

*To: Bapak Iman Hartaman
PT. Tamura Air Conditioning Indonesia*

Room Cooling Analysis in Workshop Area D95C Version 14A Modified – With Plastic Cover

By: Dena Hendriana, B.Sc., S.M., Sc.D
Center for Computational Fluid Dynamics
MIT Alumni Researcher

Purpose of the Analysis

- *To analyze room cooling effectiveness*
 - *Analyze air temperature around workers*
 - *Flow recirculations*
- *Aims:*
 - *To provide recommendations to improve air temperature (comfort) around workers*

Job Itemizations

- ***Pre-processing***

- Cleaning geometries, modeling, setting up cases, etc.

- ***CFD Simulations***

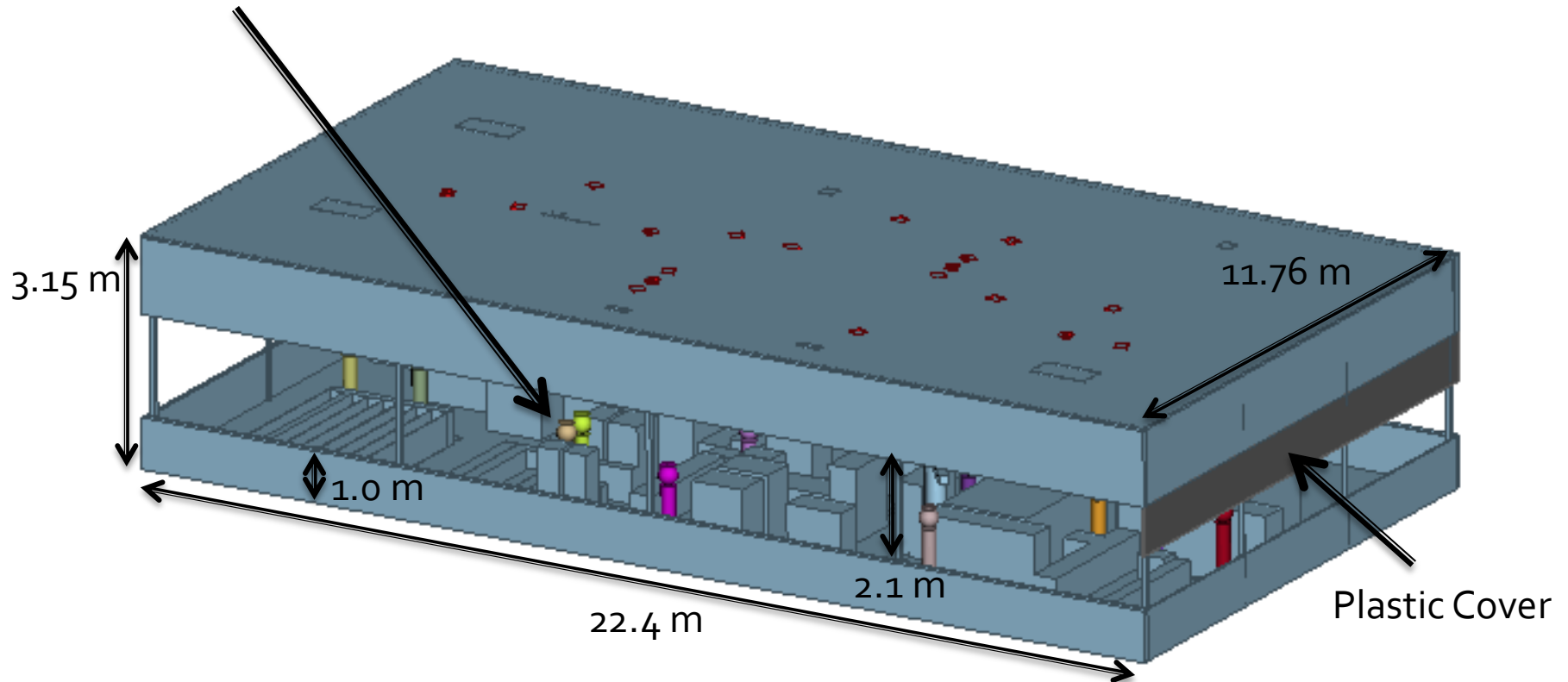
- Room cooling D95C Version 14A Modified with plastic cover

- ***Post-processing***

- CFD results
- Preparing report

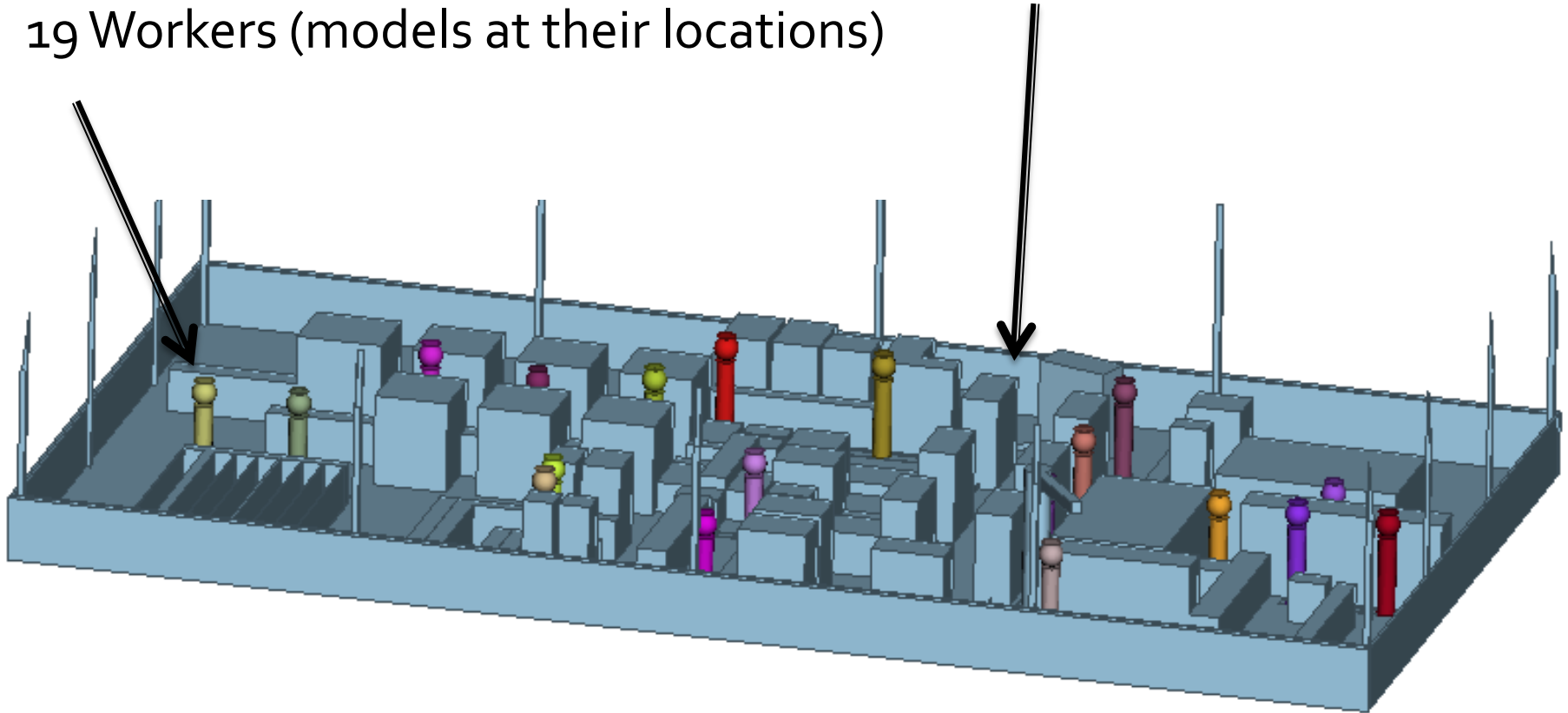
Room Configuration

- Workshop is open for air circulations
- Simplified machinery and equipments (boxes)
- 19 Workers (models at their locations)



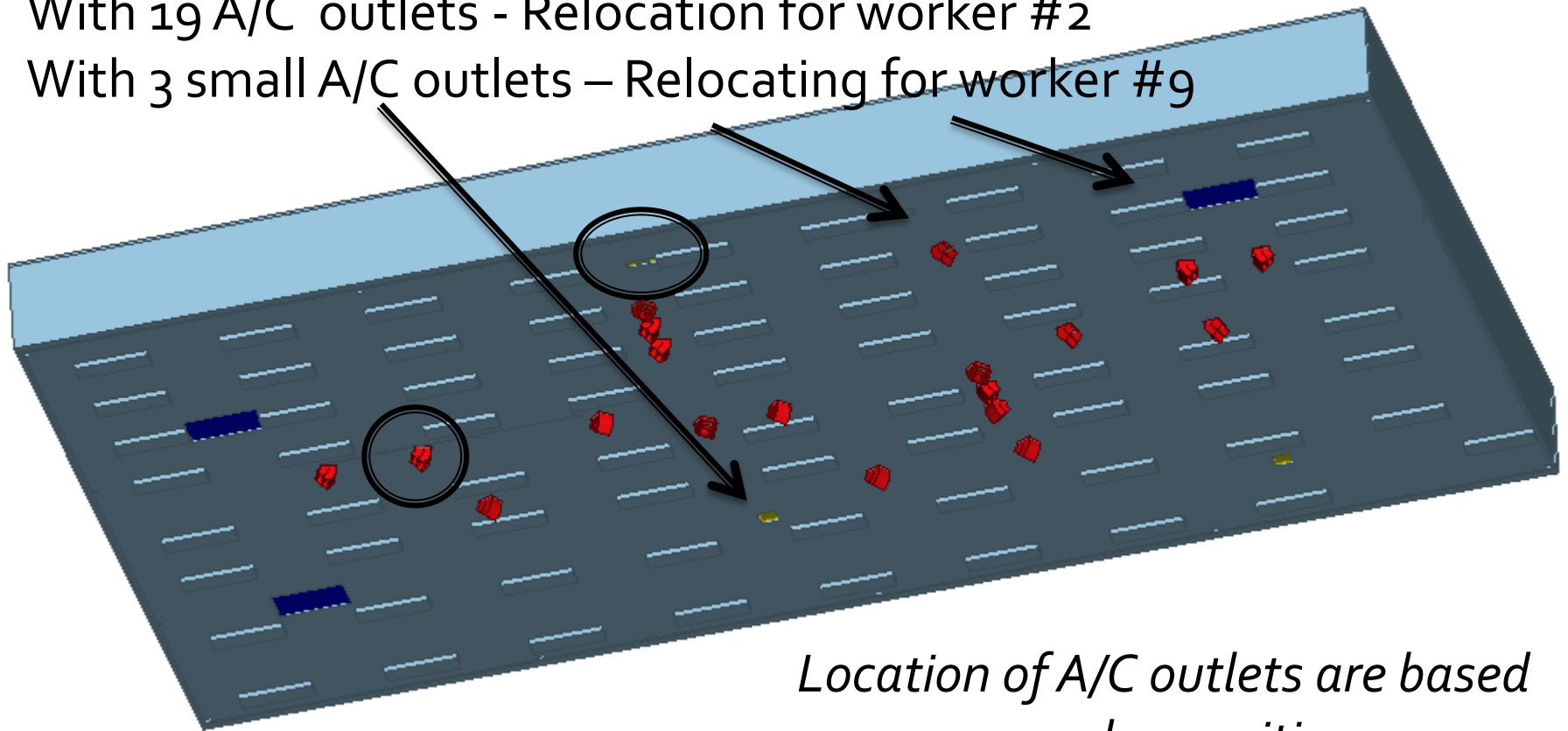
Room Configuration

- Workshop Floor Plan
- Simplified machinery and equipments (boxes)
- 19 Workers (models at their locations)



Room Configuration

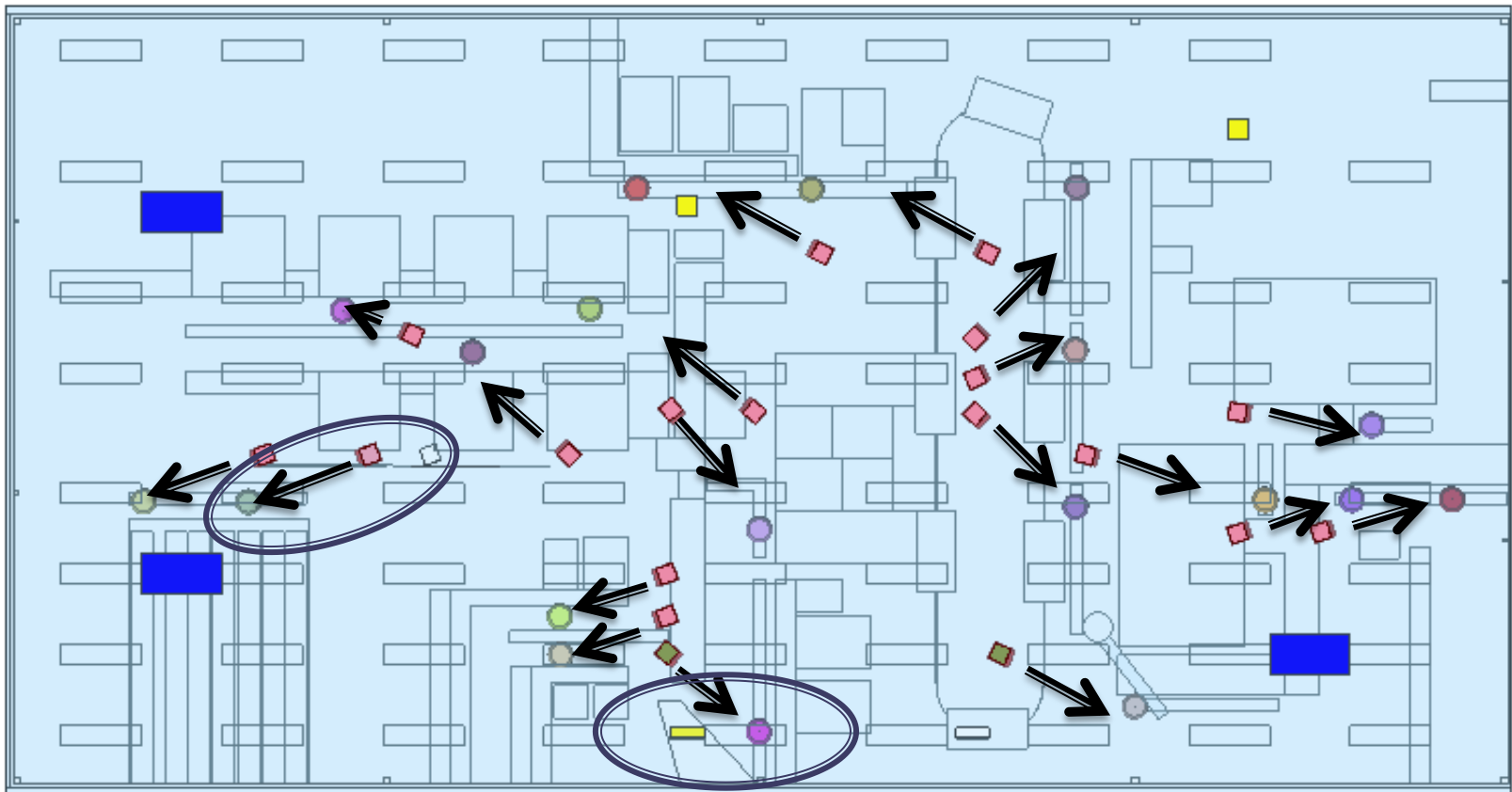
- Workshop Ceiling
- With 3 A/C recirculation inlets
- With 19 A/C outlets - Relocation for worker #2
- With 3 small A/C outlets – Relocating for worker #9



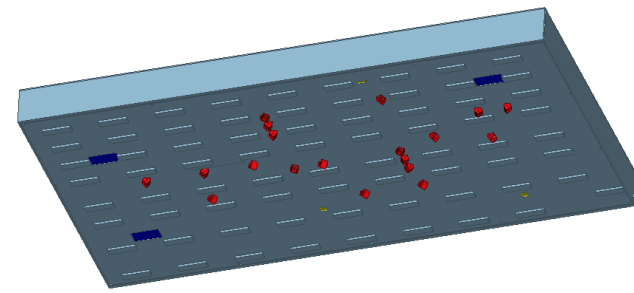
Location of A/C outlets are based on worker positions

