

A night scene featuring a fountain in the center. A bright, glowing light source is positioned to the left of the fountain, creating a strong lens flare and illuminating the water. The background shows a building with arched windows and a palm tree on the left. The overall atmosphere is dark and atmospheric.

A Million Years of Computing

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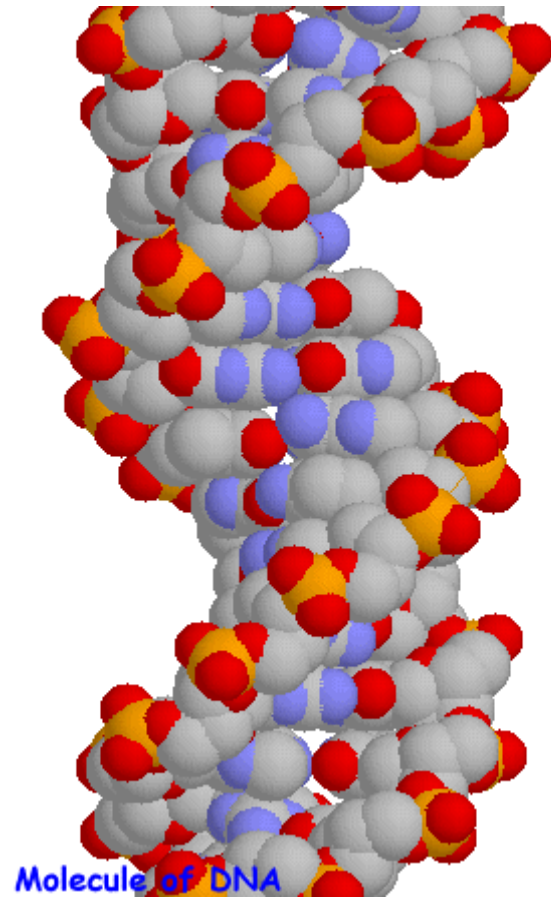
What is scientific computing?



