

High-gradient accelerator technology

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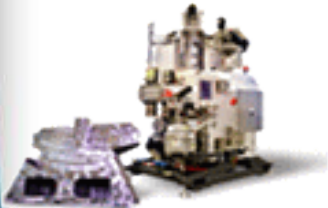
VDL Enabling Technologies Group (ETG)



1900 Philips Machine Factories



1980 Also Non-Philips Customers



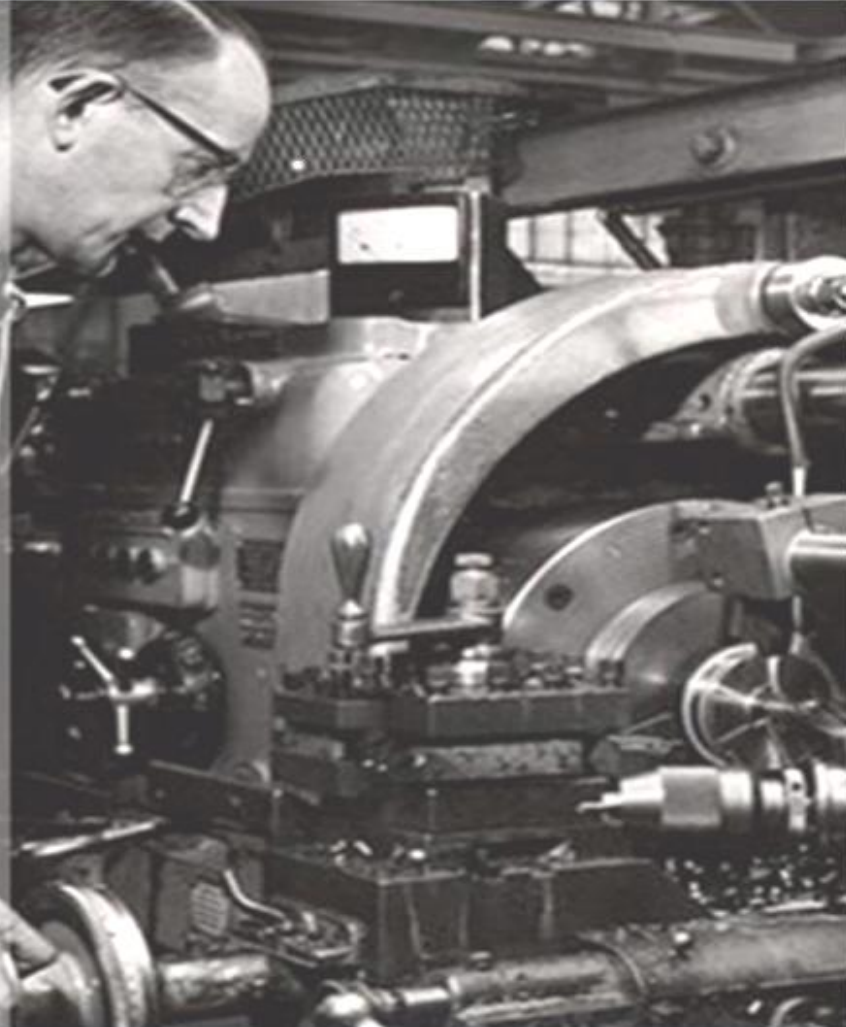
1990 Integrated Systems



2000 New name: Philips ETG



2006 ETG part of VDL Group



Locations



EINDHOVEN

Series manufacturing & assembly
High volume



Eindhoven

Turn-key & built-to-print mechanization
Low-medium volume



Projects

Proto type manufacturing & assembly
Low volume



Research



ALMELO



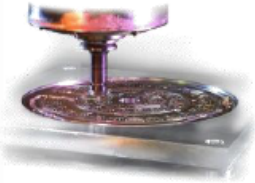
SINGAPORE



SUZHOU

Core Technology Competences

Machining



- ✓ Modern turning and milling centers
- ✓ Multi-axis complex geometry machining
- ✓ Joining technologies
- ✓ Advanced materials technology
- ✓ Vacuum technology
- ✓ Ultra precision technology

Sheet metal



- ✓ Modern sheet metal centers
- ✓ Complex frame production
- ✓ Vacuum and specific welding methods
- ✓ Production of covering including painting
- ✓ Advanced materials technology

System integration and assembly



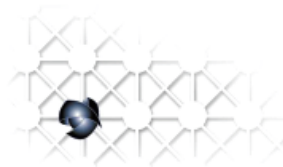
- ✓ Clean room and non clean room assembly
- ✓ Assembly of modules and complete systems
- ✓ Final test of complete systems and modules
- ✓ Process control and validation

Engineering



- ✓ (Co-) Development and engineering
- ✓ Project management (Six Sigma, Prince 2)
- ✓ Design and product optimization (DFX)
- ✓ Sustaining of product documentation
- ✓ Access to Philips resources and Technical Campus
- ✓ Long-standing relationships with knowledge institutes

