

# Grid technologies, solutions and concepts in the synchrotron Elettra

Roberto Pugliese, George Kourousias, Alessio Curri, Milan Prica, Andrea Del Linz  
**Scientific Computing Group, Elettra Sincrotrone** , Trieste, Italy



# Outline



## Grids on Synchrotrons

- Usual problems
- The ELLETRA SRF approach



## Current developments

- Instrument Element
- IE, TANGO, & LabVIEW



## Robotics

- Prototypes
- Remote Sensors



## Medical Imaging

- Data-Parallel
- CT reconstruction

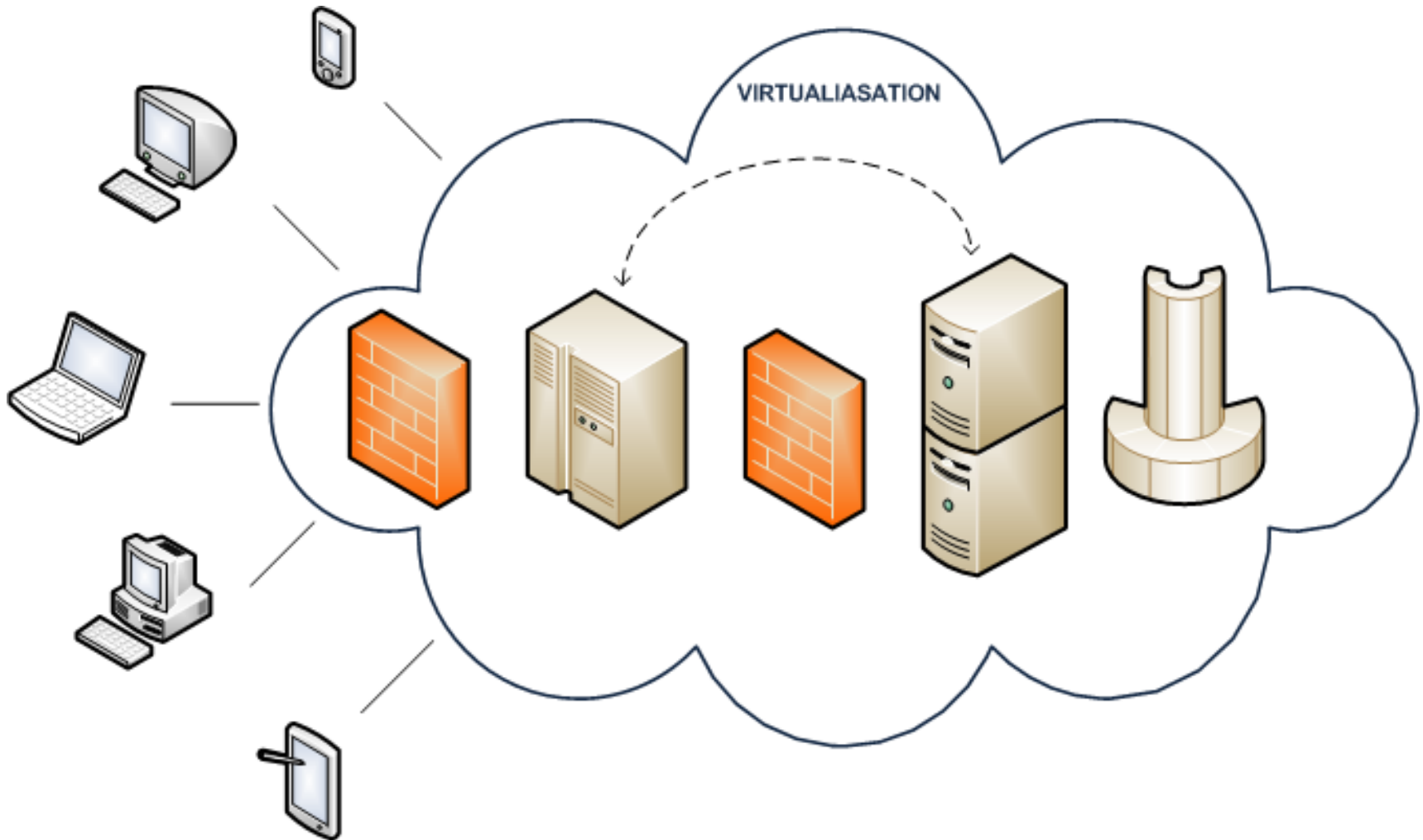


## Grid Portals

- Virtual Control Rooms



# Grid: How to make the most out of it?



# Grid computing *in general*

- Virtualisation of interconnected computing resources
- Scalability, performance, and access
- EGEE:80.000 CPUs
- Elettra/Comp.Sci group is participating in EU grid projects (i.e. DORII)
- *“the next big thing will be grid computing.”*  
John Patrick, IBM vice-president for Internet strategies

# Grid computing *in an Synchrotron*

- Transparent access to off-site computing resources
- Off-site access to SRF
  - Remote control and instrumentation
- Union of academic and research HPC resources
- High throughput computations and bandwidth
- Long computations of data-parallel problems

# The migrations Process ...else “Gridification”

- Resistance to be gridified
  - Legacy applications
    - LabView, IDL, Matlab, custom standalone apps, cluster-specific MPI, established workflows
- Network infrastructure
  - Is required to accommodate Grid specific techs
    - Middleware, access portals, suitable schedulers
- Solution: Create bridges and suggest user-friendly migration plans