Room Configuration

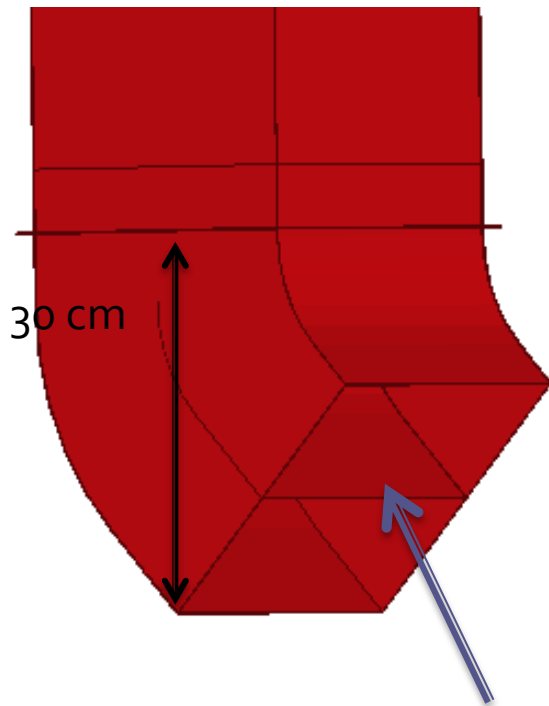
- Outlet airflow directions
- With 3 A/C recirculation inlets
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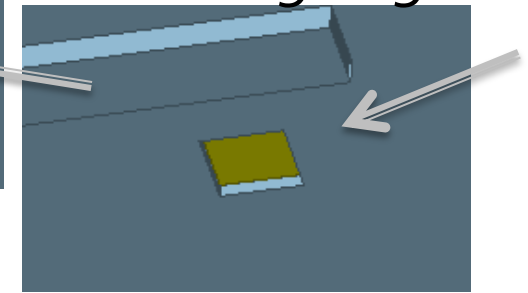
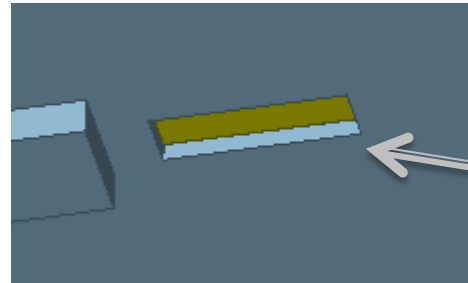
A/C outlet and inlet



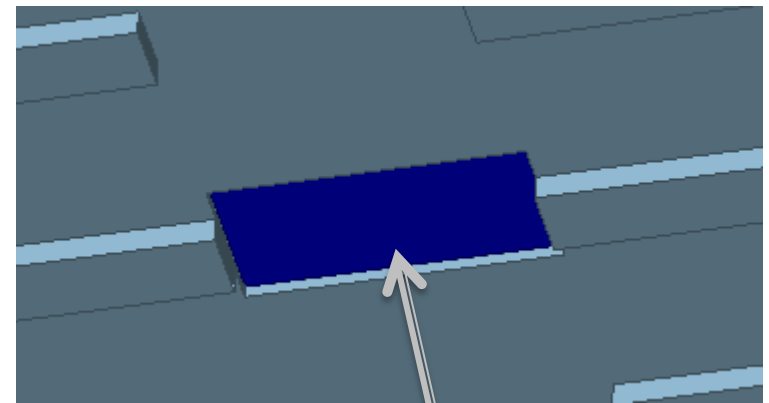
- Details of A/C outlet and inlet



*Opening Area 25 x 25 cm
Bended to 45 degree*



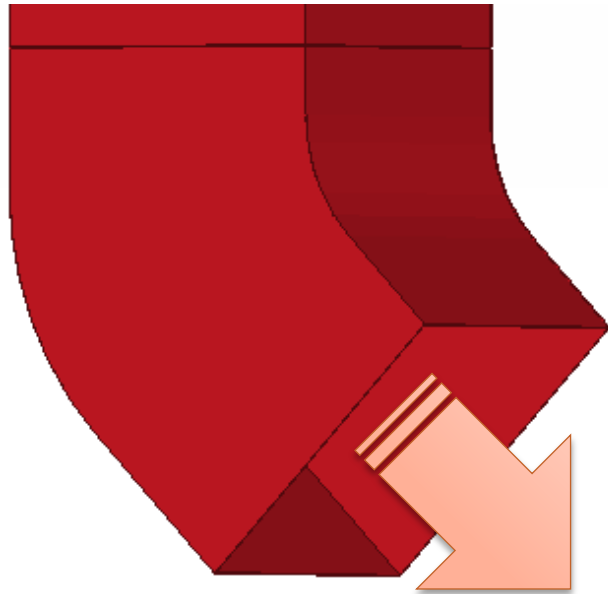
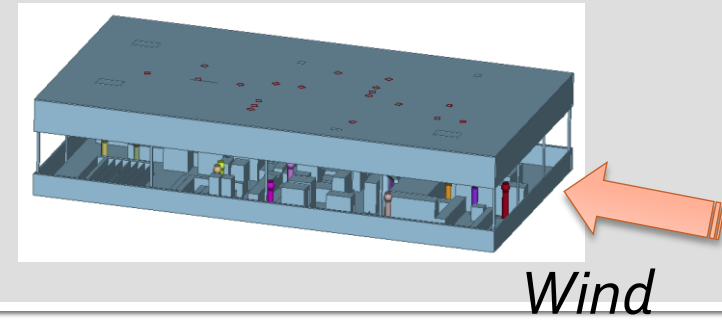
*Extra A/C outlet opening
Area 15 x 50 cm
Area 30 x 30 cm*



A/C Inlet opening Area 60 x 120 cm

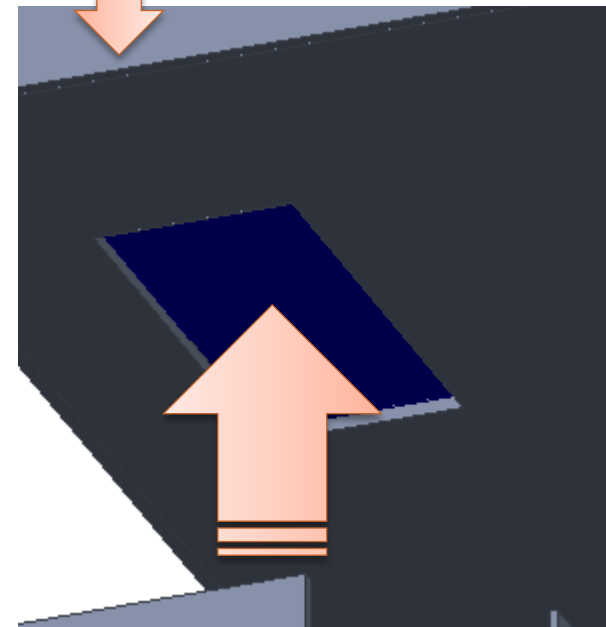
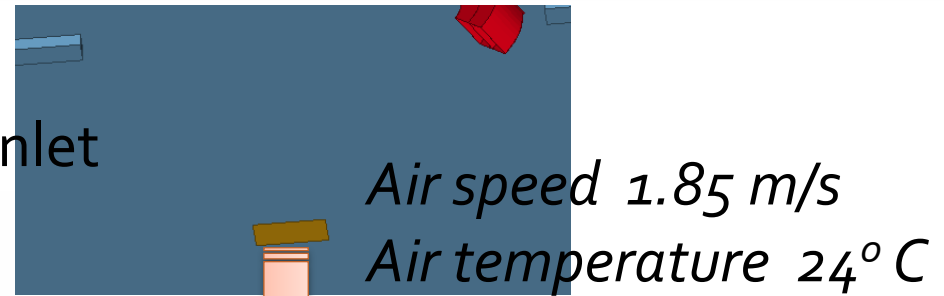
A/C outlet and inlet

- Ambient air temperature 33° C
- Wind speed of 0.3 m/s
- Air Condition at A/C outlet and inlet



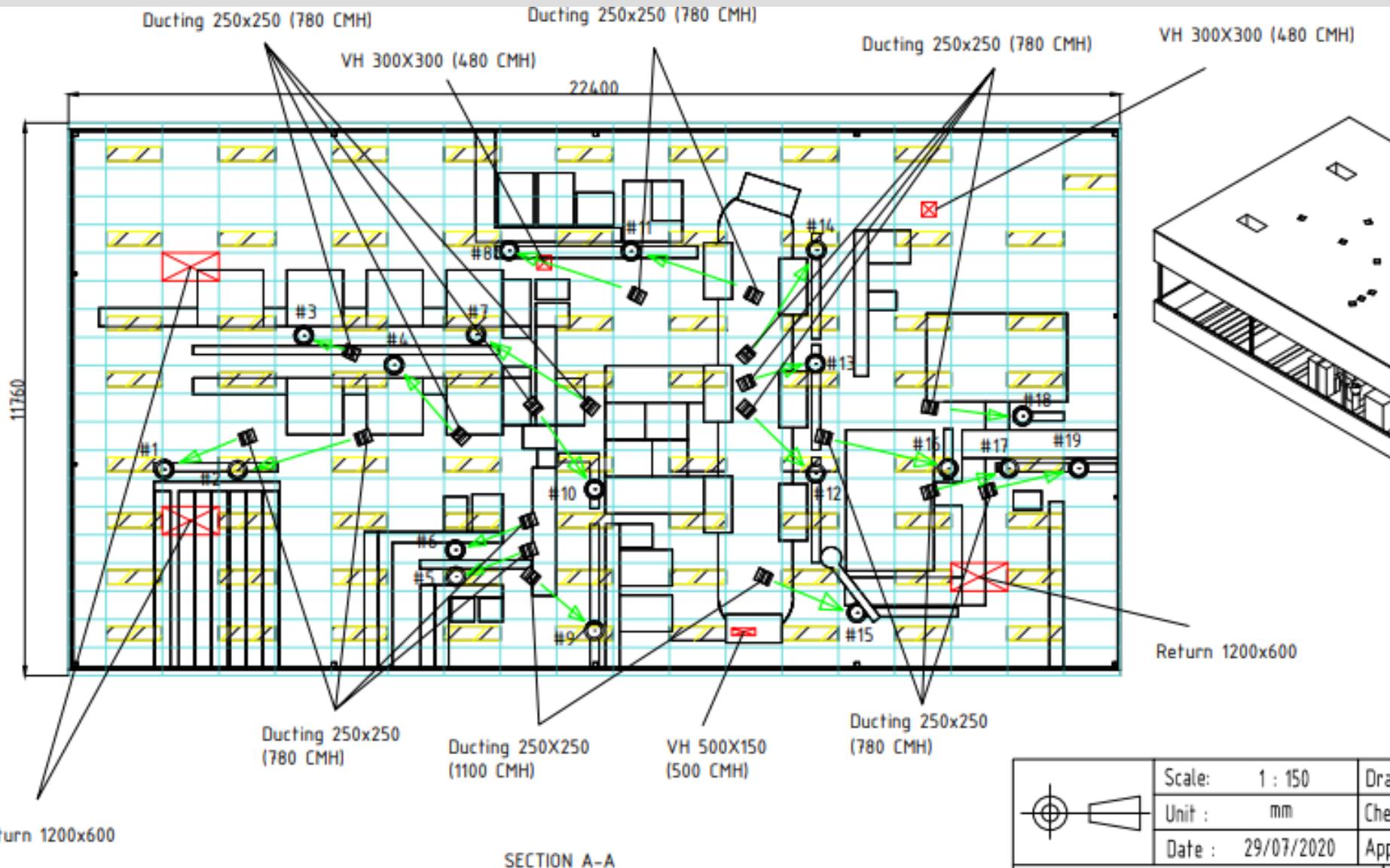
Air speed 3.46 m/s
Air temperature 24° C

$$Vel \times Area|_{outlet} = Vel \times Area|_{inlet}$$



Air speed 2.189 m/s

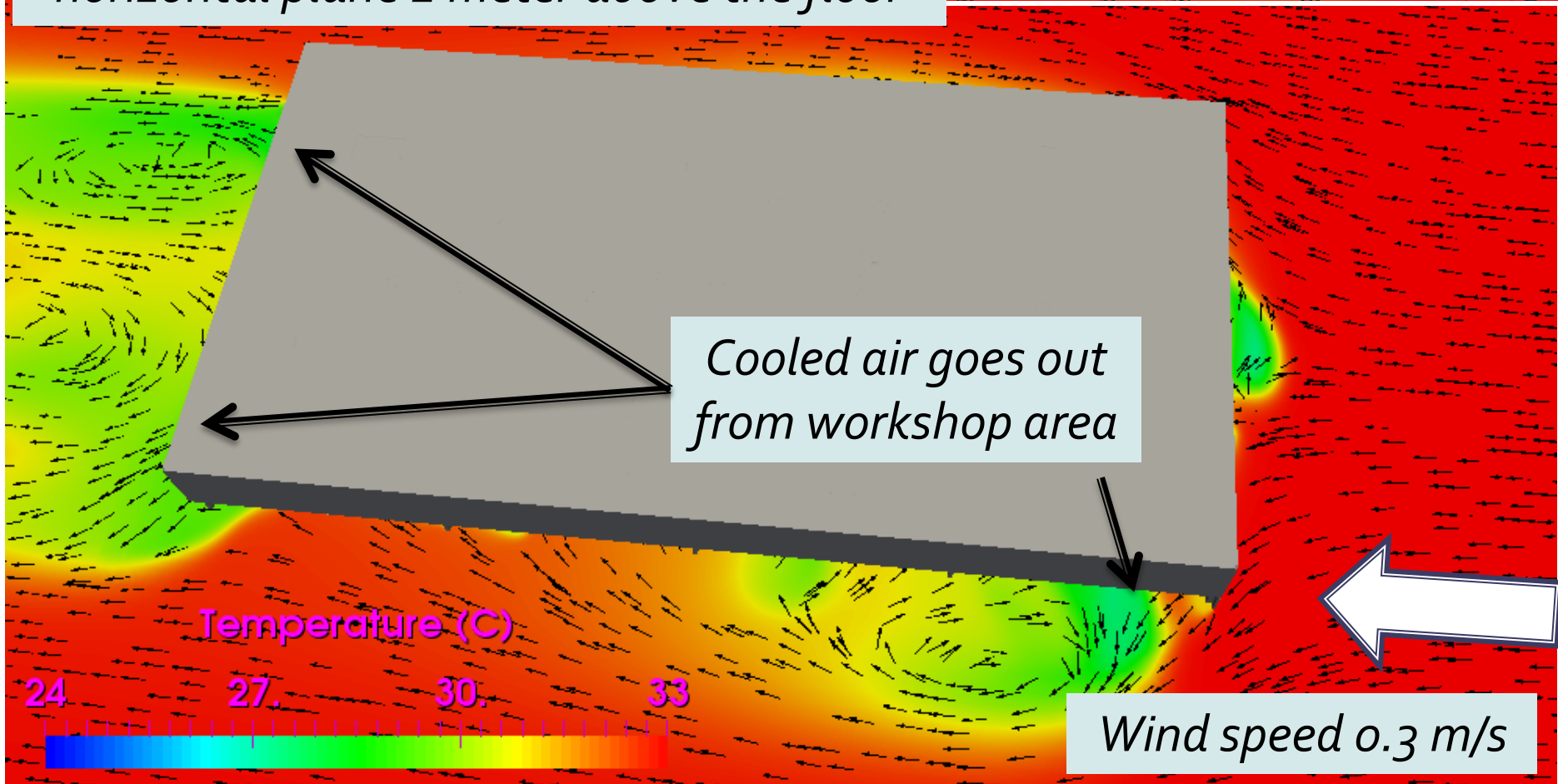
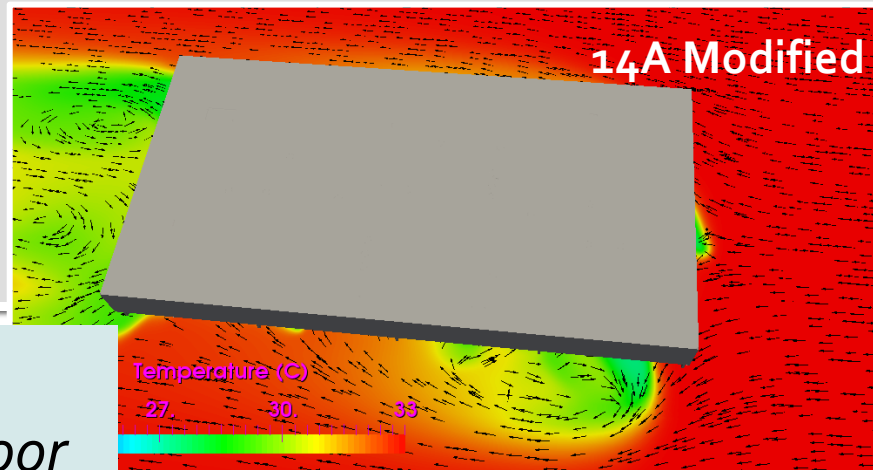
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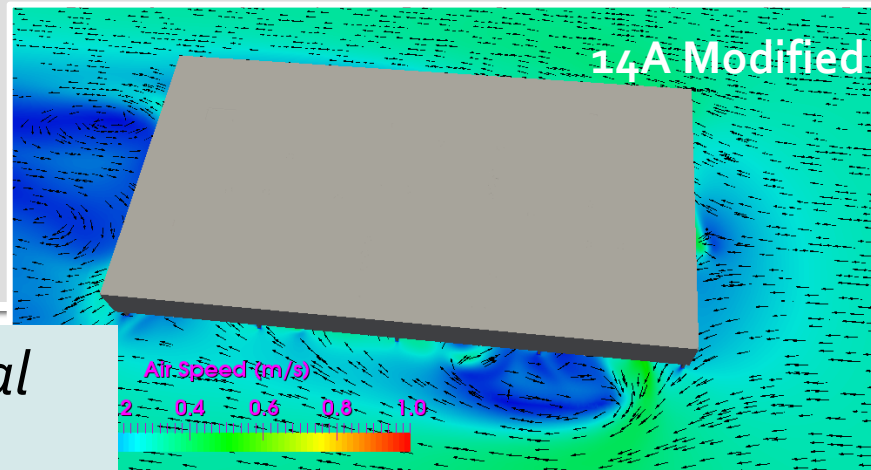
CFD Result

