COVID-19 activities in particle and astroparticle physics

Activities at DESY

Beate Heinemann (on behalf of many people)
Hamburg, 12th of May 2020

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

Outline

List of activities

- Equipment (PPE)

- Computing and Software

- Epidemology

- Selected activities beyond DESY

Equipment

Production of face shields

- Face shields provide protection to workers from spray of hazardous material, e.g.

  - Scrap from drilling

  - Gun bullets

  - Drops from cough or speech

  - ....

- Protects eyes, nose and mouth

- Effectiveness for droplets

  - Best to wear both face shield and facial mask

  - If mask not available, better face shield than nothing

Sonntag, 19. April 2020 19:41 Uhr Frankfu

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POLITIK

MONTAG, 06. APRIL 2020

New York auf Corona-Höhepunkt?

USA verzeichnen 10.000 Virus-Tote

Face Shield Recommendations

- WHO

> ### 3. Facial protection (eyes, nose, and mouth)
> ■ Wear (1) a surgical or procedure mask and eye protection (eye visor, goggles) or (2) a face shield to protect mucous membranes of the eyes, nose, and mouth during activities that are likely to generate splashes or sprays of blood, body fluids, secretions, and excretions.

- Center for Disease Control (CDC)

When health systems enter crisis mode, the CDC recommends cancellation of all elective and nonurgent procedures and outpatient appointments for which face masks are typically used, use of face masks beyond the manufacturer-designated shelf life during patient care activities, limited reuse, and prioritization of use for activities or procedures in which splashes, sprays, or aerosolization are likely. When face masks are altogether unavailable, the CDC recommends use of face shields without masks, taking clinicians at high risk for COVID-19 complications out of clinical service, staffing services with convalescent HCWs presumably immune to SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), and use of homemade masks, perhaps from bandanas or scarves if necessary.

Deutsche Gesellschaft für Allgemeinmedizin und Familienmedizin e.V.

Schutz und Sicherheit anderer Patienten und der Praxismitarbeiter/innen haben höchste Priorität.
Daher: keine Testung auf SARS-CoV-2 bei fehlender Schutzausrüstung (insbesondere Maske [mind. FFP2]), in diesem Fall ggf. Schild vor der Praxis: „Praxis kann keine Testungen durchführen."

Grundsätzlich
■ sollten Patienten mit auch nur geringsten Infektzeichen einen Mund-Nasen-Schutz (MNS) erhalten.
■ sollte Personal beim Umgang mit Patienten grundsätzlich einen MNS und einen Gesichts-Schutz-Schirm (s. u.) tragen. Dieser sollte auch getragen werden, wenn keine Masken mehr zur Verfügung stehen. Ansonsten: Abstand halten, ggfs. vor Praxistür befragen.

Mangel an Schutzausrüstung
Der im ambulanten Bereich zunehmend feststellbare Mangel an geeigneter Schutzausrüstung, insbesondere das Fehlen von FFP2/FFP3-Masken, erhöht das Risiko für eine SARS-CoV-2-Infektion bei Ärzten und Medizinischen Fachangestellten beträchtlich.

Can we make them at DESY to help shortage in PPE in Germany?

