



**Manufacturing Experience  
with Acceleration Structures**

**13 May 2008 @ KEK Tsukuba - Japan**

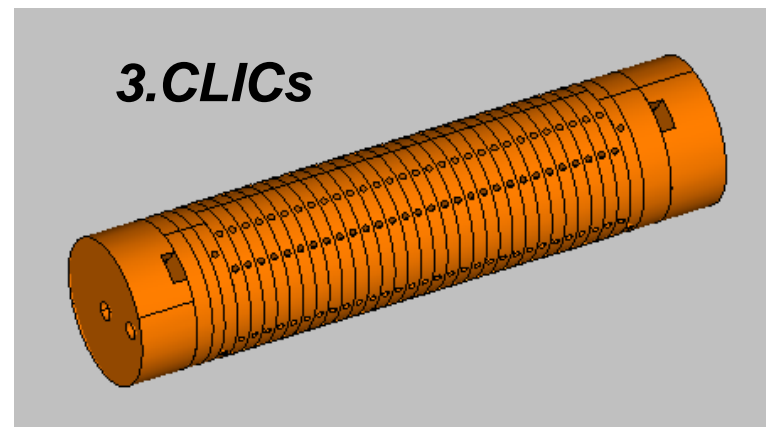
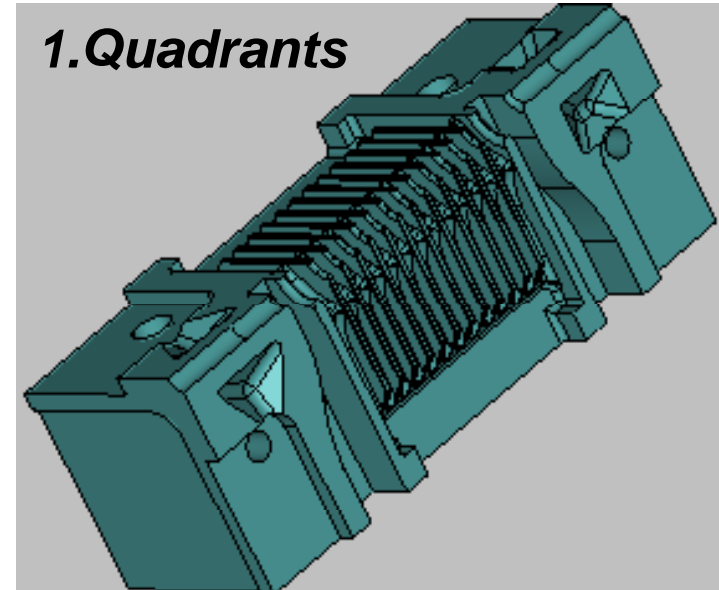
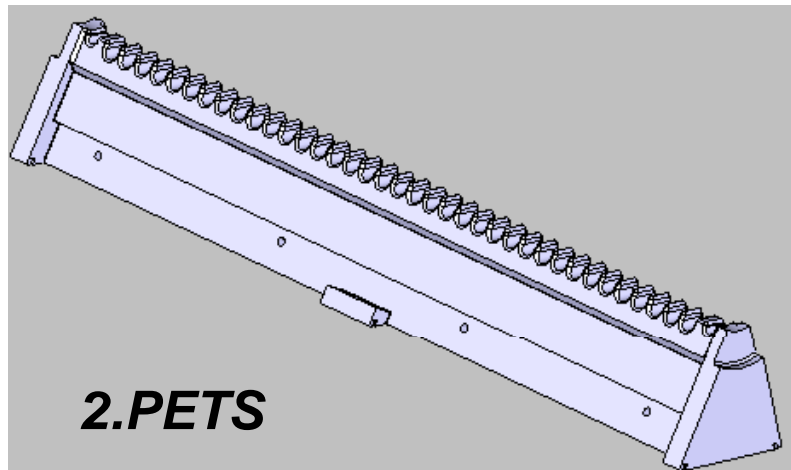
**Richard Zoetewey**

