Computing:
Status and Perspectives

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Ferrara University & INFN

for the SuperB Computing Group

Computing Parallel sessions

Monday 30 May 2011

08:30->*10:30* **Parallel Det+Comp: FullSim & Backgrounds** (Convener: Eugenio Paoloni (*PI*) , Luis Alejandro Perez Perez (*PI*) , Andrea Di Simone (*ROMA2*)) (Sala Bonaparte 1)

08:30	Bruno developments (20')	Andrea Di Simone (*ROMA2*)
08:50	SVT backgrounds and ETD rates (20')	Riccardo Cenci (*PI*)
09:10	DCH background report (20')	Dana Lindemann (*McGill University*)
09:30	FTOF background report (20')	leonid Burmistrov (*LaL*)
09:50	EMC background report (20')	Stefano Germani (*PG*)
10:10	IFR background report (20')	Valentina Santoro (*INFN Ferrara*)

Tuesday 31 May 2011

08:30->*10:30* **Parallel Comp: Distributed Computing** (Convener: Armando Fella (*PI*) , Luca Tomassetti (*FE*)) (Sala Bonaparte 1)

08:30	Bookkeeping and submission tools prototype (20')	Luca Tomassetti (*FE*)
08:50	Distributed system status (20')	Armando Fella (*PI*)
09:10	Software installation in distributed environment (20')	Silvio Pardi (*NA*)
09:30	Production workflow optimization (20')	Andrea Di Simone (*ROMA2*)
09:50	Discussion (40')	

11:00->*12:30* **Parallel Comp: R&D Projects** (Convener: Peter Elmer (*Princeton University*)) (Sala Bonaparte 1)

11:00	Test of the Liferay web portal (20')	Stefano Longo (*PD*)
11:20	Many-core platforms and HEP experiments computing (20')	Davide Rossetti (*ROMA1*)
11:40	A proposal for the distributed computing monitoring in SuperB (20')	Guido Russo (*NA*)

Wednesday 01 June 2011

08:30->*10:30* **Parallel Comp: Planning** (Convener: Fabrizio Bianchi (*TO*)) (Sala Bonaparte 1)

Computing Outline

- Development and support of the software tools and of the computing infrastructure needed for carrying out the detector design and performance evaluation studies for the **Detector TDR**
  - FullSim (Bruno): detailed simulation based on the Geant4 toolkit.
    - Used to evaluate machine background rate and particle fluxes in different sub-detectors.
  - FastSim: a faster parametric simulation and reconstruction code that can be interfaced with the BaBar analysis code.
    - Used to evaluate the effect of different sub-detector options on a large set of physics analysis.
  - A suite of distributed computing tools that use the existing HEP Grid infrastructure for simulation production purposes
  - A release infrastructure and a set of collaborative tools to support day by day code development and documentation
- R&D program
  - Devoted to the completion of the **Computing TDR** (one year after the Detector TDR).

