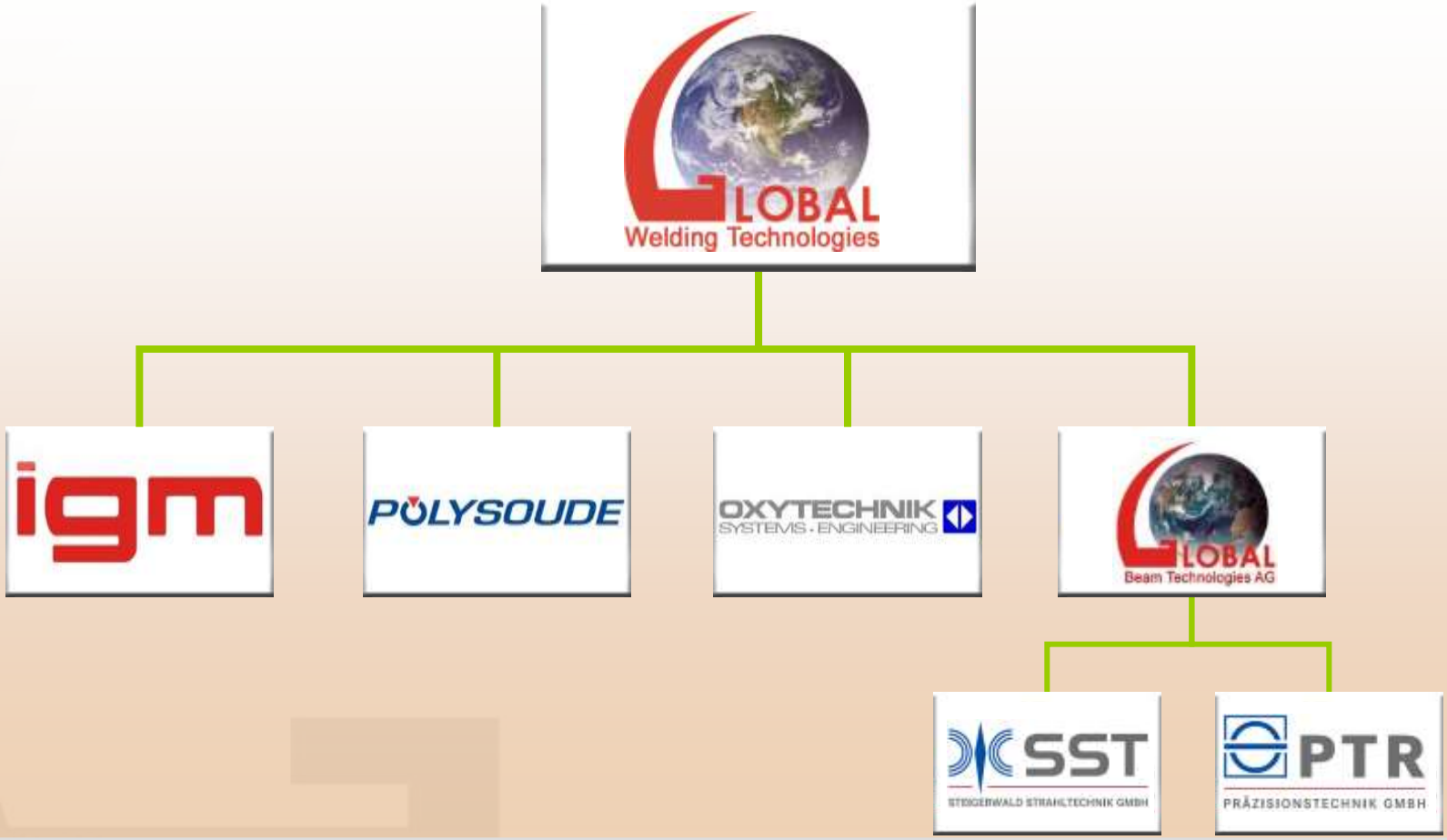




1964:
The first electron beam production facility of STEIGERWALD STRAHLTECHNIK, Munich.

The Company
History & Group

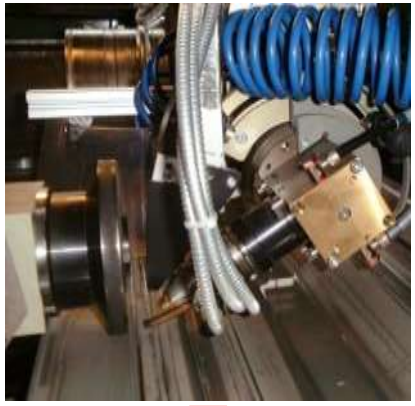
GLOBAL WELDING TECHNOLOGIES AG



The Company
History & Group

Global Welding Technologies AG – group members

A strategically focused international provider of highly engineered welding systems.

Robotic welding	Orbital welding Mechanized welding	Profile cutting Strip welding	Electron Beam welding, drilling & surface modification
			
igm	POLYSOUDE	OXY OXYTECHNIK GMBH & CO. KG	GLOBAL Beam Technologies AG
Wiener-Neudorf Austria	Nantes France	Bad-Soden Germany	Maisach Germany

The Company
History & Group

MEMBERS OF THE GBT

SST
STEIGERWALD STRAHLTECHNIK GMBH

Munich, Germany

- Chamber type machines
- Special purpose machines
- Drilling machines
- Research & Development Mass production welding machines
- Welding applications
- Service

PTR
STRAHLTECHNIK

Frankfurt, Germany

- Job shop for welding
- Job-Shop for drilling
- Service
- Welding applications
- Mass production welding machines

PTR
PRECISION TECHNOLOGIES, INC.

Enfield, CT, USA

- Chamber type machines
- GBT Representation in America
- Job shop for welding
- Service

The Company
History & Group

MEMBERS OF THE GBT

Production plant in Hungary

- **Mass production welding machines**
- **Fully automated production lines**
- **Service in Hungary**

AJM ROBOTIC SYSTEM CO., LTD.

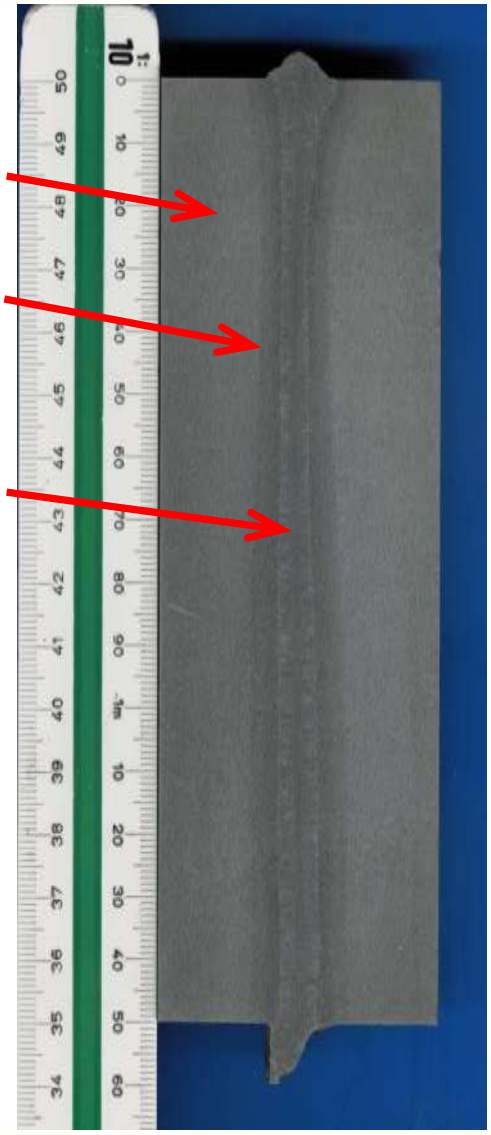
Beijing, PR China

- **Job shop for welding**
- **Service**
- **Welding applications**

Electron Beam Technology
Advantages & Applications

Advantages

- Low heat affected zone
- High depth to width ratio
- No additional material or gas
- Wide choice of materials
- Excellent reproducibility
- High efficiency