## 0. Short Intro on [VDL ETG Eindhoven \(NL\)](#)

- VDL Group is a private Dutch company, approx. 7000 employees
- **VDL ETG** is as a stand alone company part of VDL Group with approx. 1700 employees
- VDL ETG's major activities are:
  - Special Parts development and machining
  - Prototype manufacturing and volume production
  - Turn-key projects
- Key competence in high accuracy machining and assembly, such as:
  - Milling, turning, eroding, welding, brazing, assembly & measurement
- Today VDL ETG processes for CERN
  - Manufacturing and collaboration on acceleration structures, RF components & fatigue test samples

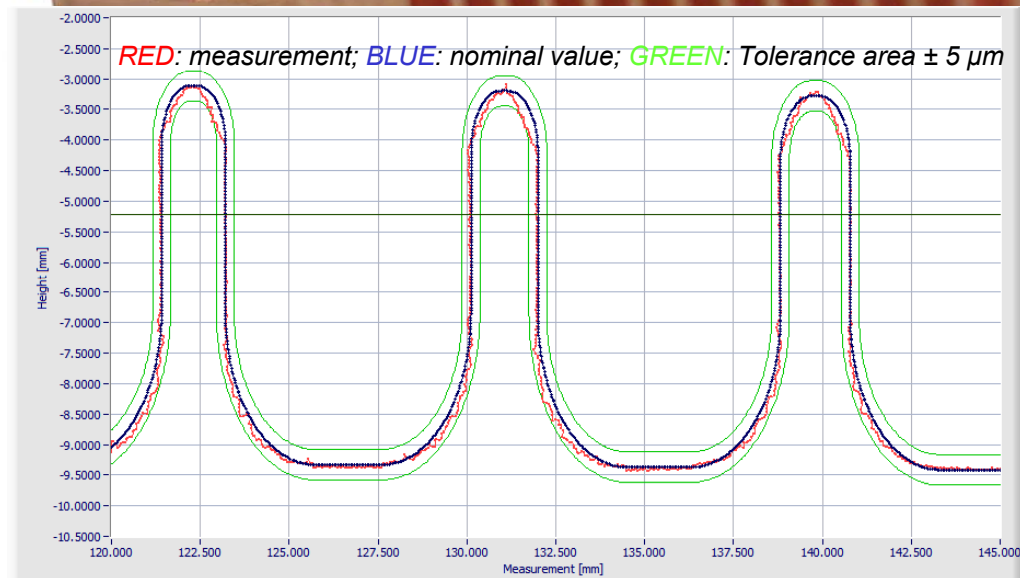
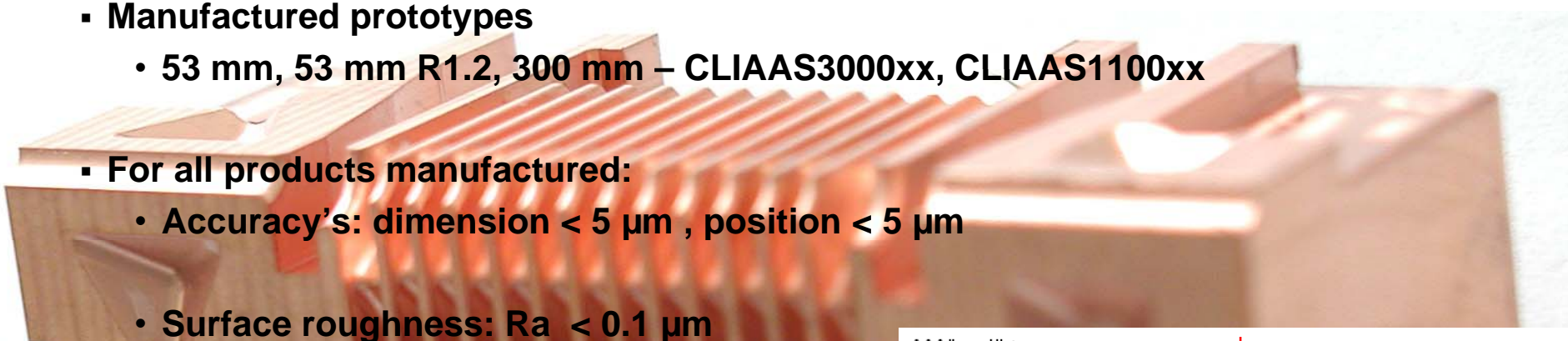