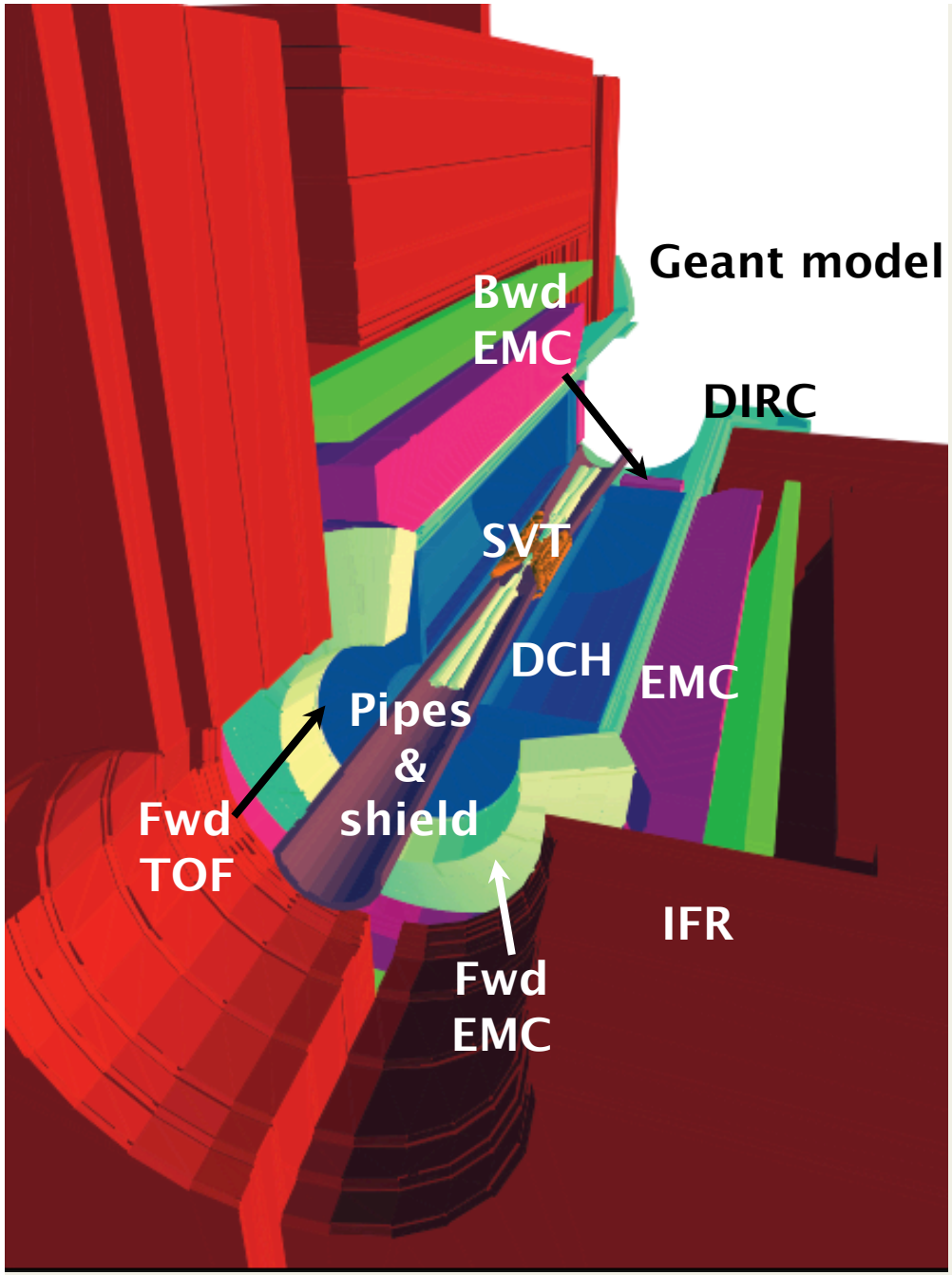
Full Simulation - Background

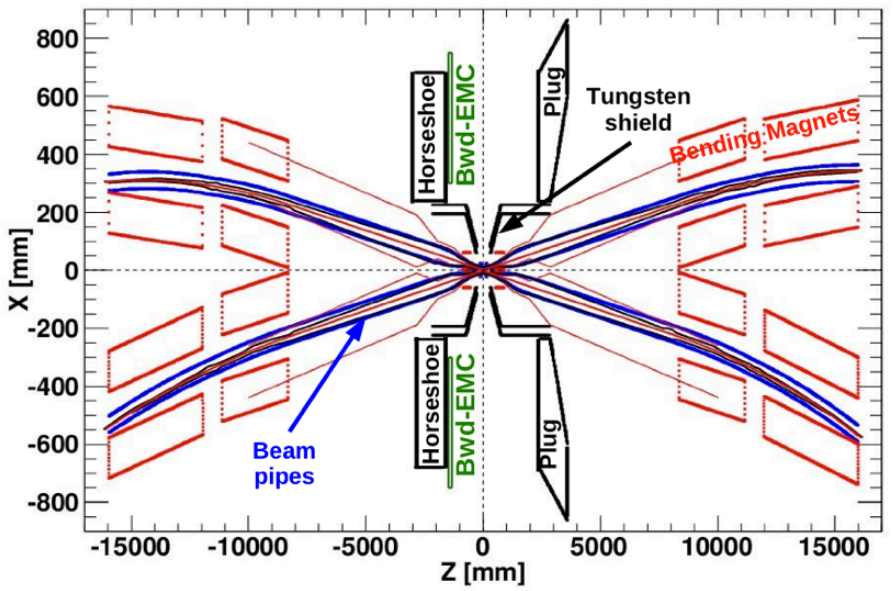
The SuperB full Monte Carlo simulation code is a Geant4 based program called Bruno

- its focus was on the simulation of the machine background effects
- it reads from a GDML file a very detailed description of the detector elements and of the machine pipe from the two dipoles upstream the IP up to the two dipoles downstream the IP (+/- 15 m).
- it reads from a set of text files the magnetic field configuration and the machine optical parameters @ IP.
- A BBBrem primary generator embedded in Bruno generates the primary particles impinging on the pipe, then the Geant4 code simulates their interaction with the machine/detector material.
- Bruno can also take a snapshot of the background particles at the machine boundary to produce a “background frame” that can be superimposed on top of a “fast-sim” Physics event

E.Paoloni

The Geant simulation progr.





- The whole detector is modeled
- The beam lines and their magnets are modeled +/- 15m from IP
- Recent developments:
  - packaging
  - newest IR layout
  - additional truth information

E.Paoloni

FullSim Recent activities: bug fixes I

Memory leaking

- The TClonesArrays that store the Monte Carlo truth information was not freed at the end of the event processing
- The leak was tolerable and was unobserved up to the previous production
- In this production the persistency of truth information in the final focus was turned ON
- The output file size jumped up from 13 MB/event to 117 MB/event
- hence the leak rate jumped up to 100 MB/event: all the jobs were killed by LSF: Max memory + swap size exceeded
- Riccardo Cenci spotted the bug and fixed it

E.Paoloni

FullSim Recent activities: bug fixes II

Observation from Dana Lindemann of a suspicious background depletion in the HER beam line

- Almost all (98%) the events of the last Frascati production were plagued by Geant4 error messages like:

```
ERROR - G4Navigator::ComputeStep()
        Track stuck, not moving for 25 steps
```

  the error message was present on ~5% of the "Caltech" events
- This error triggers an event abort before the completion of the simulation of the whole stack of primary particles
- The partially simulated event is written on the Bruno output file
- The stack is assembled in such a way that on top there are the LER losses (going toward backward) and on the bottom there are the HER losses.
- Bruno is now instructed to be less harsh in the Track stuck exception handling: Abort rate in the latest production dropped back to 2%

