



# Enhanced manufacturing processes

## New Welding Processes

Full project report

*General meeting at Vic  
26th-27th May 2008*





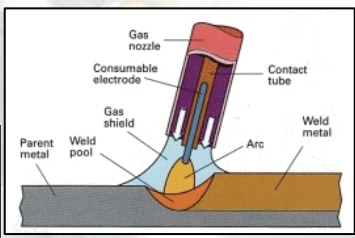
- Development and evaluation of new, alternative, welding techniques for hydraulic cylinders manufacturing
- Simulation/Modelling of welding processes
  - Instituto de Soldadura e Qualidade (ISQ) – PT
  - Scaglia S.p.A. (Scaglia) – I
  - Centre de Recherche en Aeronautique (CENAERO) – BE
  - Fundiciones de Roda S.A. (Roda) - ES
  - Pedro Roquet S.A. (Roquet) - ES



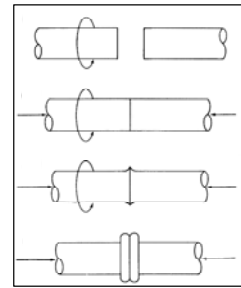
# NEW DESIGN and MANUFACTURING PROCESSES for HIGH PRESSURE FLUID POWER PRODUCTS



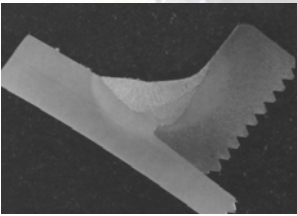
**GMAW**  
(1, 2, 3)



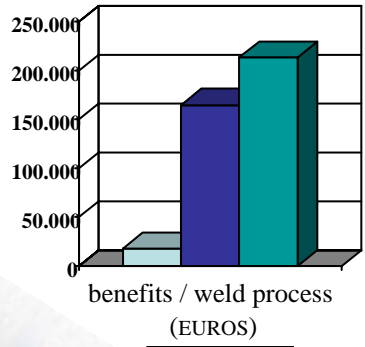
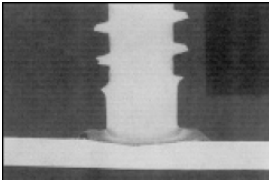
**Keyhole GTAW**  
(1, 2)



**FRICTION**  
(1, 3)

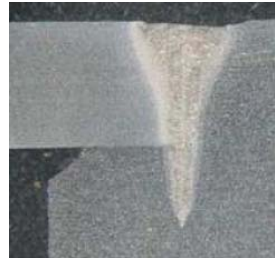


**STUD**  
(2)

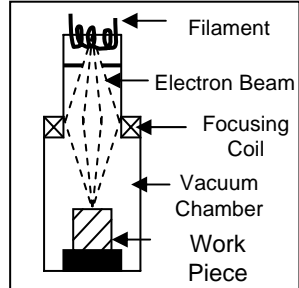
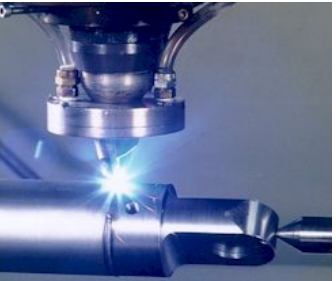


benefits / weld process (EUROS)

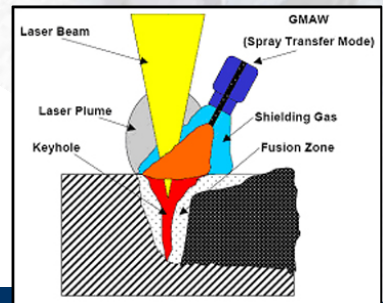
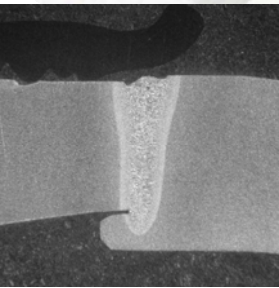
- MAG
- FRICTION
- K-TIG