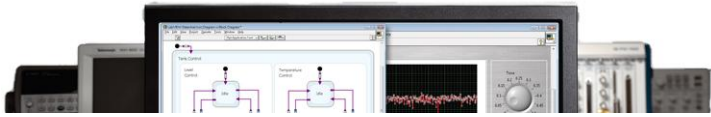
# Steps taken in *elettra*

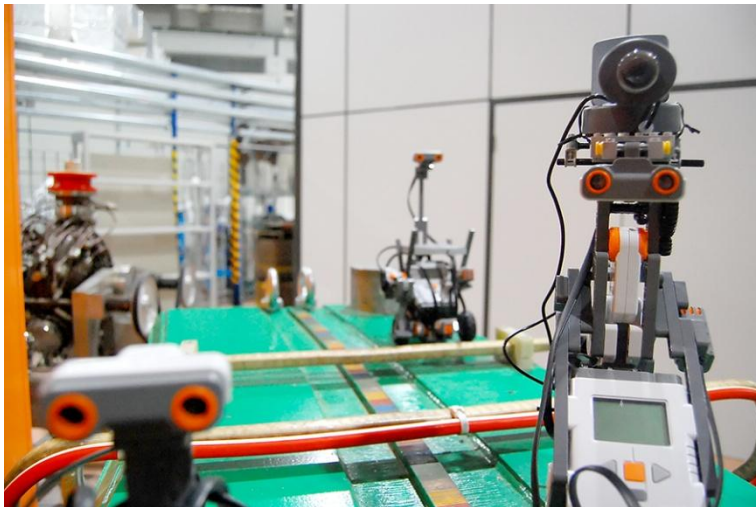


- Dedicated Grid-lab within the Sci.Comp. Group
- Participation in national and EU grid related projects
- Development of suitable technologies
  - Instrument Element, LabVIEW-TANGO Gateway, VCR, Interactive Grid (+IDL), eScience, and other
- Consultancy and education for Beamline scientists regarding Grid-based solutions
  - SYRMEP, XRD, TwinMic, and other
- Development of suitable Network, Storage and HPC infrastructure
- Experimenting with alternative architectures (GPU,CBE)

# 4 examples @ *elettra*



- Instrument Element 
- LabVIEW-TANGO Gateway 
- Medical Imaging on the Grid
- Prototype: Robots as remote sensors

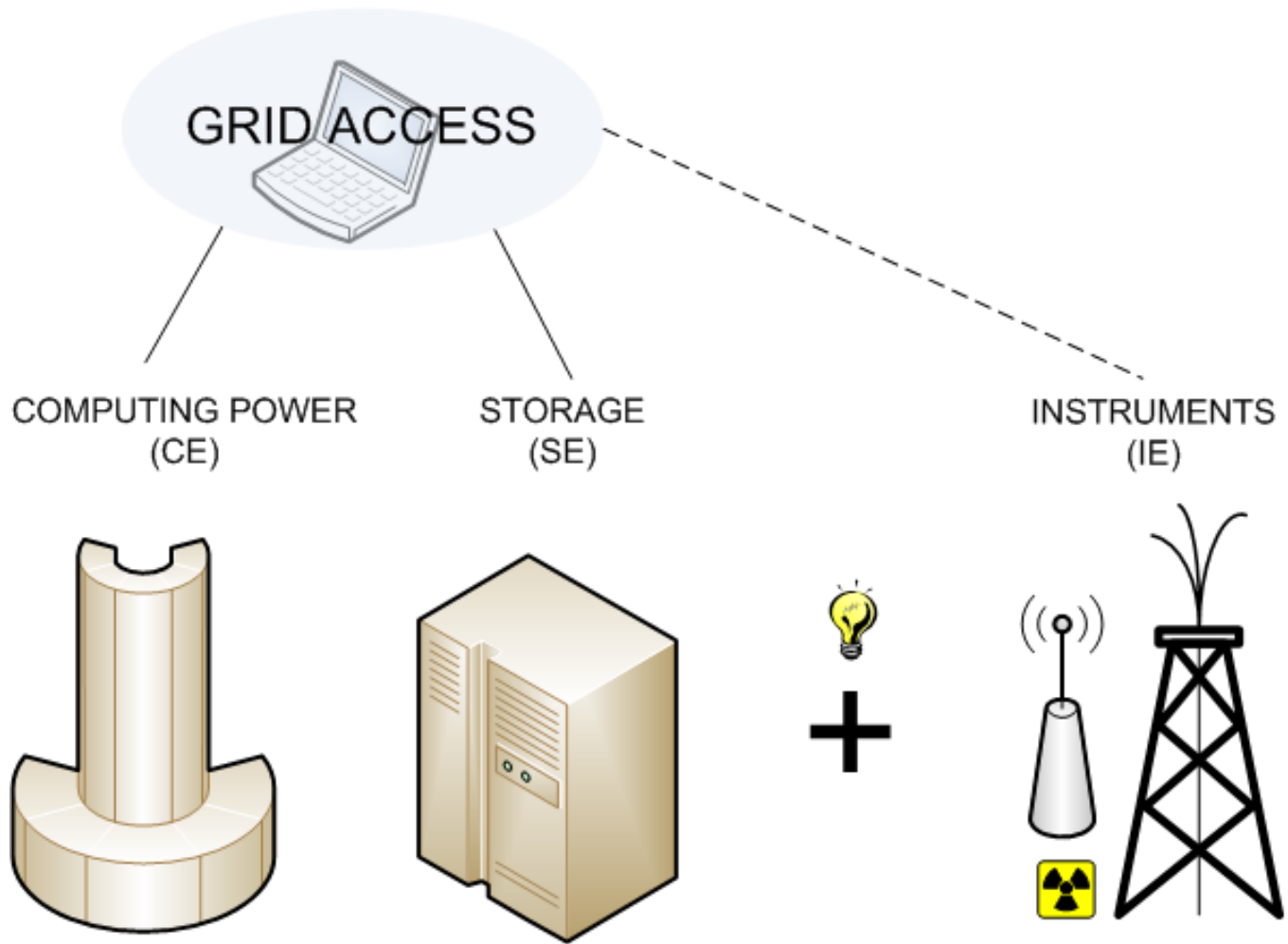




# Computing, Storage,... but Instruments?

- Plenty of Computational resources (CPUs)
- Lots of storage
- but lets virtualise the Scientific Instrumentation
  - ...a core reason: remote operations & online processing
- Suggested solution:
  - The concept of Instrument Element (IE)

