JOINING OF COPPER TO ALUMINIUM BY ELECTROMAGNETIC FIELDS – JOIN'EM

General Assembly of the Joining Sub-Platform

Brussels, November 19th, 2015

Verena Psyk



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AGENDA

- Background of the JOIN'EM project
- Principle of electromagnetic welding
- Advantages of electromagnetic welding
- Current obstacles hindering wide industrial implementation
- Aims and objectives of the project
- Technical approach
- Consortium

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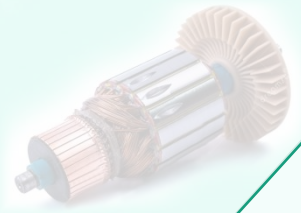
Background of the project

Excellent electrical conductivity

Excellent thermal conductivity

Electrical applications





Copper

3rd most frequently used material

Energy storage

Electrical industry

HVAC

White goods

High power electronics

Chemical industry

Heating and cooling applications

Electromobility

Important industrial Branches (selection)

Automotive & Transport

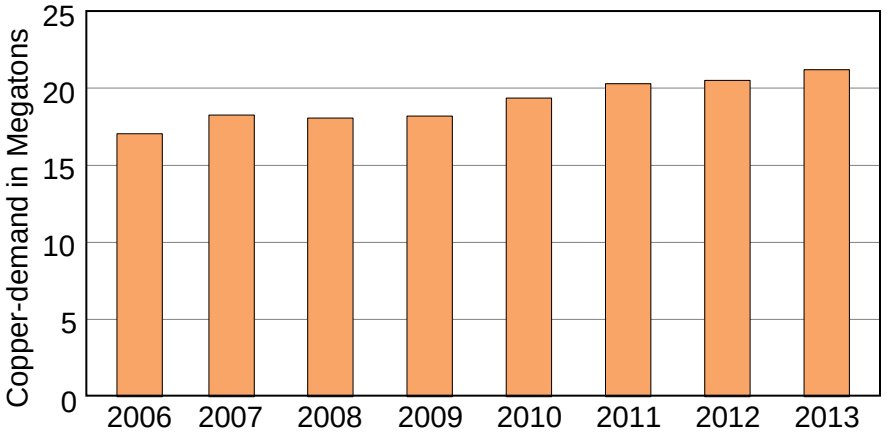
Very good chemical resistance

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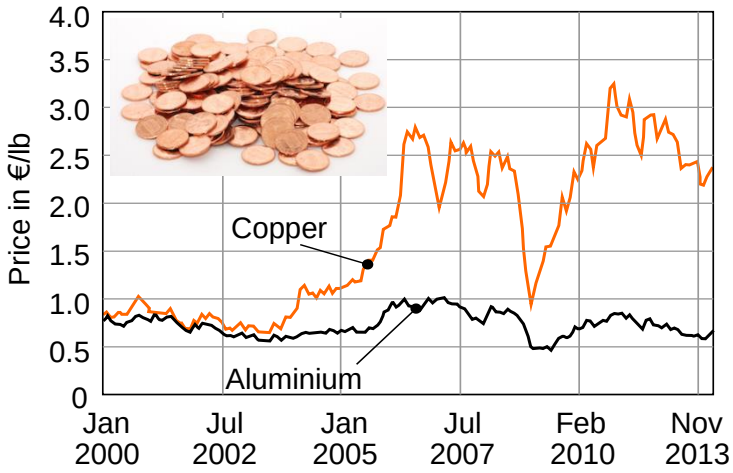
JOIN'EM

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Background of the project



(Source: http://de.statista.com/)



(Source: www.infomine.com)

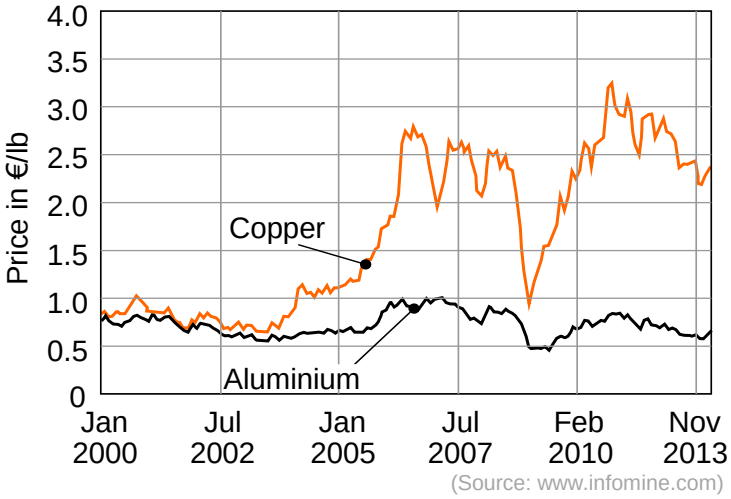
	Copper	Aluminium
Electrical conductivity	58 MS/m	36 MS/m
Thermal conductivity	401 W/mK	236 W/mK
Density	8.9 g/cm³	2.7 g/cm³
Price	4.633 €/ton*	1.420 €/ton*

(Source: http://www.boerse-online.de/rohstoffe; 2015-11-09)

