

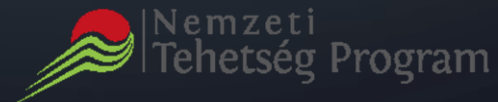
# HYBRID SMALL SIZE HPC RESOURCE – HUSSAR

LASZLO KOVACS, ANDRÁS DR. HAJDU

COMPUTER GRAPHICS AND IMAGE PROCESSING DEPARTMENT  
FACULTY OF INFORMATICS  
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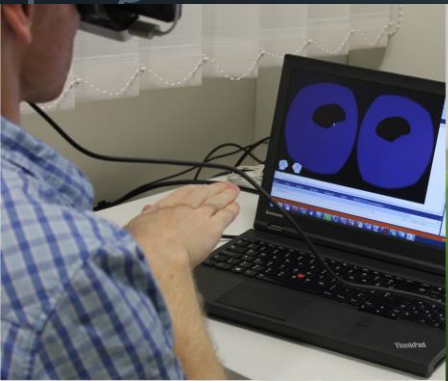
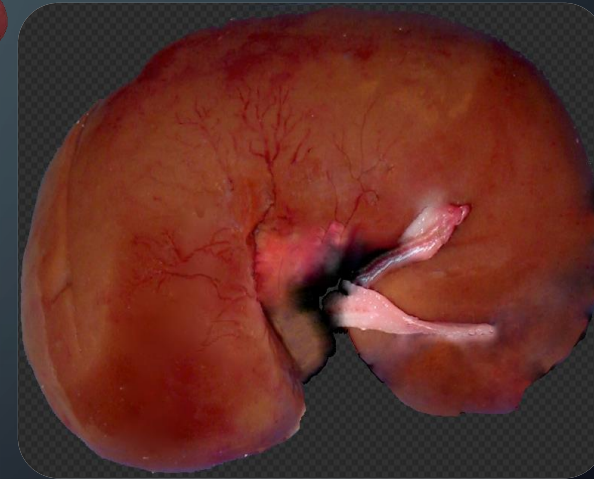
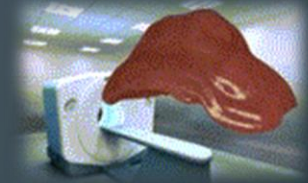
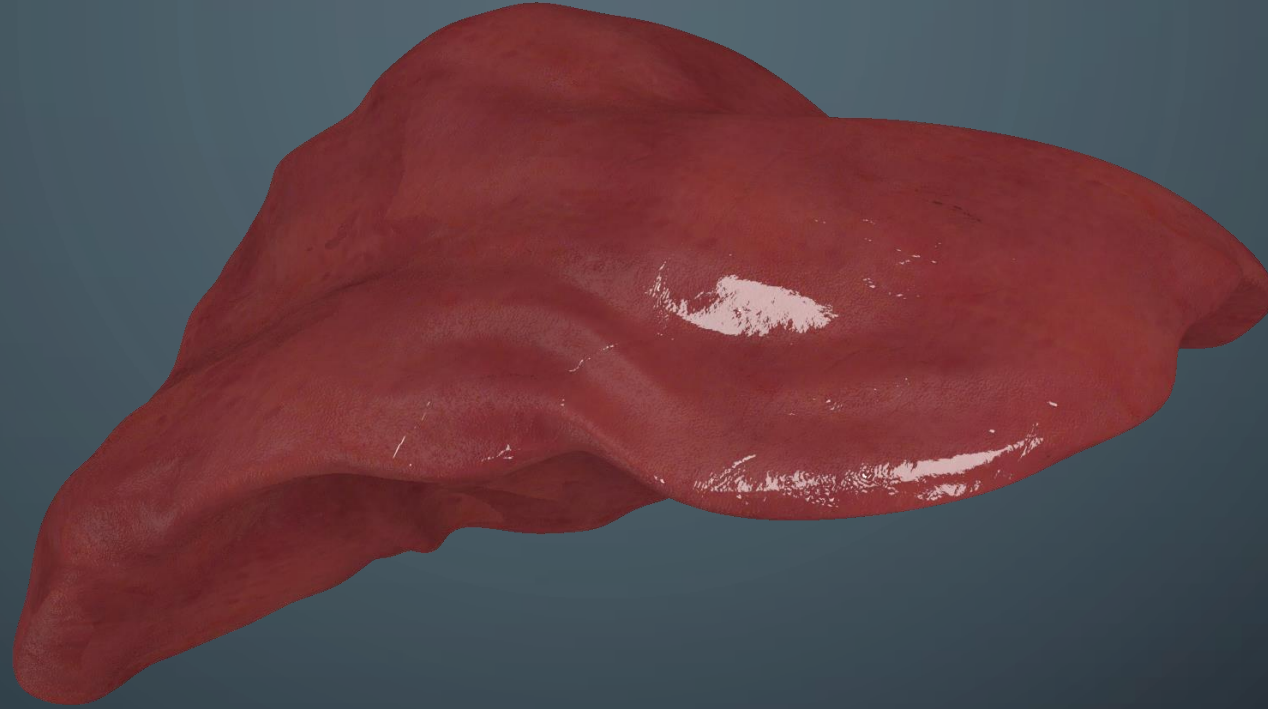
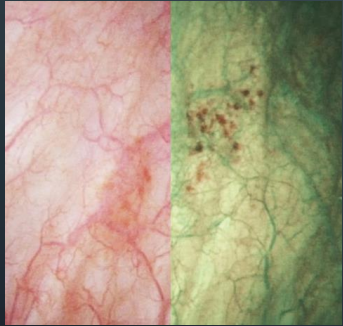
GPU DAY 2017 - THE FUTURE OF MANY-CORE COMPUTING IN SCIENCE

BUDAPEST  
JUNE 22-23, 2017



Hybrid Small Size hpcResource

# 3D CT PHOTOREALISTIC VISUALIZATION SUPPORTED BY HPC COPROCESSORS





HuSSaR

Hybrid Small Size hpcResource

## EXPECTATIONS

- Small
- Mobile
- Operable nonAC environment
- Energy and performance optimized algorithmic environment and solutions
- Scalability



