



#### LHC@home and the Impact of BOINC on Science

François Grey<sup>1</sup>, Laurence Field<sup>2</sup>, Alex Piskun<sup>3</sup> and Polina Sokolova<sup>1,4</sup> <sup>1</sup>University of Geneva, <sup>2</sup>CERN, <sup>3</sup>BOINC Community, <sup>4</sup>ITU BOINC Workshop, CERN IdeaSquare, 29 May 2024



#### Overview

- 1. How LHC@home started and what it inspired (Francois)
- 2. Status of LHC@home today still going strong (Laurence)
- 3. Impact of BOINC on Science publication metrics (Alex)
- 4. Impact of the BOINC workshop at ITU this week (Polina)
- 5. What to expect this afternoon (Francois)

## 2003: LHC@home project initiated Volunteer computing project launched 2004





#### 2005-2015 : MalariaControl.net





## 2009-19: Citizen Cyberlab





For crowdsourcing to achieve its full potential, governments will need to support projects that promote public participation in measuring progress towards the SDGs. National statistics offices must develop best practices for integrating crowdsourced data.

> "SDG indicators need crowdsourcing" N. Seth and Y. Flückiger, Nature, 23 March 2016 (https://www.nature.com/articles/531448c)



#### Institutional Outreach

- → Africa@home
- → Asia@home
- → Brazil@home
- → India@home



#### **Examples of Spin-Off**

- → Asia@home
  - Quake-Catcher Taiwan (2009)
  - CAS@home (2010-15)
  - Computing for Clean Water (2010-15)
  - Mozilla Hackfest (2011)



#### Youth Outreach

- → CERN Webfest (2012-23)
- → Science Hack Day (2013-14)
- → Open17 Challenge (2015-23)
- → Open Geneva Festival (2017-24)
- → SDG Summer School (2016-24)
- → Geneva Trialogue (2016-24)
- → SDG Olympiad (2024)



## UN, EU Outreach

- → Citizen Cyberlab (2009-19)
  - Partnership with UNITAR
  - EU Citizen Cyberlab Project (2012-2015)
- → Citizen Cyberscience Summit (2010-14)
  - ECSA Conferences (2016-24)
  - EU Crowd4SDG Project (2020-2023)



## UN, EU Outreach

- → Geneva Tsinghua Initiative (2016-23)
  - ♦ Geneva Trialogue (2016-24)
  - SDG Internship Program (2018-24)
- → Citizen Science Global Partnership (2022-24)
  - CSGP Geneva Hub with Citizen Science Zurich
  - EU Albatross Project (2024-27)



A Student Innovation Hub

#### in the Heart of International Geneva

Palace of Nations (UN)

International Telecom. Union (ITU)



World Trade Organization (WTO)

World Meteorological Organization (WMO)

Campus Biotech

UN High Commission For Refugees (UNHCR)

**SDG Solution Space** 



#### 20 Years of LHC@home







https://cern70.cern

- Innovation to stable solution
  - Impact of ideas
- Continuous improvement
  - Further innovation
- Sustainability
  - Self-driven continuity



### Some History

- 2003: CERN Physics Screensaver (CPSS)
  - Running SixTrack on Windows Desktops
- 2004: LHC@home on BOINC started
  - 50th anniversary of CERN
  - Sixtrack application
- 2011: Test4Theory as a new BOINC project
  - Pioneered the use of virtualization
    - CernVM on volunteer desktops
- 2014/15: ATLAS@home and CMS@home
  - CernVM and CernVMFS, in-house innovations
- 2016: Consolidation of LHC@home to a single project
  - Outreach and improved website
- 2018: Record CPU capacity due to BOINC Pentathlon



#### LHC@home Today





LHC@home Project - Computing - Community - Jobs - Site -

Laurence Log out

#### What is LHC@home?

This a volunteer computing project that uses Internet-connected computers to advance Particle and Accelerator Physics. Participate by downloading and running a free program on your computer. By default, you can run the classic LHC@home application Sixtrack, for simulations of accelerator physics, and help researchers at CERN to improve the LHC.

Other LHC@home simulations that utilizes virtualization to run applications for Theory and experiment simulations for ATLAS, CMS and LHCb are also available.

Please note that some of the applications on LHC@home require Virtual Box to be installed. Please visit the LHC@home information site for more information. If you have any problems or questions please visit the Message Boards, Questions and Answers and FAQ.

#### News

20th BOINC Workshop May 29-31 The registration is now open for the 2024 BOINC Workshop -- this year in person, at CERN.

https://indico.cern.ch/event/1379525/overview

Please register if you plan to attend. 22 Apr 2024, 9:21:39 UTC · Discuss

BOINC Needs Votes at a Upcoming UN Forum BOINC is a finalist for an notable award, and needs your vote (\*by Sunday):





#### The Service

- BOINC Server version 1.4.2
- Redhat Enterprise Linux 9
  - Just upgraded from CentOS 7
- ~20 large VMs running in OpenStack
  - Data Centre Infrastructure/Hardware
- Production and QA environment
  - Ihcathomedev
- Dedicated services
- Custom services
  - Volunteer Computing Credential Service (VCCS)
  - DataBridge
- Application Infrastructure
  - CVMFS servers, MCPlots, ...