Index: different acceleration structures

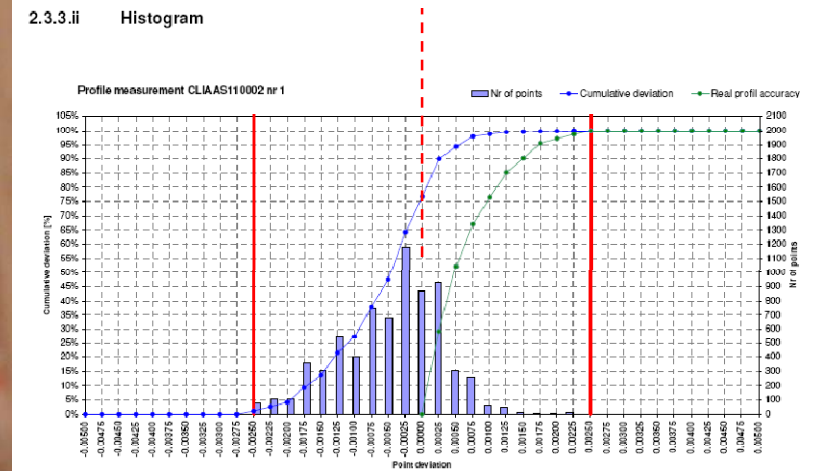


## 1.1.1 Quadrant Acceleration Structure: manufacturing experience

- **Manufactured prototypes**
  - 53 mm, 53 mm R1.2, 300 mm – CLIAAS3000xx, CLIAAS1100xx
- **For all products manufactured:**
  - Accuracy's: dimension < 5 μm , position < 5 μm
  - Surface roughness: Ra < 0.1 μm