E.Paoloni

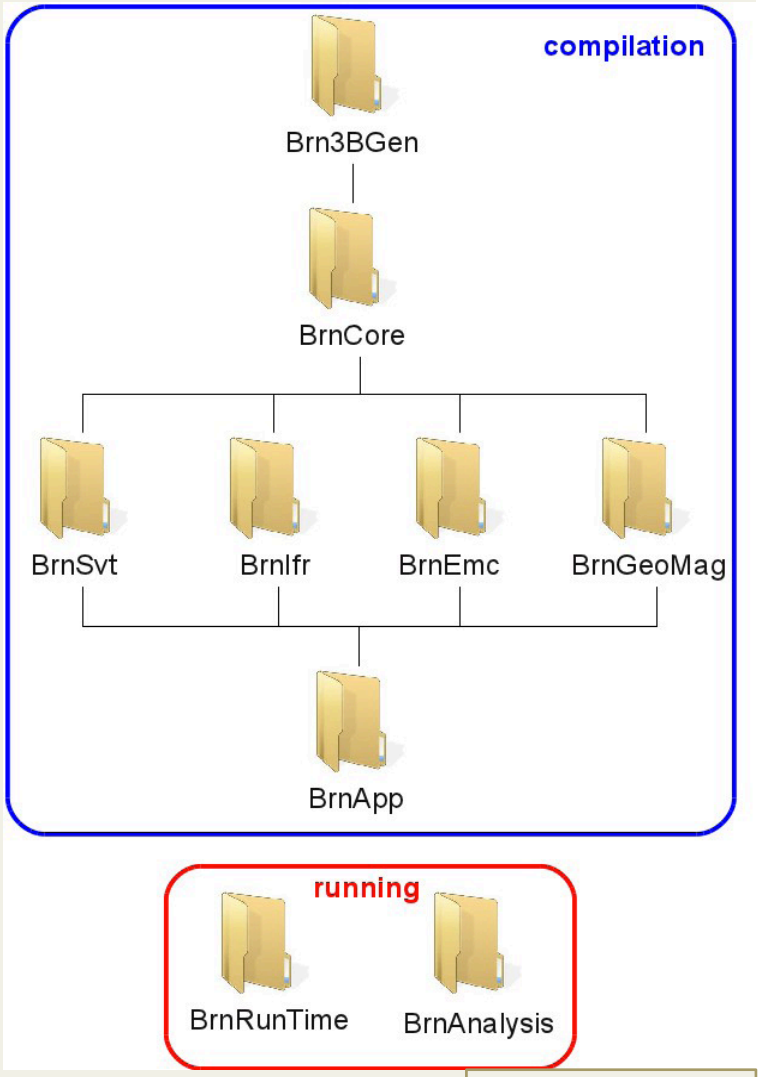
Full Simulation Packaging

Main activity in the past weeks was to complete the packaging of the "old" Bruno software dividing the code base into modular, self consistent units

- It helps code maintenance
- It helps code development: it enforces clear separation between different functionality, possibly handing over responsibility to different persons
- It encourages detectors to take more control of their own simulation, by creating detector-specific packages

Packaged version is now committed/validated, in sync with the "old" version

- Feedback and bug fixes from production not included, though



A. Di Simone

Fast Simulation

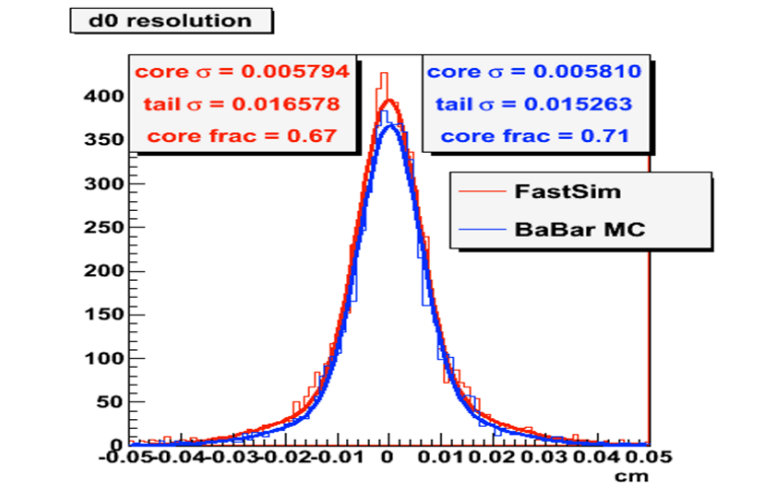
Developed to understand the effect of design options on the final result of critical physics analyses

- Required to be several orders of magnitude faster than Geant4-based simulation

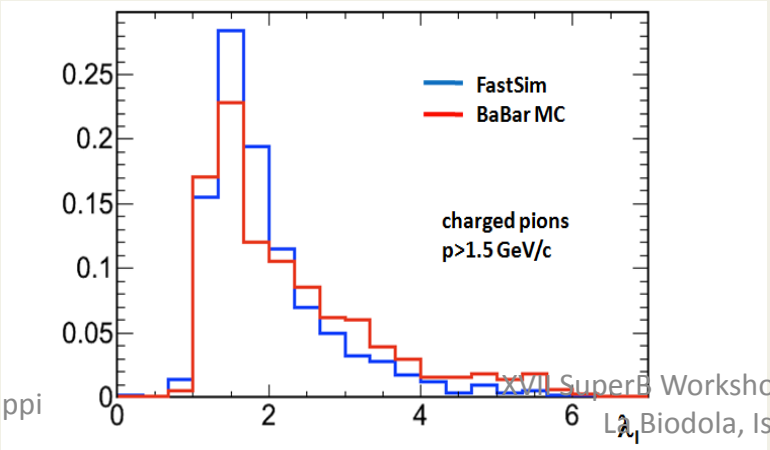
- Event generators are interfaced to simplified models of the detector geometry, materials, response, and reconstruction
  - On-peak BB events and continuum qq events generated with EvtGen and JETSET. KK and Tauola used for ττ events from polarized e^+e^- beams.
  - Cylindrical detector geometry around the solenoid B field axis.
  - Detector elements described as sections of two-dimensional surfaces.
    - Effect of physical thickness modeled parametrically.
  - Interactions of particles with matter are modeled using simplified cross-sections. Electromagnetic and hadronic showers are parameterized
  - Tracking measurements are described in terms of the single-hit and two-hit resolution, and of the efficiency.
  - The Calorimeter response is modeled in terms of the intrinsic energy resolution of clusters as a function of the incident particle energy.
  - Hits and clusters from machine backgrounds are superimposed on top of physics events.