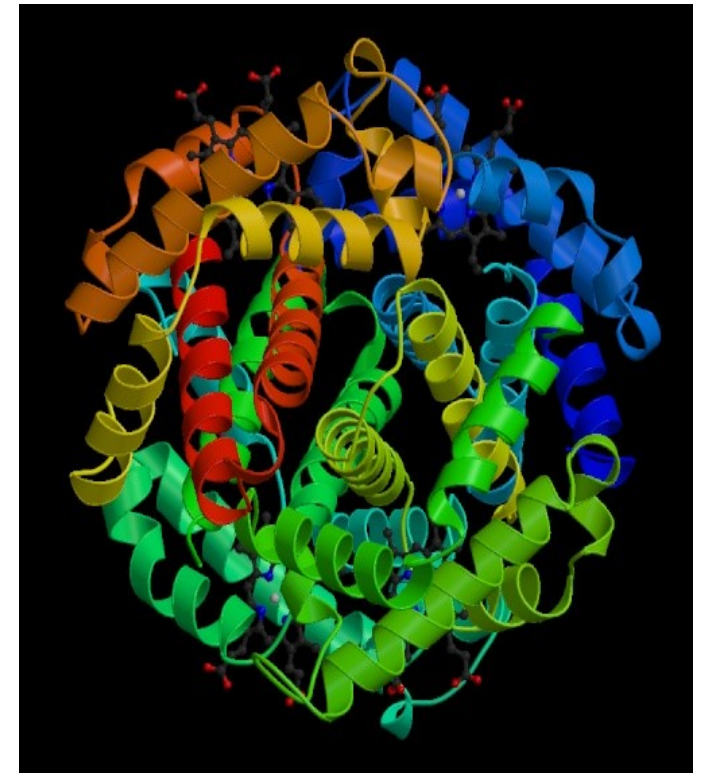
High-energy physics



Molecular biology



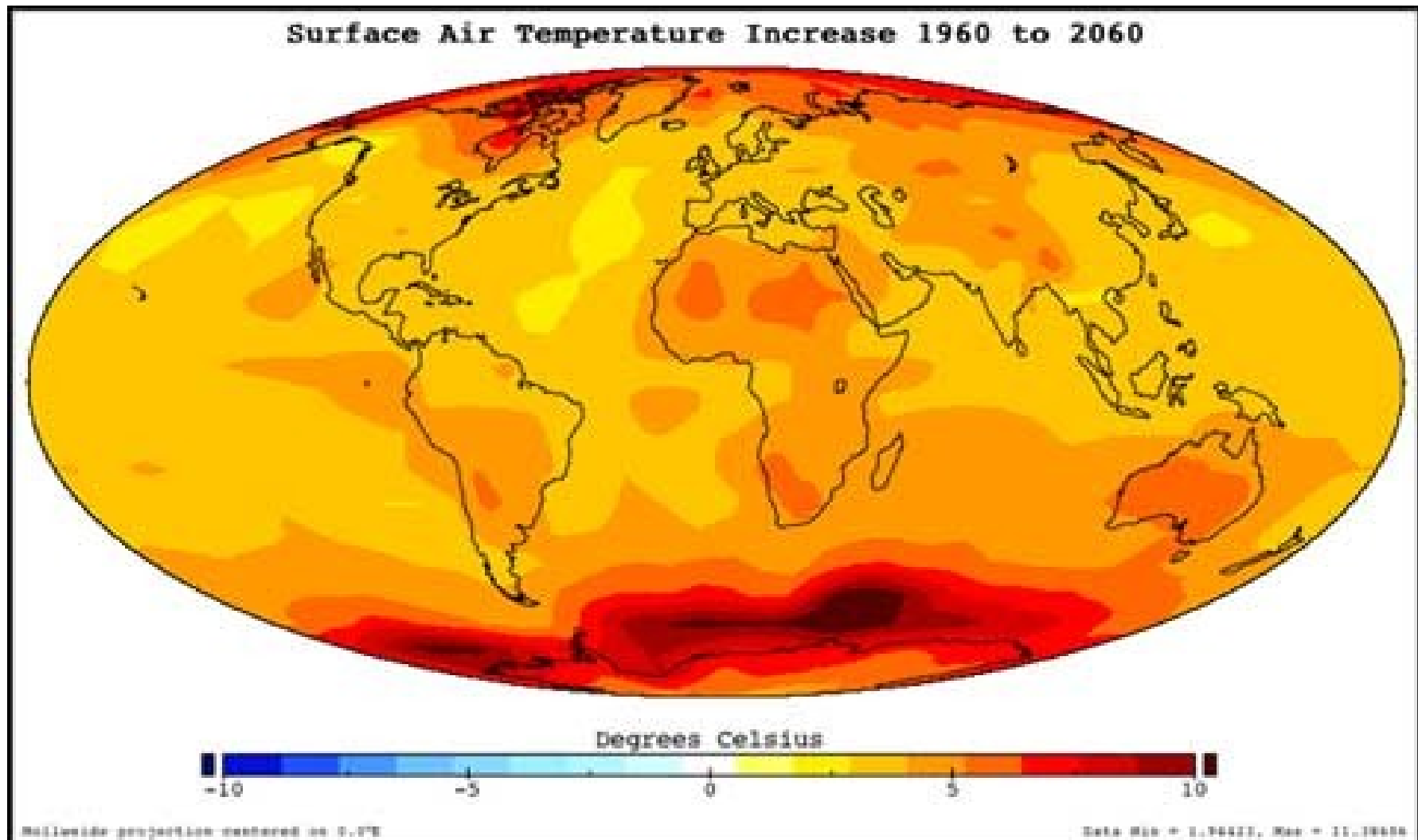
©Rothensted Experimental Station, 1997, 1998