**LASER**  
(1, 2, 3)



**Electron Beam**  
(1, 2, 3)



**HYBRID**  
(1, 2, 3)

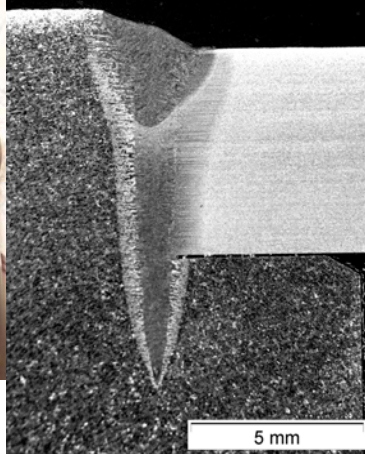


# Research/work performed - ISQ

LASER



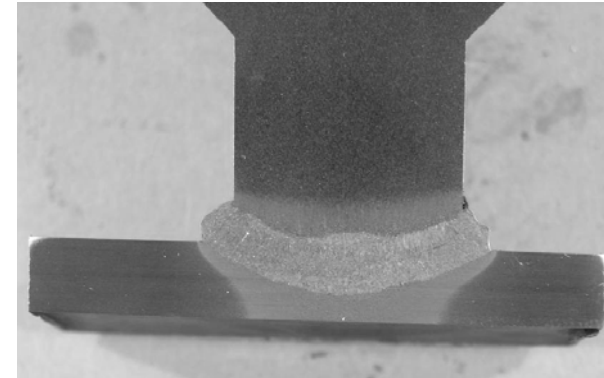
EBW



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# Research/work performed - ISQ



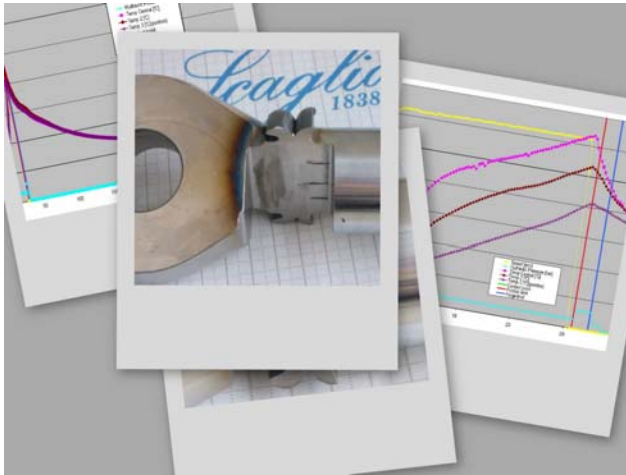
**HYBRID**



**STUD**

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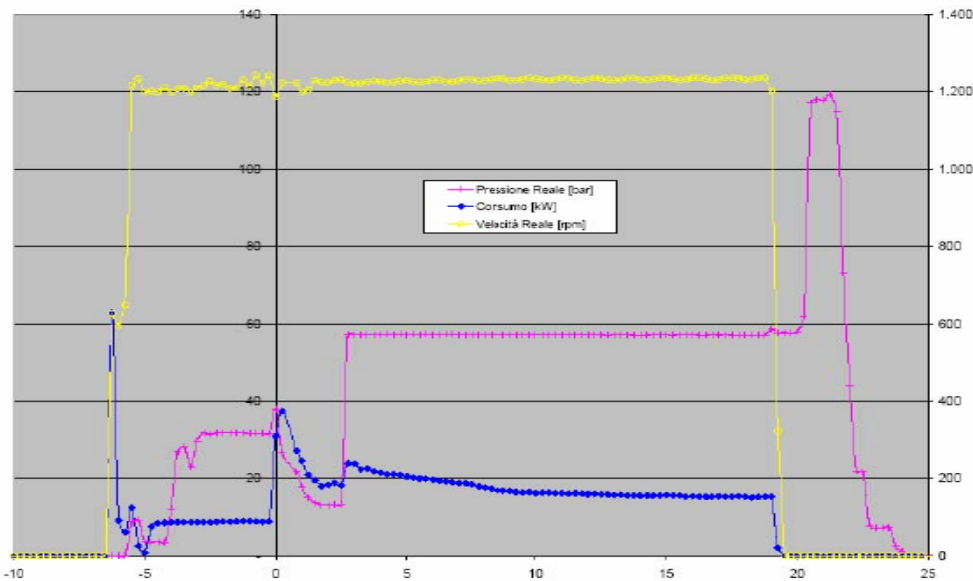




