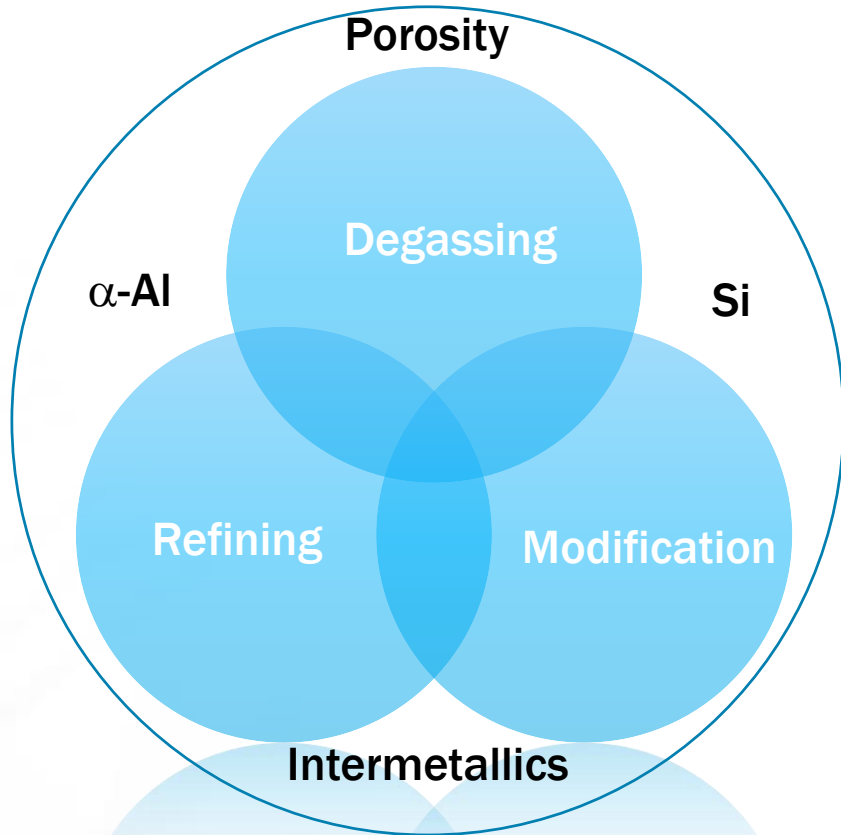
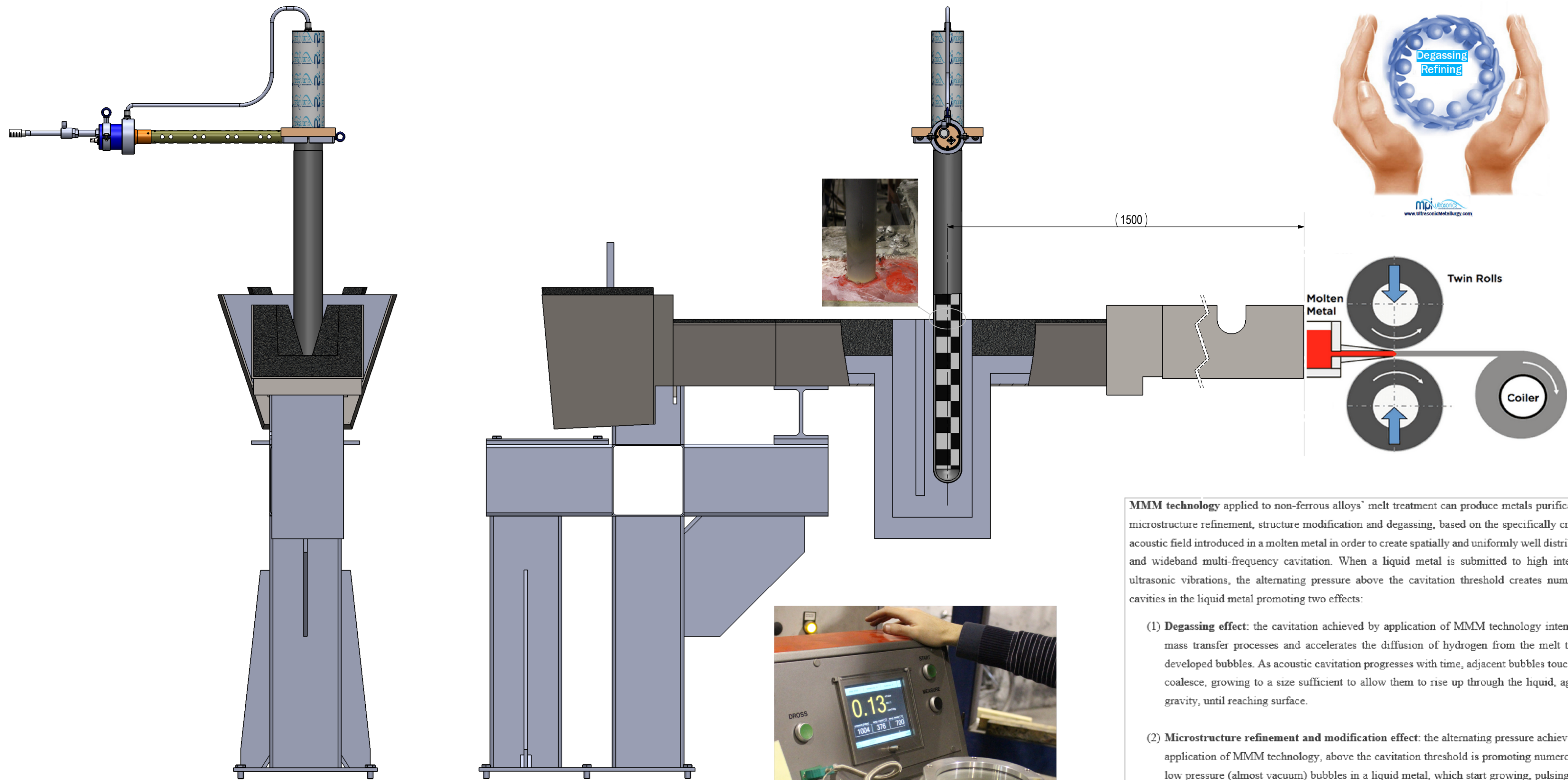


