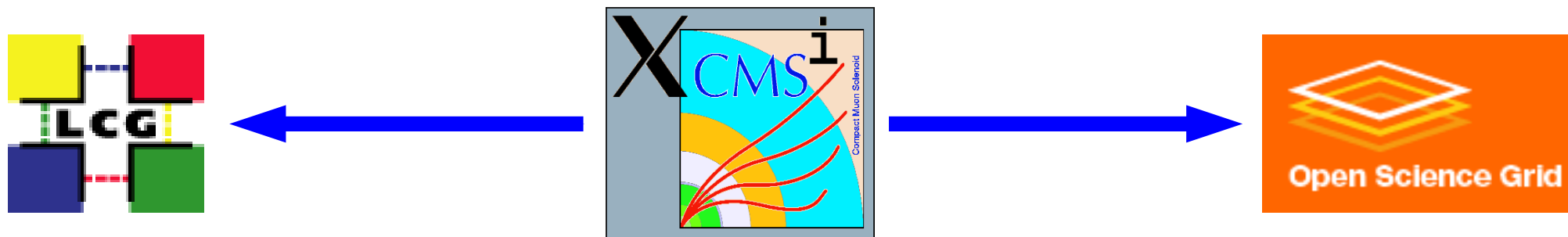
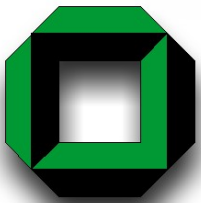


## *Software Deployment on Grids in High Energy Physics*



Volker Büge, Klaus Rabbertz, Armin Scheurer  
Institut für experimentelle Kernphysik  
Universität Karlsruhe



# Outline



Live Demo!

Short Intro to High Energy Physics

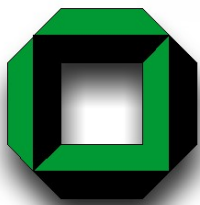
The Challenge

View on existing Implementations

Some Details on selected Components

Demo Results

Outlook



# Live Demo (1) Local Installation



## Configuration GUI

Choose software to install:  
- Tags: Select set(s) of RPMs resolving dependencies  
- Archives: Select single or multiple RPMs

Load configuration (optional)

Change configuration (if necessary)

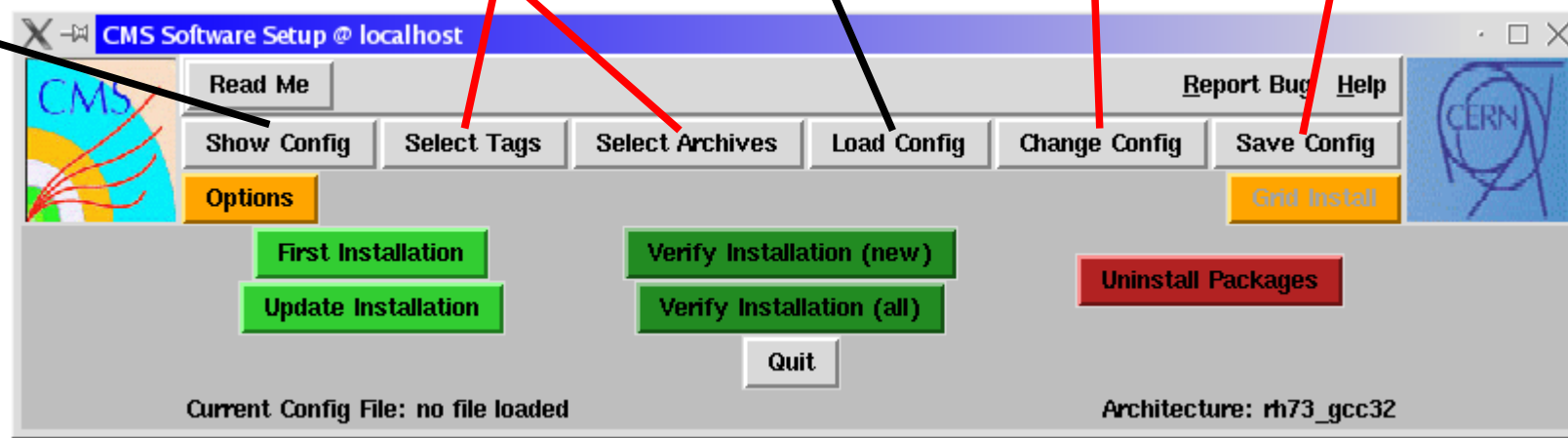
Save configuration:  
- Mandatory to transfer configured settings to command-line installer

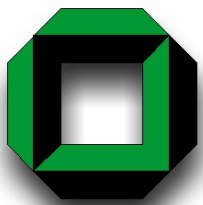
Show configuration (optional)

1.

2.

3.





# Live Demo (2)

## Grid Submission



If possible the following will be done in real:

(Needs to be run from a grid user interface (UI))

Get name of compute element for GridKa/FZ Karlsruhe:

```
> lcg-infosites --vo cms ce | grep gridka
```

List info on installed software, look for LinuxTag\_6\_5\_6:

```
> lcg-ManageVOTag -vo cms -host a01-004-128.gridka.de --list
```

→ Already there, nothing to be done

List same info for EKP/University of Karlsruhe:

```
> lcg-ManageVOTag -vo cms -host ekp-lcg-ce.physik.uni-karlsruhe.de --list
```

→ Software is missing ...

Initialize grid authentication:

```
> grid-proxy-init
```

Give details on certificate:

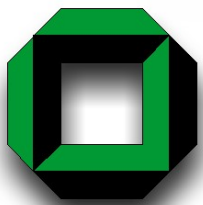
```
> grid-proxy-info
```

Submit grid install job in debug mode, nothing gets sent:

```
> ./cmsg.pl -t rpm -s ekp-lcg-ce.physik.uni-karlsruhe.de -n -i LinuxTag_6_5_6
```

Really submit:

```
> ./cmsg.pl -t rpm -s ekp-lcg-ce.physik.uni-karlsruhe.de -i LinuxTag_6_5_6
```



# Live Demo (3)

## Automated Submission



If possible the following will be done in real:

(Again from a grid user interface (UI))

Add software install request to some grid sites, e.g. DESY:

```
> lcg-ManageVOtag -vo cms -host grid-ce0.desy.de --add  
-tag VO-cms-LinuxTag_6_5_6-request-install
```

→ Software will be submitted for installation during next monitoring period

Finished ...

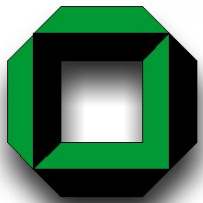
For the demonstration a cron job was set to start the monitoring at 17:15 today

```
> crontab -l
```

Keep your fingers crossed ...