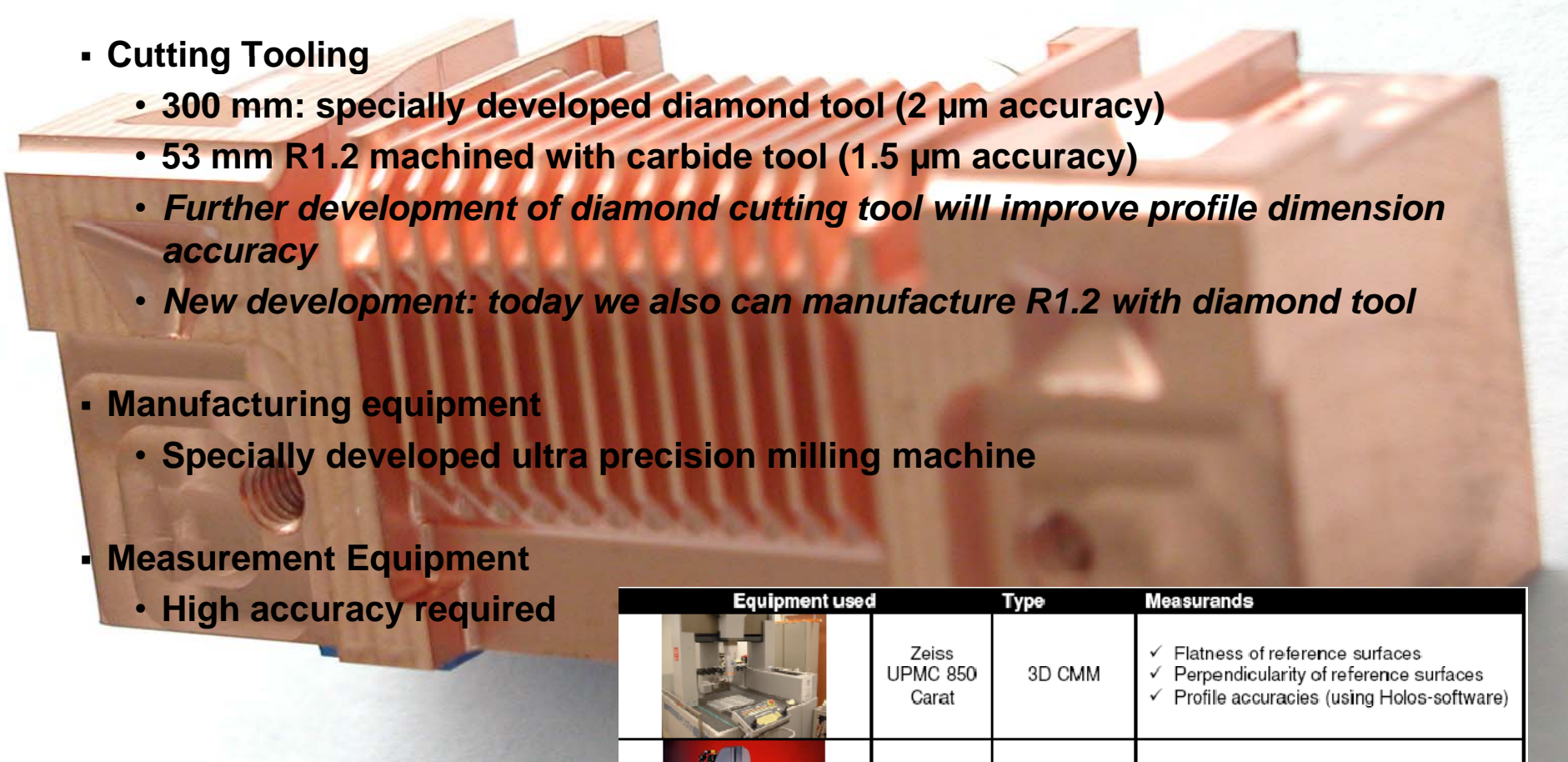




ZOOM profile CLIAAS110001



## 1.1.2 Quadrant Acceleration Structure: manufacturing experience

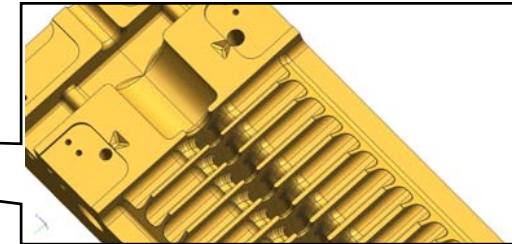
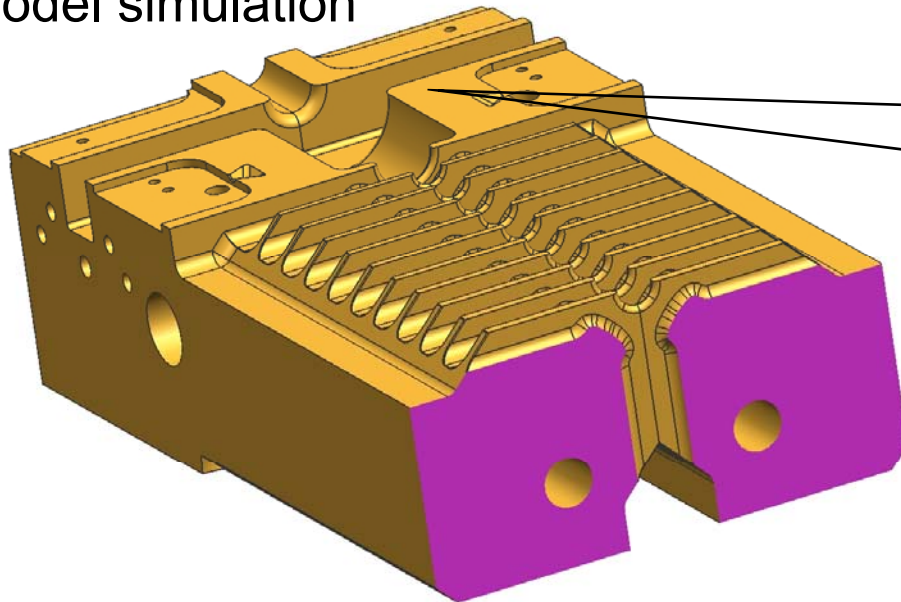
- **Cutting Tooling**
  - 300 mm: specially developed diamond tool (2  $\mu\text{m}$  accuracy)
  - 53 mm R1.2 machined with carbide tool (1.5  $\mu\text{m}$  accuracy)
  - *Further development of diamond cutting tool will improve profile dimension accuracy*
  - *New development: today we also can manufacture R1.2 with diamond tool*
- **Manufacturing equipment**
  - Specially developed ultra precision milling machine
- **Measurement Equipment**
  - High accuracy required