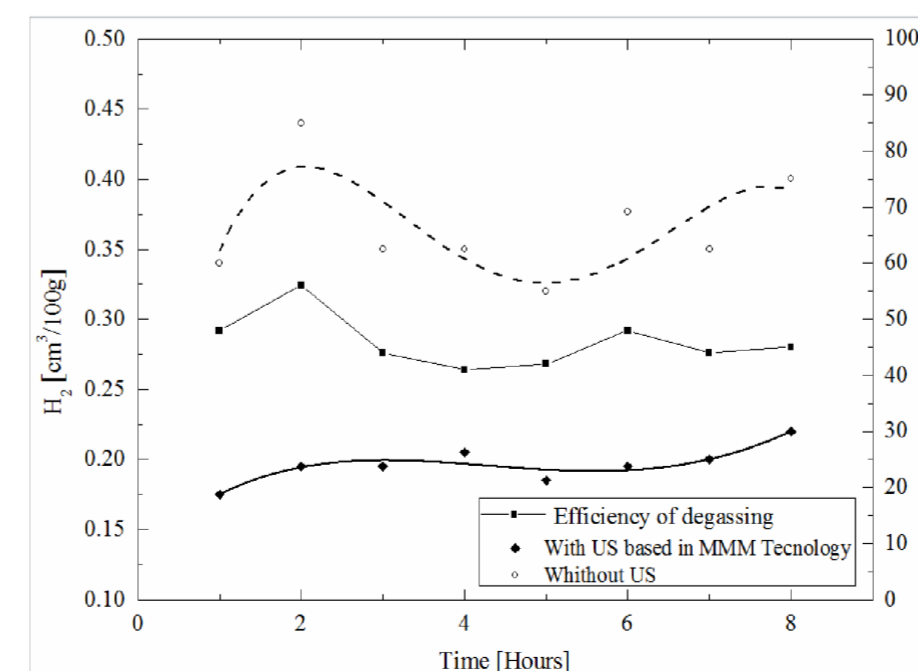
Breakthrough in Ultrasonic assisted industrial Continuous Casting





MMM technology applied to non-ferrous alloys' melt treatment can produce metals purification, microstructure refinement, structure modification and degassing, based on the specifically created acoustic field introduced in a molten metal in order to create spatially and uniformly well distributed and wideband multi-frequency cavitation. When a liquid metal is submitted to high intensity ultrasonic vibrations, the alternating pressure above the cavitation threshold creates numerous cavities in the liquid metal promoting two effects:

- (1) **Degassing effect:** the cavitation achieved by application of MMM technology intensifies mass transfer processes and accelerates the diffusion of hydrogen from the melt to the developed bubbles. As acoustic cavitation progresses with time, adjacent bubbles touch and coalesce, growing to a size sufficient to allow them to rise up through the liquid, against gravity, until reaching surface.
- (2) **Microstructure refinement and modification effect:** the alternating pressure achieved by application of MMM technology, above the cavitation threshold is promoting numerous of low pressure (almost vacuum) bubbles in a liquid metal, which start growing, pulsing with a continuous expansion/compression regime and finally collapse. During expansion, bubbles absorb energy in the melt, undercooling the liquid at the bubble-liquid interface, resulting in nucleation on the bubble surface. When bubbles collapse acoustic streaming develops in the melt, distributing the nuclei into the surrounding liquid producing a significant number of nuclei in the molten alloy, thus promoting heterogeneous nucleation.