# HUSSAR PROJECT

- Supported by Nvidia via hardware grant
- Hungarian National Talent Program
- Patent pending (coauthors: Dr. András Hajdu, Dr. Balázs Harangi, Anita Sós)
- hybrid Co-processed computing (GPGPU+MIC)

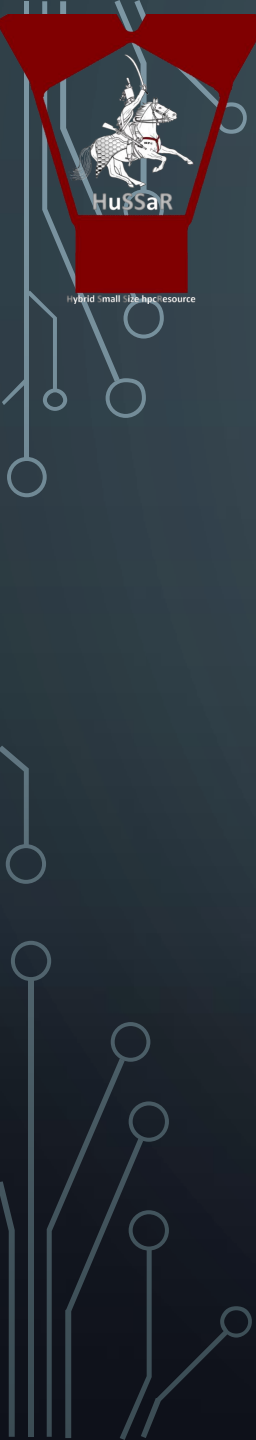


**NVIDIA**



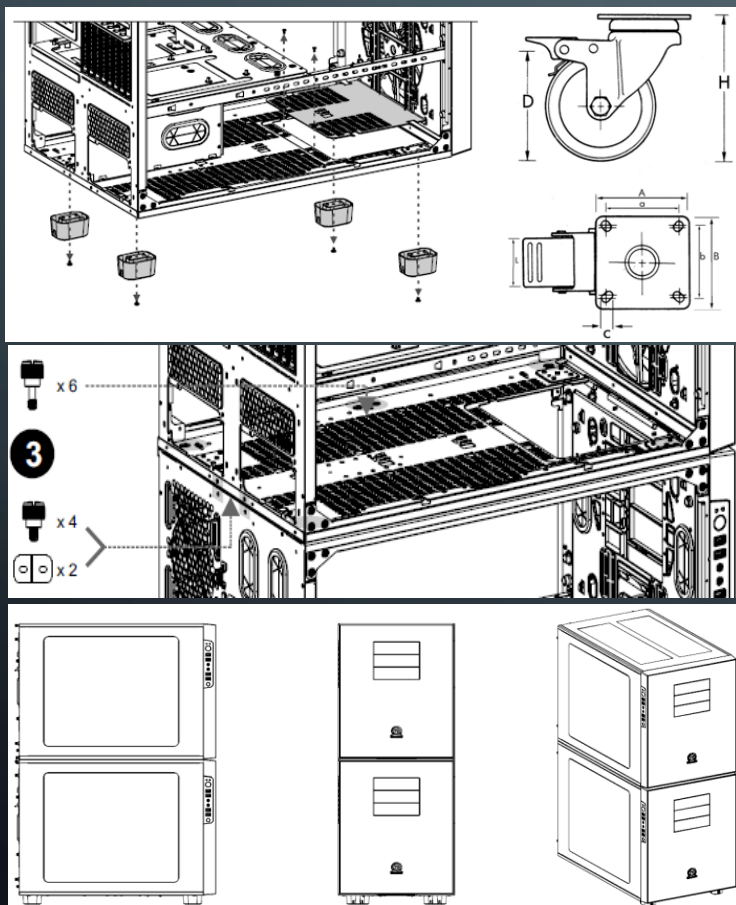
Nemzeti  
