Univ. Turin and I.N.F.N.

Dept. of General Physics "A.Avogadro"

MonteCarlo simulations in a GRID environment for the COMPASS experiment

Antonio Amoroso
for the COMPASS Coll.

COMPASS Experiment

- Experimental apparatus
- Lambda polarization
- The importance of MonteCarlo simulation

The GRID Project

- What is GRID
- GRID Structure
- INFN Prod. GRID and LCG2

COMPASS@GRID

- Software packages
- Software installation procedure

GRID Results

- Transverse Λ pol.

Analysis

- MonteCarlo

COmmon Muon and Proton Apparatus for Structure and Spectroscopy

Physics with the Muon beam

Gluon polarization

Longitudinal and transversal spin distribution

Polarization of Λ and $\overline{\Lambda}$
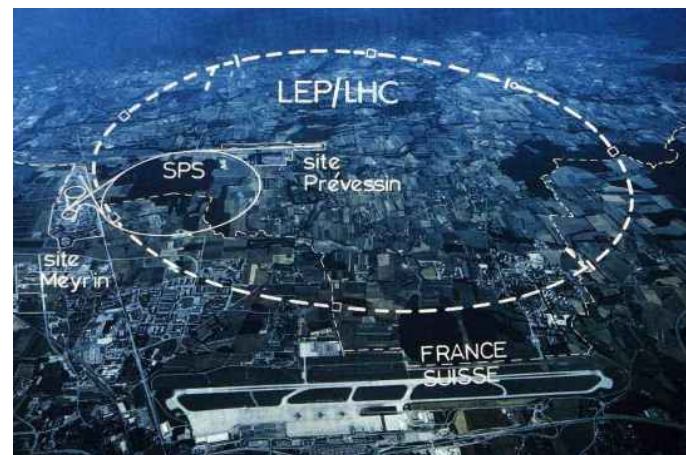
Physics with the Hadron beam