# Computing, Storage,... but Instruments?

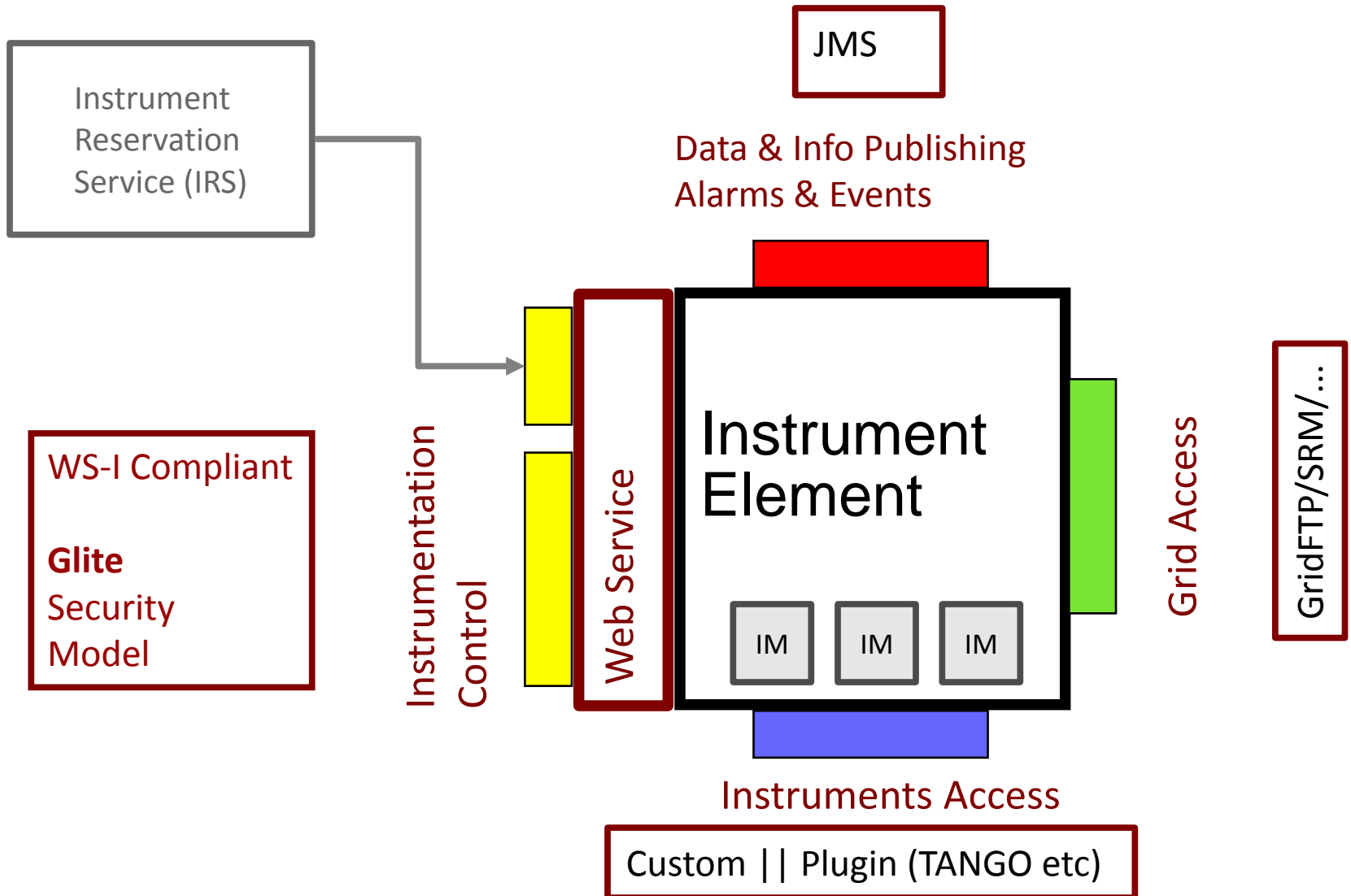


# Instrument Element (IE)

- **The Instrument Element provides the traditional grid with a virtualization of real instruments and sensors**, and provides the grid users with a more interactive interface to control them.
- **IE is an open source**, pure Java, framework that runs as an Axis web service.
- Instrument Managers are protocol adapters that link the IE to the APIs of instruments and sensors.
- IM may be either custom developed for a single device or generic (plug-in) for self-descriptive control systems.