Tehetség Program





# HUSSAR PROJECT - BASE

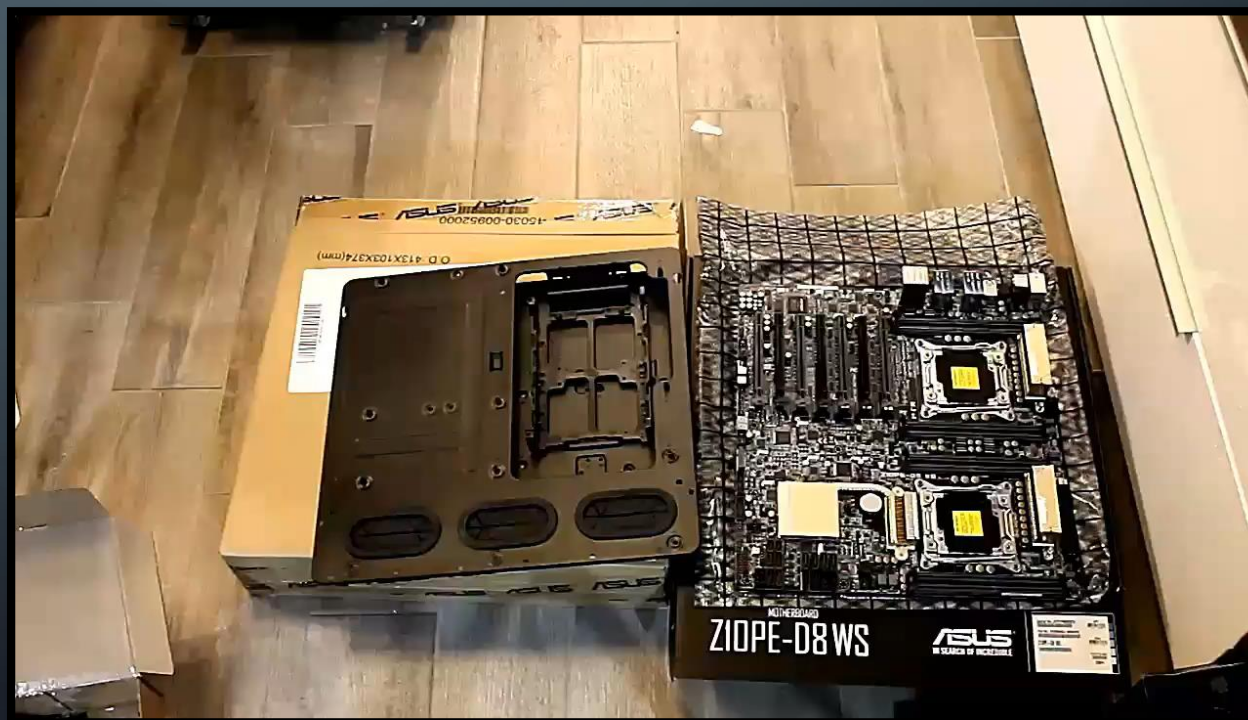
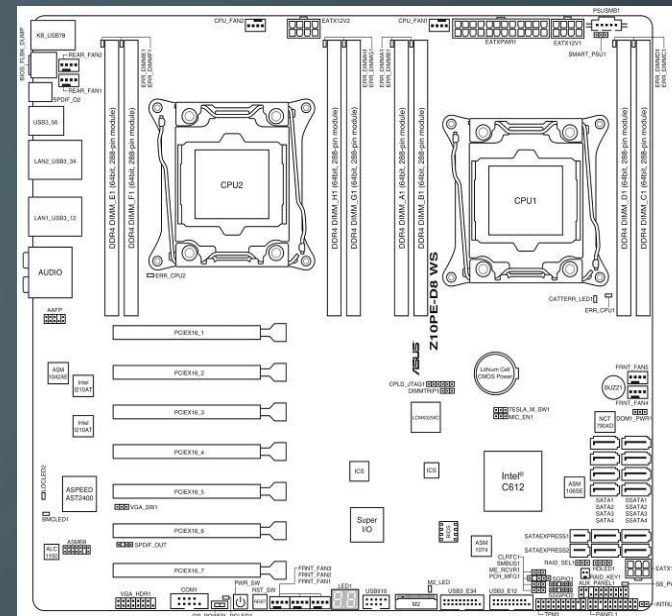
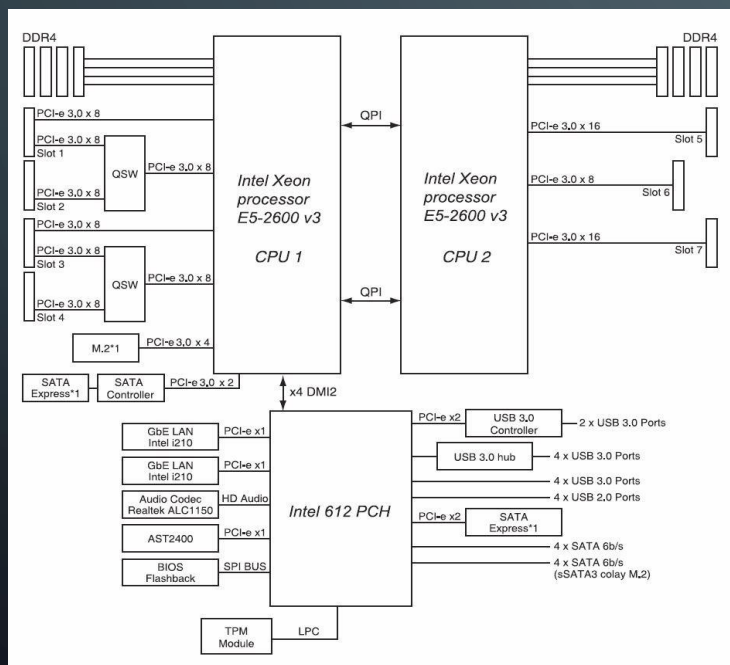
- Case for SSI-EEB sized motherboard
- Heavy-duty wheels:
  - Prototype one: one, max two mainboards (approx. from 50Kg)
  - Prototype two: one, max four mainboards