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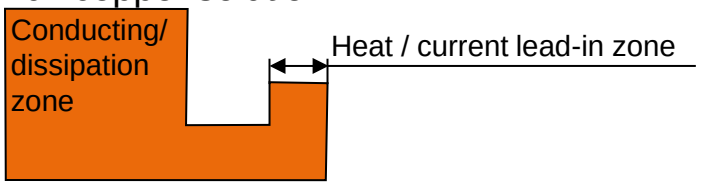
Major aims of JOIN'EM

- Supplementing the heavy use of full copper components in applications related to electrical and thermal conductivity by high quality hybrid copper – aluminium solutions
  - Reduce material costs
  - Reduce product weight
- Development of a flexible, highly productive, and cost effective joining process for high quality dissimilar material joints
- Enabling the industrial implementation of ElectroMagnetic Welding (EMW)
- Facilitating the exploitation of known process advantages in series production

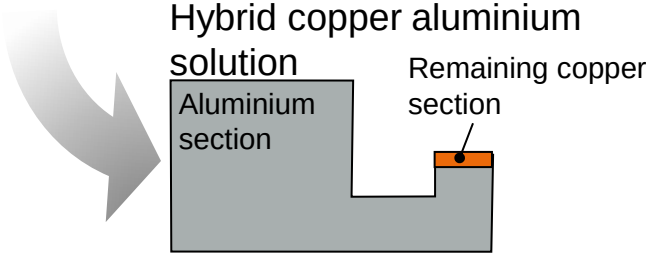


(Source: www.infomine.com)

