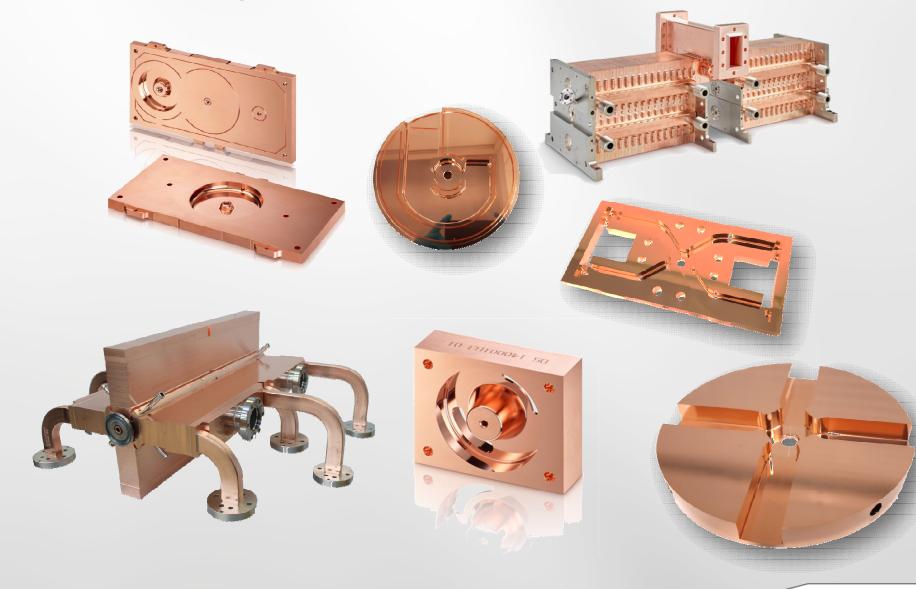


## **VDL ETG Science and Technology**

- Space
- Astronomy
- Accelerators

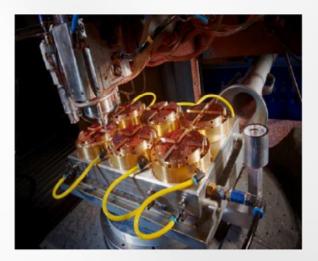


VDL Groep



### Most relevant competences are in-house

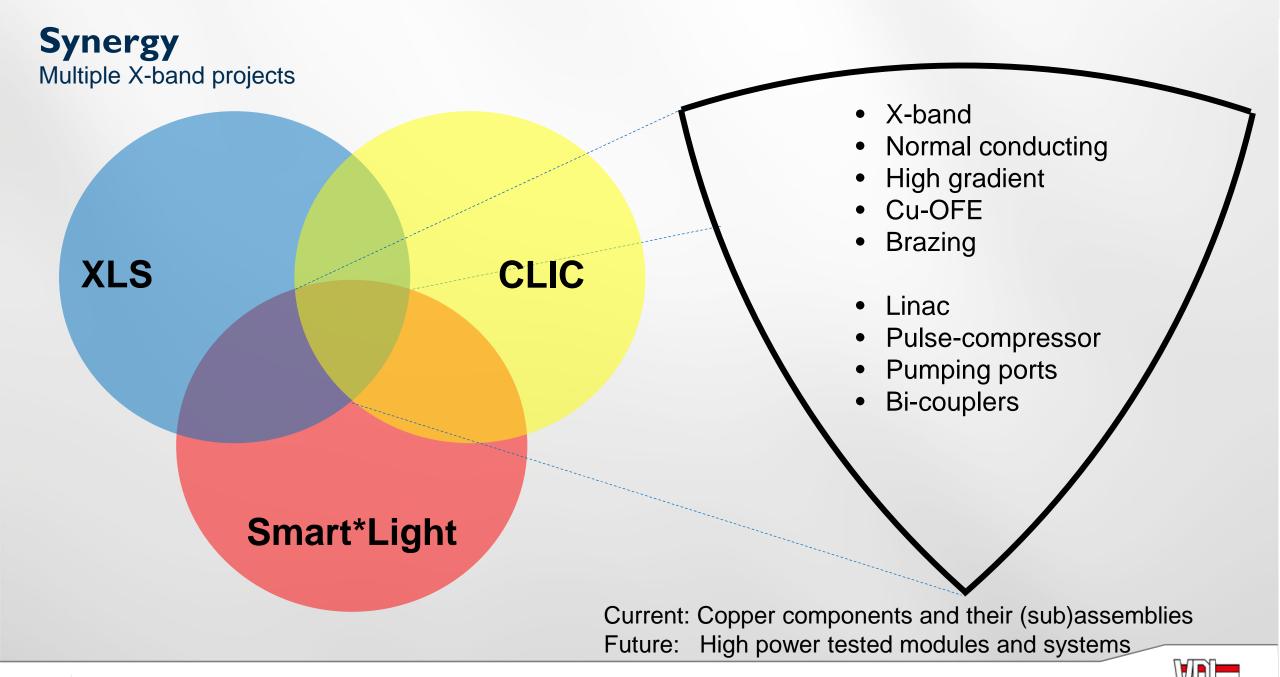
- High Precision Machining (HPT)
- Ultra High Precision Machining (UPT)
- Metrology
- Sheet Metal
- Welding/Vacuum Brazing
- Vacuum Technology
- Clean room assembly
- Electromagnetic technology
- Functional frames
- **Complex Assemblies**
- Cleaning
- Functional qualification
- Engineering
- Industrialization & Redesign