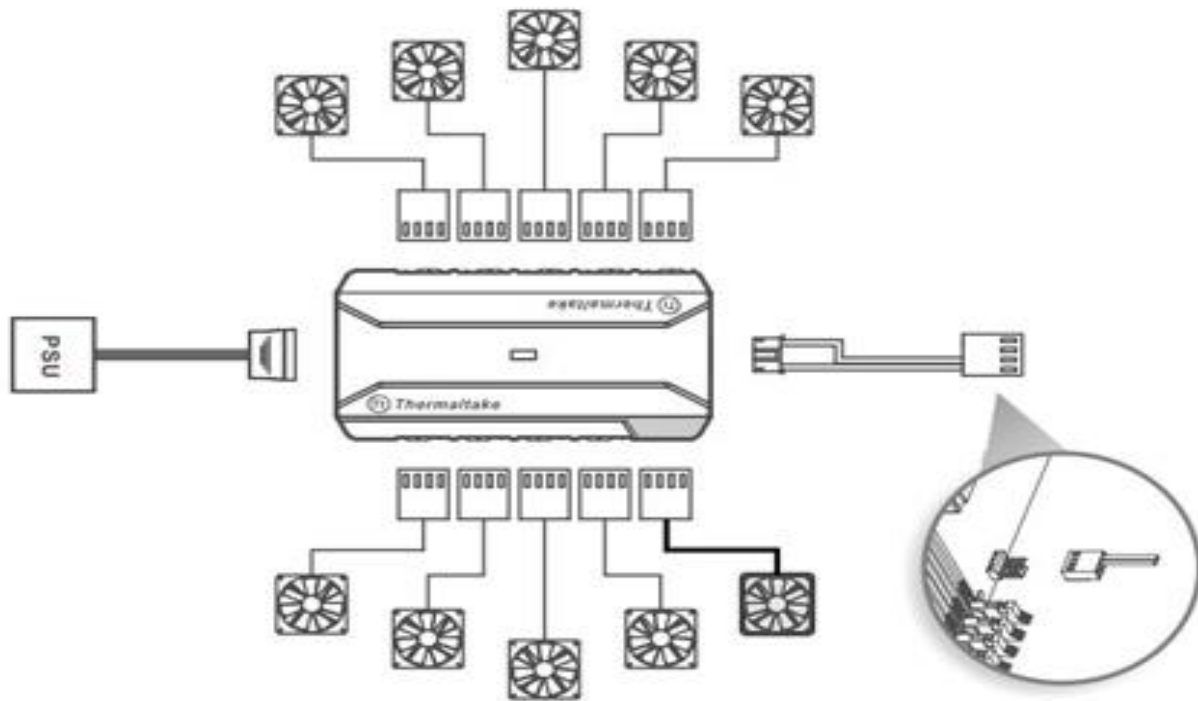
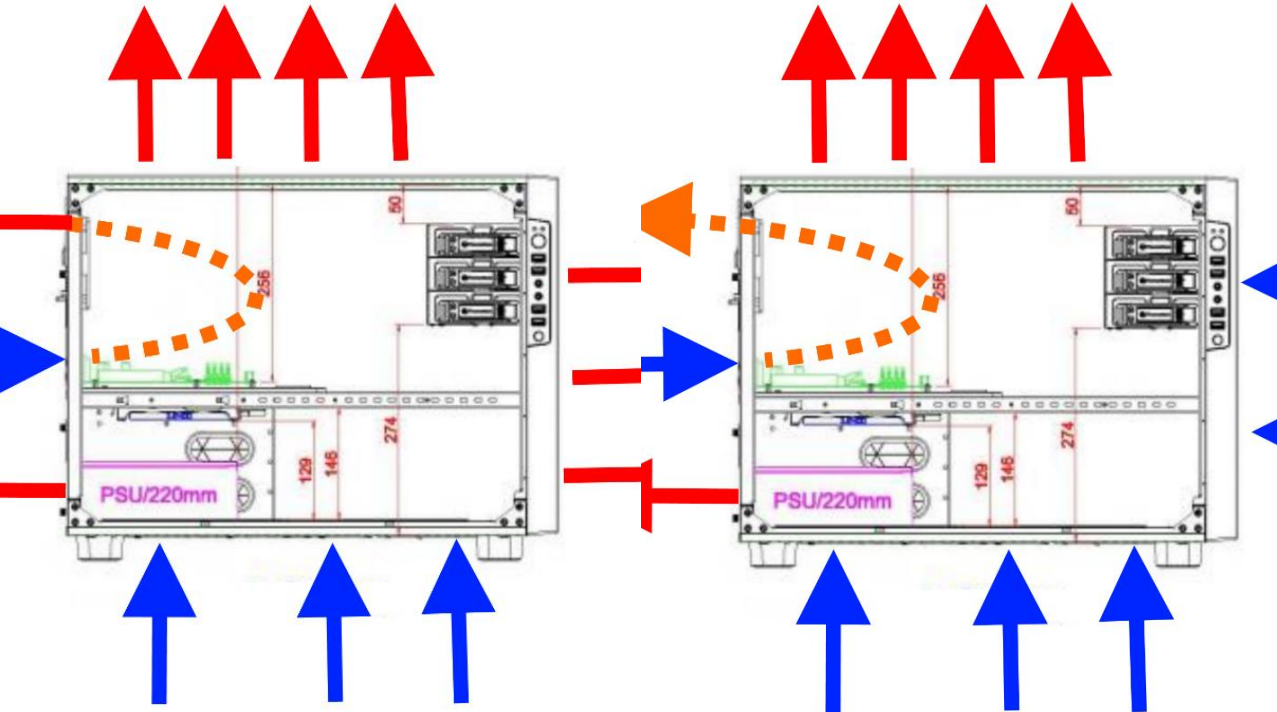


# HUSSAR PROJECT - MAINBOARD

- For a mainboard:
- 2 diff. type cooprocessed cards for every CPU

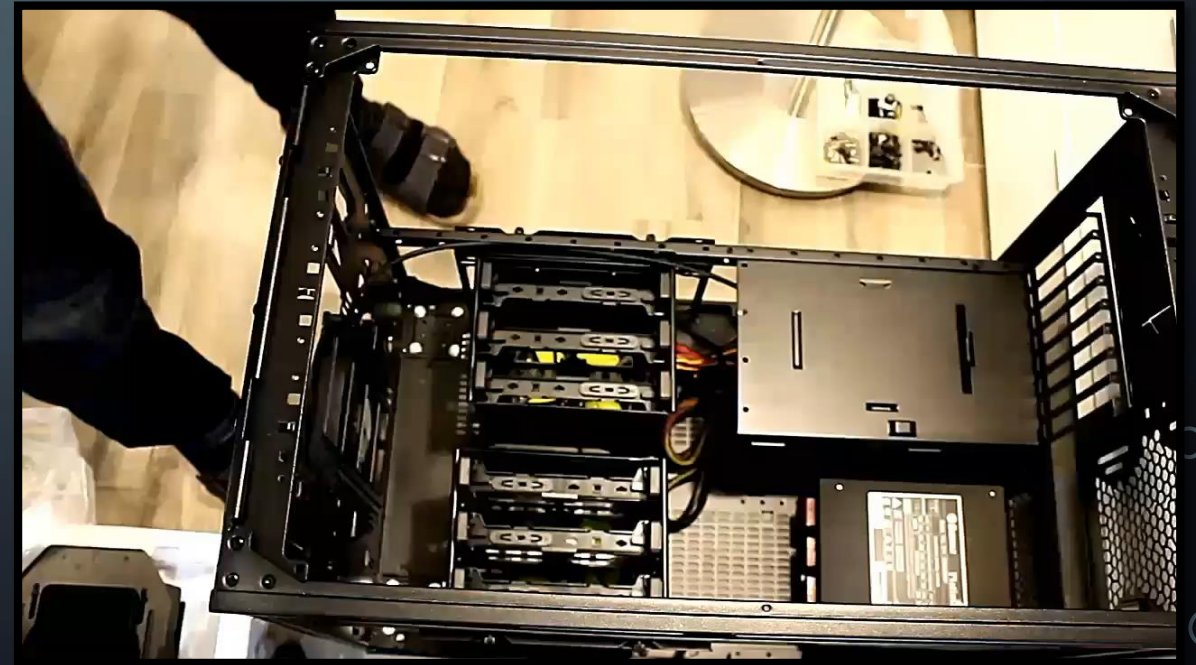






# HUSSAR PROJECT – COOLING (AIR)

- Hybrid air and liquid cooling
- Controlled airflow (direction and static pressure with PWM sign)
  - Speed 3000rpm
  - Max Air Flow: 107 CFM = 181 m<sup>3</sup>/h
  - Static Pressure: 5.81 mm H<sub>2</sub>O = 57 Pa )