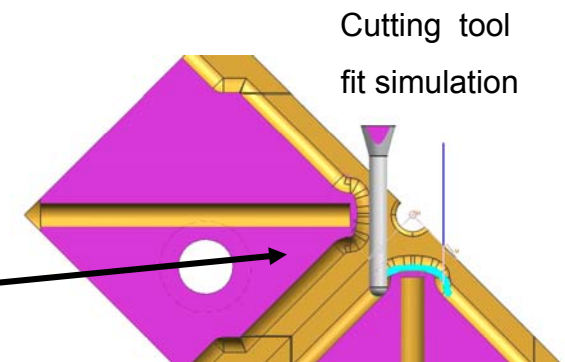
Equipment used	Type	Measurands
	Zeiss UPMC 850 Carat 3D CMM	<ul style="list-style-type: none"> <li>✓ Flatness of reference surfaces</li> <li>✓ Perpendicularity of reference surfaces</li> <li>✓ Profile accuracies (using Holo-software)</li> </ul>
	Zygo Newview 5032 White light interferometer	<ul style="list-style-type: none"> <li>✓ Roughness of milled surfaces</li> </ul>

## 1.2.1 Two Halves Acceleration Structure

- 3D-Model simulation



- Simulation profile machining halve structure
  - DONE, tested for manufacturability



## 1.2.2 Two Halves Acceleration Structure

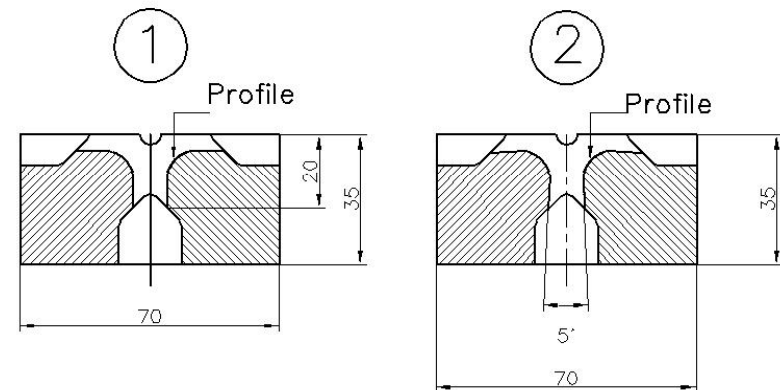
- Expectations compared to quadrant (300 mm)
  - Manufacturing time: 25% longer as for 2 quadrants (more steps)
  - Accuracy: more accurate in positioning complete structure
  - Design optimization: VDL propositions to be discussed with CERN, could lead to a shorter manufacturing time then for quadrants. Would also be a good preparation for future volume manufacturing

- Proposal 1

- Manufacture in 1 clamping
- Straight short damping groove run-out
- High manufacture accuracy possible
- Shape ready for volume manufacturing

- Proposal 2

- Manufacture in 2 clampings
- Conical damping grooves (5°)
- Less accurate then proposal 1
- More difficult for volume manufacturing