Supply-chain management



- ✓ Supply chain control and optimization
- ✓ Flexibility
- ✓ Lead-time road-mapping and lead time reduction
- ✓ Break-even point reduction

Property right

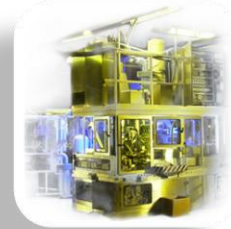


- ✓ Intellectual property right protection
- ✓ Production under license

Core Technology Markets



Semiconductor Capital Equipment



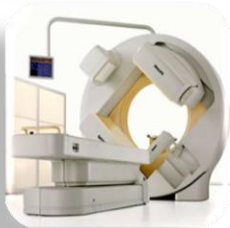
Turn Key Projects



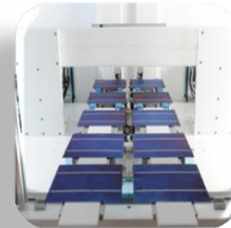
Analytical Equipment



Led Manufacturing Equipment



Medical Equipment



Solar Production Equipment



Science & Technology

The Science & Technology Segment

- ✓ Astronomy
- ✓ Accelerators



Competences for S&T - Manufacturing

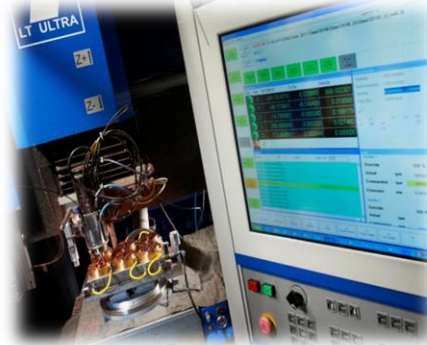
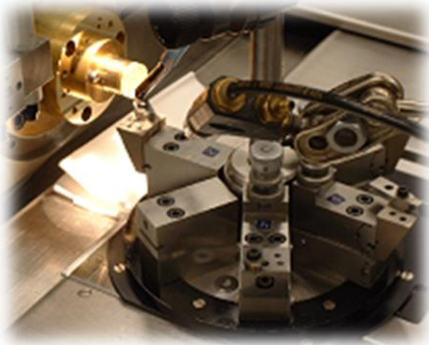
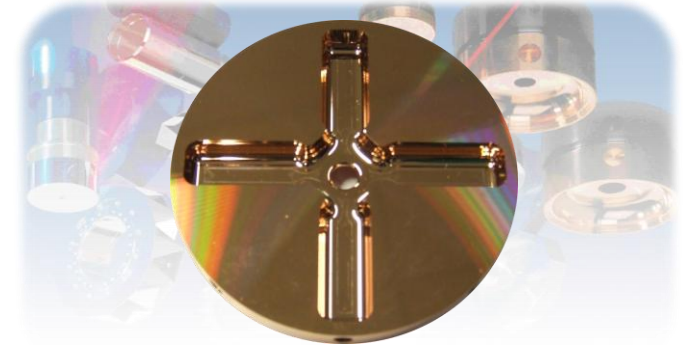
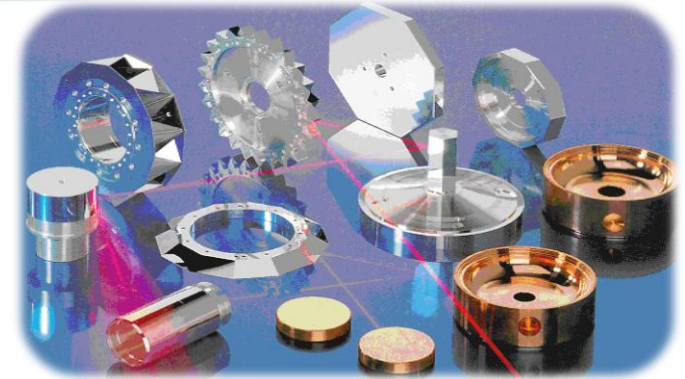
Machining

✓ Single Point Diamond Turning

- Form accuracies $< 0.1 \mu\text{m}$
- Surface finish better than 5 nm Ra
- 2/3 axis and freeform capabilities

✓ Single Point Diamond Milling

- Form accuracies $< 1 \mu\text{m}$
- Surface finish better than 25 nm Ra
- Up to 5-axis capabilities
- Pallet machining of micron accuracy parts

