

# Grid computing at the ATLAS experiment and Swiss Grid resources

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# Laboratory for High Energy Physics at the University of Bern



Head of department: Antonio Ereditato

People: 33

PhD students: 5, involved in...

... High-energy collider physics (ATLAS)

(Andreas Battaglia, Cyril Topfel, Nicola Venturi)

... Development of novel particle detectors

(Biagio Rossi)

... Neutrino physics (OPERA)

(Jonas Knüsel)



## ATLAS experiment

5 continents, 35 countries,  
164 institutions, 1800 physicists

Uni Bern involved in:

- data taking
- trigger selection
- physics Analysis
- computing

# Talk Organization

A. Battaglia

30 minutes

ATLAS Trigger System:

- General Architecture
- Event Building - SFO

C. Topfel

20 minutes

Grid computing:

- Grid computing basics
- Grid @ ATLAS in Switzerland

N. Venturi

20 minutes

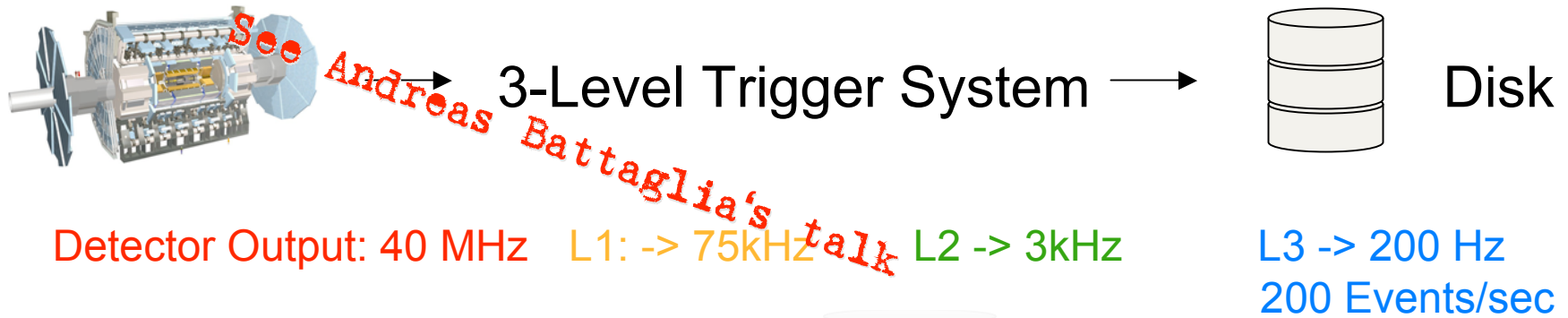
Supersymmetry Analysis:

- Supersymmetry Introduction
- Inclusive & exclusive SUSY studies

# Outline

- A. Motivation for Grid-computing
- B. Grid computing basics
- C. Grid computing @ ATLAS
- D. Swiss Grid resources

# A: ATLAS: from the Detector to Disk:

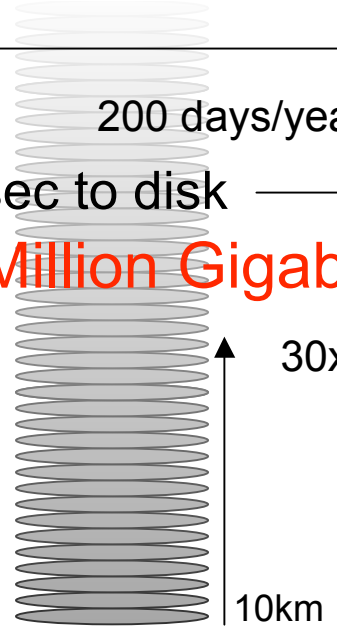


1 Event ~ 1.6 MegaBytes  
200 Events / sec

200 days/year, 14h/day  
} 300 MB/sec to disk → 3 PetaBytes/year

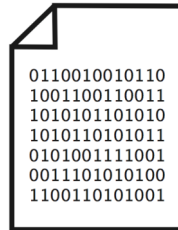
**3 Million Gigabytes per year!**

A pile of CD's of 10 km height!  
OR  
30 ATLAS caverns filled with books!  
30 x (35m x 55m x 40m)



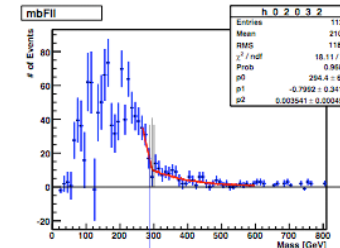
# A: Motivations for the Grid

Task:



RAW data

?