MMM technology is a reliable technique for melt treatment that has been developed and applied in different non-ferrous alloys. Based on the results achieved from different alloys and according to results obtained in a laboratory and industrial scale, the main conclusions that can be drawn are:

- (1) Ultrasonic degassing can be an efficient process to degas molten non-ferrous alloys. For melting charges (industrial scale) acceptable degassing is achieved after 2 minutes ultrasonic treatment, although after 1 min the alloy density is already up to 90% of the maximum value.
- (2) When compared with the traditional fixed-frequency ultrasonic sources MMM ultrasonic technique seems to improve significantly the ultrasonic degassing process by increasing the final alloy density and degassing rate.
- (3) Ultrasonic processing by MMM technology is an external supply of energy – presenting physical process - environmentally clean and efficient that promotes refinement of primary grains, intermetallic phases, modification of eutectic Si and a decrease of porosity in non-ferrous alloys.

Application of acoustic waves in treating of melt aluminum alloys.

A promising future



Ultrasound above the threshold of acoustic cavitation can be introduced into a molten metal (e.g. during the continuous casting process), this way promoting:

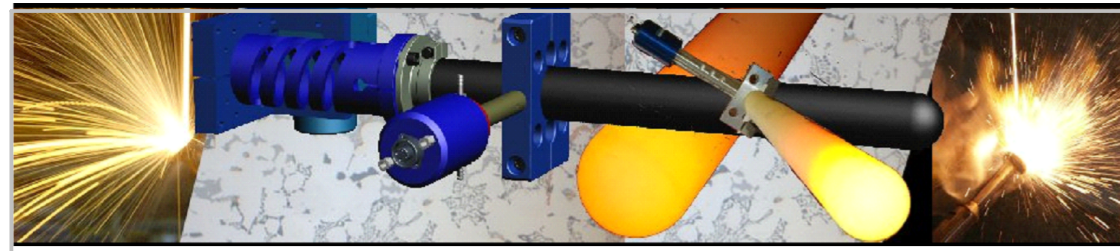
Degassing of liquid metals using high intensity ultrasonic activity.

Ultrasonic grain modification technology (improving micro crystallization).

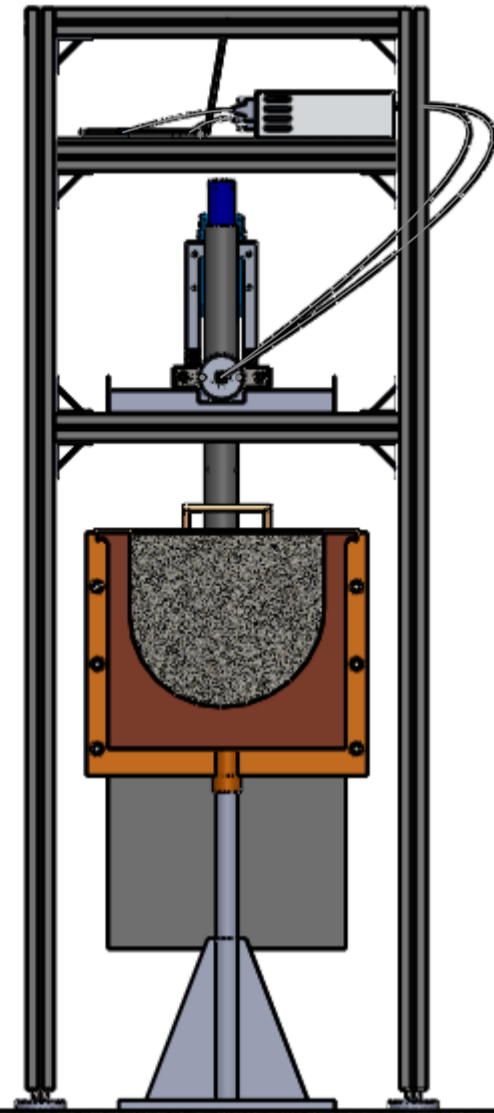
Ultrasonic filtering and refining of molten metal.

Ultrasonic mixing and homogenizing of liquids is exceptionally efficient.