FastSim: Comparison with BaBar MC & Sample Result

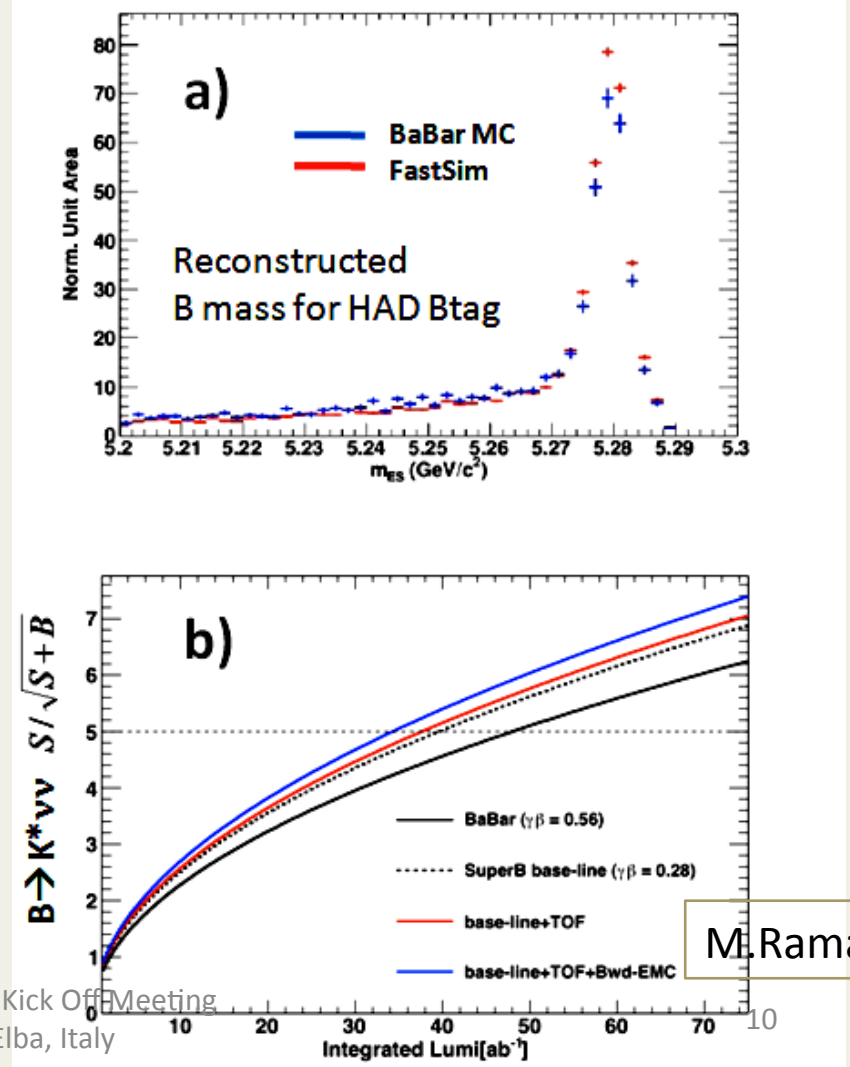
Track impact parameter resolution
FastSim vs Babar MC



Crossed int. lengths in the IFR (pions)
FastSimvsBabar MC



Example of complex measurement
simulated with FastSim: BF(B->K*vv)

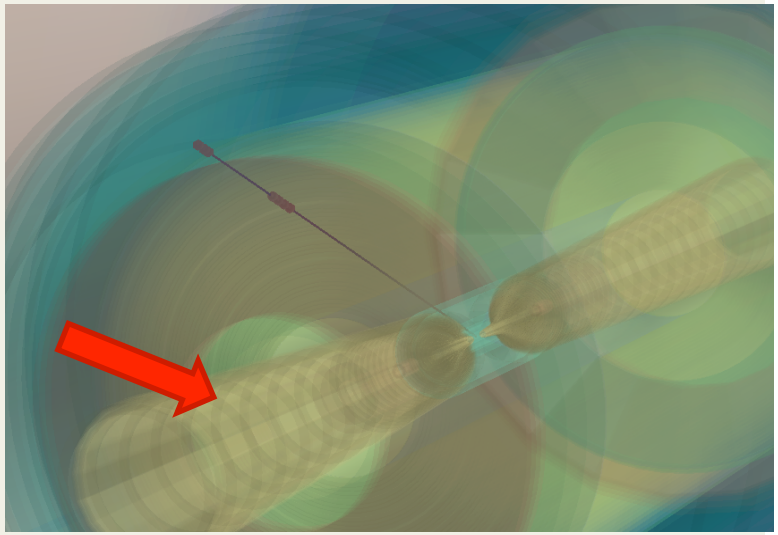


M.Rama

FastSim of the detector recent activities

New tungsten shield

- built from the new model in Bruno



- Simulation of backward EM calorimeter
  - Problem reported during the last workshop → reco efficiency underestimated. Now fixed.
  - 'September 2010' production affected

    ↳ it is needed to evaluate the bwd EMC impact on physics
  - Attempts made to avoid running a new production (next slide)

M. Rama

FastSim of the detector recent activities

New particle generator

- It takes as input a list of MC 'truth' particles stored in input file
- It allows to re-simulate pre-selected events
- Developed in the attempt to 'bypass' the bwd EMC bug of the September 2010 production
- Examples of its use discussed at this meeting

Joint session with EMC

- Impact of backward EM calorimeter on Physics
- Impact of material on p0 reconstruction and efficiency

Tuesday 31 May 2011

M. Rama

16:00->*17:30* Parallel: Joint detector geometry WG-FastSim-EMC session (Convener: Frank Porter (*Caltech*) , Claudia Cecchi (*PG*) , Matteo Rama (*LNF*) , David Brown (*Lawrence Berkeley National Lab*) , Achille Stocchi (*LAL - Université Paris Sud and IN2p3/CNRS*)) (Sala Bonaparte 2)

16:00	Impact of bwd EMC on Physics using the Sep2010 fastsim production (20')	ALEJANDRO PEREZ (*PI*)
16:20	updated study of HAD recoil B-->K*nunubar vs bwd EMC (20')	Elisa MANONI (*PG*)
16:40	impact of fwd PID material on pi0 reconstruction (20')	Stefano GERMANI (*PG*)
17:00	Backward physics impact, B to tau nu (20')	Sasha RAKITIN (*Caltech*)