Full copper solution

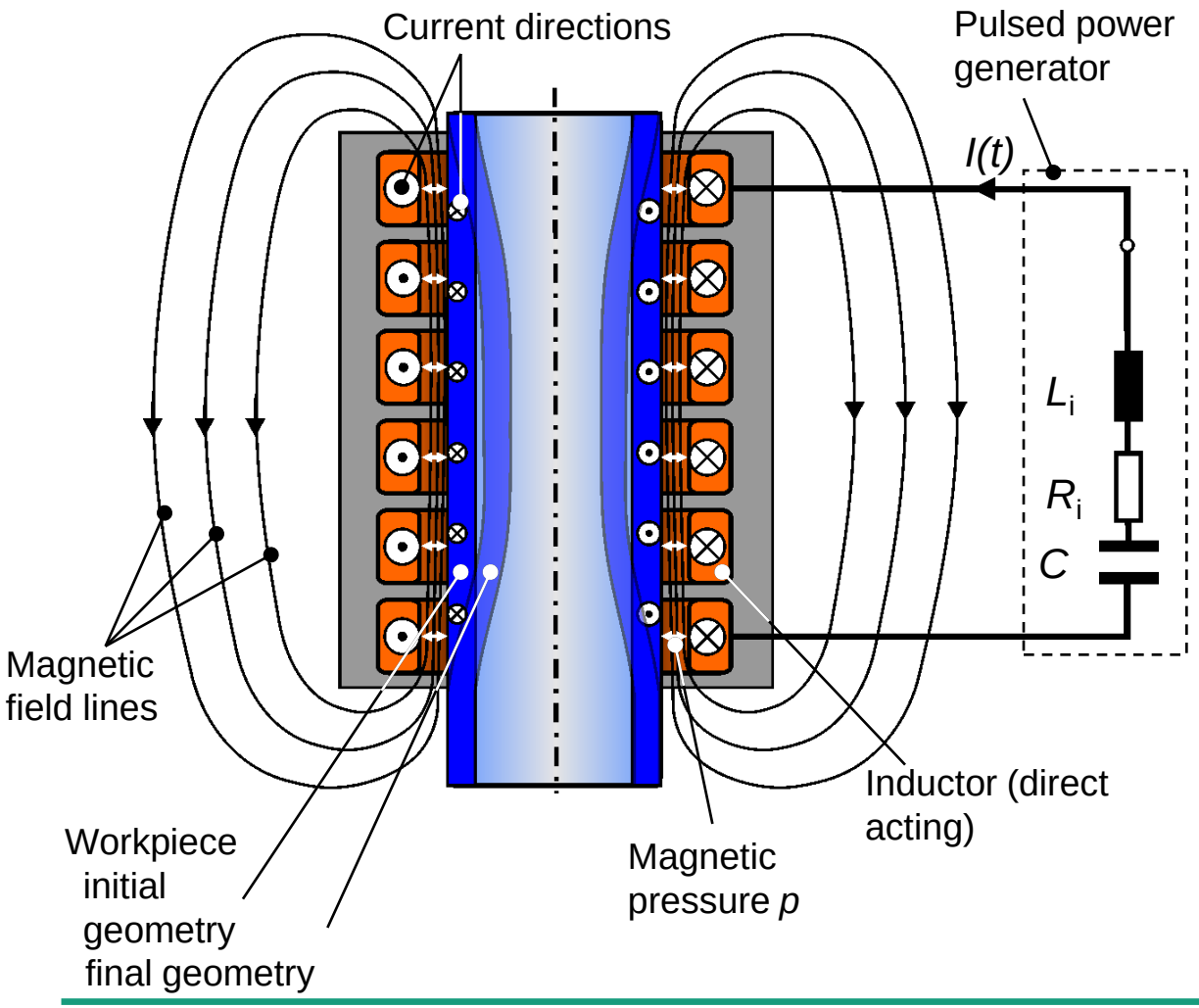


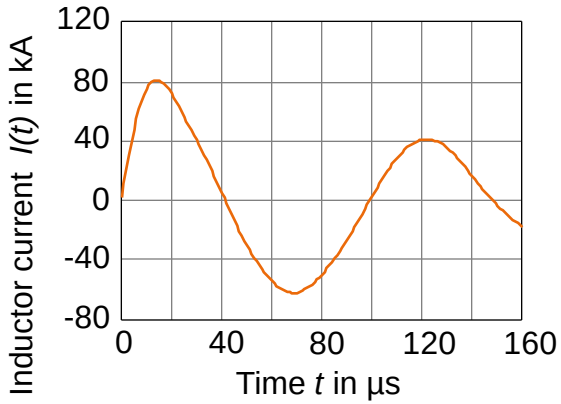
Hybrid copper aluminium solution



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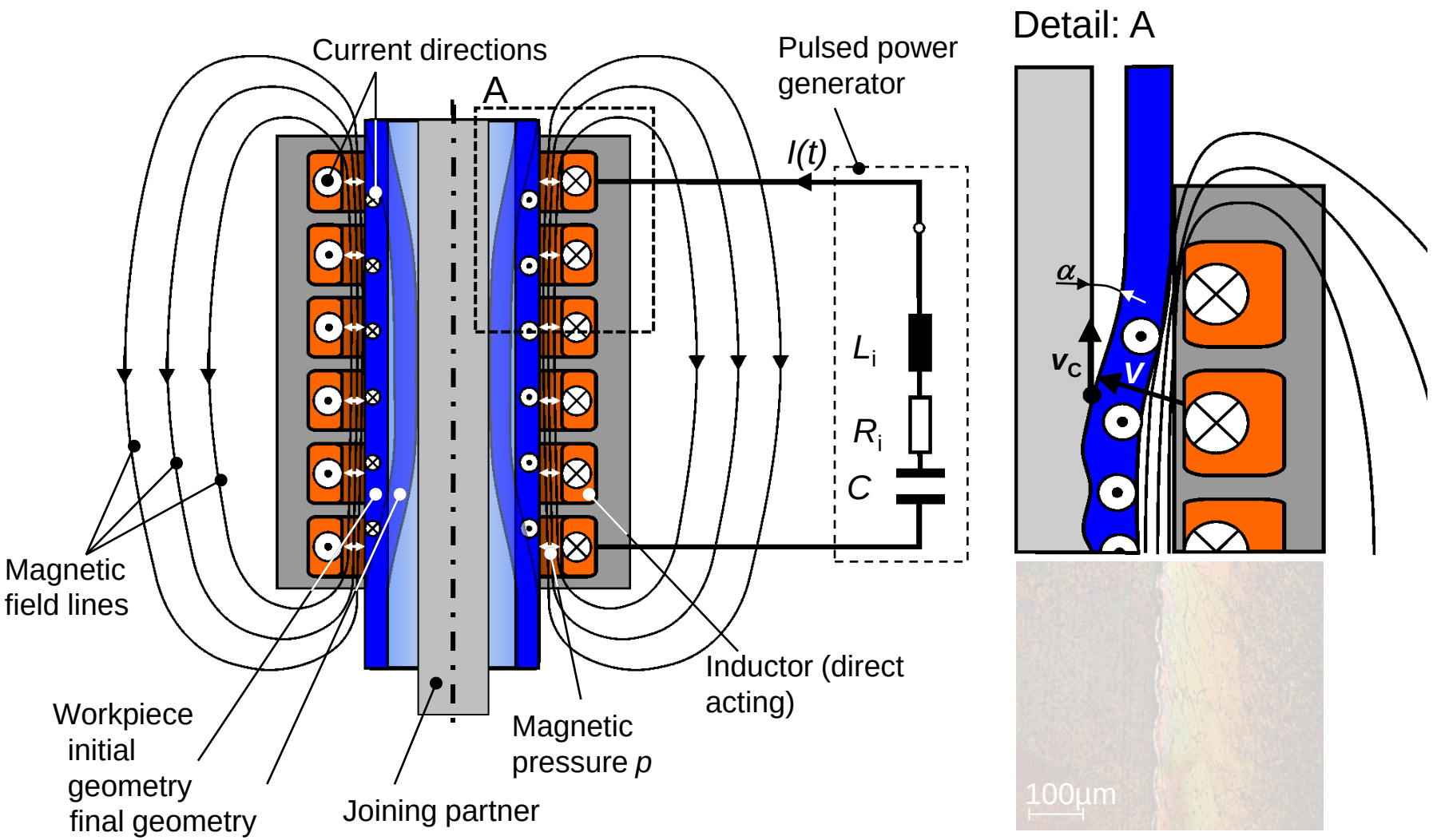
Process principle: electromagnetic compression of tubes