14A Modified

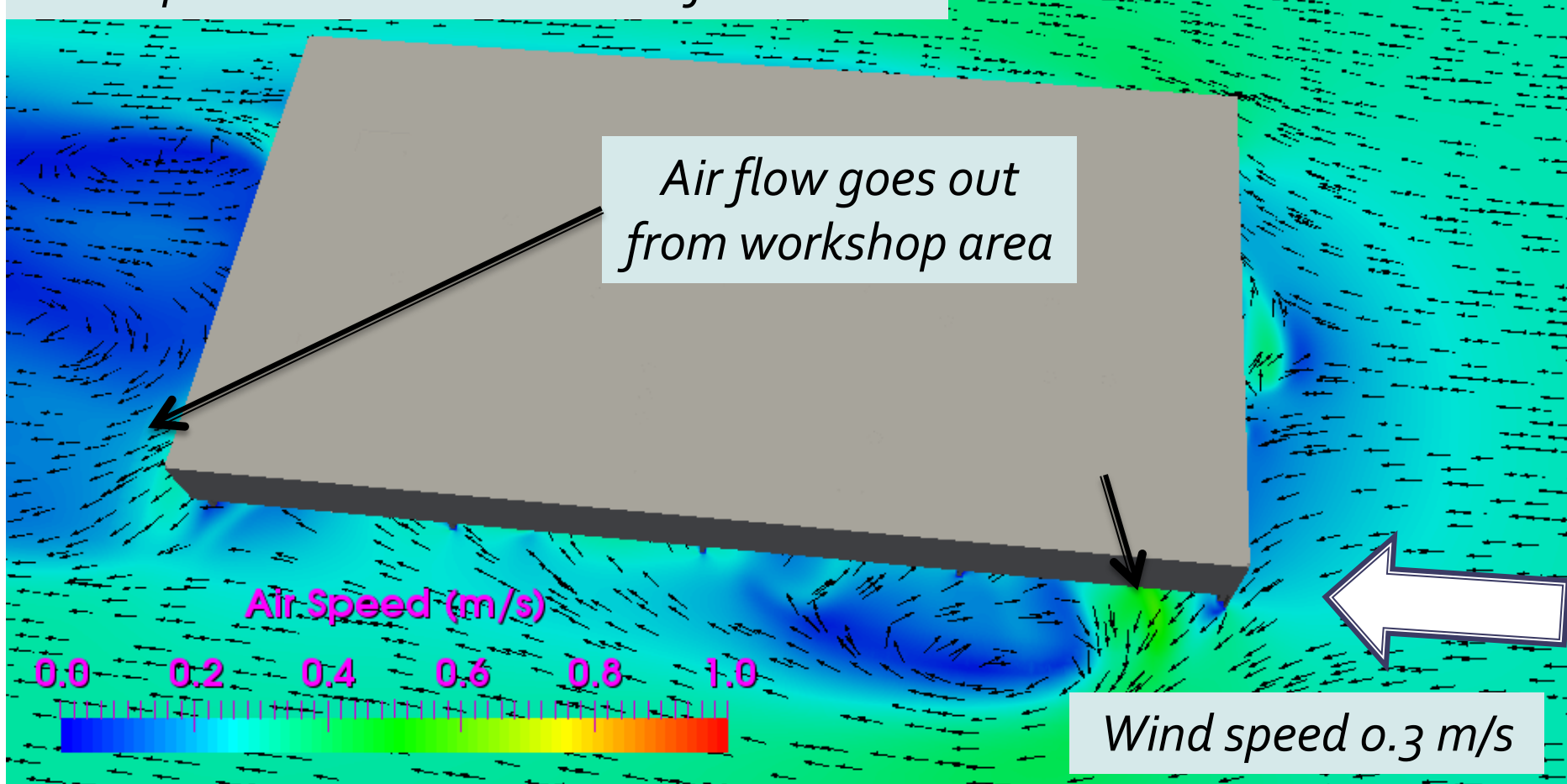
Air temperature distribution on a horizontal plane 2 meter above the floor



CFD Result



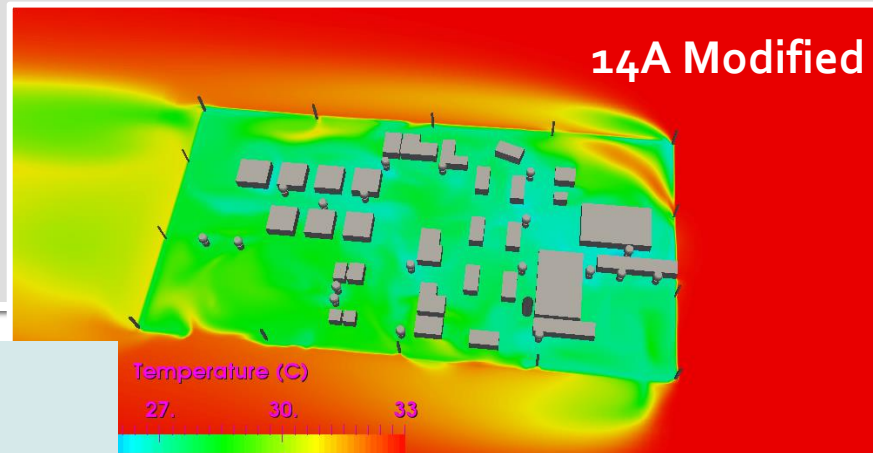
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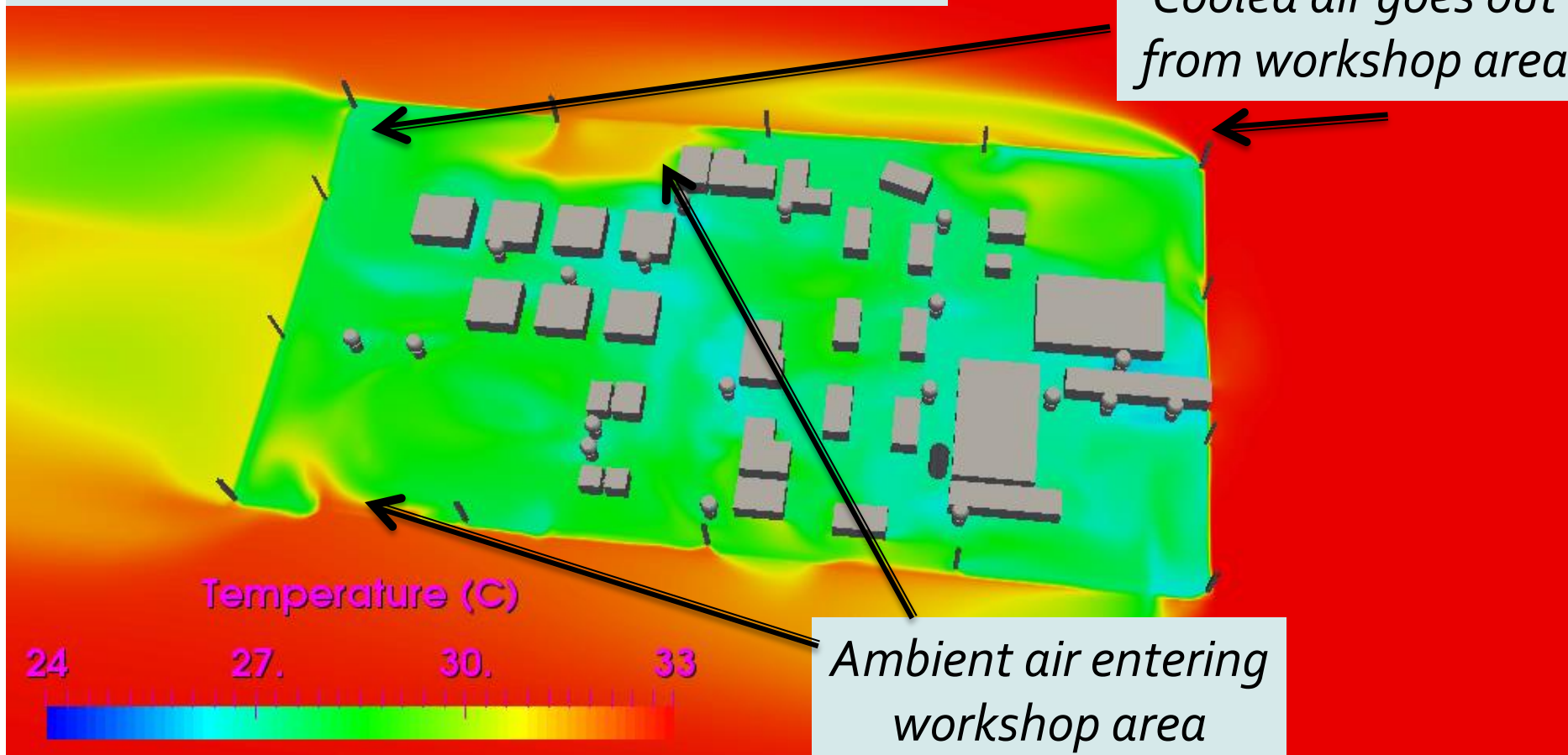
CFD Result

14A Modified

Air temperature distribution on a horizontal plane 1 meter above the floor

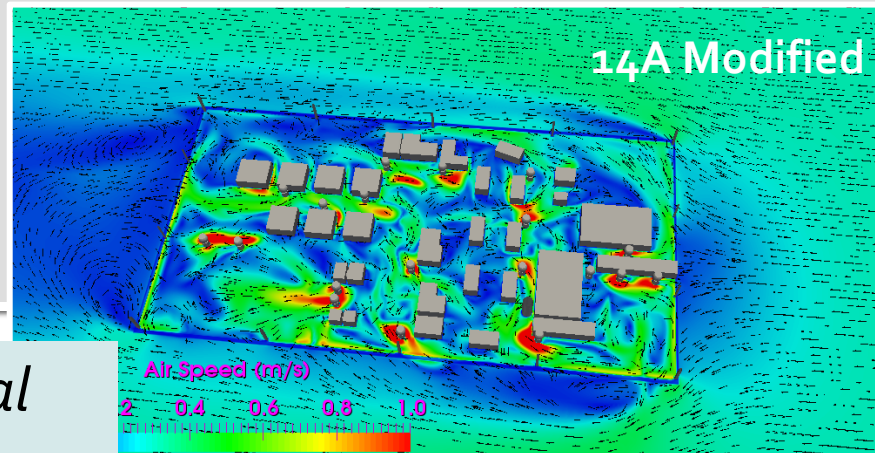


Cooled air goes out from workshop area

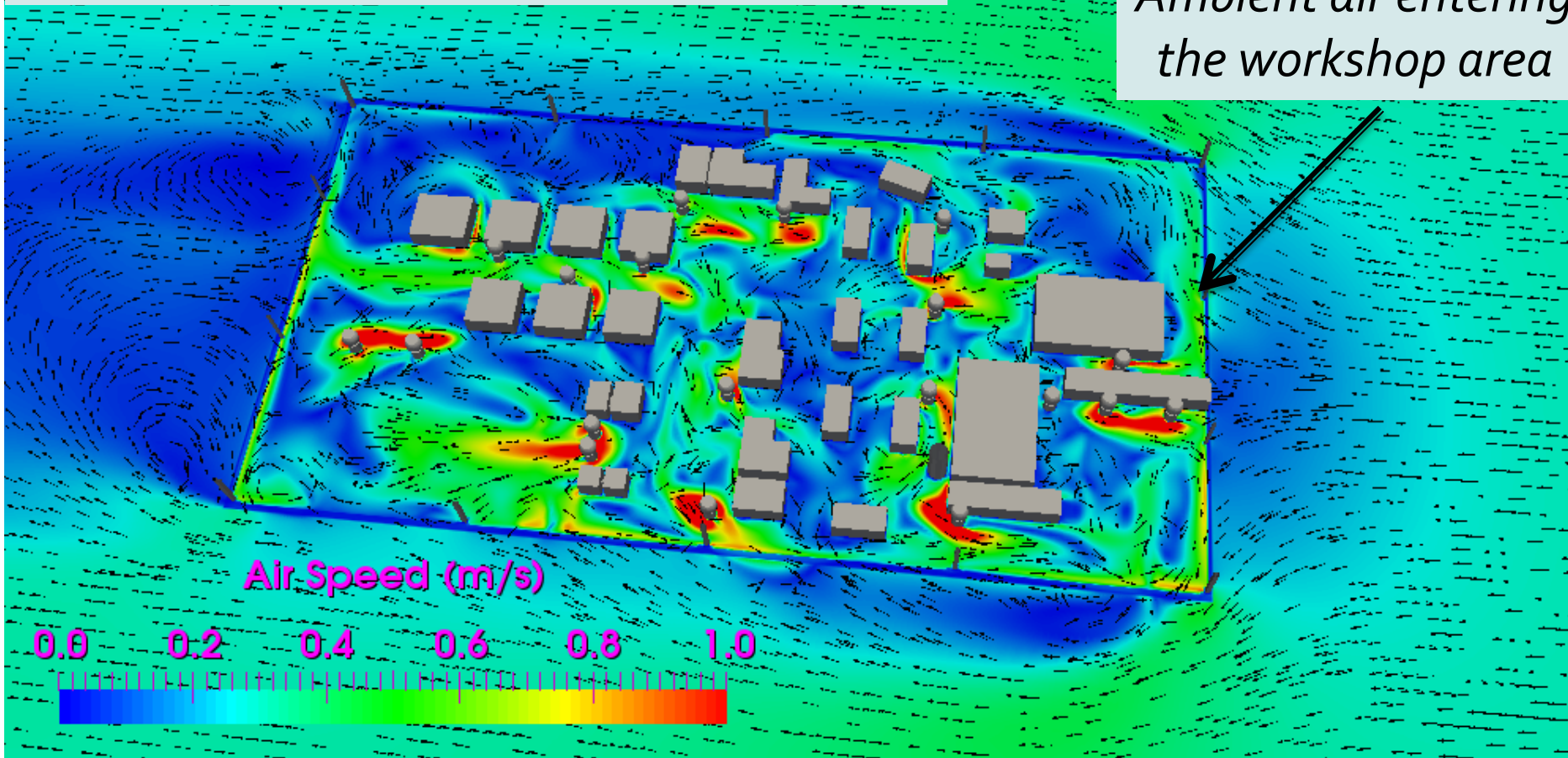


CFD Result

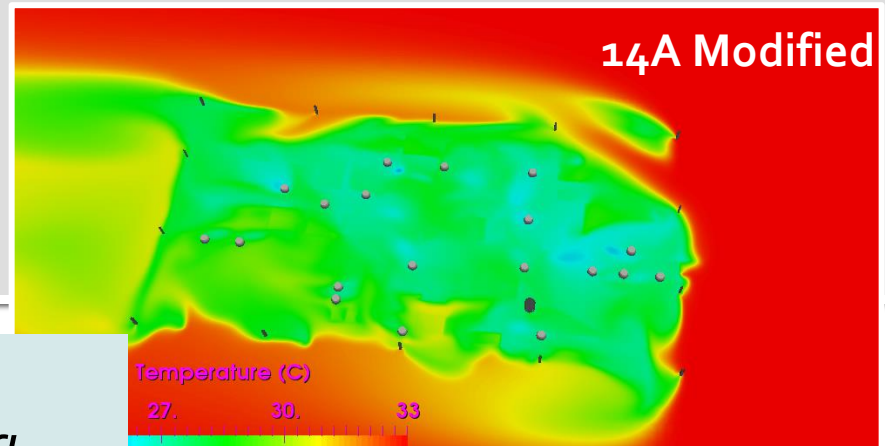
Air speed distribution on a horizontal plane 1 meter above the floor