- Structure cost: with design optimization proposal, could be 15% cheaper as 2 quadrants

## 1.3 Quadrant Super Structure (500 mm)

- Design
  - To be developed by CERN (summer 2008?)
- Expectations vs 300 mm quadrant
  - Accuracy
    - Comparable, is  $< 5 \mu\text{m}$
  - Surface roughness
    - Comparable, is  $R_a < 0.1 \mu\text{m}$
  - Tooling behaviour
    - Lifetime diamond to be tested, depending on structure profile. VDL expects it's possible.
  - Manufacturability
    - Comparable, but additional annealing steps are required !

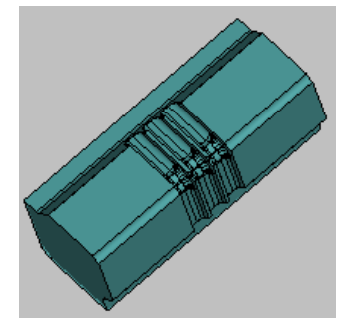


## 1.4 Acceleration Structure: volume manufacturing

- **Manufacturing method: Electro Chemical Machining**
- **ECM:** non-conventional metal machining technique based on electrolysis, metal is anodic machined, dissolving locally with high accuracy
- **ECM material tests**
  - Carried out on OFE-Cu, CuZr and Mo samples
  - Achieved surface roughness:  
OFE-Cu: 0.02 – 2.0  $\mu\text{m}$  ; Mo: 0.04 – 0.8  $\mu\text{m}$ ; CuZr: comparable to Cu
- **Test structure manufacturing (105x45x45 mm)**
  - ECM prototype planned to be manufactured
- **Expectations**
  - Manufacturing time: approx. 10% of conventional machining
  - Accuracy's: comparable to conventional
  - Structure cost: 25-30% of conventional quadrant

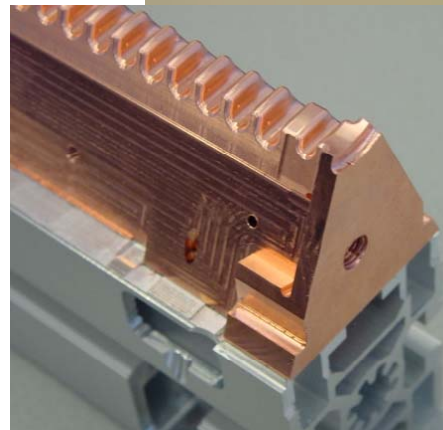
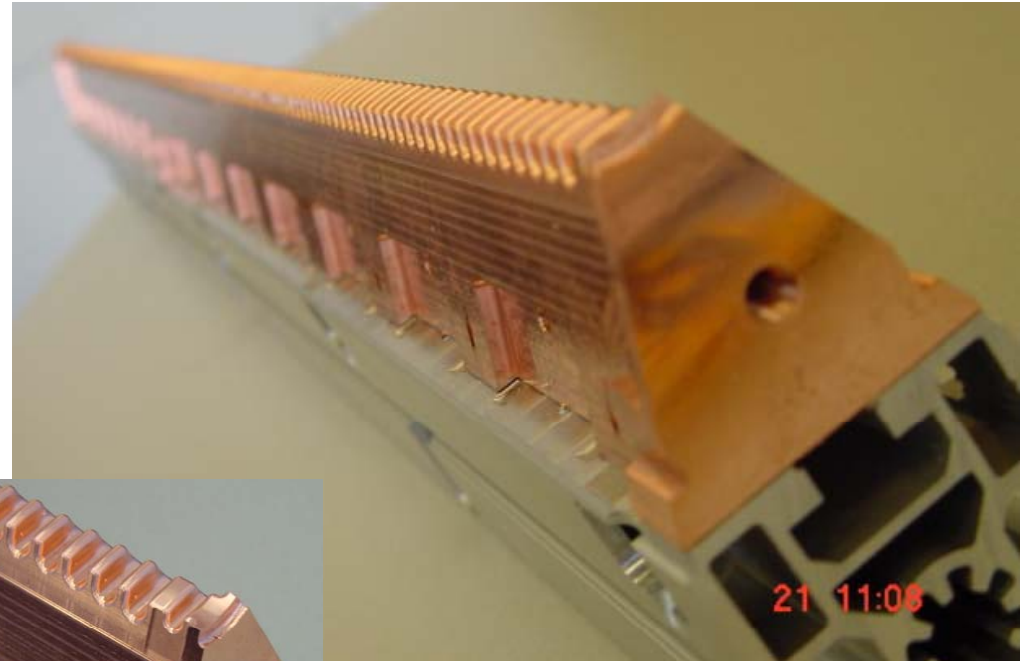