## **Ongoing Activities**

- Keeping the service running
- Community Participation
  - Transition BOINC to Open Source
  - BOINC Software
    - Server Releases (and testing)
    - GDPR
    - Further Innovations
      - Prototype Web-based Manager
      - Containers
  - Projects Calls
    - Sharing experiences
  - BOINC Workshops
- Volunteer engagement



### The Future: XTrack

- SixTrack
  - Beam simulations of the stability of proton orbits in the LHC accelerator (and FCC)
- Xtrack
  - $\circ$   $\,$  Workloads already moved
    - Less Sixtrack jobs for BOINC
  - Native pre-compiled, stand-alone executable
  - CPU and GPU
  - LHC and FCC studies
- More details in a dedicated presentation
  - 2023 BOINC Workshop Day 02

https://www.youtube.com/watch?v=3QLk6y2WNGs

# **BOINC** publication methodology

- → began updating BOINC's own MediaWiki page by gathering publications from project websites, internet searches and other existing lists (Boinc.Italy, Rechenkraft.net etc.)
- → the list became impressive enough to warrant its own php page boinc.berkeley.edu/pubs.php
- → Zotero research assistant software is used to organize publications and export files that are uploaded to BOINC GitHub and then used to generate pubs.php
- → criteria to be included on the pubs page solidified to list papers containing scientific results arising, directly or indirectly, from BOINC-based computing.
- → publications are confirmed manually by myself and by the projects where possible.





#### LHC@home publications per year





#### LHC@home citations per publication

		Number of Citations per Publication
Total Dublicationa, 70	Status and Roadmap of CernVM -	
Total Publications. 70	JACoW : SixTrack project: Status, runtime environment, and new developments - Phenomenology of Soft QCD: The Role of Minimum-Bias Measurements -	
	- Multiple Parton Interactions at the LHC - Precise measurement of the top-quark mass at the CMS experiment using the ideogram method	
Total Citations 15 592	Particle Identification in Jets and High-Multiplicity pp Events with the ALICE TPC - Outlook on MPI and MC models -	
	Parton Showers since LEP - Massive Tracking on Heterogeneous Platforms -	
	Large Scale Beam-beam Simulations for the CERN LHC using Distributed Computing - IACoW : Extended-Domain Tune-Scans for the HL-LHC Dynamic Aperture in Presence of Beam-Beam Effects -	
	A world-wide databridge supported by a commercial cloud provider Extended-Domain Tune-Scans for the HL-LHC Dynamic Aperture in Presence of Beam-Beam Effects	
	Backfilling the Grid with Containerized BOINC in the ATLAS computing Release of Crystal Routine for Multi-Turn Proton Simulations within SixTrack v5	
	The Open High Throughput Computing Content Delivery Network - Improving the Performance of Volunteer Computing with Data Volunteers: A Case Study with the ATLAS@home Project	
	Exotic decays of heavy B quarks CMS@home: Integrating the Volunteer Cloud and High-Throughput Computing	
	ATLAS Grid Workflow Performance Optimization – Towards a Production Volunteer Computing Infrastructure for HEP –	
	QCD studies at FCC-ee Using ATLAS@Home to Exploit Extra CPU from Busy Grid Sites -	
	Extending CERN computing to volunteers - LHC@home consolidation and outlook - CernVM Co-Pilot: an Extensible Framework for Building Scalable Computing Infrastructures on the Cloud -	
	CernVM WebAPI - Controlling Virtual Machines from the Web - Particle spectra from dark matter annihilation: physics modelling and QCD uncertainties -	
	Studying QCD modeling of uncertainties in particle spectra from dark-matter annihilation into jets - Dynamic federation of grid and cloud storage -	
	Evolution of the CMS Global Submission Infrastructure for the HL-LHC Era Advances in ATLAS@Home towards a major ATLAS computing resource -	
	String fragmentation with a time-dependent tension - New Features of the 2017 SixTrack Release -	
	은 Fragmentation of two repelling Lund strings - 걸 SixTrack Project: Status, Runtime Environment, and New Developments -	
	CMS@home: Enabling Volunteer Computing Usage for CMS LHC@Home: a BOINC-based volunteer computing infrastructure for physics studies at CERN	
	Nonlinear correction schemes for the phase 1 LHC insertion region upgrade and dynamic aperture studies - BOINC service for volunteer cloud computing -	
	Soft-QCD and UE spectra in pp collisions at very high CM energies (a Snowmass white paper) - QCD Monte-Carlo model tunes for the LHC -	
	Revised QCD effects on the Z → b□ar{b} forward-backward asymmetry - SixTrack V and runtime environment -	
	Innovative method to measure the extent of the stable phase-space region of proton synchrotrons - Working Group Report: Hadron Colliders -	
	Confronting experimental data with heavy-ion models: Rivet for heavy ions - The Development of MPI Modeling in Pythia -	LHC@home BOINC h-index is 23.
	Revisiting radiation patterns in e+ e- collisions Longitudinal double-spin asymmetries for π 0 s in the forward direction for 510 GeV polarized p p collisions	(23 publications cited 23 times or more)
	Collective flow in high-multiplicity proton-proton collisions - Fragmentation uncertainties in hadronic observables for top-quark mass measurements -	
	Charged jet cross section and fragmentation in proton-proton collisions at s = 7 TeV Proceedings of the Sixth International Workshop on Multiple Partonic Interactions at the Large Hadron Collider	
	Future hadron colliders: From physics perspectives to technology R&D	
	Probing collective effects in hadronisation with the extremes of the underlying event	
	Colour reconnection and its effects on precise measurements at the LHC	
	SoftXiller, a particle-level pileup removal method - Svottsmatics of duark/dluon tagging	
	Chapter 1: Standard Model Processes LHC forward physics	
	Effects of overlapping strings in pp collisions String formation bevond leading colour	
	FCC Physics Opportunities: Future Circular Collider Conceptual Design Report Volume 1 Tuning PYTHIA 8.1: the Monash 2013 tune	
	Review of Particle Physics An introduction to PYTHIA 8.2	
		Number of Citations