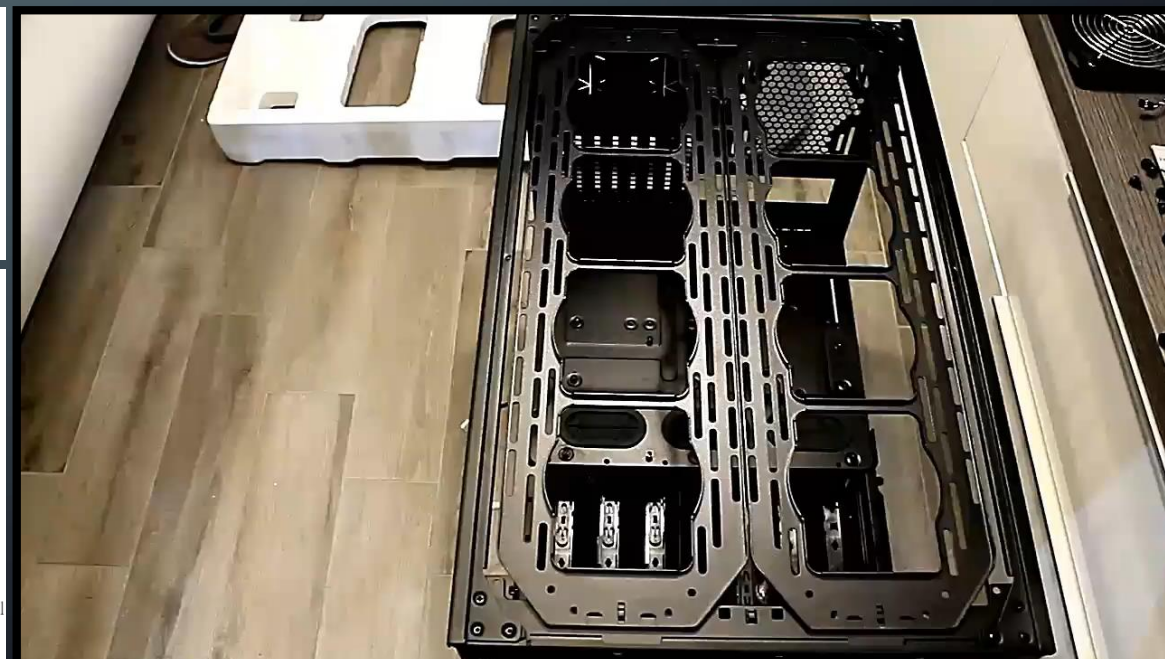
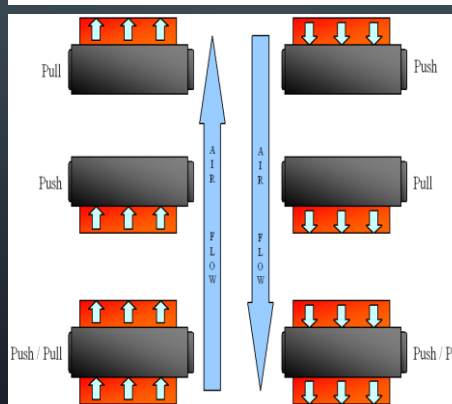
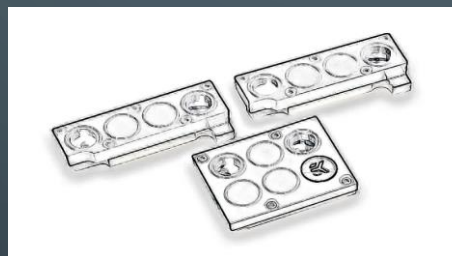
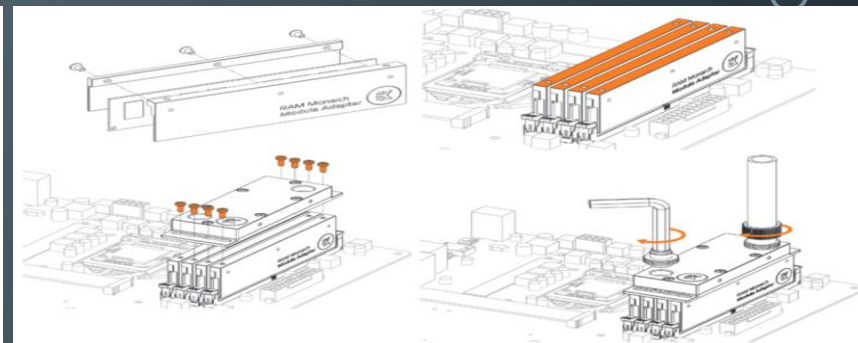
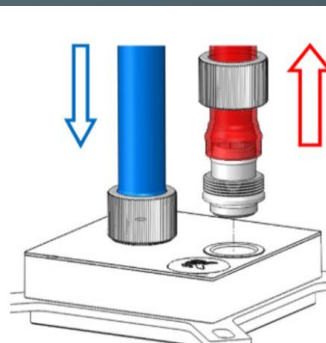
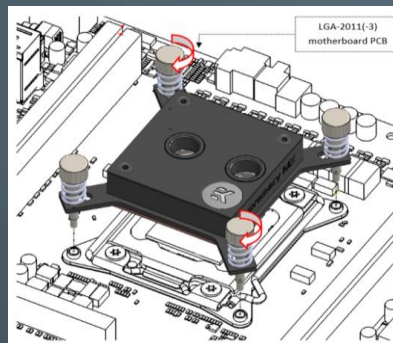


# HUSSAR PROJECT – COOLING (LIQUID)

- Two parallel loops (for two CPUs)

- Cooling Order:

- RAM
- MosFet
- CPU
- Radiator (optinal)
- GPGPU
- Radiator (optinal)
- MIC
- Resovier&Pump  
(overpressure relief valve)
- Radiator



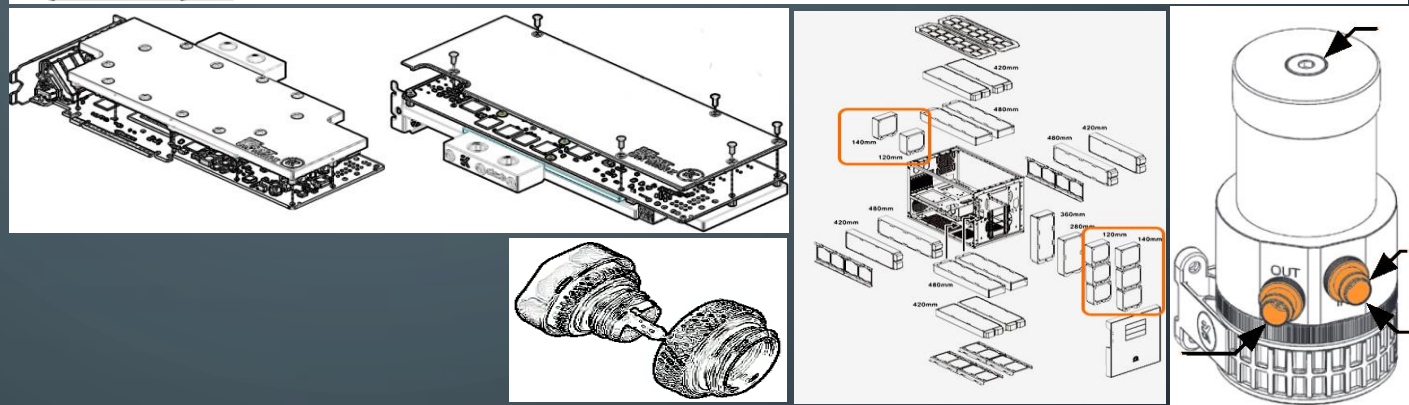
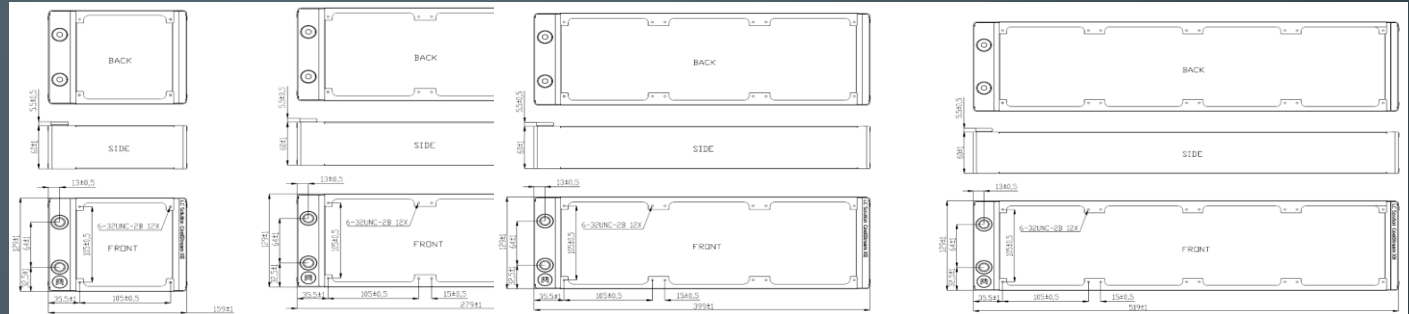




# HUSSAR PROJECT – COOLING (LIQUID)

- Cooling Order:

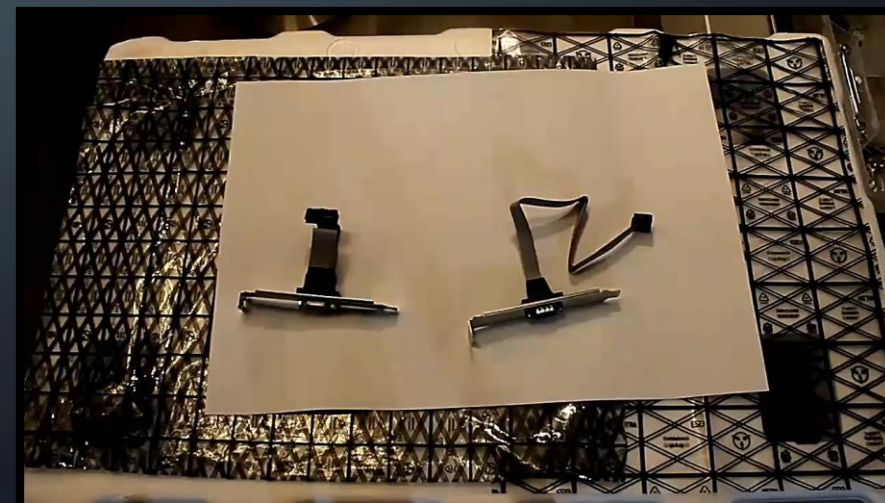
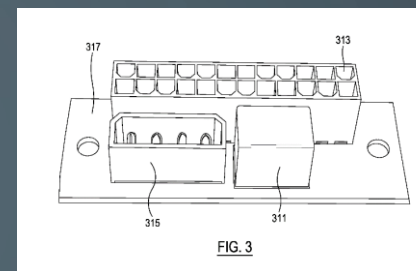
- RAM
- MosFet
- CPU
- Radiator (optinal)
- GPGPU
- Radiator (optinal)
- MIC
- Resovier&Pump  
(overpressure relief valve)
- Radiator





# HUSSAR PROJECT – PSU

- Setup coprocessor cards hybrid way
- PSU (interconnected):
  - One for main operation: 1700W
  - One for cooling: 450W