Study of charm baryons

Study of gluonic systems

Hadron structure with virtual photons

Exotic hadrons
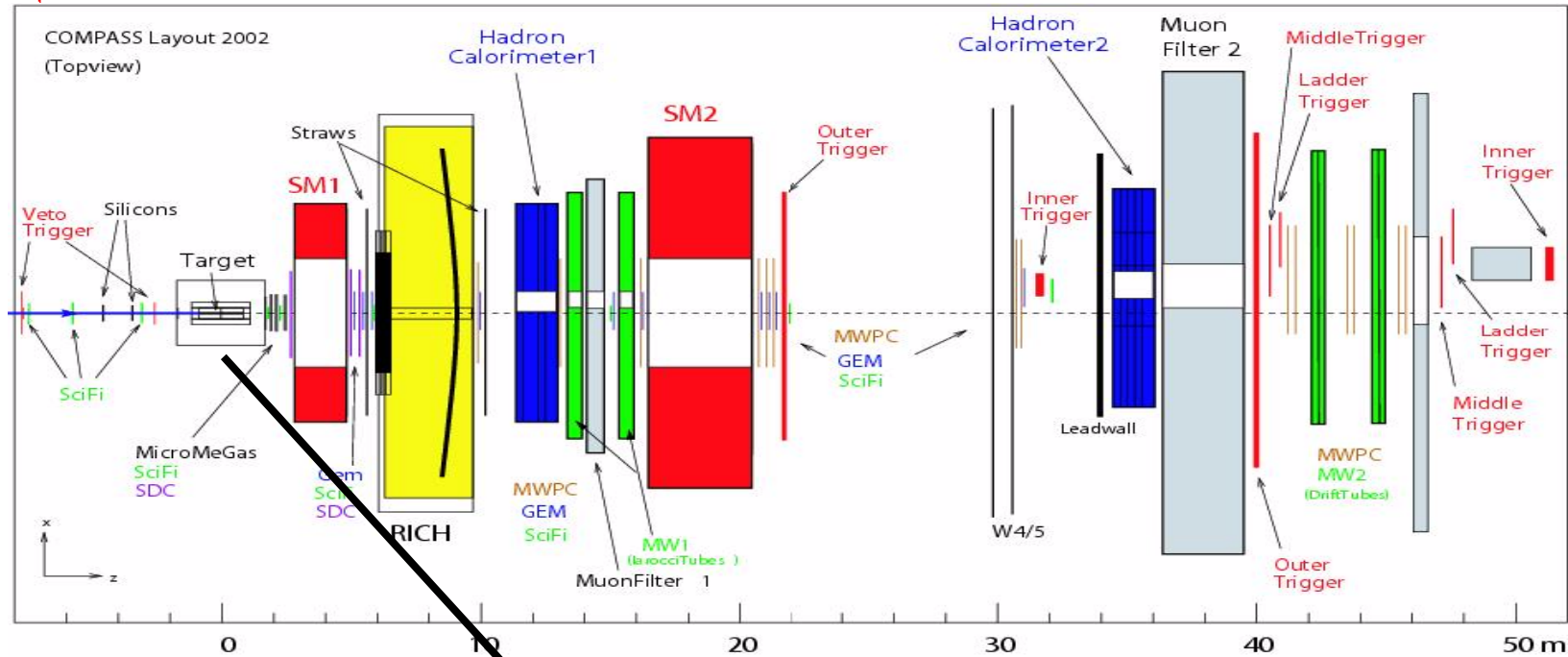

~250 physicists
from 28 institutes,
11 countries

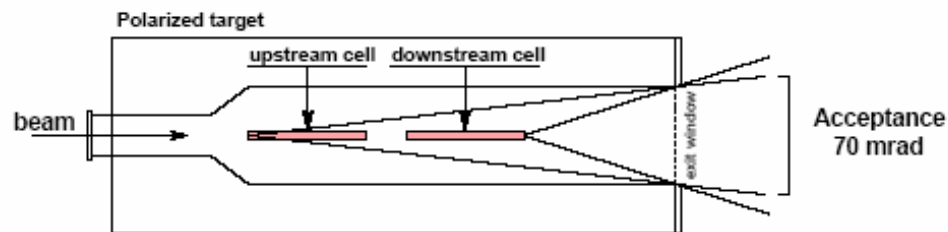**The beam intensity is about $2\cdot10^8\mu^+ / \pi$ per spill (4.8 s)**

Data taking starts in 2002 will continue from 2006 till at least 2010

COMPASS Experimental apparatus

First Spectrometer: ... Second Spectrometer: SAS

Geometrical Accep... ...nce: θ<30 mrad
Gap: 172 × 229 cm²
Integral field: 1 Tm
Analyzed momentu... ...: p>10 GeV/c

Λ polarization

The Semi-Inclusive DIS (SIDIS) reactions with transversely polarized target allow to access the transversely polarized quark distribution of the nucleon target.

$$\Delta_T D = D_{q\uparrow}^{\Lambda\uparrow} - D_{q\uparrow}^{\Lambda\downarrow}$$

$V_1(x_1,y_1,z_1)$

μ'

μ

Λ

$V_2(x_2,y_2,z_2)$

π^-

p

$$P_\Lambda^{meas.} = \frac{\sum_q e_q^2 \Delta_T q(x) \Delta_T D_q^\Lambda(z)}{\sum_q e_q^2 q(x) D_q^\Lambda(z)} \frac{2(1-y)}{1+(1-y)^2} fPT$$

$$W(\theta_T^*) \propto 1 + \alpha \cdot P_\Lambda \cdot \cos\theta_T^*$$

The Λ polarization allows to measure $\Delta_T q_i(x)$ the transversity distribution function