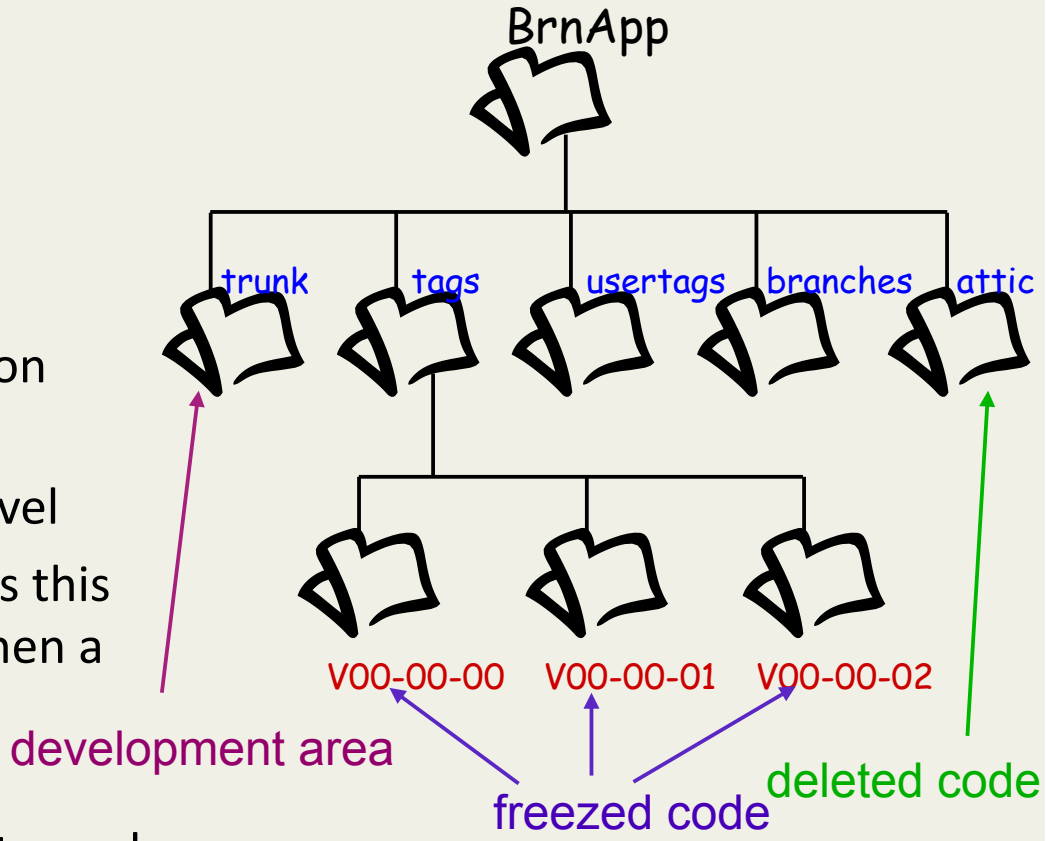
Release infrastructure

- A software release is a set of software packages with well defined versions
- A package consist of a set of code for a particular task
  - with rules to build and define dependencies
    - in Software Release Tool (SRT) the building is done using GNUmake and the rules are defined in GNUmakefile files
- Between a given release and another a package might stay the same
  - the package version will remain the same
- Package versions are defined within the Subversion repository
- External software dependencies are managed by SRT
  - Geant4 dependency is handled through this mechanism
- SuperB software is packaged with RPM and distributed with yum, along with external software used by it, such as ROOT, Geant4, CLHEP, CERNLIB and Xerces-c .
  - To improve security, packages are signed in order to guarantee their origin.

R. Stroili

Repository structure

- Each package has its own structure
  - trunk
  - tags
  - usertags
  - Branches
  - Attic
- tagged packages are meant to be non modifiable code
  - code that is working at some level
  - the subversion repository forces this policy through some control when a commit is made
    - it shouldn't be possible to commit code changes to a tagged version



R. Stroili

Software Release Tools

- Software Release Tools (SRT) are tools developed for BaBar and other experiments (CDF…) to simplify the code management/ development
- it helps building large projects keeping track of the version of the building blocks (the packages)
- in SuperB FastSim decided to use SRT and the code structure associated with SRT
  - as FastSim is build with several packages borrowed from BaBar it was a logical choice
  - the SRT system implemented in FastSim is different from the original one
    - based on subversion
    - simplified version
  - since the beginning SRT was thought as a temporary tool

R. Stroili

Building Tools

- CMake was added as alternative build system (Makefile generator) to FastSim V0.2.7
  - Based on CMake 2.6 and available for build on SL4, SL5 (32 and 64 bit) and MacOS
  - It doesn't substitute but works in parallel with SRT
- First FullSim build with Cmake recently
  - Code "packaging" completed
  - Added a macro to manage Geant4 external libraries
- Provides Release and Debug builds
  - Still coupled to some SRT features
  - Build dependencies calculated starting from link_X.mk and bin_X.mk files
  - Management of placeholders for external libraries (ROOT, CLHEP) to be improved
- Extend build platforms as required
- Investigate automatic build frameworks