3D printing
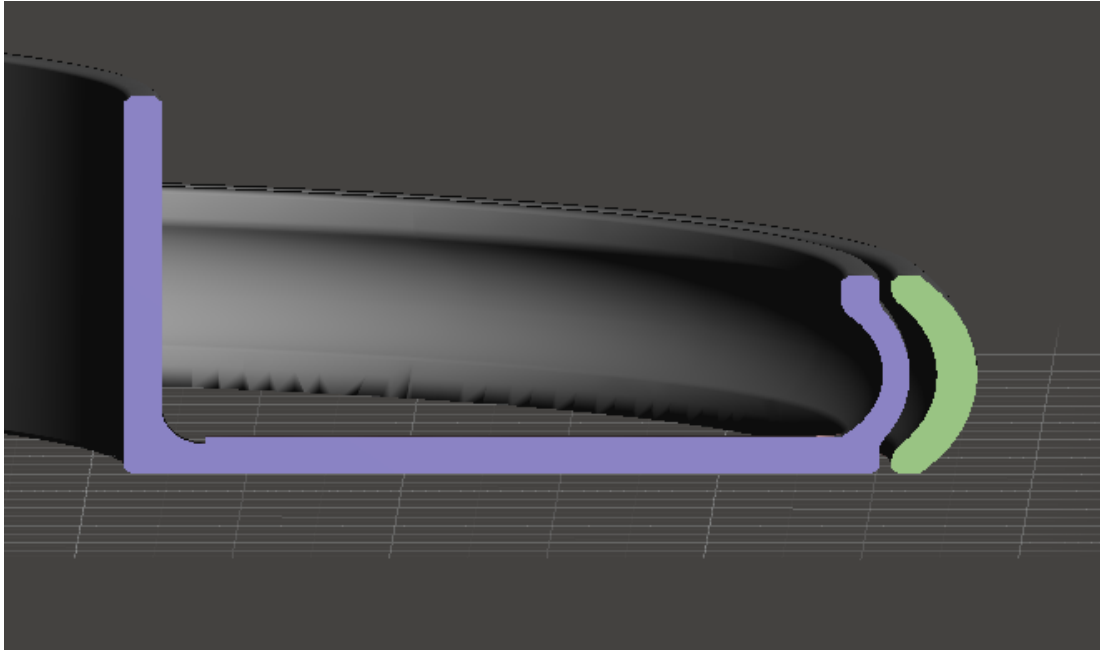

Shield attached by pinching between
two parts

Shield is transparency of laser printer

Takes about 1-3h per face shield depending on printer

- K. Jaehnke modified design so that can print 40 face shields at once (takes about 60h)
- With 2 fast ZM1 and MEA) printers: ~30-40 per day
- Delivered 490 to medical personnel to date (via Krankenkassenärztlicher Vereinigung Hamburg or directly)
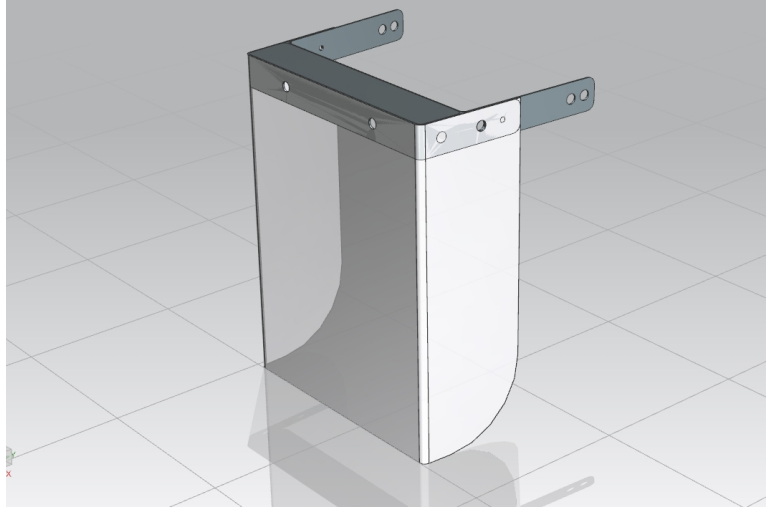
Based on files provided: https://www.thingiverse.com/thing:4233193