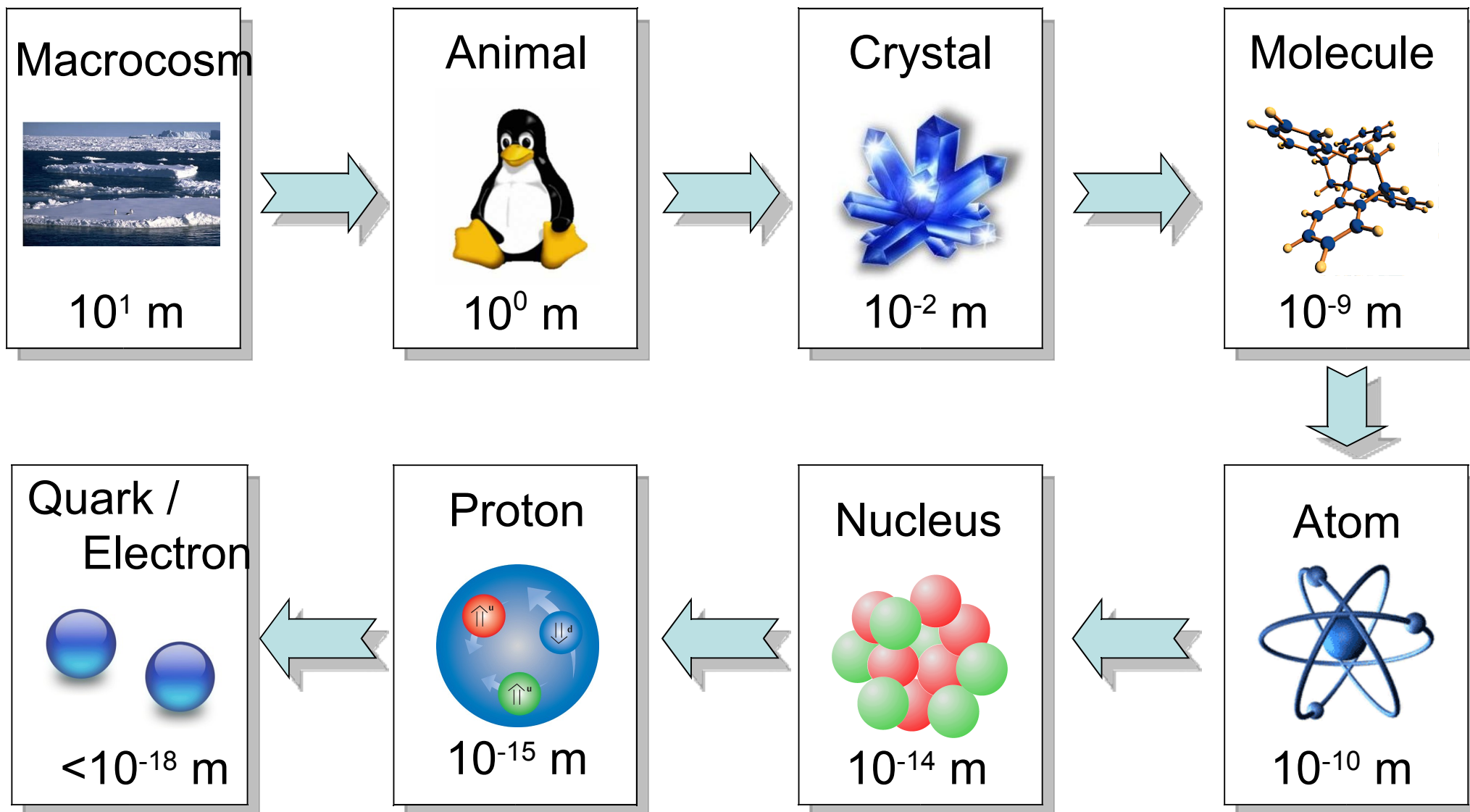
Time for a quick look on the current status:

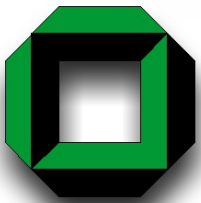
<http://www-ekp.physik.uni-karlsruhe.de/~rabbertz/xcmsi/cmsmon.html>



# High Energy Physics (1)

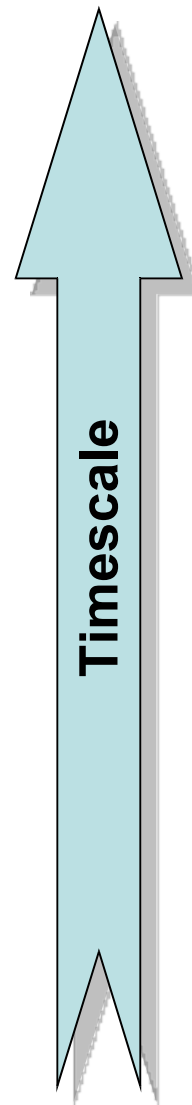
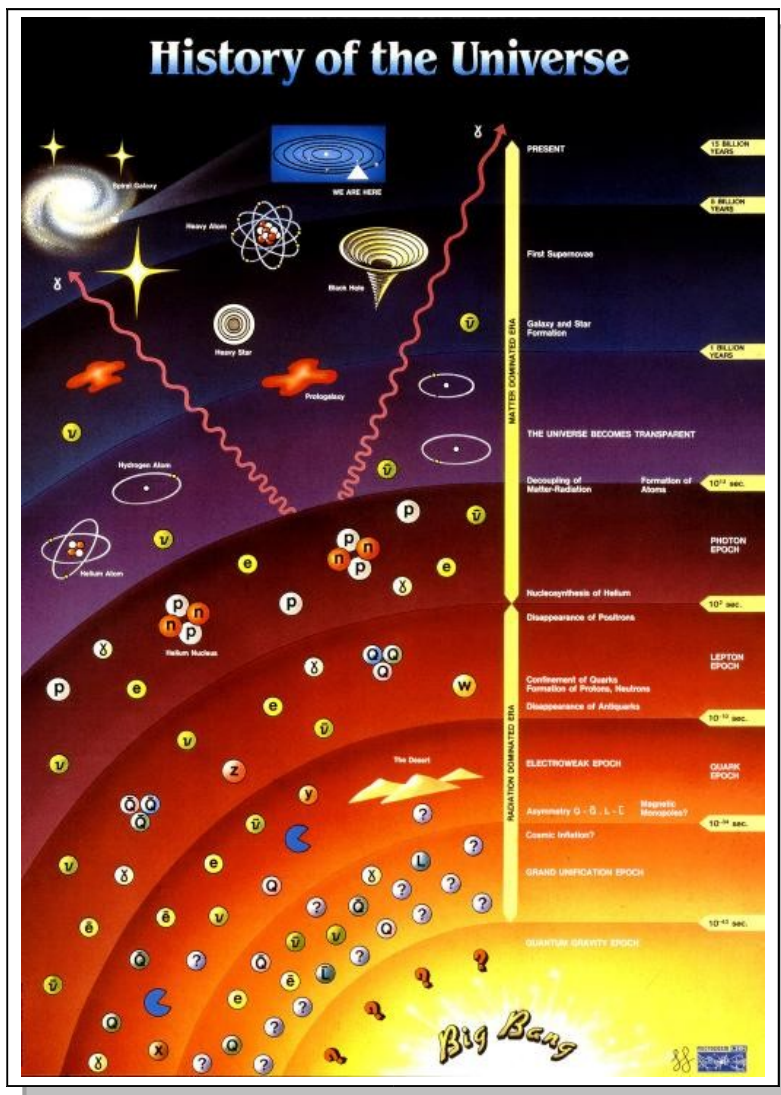
## Spatial Dimensions