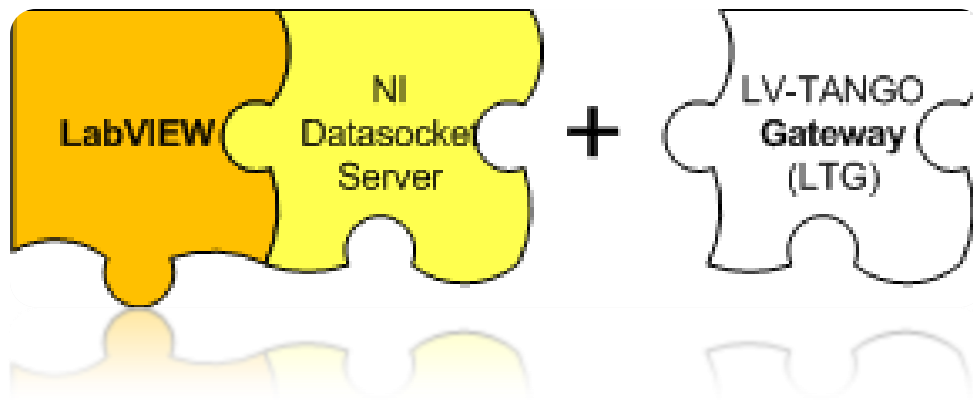


# Instrument Element



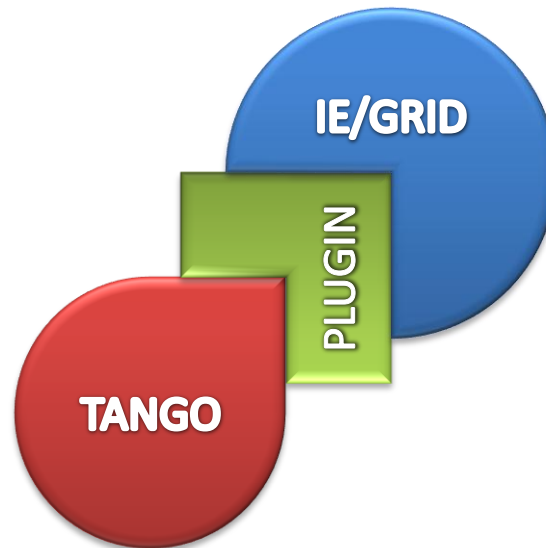
# LabVIEW as a TANGO device

- LV-TangoGateway (LTG)
- Note on Instrumentation:
  - TANGO along with EPICS are the main distributed control systems