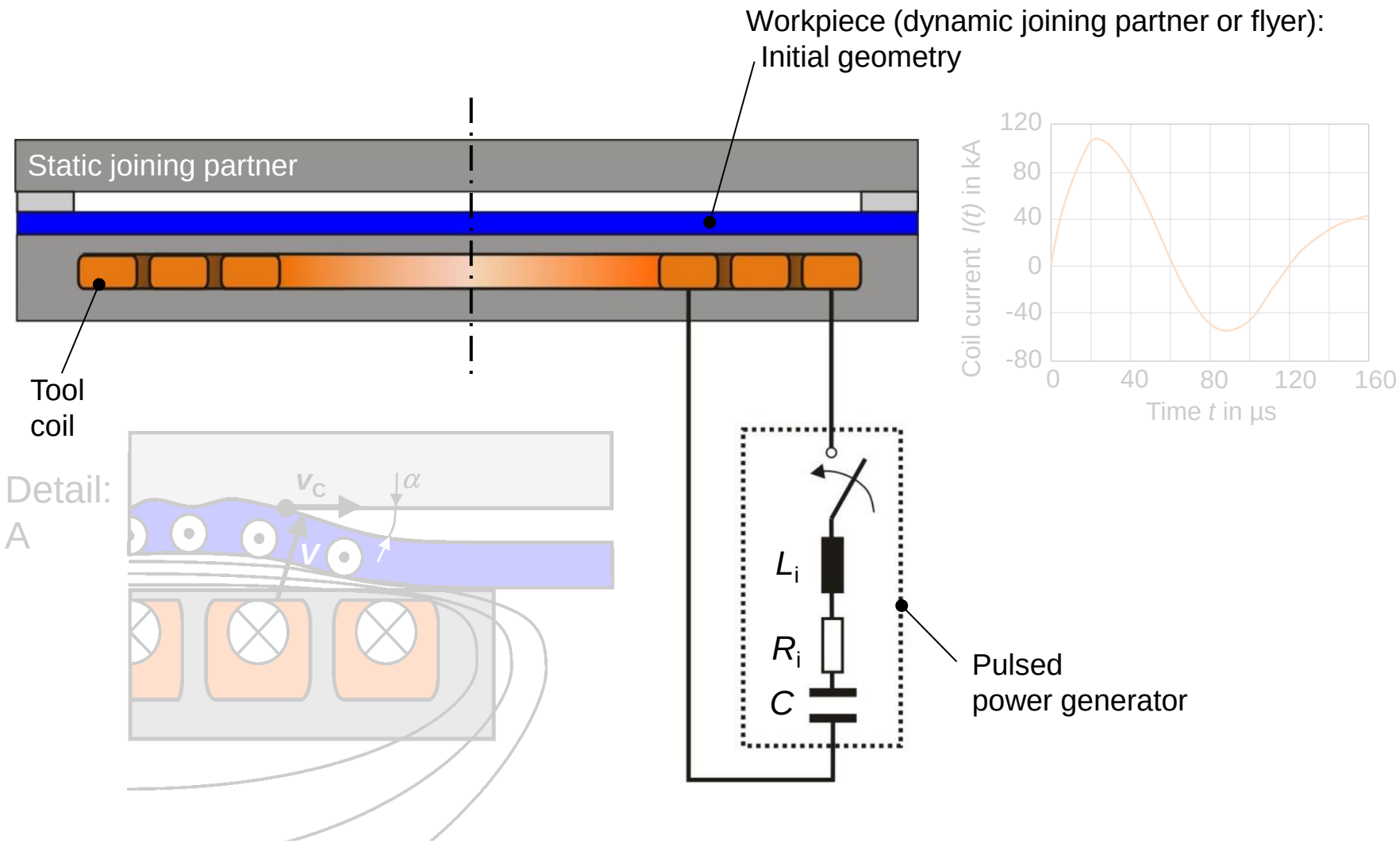


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Process principle: electromagnetic welding of tubes