ECM EQUIPMENT



## 2. PETS Structure

- Manufacturing experiences VDL
  - Manufactured prototypes
    - 1030 mm 2BTS - CLIAP122000x  
Manufacturing is in progress
  - Expected Accuracy's
    - Dimension: 20  $\mu\text{m}$
    - Position: 20  $\mu\text{m}$
  - Surface roughness
    - Ra 0.1  $\mu\text{m}$
  - Tooling : diamond tooling
    - Special milling machine



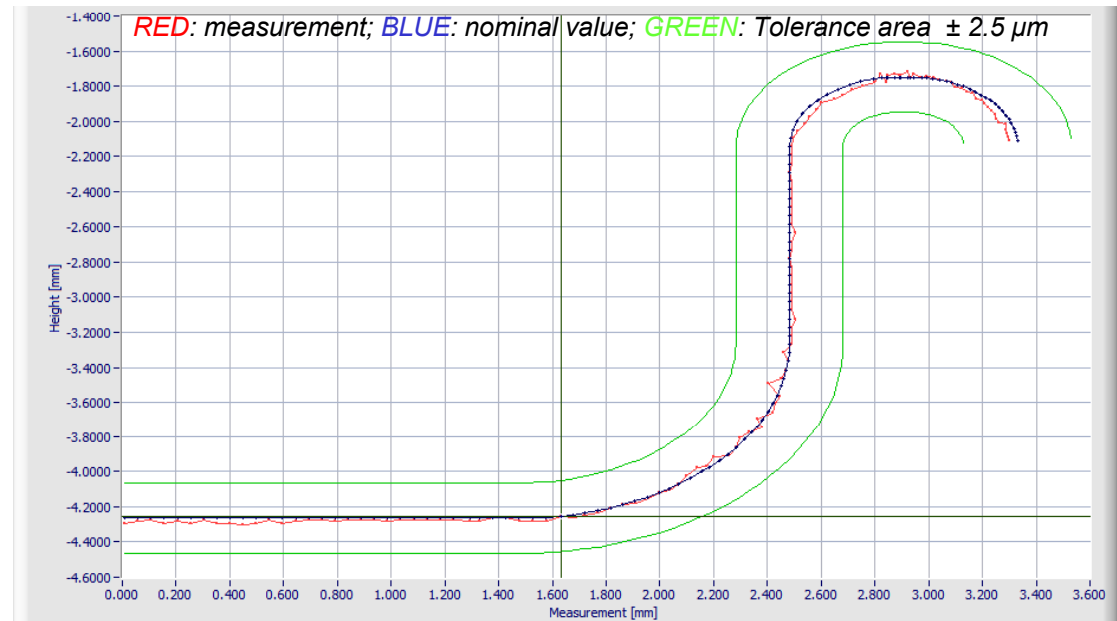
### 3. CLIC Structure

- Manufacturing experiences VDL



- Manufactured prototypes
  - Speed bump, TM02, testsamples – CLIAAS3000xx (Ø 35, Ø 80 mm)

- Accuracy's
  - 1µm
- Surface roughness
  - Ra 0.05 µm



- Cutting Tooling: diamond
- Manufacturing equipment: ultra precision turning & milling machines