Towards our own model…
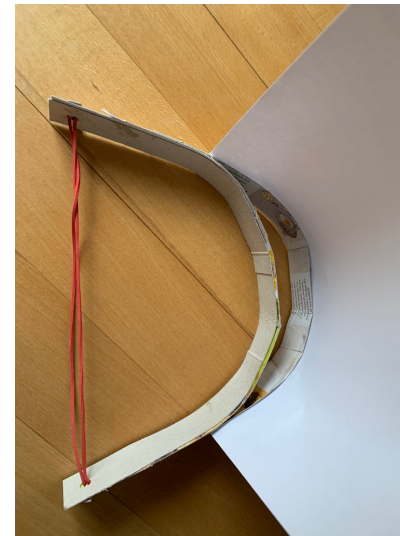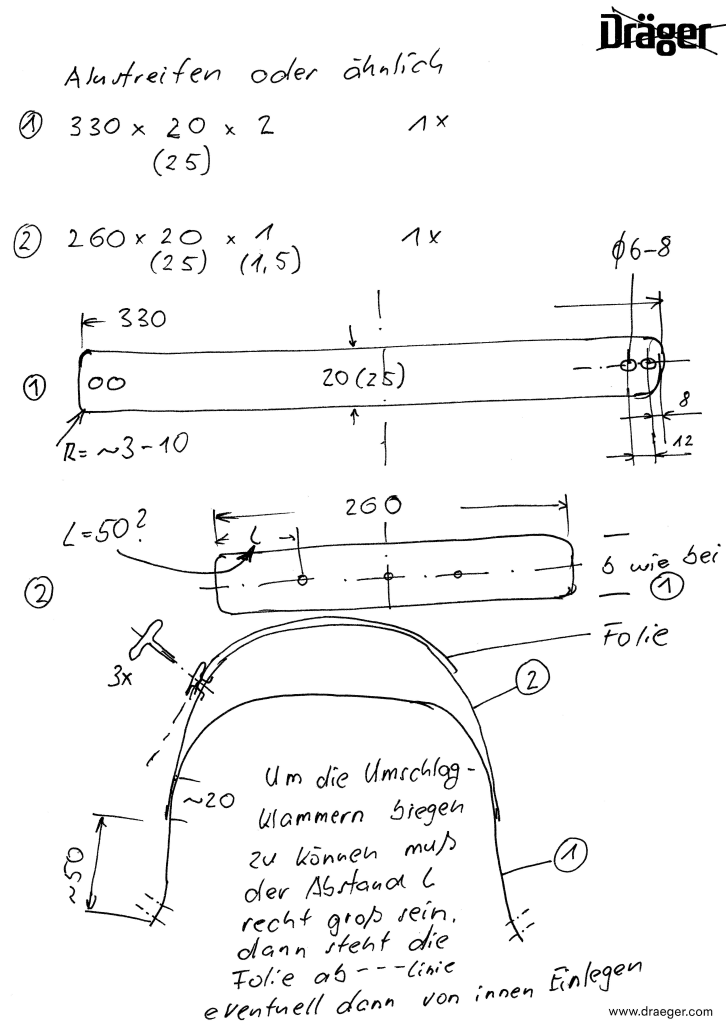
~3 iterations, discussed each time with medical doctors

Aluminum model

Based on custom design: O. Bach, B. Beyer, V. Prahl

Design and production

- Aluminum strips cut and bent in Zentralwerkstatt

- Assembly in ATLAS meeting room in Building 1c by ~30 shifters (2-3 people per shift)
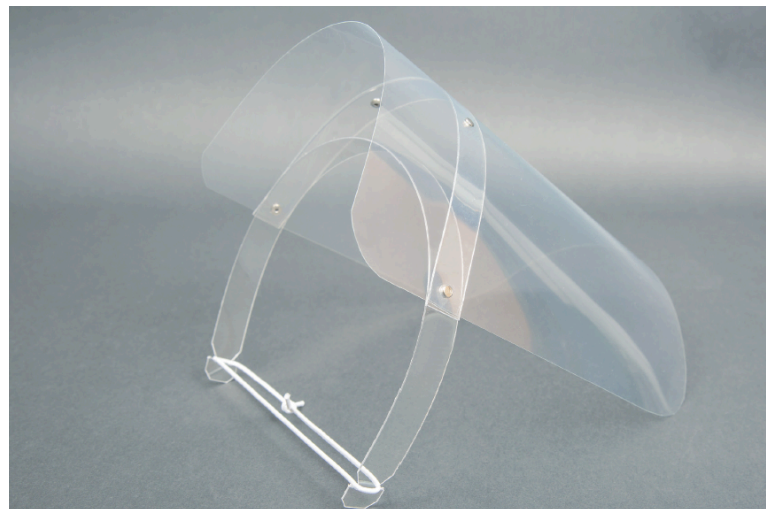
Makrolon model