#### LHC@home citation count distribution





#### Metrics of BOINC publications

- → What other metrics should we extract from the broader data set?
  - e.g. national, regional distribution of author institutions (per project and global)



- → WSIS Prizes: submission within Action Line 7 E-science
- → Open Panel: Volunteer computing for climate science, sustainable development and human health
- → Geneva Trialogue: table on volunteer computing for AI Related activities:
- → Space and Global Health Hackathon
- → Preparation of the report on the results of the Panel





#### **WSIS** Prize

→ WSIS Prizes: Champions Prize for Action Line 7 - E-science



Ses	sion 478
🛗 Т	hursday, 30 May 2024
01	4:00-15:30 (UTC+02:00)
i P	hysical (on-site) participation only
<b>9</b> 10	CT Discovery, ITU Montbrillant Building
¢° V	VSIS Prizes



#### A prize-winner from last year



#### NEWS

#### Seeed Studio Wins "WSIS Prize 2023 Champion" Certificate for Using AloT for Environment at UN ITU: Global Recognition of IoT2Wild Contest!

By Ye Seong SHIN 1 year ago

On March 15th, Seeed Studio was awarded "WSIS Prize 2023 Champion" prize certificate at the UN ITU, in Geneva, Switzerland. It's a UN-level of recognition for the success of IoT2Wild Contest 2022 and the usage of ICTs for environment, which was awarded at ITU's 14th World Summit on the Information Society (WSIS) Forum 2023.



## **ITU WSIS Panel on BOINC**

- → "Volunteer computing for climate science, sustainable development and human health"
- → Summarize main outcomes of the Workshop

#### Panelists:



Prof. David Wallom Associate Director Oxford e-Research Centre



Prof. Ana-Lucia Varbanescu Associate Professor The University of Twente



Dr. Ben Segal CERN Alumnus and Internet Hall of Fame, Switzerland

Session 215	
🎬 Friday, 31 May 2024	
② 11:00-11:45 (UTC+02:00)	
i Physical (on-site) participation only	
SDG Stage, ITU Montbrillant Building	
📽 Interactive Session	



#### Geneva Trialogue



#### **CO-CREATION TABLES**

1) Creating a youth-powered global computing resource for sustainable AI

Sharada Mohanty, AlCrowd

2) Accelerating Serendipitous Collaborations for Youth Conferences using AI

Lee Howell, Villars Institute

3) Healing the Post-MUN Syndrome at Scale with AI and Online Learning

Prajeeth Sitherasenan, Swiss Learning Exchange (SLX)

4) Enabling the Use of Open Humanitarian Data for MUNs thanks to AI

Javier Teran Castro, Humanitarian Data Exchange (HDX)

....(8 more Co-creation tables)



# **B**MAL TO Expect this afternoon

Ana Varbanescu	Energy consumption and carbon footprint of volunteer vs data center computing
Bastien Chopard	New opportunities for BOINC in the field of scientific simulations
Sharada Mohanty	New strategies for combining volunteer computing and BOINC
Clemens Gregor	Open source software projects in high-energy physics: some lessons learned
Levi Rybalov	Incentives for distributed computing: new concepts and methodologies
Violet Su	Beyond Computing: new trends in networked sensors



#### What to expect this afternoon

**Breakout Sessions:** 

- 1. BOINC and new science applications
- 2. BOINC for reducing carbon footprint of distributed computing
- 3. BOINC and new open-source management methods
- 4. BOINC and large-scale computing for AI
- 5. Promoting BOINC on new platforms
- 6. Promoting BOINC as national Cyber Infrastructure