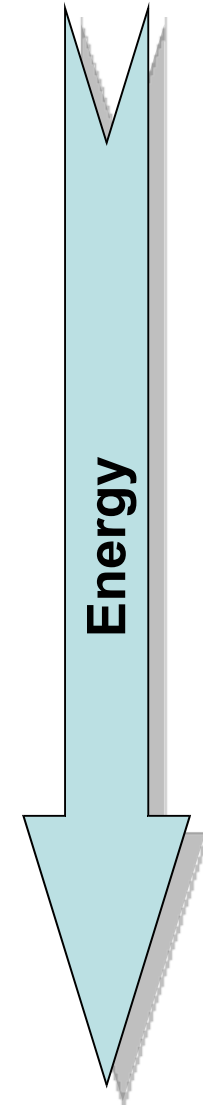


# High Energy Physics (2)

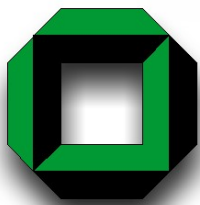
## Temporal Dimensions



- Today
- Heavy Atoms
- ⋮
- Light Atoms
- Nuclei
- Nucleons
- ⋮
- Elementary Particles**
- Big Bang







# The Large Hadron Collider



Lake Geneva

## Large Hadron Collider

Length: 27 km  
Beam energy: 7 TeV  
Below surface: 100 m  
Temperature: -271 °C  
Energy use: 1 TWh/a

Best vacuum between earth and andromeda galaxy

4 large experiments:

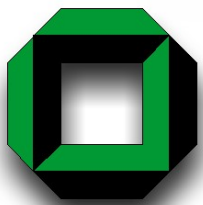
**CMS**  
LHCb

ATLAS  
ALICE

CERN

Airport





# The Challenge (1)

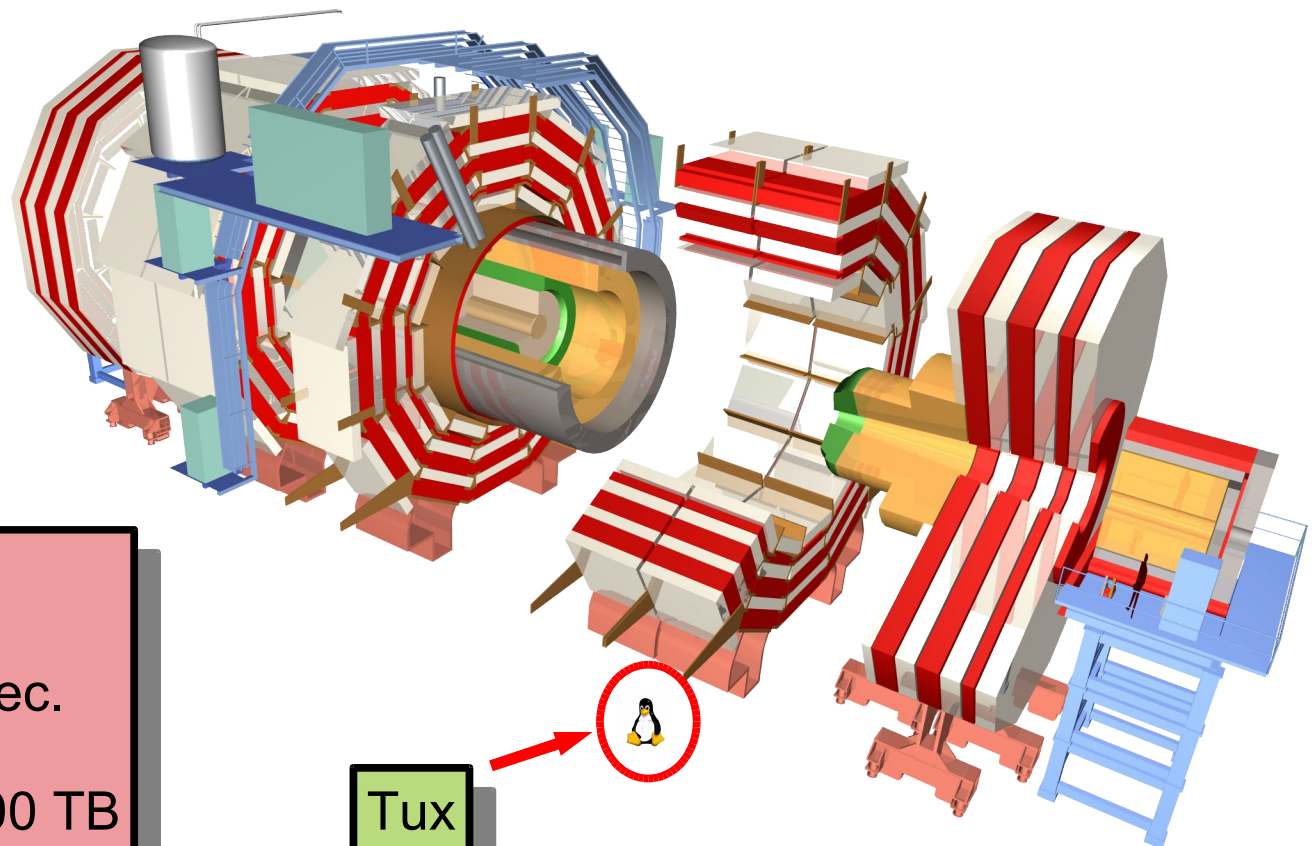
## Huge Amounts of Data



### Technical Data:

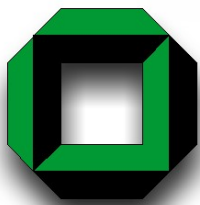
CMS: Length: 21.5 m  
Diameter: 15.0 m  
Weight: 12500 t  
Magnetic field: 4 T  
(200000 x terr. magn. field)

### The CMS Detector (Compact Muon Solenoid)



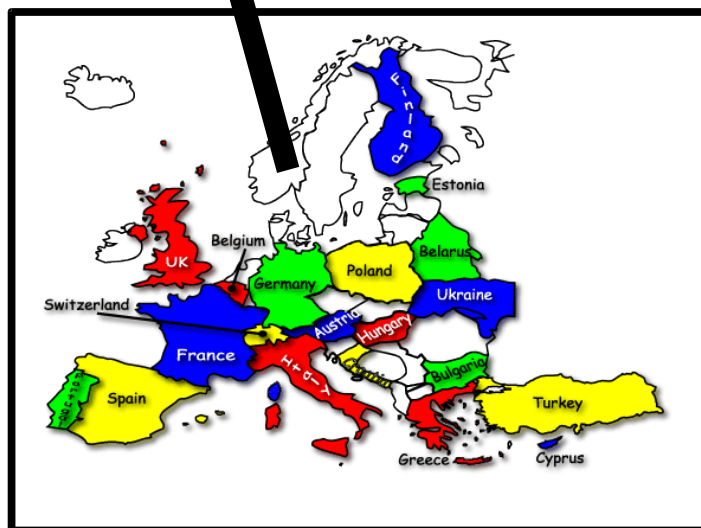
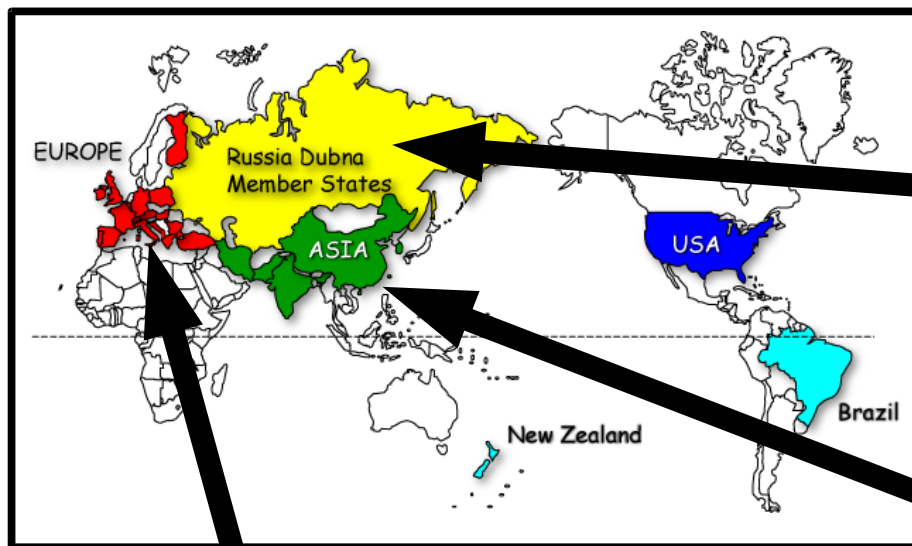
### Huge Amounts of Data:

CMS: Event size: 1.5 MB  
Event rate: 150 events/sec.  
Events/year: 1 billion  
Total raw data/year: 1,500 TB

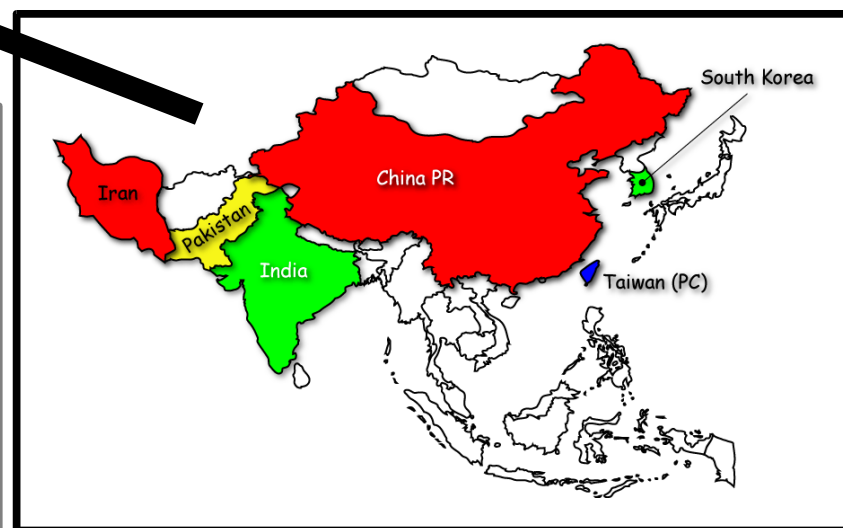


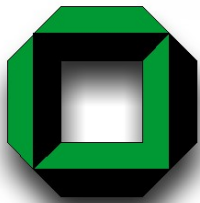
# The Challenge (2)

## Many People Worldwide

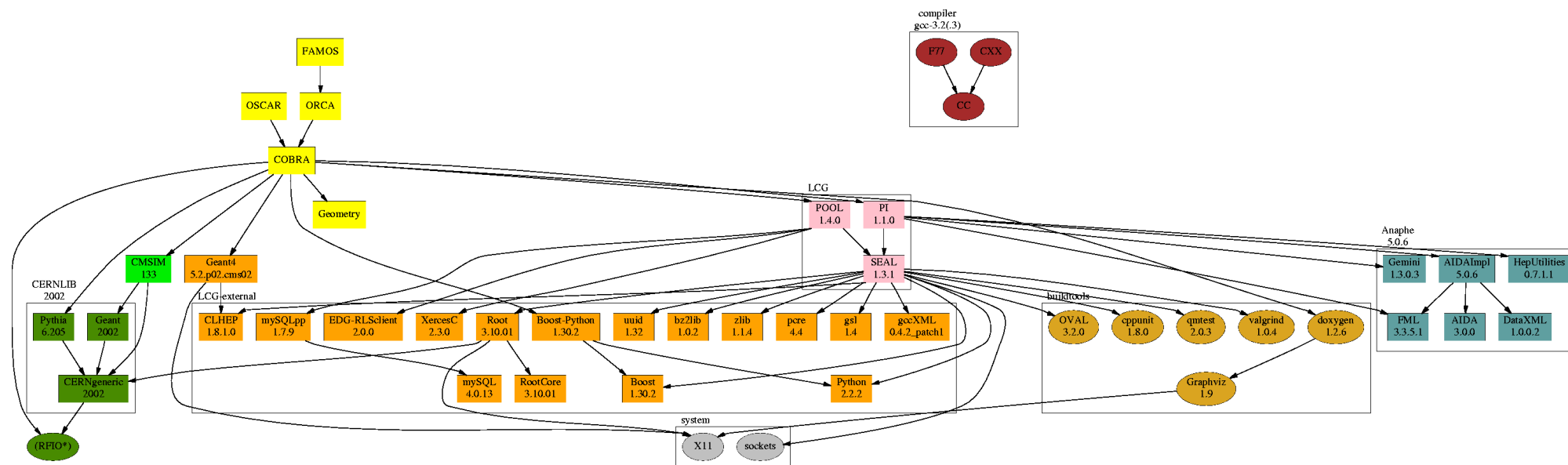


Big International Collaborations:  
CMS  
38 Countries  
182 Institutes  
2000 Scientists & Engineers

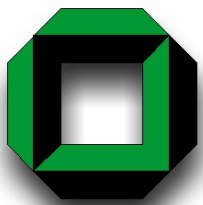




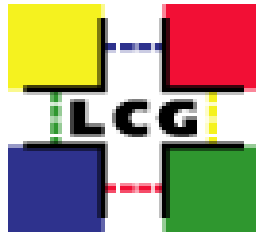
# The Challenge (3) Complex Software



Typical Experiment Software Installation:  
CMS Detector Simulation and Reconstruction  
> 200000 lines of code  
≈ 100 RPM packages of 2 GB in total  
≈ 6 GB of disk space unpacked



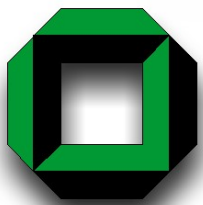
# The Challenge (4) Numerous Grid Projects



### Many Grid Projects:

- LHC Computing Grid (LCG)
- OpenScienceGrid (OSG)
- D-Grid
- NorduGrid
- BalticGrid, ...