### Current academic projects fuel commercial projects

#### **VDL** involvement

- Smart\*Light
  - System design
  - Manufacturability
  - Business development
- CERN CLIC
  - "Technical Questionnaire for Industrialization study of CLIC 380 GeV accelerating structures production"

**VDL** Groep

- XLS
  - WP4.2: Industrialisation



Comparable/overlapping development involvement

- → VDL to combine as much as possible
- → Projects to benefit from gained knowledge
- → Faster route to standardization in X-band technology



# **Spin-offs** Non X-band but comparable User experience and industrialization **Swiss-FEL XLS** CLIC Industrialization **AVO** New startups **Smart\*Light**



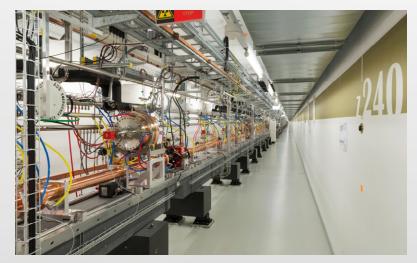
Similar except for frequency

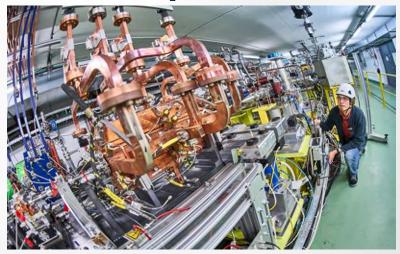
Knowledge transfer from

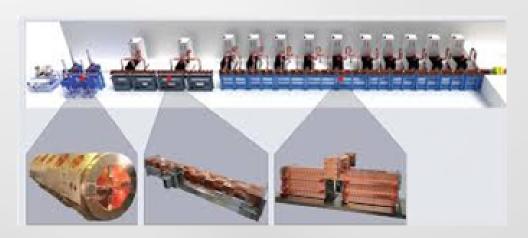
science to industry

### Requests to industry from spin-offs and start-ups

- Manufacturability
- Standardization → Modular design
- Series production on module level → system integrator
- Testing
- Cost optimization
- Business development









# **Joined development with academia**DfX

For a successful industrialization of a modular X-band accelerator system, a joined early development between industry and academia is essential.

Academia/science has fundamental and functional knowledge

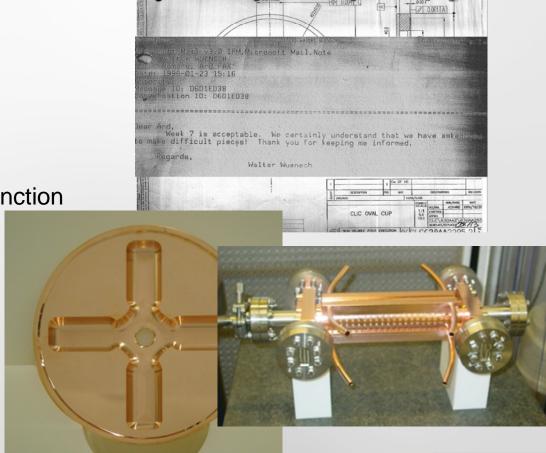
■ Manufacturing technology → relax tolerances where possible

Joining technology → brazing instead of bonding

■ RF testing → Relationship between geometry, tolerance and function

Tuning → reduce labor intensive manual tuning

Serviceability and End-of-Life decommissioning → design





VDL Groep

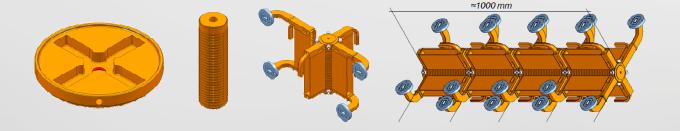
### Contribution to XLS; WP 4.2 Industrialization