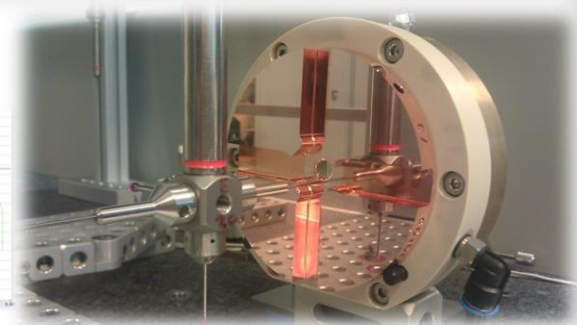
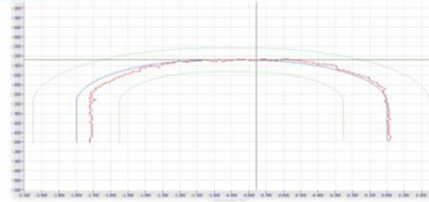


Competences for S&T - Measuring

Metrology

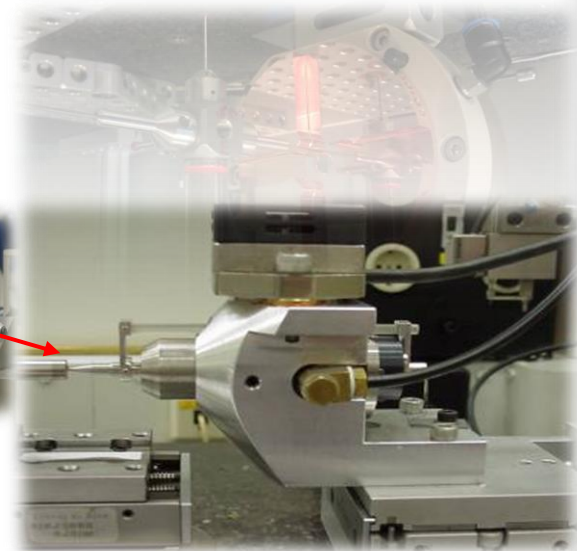
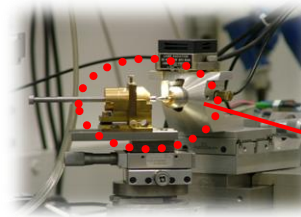
✓ 3D- metrology

- 3D CMM × 0.8 μm accuracy × low measuring force
- Multi sensor CMM × camera / touch probe / laser



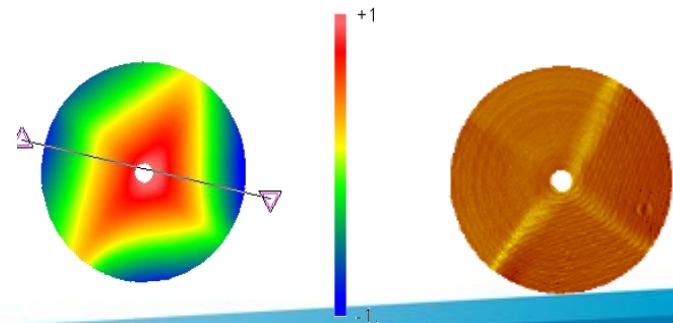
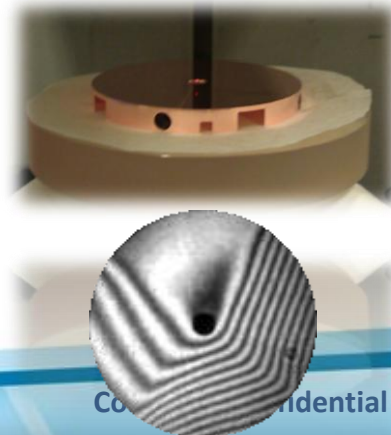
✓ Profilometry

- Surface finish measurements
- Form measurements (2D and 3D)



✓ Optical measurement techniques

- Surface finish and step heights
- Flatness (up to $\varnothing 100$) and form



Parts for SwissFEL

✓ X-band structure

- All 4 structures delivered

✓ Gun

- Delivered – currently under test
- Potential second as spare e.o. 2014

✓ BOC Pulse compressor

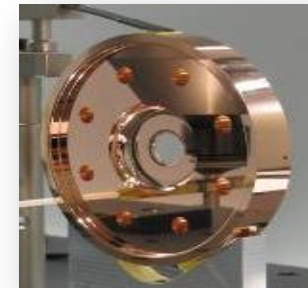
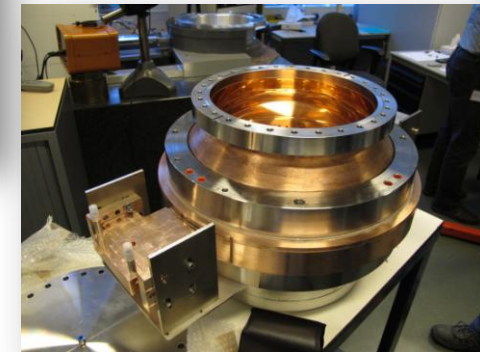
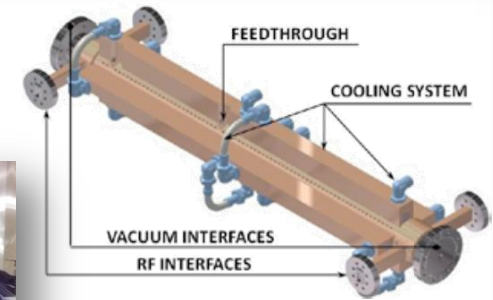
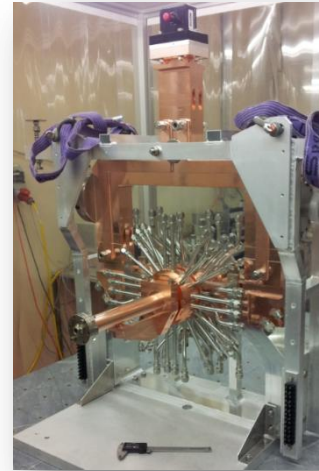
- Prototype delivered
- Series of 28 in-house by PSI