Ambient air entering the workshop area

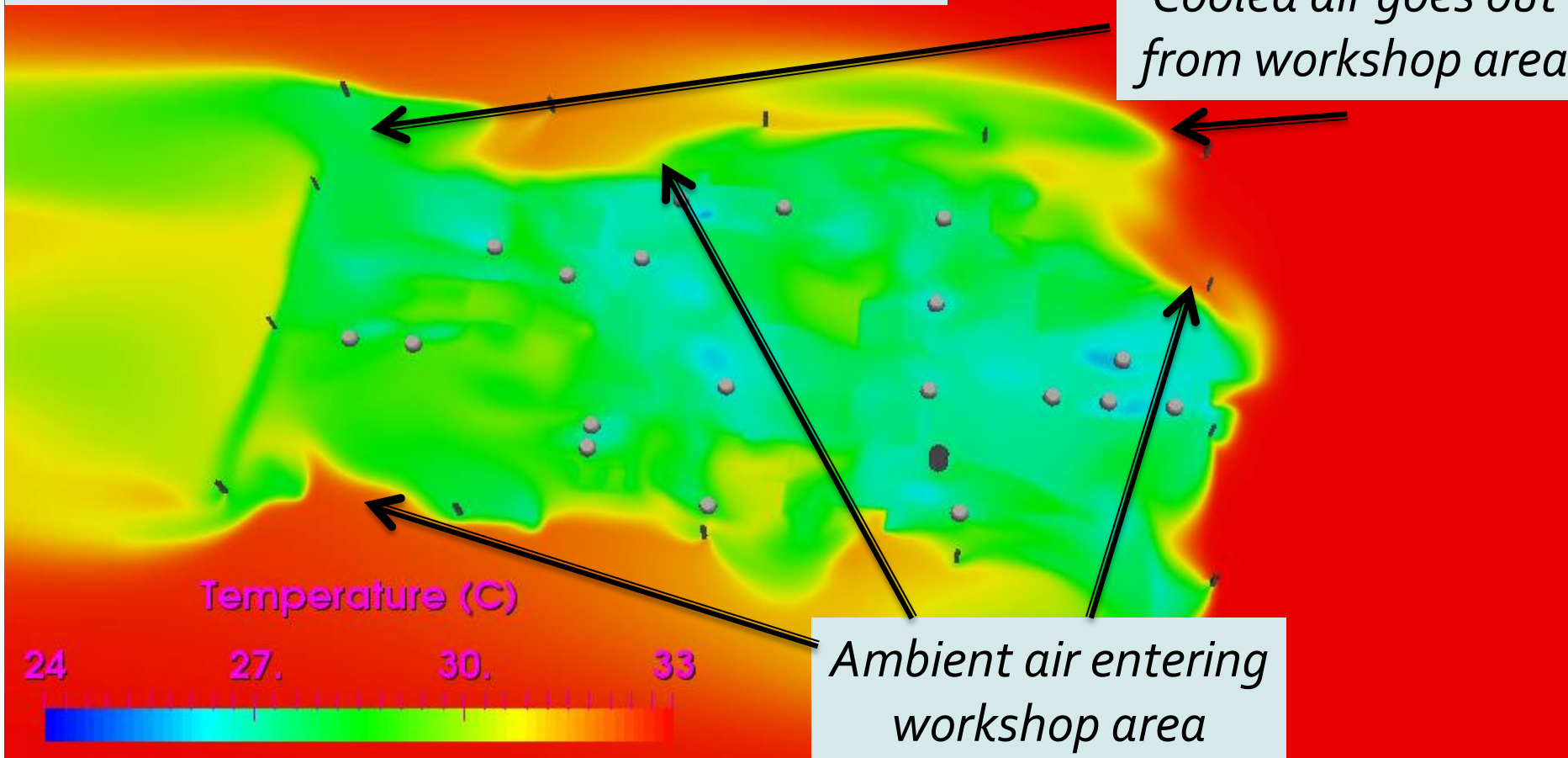


CFD Result

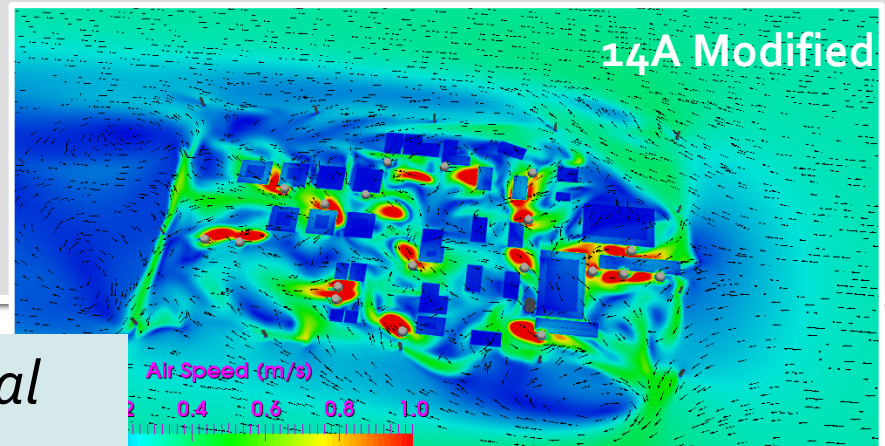


Air temperature distribution on a horizontal plane 1.5 meter above the floor

Cooled air goes out from workshop area

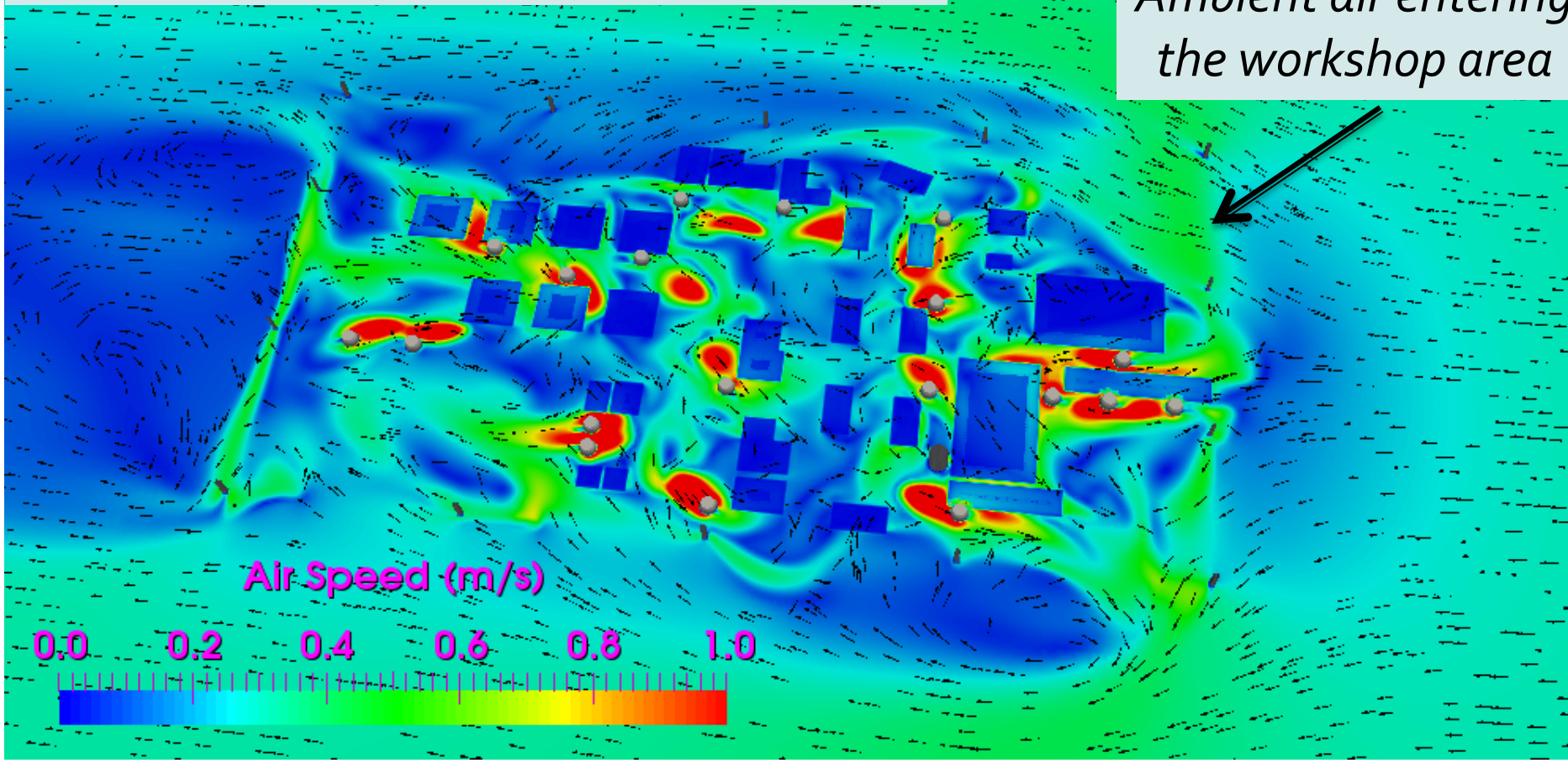


CFD Result



Air speed distribution on a horizontal plane 1.5 meter above the floor

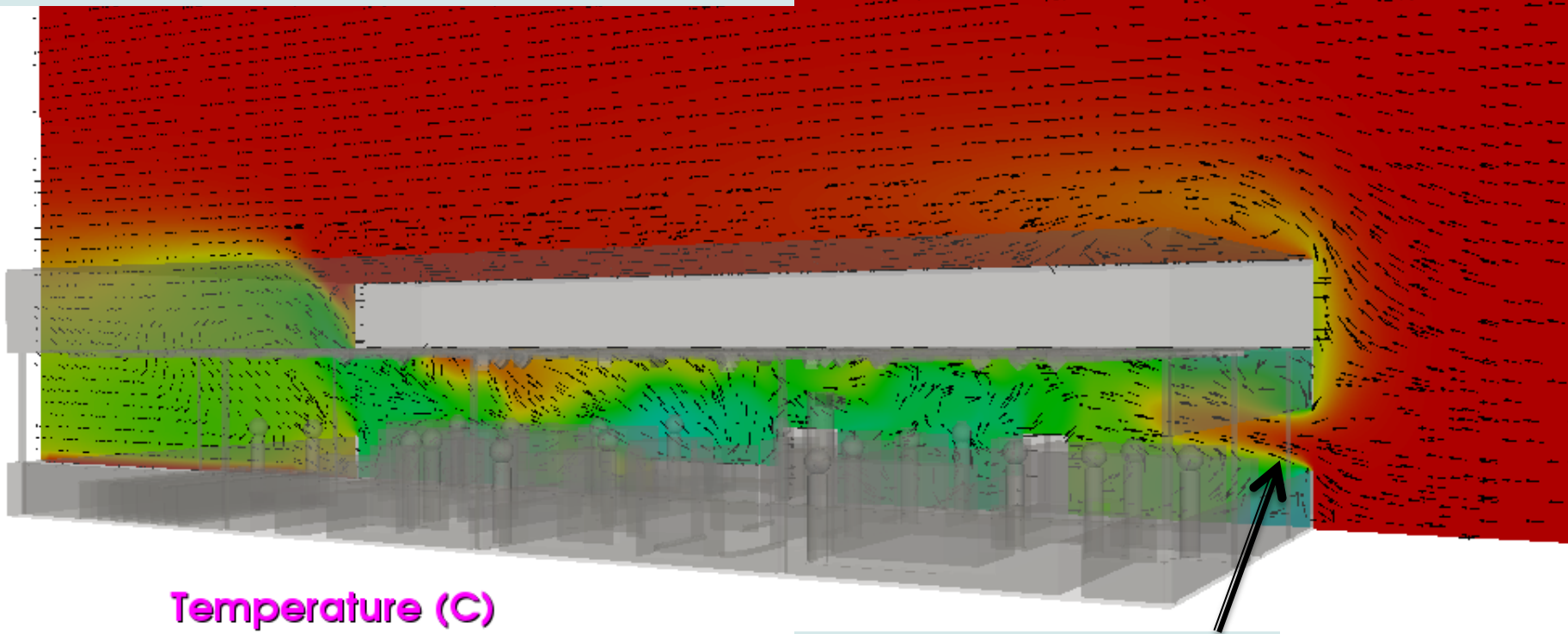
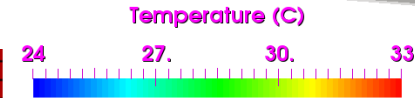
Ambient air entering the workshop area



CFD Result

14A Modified

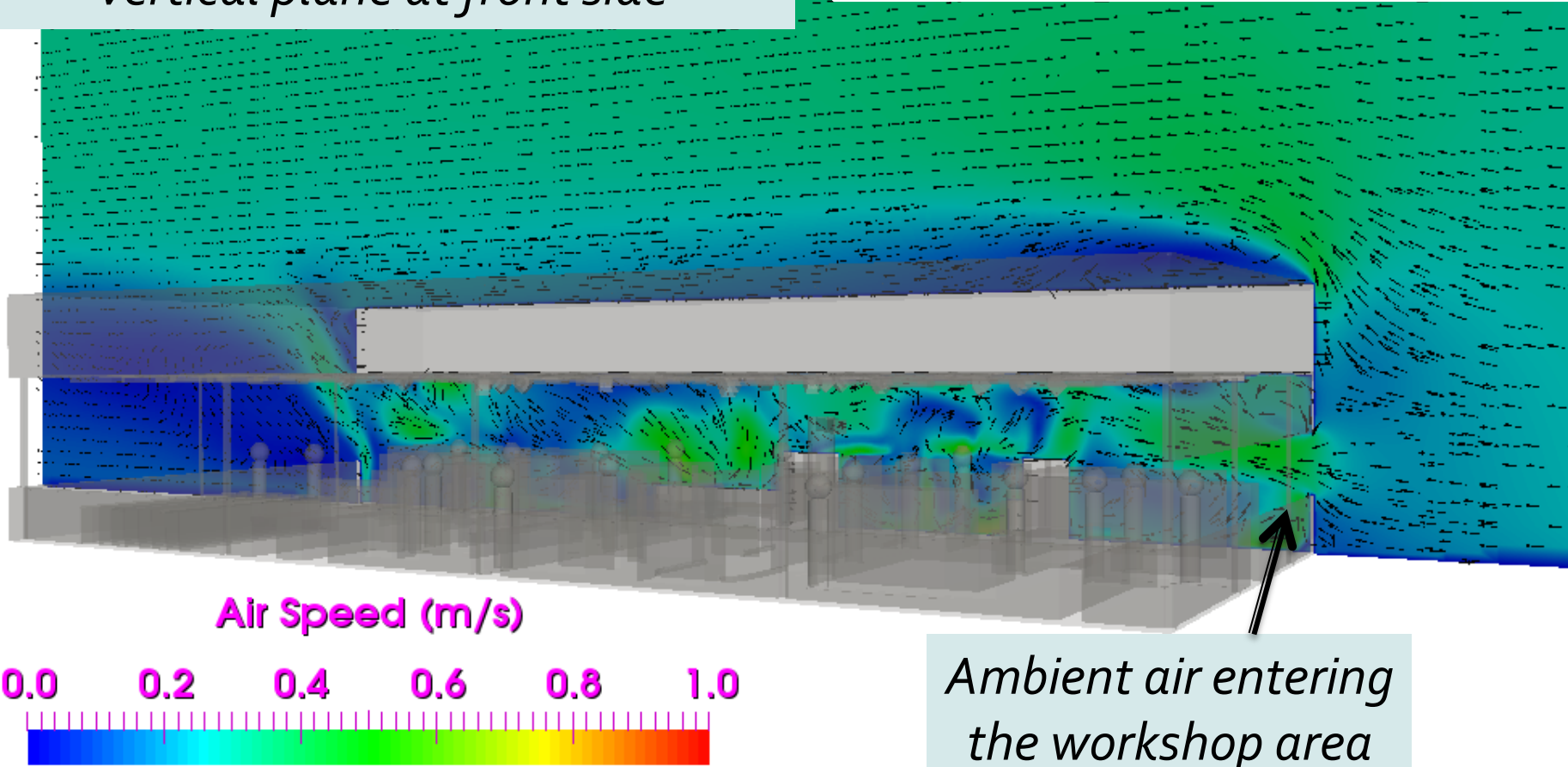
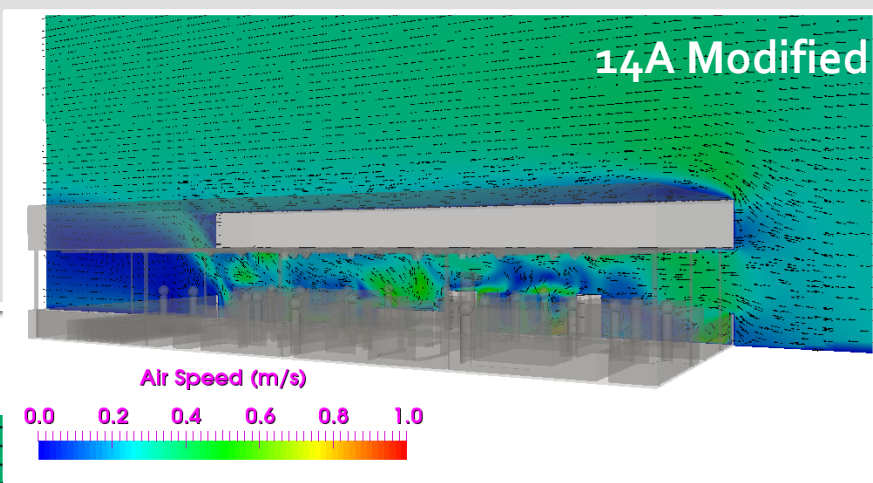
Air temperature distribution on a vertical plane at front side