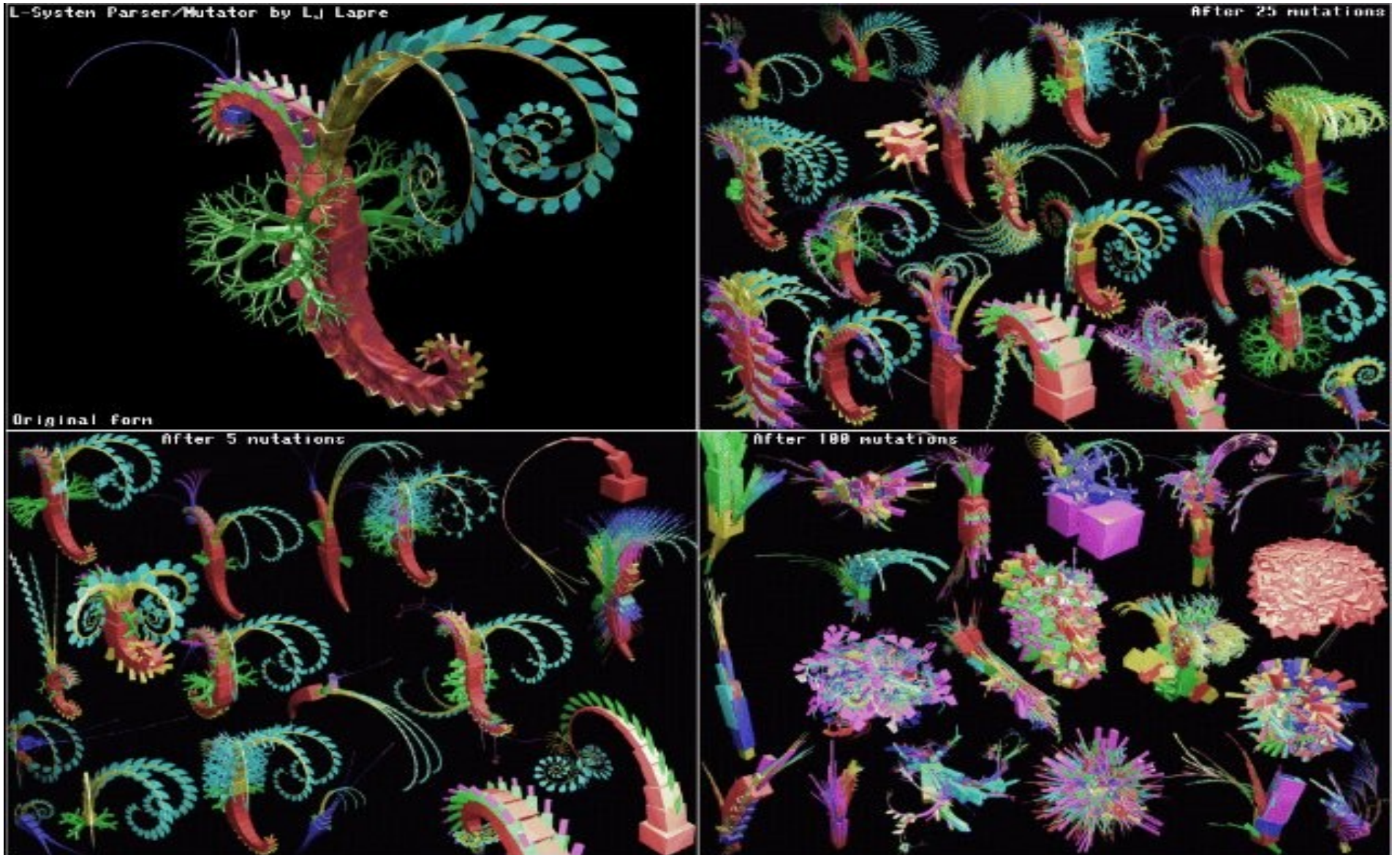
DNA

protein

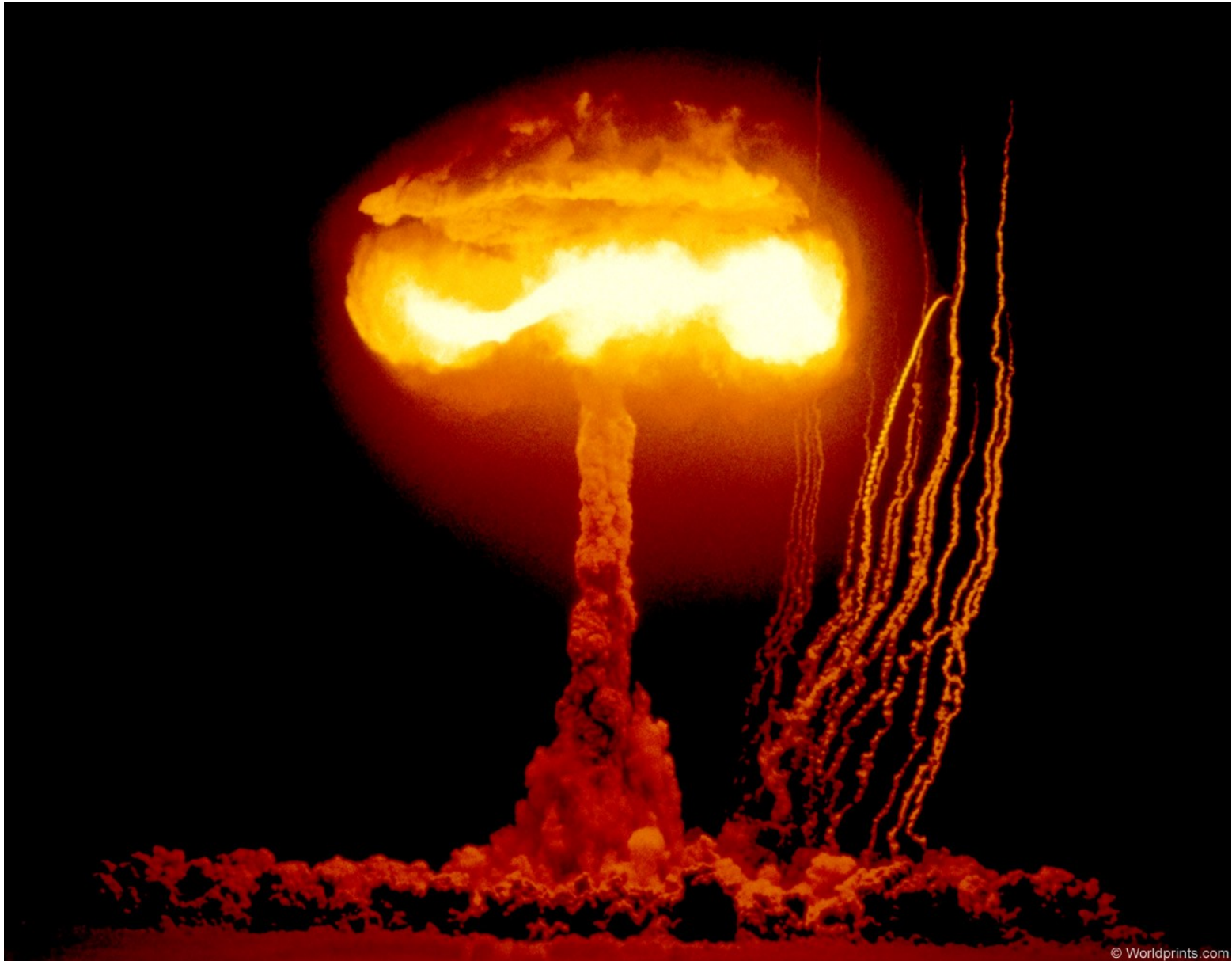
Climate change study



Artificial life



Weapons of mass destruction



Measuring computing power

- FLOPS: floating-point operations per second
 - e.g. $2.458817 + 15.49848 = 17.957297$
 - 1 GigaFLOPS = 1 billion (10^9) FLOPS
 - 1 TeraFLOPS = 1 trillion (10^{12}) FLOPS
 - 1 PetaFLOPS = 1 quadrillion (10^{15}) FLOPS
- Storage (memory, disk)
 - 1 byte = 8 bits (e.g. 00100011)
 - Megabytes, Gigabytes etc.