Physics analysis plots

- ATLAS (and also CMS, LHCb, ALICE etc) produce huge amounts of data, which have to be stored and analyzed.
- It is very difficult to do this centrally.
- The data must be distributed and processed around the globe.



**Grid computing**

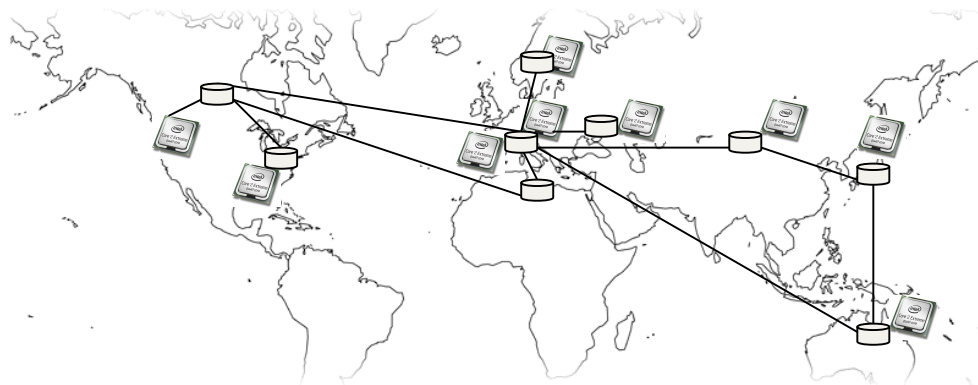
# B: Grid Basics

WorldWideWeb invented in ~1990 by  
Tim Berners-Lee at CERN.

(Hypertext, TCP, DNS)

⇒ Information is made available worldwide.

The **Grid** takes this idea one step further,  
**distributing** not only Information, but also  
resources like **processing power** and  
**data storage** around the globe.



First webserver at CERN...



... set up by Tim Berners-Lee

# B: Grid Basics

## Security and authentication:

**Security** is a big issue in a Wide Area Network like the Internet.


In the **Grid** environment, so-called certificates are given to every

- Person
- Grid-Frontend-Machine (more on this later)
- Grid-File-Server

These certificates are like identification cards:

Whenever a connection to a grid-service is made, X.509-based mutual authentication is performed to make sure who you're talking to.


Server certificate  
issued to:  
lheppc50.unibe.ch  
University of Bern



e654-535e3534-5634...

SIGNED BY CA  
453f-a.b54-3564

Personal certificate  
issued to:  
Cyril Topfel  
University of Bern



385a-e2345435-32454...