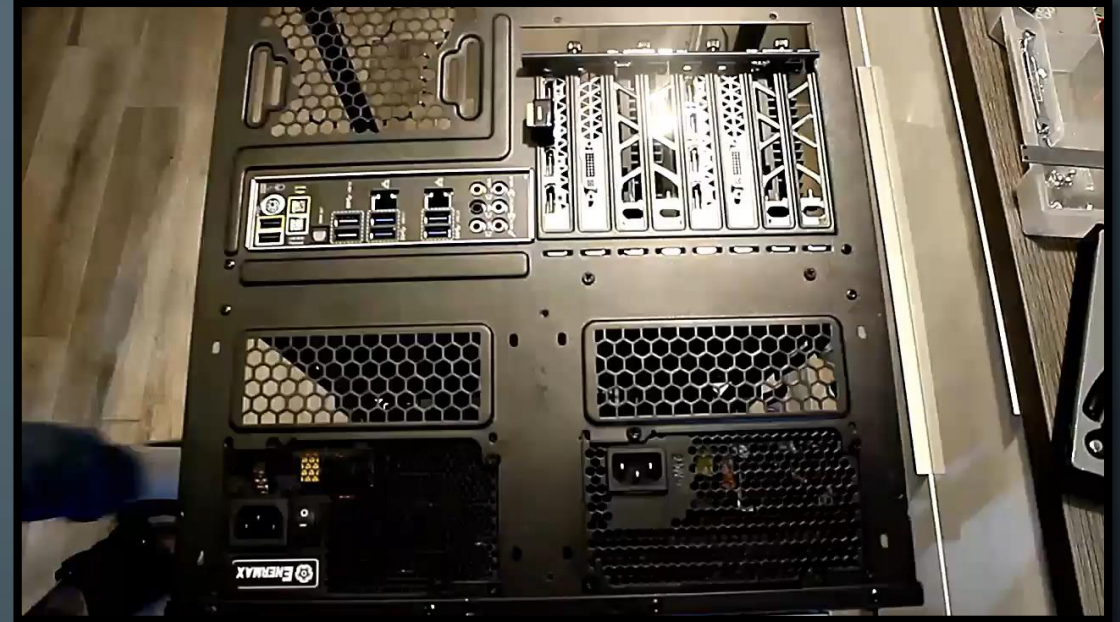
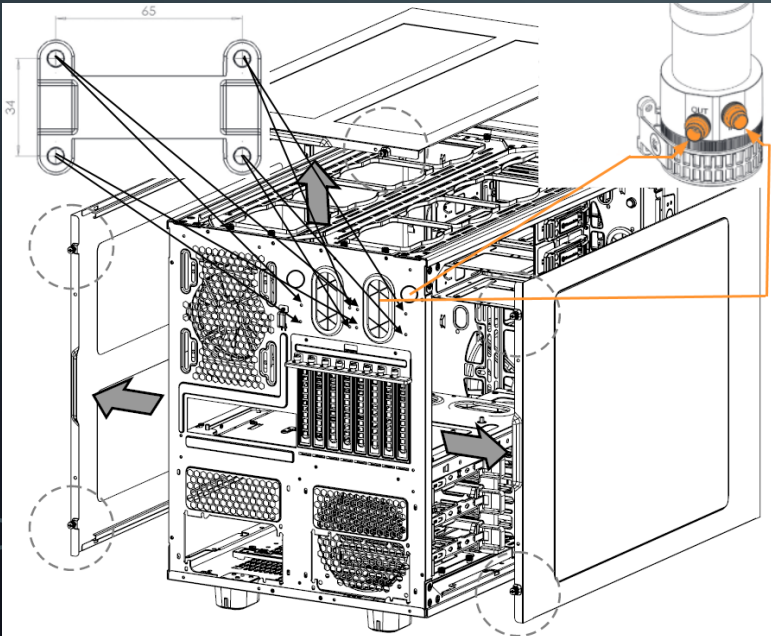






# HUSSAR PROJECT – CASE MODIFICATIONS

- Modifications for components
- Outsided overpressure relief valve

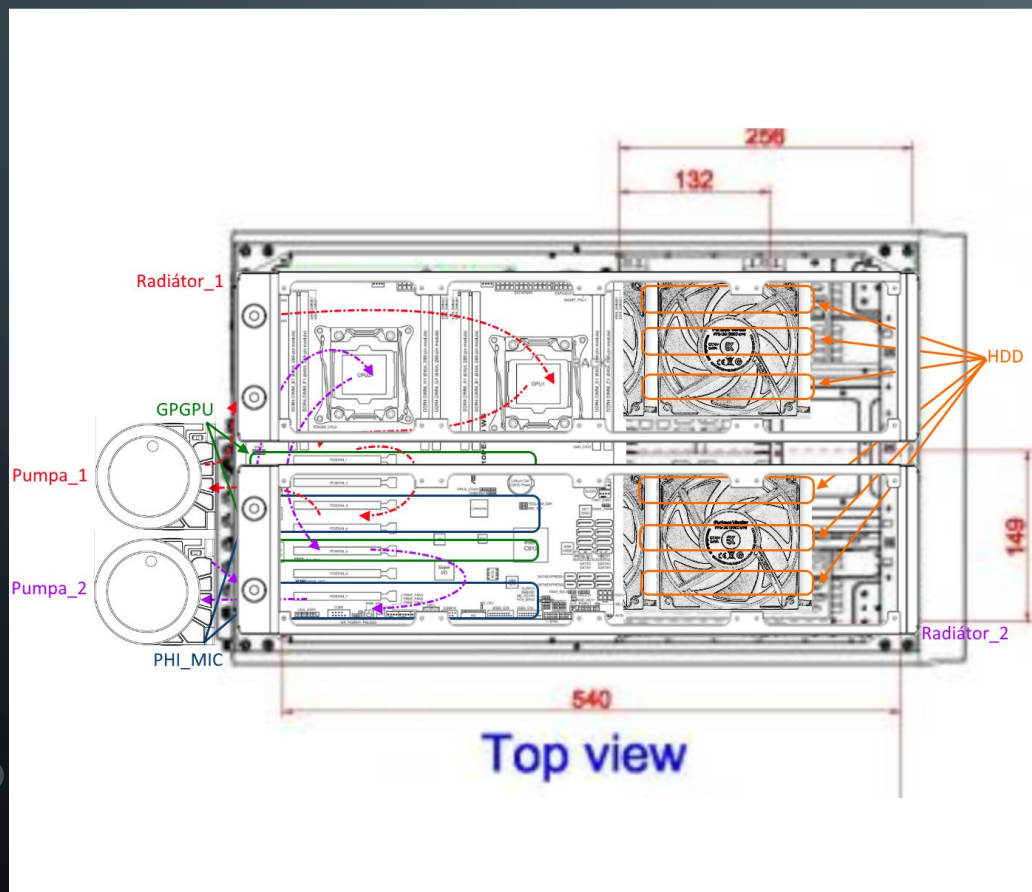






# HUSSAR PROJECT – BENDING

- Connecting components
- Water clear PVC tubes (copper)
- Solid-tube compression fitting (O ring)