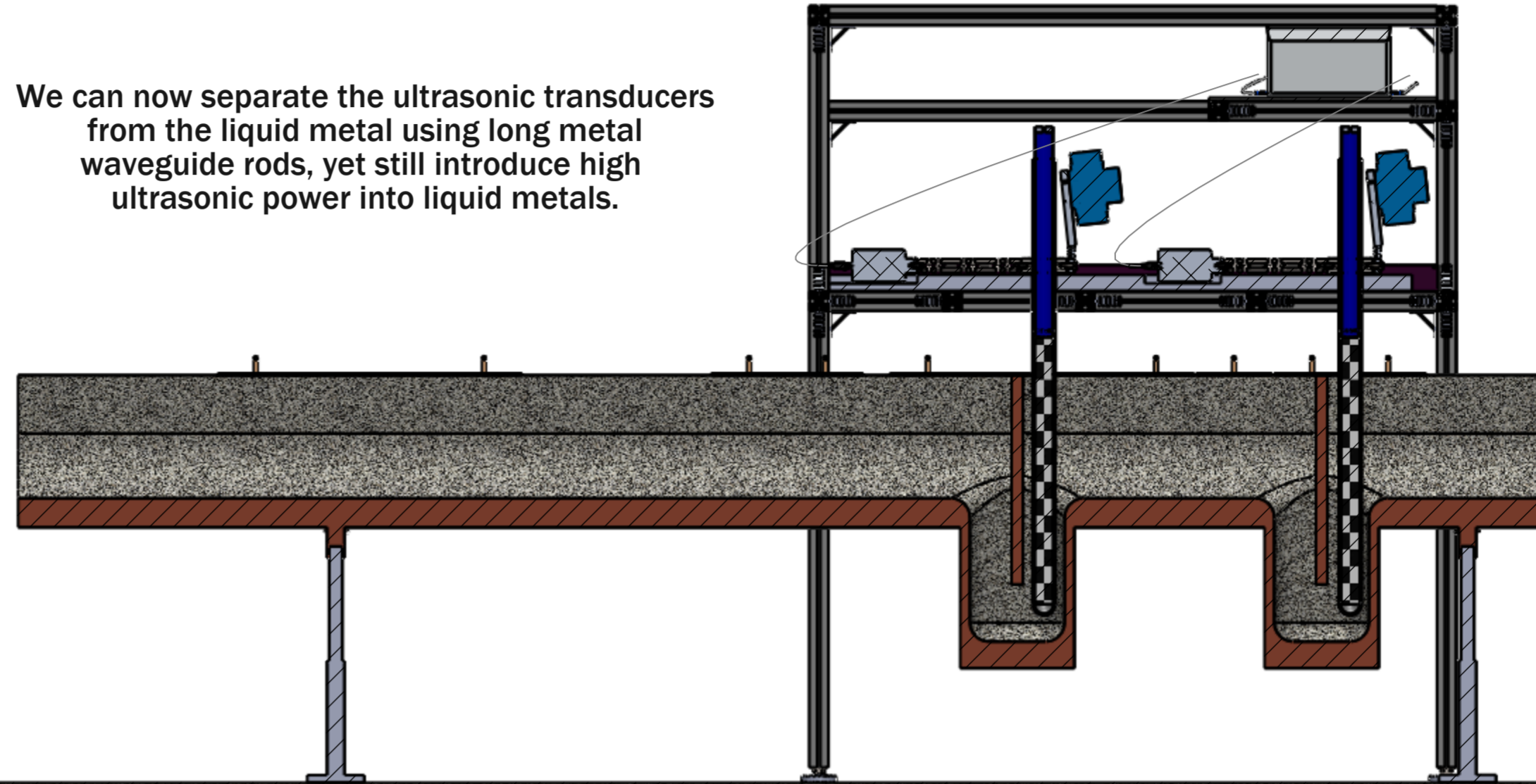
Liquids and liquid metals that do not mix in normal conditions can also be mixed in number of combinations, homogenized and/or alloyed in high intensity ultrasonic reactors, or in certain ultrasonically optimized casting process.



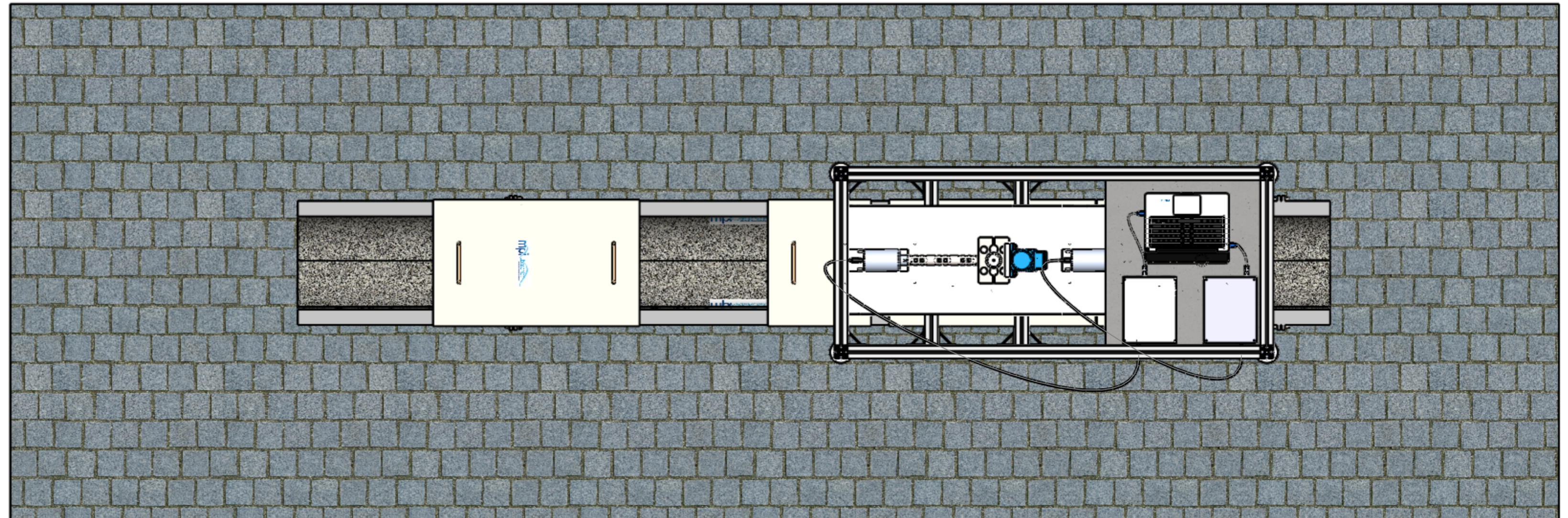
Ultrasonic vibrations in metallurgy (Universal Proposal)