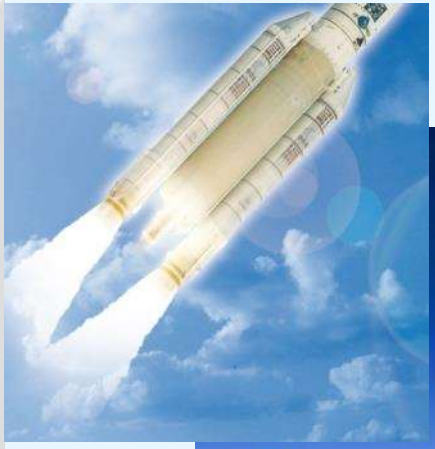
Less Distortion and Shrinkage

than other processes

Electron Beam Technology
Advantages & Applications

Branches

Aviation- and space industry



Automotive industry

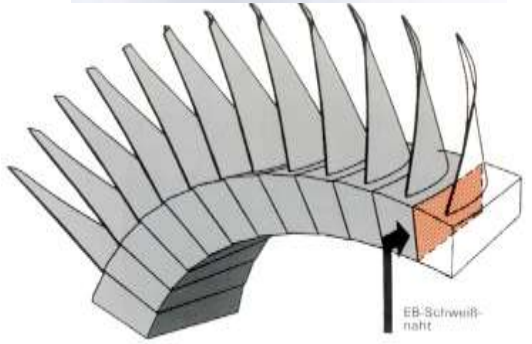
Electrical power industry

Other industries & Research

Electron Beam Technology
Advantages & Applications

Examples of EB welded parts in Aviation- and space industry

STATOR made of TiAl6V4



ROTOR made of TiAl6V4

Electron Beam Technology
Advantages & Applications

Examples of EB welded parts in Automotive industry

Turbocharger

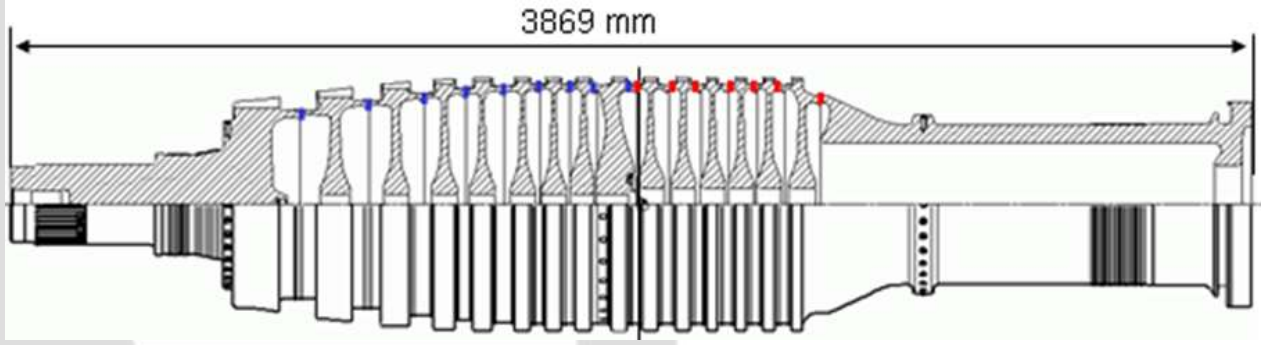
Airbag

Gear components

Electron Beam Technology
Advantages & Applications

Examples of EB welded parts in Electrical power industry

Gas and steam turbine manufacturing

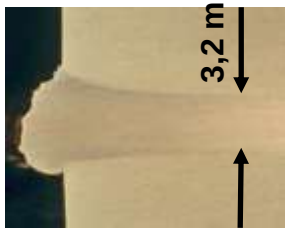


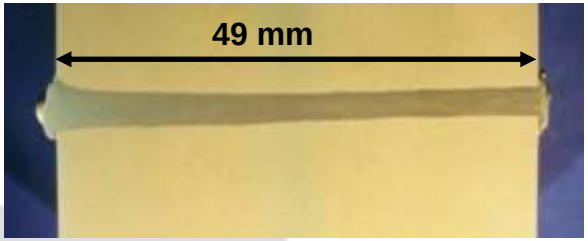
Electrical contacts
Made from Tungsten and Copper

Electron Beam Technology
Advantages & Applications

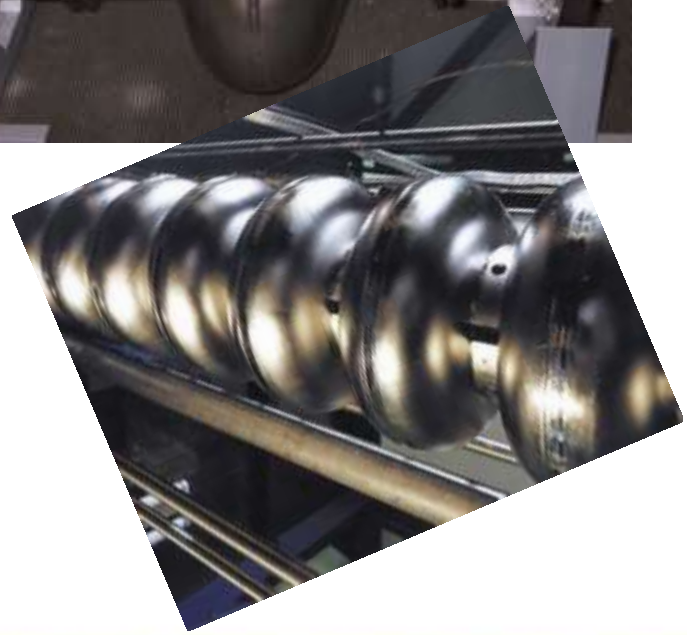
Examples of EB welded parts in Research and other industries

Al-Process chamber for wafer fabrication





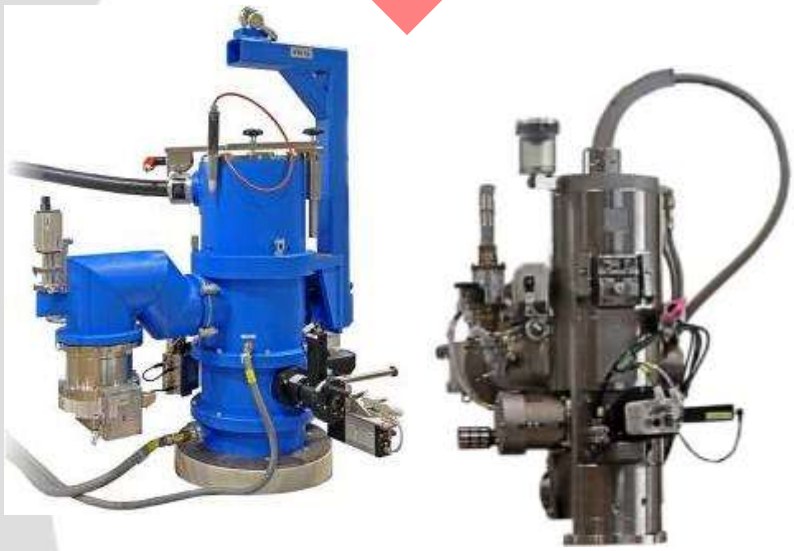
CAVITIES (for accelerators) made from Nb = Niobium



EB - Generator
The tool for this process

EBOGEN EG

EB generator outside of working chamber

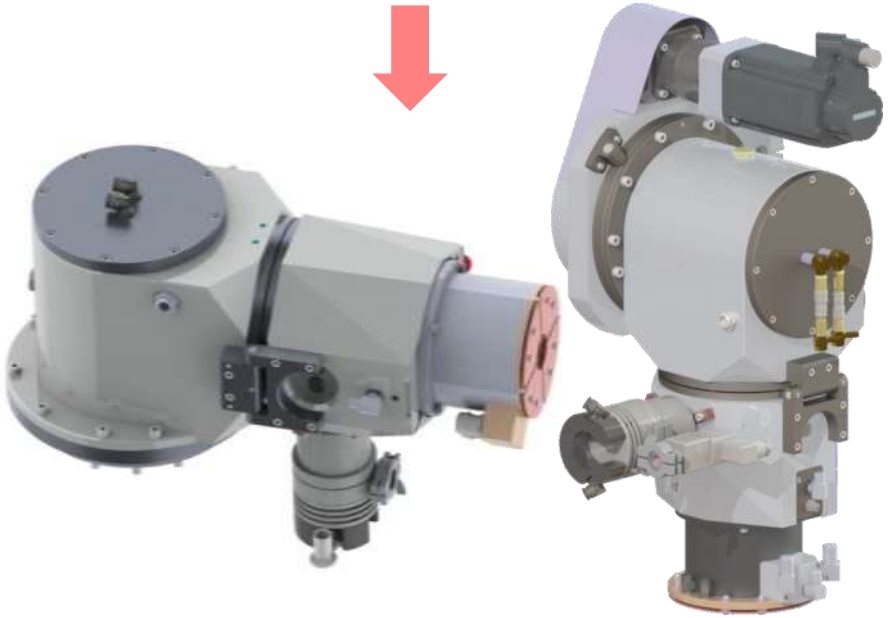


Accelerating voltage: up to 150 kV

Beam power: up to 60 kW

MOBILGEN MG

EB generator inside of working chamber



Accelerating voltage: up to 60 kV

Beam power: up to 30 kW

EB - Generator
The tool for this process

EBOGEN EG 60-series

- Accelerating voltage up to 60 kV
- Beam power up to 25 kW
- Working distance up to 700 mm
- Spot diameter minimal < 0.4 mm
- Direct heated Tungsten cathode
- Vertical & horizontal position of installation
- Beam deflection

EBOGEN EG 150-series

- Accelerating voltage up to 150 kV
- Beam power up to 60 kW
- Working distance up to 1,800 mm
- Spot diameter minimal < 0.2 mm
- Direct heated Tungsten cathode
- Vertical & horizontal position of installation
- Beam deflection

EG-series provides 5 to 60 kW beam power

EB - Generator
The tool for this process

MOBILGEN MG

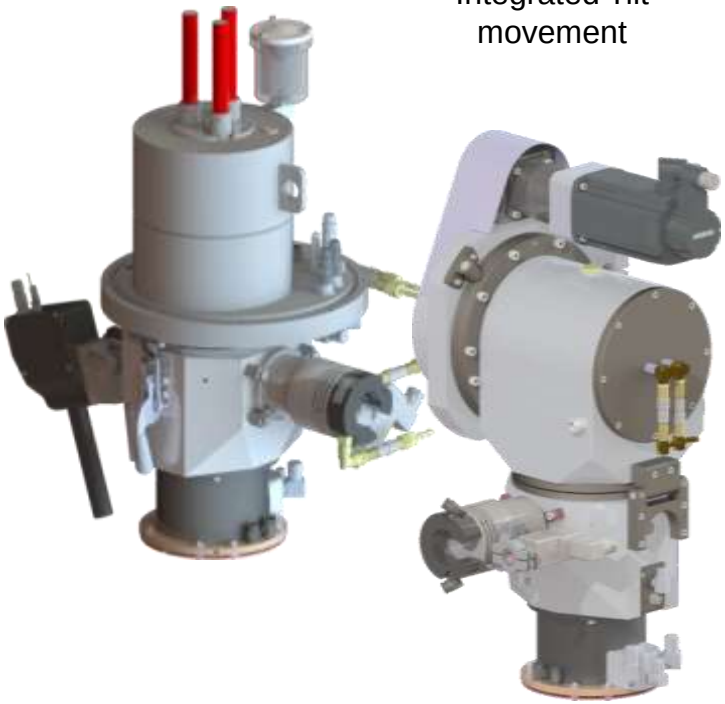
- Accelerating voltage up to 60 kV
- Beam power up to 30 kW
- Working distance up to 300 mm
- Beam deflection
- Direct heated Tungsten cathode