Computing paradigms



mainframes



personal computers

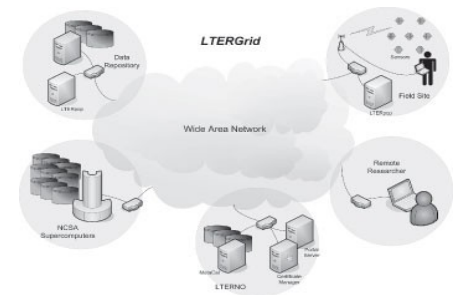
supercomputers

cluster computing



Grid computing

Volunteer computing



Supercomputer history

1938	Zuse Z1	0.9 FLOPS
1946	ENIAC	50 KFLOPS
1958	UNIVAC LARC	500 KFLOPS
1975	Burroughs ILLIAC IV	150 MFLOPS
1976	Cray-1	250 MFLOPS
1983	Cray X-MP/4	941 MFLOPS
1985	Cray-2/8	3.9 GFLOPS
1993	Thinking Machines	65.5 GFLOPS
1996	Hitachi SR2201	220 GFLOPS
2000	IBM ASCI White	7.2 TFLOPS
2002	NEC Earth Simulator	35 TFLOPS
2006	IBM Blue Gene/L	280 TFLOPS

PCs versus Supercomputers

- PCs trail supercomputers by about 20 years
- 100,000 PCs == 1 supercomputer
- There are ~ 1 billion PCs on the Internet
- Consumer products (PCs, game consoles) are getting faster faster
- PC owner buys PC, maintains it, buys electricity
- But: PCs are unreliable and untrusted

Volunteer computing

<u>Project</u>	<u>start</u>	<u>where</u>	<u>area</u>	<u>peak #hosts</u>
GIMPS	1994		math	10,000
distributed.net	1995		cryptography	100,000
SETI@home I	1999	UCB	SETI	600,000
Folding@home	1999	Stanford	biology	200,000
United Devices	2002	commercial	biomedicine	200,000
CPDN	2003	Oxford	climate change	150,000
LHC@home	2004	CERN	physics	60,000
Predictor@home	2004	Scripps	biology	100,000
WCG	2004	commercial	biomedicine	200,000
Einstein@home	2005	LIGO	astrophysics	200,000
SETI@home II	2005	UCB	SETI	850,000
Rosetta@home	2005	U. Wash	biology	100,000
SIMAP	2005	T.U. Munich	bioinformatics	10,000

Performance of BOINC projects

- 680,000 participants in 245 countries
- 1,000,000 computers
- 400 TeraFLOPS (more than BlueGene!)
- 12 Petabytes of free disk space
- [SETI@home](#): 2.7 million years of computer time
- But the potential is much larger!

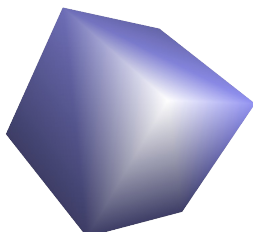
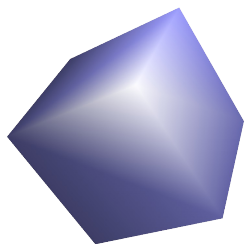
projects