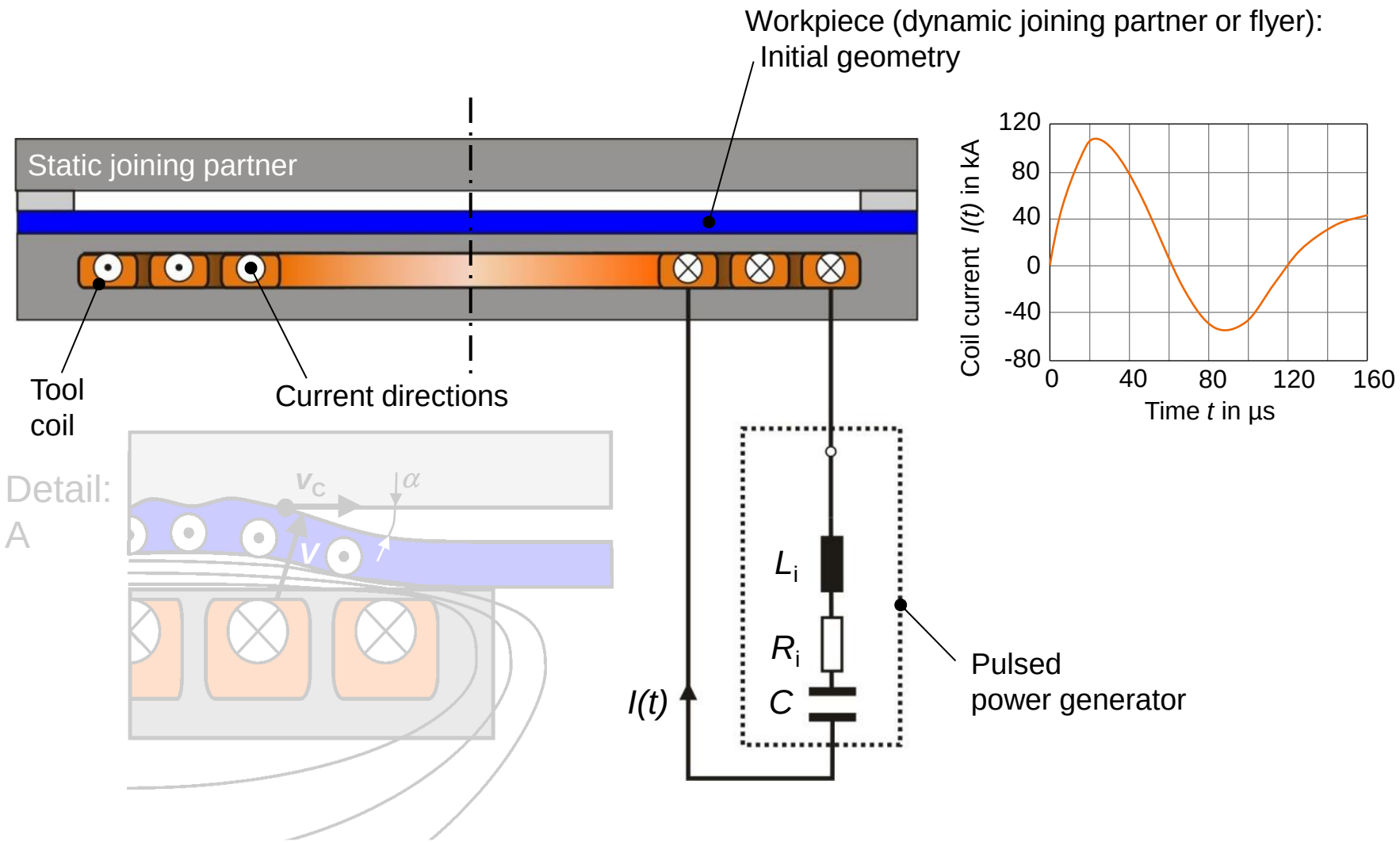


Process principle: electromagnetic welding of sheets

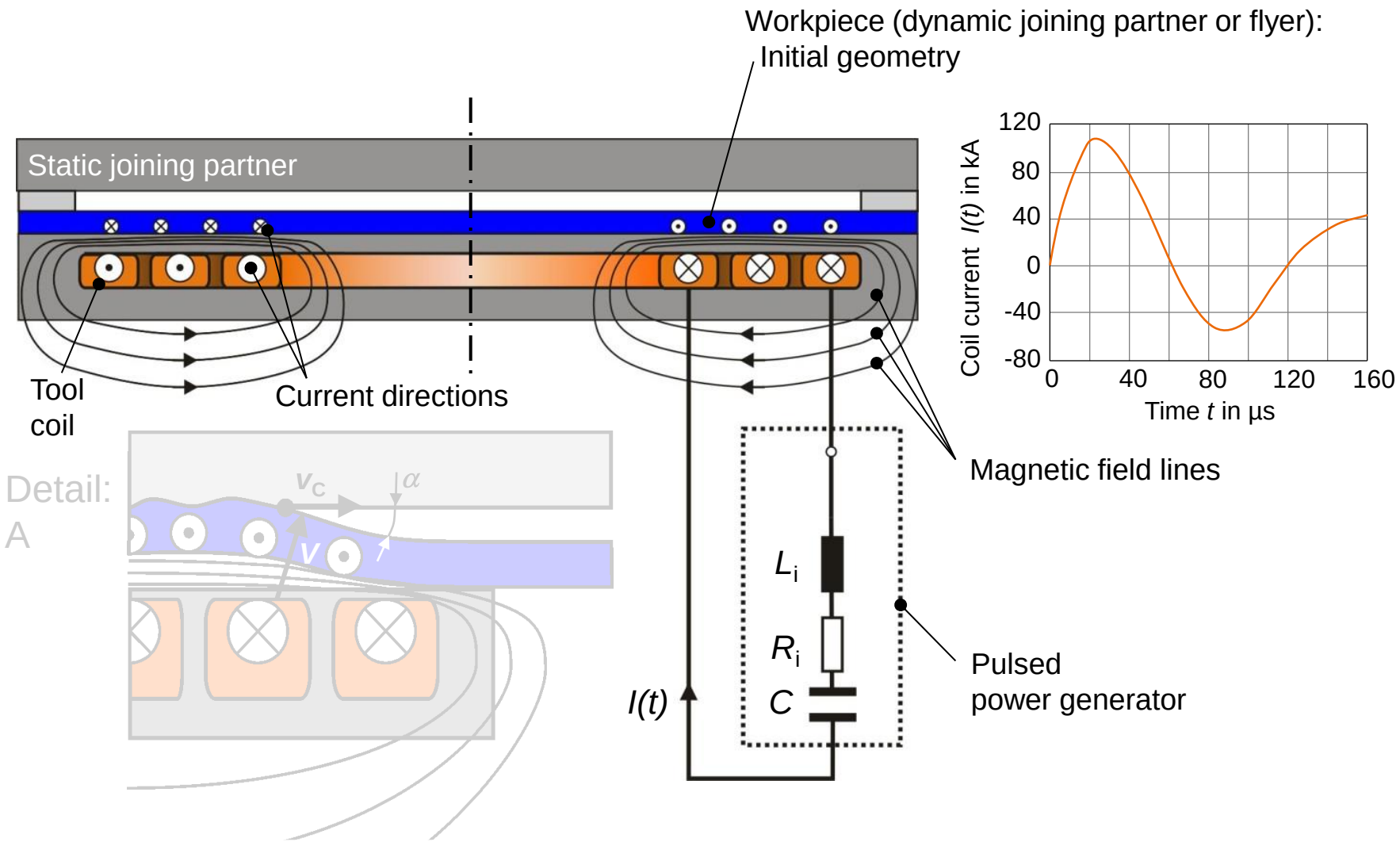