Based on custom design: U. Packheiser, T. Behnke, B. Heinemann

Design and production

- Makrolon cutting and hole punching in Zentralwerkstatt

- Assembly in ATLAS meeting room in Building 1c by ~50 shifters (2-3 people per shift)

Status and Plans

Production and distribution

3D printed face shields

- Can produce up to 35 per day

- Material cost: 1,70 euro

- Delivered 490 to doctors

Aluminum models and Makrolon Models

- Can produce about 50-100 per day

- Material cost: 0,90 Euro

- Delivered 300 Aluminum Models to nursing homes and 200 Makrolon models to nursing homes and doctors

Plan:
- Produce ~600 more (then total is 2000)
- Clients: individual contacts of DESY employees, doctors via KVH, nursing homes, KITAs, schools, …

Epidemology activities: Zeuthen

Side activity of the theoretical astroparticle physics group (NEUCOS)

- April10, 2020: The EU has formally approved a **new work package** of the ERC NEUCOS (PI Walter Winter) on "interdisciplinary applications of simulation methodology to the new viral disease Covid-19"

- **Current activities (A. Palladino)**

  - Maintenance of an outreach page for Italy: https://covstat.it (international version to be added)

  - Contribution to a white paper for a Covid-19 app: https://www.covid-app.io

- Mostly epidemological modeling/outreach using SIR (Susceptible-Infected-Recovered) model:

  - The kinetic equations are similar to the ones used in astrophysics

  - The description of phenomena on exponential scales and the interpretation of corresponding data are similar to astrophysical scenarios

  - External effect (e.g. social measures) require extensions of the model, similar to damping terms in astrophysics systems
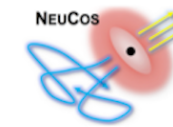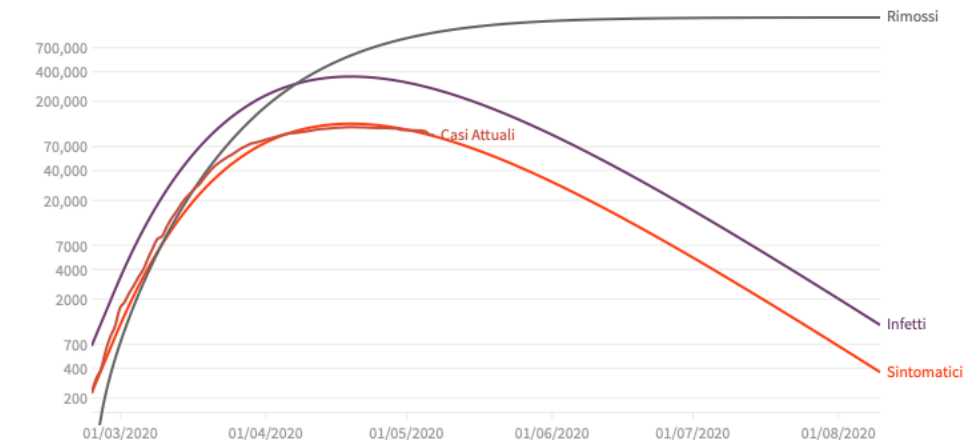

Modello SIR
(Suscettibili, Infetti, Rimossi)

Grafico elaborato utilizzando i dati pubblicati dal Dipartimento della Protezione Civile

Contact tracing

What is required for app to work?

Minimum fraction of population that needs to enroll

Contact Tracing: a game of big numbers in the time of COVID-19

Hyunju Kim[1,2,3,†] and Ayan Paul[4,5,†]