SETI

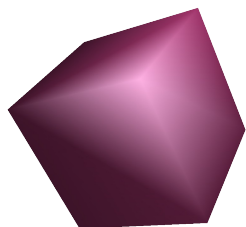
Climate

physics

biomedical



Volunteers "attach"
computer to projects

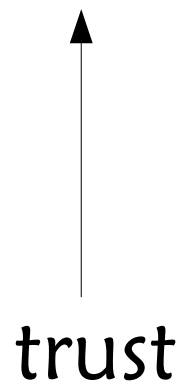


Joe

Alice

Jens

volunteers

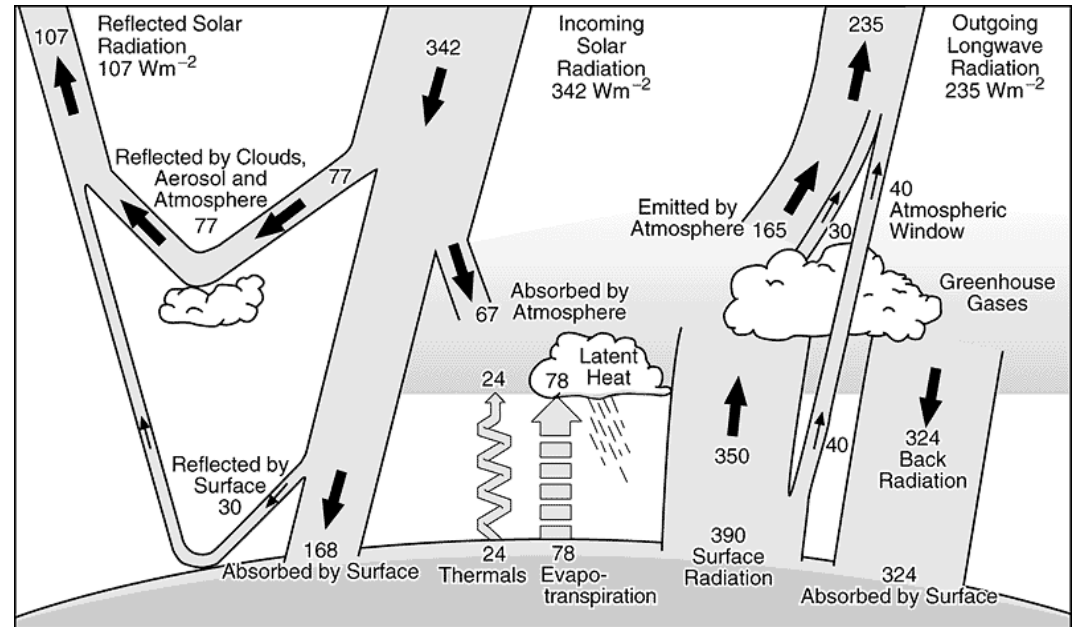


distrust

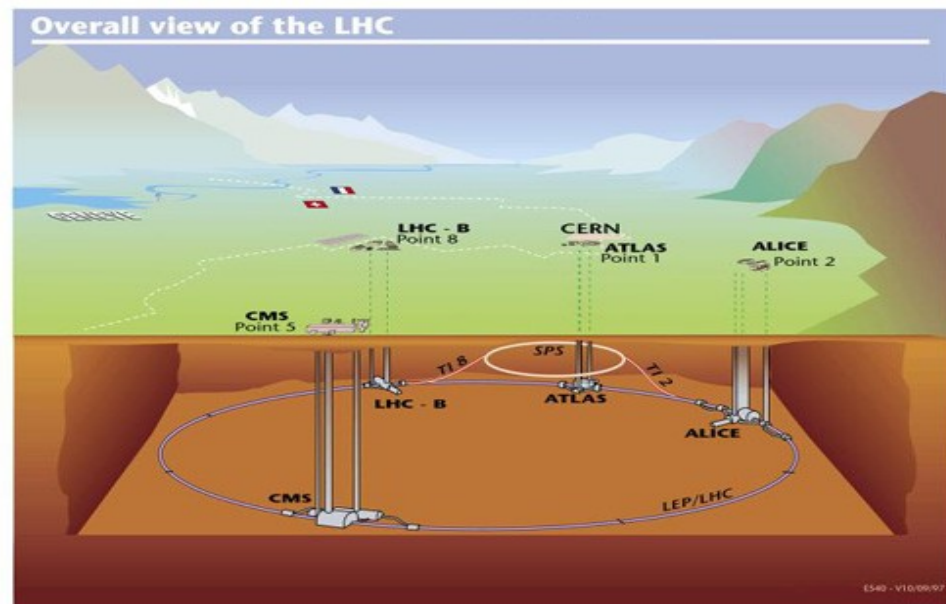
trust

Some BOINC-based projects

Climateprediction.net
(Oxford University)



LHC@home
(CERN)

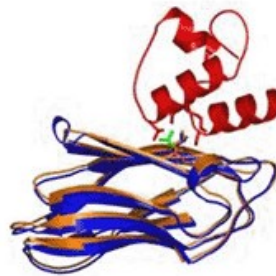


SETI@home
(U.C. Berkeley)



Rosetta@home
(Univ. of Washington)

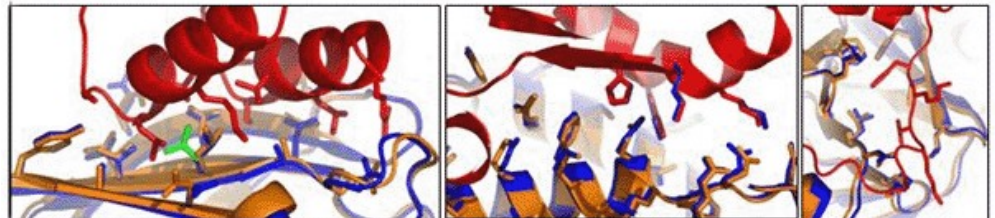
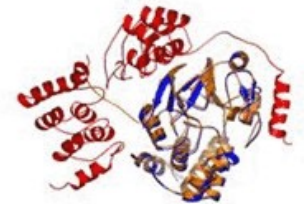
Target 12: Dockerin-cohesin complex