✓ J-couplers

- 7 prototype sets delivered
- **Series production of 104 sets**

✓ H-tassen

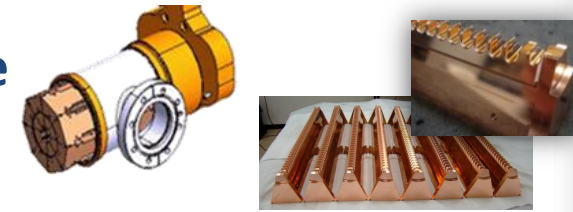
- 1 prototype set delivered
- **Production of 4 more structures**



Parts for CERN CLIC

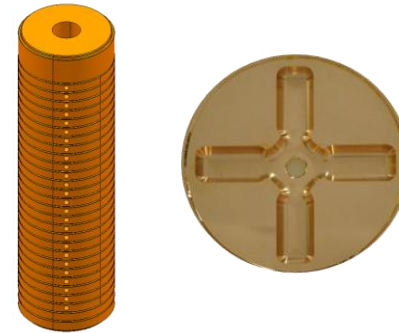
✓ Octants for Power Extraction & Transfer Structure

- Several structures delivered



✓ Disks for Acc.-structure

- Several prototype designs delivered
- 8 TD26 structures delivered

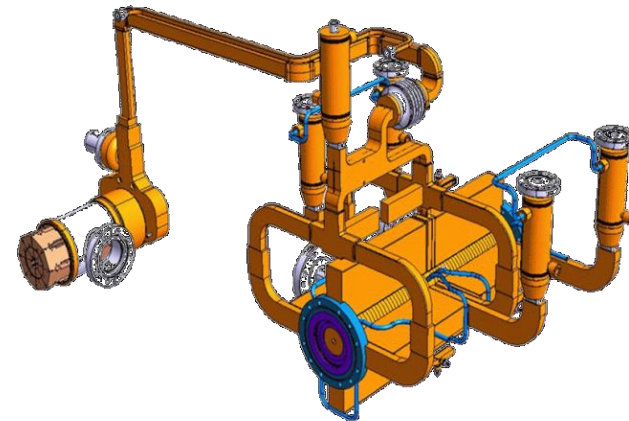


✓ High power loads

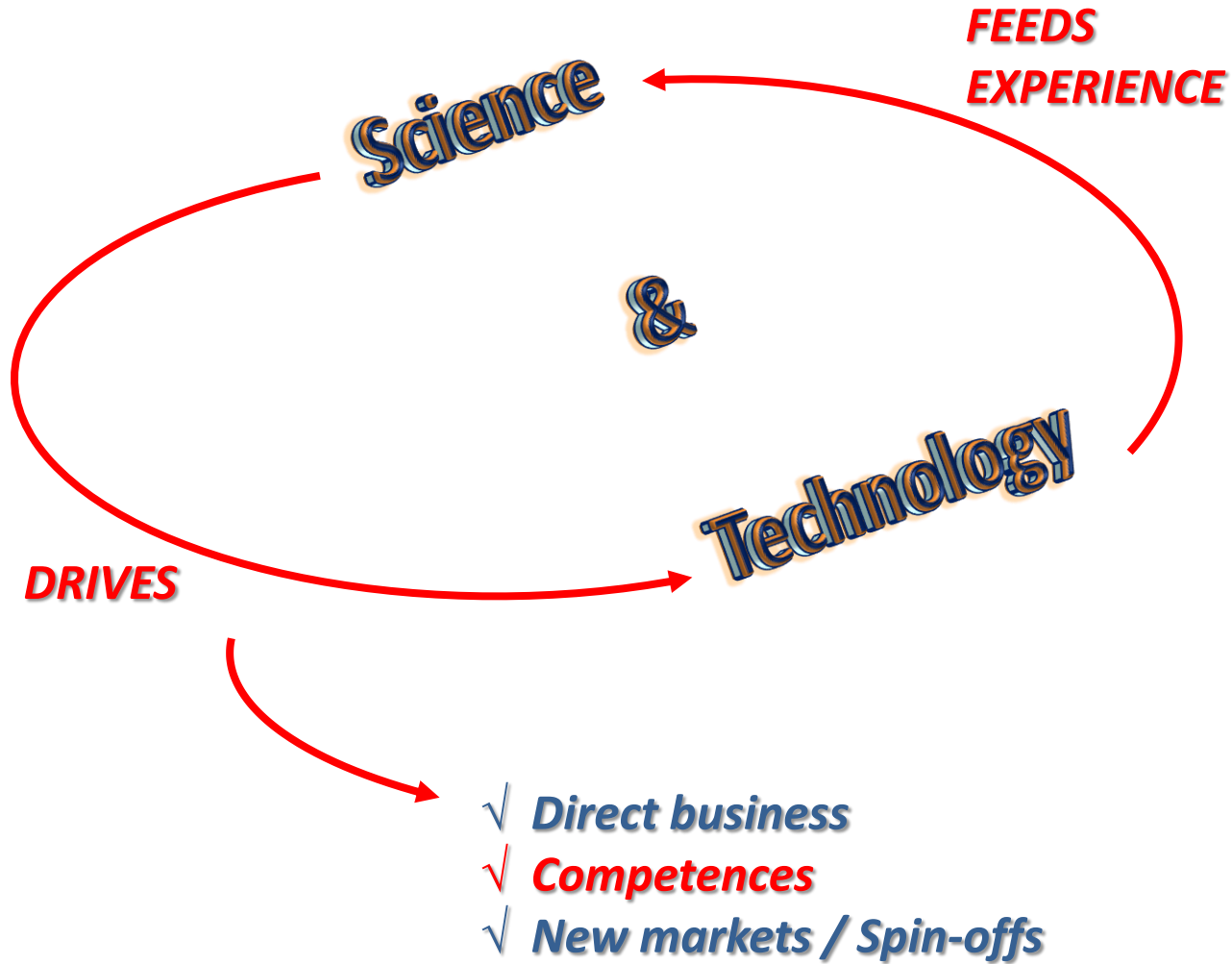
- Several structures delivered

✓ RF-network components delivered

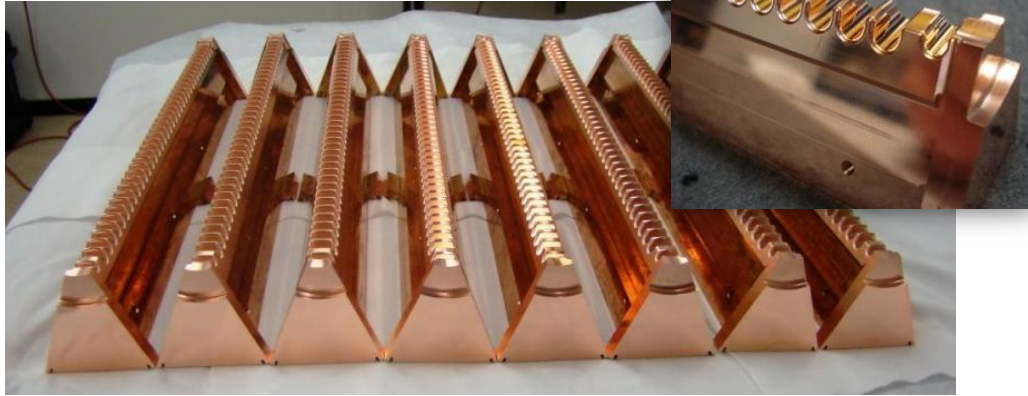
- Splitters
- Directional couplers
- Pumping ports
- Flanges



Drivers for Industry



Improving existing machining techniques



Form	12 μm
Ra	50 nm

Length	500 mm
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Form	2 μm
Ra Iris	5 nm
Ra Cross	25 nm