# HUSSAR PROJECT – COOL&WARM PRESSURE TEST

## Filling:

- Very clean H<sub>2</sub>O
  - Conductivity:
    - TDS-Total dissolved solids (TDS) ppm-Parts Per Million)
    - Osmosis vs distilled water vs ion-replaced water
- Anti-corrosion material
- Anti-bacterial material

## Pressure test

- Temperatures 35°C, 45°C, 57°C, 70°C

## Configuration (for one compute node):

- Number of cores: 6274 (130 Intel + 6144 Nvidia Cuda)
- Number of threads: 6632 (488 Intel + 6144 Nvidia Cuda)

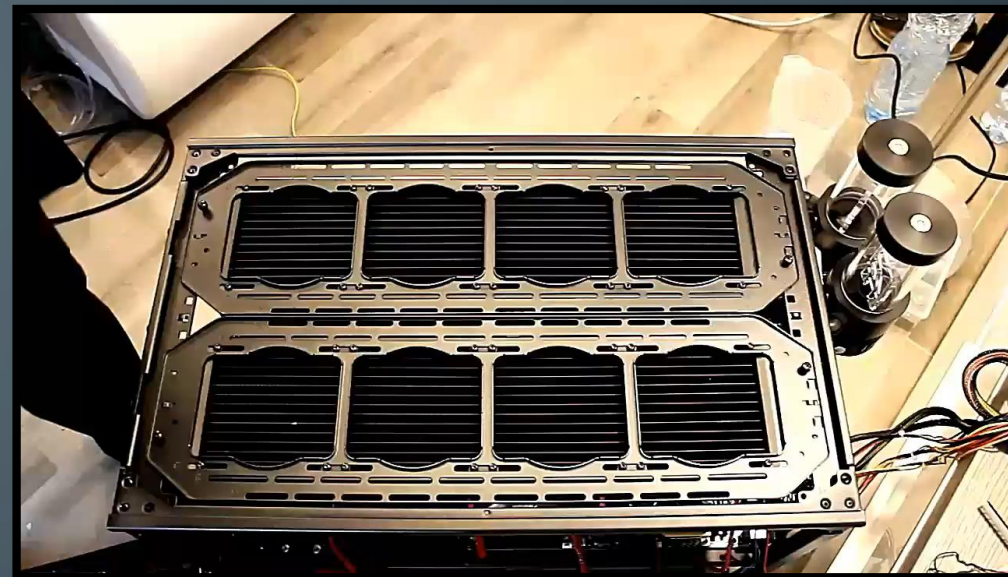
## Performance:

- $2 \times 0.3 \text{Tflop} + 2 \times 2 \text{Tflop} / 1 \text{Tfop} + 2 \times 6.144 \text{Tflop} / 0.206 \text{Tflop}$

## Measured:

- 300GFlop, 1.1Tflop, 1.4TFlop

- [https://arato.inf.unideb.hu/kovacs.laszlo/research\\_hybridmicrohpc.html](https://arato.inf.unideb.hu/kovacs.laszlo/research_hybridmicrohpc.html)







# HUSSAR – POSSIBLE CONFIGURATIONS

- 2017.06.22
- 1 Node: 1 CPU socket 2 coprocessor card up to
  - Cores (up to): 3678 cores (94 intel + 3584 nvidia cuda)
  - Threads (up to): 3916 cores (332 intel+3584 nvidia cuda)
  - Theoretical Tflops: 17.12(single)/8.76(double)Tflop (7.82/4.06Tflop + 9.3(single)/4.06double)
- 1 Node: 2 CPU socket 4 coprocessor card up to (HuSSaR prototype)
  - Cores (up to): 7356 (188 intel + 7168 nvidia cuda)
  - Threads (up to): 7832 (664 intel + 7168 nvidia cuda)
  - Theoretical Tflops: 34,24(single)/17.52(double)Tflop
- 1 Node: 4 CPU socket 8 coprocessor card up to
  - Cores (up to): 14712 Cores (376 intel + 14336 nvidia cuda)
  - Threads (up to): 15664 Threads (1328 intel + 14336 nvidia cuda)
  - Theoretical Tflops: 136,96(single)/70,08(double)Tflop
- 1 Node with 1 - 3 computing node
  - Cores (up to): 58848 Cores (1504 intel + 57344 nvidia cuda)
  - Threads (up to): 62656 Threads (5312 intel + 57344 nvidia cuda)
  - Theoretical Tflops: 273,92(single)/140,16(double)Tflop



# SUMMARY

- Operable on room temperature
- Hybrid coprocessor architecture
- Scalable (built in compute nodes)
- Numerous application fields
- Among application fields:
  - clinical screening systems in hospitals, surgeries, mobile screening on trucks
  - many computing task in learning and operation phase regarding all the architectures
- Patent pending (coauthors: Dr. András Hajdu, Dr. Balázs Harangi, Anita Sós)
- Current Work:
  - Hybrid linpack computing, deep learning, medical screening
- FPGA as a coprocessor also possible
- Project Homepage:  
[https://arato.inf.unideb.hu/kovacs.laszlo/research\\_hybridmicrohpc.html](https://arato.inf.unideb.hu/kovacs.laszlo/research_hybridmicrohpc.html)  
<https://youtu.be/vK3CNU3XGAU>



THANKS FOR YOUR ATTENTION!