Target 15: Immunity protein-colicin tRNAse complex



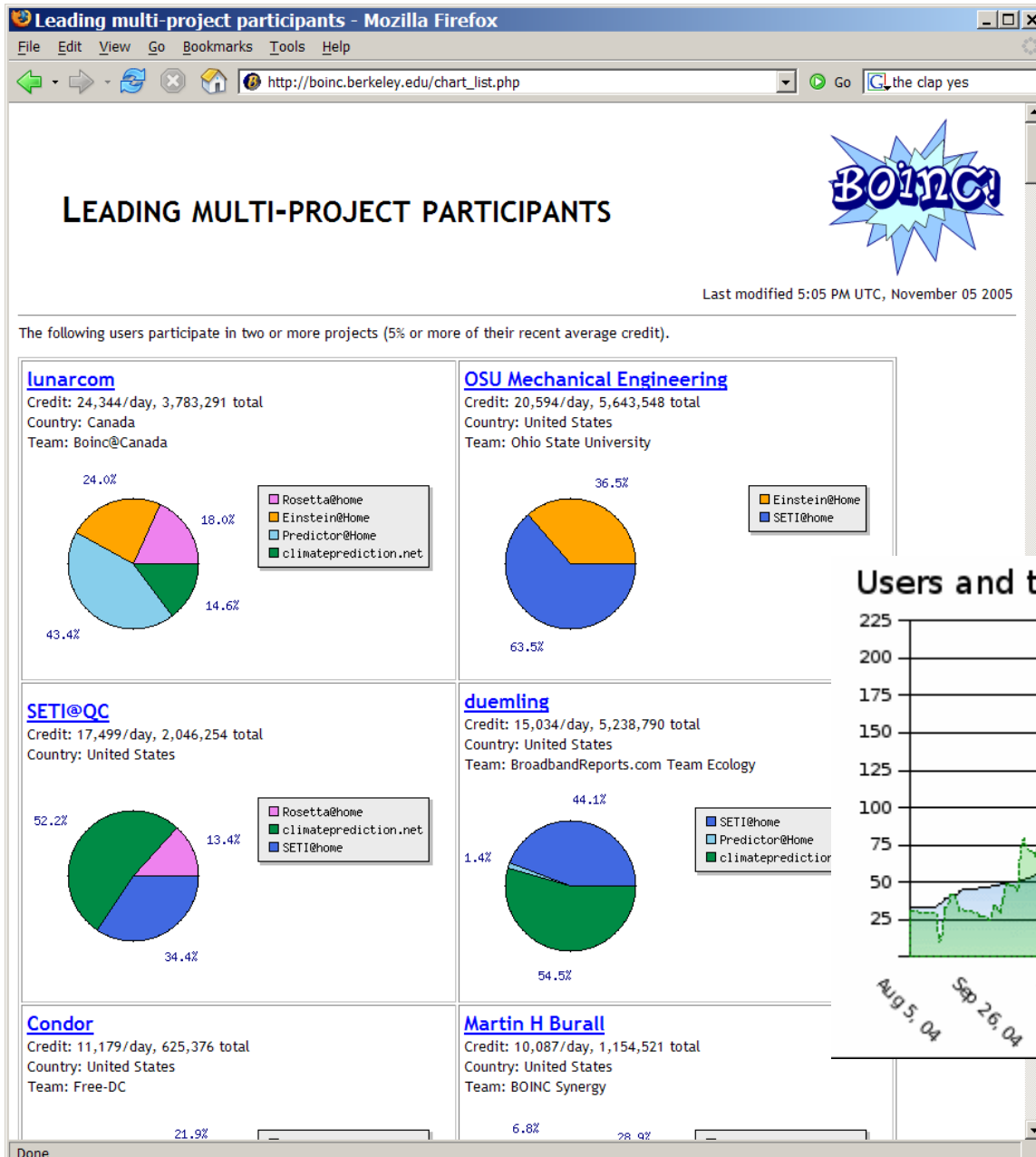
Target 14: Myosin phosphatase-targeting subunit—protein S/T phosphatase



How to participate

- Install and run BOINC client software
 - <http://boinc.berkeley.edu>
 - Available for Windows, Mac OS X, Linux
- Enter the URL of a project
 - e.g.: <http://setiathome.berkeley.edu>
- Enter your email address and password
- Done!

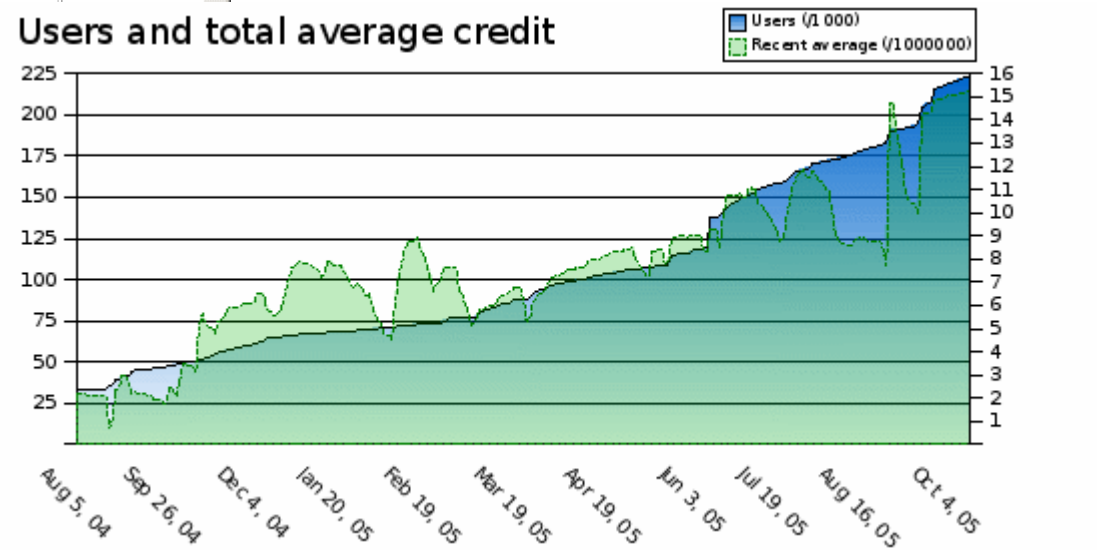
Credit



barbarossa / mithfang			
	Credits:	RAC:	Rank:
SETI	215514	1912	2094
CPDN	40926	216	5381
Einstein	25798	236	5399
Rosetta	652	30	3984
BOINC	282892	2396	2235