Ambient air entering workshop area

CFD Result

Air temperature distribution on a vertical plane at front side



Ambient air entering the workshop area

CFD Result

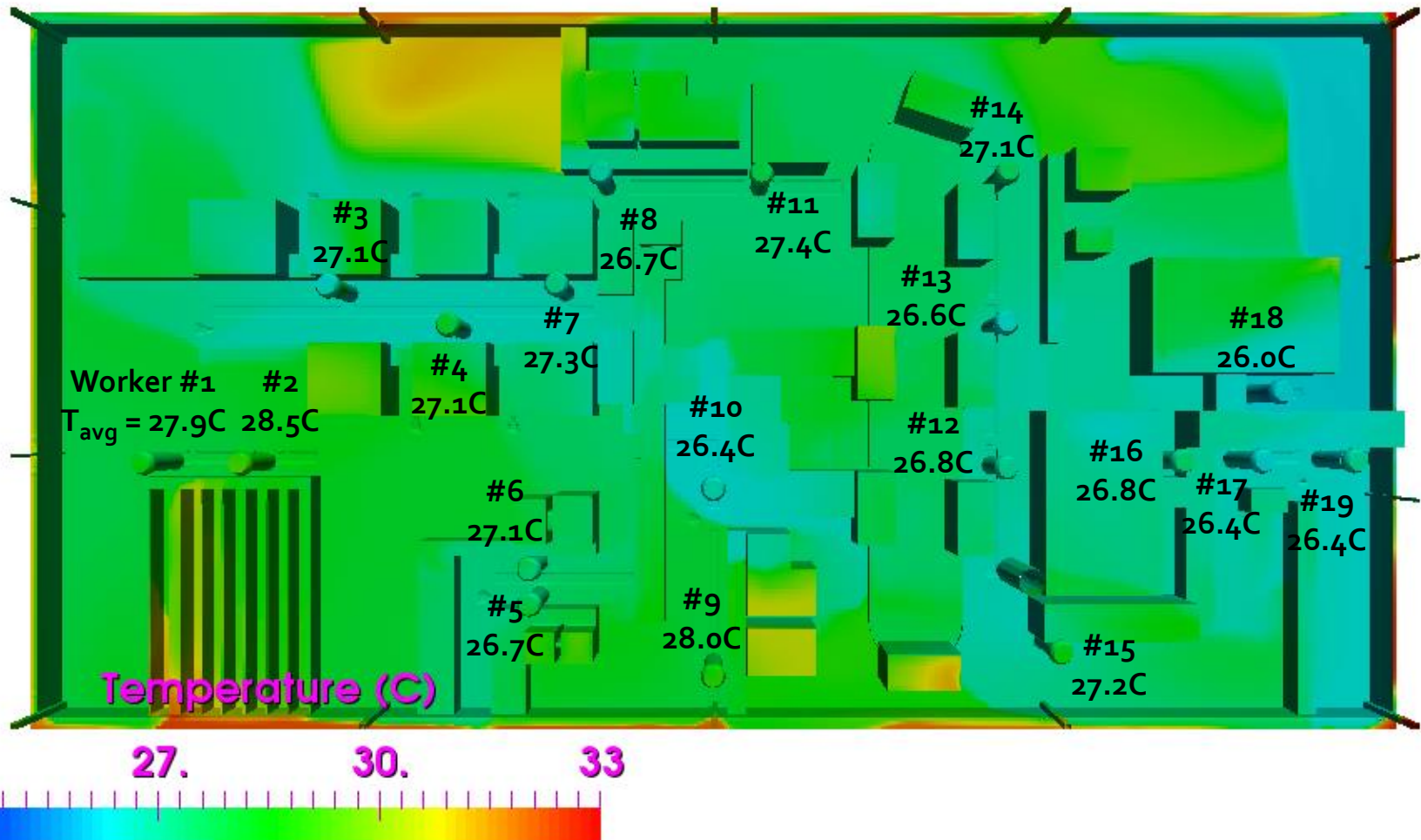
14A Modified with Cover

Hot >29C : None

Warm 28-29C : Worker # 2, 9

Cool < 28C : Worker #1, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19

Air temperature distribution near the surfaces



CFD Result

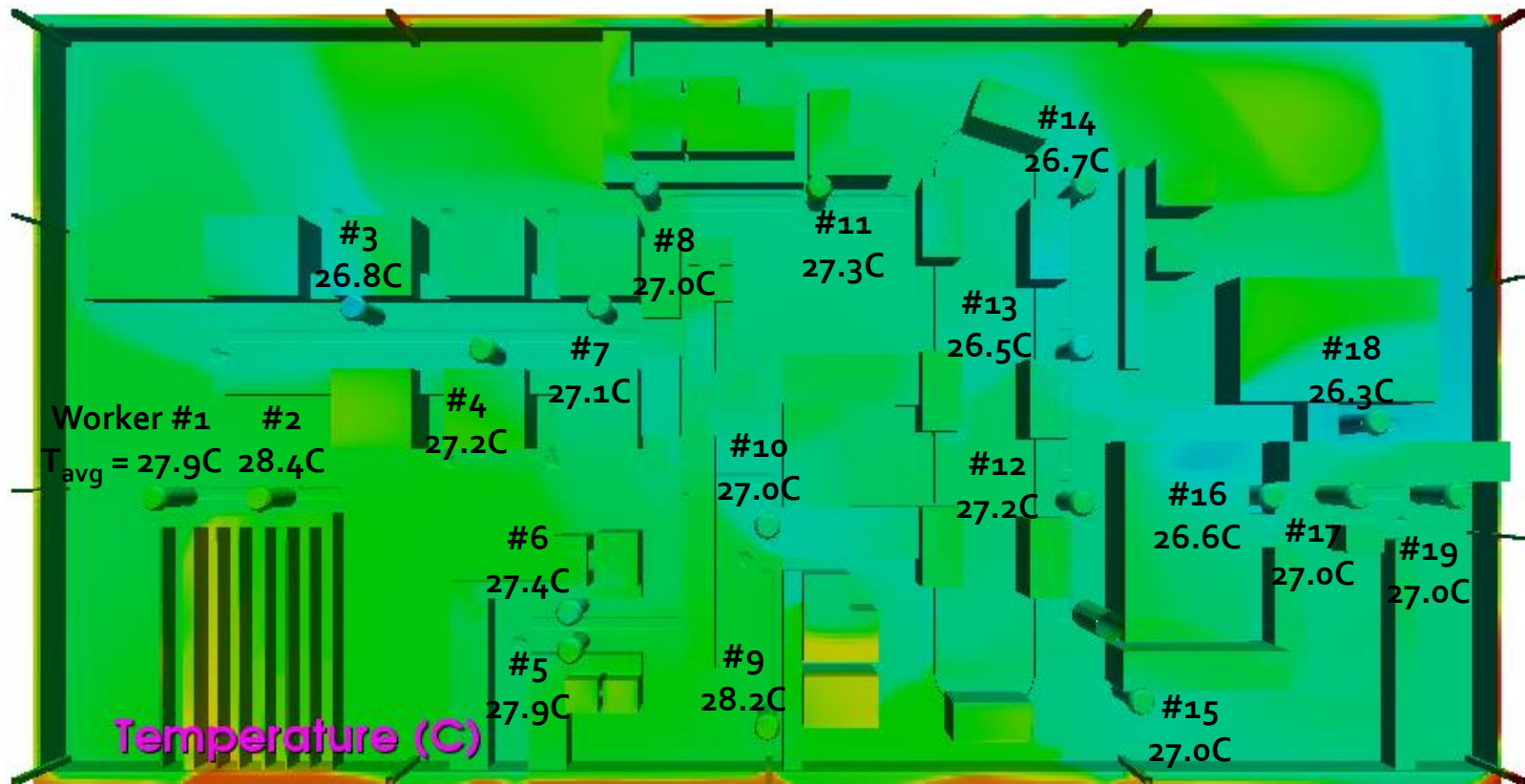
14A Modified

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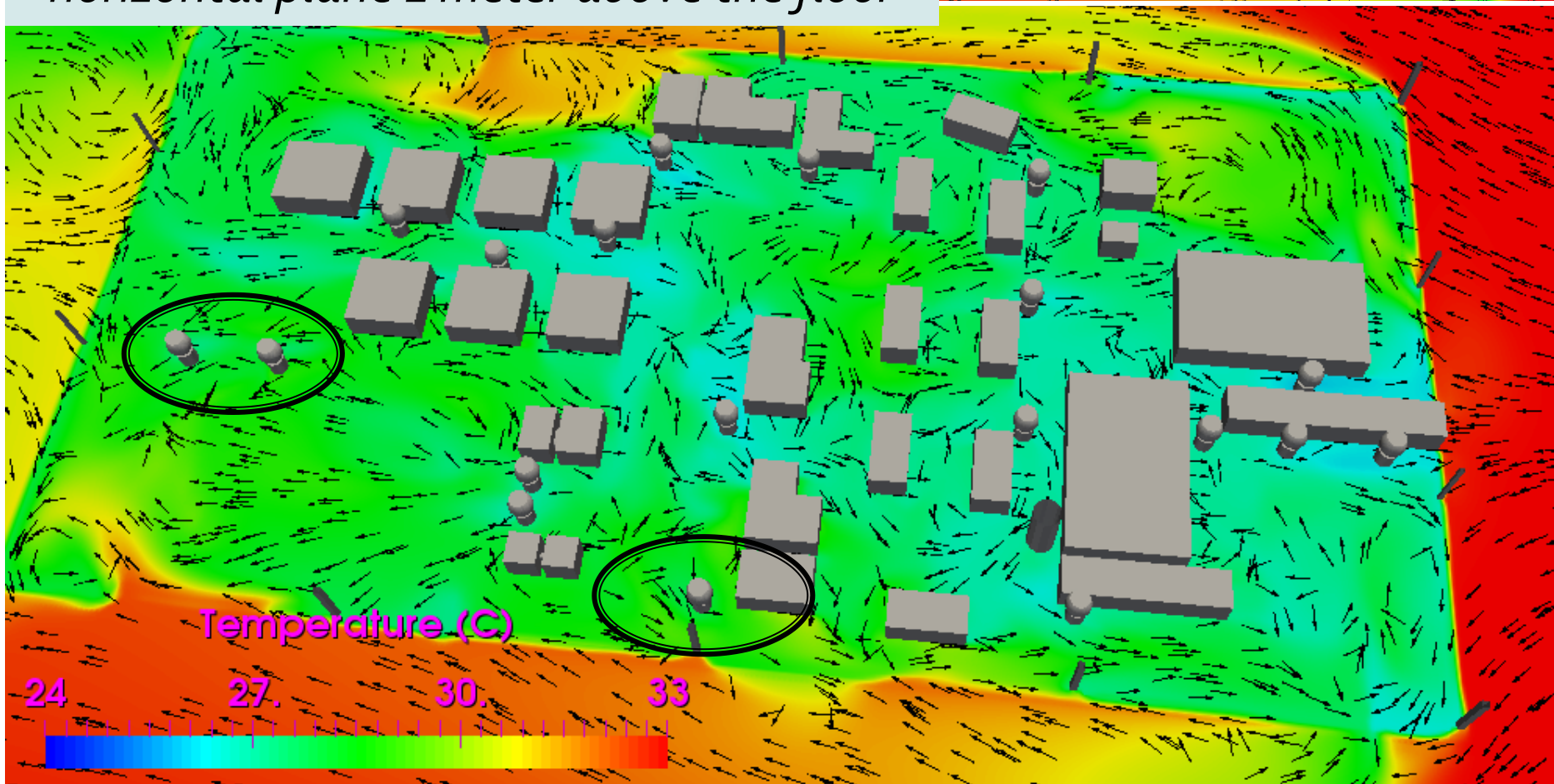
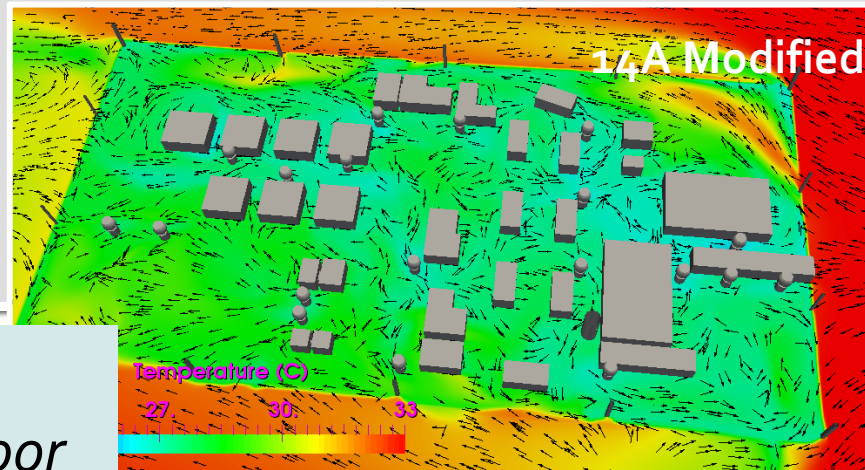
Air temperature distribution near the surfaces



CFD Result

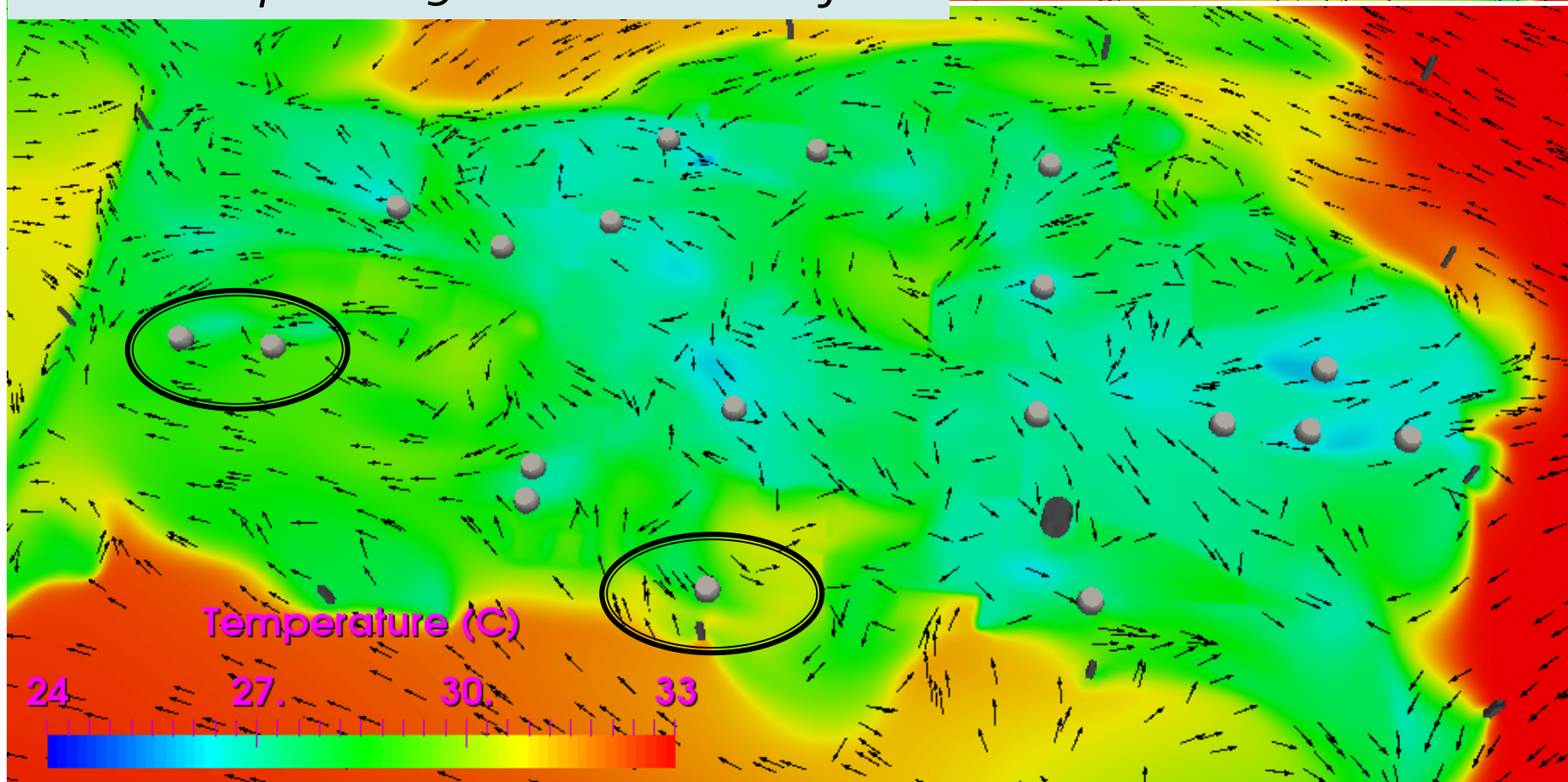
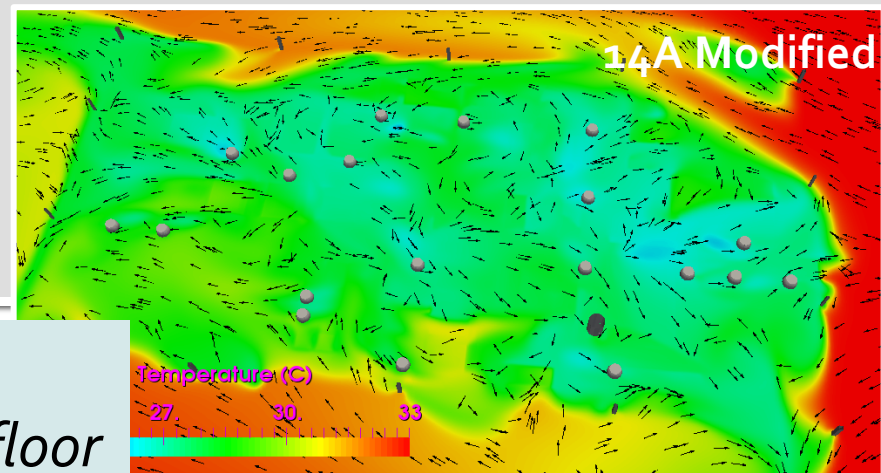
14A Modified