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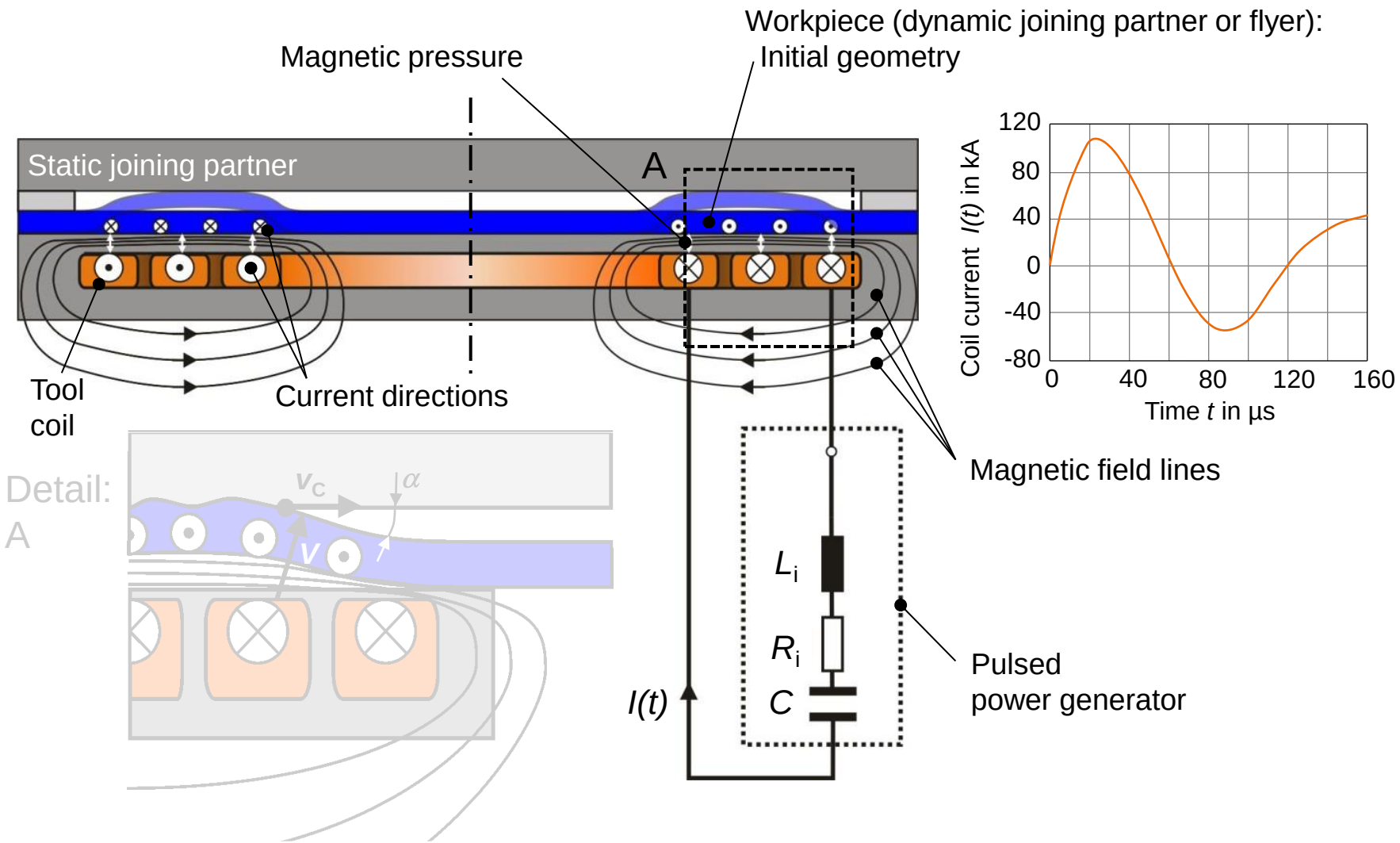
Process principle: electromagnetic welding of sheets