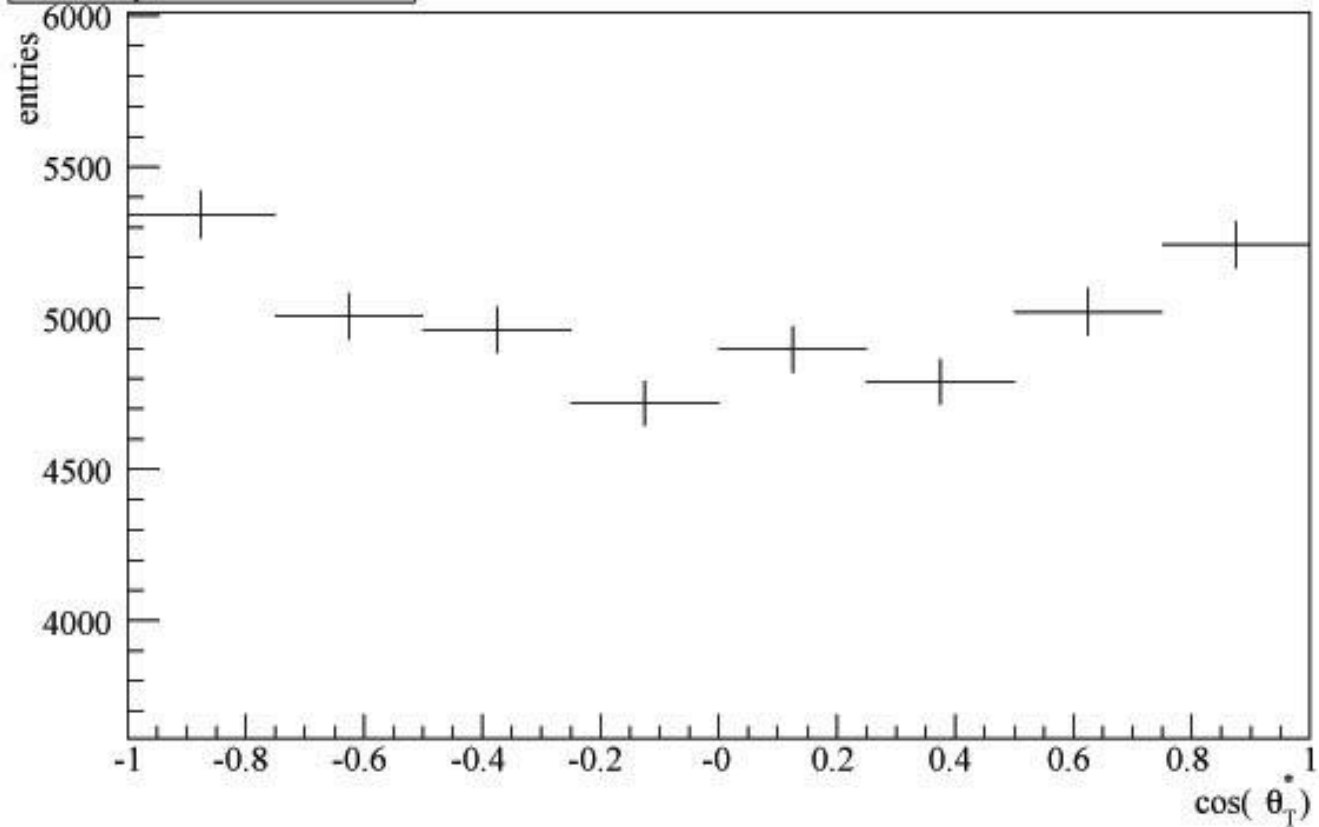# The importance of MC simulation

To correct the acceptance of the experiment generated by analysis cuts:

To t

To e

To s

cos(θ_T^*) distribution

What's GRID

Computing environment to combine and share the heterogeneous resources of a large number of collaborating institutions and computing centres.