3 variants

Without integrated movement

Integrated Tilt movement

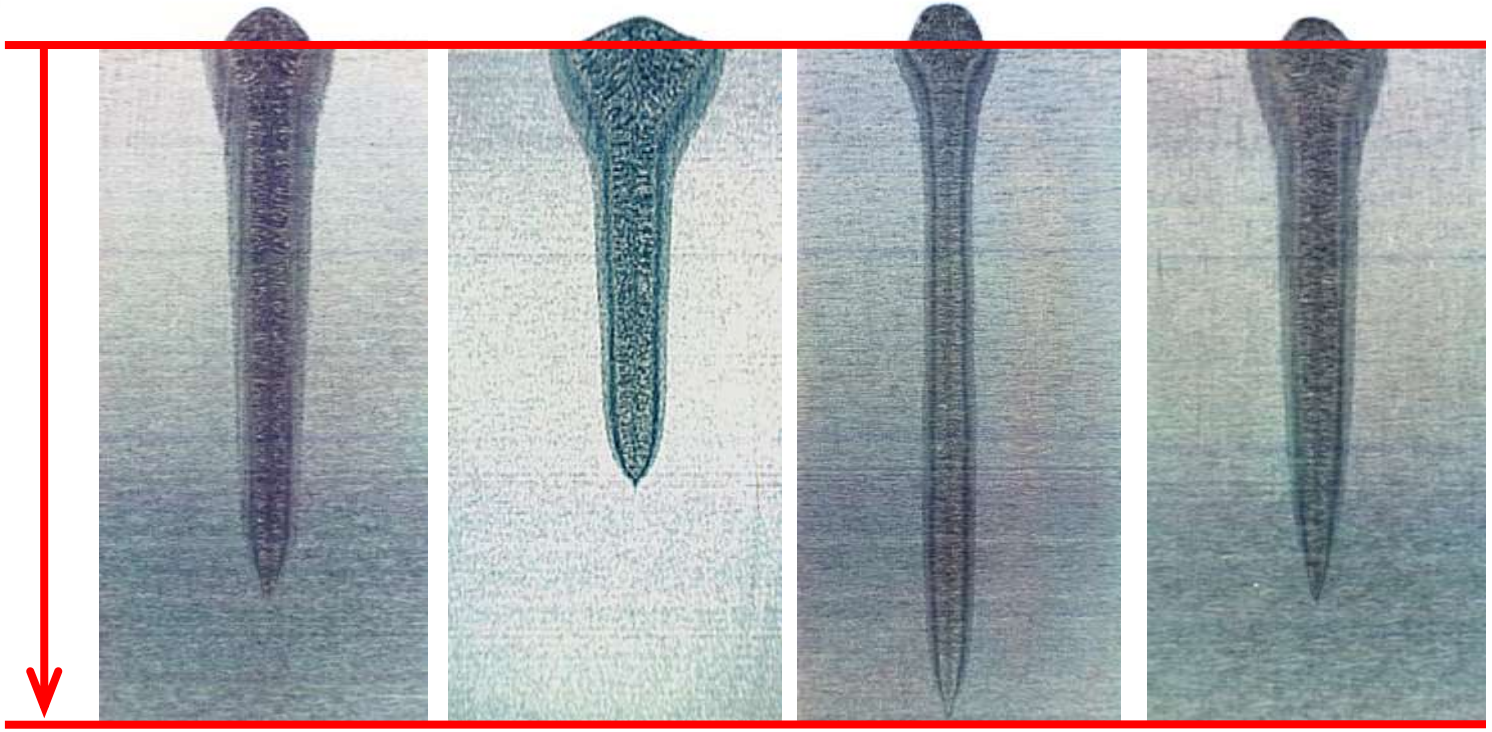
Integrated Tilt and Rotate movement



MG-series provides 15 to 30 kW beam power

EB - Generator
The tool for this process

Comparison between 60 kV and 150 kV



U =	60 kV	60 kV	150 kV	150 kV
FA =	350 mm	700 mm	350 mm	700 mm

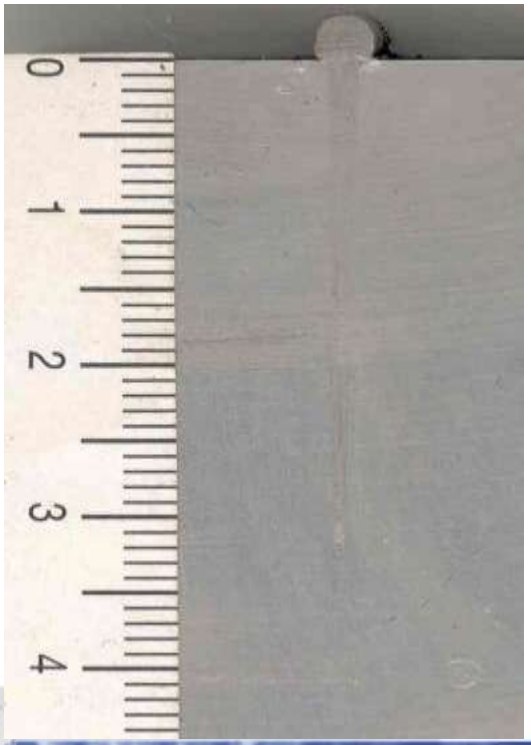
Material : 10 CrMo 9 10
P = 15 kW and v = 5 mm/s

EB - Generator
The tool for this process

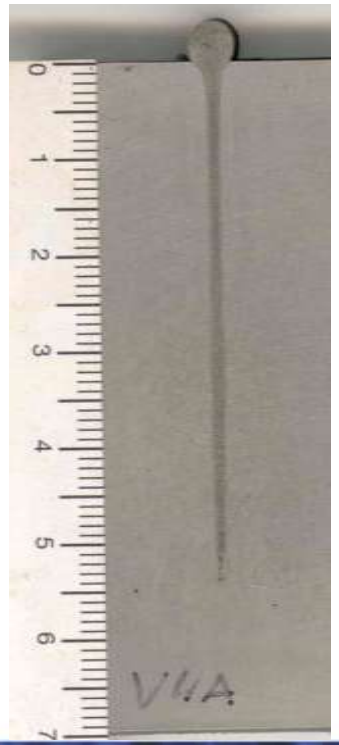
Comparison between 60 kV and 150 kV

Stainless steel (1.4571)
welded with:

60 kV
Ratio (width to depth) 1:25

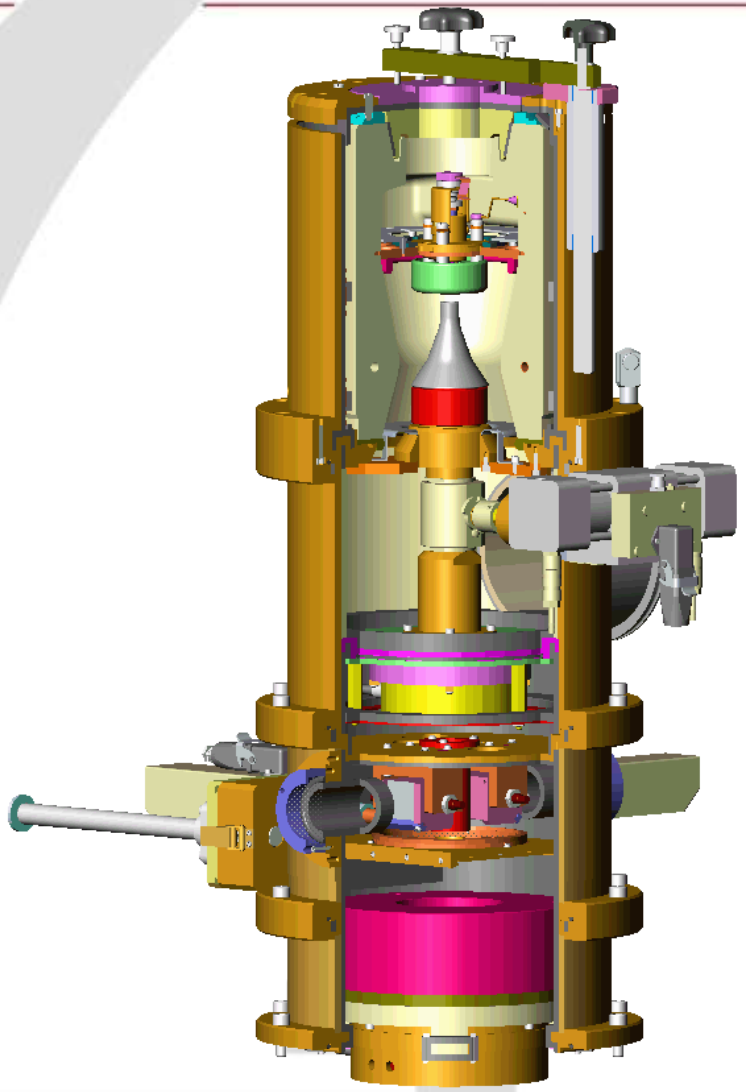


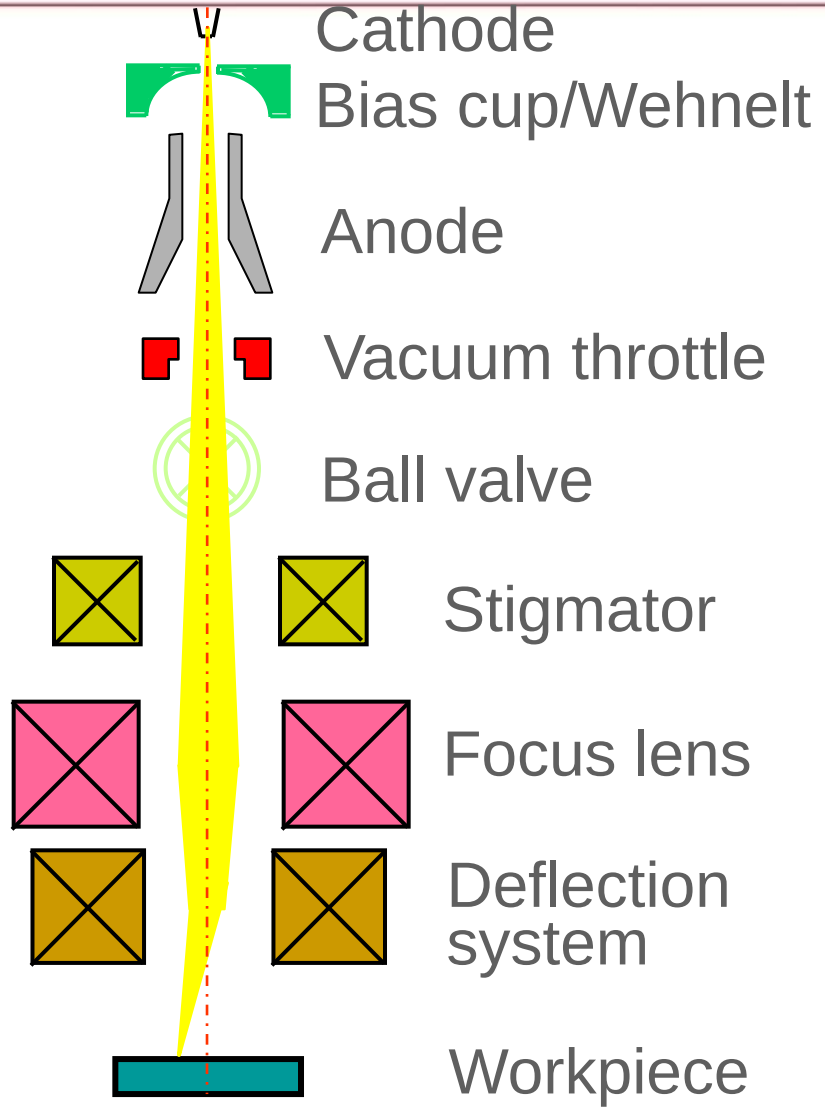
150 kV
Ratio (width to depth) 1:50



EB - Generator
The tool for this process

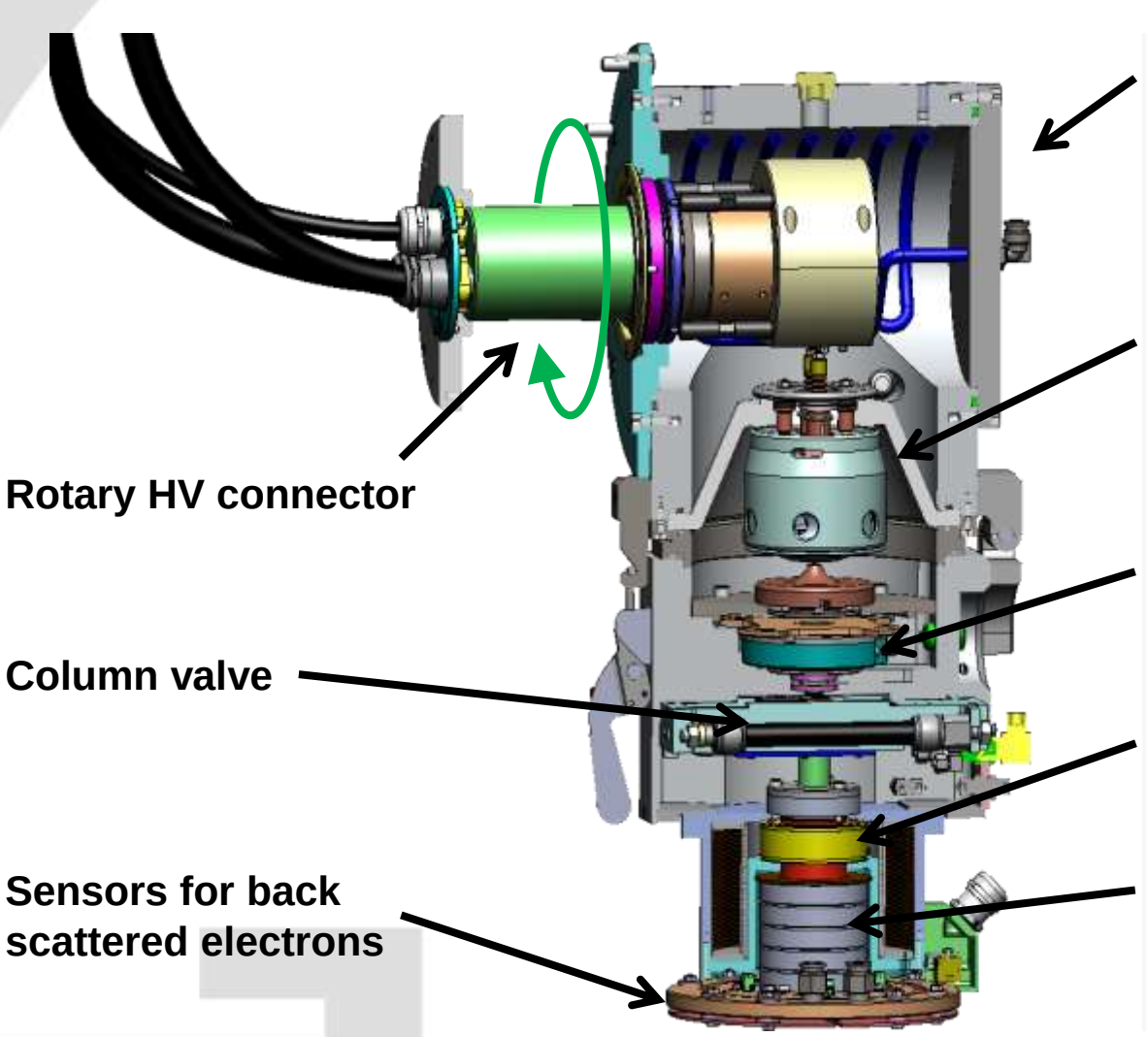
Scheme of (150kV) EBOGEN





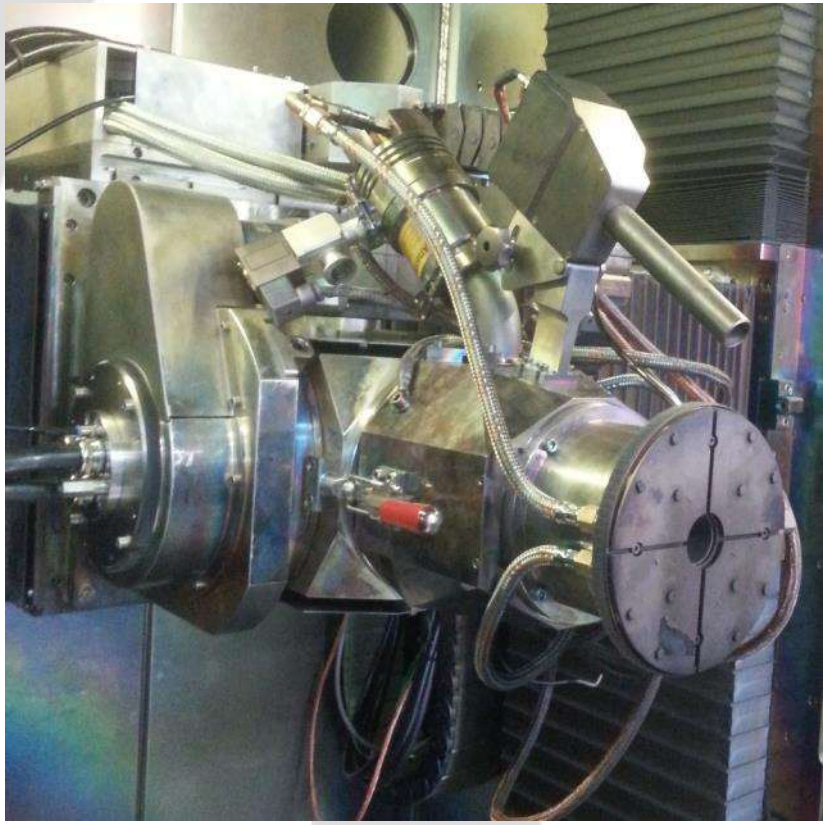
EB - Generator
The tool for this process

Scheme of MOBILGEN



EB - Generator
The tool for this process

MOBILGEN



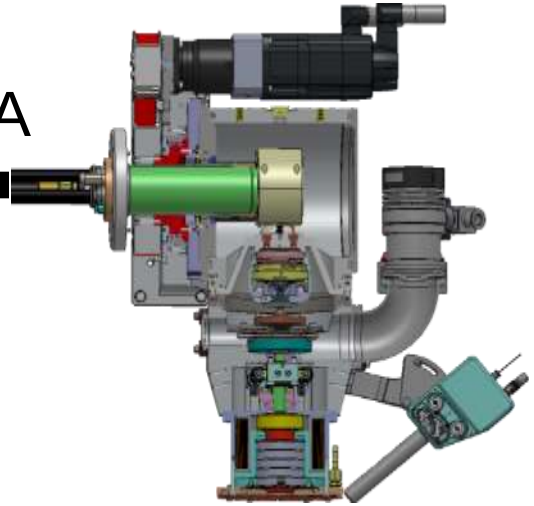
without cover

with cover

EB - Generator
The tool for this process

Connection and supply of MOBILGEN

3 Wires: 60kV 80A



HV Control

HV Tank

Hot Box

Wehnelt Filament

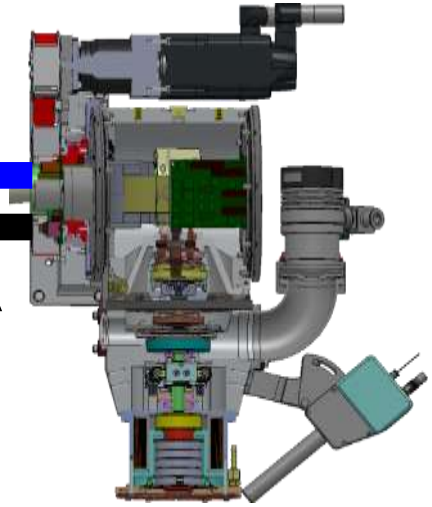
Feed through of chamber

EB - Generator
The tool for this process

New Connection and supply of MOBILGEN

2 Wires: 100V 5A

2 Wires: 60kV 0.5A



HV Control

HV Tank

Hot Box

Wehnelt

Lower current on HV site lead to simpler and more robust HV connection.