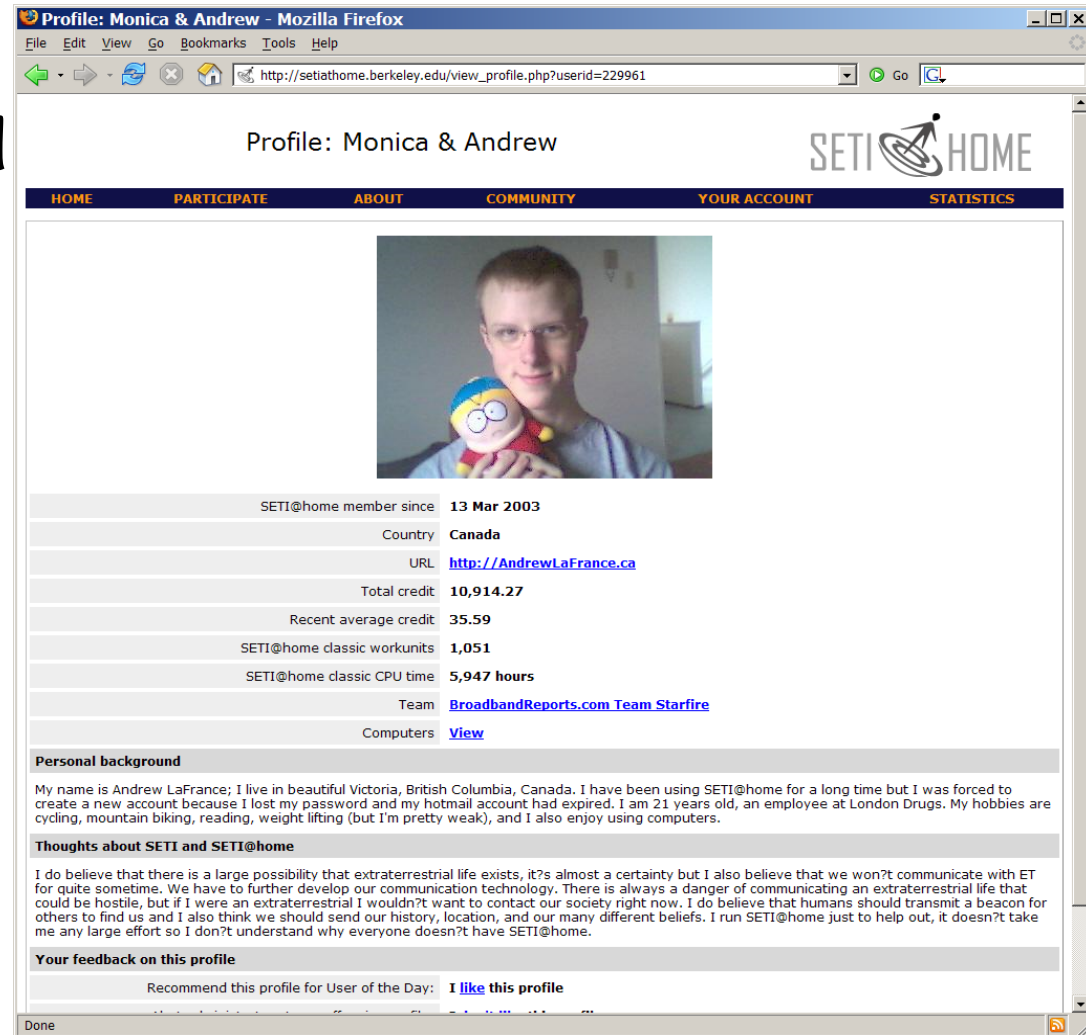
BOINCSTATS user stats
www.boincstats.com

Users and total average credit



Community features

- Message boards
 - Science, technical, social
- User profiles
- Teams
- Translations
- Web sites
 - (statistics, teams)



The screenshot shows a web browser window displaying a user profile for 'Monica & Andrew' on the SETI@home website. The browser's address bar shows the URL 'http://setiathome.berkeley.edu/view_profile.php?userid=229961'. The profile page features a navigation menu with links for HOME, PARTICIPATE, ABOUT, COMMUNITY, YOUR ACCOUNT, and STATISTICS. A central photograph shows a young man with glasses holding a plush toy. Below the photo is a table of statistics:

SETI@home member since	13 Mar 2003
Country	Canada
URL	http://AndrewLaFrance.ca
Total credit	10,914.27
Recent average credit	35.59
SETI@home classic workunits	1,051
SETI@home classic CPU time	5,947 hours
Team	BroadbandReports.com Team Starfire
Computers	View