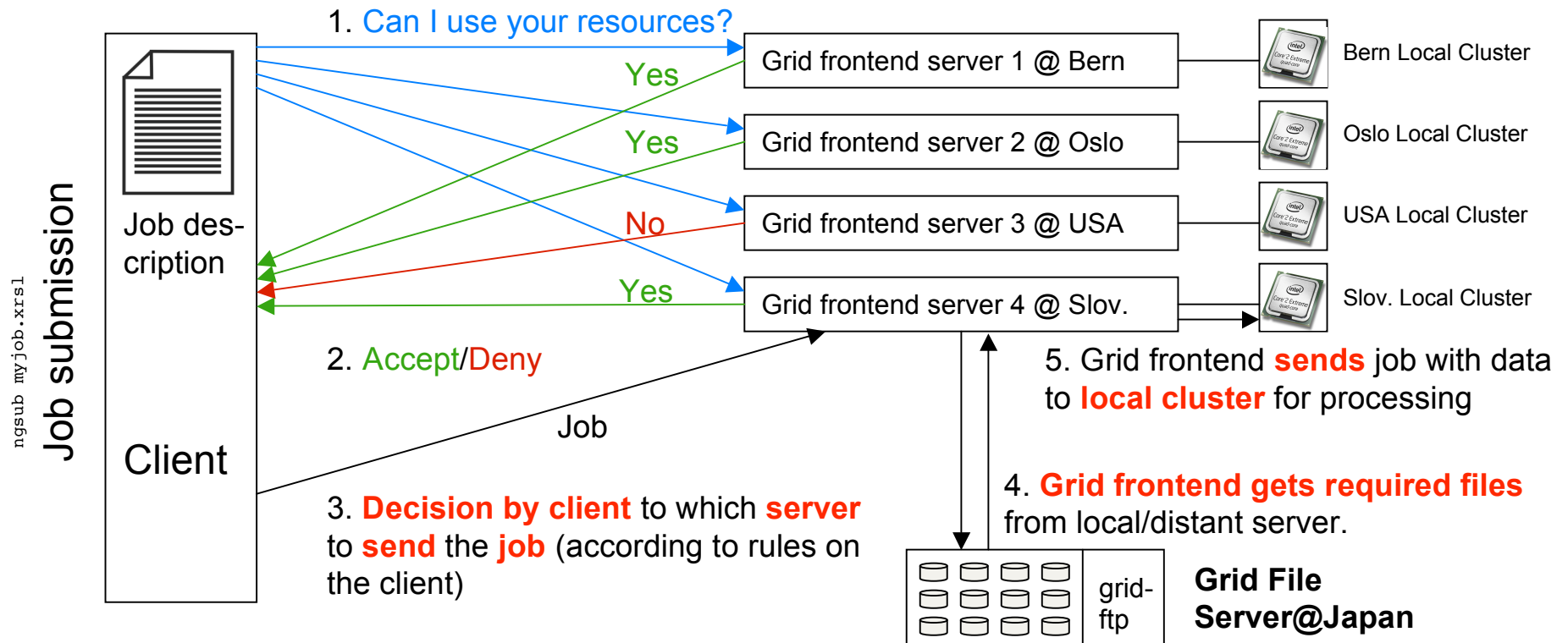
SIGNED BY CA  
453f-a.b54-3564



# B: Grid Basics

## Job Submission in Nordugrid:

Job description file: **How long** does the job run, how much **memory** is used, **software environment**, what **files** from **which server** is used etc.



# Grid Monitor (Nordugrid)

## ATLAS Grid Monitor

2008-01-10 CET 10:11:11

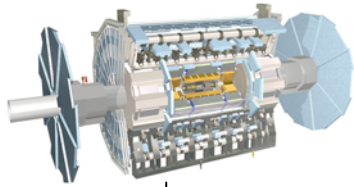
Processes: ■ Grid ■ Local

Country	Site	CPU	Load (processes: Grid+local)	Queueing
<span style="color:red">■</span> Denmark	Steno (DCSC/KU)	117	0+464	0+1470
<span style="color:blue">■</span> Norway	EPF (UIO/FI)	25	19+2	25+0
	Hyperion (USIT/UIO)	170	92+75	
	Norgrid@NTNU	42	0+14	
<span style="color:green">■</span> Slovenia	Titan A (USIT/UIO)	2356	293+1289	
	SIGNET	196	196+0	
<span style="color:blue">■</span> Sweden	Bluesmoke (Swegrid,NS>	92	52+38	
	Hagrid (SweGrid, Uppm>	84	88+0	
	Hive (Swegrid, C3SE)	101	18+24	
	Ingrid (SweGrid,HPC2N)	95	31+64	
	Sigrid (SweGrid, Luna>	97	91+4	
<span style="color:red">■</span> Switzerland	Bern ATLAS T3 Cluster	24	5+0	
	Bern UBELIX Cluster	512	44+384	
	Geneva ATLAS	72	23+49	
<b>TOTAL</b>	<b>14 sites</b>	<b>3983</b>	<b>936 + 2407</b>	