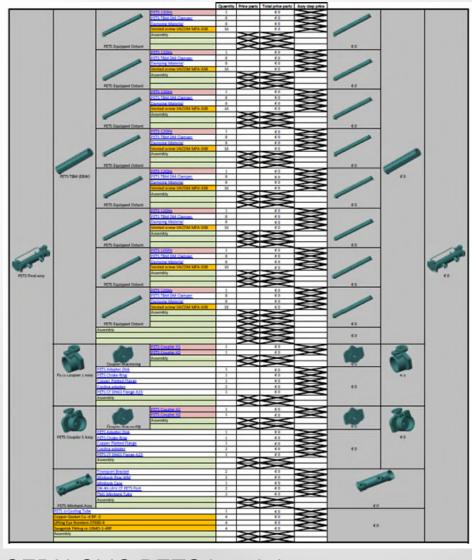
- Investigate design of mono-parts i.e. check manufacturability, industrialization
- Assembly breakdown of brazed sub-assemblies
- Cost driver breakdown of entire RF-section
- All limited to functional RF parts i.e. accelerator, pulse-compressor, bi-couplers, pumping ports, splitters



### **Approach XLS**

- Breakdown accelerator module down to monoparts
- Cost drivers monoparts
- Cost drivers assembly to functional module
- Limited to functional RF parts i.e. accelerator, pulse-compressor, bi-couplers, pumping ports, splitters



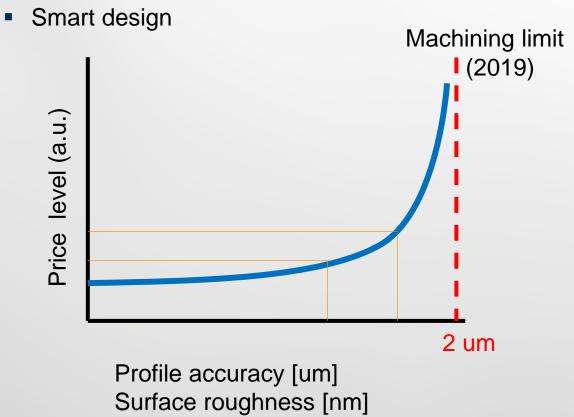


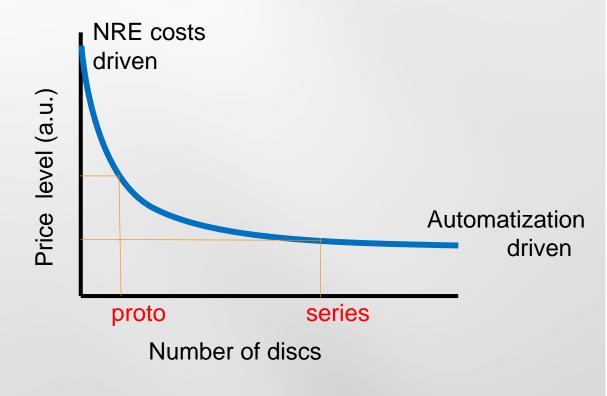
CERN CLIC PETS breakdown



### **Cost drivers mono-parts**

- Percentage of dimensional control i.e. 3D CMM time
- Material e.g. type, treatment and batch size
- Shape/profile accuracy and surface roughness
- Size of production volume







### Cost drivers accelerator assembly

Assembly accuracy and procedure i.e. manual stacking (CLIC) v.s. robot (SwissFEL)



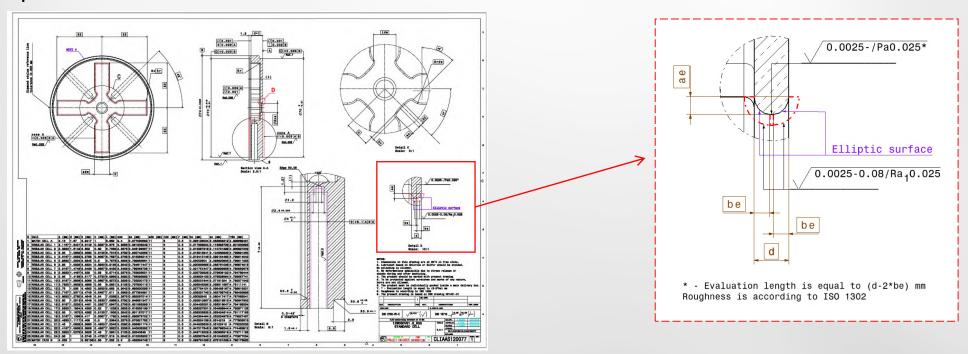


- Industrial maturity of joining technique i.e. bonding v.s. brazing
- Dimensional control i.e. CMM time
- RF-tuning i.e. cavity-by-cavity tuning (CLIC) v.s. accelerator stack tuning (SwissFEL)
- RF conditioning



### Input needed from RF design

- General dimension of RF-cavities e.g. iris diameter, nose-thickness, cell diameter, geometry, flatness
- Structure breakdown of RF system e.g. number of cells per accelerator unit, number of units per pulse compressor



Assumption after September 2019: Latest PSI design (x-band) in brazed structure as baseline