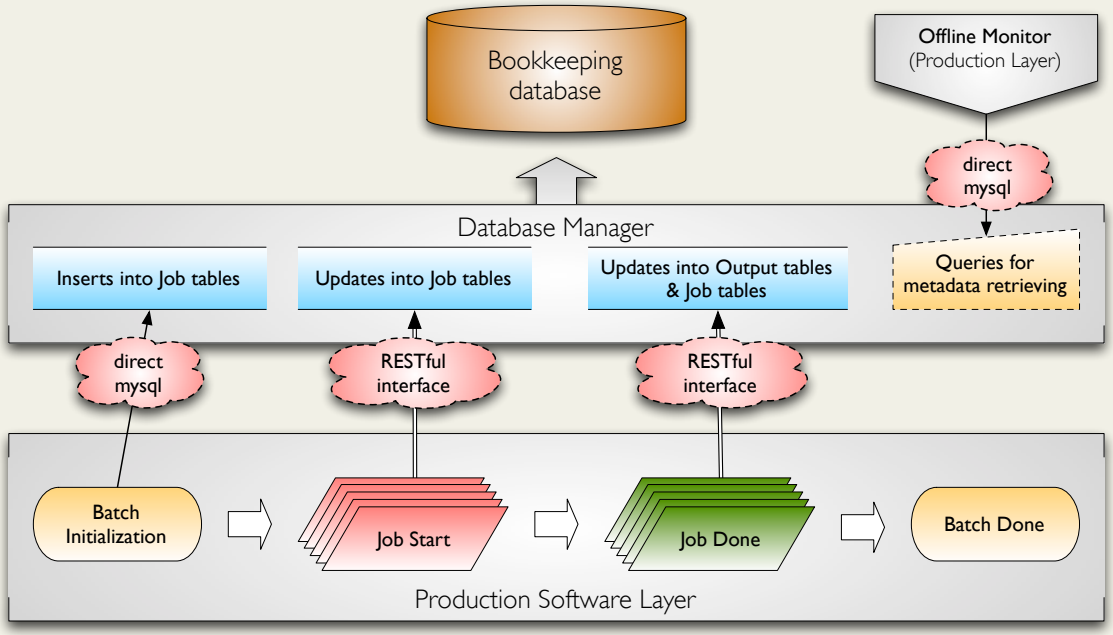
M. Corvo

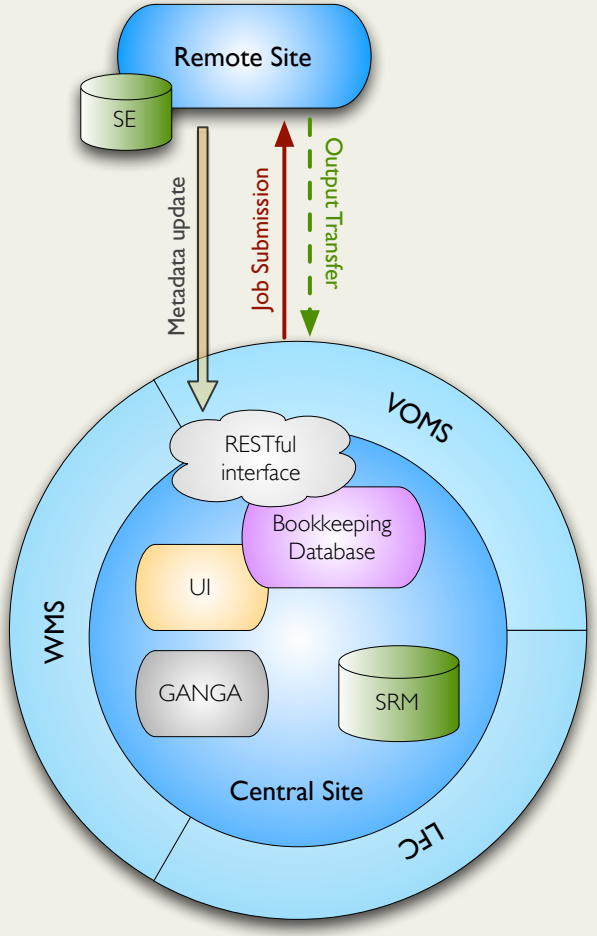
Distributed Production Infrastructure

- Designed a distributed computing facility exploiting the existing HEP Grid computing infrastructure worldwide
  - Current tools are for supporting the Detector TDR activities
  - R&D will be needed to have the final design
- The LCG Grid architecture was adopted
  - INFN-CNAF (Bologna) is the central site where Job Submission Management, Bookkeeping Data Base, and Data Repository would reside.
  - Jobs submitted to remote sites transfer their output back to the central repository and update the Bookkeeping Data Base containing all metadata related to the production input and output.
  - The system uses standard Grid services such as WMS, VOMS, LFC, StoRM, GANGA.
  - The EGI Workload Manager System (WMS) allows a job's progress through the different Grid middleware flavors to be managed transparently.
  - The job submission procedure includes a per site customization to adapt the job actions to site peculiarities: e.g. file transfer to and from three different data handling systems: StoRM, dCache, and DPM .

Distributed Framework design

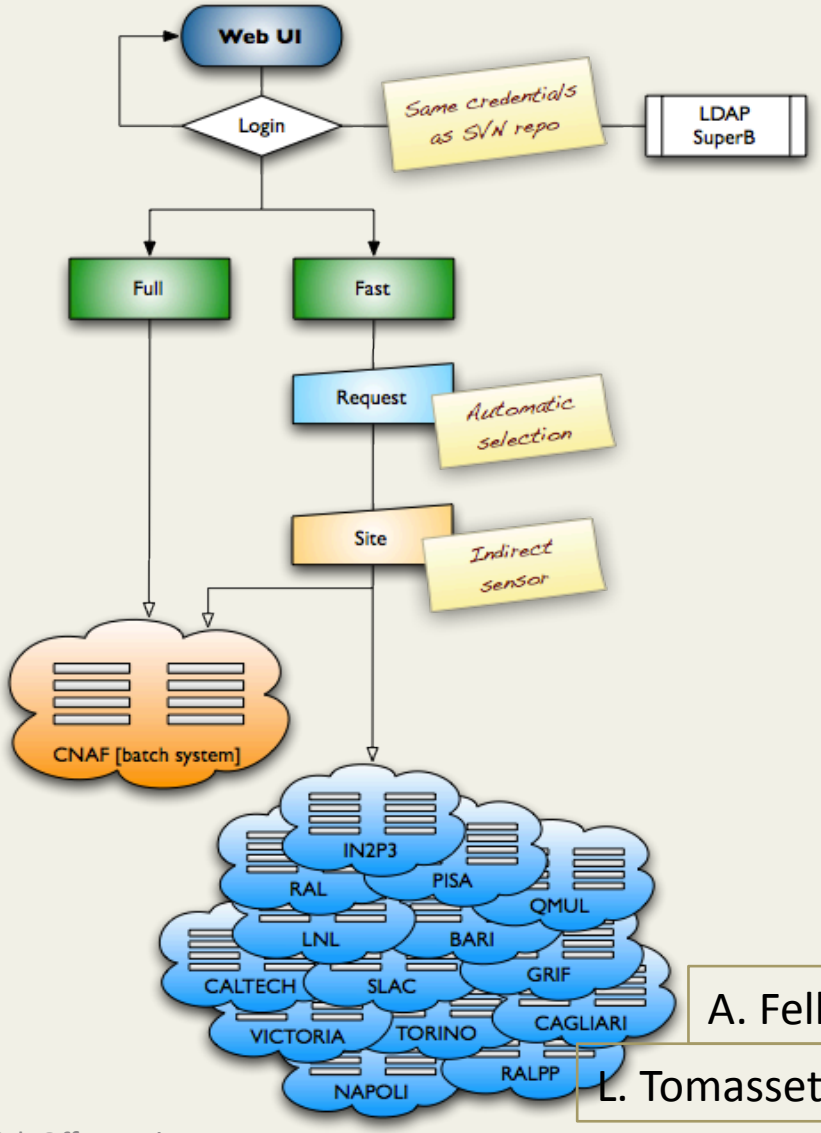
- Central EGI service site
- Web Interface
- Job and metadata management tool for submissions
- Database system to store the distributed production metadata (bookkeeping)