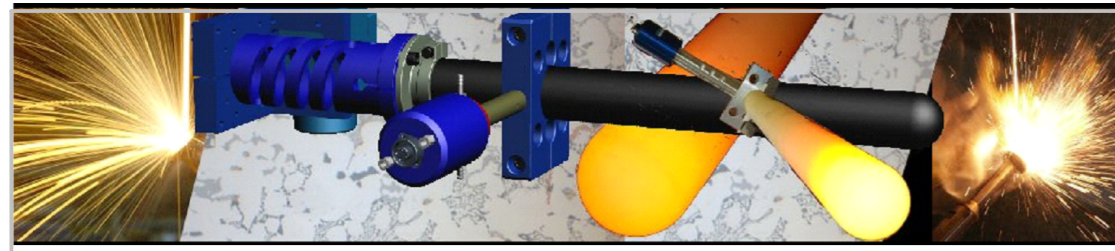


We can now separate the ultrasonic transducers from the liquid metal using long metal waveguide rods, yet still introduce high ultrasonic power into liquid metals.



Thanks to MMM technology

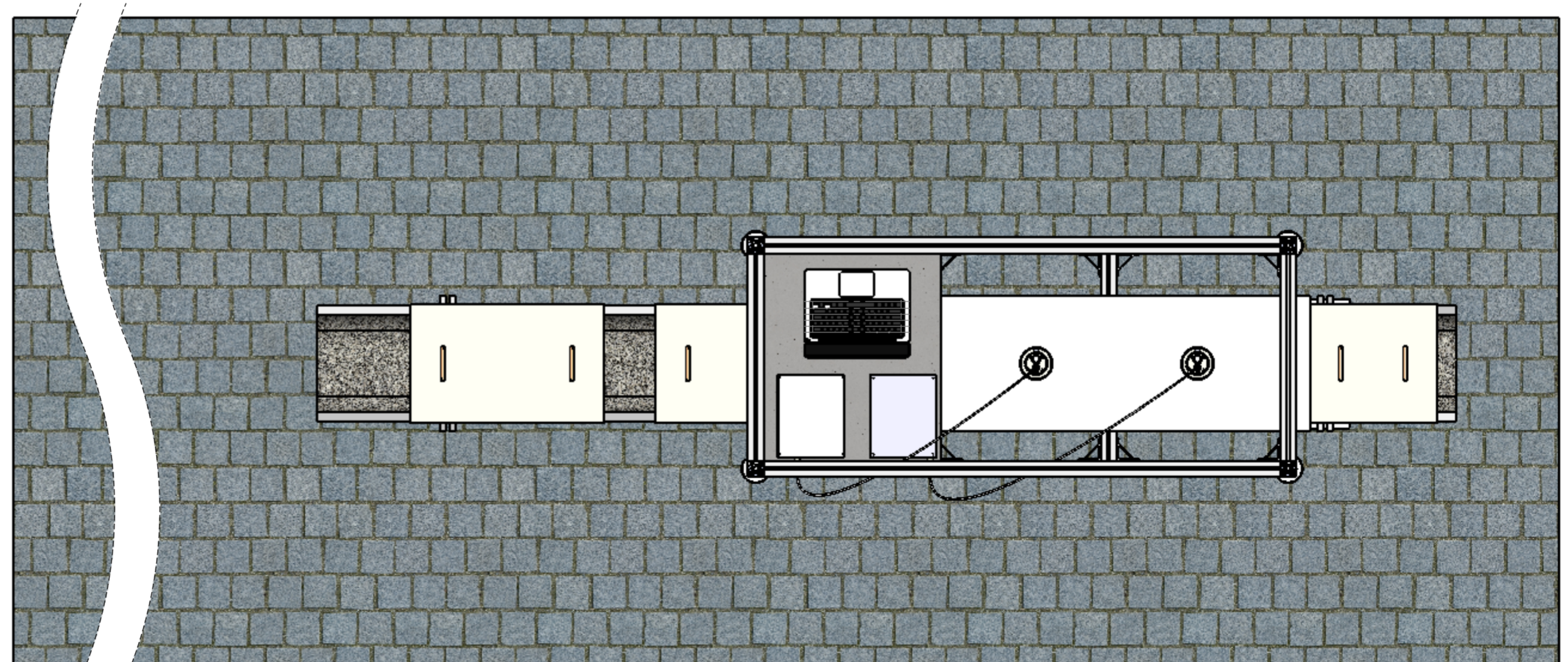