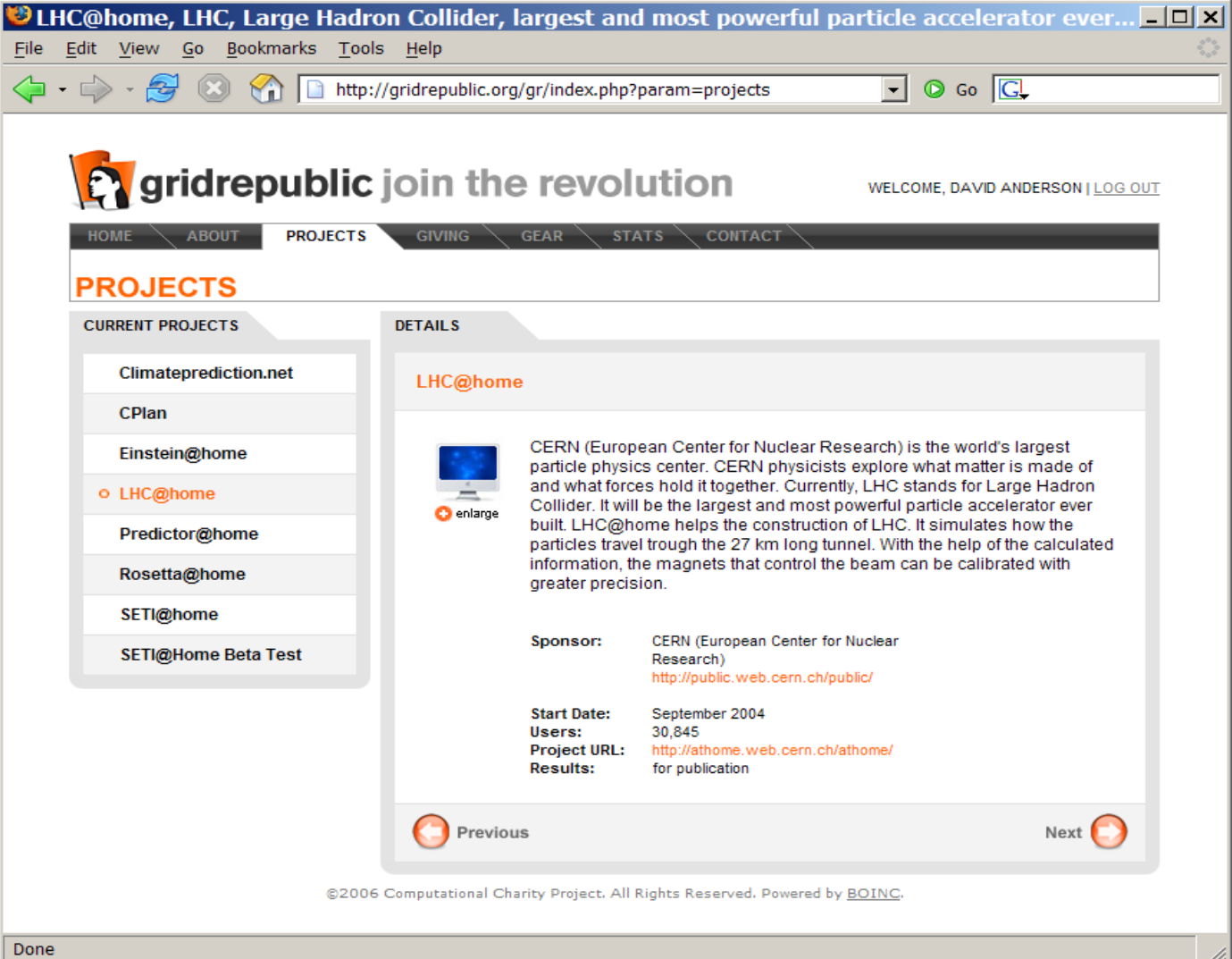
Below the statistics is a section titled 'Personal background' with the following text: 'My name is Andrew LaFrance; I live in beautiful Victoria, British Columbia, Canada. I have been using SETI@home for a long time but I was forced to create a new account because I lost my password and my hotmail account had expired. I am 21 years old, an employee at London Drugs. My hobbies are cycling, mountain biking, reading, weight lifting (but I'm pretty weak), and I also enjoy using computers.'

There is also a section titled 'Thoughts about SETI and SETI@home' with the text: 'I do believe that there is a large possibility that extraterrestrial life exists, it's almost a certainty but I also believe that we won't communicate with ET for quite sometime. We have to further develop our communication technology. There is always a danger of communicating an extraterrestrial life that could be hostile, but if I were an extraterrestrial I wouldn't want to contact our society right now. I do believe that humans should transmit a beacon for others to find us and I also think we should send our history, location, and our many different beliefs. I run SETI@home just to help out, it doesn't take me any large effort so I don't understand why everyone doesn't have SETI@home.'

At the bottom, there is a section for 'Your feedback on this profile' with a button that says 'I like this profile'.

Account managers

GridRepublic



The screenshot shows a web browser window displaying the GridRepublic website. The browser's address bar shows the URL <http://gridrepublic.org/gr/index.php?param=projects>. The website header includes the GridRepublic logo and the text "gridrepublic join the revolution". A navigation menu contains links for HOME, ABOUT, PROJECTS, GIVING, GEAR, STATS, and CONTACT. The "PROJECTS" section is active, displaying a list of "CURRENT PROJECTS" on the left and a "DETAILS" view for the "LHC@home" project on the right. The "LHC@home" details include a description of the CERN Large Hadron Collider, a list of project statistics (Sponsor, Start Date, Users, Project URL, Results), and navigation buttons for "Previous" and "Next".

gridrepublic join the revolution WELCOME, DAVID ANDERSON | [LOG OUT](#)

HOME ABOUT **PROJECTS** GIVING GEAR STATS CONTACT


PROJECTS

CURRENT PROJECTS

- Climateprediction.net
- CPlan
- Einstein@home
- LHC@home**
- Predictor@home
- Rosetta@home
- SETI@home
- SETI@Home Beta Test

DETAILS

LHC@home

 [enlarge](#)

CERN (European Center for Nuclear Research) is the world's largest particle physics center. CERN physicists explore what matter is made of and what forces hold it together. Currently, LHC stands for Large Hadron Collider. It will be the largest and most powerful particle accelerator ever built. LHC@home helps the construction of LHC. It simulates how the particles travel through the 27 km long tunnel. With the help of the calculated information, the magnets that control the beam can be calibrated with greater precision.

Sponsor: CERN (European Center for Nuclear Research)
<http://public.web.cern.ch/public/>

Start Date: September 2004

Users: 30,845

Project URL: <http://athome.web.cern.ch/athome/>

Results: for publication

[Previous](#) [Next](#)

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Done

Conclusion

- Scientific computing
 - Will always need more computing power
- Volunteer computing
 - The computing paradigm of the future
- BOINC
 - Middleware for volunteer computing
- Goals
 - 1000+ projects
 - 10 million volunteers
 - Give the public a voice in science research policy