Increasing of Beam Power

Machines, Future developments and Innovations

EB welding machine

External EB generator

- EBOCAM
- EBOCUBE
- EBOMAT
- EBOCONT

Internal EB generator

- EBOMOVE
- EBOFLEX
- EBODISC

EB drilling machine

- EBOPULS

Machines, Future developments and Innovations

EBOCAM – Chamber machines

EBOCAM

- chamber volume up to 60 m³
- low- or high voltage (60kV – 150 kV)
- manipulators
- low- or high vacuum systems
- CNC controlled

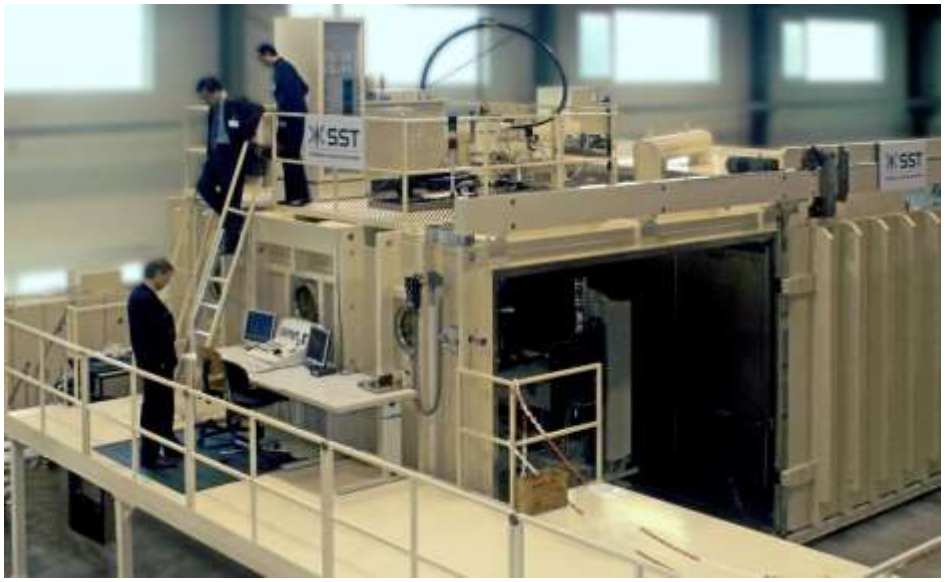
- aviation- and space industry
- nuclear industry
- special machines

Machines, Future developments and Innovations

EBOCAM – Chamber machines

Machines, Future developments and Innovations

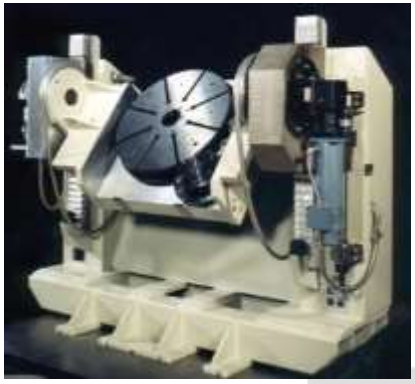
EBOCAM – Chamber machines



Machines, Future developments and Innovations

EBOCAM – Examples of Manipulators

EBOCAM



EBOMOVE – Internal generator system

EBOMOVE

UNIVERSAL CHAMBER PROCESSING SYSTEM with internal EB generator

CHARACTERISTIC

- standard chamber volumes up to 100 m³
- bigger volumes possible
- large number of different manipulators
- pump systems for short pump down time
- CNC system for evaluation & control of process parameters

FIELD OF APPLICATION

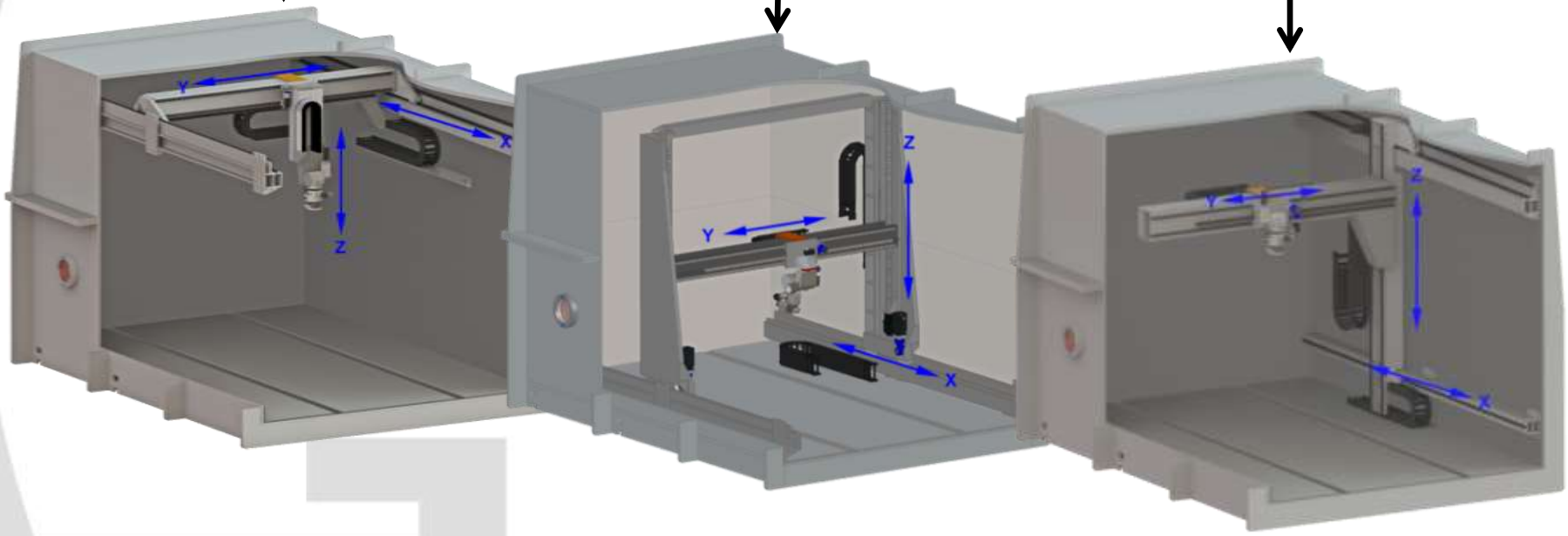
- mostly used for heavy and big parts
- jet engine manufacturing
- nuclear engineering
- air and space technology

Machines, Future developments and Innovations

EBOMOVE – Internal generator system

EBOMOVE

EM “A”	EM “B”	EM “C”
Generator movement by use of a bridge-like traverse and a telescopic slide-out	Generator movement by use of a gantry system with longitudinal roadways	Generator movement by use of a cantilever system



Machines, Future developments and Innovations

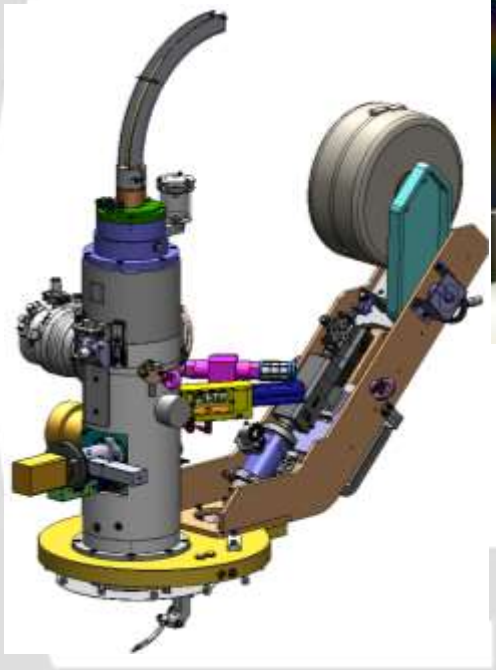
3D-Metal Additive Manufacturing

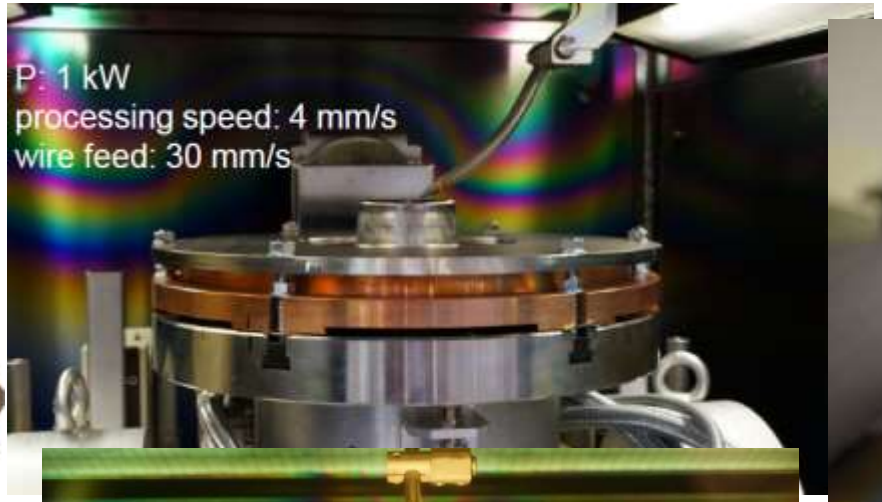
EBOPRINT

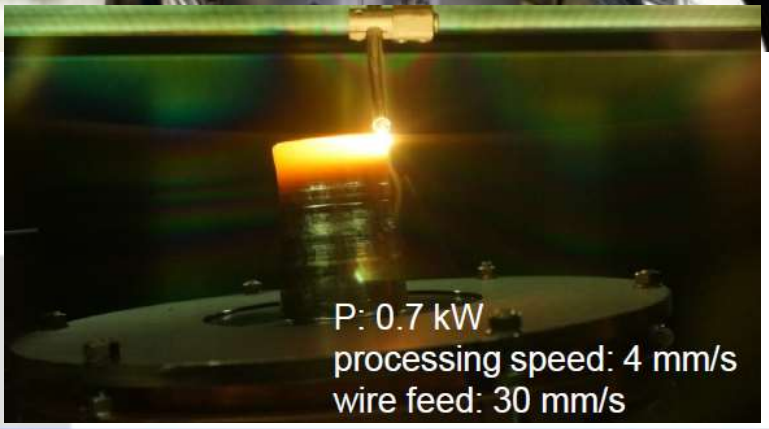
- Speed up to 10kg per hour
- Materials: e.g. Titanium, Inconel, Stainless Steels, Niobium…

Machines, Future developments and Innovations

EBOPRINT







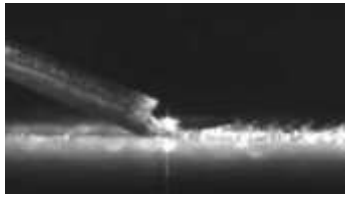
Machines, Future developments and Innovations

Additive Manufacturing

Built-up welding at STATOR VANES

Built-up welding is used for

- Repair of damaged parts
- Adding of resistant materials in areas with high mechanical stress