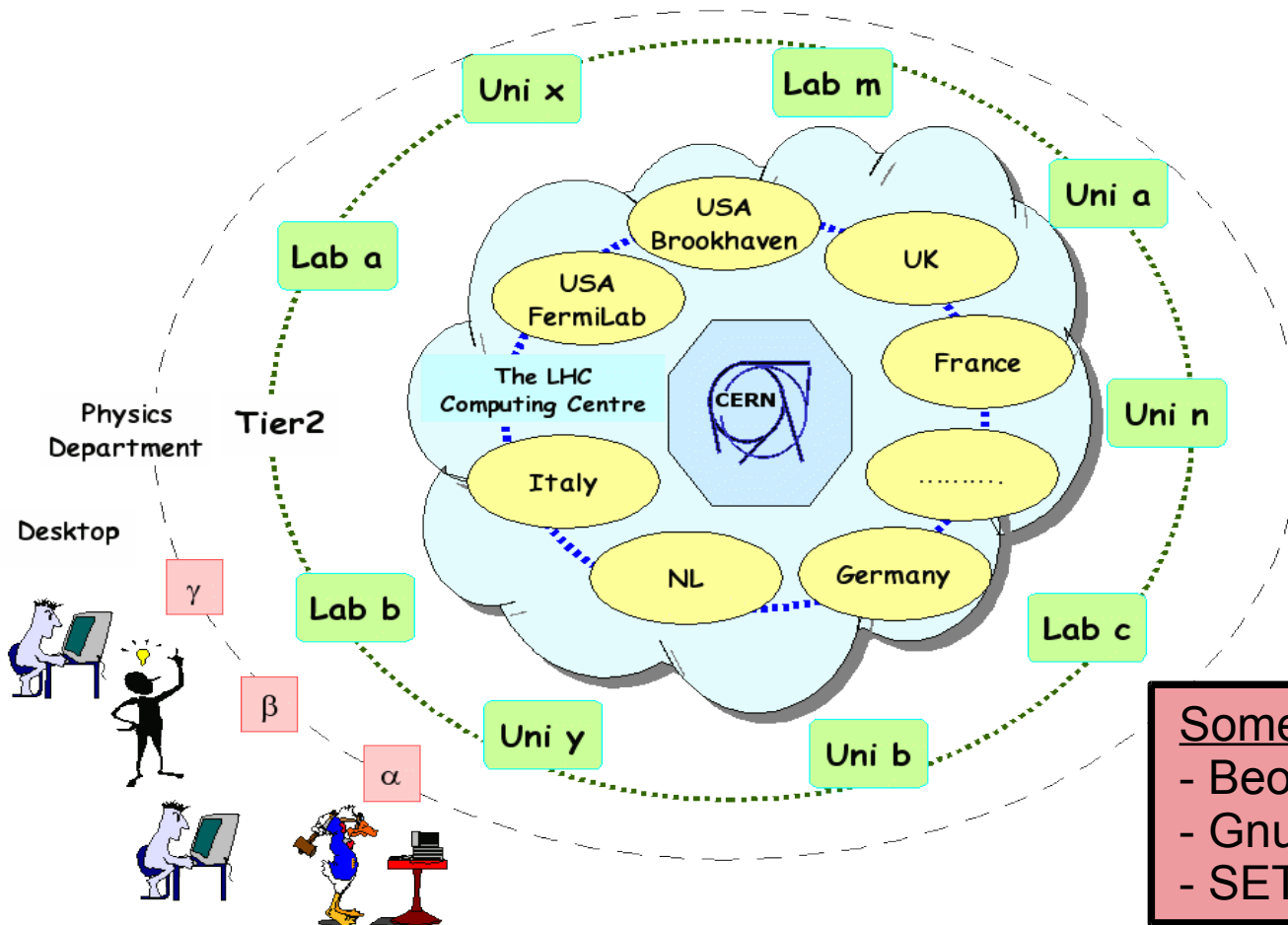




# Some Remarks on Grids



## Tiered Architecture of the Worldwide LHC Computing Grid

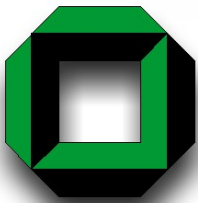


I. Foster on Grid Computing:  
... coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organizations ...

Some Projects which are NOT Grids:

- Beowulf: Cluster Computing
- Gnutella: Peer-to-Peer
- SETI @ home: Distributed Computing





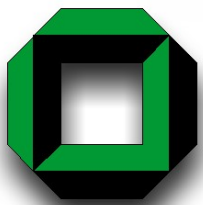
# The Task



## Grids-wide Deployment of Experiment Software for Simulation, Data Analysis and Development

Desirable properties of experiment software installations:

- **No root privileges required!**
- **Relocatable packages**
- **Parallel installation of multiple versions of a project**
- Optional network download
- Batch mode installable
- Save-able and reusable set-up
- Included validation procedure
- Concise configuration also for less experienced users
- Multi-platform support
- Multiple installations possible

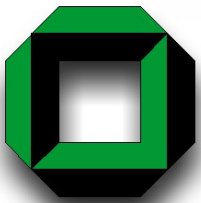


# Software Preparation

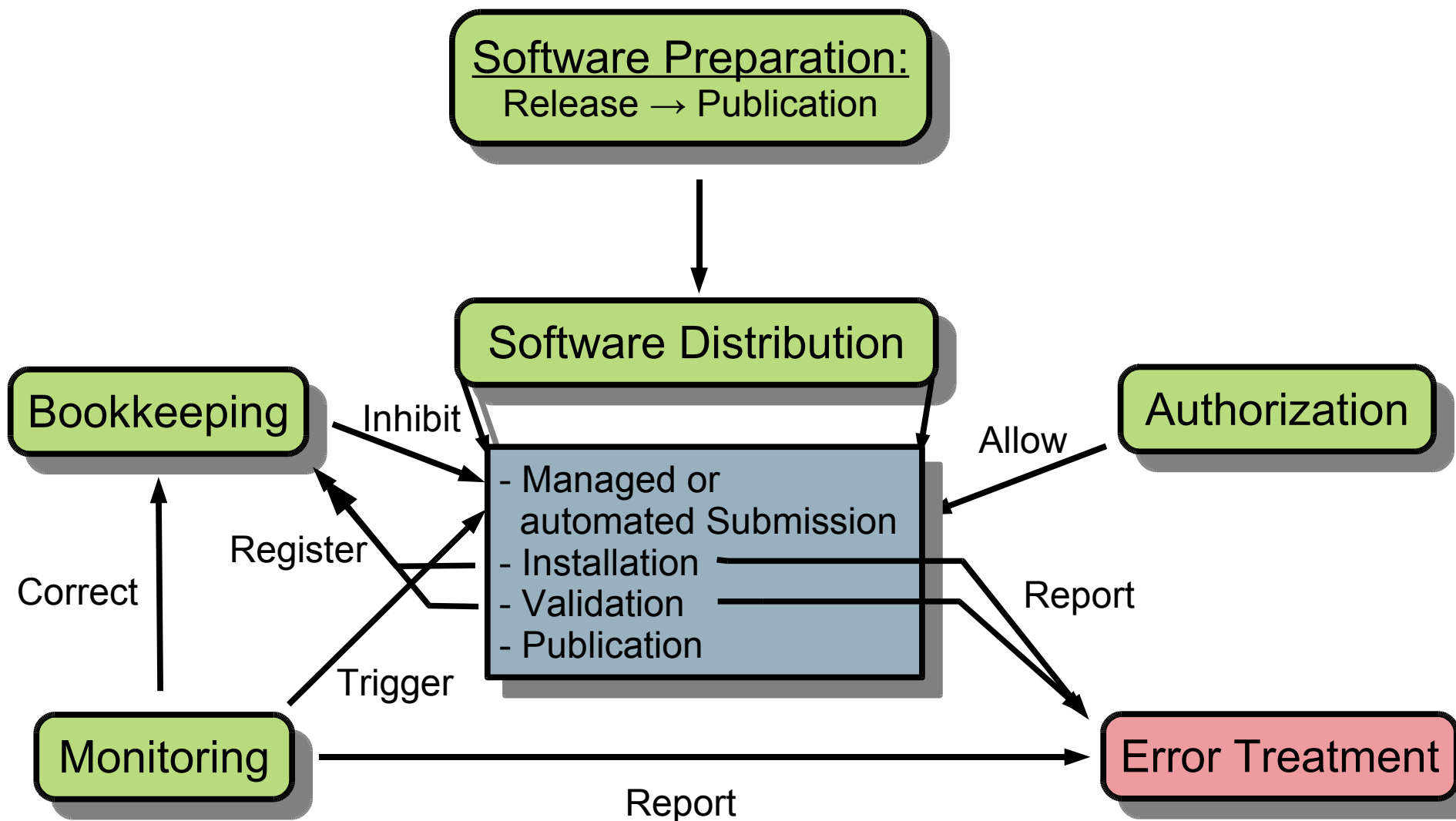


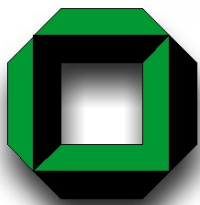
## Common Tasks before Deployment on Grids:

- ➔ Release and Build
- ➔ Packaging
- ➔ Test Install and Validation
- ➔ Archiving
- ➔ Web/Grid Storage
- ➔ Publication
- ➔ Mirroring/Load Balancing

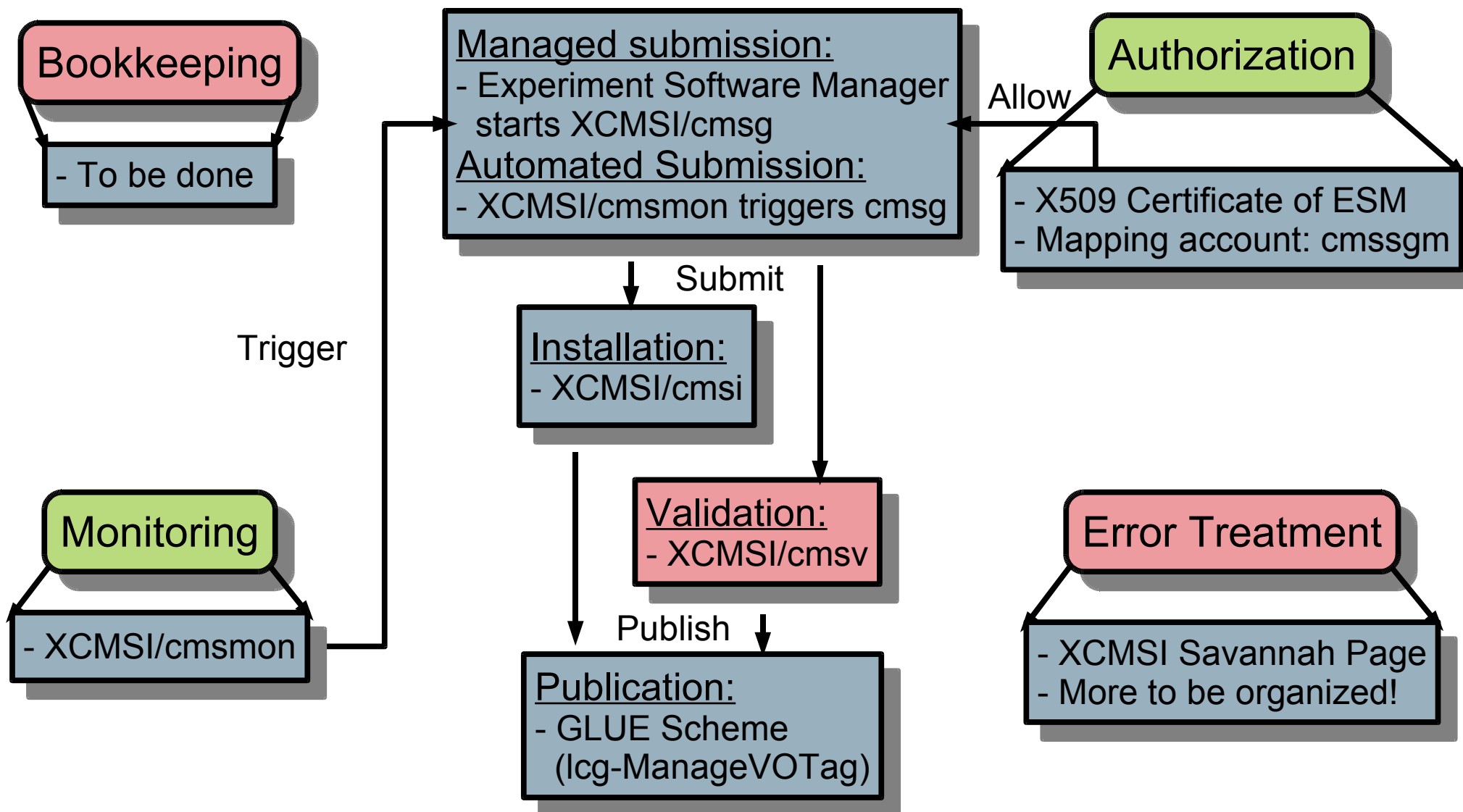


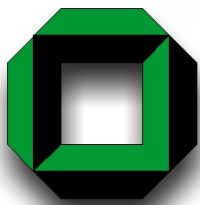
# A Generic View



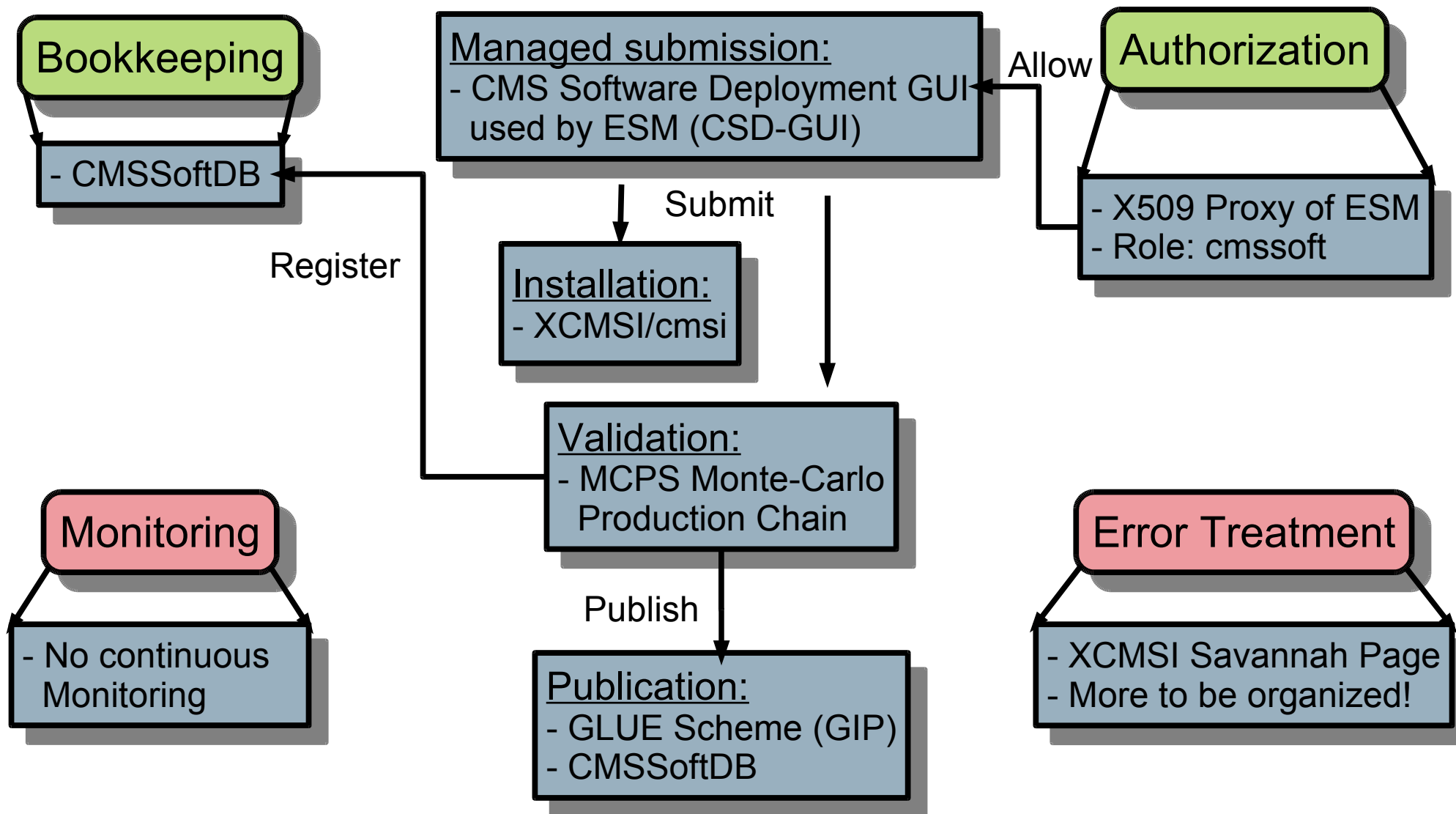


# Implementation within LCG

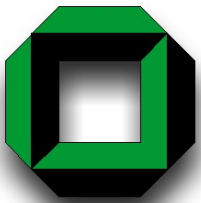




# Implementation within OSG







# Bookkeeping with CMSSoftDB



**Software Installation Table:** Provides i.a. comprehensive overview of CMS SW Installation Status on the OSG

- ✚ Employs a MySQL Database
- ✚ No continuous Crosscheck with Monitoring

## Show CMS Software Installation Table

Choose from sites...  or enter a site...

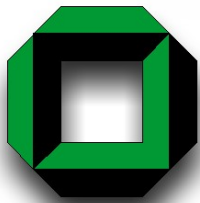
Choose from projects...  or enter a project...

Show Reason Column

Show Who Column

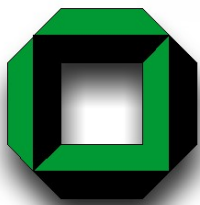
### Overview of CMS Software Installation

/home/coldfeet/services/csdogrid/data/x509_dn_unknown			
Sitename	Name	Status	Date Time
ASCC_OSG	ORCA_8_7_5	I_FORENSIC	Wed Nov 23 19:22:53 EST 2005
BNL_ATLAS_2	CMKIN_5_1_0	INSTALLED	Fri Jul 15 17:23:15 EDT 2005
BNL_OSG_Test1	ORCA_8_7_3	INSTALLED	Fri Jun 17 00:26:36 EDT 2005
CIT_CMS_PG	CMKIN_5_1_1	INSTALLED	Mon Sep 12 15:02:08 EDT 2005
CIT_CMS_PG	OSCAR_3_6_5	INSTALLED	Mon Sep 12 23:38:40 EDT 2005



# CSD-GUI





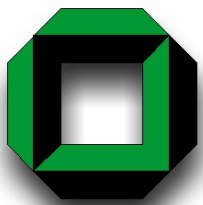
# Monitoring with XCMSI



CMS SW specific Monitoring: Runs short test job on compute elements

- Architecture, SW Installation Directory, RPM Database, Local Catalogs, installed Projects in comparison with published information