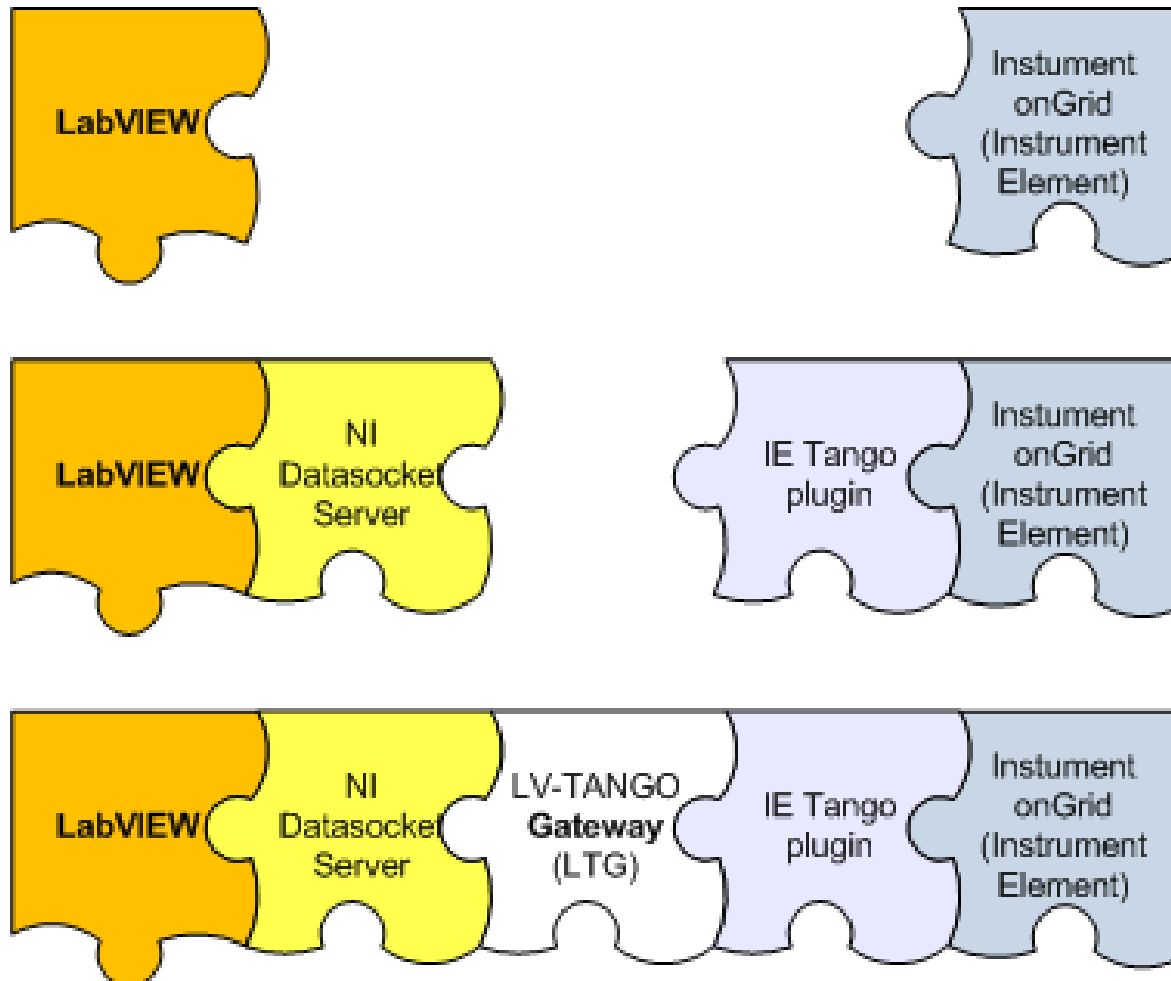


# Any TANGO Device Server in the Grid

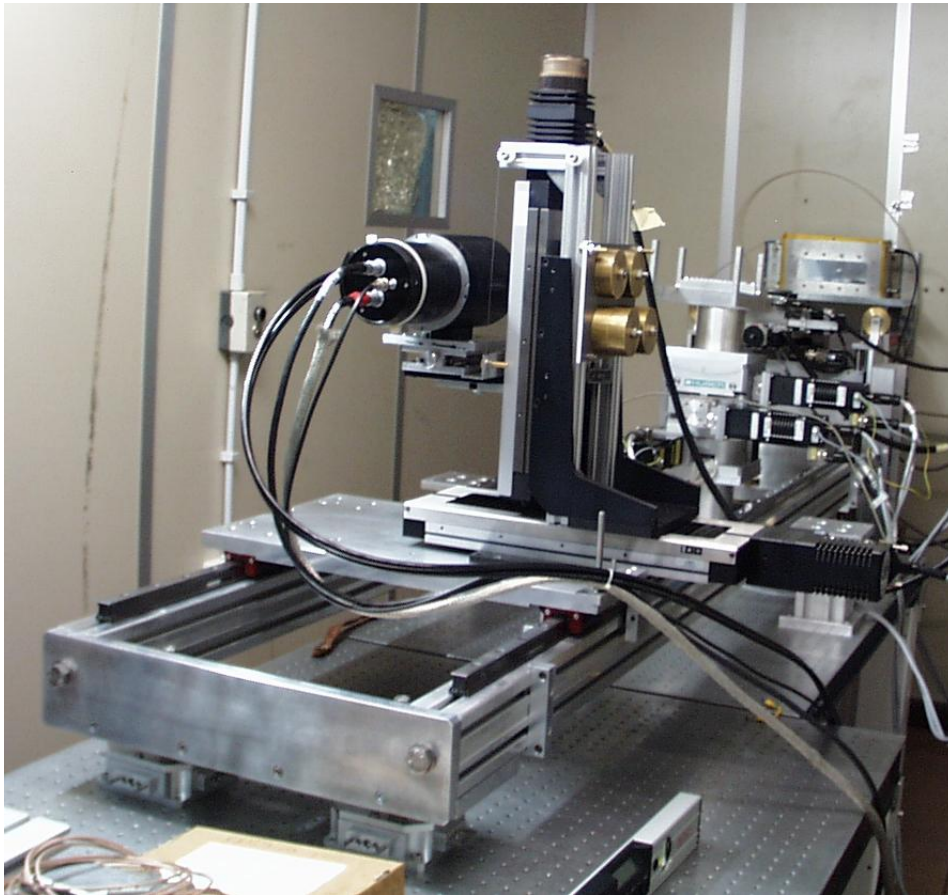
- IE Tango Plugin
  - Enables/Exports a TANGO device as an IE(IM)
  - Any current TANGO device becomes Grid-enabled.



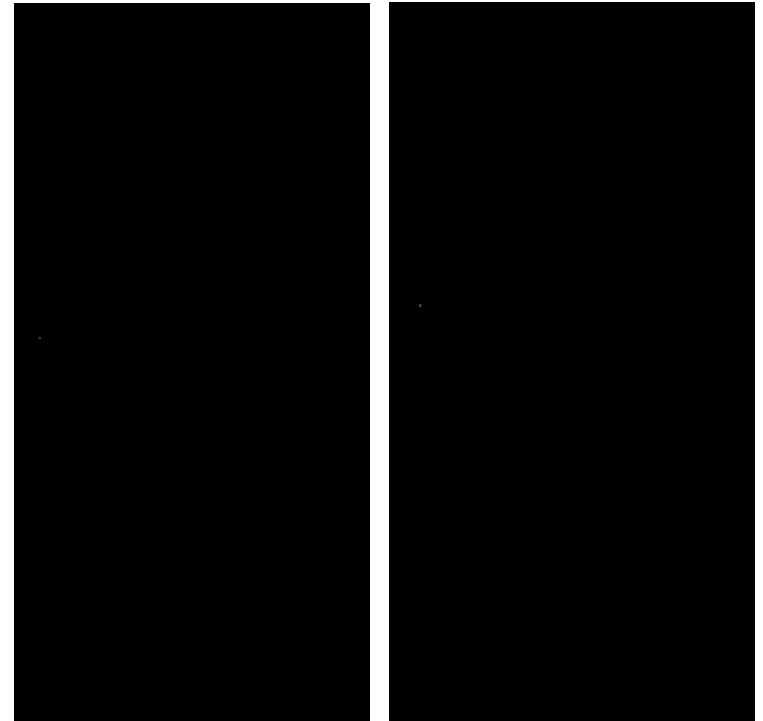
# LabVIEW as a Scientific Instrument on the GRID