Process principle: electromagnetic welding of sheets



Process principle: electromagnetic welding of sheets



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Significant advantages of EMW

- No heating of large component areas
  - No thermal softening
  - No heat distortion
  - No critical intermetallic phases
  - Parts can be handled safely
- Precise adjustment of forces; high reproducibility
- High joint strength
- Short process time ➔ high production rate
- Higher formability due to high strain rates for many materials
- Environmental and operator friendly process
  - No heat, radiation, gas, or smoke
  - No lubricants required
  - Low energy consumption
  - No additives or filler materials



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Important obstacles hindering wide industrial implementation to be overcome by JOIN'EM



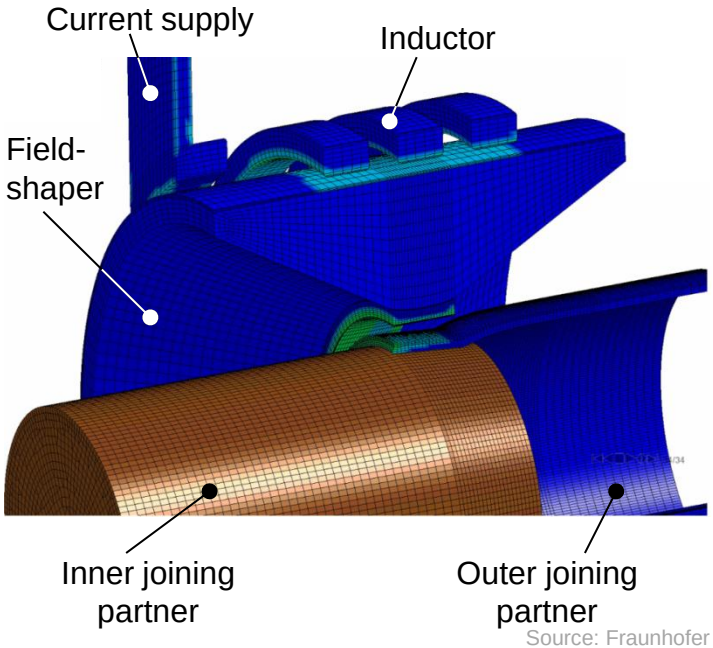
- Lack of validated and practically applicable guidelines for joint design
- Lack of developed simulation tools required for process design
- Lack of validated methods for designing durable and efficient tools
- Lack of appropriate joint evaluation methods (especially non-destructive)
- Lack of validated industrial case studies
  - validating the applicability of the process in an industrial environment
  - evaluating process and equipment design strategies in an industrial setting.
  - quantifying advantages of EMW via economic efficiency calculations and LCA

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Scientific knowledge objectives

- Experimental and numerical process analysis
- Development of simulation strategies
  - Macroscopic modelling ➔ acting loads, deformations, impacting conditions
  - Microscopic modelling ➔ joint development and properties
- Development of non-destructive testing
- Deep understanding of behaviour of tool materials
- Development of a lifetime prediction methodology for tools for EMW

Numerical model of a tube joining process



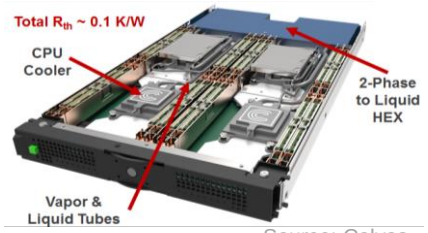
Source: Fraunhofer

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Technological knowledge objectives

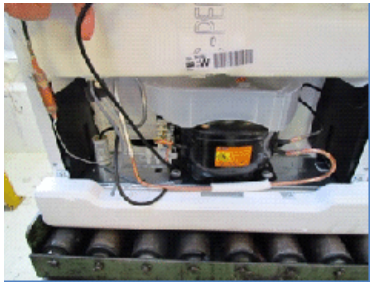
- Development of validated process and joint design concepts
  ➔ Guidelines for obtaining high-quality joints
- Design, realisation, and evaluation of industrial demonstrator parts
- Development of suitable joint preparation approaches
- Design, realisation, and evaluation of tools

High power electronics passive cooling



Source: Calyos

White goods



Source: Whirlpool

HVAC



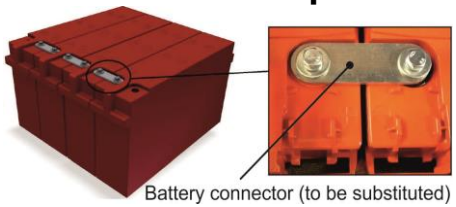
Source: Refco

Battery



Source: Cegasa

Transport / automotive components



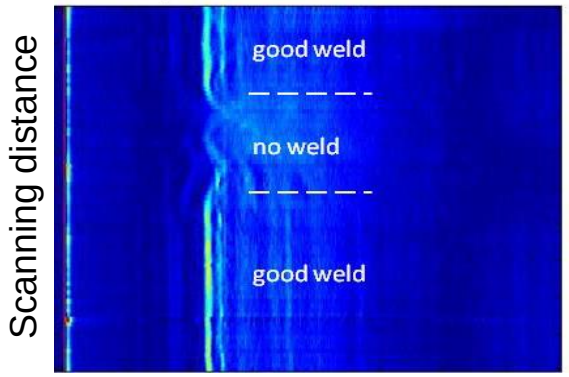
Source: Alke

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Implementation knowledge objectives