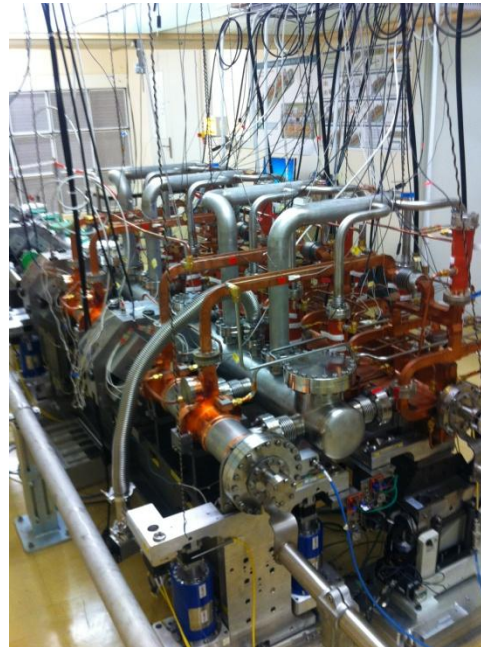
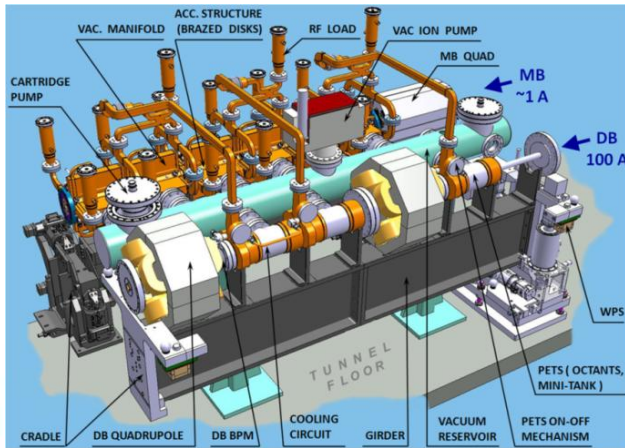
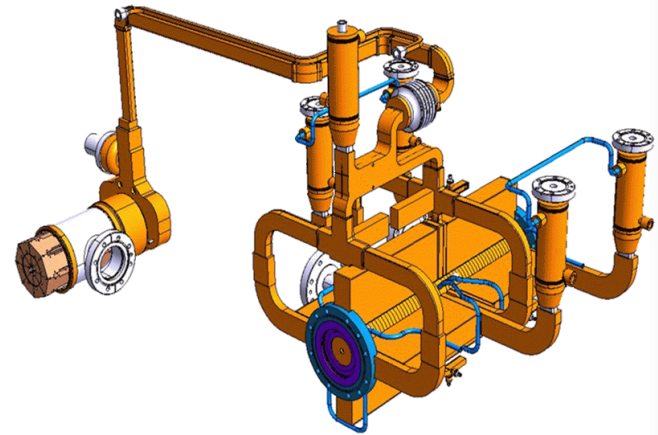
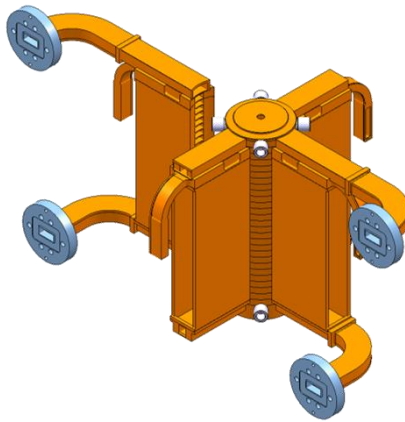
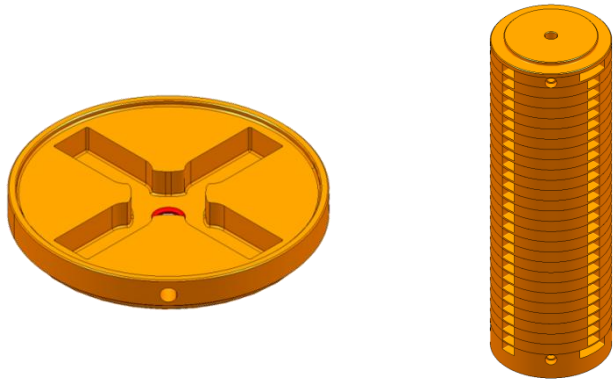
Diameter	80 mm
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Form	5 μm
Ra	25 nm

Length	200 mm
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From mono-parts to (sub)assemblies



CLIC at 500 GeV (4248 modules)

26312 Accelerating structures

13156 PETS

~ 70000 RF components

CLIC at 3 TeV (20924 modules)