Distributed Production Workflow

- Pre-Production
  - Input files and sw transfers to site SEs
- Job preparation
  - with the Framework Web Interface
  - launch of submission script from UI(automation, myProxy solution)
- GANGA bulk submission via WMS
- Output files transfer
- Metadata update

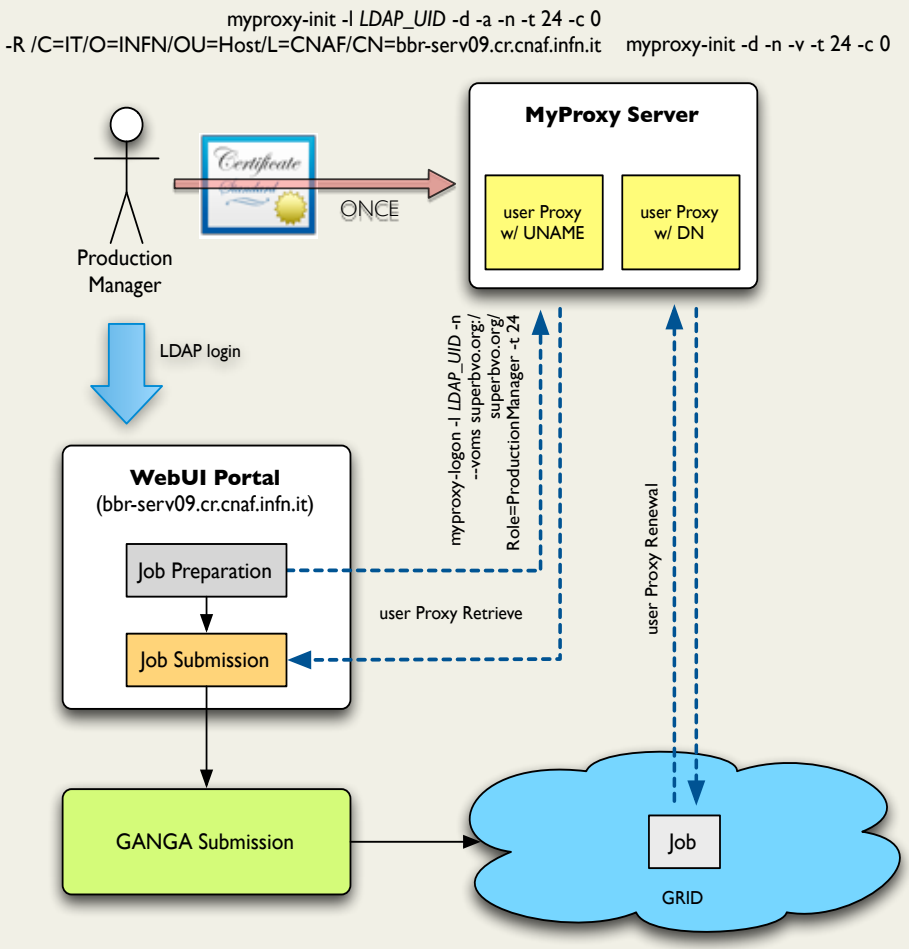


A. Fella

L. Tomassetti

Automatic Grid Submission – Web Portal

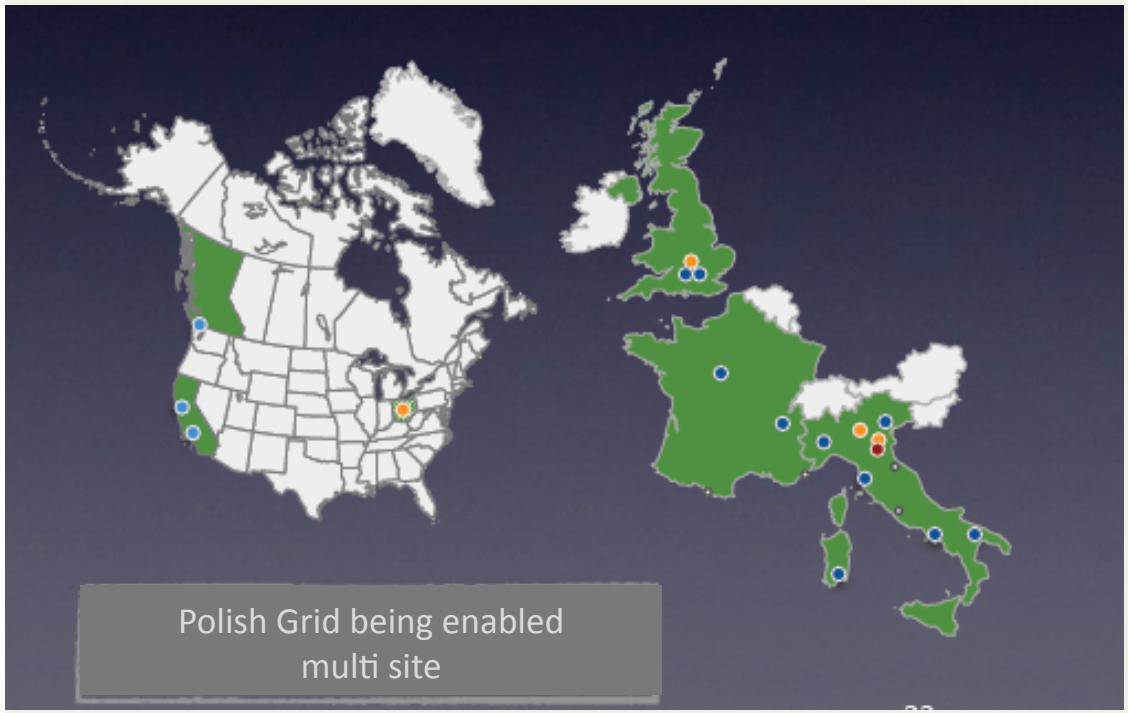
Production Tools allow Job preparation, bookkeeping updates, submission scripts generation



L. Tomassetti

SuperB remote sites

19 sites, three ‘flavors’
(EGI, OSG, WestGrid)