- Optimisation of processes and tools regarding the industrial manufacturing process chain and environment
- Optimisation of inspection and testing methods guaranteeing transferable load, throughput rate, and robustness
- Evaluation of strategies for automated processes and quality control
- Economic process and product evaluation via life cycle cost analysis
- Technological process and product evaluation

Weld inspection by Laser-UltraSound



Runtime of Ultrasound waves

Source: Recendt



Source: Vertech

Dissemination objectives



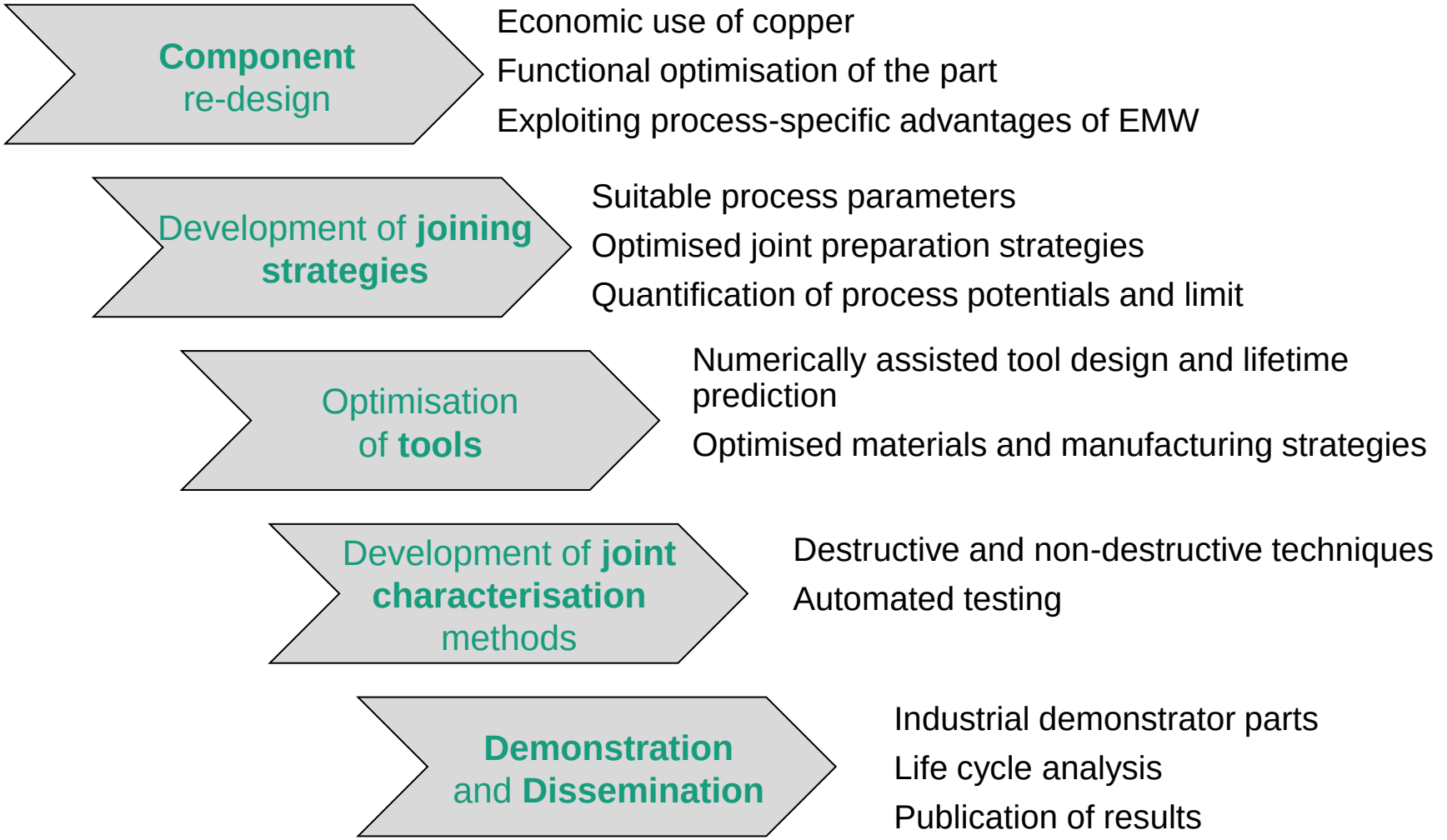
- Publication of a project brochure, poster, and flyer
- Publication of a newsletter
- Creation and maintenance of a webpage
  http://www.join-em.eu
- Video publications via internet
- Peer reviewed scientific publications
- Conference presentations
- Organization of workshops
- Development of training material
- Preparation of standards for EMW





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Technical approach: 5 phases of the project work



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