Air temperature distribution on a horizontal plane 1 meter above the floor



CFD Result

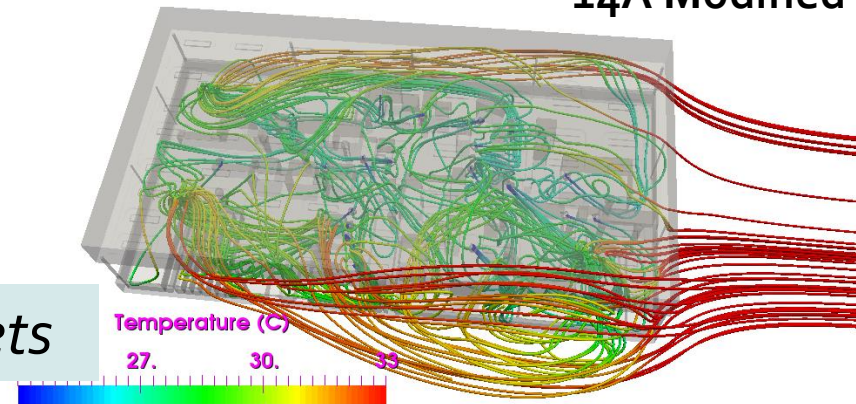
Air temperature distribution on a horizontal plane 1.5 meter above the floor



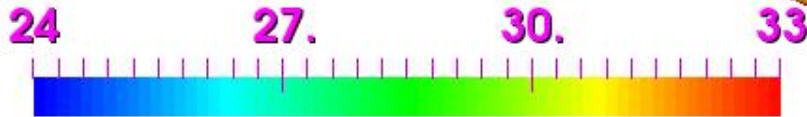
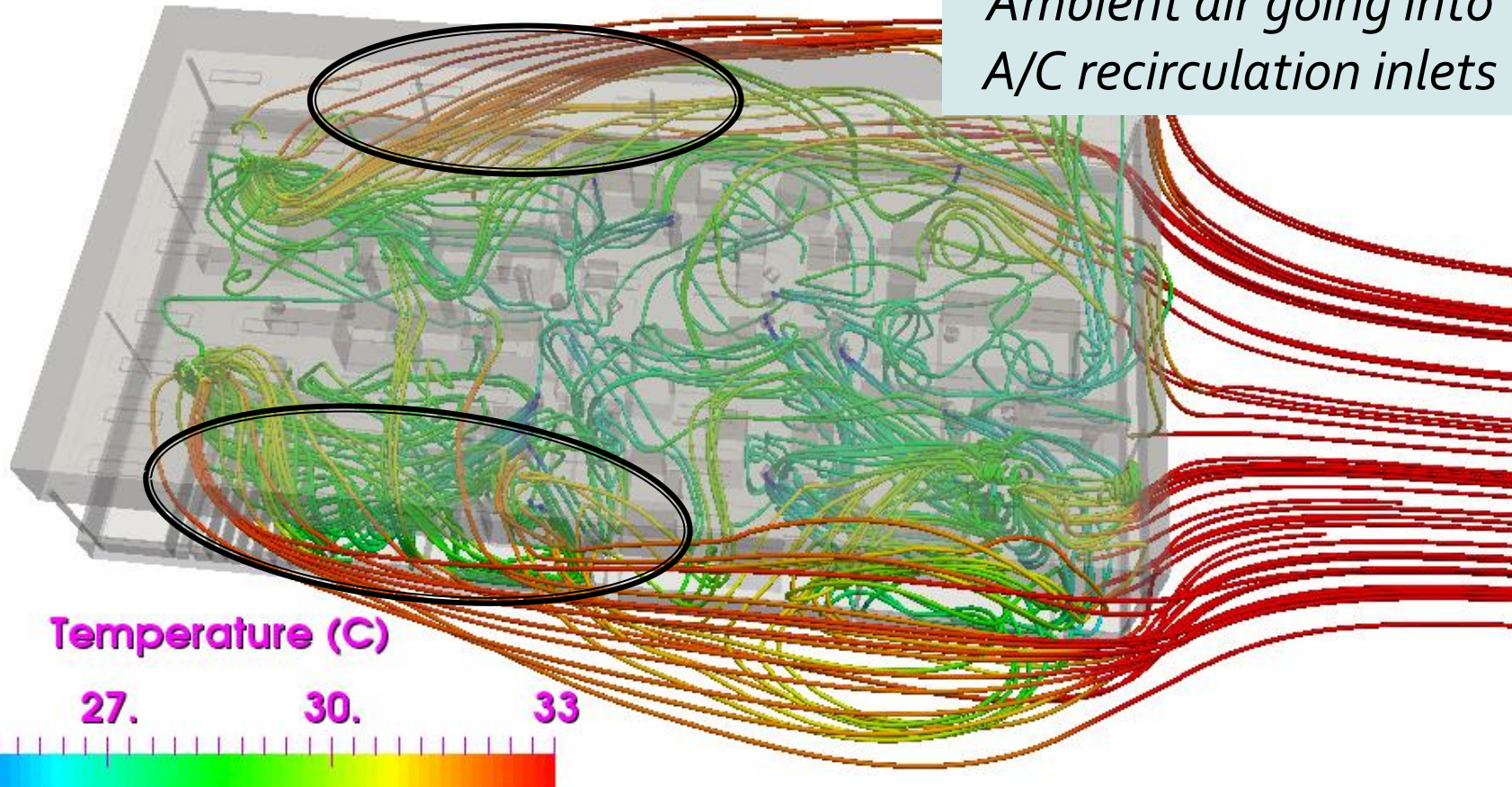
CFD Result

14A Modified

3D streamlines to A/C recirculation inlets

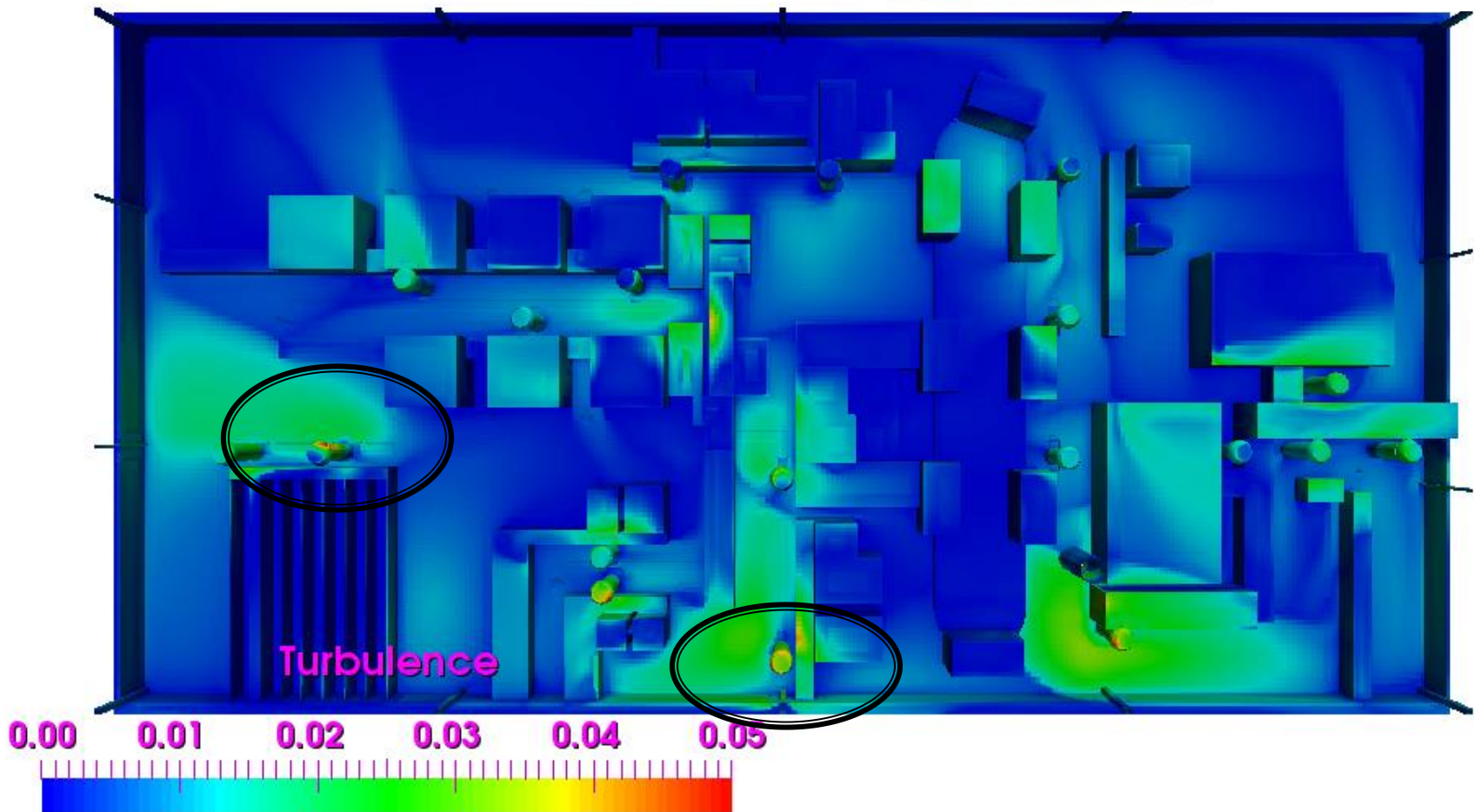
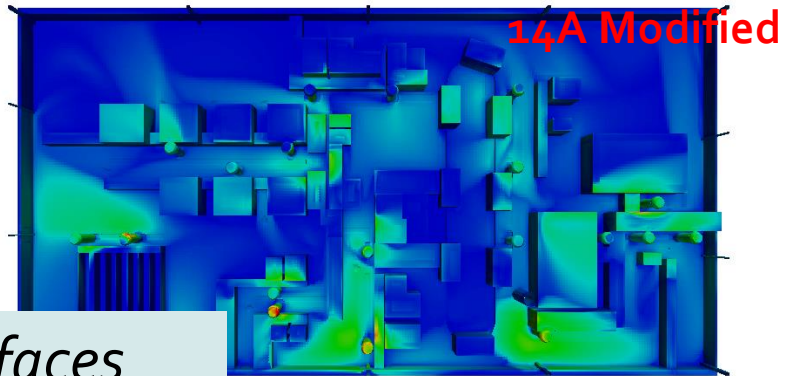


Ambient air going into A/C recirculation inlets



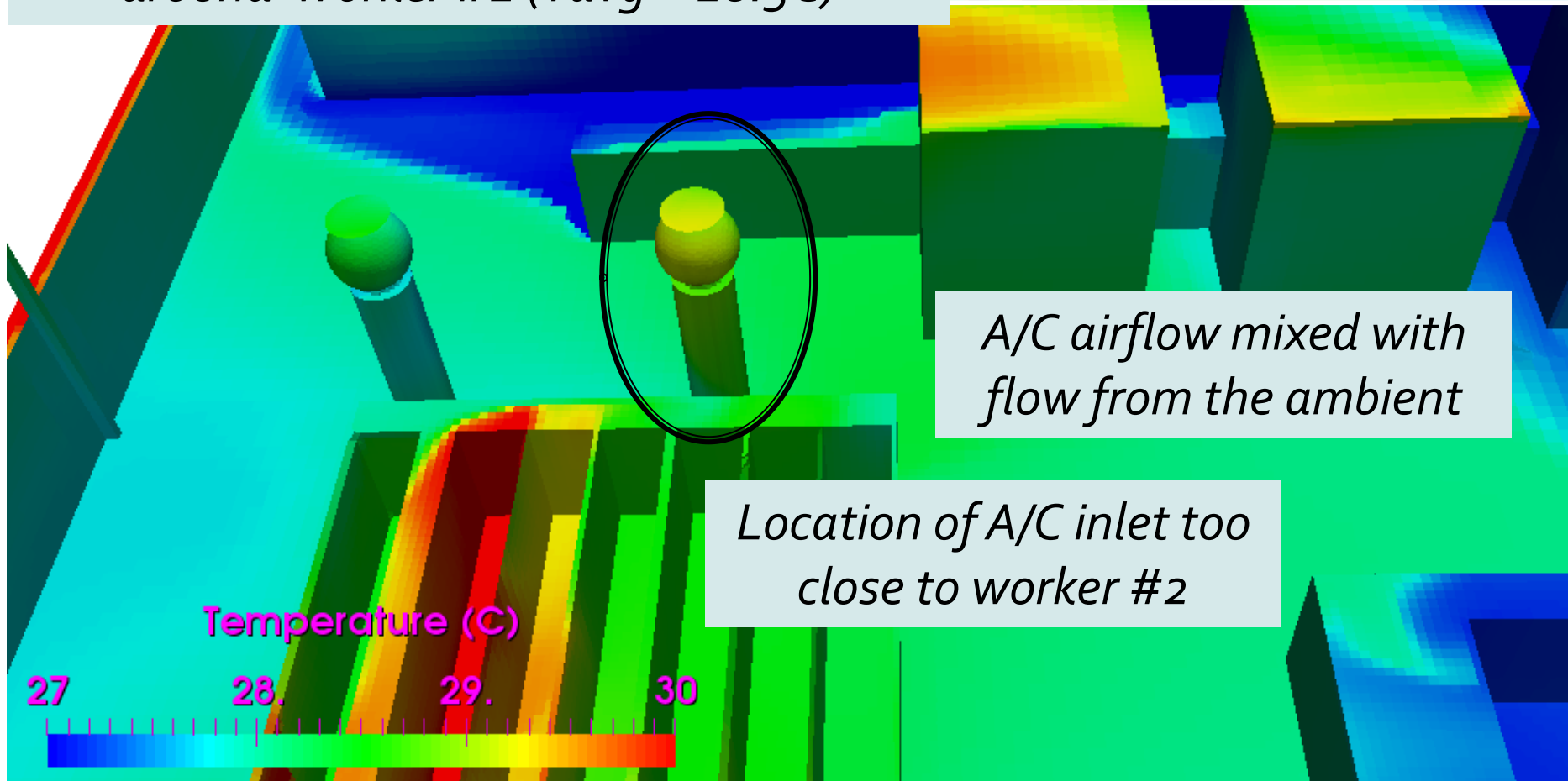
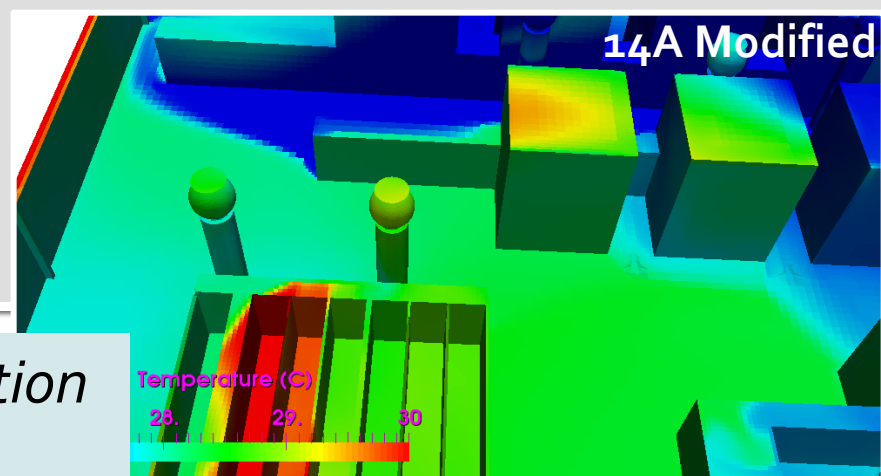
CFD Result