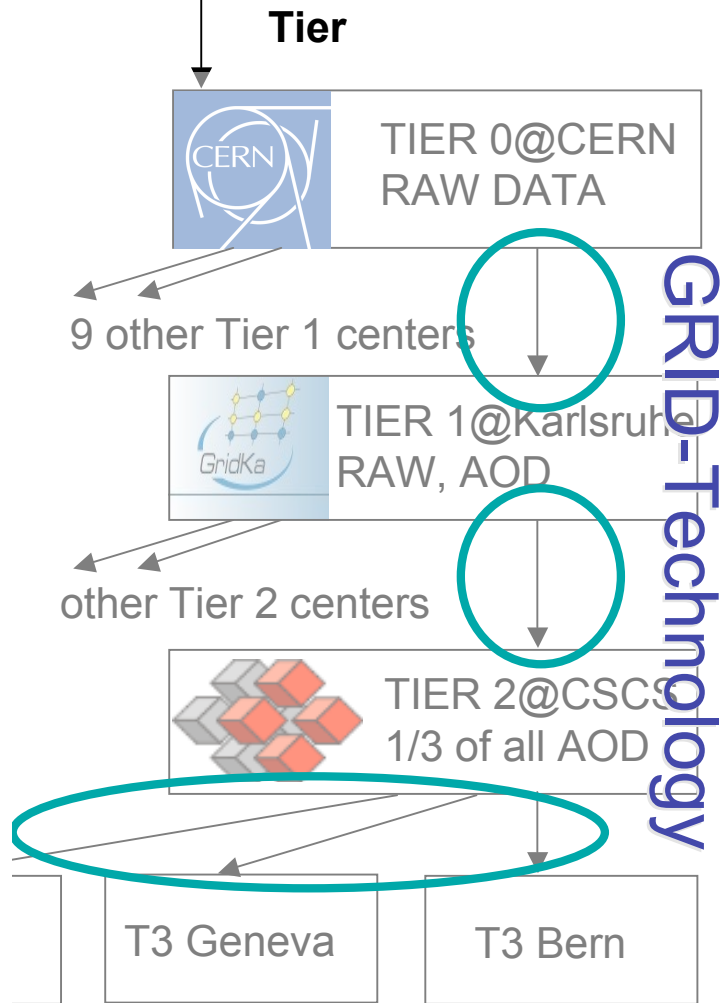
Jobs at nordugrid.unibe.ch

Job name	Owner	Status	CPU (min)	Queue	CPUs
1 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid017844_63395.job	Katarina Pajchel	INLRMS: R	265	all	1
2 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid017844_64543.job	Katarina Pajchel	INLRMS: R	237	all	1
3 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid017846_87471.job	Katarina Pajchel	INLRMS: R	213	all	1
4 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid017846_89079.job	Katarina Pajchel	INLRMS: R	195	all	1
5 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid017845_76879.job	Katarina Pajchel	INLRMS: R	224	all	1
6 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid017846_85420.job	Katarina Pajchel	INLRMS: R	209	all	1
7 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid017845_77943.job	Katarina Pajchel	INLRMS: R	196	all	1
8 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid017844_69016.job	Katarina Pajchel	INLRMS: R	191	all	1
9 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid017844_69284.job	Katarina Pajchel	INLRMS: R	192	all	1
10 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid017844_69478.job	Katarina Pajchel	INLRMS: R	187	all	1
11 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018292_85622.job	Katarina Pajchel	INLRMS: R	188	all	1
12 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018292_85622.job	Katarina Pajchel	INLRMS: R	181	all	1
13 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018292_85572.job	Katarina Pajchel	INLRMS: R	179	all	1
14 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018292_86155.job	Katarina Pajchel	INLRMS: R	174	all	1
15 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018292_89131.job	Katarina Pajchel	INLRMS: R	175	all	1
16 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018292_88520.job	Katarina Pajchel	INLRMS: R	171	all	1
17 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018292_89199.job	Katarina Pajchel	INLRMS: R	174	all	1
18 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018293_96048.job	Katarina Pajchel	INLRMS: R	171	all	1
19 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018292_88132.job	Katarina Pajchel	INLRMS: R	165	all	1
20 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018293_95996.job	Katarina Pajchel	INLRMS: R	170	all	1
21 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018292_87792.job	Katarina Pajchel	INLRMS: R	171	all	1
22 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018292_88171.job	Katarina Pajchel	INLRMS: R	165	all	1
23 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018292_89807.job	Katarina Pajchel	INLRMS: R	170	all	1
24 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018292_87322.job	Katarina Pajchel	INLRMS: R	157	all	1
25 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018293_97949.job	Katarina Pajchel	INLRMS: R	166	all	1
26 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018293_98906.job	Katarina Pajchel	INLRMS: R	161	all	1
27 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018293_98819.job	Katarina Pajchel	INLRMS: R	160	all	1
28 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018293_96931.job	Katarina Pajchel	INLRMS: R	156	all	1
29 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018293_96970.job	Katarina Pajchel	INLRMS: R	157	all	1
30 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018294_07876.job	Katarina Pajchel	INLRMS: R	151	all	1
31 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_14859.job	Katarina Pajchel	INLRMS: R	155	all	1
32 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018294_09632.job	Katarina Pajchel	INLRMS: R	150	all	1
33 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_14940.job	Katarina Pajchel	INLRMS: R	143	all	1
34 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_16036.job	Katarina Pajchel	INLRMS: R	139	all	1
35 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_19072.job	Katarina Pajchel	INLRMS: R	145	all	1
36 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_16879.job	Katarina Pajchel	INLRMS: R	137	all	1
37 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_17663.job	Katarina Pajchel	INLRMS: R	128	all	1
38 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_16788.job	Katarina Pajchel	INLRMS: R	131	all	1
39 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_15395.job	Alex Read	INLRMS: R	12	all	1
40 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_14868.job	Alex Read	INLRMS: R	121	all	1
41 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_14869.job	Alex Read	INLRMS: R	57	all	1
42 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018294_09627.job	Alex Read	INLRMS: R	10	all	1
43 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_16760.job	Alex Read	INLRMS: R	all	all	1
44 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_17897.job	Alex Read	INLRMS: R	all	all	1
45 misal1_mc12.005805.filtered_minbias6.digit.v12003103_tid018295_18224.job	Alex Read	INLRMS: R	all	all	1