# SYnchrotron Radiation for MEdical Physics: SYRMEP Beam Line



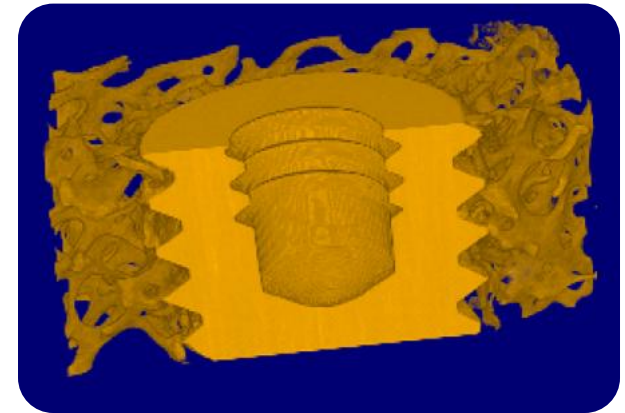
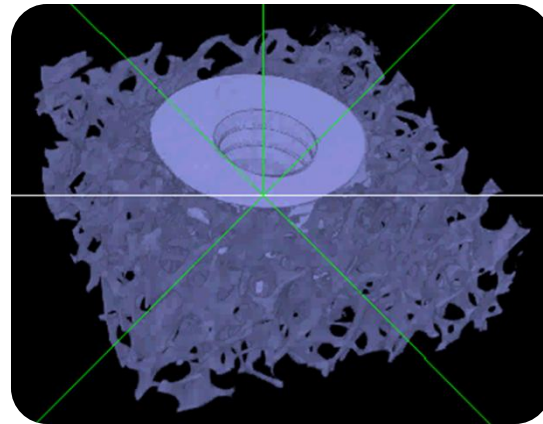
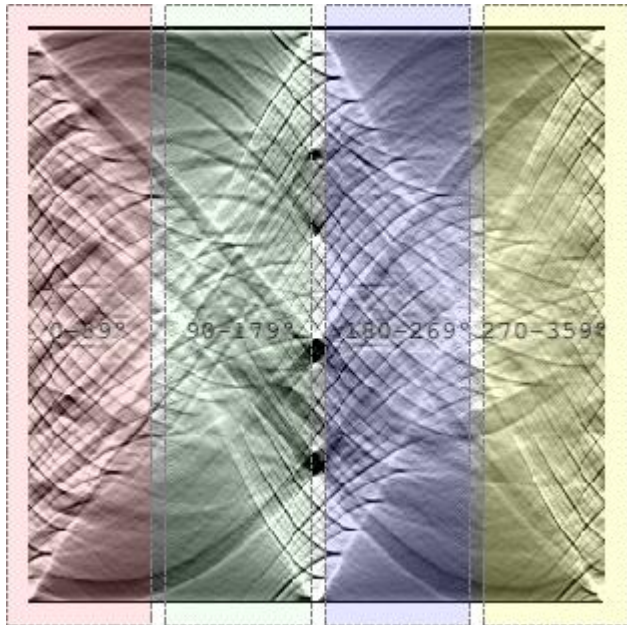
Energy range: 8 ÷ 35 keV  
Source-to-sample distance:  $D \cong 24$  m  
Beam size at sample (h $\times$ v)  $\cong 150 \times 6$  mm



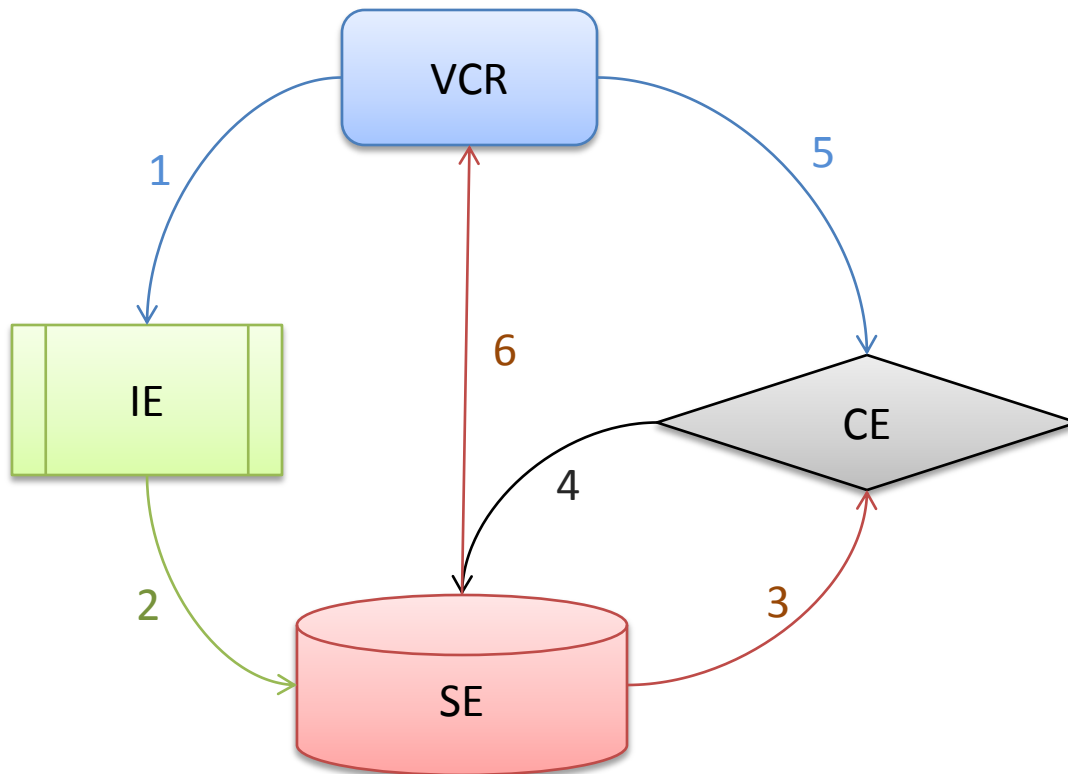


# SYnchrotron Radiation for MEdical Physics: SYRMEP Beam Line

- Computerised Tomography
  - High needs for Storage, Bandwidth, Computation
    - Data-Parallel problem



# Example online processing workflow



1. The user controls the BL and the detector and defines the data collection strategy.
2. Each image is stored on a SE.
3. The interactive tomographic application is started.
4. When the user requests a reconstructed slice, suitable algorithms produce it the result is stored.
5. The user interactively controls the application.
6. The user visualises the result.

# Case study/Prototype

- Robots as remote sensors for hazardous environments
  - Synchrotron ELETTRA Storage Ring
- LabVIEW for computer vision (pattern recognition)
- ...then as a TANGO device/server
- and subsequently: as an IE for the GRID



Grid user

Multipurpose Collaborative Environment  
a Virtual Control Room over the V

Resource Control Instrument Control Script Manager Application Manager

Resource Browser

Instrument Elements

- los.elettra.trieste.it:8080/min3Z/
- amimefunzia2.esce.elettra.trieste.it:8080/min3Z/
- https://panda.elettra.trieste.it:8443/text3Z/
- enterprise.elettra.trieste.it:8080/text3Z/