Air turbulence distribution near the surfaces

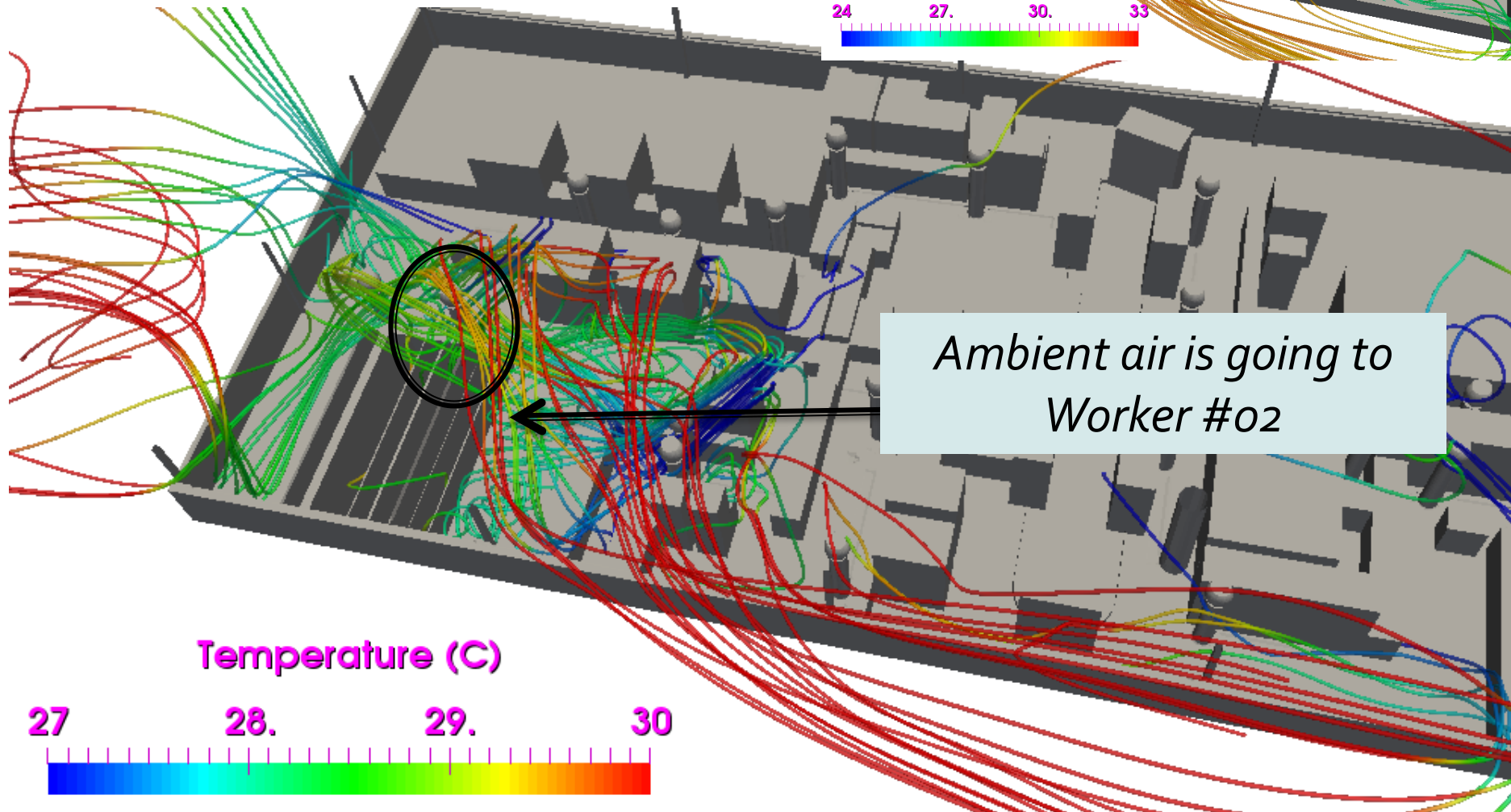
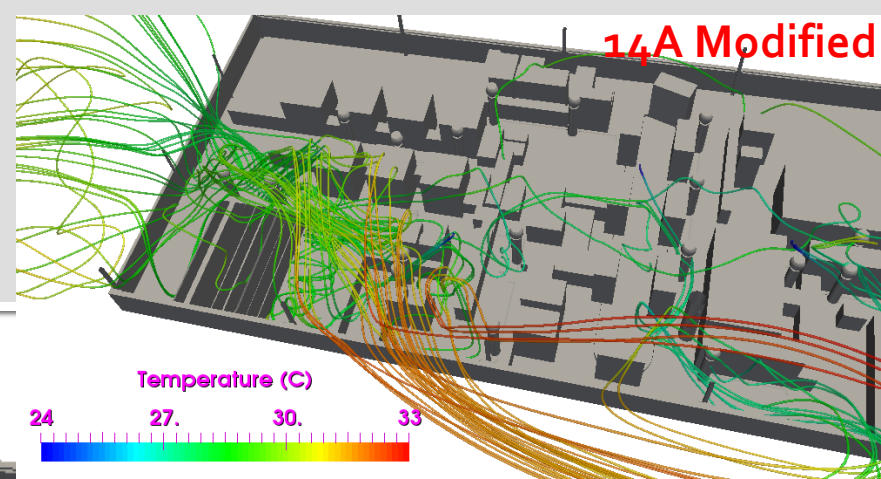


CFD Result Around Worker #2

*Near surface air temperature distribution
around Worker #2 ($T_{avg} = 28.5C$)*



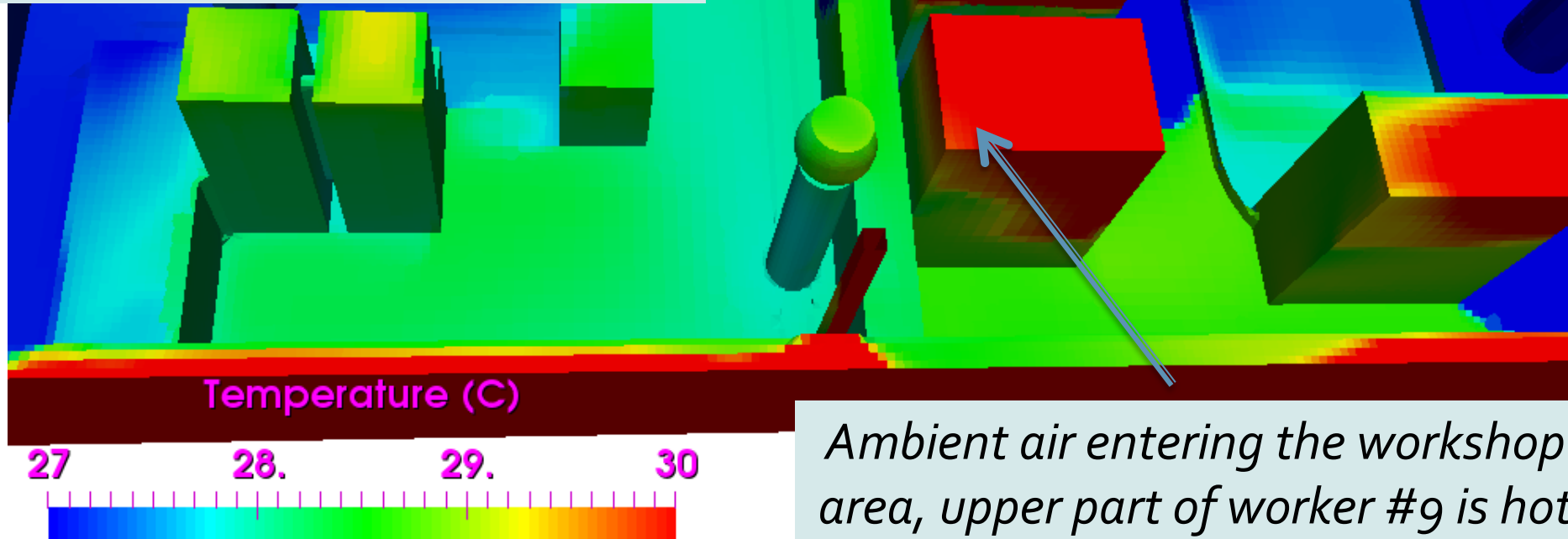
CFD Result Around Worker #2



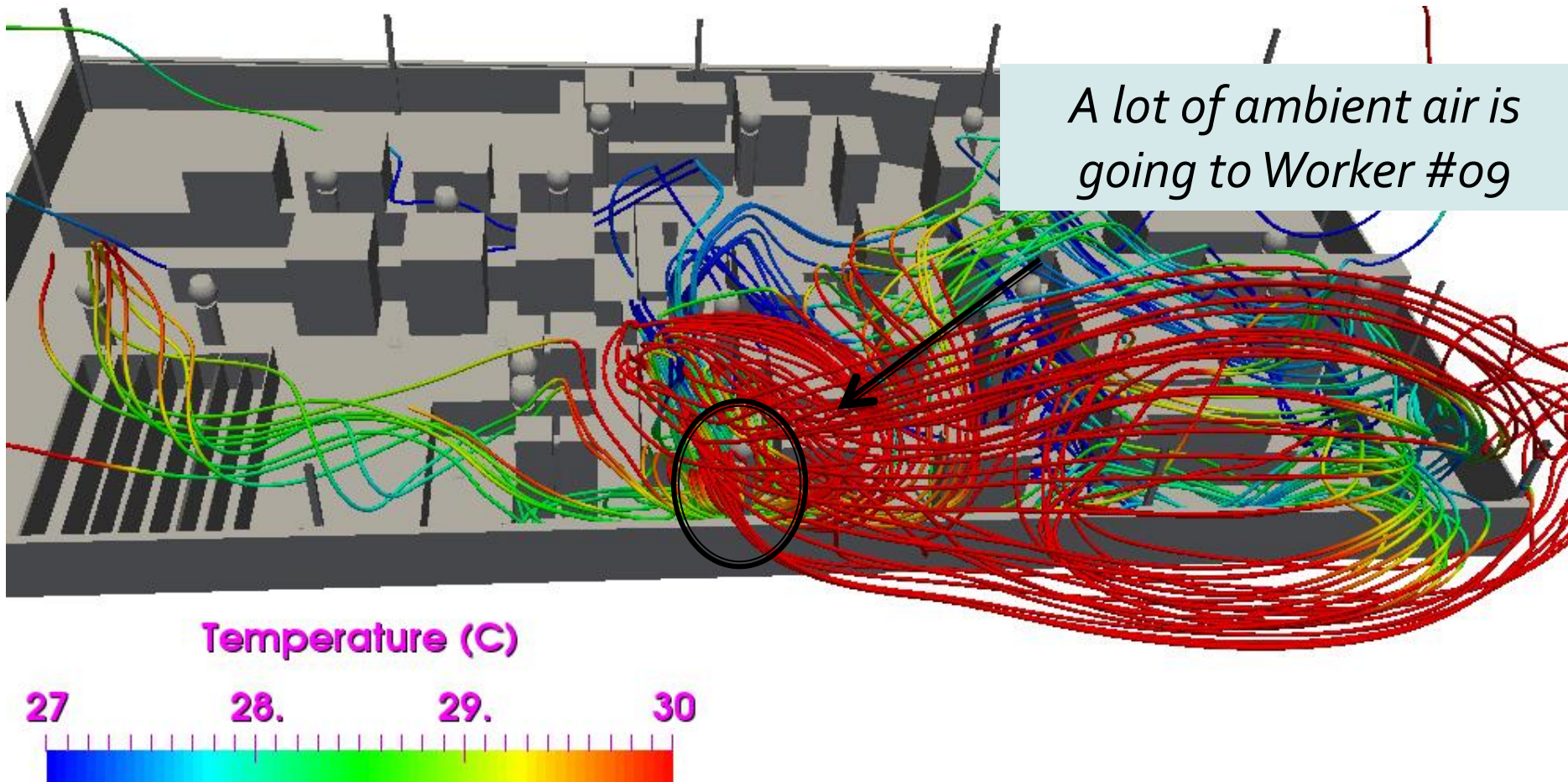
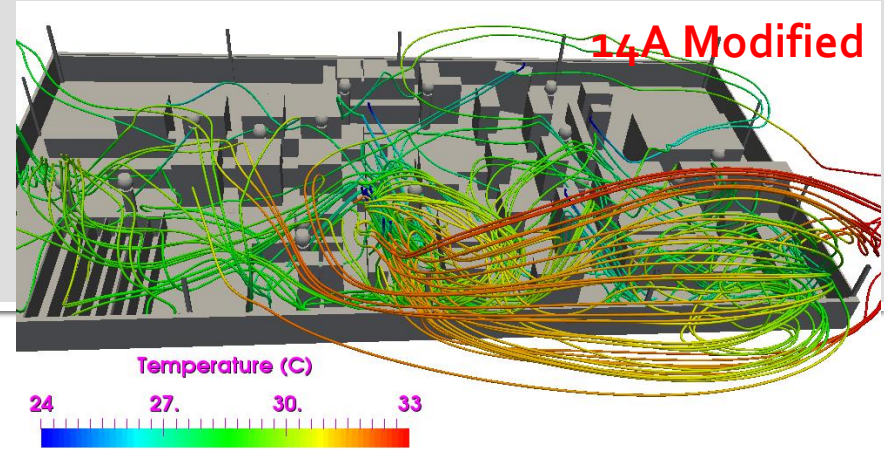
CFD Result Around Worker #9

*Near surface air temperature distribution
around Worker #9 ($T_{avg} = 28.0^{\circ}\text{C}$)*

*A/C blower for worker #9 is
strong with 1100 CMM*

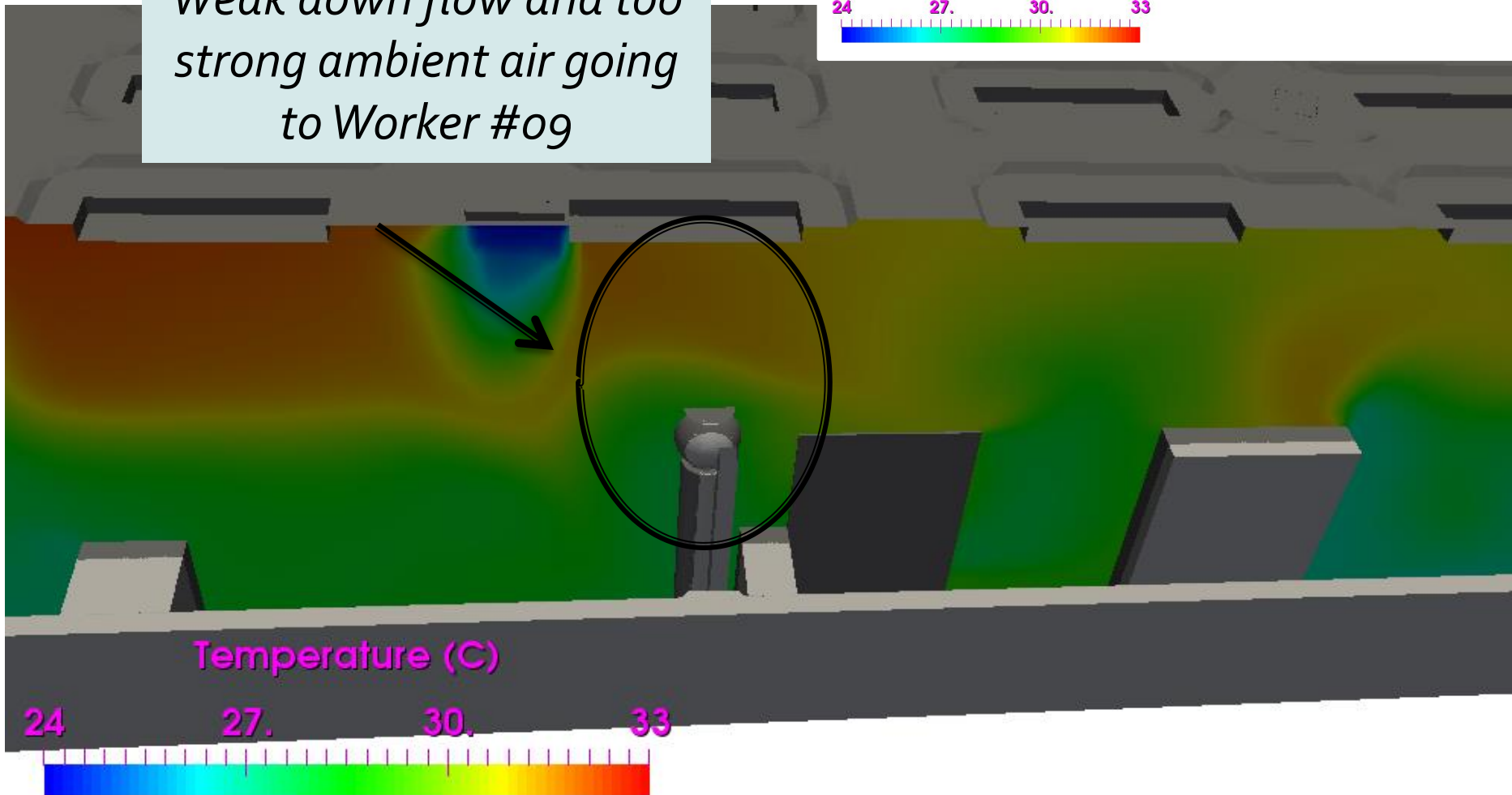
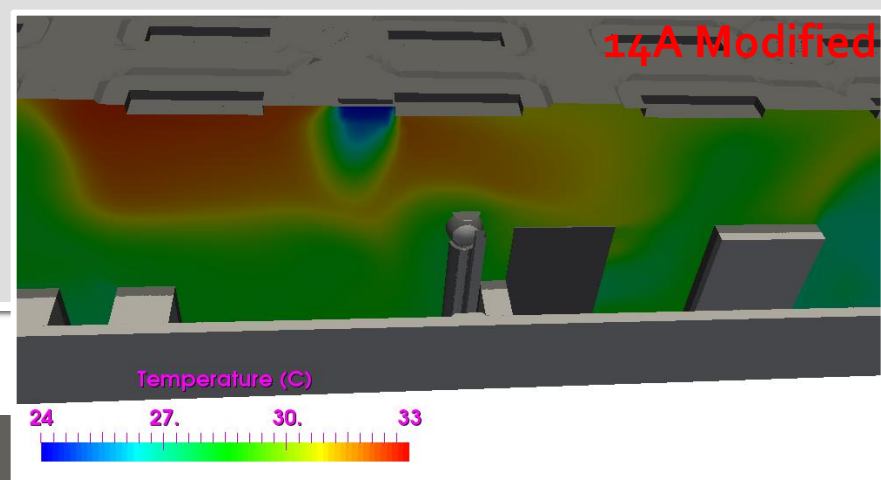


CFD Result Around Worker #9



CFD Result Around Worker #9

Weak down flow and too strong ambient air going to Worker #9



Conclusions

- Plastic cover can reduce ambient air entering the workshop area from the front side. Worker #17, #18, #19 are getting cooler.
- Worker comfort is slightly better for Version 14A Modification with plastic cover.
- Ambient temperature around worker #2 is still high, 28.5°C
- Worker #2 is too close to A/C inlet which then get hot flows turbulence from ambient air going to A/C inlet.
- Down flow for worker #9 is too weak to reduce air temperature around worker #9. The A/C down flow could attract ambient air flow to go closer to worker #9.
- There are still 2 workers (#2, 9) who are in medium temperature area with average air temperature between 28°-29°C.