[www.nordugrid.org/monitor/atlas](http://www.nordugrid.org/monitor/atlas)



# C: ATLAS TIER structure (TDR)



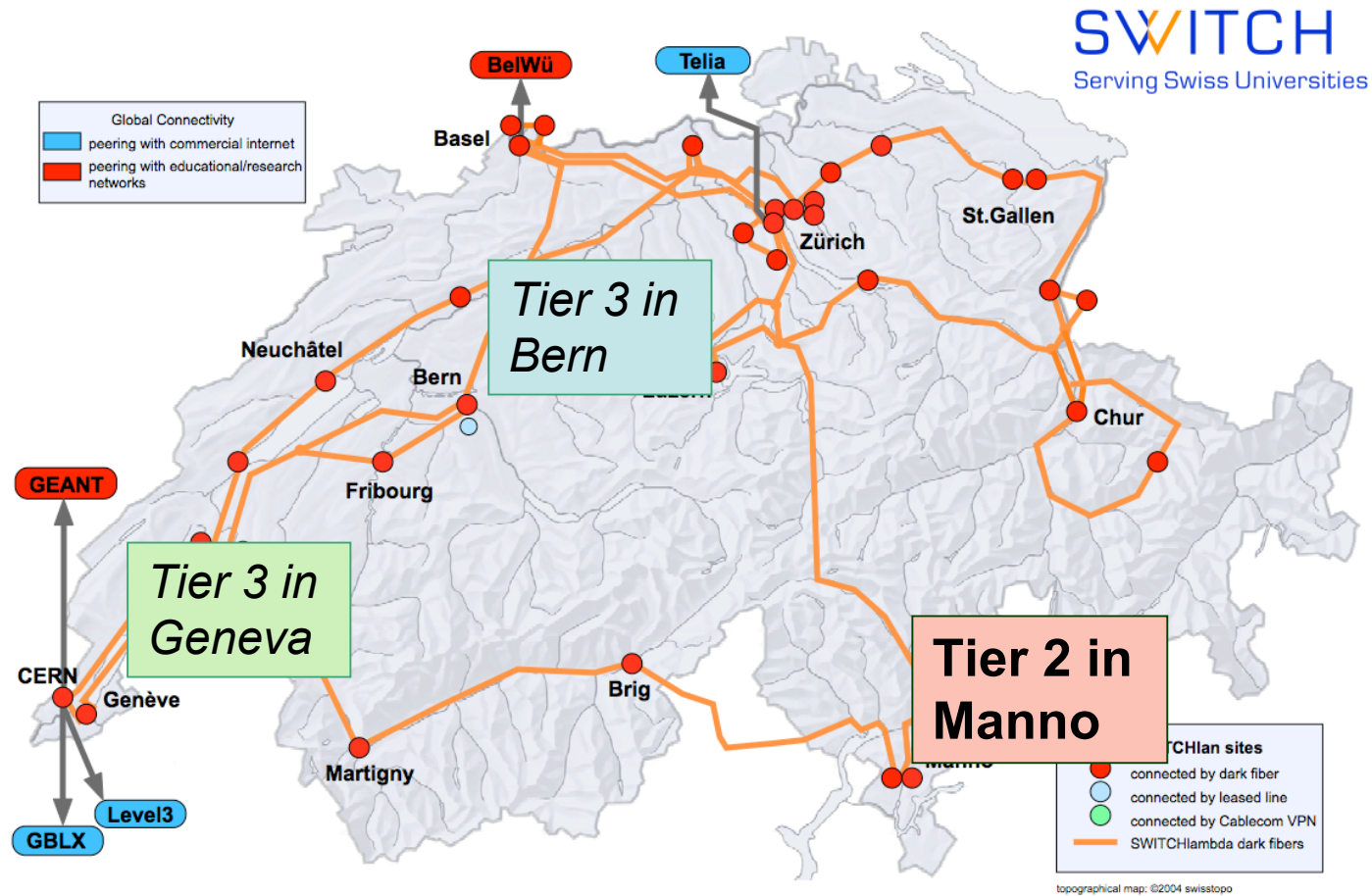
## Tasks

- Receives data from detector
  - Stores data (disk & tape)
  - Distributes data to Tier 1
  - Reconstruction & calibration
- 
- Stores (1+1)/10th of RAW data
  - Provide ATLAS-wide access to derived data (ESD & AOD)
  - RAW data reprocessing
- 
- Stores 1/3 of AOD data
  - Simulation, calibration, analysis
- 
- Simulation, analysis

## Access

- Central production
  - First-pass calibration
- 
- Workgroup production managers
  - Central production (for reprocessing)
- 
- Workgroups
- 
- Local Users

# D: Swiss Grid resources



**SWITCHlan topology 2007**

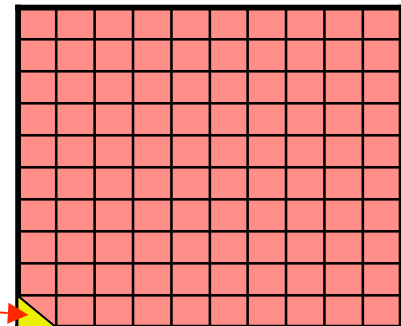
# D: Swiss Grid resources

Year	Bern		Manno	Geneva	2008
	BAC <small>(Bern ATLAS Cluster)</small>	UBELIX <small>(University of Bern Linux Cluster)</small>	Phoenix	DPNC	Total
# CPU	16 30 50	288 512* 512	30 130* 400	24 84 188	~ 1000
Storage (TB)	12 12 33	0	8 52* 225	9.6 26 75	~ 350 TB
Mem/Core(GB)	1 1 2	1-2 2 2	1 2 2	1-2 1-2 1-2	2
OS	SLC	Gentoo	SLC	SLC	
hours 2007	95 000	74 000	131 000	150 000	

\* shared resources

- Resource usage by Bern and Geneva groups