Temperature control with thermocouples



Measurement of power consumption



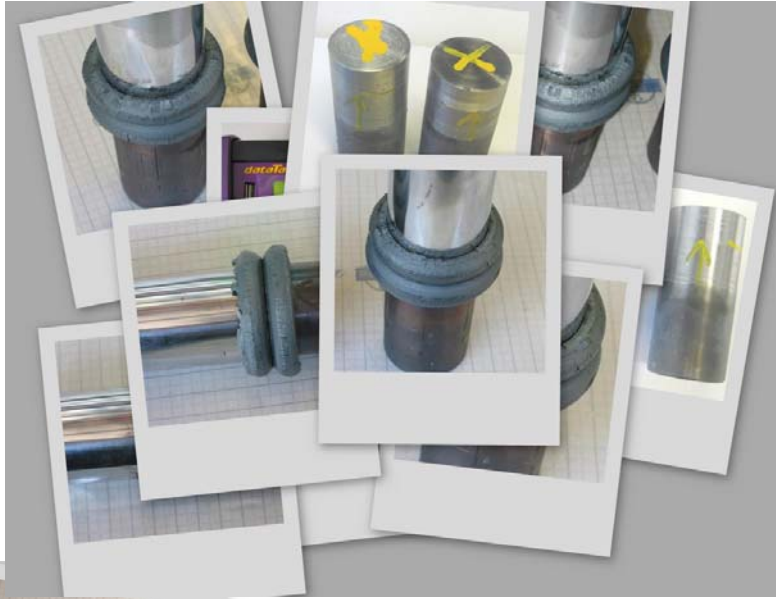
Characterisation of the friction welding cycle



# Research/work performed - SCAGLIA



Welding of cast irons with using casted inserts (RODA)



Welding of cast irons with using welded inserts (ISQ)



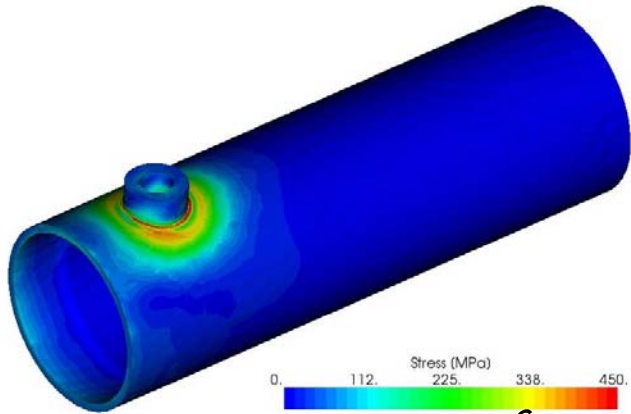
Welding of modified cast irons (RODA)

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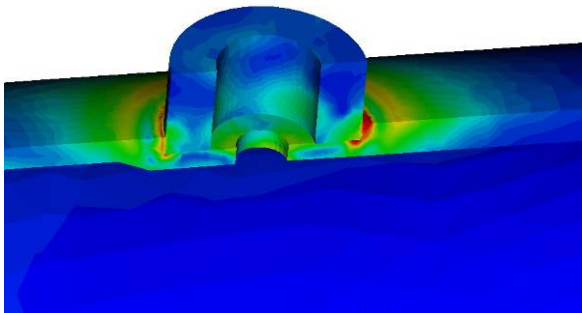