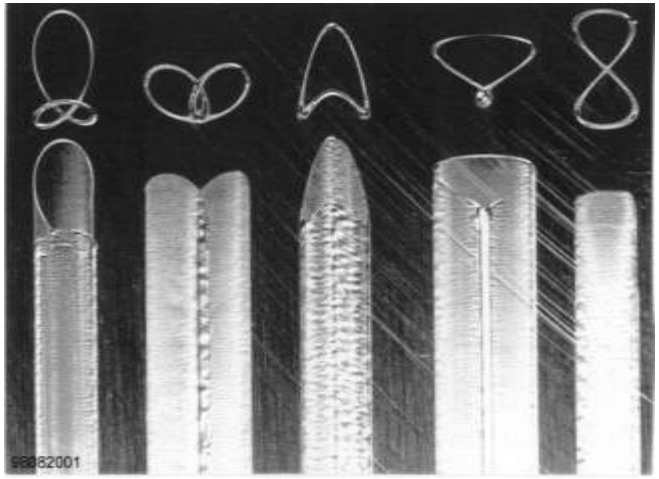


Machines, Future developments and Innovations

Beam Deflection

Standard beam deflection

- frequency up to 10kHz
- creation of beam patterns



Advanced beam deflection

EBO Deflect

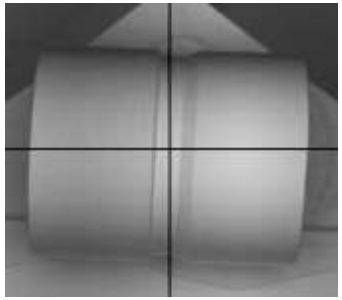
- Analogue amplifiers

EBO Jump

- Digital amplifiers

Allows functions like

- Joint tracking
- EO picture
- Automatic beam adjustment
- …



Machines, Future developments and Innovations

Advanced DIGITAL beam deflection → EBO Jump

<u>Technical data (for 150 kV generators)</u>

- Raster size at working distance 300 mm
  80 mm x 80 mm
- Pixel count per Figure up to
  2000 x 2000Pixel
- EBO Jump → Pixel frequency (creating deflection patterns)
  ≤ 1 MHz
- EBO Jump → Beam jump-frequency (between positions)
  ≤ 200 kHz
- Deflection angle at 150kV
  ± 5,5°

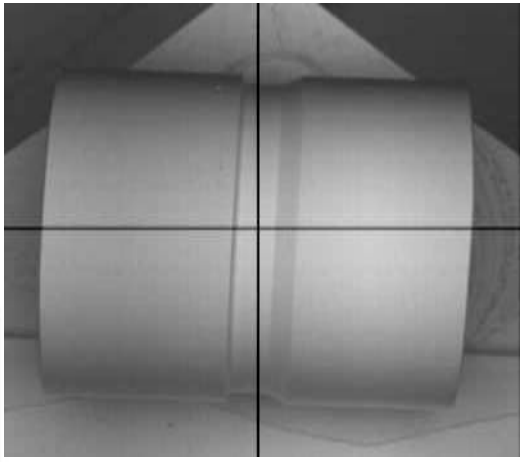
Machines, Future developments and Innovations

EBO Jump

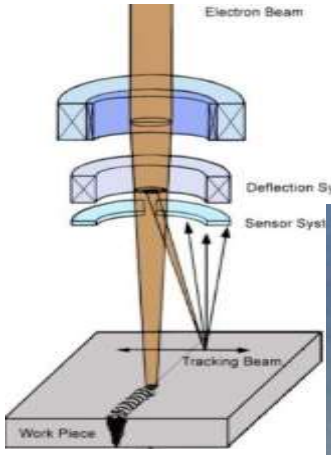
Multi process technology

Example:
Five simultaneous welds with different depth

Electron Optical viewing



Seam Tracking System

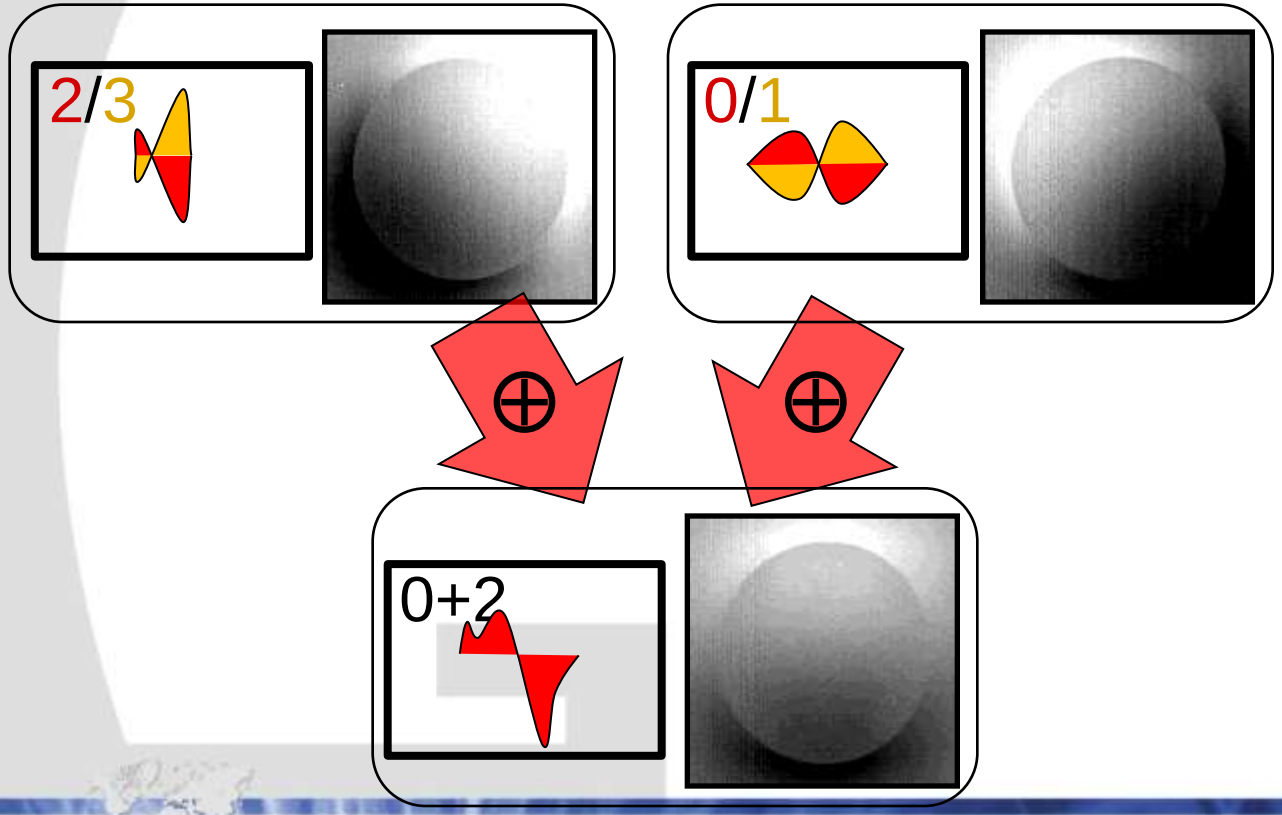


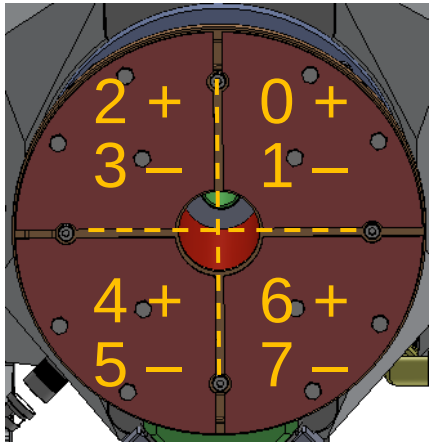
Deviations from the theoretical joint path are stored and corrected during welding by a deflected electron beam.

Improvement of Electron Optical picture:

→ Electron antenna with 4 sectors

→ Creation of 1 picture out of 4 single pictures

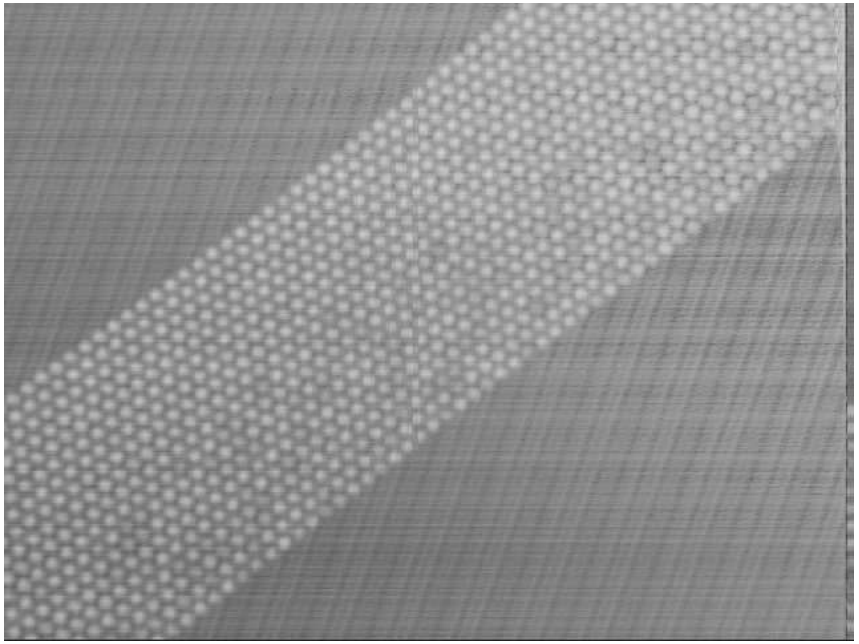




Machines, Future developments and Innovations

Sample Work Piece

125µm holes EB drilled

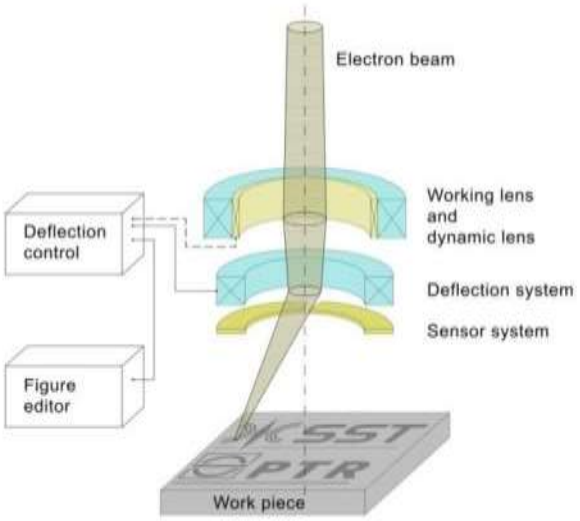


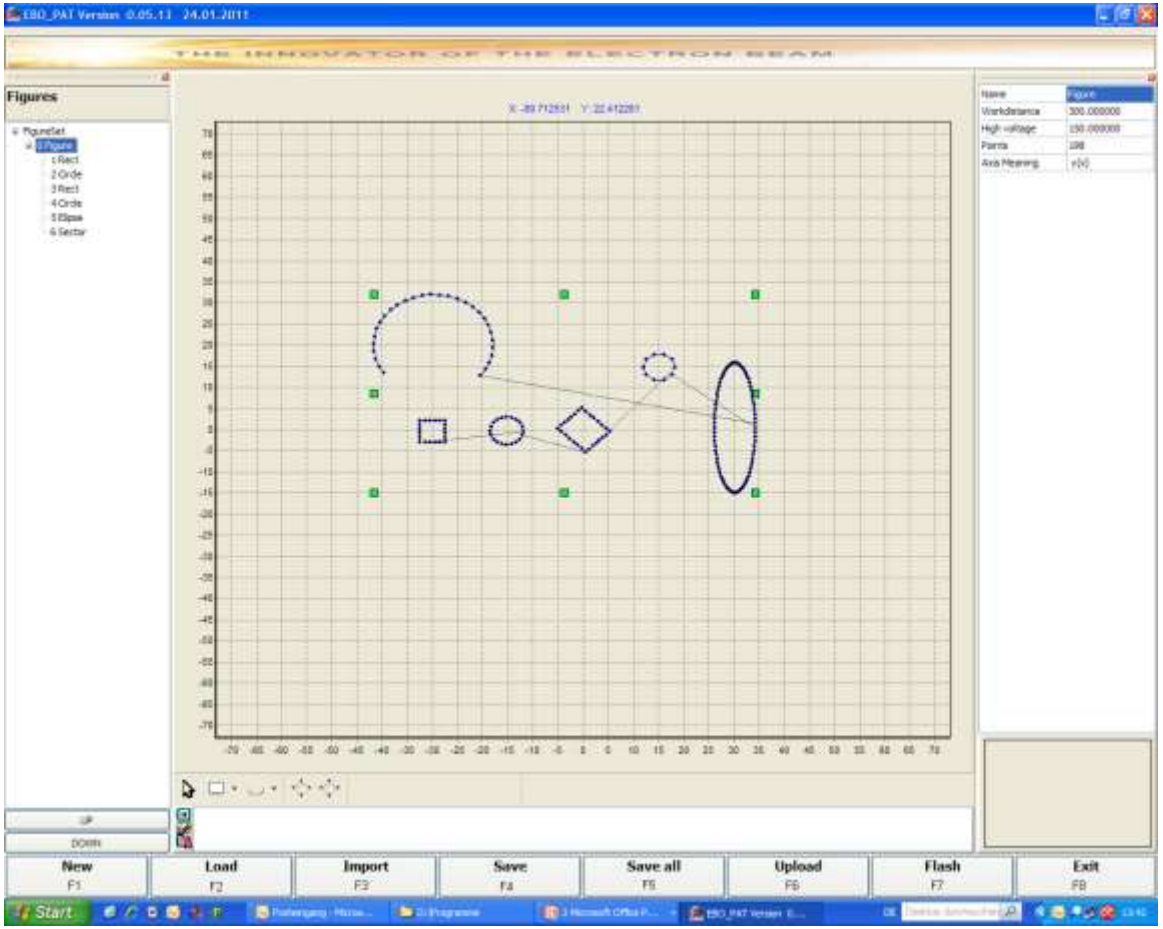
Optimized Dynamic Range / high resolution

Machines, Future developments and Innovations

EBO Pat

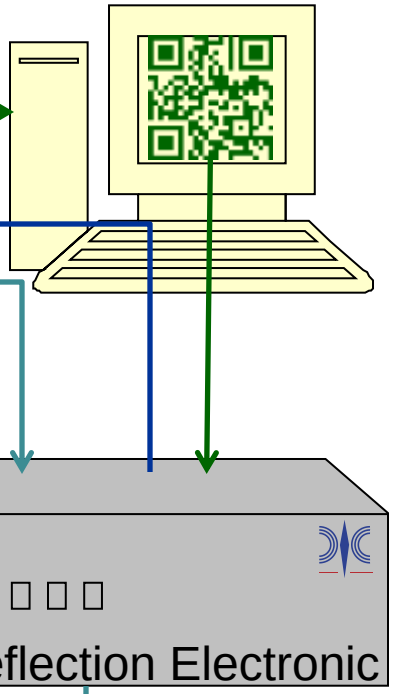
- allows users to define their own patterns
- loads images from files



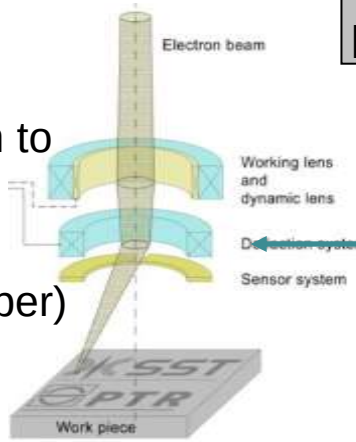


Online Pattern creation

```
N1000 …
N1010 PNr = RemPat(1,”S/N1234”)
N1020 AC_Set(PNr,15,15,2,0)
N1030 G00 SQ=AC(5) M03
N1040 G04 F=2
N1050 G00 SQ=AC(0) M05
N1060 …
```



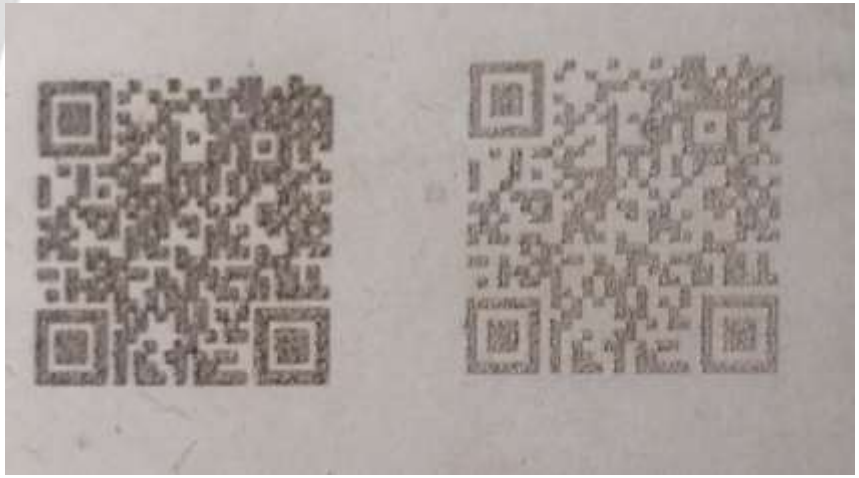
- CNC requests a pattern; optionally giving parameters (S/N, date, …)
- PC loads pattern from a file or runs a program to create the pattern requested
- Pattern is stored on deflection electronic and acknowledged to CNC (with new pattern number)



Machines, Future developments and Innovations

Pattern on aluminium

12mm x 12mm

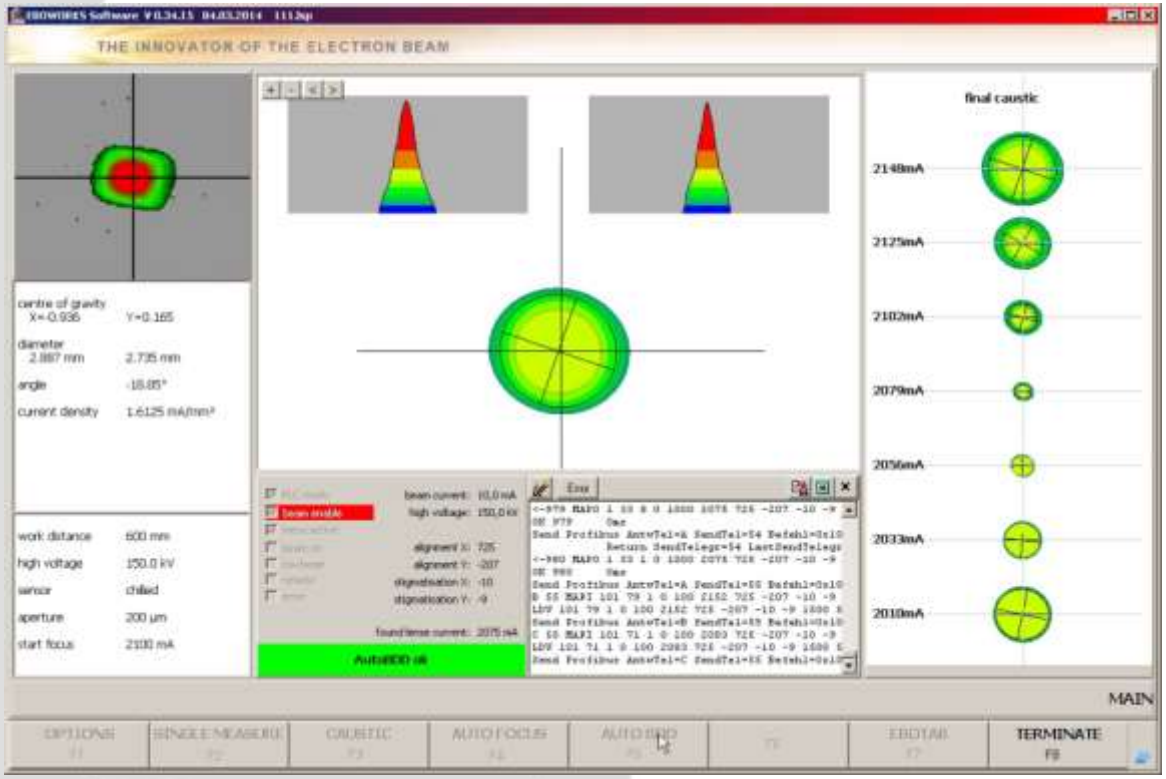


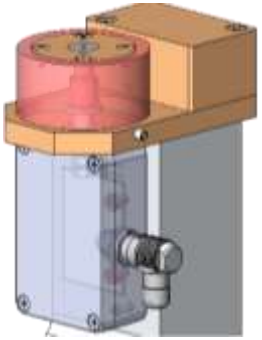
Pattern on stainless steel

14mm x 14mm

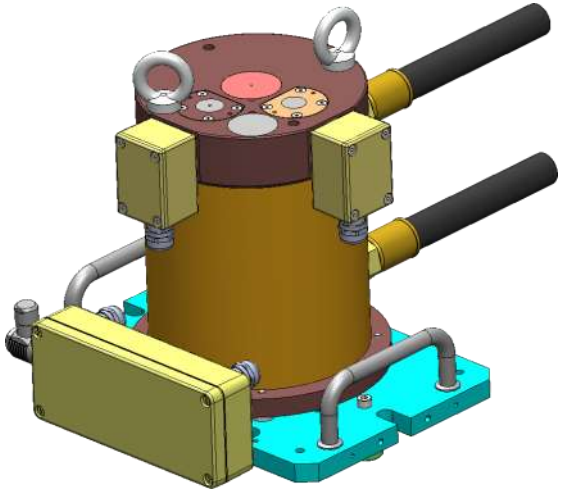
EBO Set - Automatic beam adjustment

- Measuring of the power density distribution up to 15 kW
- Automatic beam adjustment of focus spot and stigmator
- Archive of beam parameter and power density distribution