- Access to express queue needed ( → VOMS, Virtual Organization Membership Service)
- More elaborate Bookkeeping desirable

CE-Name	Last test	Architecture	VO_SW_DIR	rpmDB	Local Catalogue	SW OK	SW Problems	PU-Tags
<a href="#">CE.pakgrid.org.pk</a>	2006/02/05_14:02 Aborted	VO-cms-slc3_ia32_gcc323	OK, read-write	-	-	0	0	-
<a href="#">a01-004-128.gridka.de</a>	2006/02/05_18:10 Time out	VO-cms-slc3_ia32_gcc323	OK, read-write	OK	OK	19	5	-
<a href="#">a01-004-164.gridka.de</a>	2006/02/05_18:10 Time out	VO-cms-slc3_ia32_gcc323	OK, read-write	OK	OK	0	21	-
<a href="#">alexander.it.uom.gr</a>	2006/02/05_12:41 OK	VO-cms-slc3_ia32_gcc323	OK, read-write	-	-	1	2	-
<a href="#">antaeus.hpcc.ttu.edu</a>	2006/02/05_18:10 Disapp. from LDAP	-	-	-	-	0	0	-
<a href="#">atlasce01.na.infn.it</a>	2006/02/05_12:07 OK	VO-cms-slc3_ia32_gcc323	OK, read-write	-	-	4	0	-

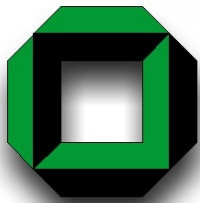


# Automated Installation



XCMSI/cmsmon can be run in passive (Monitoring) and active Mode (Simple Fault Recovery, Installation Trigger)

- + E.g. Setting of Architecture Tag
- + Can trigger SW Installation or Validation
- + GLUE Tags provide simple Control (s. also: [Exp. SW Installation in LCG-2](#))
  - VO-CMS-SW\_i\_j\_k-request-install => triggers Installation
  - VO-CMS-SW\_i\_j\_k-processing-install => blocks concurr. Submission
  - VO-CMS-SW\_i\_j\_k-running-install => blocks concurr. Installation
  - VO-CMS-SW\_i\_j\_k-to-be-validated => triggers Validation
- + Time to check on the [Live Demo](#)