Assignment Letter / *Surat Tugas*

No. AL/ARCS/1856/VIII/2020
 Date August 1st, 2020
 Page 1 of 1
 Doc. Main Document / *Dokumen Utama*
 Type

Dena Hendriana, BSc., S.M., Sc.D,

Activity Assignment

Penugasan Kegiatan

Director of Academic Research and Community Services

Direktur Lembaga Penelitian Akademik dan Pengabdian kepada Masyarakat

In consideration of:

His appointment as Director of Academic Research and Community Services of Swiss German University under Decree nr. SK/020/HR/XI/19, dated November 18th, 2019

Mengingat:

Pengangkatannya sebagai Direktur Lembaga Penelitian Akademik dan Pengabdian kepada Masyarakat dengan SK pengangkatan no. SK/020/HR/XI/19, tertanggal 18 November 2019

Herewith gives the task to:

Name : **Dena Hendriana, BSc., S.M., Sc.D,**
 Position : **Head of Master of Mechanical Engineering Study Program**
 Employee ID : **11211528**

Dengan ini menugaskan kepada:

Name : **Dena Hendriana, BSc., S.M., Sc.D,**
 Position : **Kepala Program Studi Master Teknik Mesin**
 NIK : **11211528**

To follow the activity below:

Untuk berpartisipasi pada kegiatan berikut ini:

Nr.	Activity/ <i>Kegiatan</i>	Organizer/ <i>Penyelenggara</i>	Day & Date/ <i>Hari & Tanggal</i>	Venue/ <i>Tempat</i>
1.	Penelitian simulasi aliran udara dingin dari AC outlet untuk pendinginan ruang terbuka bekerja sama dengan PT. Tamura	Swiss German University	Agustus 2020 – Februari 2021	Swiss German University The Prominence Office Tower

The appointed shall accomplish the task in responsible ways in line with the related guidelines and other regulations given by SGU.

Pihak yang bersangkutan harus melaksanakan tugas dan tanggung jawab sebaik-baiknya, sesuai dengan petunjuk dan peraturan dari SGU.

Assignor/ *Pemberi Tugas:*



Kholis Abdurachim Audah , M.Sc, Ph.D

Director of Academic Research and Community Services
Direktur Lembaga Penelitian dan Pengabdian kepada Masyarakat



SWISS GERMAN UNIVERSITY

LAPORAN

**PENELITIAN SIMULASI ALIRAN UDARA DINGIN DARI AC
OUTLET UNTUK PENDINGINAN RUANG TERBUKA
BEKERJA SAMA DENGAN PT. TAMURA**

Dena Hendriana, B.Sc., S.M., Sc.D – Team Leader
Iman Hartaman (PT. Tamura) – Team Member

MASTER OF MECHANICAL ENGINEERING

2021

Swiss German University
The Prominence Tower Alam Sutera
Jalan Jalur Sutera Barat No 15, Tangerang 15143
INDONESIA

Tel. +62 21 2977 9596/9597
Fax. +62 21 2977 9598
info@sgu.ac.id
www.sgu.ac.id

Judul Penelitian : Penelitian Simulasi Aliran Udara Dingin dari AC Outlet untuk Pendinginan Ruang Terbuka Bekerja Sama dengan PT. Tamura

Nama Team Leader : Dena Hendriana, B.Sc., S.M., Sc.D

Research Center/Dept. : Master of Mechanical Engineering

E-mail : dena.hendriana@sgu.ac.id

Mobile phone : 081213715844

Masa program : Agustus 2020 – Februari 2021 (6 bulan)

Keterangan Aktifitas : PT. Tamura sedang melakukan pengaturan sistem AC untuk mendinginkan ruang workshop yang terbuka tanpa dinding samping. Workshop terbuka untuk mendapatkan udara segar dari lingkungan karena adanya proses dalam workshop yang mengeluarkan uap tidak nyaman untuk pernafasan. Beberapa konfigurasi AC Outlet telah di simulasikan dengan menggunakan software CFD OpenFOAM yang merupakan software OpenSource. Simulasi dilakukan untuk memprediksi distribusi suhu udara dingin yang keluar dari AC Outlet. Lokasi dan besaran lubang AC Outlet di atur supaya distribusi suhu udara dingin tersebar secara merata di area Workshop. Simulasi telah berhasil memberikan arahan pengaturan lokasi dan besaran lubang AC Outlet. Hasil dari simulasi kemudian di implementasikan dalam setup hardware AC Outlet dan hasilnya selaras dengan hasil simulasi.

Kegiatan ini merupakan kegiatan pengabdian masyarakat dari Swiss German University yang memanfaatkan keilmuan akademik dari Komputasi Fluida untuk kebutuhan masyarakat yang disini adalah dari pihak Industri yaitu PT. Tamura.

Hasil dari penelitian ini tidak dipublikasikan dikarenakan kerahasiaan dari produk PT. Tamura.

Alam Sutera, Tangerang

Date: Februari 2021



Dena Hendriana, B.Sc., S.M., Sc.D

NIK: 11211528

*To: Bapak Iman Hartaman
PT. Tamura Air Conditioning Indonesia*

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MIT Alumni Researcher

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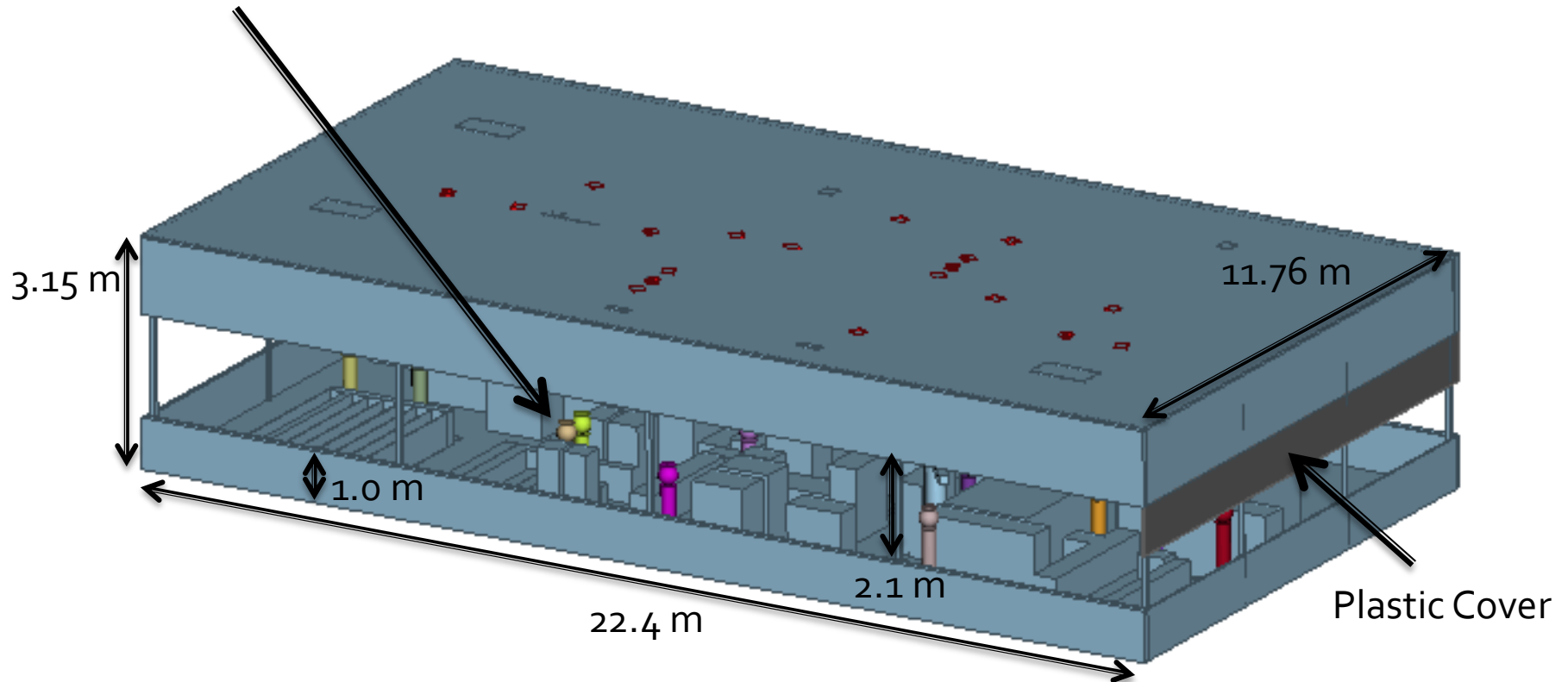
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- ***CFD Simulations***
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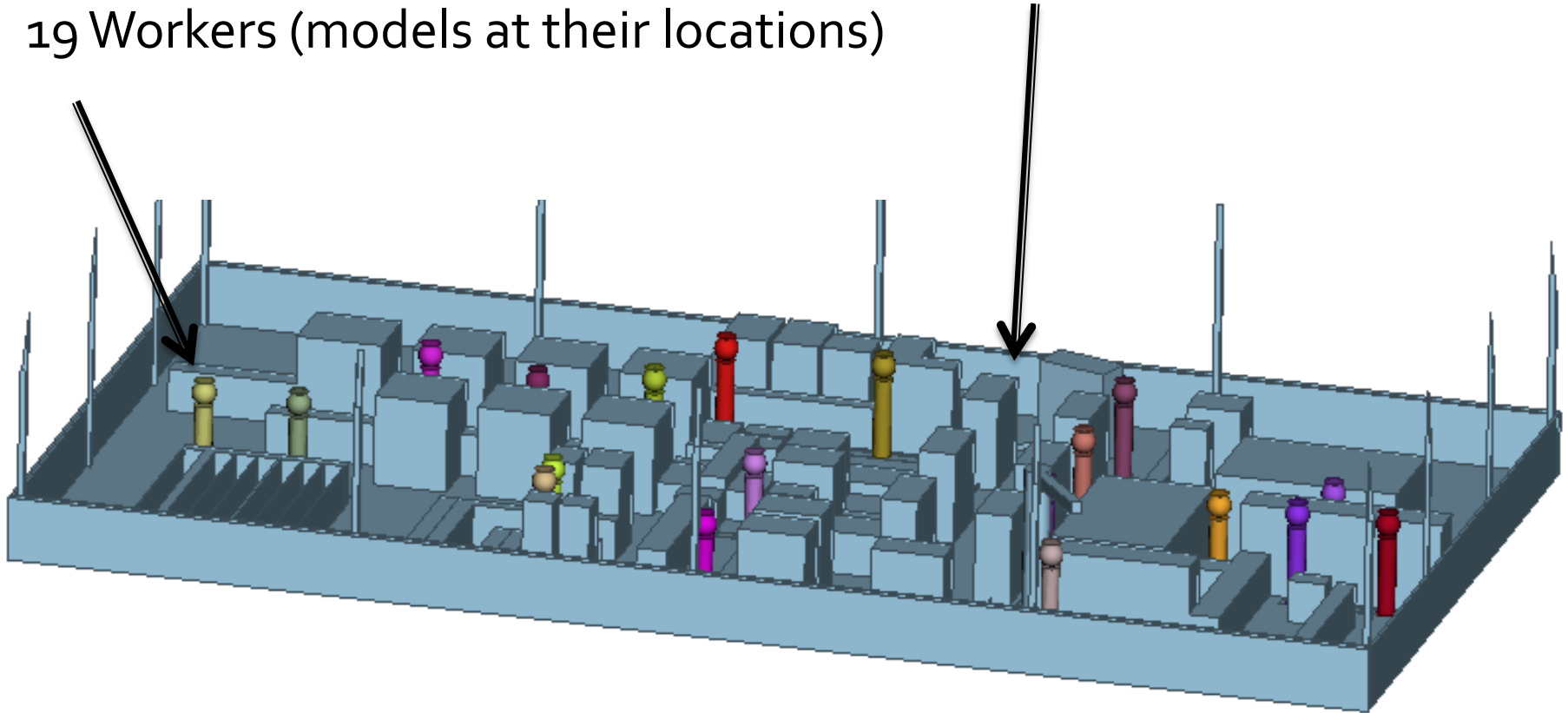
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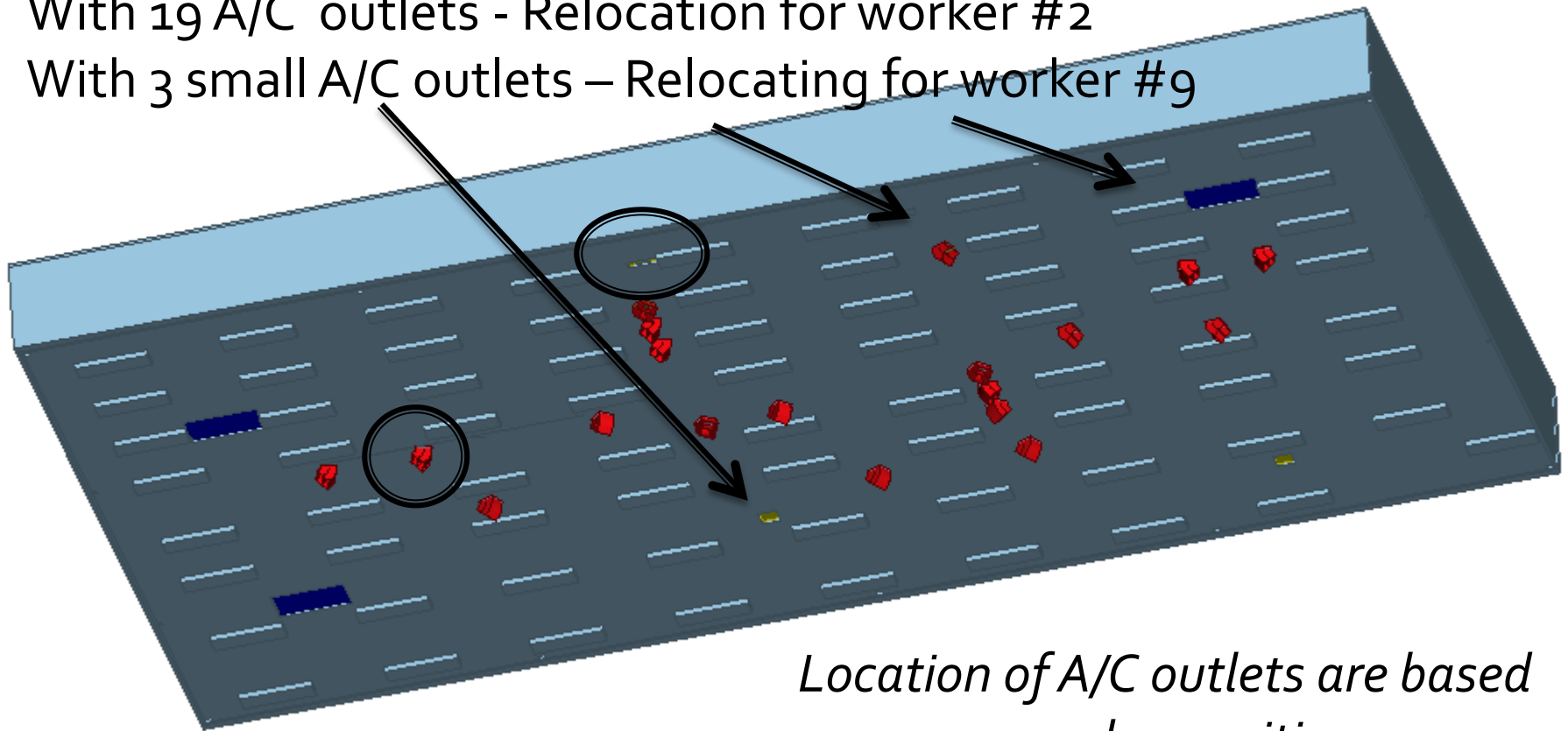
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Location of A/C outlets are based on worker positions

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