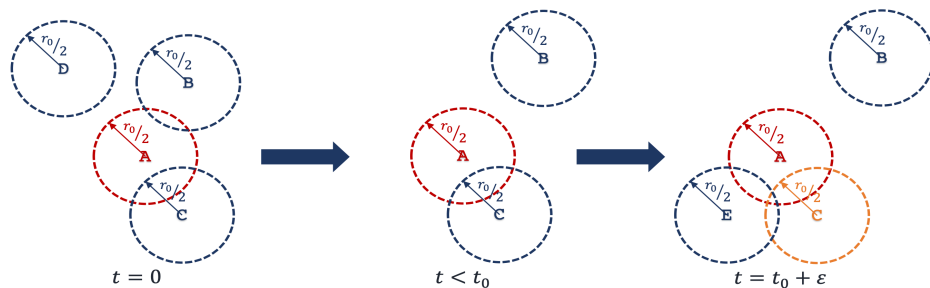[1]Beyond Center for Fundamental Concepts in Science, Arizona State University, Tempe, AZ, USA
[2]ASU-SFI Center for Biosocial Complex Systems, Arizona State University and Santa Fe Institute, USA
[3]School of Earth and Space Exploration, Arizona State University, Tempe, AZ, USA
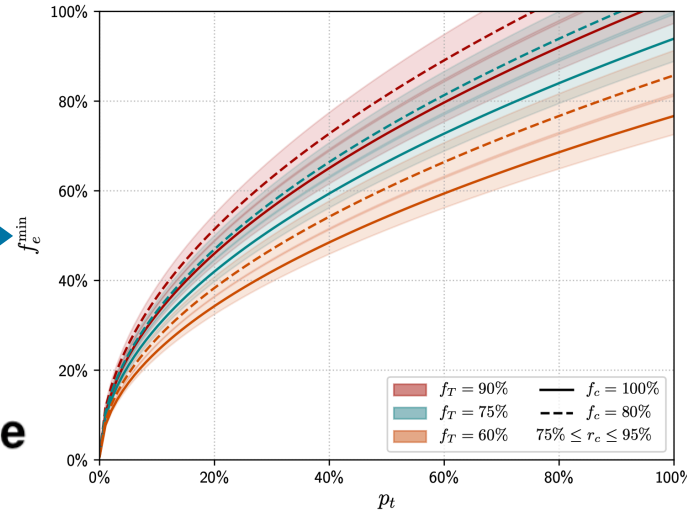[4]DESY, Notkestraße 85, D-22607 Hamburg, Germany
[5]Institut für Physik, Humboldt-Universität zu Berlin, D-12489 Berlin, Germany
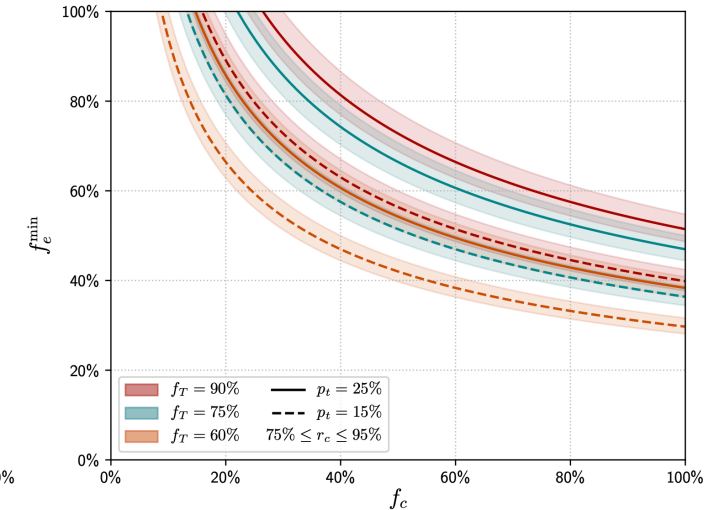[†]e-mail: hyunju.kim@asu.edu, apaul2@alumni.nd.edu

Probability of transmission (large for COVID-19)

Fraction of people who will confirm sickness

automated contact tracing using proximity data
RED: Sick. ORANGE: at risk. BLUE: not at risk.

- E.g. if asymptomatic rate ~20% => need enrollment of >80% to quarantine 75% of infected people

- Conclusion: App alone not sufficient due to asymptomatic cases and finite fraction of people enrolling => also need still social distancing and masks to reduce transmission probability

Determining the immunity and risk of patients

App to determine risk score

- Diverse team met at MIT COVID-19 hackathon

  - MDs, computer experts, life science, business people

  - Ayan Paul (DESY) => Bayesian Statistics

  - Team won the hackathon!

- Several governments, institutions, companies ….have shown interest

  - Also in discussion with Arik Wilner et al.