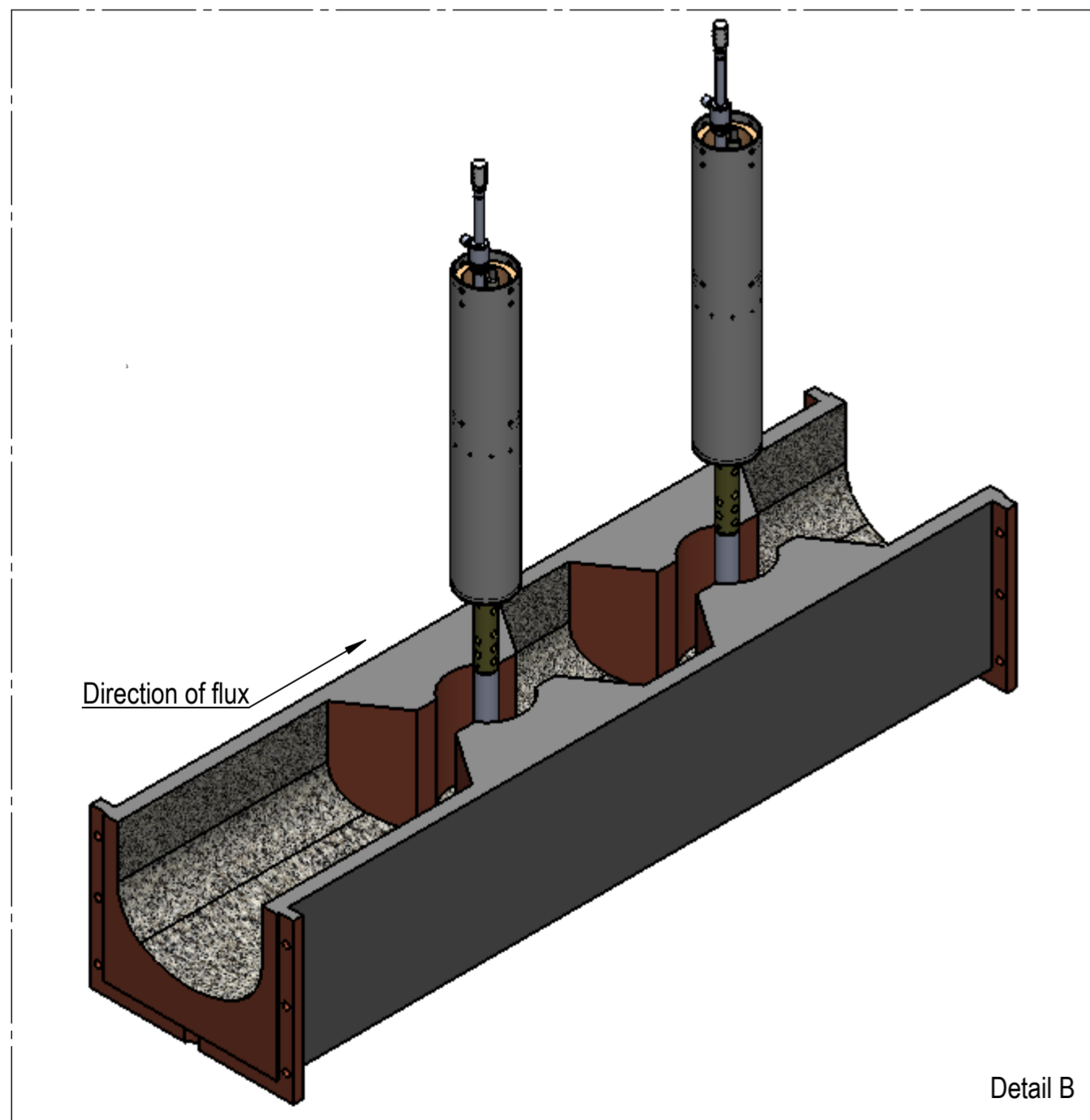
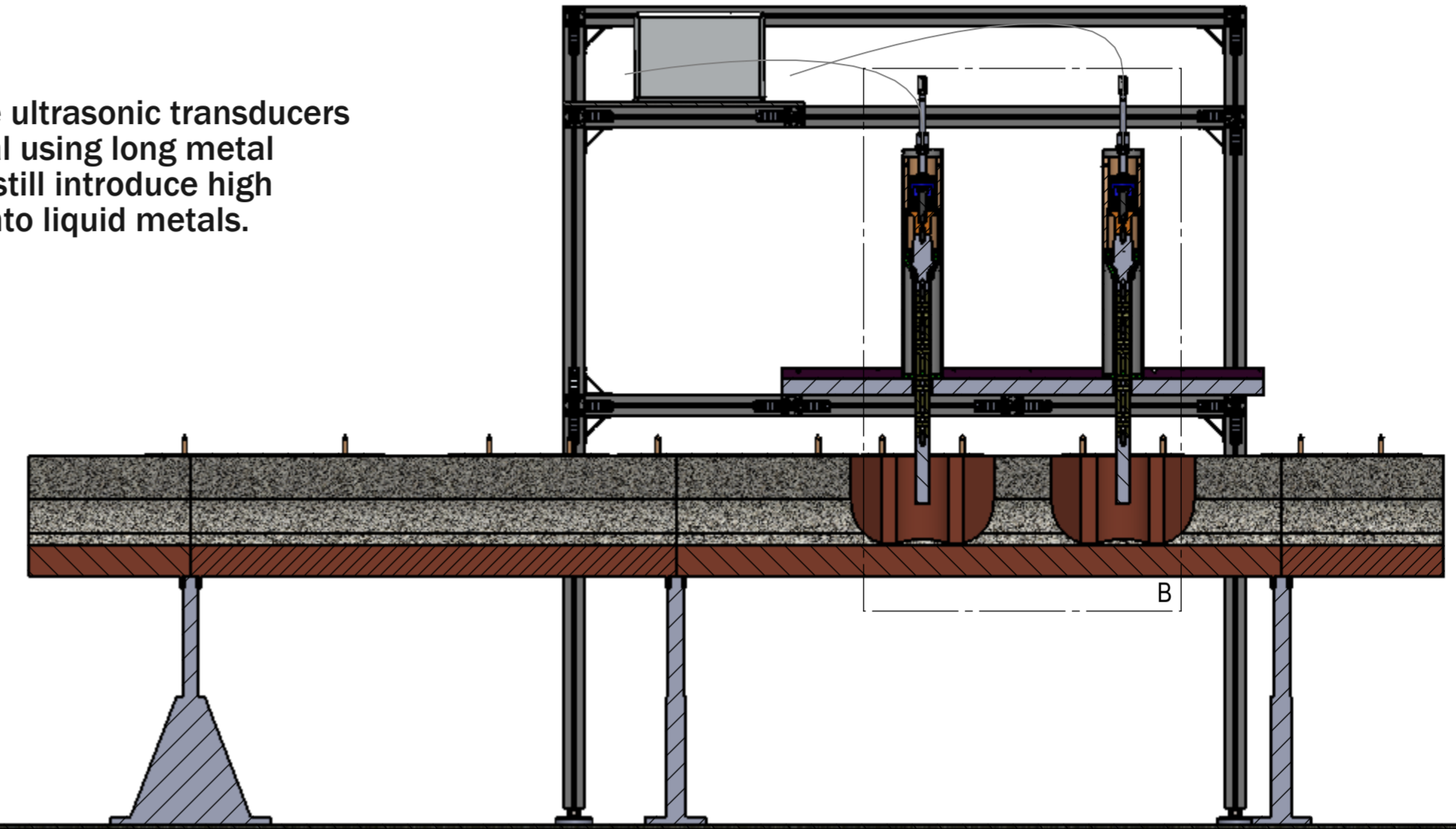
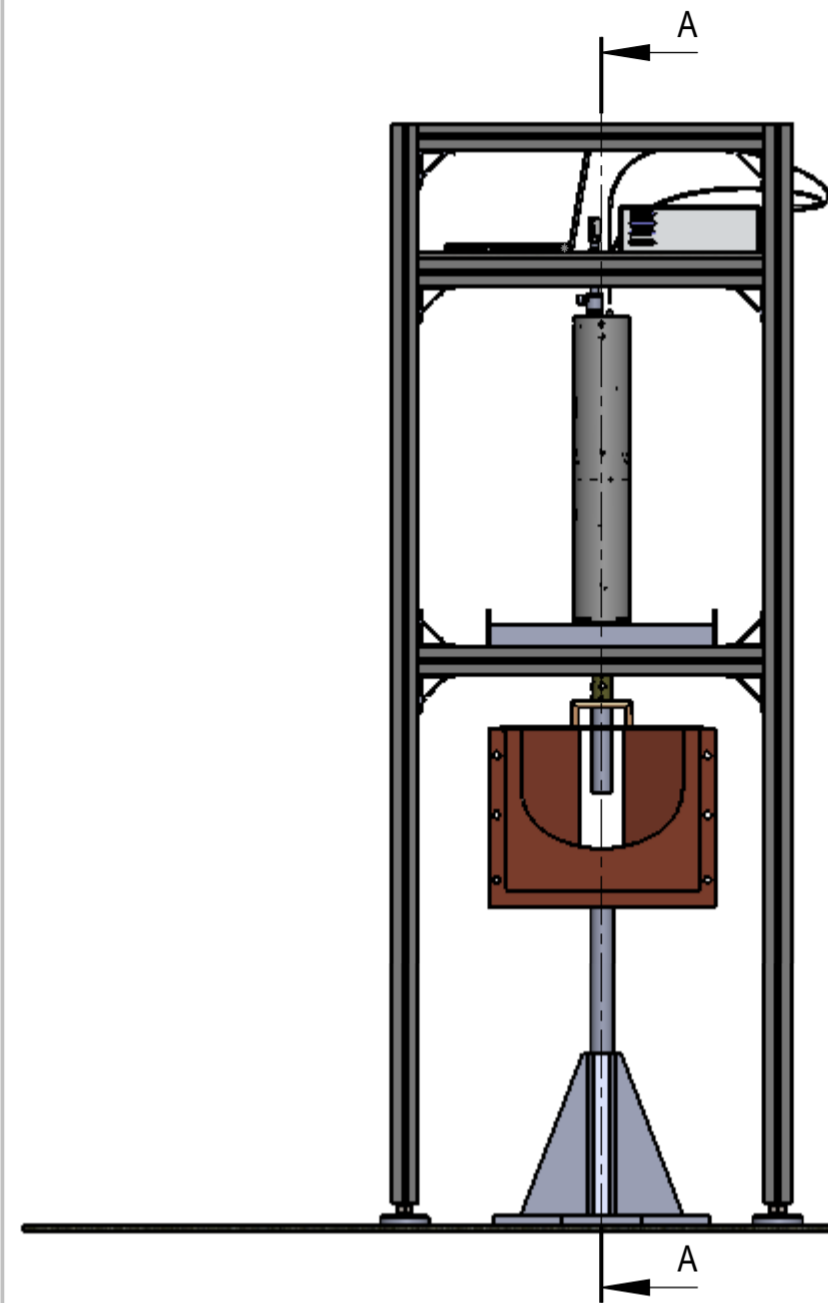