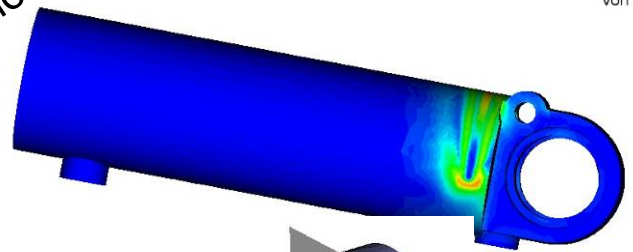
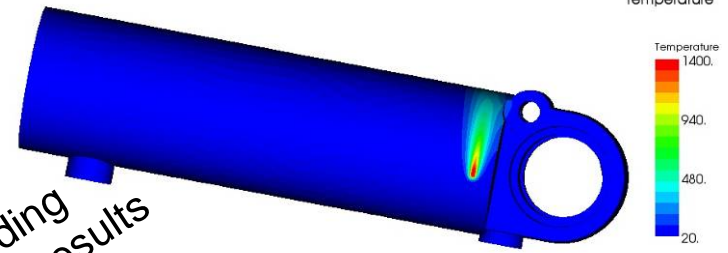
# Research/work performed - CENAERO



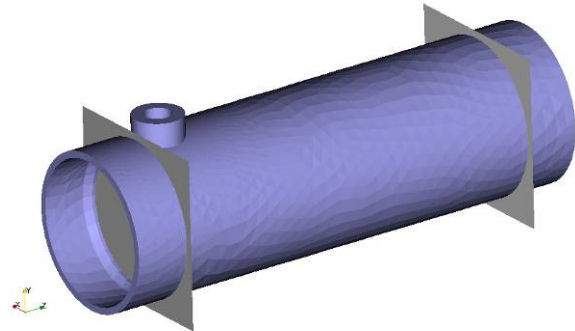
Residual stresses



Laser welding simulation results

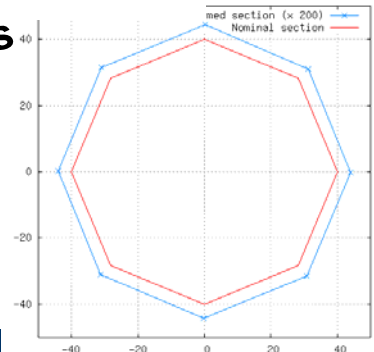
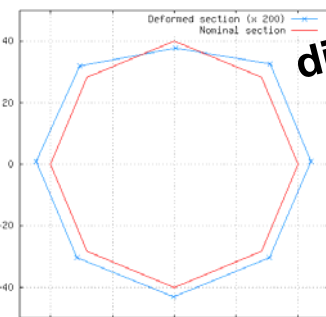


Temperature  
Temperature 1400.  
940.  
480.  
20.  
von Mises stress  
Stress (MPa)  
450.  
300.  
150.  
0.  
Morfeo 2008



[end cap welding temperature stresses\\_720x576.avi](#)

distortions



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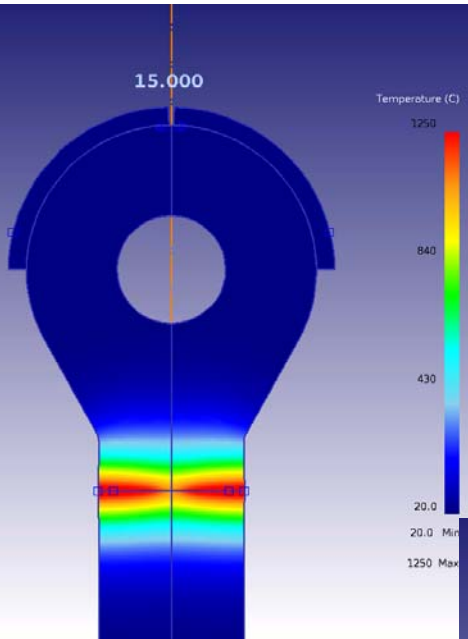