- Idea: Use machine learning to determine "immunity score" and "risk score" of individuals

  - Based on cell phone location data (GPS) and known risks of locations (e.g. known virus hotspots, highly populated places, …)

  - Access probability of prior COVID-19 exposure and recovery (potentially asymptomatic)

  - Helps e.g. to target testing better at "at-risk people"

company website:
covishealth.com
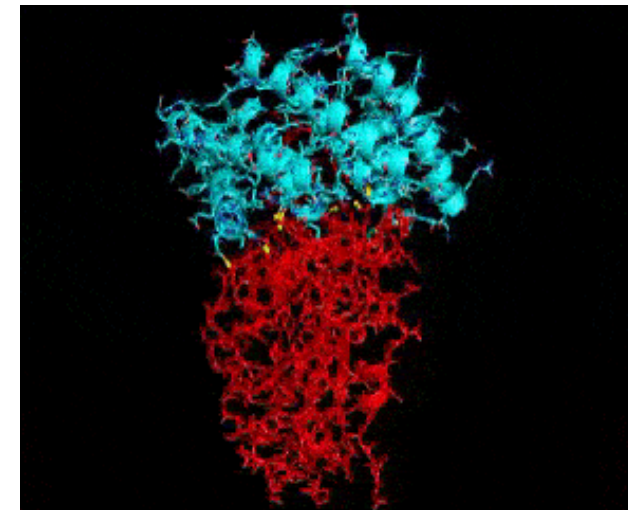
Computing against COVID-19

Protein Folding

- The arrangement of the atoms within the proteins ("folding") into structures determines the function of the protein

- Viruses have proteins that they use to suppress our immune system and reproduce themselves

- Simulations are used to predict and understand proteins structures and their dynamics

- May give important insights on how to develop therapeutics

- Two initiatives with citizen science:

  - Folding@Home: https://foldingathome.org/

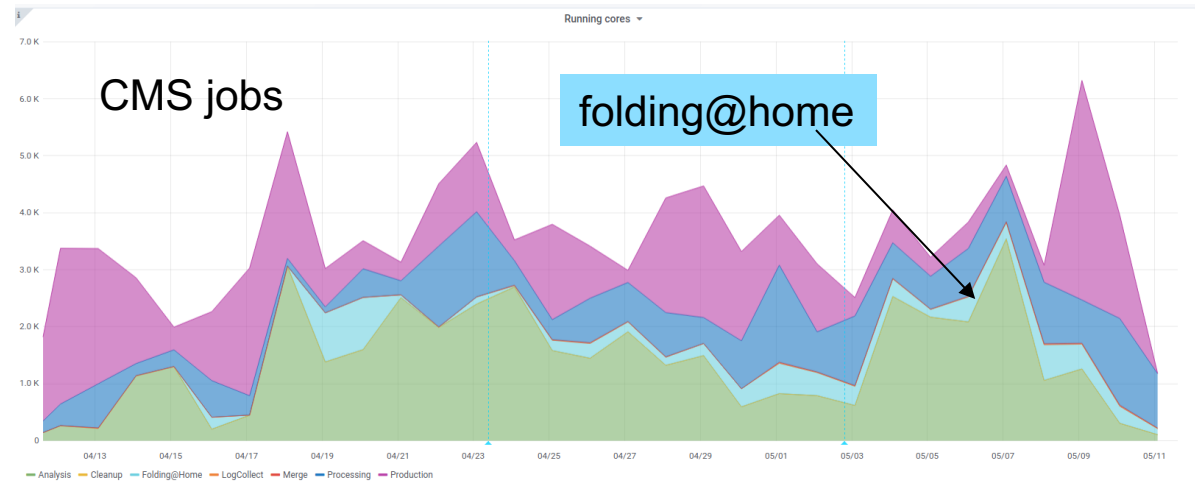 - Rosetta@Home: https://boinc.bakerlab.org/rosetta/