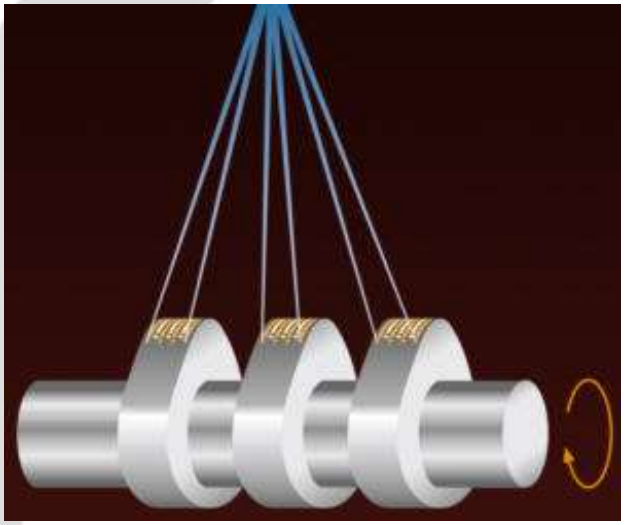
EBO Set 300

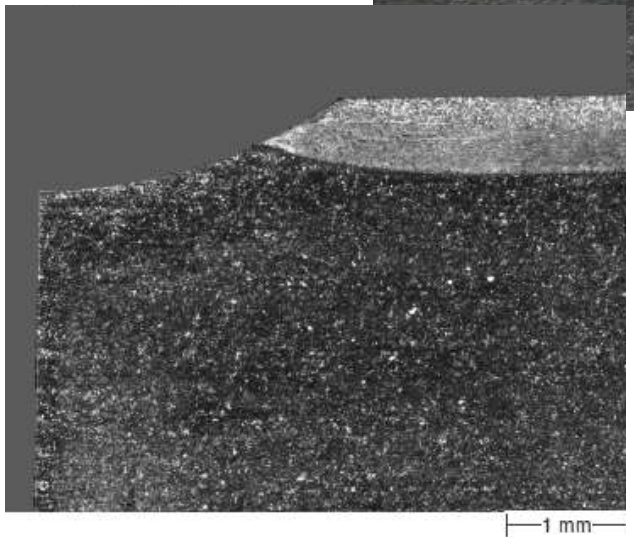


EBO Set 6k-60k

Machines, Future developments and Innovations

EB hardening and re-melting

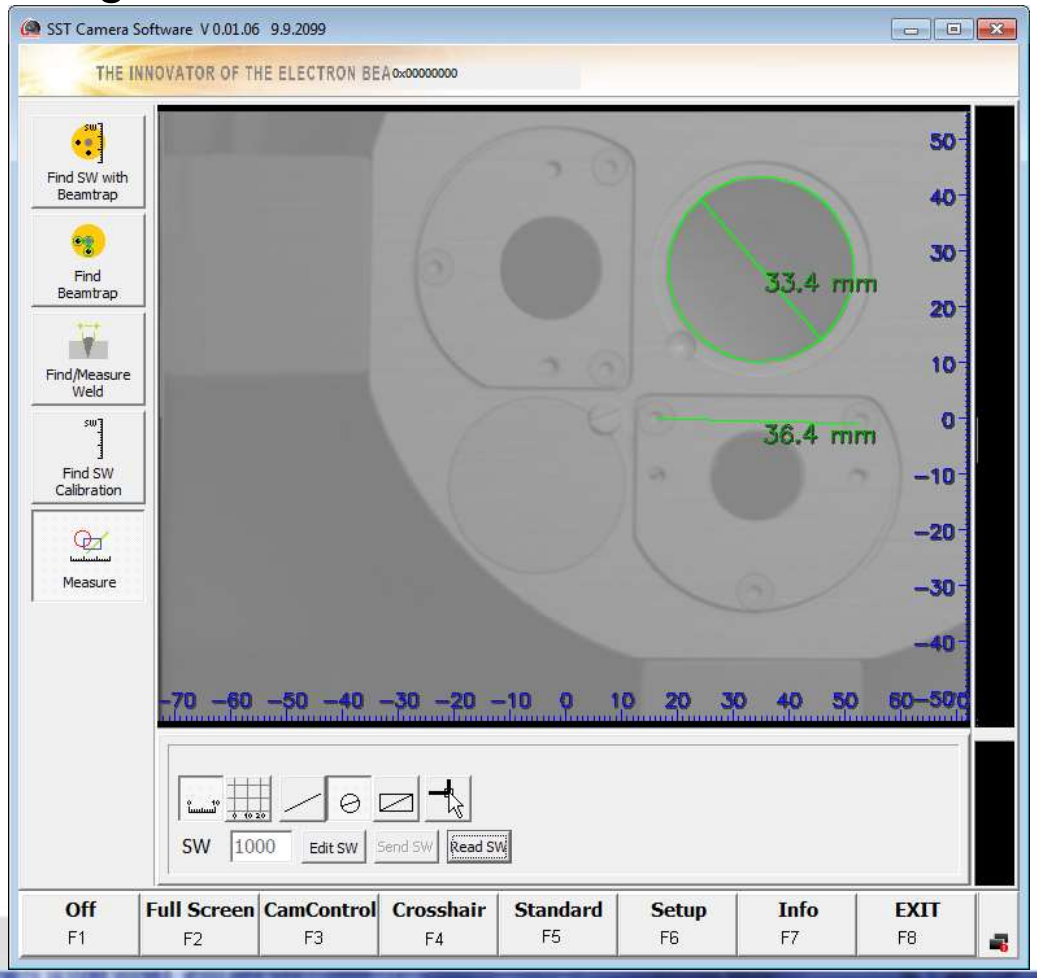




EB hardening of cam shafts and parts of shafts

Analysis Software for EO picture

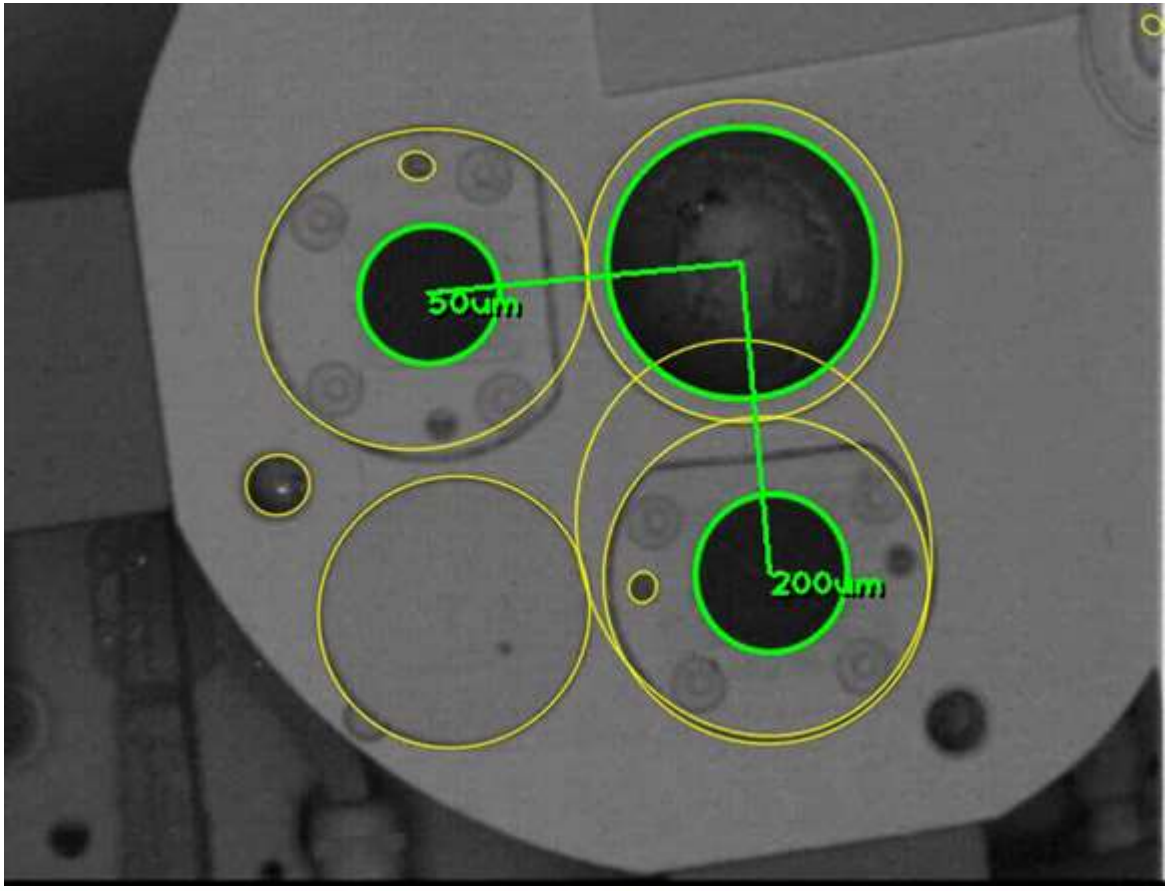
Image measurements



Analysis Software for EO picture

Part Recognition

- Finds features like circles and lines automatically from electron optical image
- Calculates position and size of features
- Verifies size ratios and relative positions



Machines, Future developments and Innovations

Analysis Software for EO picture

Positioning of Beam Trap

Thanks for your attention !