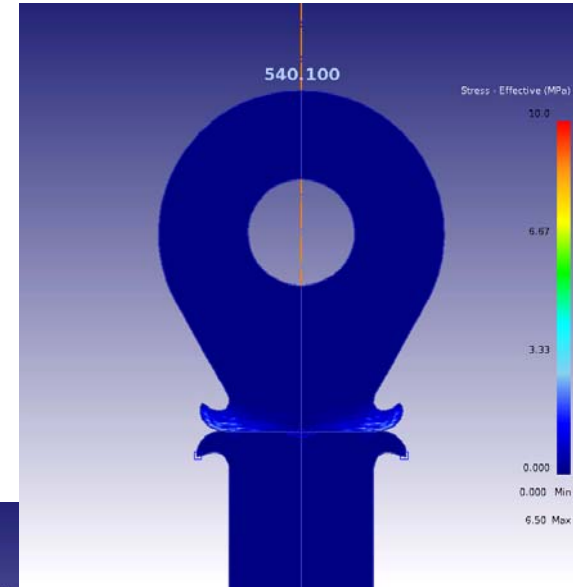


# Research/work performed - CENAERO

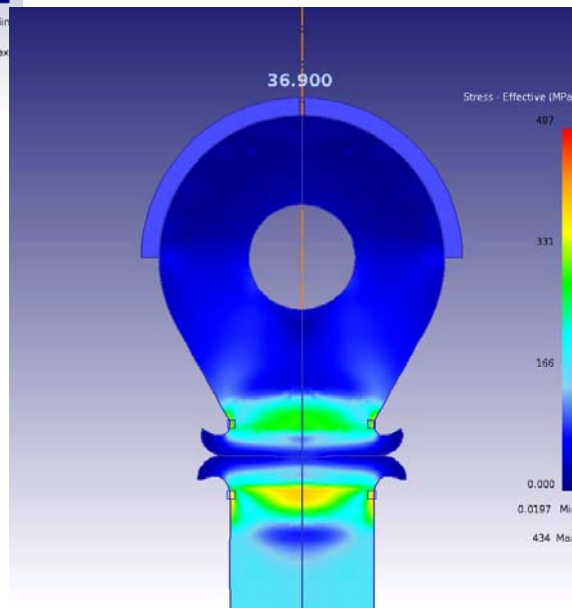
heating



cooling



forging



**Driven friction welding simulation**

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## Alternative processes: Higher performance and competitiveness

Application \ Welding process	OIL Port	Shell/Cap	Rod/Eye
<b>GMAW (reference)</b>	Weld time: 30 s Heat input: 33 Wh	Weld time: 74 s Heat input: 101 Wh	Weld time: 87 s Heat input: 13 Wh
<b>FRICTION</b>	Not feasible	Weld time: 22 s Heat input: 60 Wh	Weld time: 20 s Heat input: 50 Wh
<b>LASER</b>	Weld time: 8 s Heat input: 6 Wh	Weld time: 22 s Heat input: 31 Wh	Cracks
<b>EBW</b>	Weld time: 12 s Heat input: 13 Wh	Weld time: 71 s Heat input: 52 Wh	Weld time: 27 s Heat input: 23 Wh
<b>HYBRID</b>	Not feasible	Weld time: 20 s Heat input: 35 Wh	Cracks
<b>STUD</b>	Weld time: 0.75 s Heat input: 12 Wh	Not feasible	Not feasible

- Development of **novel processes** for welding cast iron components
- Production of **prototypes** demonstrating main project developments in welding
- Determination of real friction welding temperatures and energies involved





## Alternative processes: Higher performance and competitiveness

- Development of a new solution for welding cast iron components, complying with the project's objective of new basic materials for cylinders

**NEW SOLUTION: Use of intermediate inserts for joining cast iron to steel**

- Development of more competitive welding processes for assembling hydraulic cylinder components



## Driven Friction Welding model

- A math. and a numerical model have been set up for the DFW process
- DFW of a rod – eye welding using DEFORM 2D
- **Numerical results are in good agreements with samples welded by Scaglia**

## Fusion welding model

- Numerical model implemented in Morfeo (Cenaero in house software)
- Heat flux parameters derived from macro sections
- Laser welding simulations performed on Cylinder 2230 (oil port and end cap welding)
- **Numerical results are in good agreements with measured distortions**
- Computation of residual stresses and distortions after cooling

## Major technical issues:

- Reliable material parameters not always available from the literature and should be measured experimentally over a large range of temperature