Computing Elements

Storage Elements

- prod-se-02.pd.infn.it:
- grid0002.pd.infn.it:2811
- prod-se-01.pd.infn.it:8444

Resource Brakers

- https://prod-wms-01.pd.infn.it:7443/glite\_wms\_wmproxy\_server

LFC Catalogs

- lfcserver.cna.f.infn.it

Portal File Systems

- VCR user space
- VCR shared space

Hosts

Path

MONITORING

Name	Min	Max	Value	Unit	Op.
Distance	0		58		

COMMANDS

Commands List

Transitions List

MONITORING

Computing Element

CE:

Create New Job, Update Jobs List

JOB LIST

Job ID	Status	Submission Date	Op.	Output

Multiple Instrument Control

ON GRID/ON-LINE



LFE\_Area\_Virtual

Match (Pattern Matching)

Position

Angle

Scale

Scale

Rotation

Number of Matches (Pattern Matching)

Remaining Inputs

Minimum Match Score (Pattern Matching)

Subtract Accuracy (Pattern Matching)

Rotation Angle Range (Degrees) (Pattern Matching)

Match Mode (Pattern Matching)

Match Order (Pattern Matching)

Number of Matches Required (Pattern Matching)

Match By Path (Pattern Matching)

CE

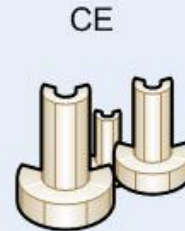
SE

off grid/off-line services

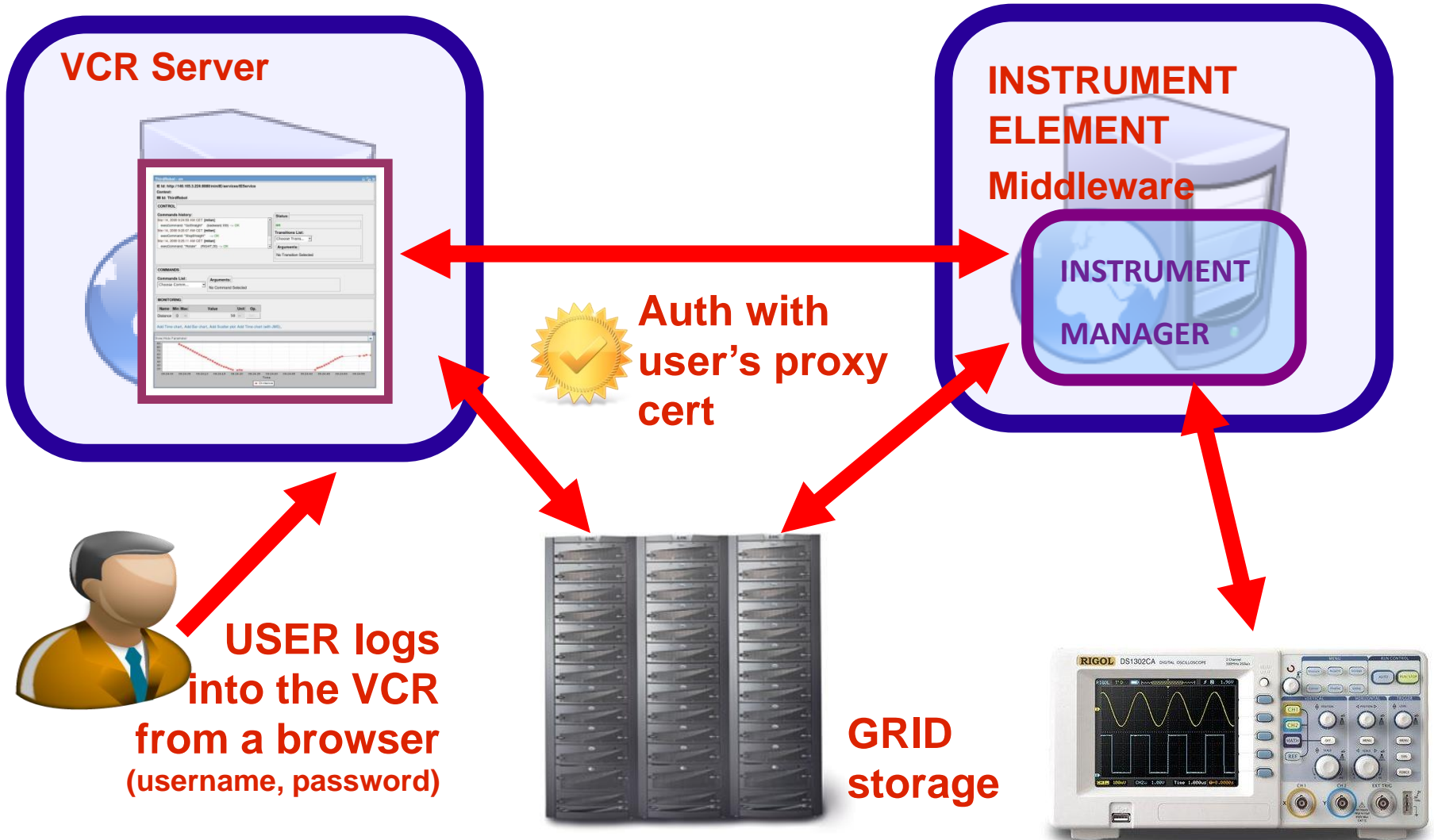
Other assistive services  
(i.e. TANGO DB)

NI Datasocket  
Server

LV-TANGO  
GATEWAY



# Remote Control of an Instrument



# Virtual Control Rooms (VCR)

- **VCR is a collaborative environment** that offers a set of groupware tools in support of scientific team-work such as logbook, chat, wiki help, people & resource browsers. It integrates with the third party tools like Skype
- **VCR is an open source GRID portal** based on Gridsphere and Web 2.0 technologies.
- **VCR is the front end to the Instrument Element.**
- VCR can be adopted both as a ready-to-use “**virtual collaboratory**”, and as an extendible framework for developing advanced, application specific collaboratories.