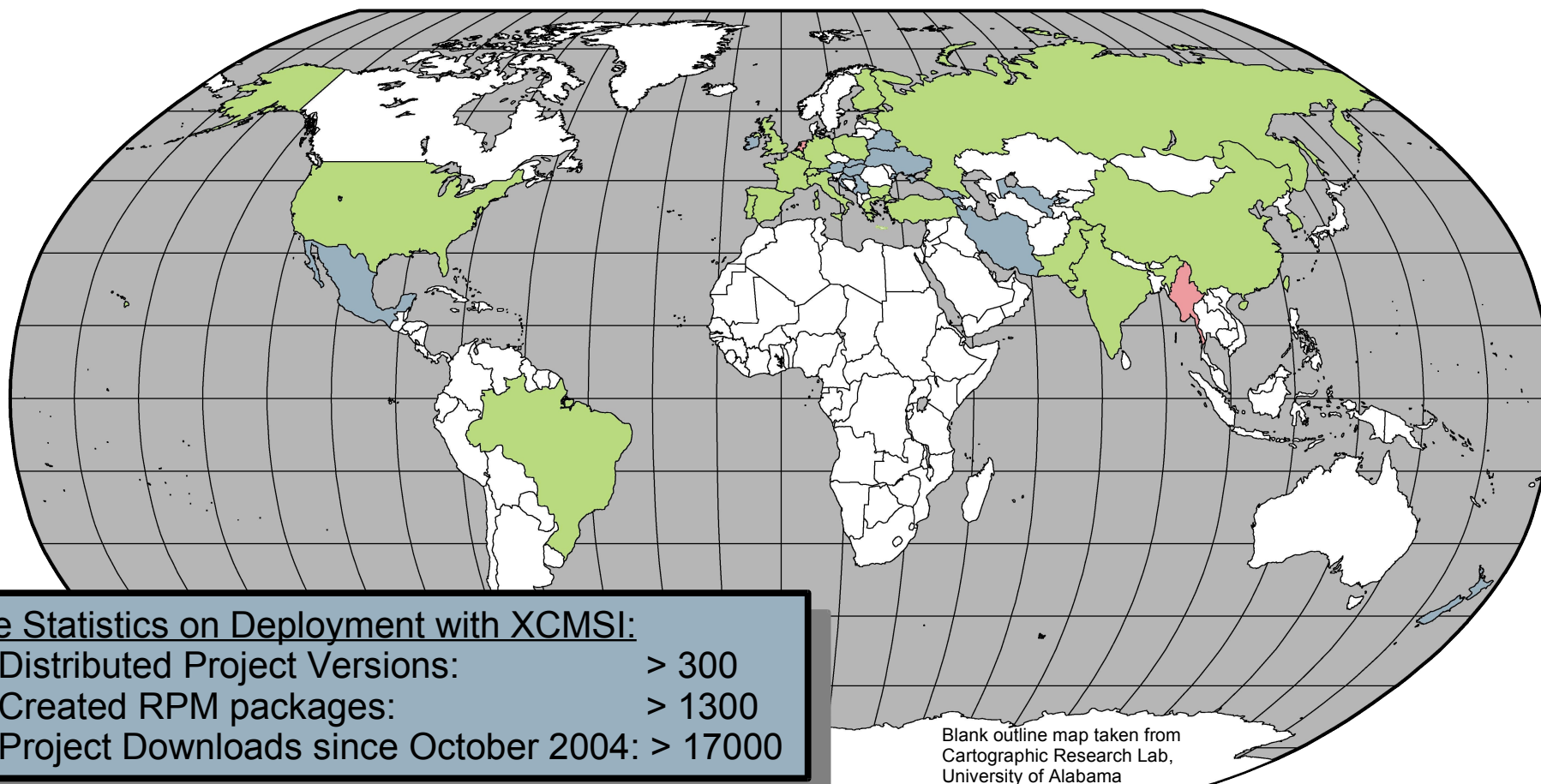
# Software Distribution Map



15 Countries with CMS Institutes  
and NO registered SW download

22 Countries with CMS Institutes  
and registered SW downloads

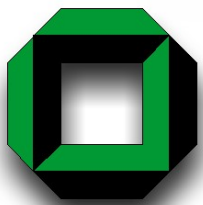
2 Countries without CMS Institute  
BUT registered SW download



Some Statistics on Deployment with XCMSI:  
Distributed Project Versions: > 300  
Created RPM packages: > 1300  
Project Downloads since October 2004: > 17000

Blank outline map taken from  
Cartographic Research Lab,  
University of Alabama





# Outlook

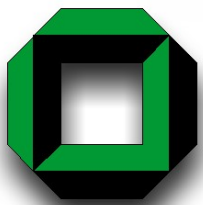


We can deploy complex software to analyze distributed data as well as monitor the activities on the Grids!

Considering 6 GB of application software (!)  
versus 1 GB of Operating System ...

Future Vision:

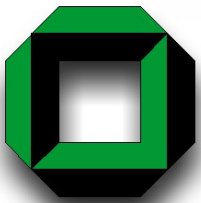
- Distribution of Virtual Machines containing already the application software



# Link Collection



- ➡ CERN Home Page
- ➡ The Large Hadron Collider (LHC)
- ➡ CMS Outreach
- ➡ The LHC Computing Grid (LCG)
- ➡ The OpenScienceGrid (OSG)
- ➡ Scientific Linux (SL)
- ➡ Scientific Linux CERN (SLC)
- ➡ Grid Operations Centre (GOC)
- ➡ Grid Information Index Server (GIIS)
- ➡ Site Functional Tests (SFT)
- ➡ LCG Google Map
- ➡ Global Grid User Support (GGUS)
- ➡ CHEP06 Conference (Computing in HEP)
- ➡ EKP, University of Karlsruhe
- ➡ XCMSI Home Page
- ➡ XCMSI Monitoring Page
- ➡ XCMSI/RpmGen Savannah Page
- ➡ CMS CVS Browser
- ➡ Grid Acronym Soup (GAS)

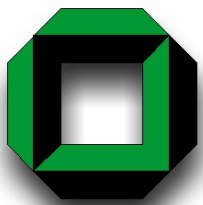


# Acronymitis



CASTOR: CERN Advanced Storage Manager	GLUE: Grid Laboratory Uniform Environment
CE: Compute Element	GUI: Graphical User Interface
CMS: Compact Muon Solenoid	HEP: High Energy Physics (Particle Physics)
CSD: CMS Software Deployment	MB/GB/TB: Mega-, Giga-, TeraBytes
CVS: Concurrent Versions System	RPM: RedHat Package Manager
DB: Database	MCPS: Monte Carlo Processing Service
DC04: Data Challenge 04	SW: Software
EKP: Experimentelle Kernphysik	VO: Virtual Organization
ESM: Experiment Software Manager	VOMS: Virtual Organization Membership Service
GIP: Generic Information Provider	XCMSI: CMS Software Installation Project

➡ Grid Acronym Soup (GAS)



# Acknowledgements



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Günter Quast, University of Karlsruhe

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Andreas Nowack, RWTH Aachen  
Joanna Weng, CERN/University of Karlsruhe

## CMS colleagues at CERN:

Stefano Argiro, CERN  
Shaun Ashby, CERN  
Nikolay Darmenov, SOFIA-INRNE/CERN  
Shahzad Muzaffar, Northeastern University  
Tony Wildish, Princeton

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David Evans, FERMILAB  
Burt Holzman, FERMILAB  
Bockjoo Kim, University of Florida  
Natalia Ratnikova, FERMILAB  
Michael Thomas, CALTECH



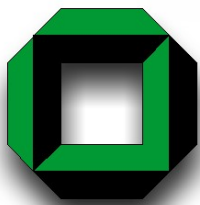
***A big Thank-you also to the Organizers***

***There were a lot of penguins in Wiesbaden ...***



***But one thing we had only in Karlsruhe ...***





# An Installation Example (Backup)



Grid part:



```
cmsg.pl  
-t rpm -s fzk.de  
-i "ORCA_8_7_1 OSCAR_3_6_5"
```

On LCG sites the default software installation area is given by the variable `$VO_CMS_SW_DIR`

## Preparations:

- Find compute element(s) (CE)
- Check against installed software
- Prepare `tar.gz` archive of `xcmsi`
- Generate executable to submit
- Prepare job description file (`jd1`)
- Submit `jd1` file (`edg-job-submit`)
- Start job monitor to fetch output after completion

## Generated executable:

- Check on `$VO_CMS_SW_DIR`
- Check disk space
- Generate default configurations (first install only)
- Call installer `cmsi.pl`
- Copy configuration to default software area (first install only)
- Publish new software