Ultrasonic vibrations in metallurgy (Universal Proposal)

MMM Technology

We can now separate the ultrasonic transducers from the liquid metal using long metal waveguide rods, yet still introduce high ultrasonic power into liquid metals.



Papers:

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[2] M. Prokic - Multifrequency Ultrasonic Actuators with Special Application to Ultrasonic Cleaning in Liquid and Supercritical CO₂. UIA Conference, Atlanta, 10-12 October 2001.

[3] M. Prokic, J. Tapson, B. Mortimer - The ultrasonic Hammer Transducer

[4] M. Prokic, J. P. Sandoz - Innovative MMM Technology for Implementing Power Ultrasonic Technique in Food-Processing Industry. IFT Institute of Food Technologists) symposium 2005 - Advances in Power Ultrasound Research and Technology: Food and Bio-product Applications. New Orleans, USA, July 2005. www.mpi-ultrasonics.com

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Patents:

Below listed patent applications are owned by the company MP Interconsulting (and Miodrag Prokic):

www.mpi-ultrasonics.com

www.mastersonics.com

[1] DISPOSITIF POUR LA GENERATION D'ONDES ULTRASONORES

Inventeurs : Miodrag Prokic et Jean Claude Padoy

N° de publication 2 743 929

N° d'enregistrement national : 96 01029

République Française, Institut National de la Propriété Industrielle, Paris, 25.07.97 & 10.04.98, bulletin 98/15

[2] LINEAR ARRAY OF SONIC AND ULTRASONIC TRANSDUCERS, ASSEMBLED IN THE FORM OF COMPLEX, INTEGRAL TUBE RESONATOR

Applicants: Prokic Miodrag, MP Interconsulting, and Lee, Hee-Myong, Ilsan Suntek, 03.10.2002 - 07.04.2004

European Patent Application: [EP 1 405 679 A1](#)

[3] ULTRASONIC TRANSDUCER

Applicants: Prokic Miodrag, MP Interconsulting, and Lee, Hee-Myong, Ilsan Suntek, 18.06.1999 - 24.07.2002

European Patent Application: [EP 1 050 347 A3](#)

[4] UNIDIRECTIONAL SINGLE PISTON ULTRASONIC TRANSDUCER

Applicant: Prokic Miodrag, MP Interconsulting, 8.06.1999 – 20.12.2000

European Patent Application: [EP 1 060 798 A1](#)

[5] MULTIFREQUENCY ULTRASONIC STRUCTURAL ACTUATOR

Applicant: Prokic Miodrag, MP Interconsulting, 5.03.2001 – 11.09.2002

European Patent Application (related to MMM technology): [EP 1 238 715 A1](#)

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