  - production of SUSY, Higgs, SM samples, fast and full simulation
  - physics analyses: test-beam, cosmics, pp physics
  - ATLAS trigger code and trigger rate studies
  - data storage: cosmic data, Monte Carlo samples, in 2008: **data!**
- ATLAS "production" jobs via NorduGrid on all clusters, also via LCG on Phoenix Tier2 (Manno)

450k hours in 2007  
0.5 % of the whole!



# Conclusions

- ATLAS produces huge amounts of data
- Data will have to be stored and analysed world-wide
- Grid computing provides means to do this efficiently
- Switzerland is involved in a lot of Grid operations
- Data is coming in 2008, we have to be prepared.

Thank you

# Talk on behalf of the SwiNG Working group: ATLAS Working Group

Contact: Sigve Haug, sigve.haug@lhep.unibe.ch



$u^b$  S. Haug, C. Topfel



S. Gadomski, ?



P. Kunszt, ?



SWiNG: **Swiss National Grid Association.**  
<http://www.swing-grid.ch>

## SwiNG's mission is to...

- ensure competitiveness of Swiss science, education and industry by creating value through **resource sharing**.
- Establish and coordinate a sustainable **Swiss Grid infrastructure**.
- **Represent the interests of the national Grid community** towards other national and international bodies.