Folding@Home
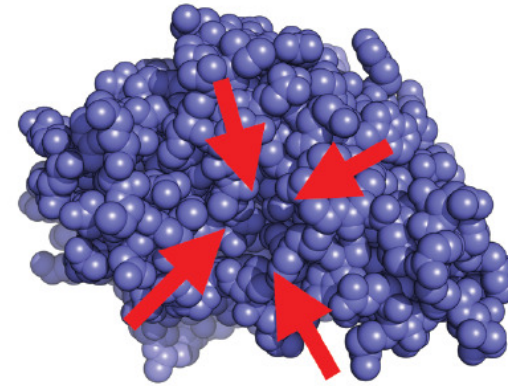
Rosetta@Home

Computing against COVID-19 at DESY

Contributions to F@H and R@H

- ATLAS and CMS collaborations contribute to F@H in context of WLCG with computing resources

  - DESY cloud contribution about 20%

  - WLCG is now in top 40 all-time F@H contributors
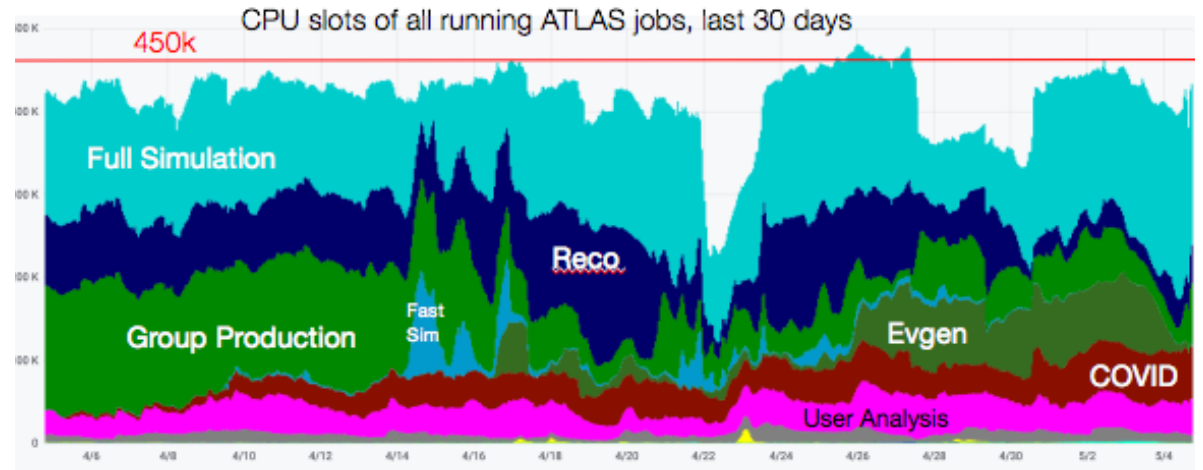   - CERN is also helping F@H researchers with data aggregation/organisation