142812 Accelerating structures

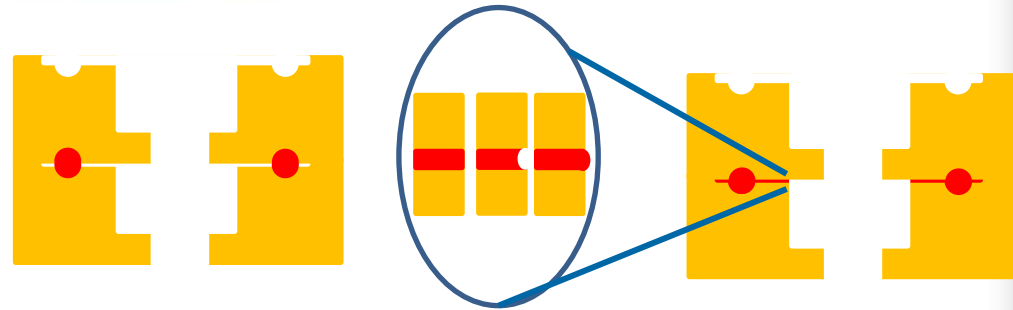
71406 PETS

~ 400000 RF components

Develop / obtain new techniques

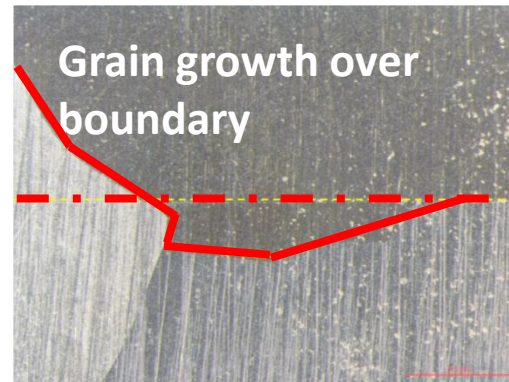
✓ Vacuum brazing

- Increasing number of steps
- Various brazing materials
- Complex geometries



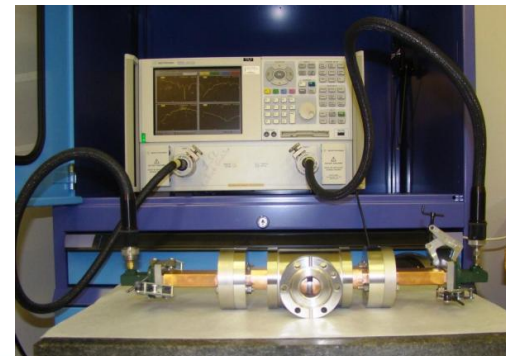
✓ Hydrogen bonding

- **Developed within science**
- Promising for main stream
- Highly specialized equipment