# Multipurpose Collaborative Environment

## a Virtual Control Room over the Web

Home Administration **mceinstruments**

Resources Control Instrument Control Script Manager Application Manager

**Resource Browser**

Update Resources List Geo Visualization

**Instrument Elements**

- los.elettra.trieste.it:8080/miniIE/
- amimefunzia.esce.elettra.trieste.it:8080/miniIE/
- amimefunzia2.esce.elettra.trieste.it:8080/miniIE/
- https://panda.elettra.trieste.it:8443/testIE/
- enterprise.elettra.trieste.it:8080/testIE/

**Computing Elements**

**Storage Elements**

- prod-se-02.pd.infn.it:
- gridit002.pd.infn.it:2811**
- prod-se-01.pd.infn.it:8444

**Resource Brokers**

- https://prod-wms-01.pd.infn.it:7443/glite\_wms\_wmproxy\_server

**LFC Catalogs**

- lfcserver.cnaf.infn.it

**Portal File Systems**

- VCR user space
- VCR shared space

**Storage Element**

Host: gsiftp://gridit002.pd.infn.it:2811//

Path: /

Listing successful - 48 file(s)

- .
- alice
- atlas
- babar
- bin
- bio
- biomed
- bkp
- boot
- cdf

**Computing Element**

CE:

Create New Job, Update Jobs List

**JOBS LIST**

Job ID	Status	Submission Date	Op.	Output

**Multiple Instrument Control**

(for a video/demo/etc please contact the group)

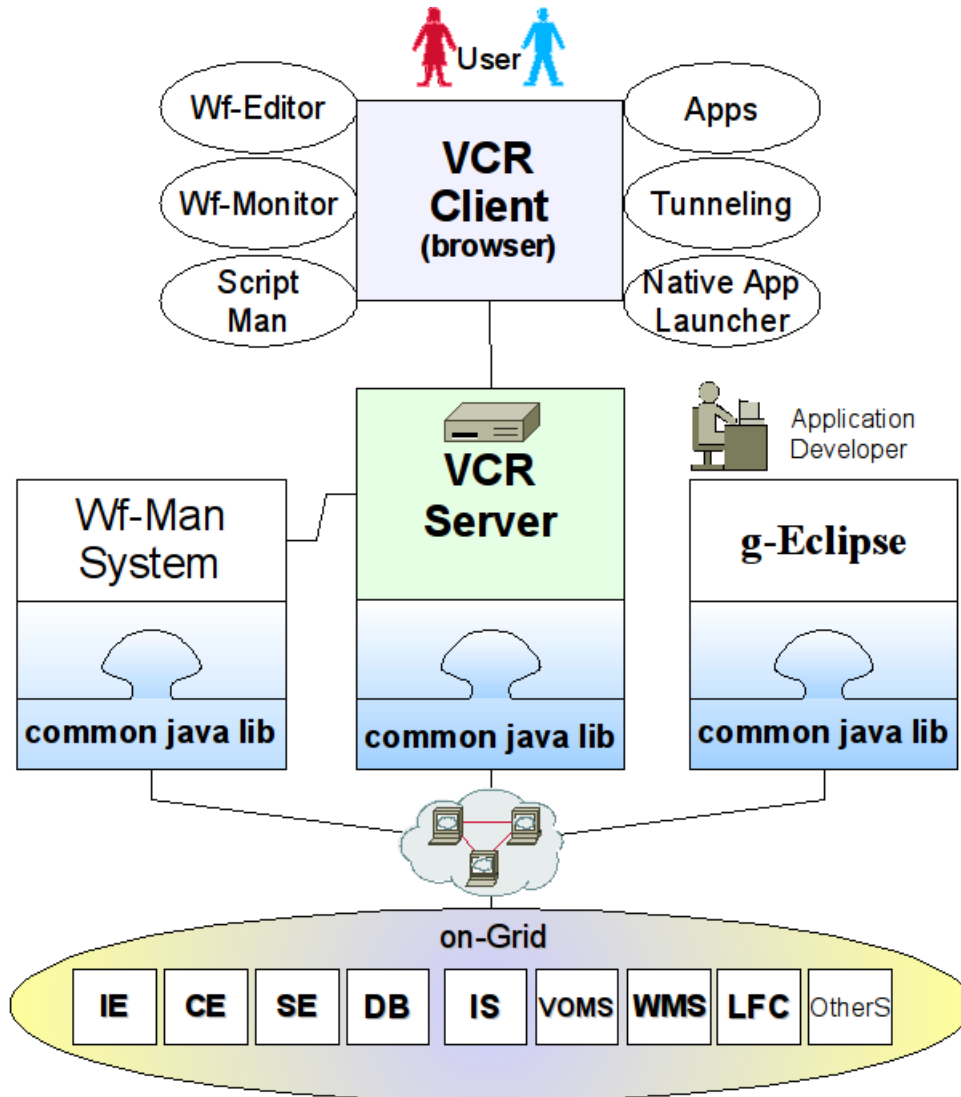


# VCR as a Grid portal

- VCR allows users to search, browse, control and manage Grid resources (e.g. job and workflow submission, file transfer, credential management), including remote instrumentation.
- VCR includes a scripting environment for creating and running simple workflows.
- VCR includes application manager for creating simple, application-specific forms.
- VCR provides a secure servlet for creating long term proxy certificates on the MyProxy server.
- VCR makes the Grid transparent to the end users.



# Current GRID project:



Started – Feb. 1st, 2008 + 30 months (FP7, RI-213110)

Grant agreement for: Combination of Collaborative projects & Coordination and support action

•11 partners:

- Scientific community
- IT partners: Service providers (services + infrastructure)
- Industry

[www.dorii.eu](http://www.dorii.eu)

Thanks for your attention !

For further information contact  
Elettra Sincrotrone - Comp.Sci Group