- Tier-1
- INFN-T1 (Bologna, Italy),
- IN2P3-CC (Lyon, France),
- RAL-LCG2 (Oxford, UK)
- • Tier-2
- UKI-LT2-QMUL (London, UK),
- UKI-SOUTHGRID-RALPP (London, UK),
- UKI-SOUTHGRID-OX-HEP (Oxford, UK),
- GRIF (Orsay, France),
- SLAC (Stanford, USA),
- CIT-CMS-T2B / CIT-HEP-CE (Caltech, USA),
- OSC (Ohio, USA),
- VICTORIA-LCG2 (Victoria, Canada),
- INFN-BARI (Bari, Italy),
- INFN-CAGLIARI (Cagliari, Italy),
- INFN-FERRARA (Ferrara, Italy),
- INFN-LNL-2 (Legnaro, Italy),
- INFN-MILANO (Milano, Italy),
- INFN-NAPOLI (Napoli, Italy),
- INFN-PISA (Pisa, Italy),
- INFN-TORINO (Torino, Italy)

A. Fella

Distributed Computing recent activities

- Evaluation of Dirac system started
  - Study of the project
  - Testbed installation at CNAF
  - Focusing on the following use case first
    - Simulation Production
    - User interface, GANGA plugin
- SuperB sw installation procedure Grid based have been tested at CNAF successfully

A. Fella

Collaborative Tools

A set of computing tools to support day by day document and code development

- The SuperB web site *(http://web.infn.it/superb/*) is managed by the Joomla open source content management system
  - In addition a wiki site has been set up to permit the easy creation of web pages to be used as internal documentation
- A directory service based on LDAP application protocol has been set up to support the access to the collaborative tools through a single authentication and authorization interface.
- Alfresco has been chosen as document repository and management system.

Portal System

- Several collaboration tools are available to the SuperB community (websites, wiki, document management system…)

  -> some kind of consolidation would be desirable
- A portal system can solve this problem, providing all the collaboration tools to the users, within an homogeneous environment
- A prototype based on the Liferay Portal System is already online at CNAF (http://lr.cnaf.infn.it:8080/liferay-portal; access is granted to all SuperB users)
- The prototype hosts a copy of the collaboration website, plus some examples of application integration («Tools» page, with a group calendar, discussion forum, wiki and Alfresco document manager), to demonstrate how role based content delivery works (ACL) and what kind of consolidation is available
- We are investigating if Liferay may become the platform for future web application development

S. Longo

SSO and Central Authentication Service

- A portal system allows the aggregation of tools in a single site (consolidation). From the usage point of view, a Single Sign-on mechanism is needed to allow users to log into the portal and then employ the same credentials for the “aggregated” tools
- A central authentication service prototype that implements SSO (Jasig CAS) is online on the same machine hosting the portal, configured to bind users to the SuperB LDAP server
- Liferay portal and Alfresco document manager on lr.cnaf.infn.it are setup to validate users through the CAS server
- Jasig CAS provides libraries to authenticate Java, PHP, .NET and Apache applications, so we are evaluating it as a tool to implement SSO also for other SuperB web tools

S. Longo

Study of the Computing Model

- For the Computing TDR:
  - R&D projects. Most relevant:
    - Optimal exploitation of multi/many core system architectures, parallelize HEP applications
    - Distributed, fault tolerant data storage system
    - Grid/Cloud computing tools
  - All major design choices should be in place for TDR
- After the Computing TDR:
  - A preliminary version of a fully-functional offline system is built and validated via dedicated data challenges
  - The collaboration can start using it for detector and physics simulation studies
- Before the start of the data taking:
  - Further extensive test and development cycles to bring the system to its full scale
  - Acquisition and deployment of dedicated computing resources
  - Consolidation and validation of the distributed computing infrastructure

R&D Projects I

- After the first Ferrara SuperB R&D Computing Workshop, the Computing R&D group has written a document listing the baseline projects considered relevant for SuperB
  - It will be uploaded on Alfresco
- Recently we started to have regular bi-weekly meetings on R&D activities
- R&D projects are an opportunity to attract computing experts to SuperB
  - We'll try to exploits synergies with other experiments
- Next SuperB R&D Computing Workshop will be held in Ferrara on July 4-7
  - www.fe.infn.it/superb11
  - Participate!

R&D Projects II

- General Computing Requirements
  - cost/technology trends
- Software Development Model and Framework
  - Software build system, deployment, installation, programming languages, compilers/platforms and online/offline sharing
- Exploitation of multi/many core system architectures:
  - Benchmarking of HEP typical applications
    - Investigate possibility of exploiting LHC developments
  - Understand how to exploit different level of parallelism (event or more fine–grained)
  - Benchmark existing parallel HEP applications and investigate their use within SuperB
- User tools and interfaces

R&D Projects III

- Persistence, data handling models and Databases
- Distributed and large storage systems:
  - Testing new storage technologies and new infrastructure implementation
    - Wide Area Network distributed storage infrastructure
    - Affinity job scheduling
  - Effort mainly in data access (analysis use case) and data placement for a distributed Tier1
  - Technologies under evaluation: hadoop, lustre, xrootd, ceph
- Distributed computing:
  - Design a distributed computing framework, possibly fully integrated with national Grid initiatives
  - Support of multi-thread programming and distributed data storage
    - Integration of multi/many core CPU (and possibly GPU)
  - Support of Cloud and/or Grid infrastructures

Working Opportunities

We need people: groups are undersized and projects/plans/ideas are growing

Every aspect of the computing projects is tightly coupled to the others
A short (and incomplete…) list of activities that need people:

- Full Simulation:
  - Core and sub-detector level improvements
  - Porting of Bruno to newer version of Geant
  - Sub-detector digitization
- Fast simulation:
  - subdetectors response development
  - physics tools development
- Reconstruction:
  - Framework and data structures
  - Sub-detector level code
- Data persistency:
  - Event Store
  - Condition and calibration data
- Bookkeeping
- Collaborative tools
- **R&D projects**
  - Exploitation of multi/many core system architectures
  - Distributed Storage
  - Distributed computing
  - Code development: languages, tools, standards and QA
  - User tools and interfaces

Credits

Many thanks to:

- F. Bianchi
- M. Corvo
- A. Di Simone
- A. Fella
- S. Longo
- E. Paoloni
- M. Rama
- R. Stroili
- L. Tomassetti
- R. Stroili

For their contribution