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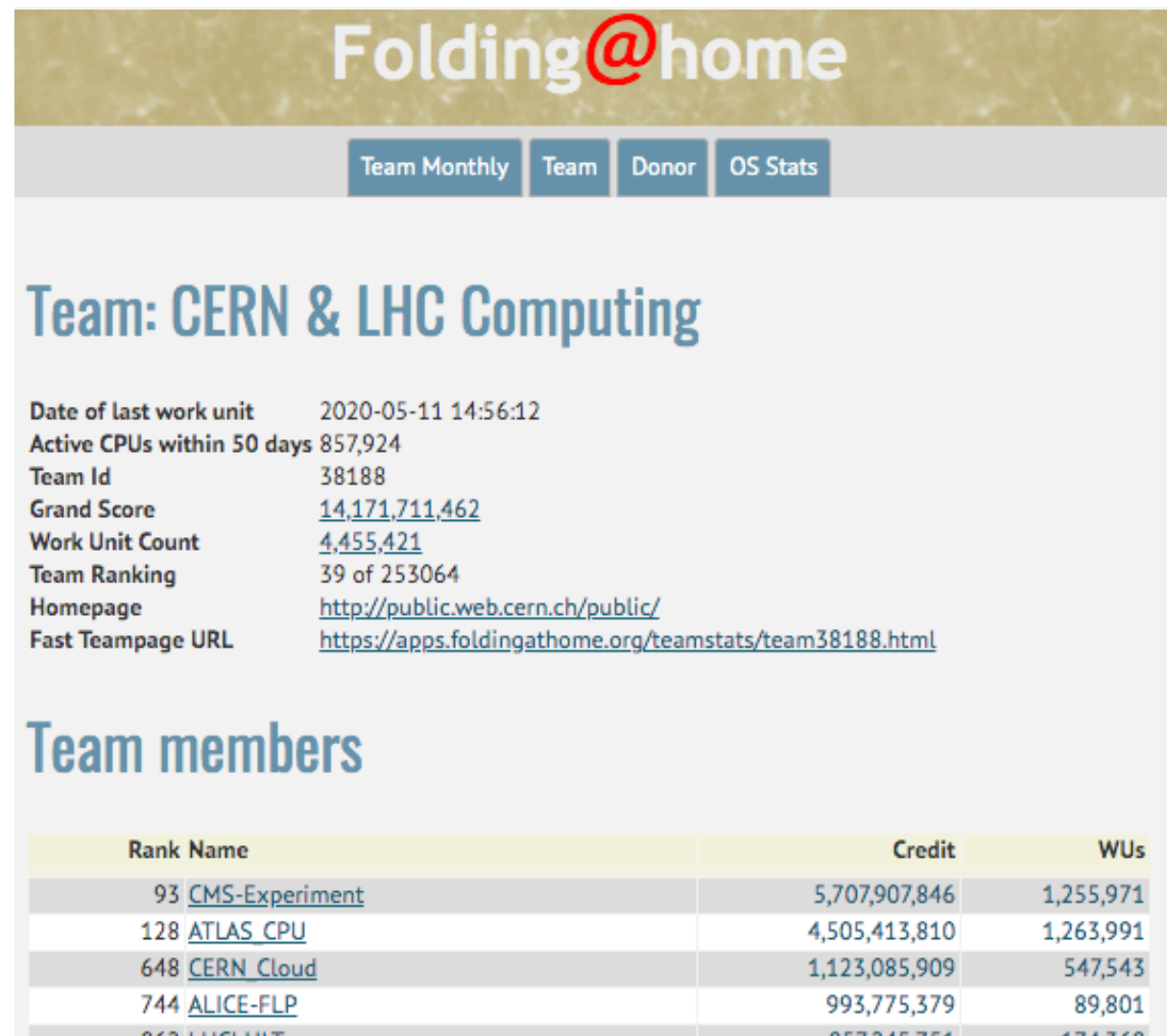
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- Rosetta@Home also supported at DESY

  - 500 CPU-Cores in HH

  - Backfilling of ZN HPC cluster

Folding@home

| Team Monthly | Team | Donor | OS Stats |

Team: CERN & LHC Computing

Date of last work unit	2020-05-11 14:56:12
Active CPUs within 50 days	857,924
Team Id	38188
Grand Score	14,171,711,462
Work Unit Count	4,455,421
Team Ranking	39 of 253064
Homepage	http://public.web.cern.ch/public/
Fast Teampage URL	https://apps.foldingathome.org/teamstats/team38188.html

Team members

Rank	Name	Credit	WUs
93	CMS-Experiment	5,707,907,846	1,255,971
128	ATLAS_CPU	4,505,413,810	1,263,991
648	CERN_Cloud	1,123,085,909	547,543
744	ALICE-FLP	993,775,379	89,801
862	LHCbHLT	857,245,751	174,368

Other Activities in HEP and Astro-Particle Community

Selection of other activities

- CERN has task force on COVID-19 (BH is member): https://againstcovid19.cern/ , e.g.

  - Produced >5000 face shields, >10000 litres of desinfectant (for own staff & local doctors/hospitals)

  - Ventilator (HEV): https://arxiv.org/pdf/2004.00534.pdf

  - Support for storage of open data and analysis (ZENODO)

  - …

- MVM Ventilator approved by FDA

  - C. Galbiati et al. (originated in DarkSide, 58 institutes): https://arxiv.org/abs/2003.10405

- See also more projects at Science Responds: https://science-responds.org/

CERN DG F. Gianotti visiting face shield production at CERN

Fermilab physicists go outside comfort zone to help design low-cost ventilator to fight COVID-19