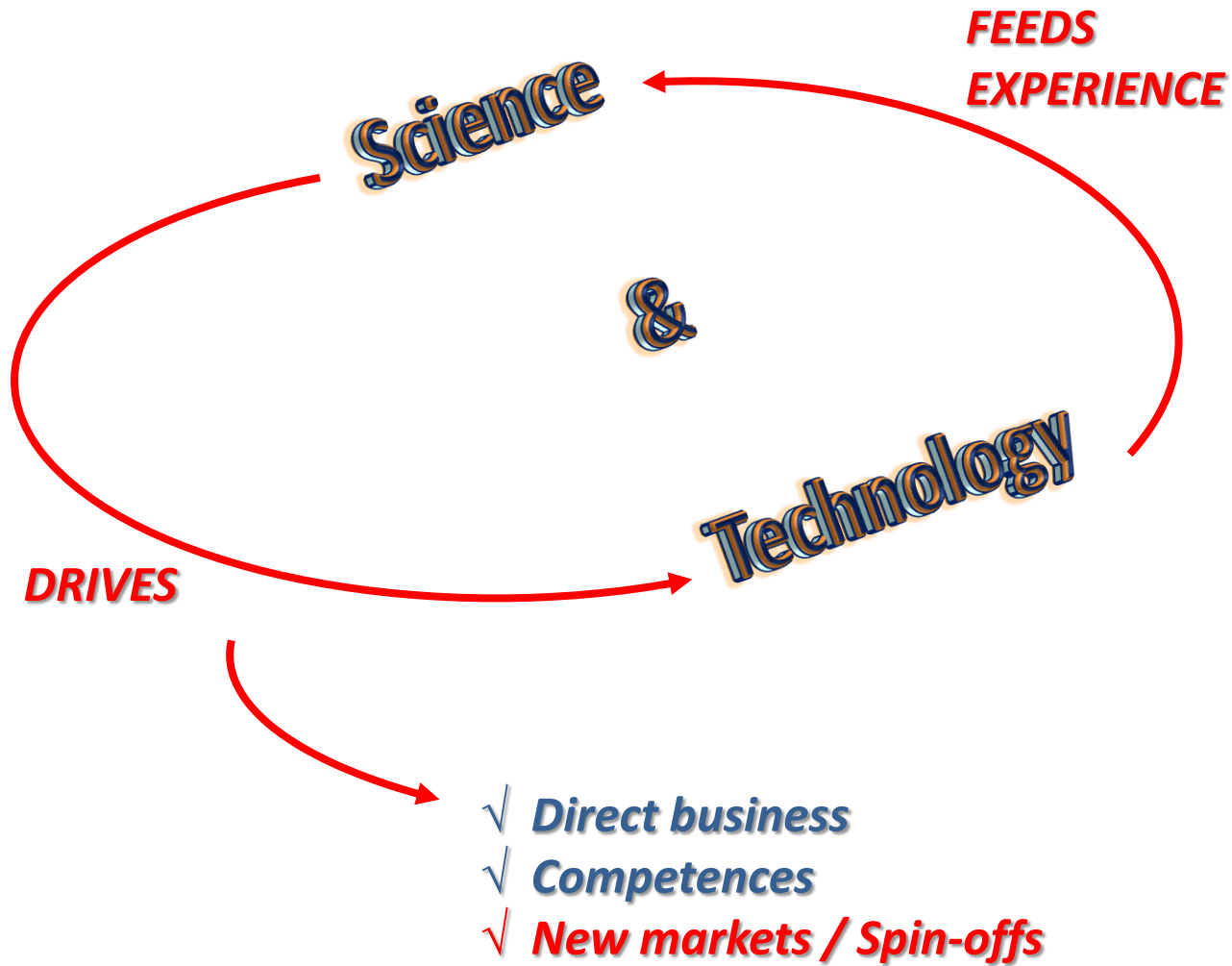


✓ In-house RF testing

- Key for delivering entire RF-structures



Drivers for Industry



High Gradient Accelerator Spin-off

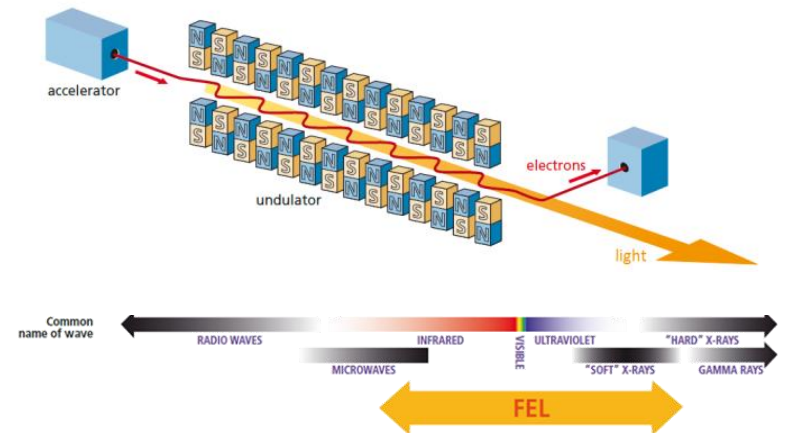
Proton therapy of tumors

- 5% of tumors not cured by classic radiotherapy
- Potentially cured by proton therapy



Free electron laser:

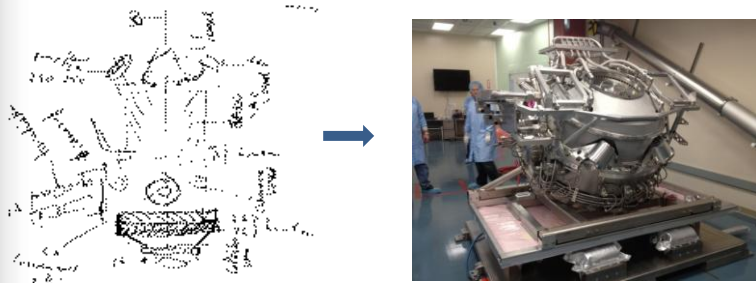
- Bright light source
- Wavelengths from infrared down to x-ray



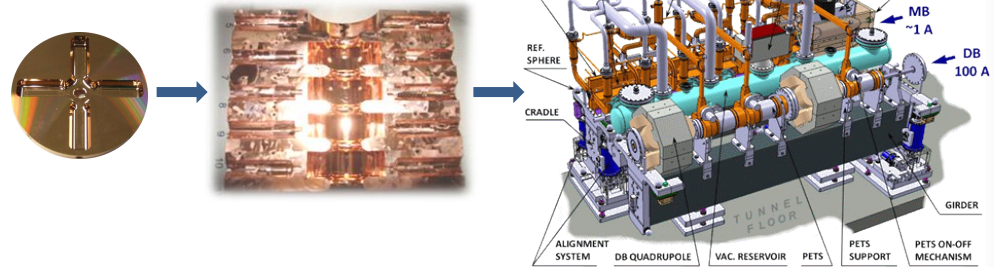
Benefits for science

✓ Time to market

- Co-development & rapid proto typing
- Increased complexity requires higher level outsourcing



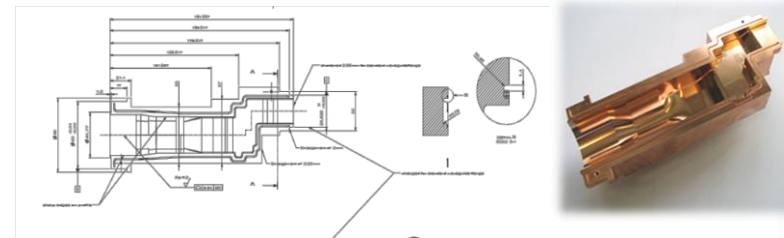
EUV light source : from idea to product in 1 year



CLIC (future): from cell over bonding to (ultimately) complete module

✓ Industrialization

- Early customer involvement
- Cost control & risk reduction
- Co / Redesign for manufacturability



Straight mode converter - from 16 to 2 parts

✓ Spin offs

- Increased market size for technologies → Cost reduction
- Show public relevance of fundamental research → Funding



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