The huge demand of computing power for the coming in HEP Esperiments cannot be satisfied by traditional computing systems
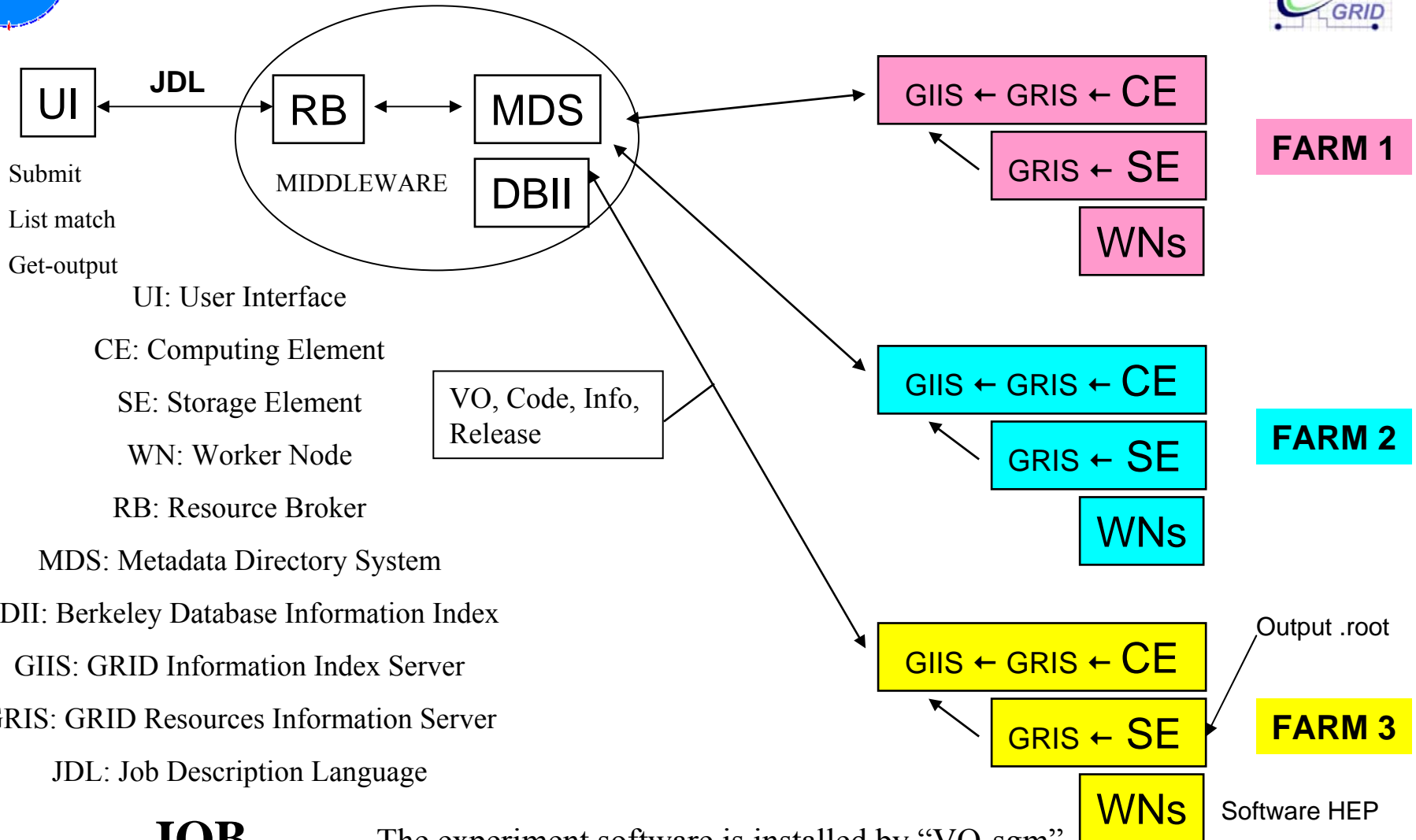
- CMS, ATLAS, ALICE, LHCb

  Will collect data 6-8 PB/year

- COMPASS

  Collected data more than 270 TB/year (start from 2002)

GRID Infrastructure

UI ← **JDL** → (**RB** ↔ **MDS** / **DBII**) MIDDLEWARE → **FARM 1** [GIIS ← GRIS ← CE / GRIS ← SE / WNs]

Submit

List match

Get-output

UI: User Interface

CE: Computing Element

SE: Storage Element

WN: Worker Node

RB: Resource Broker

MDS: Metadata Directory System

BDII: Berkeley Database Information Index

GIIS: GRID Information Index Server

GRIS: GRID Resources Information Server

JDL: Job Description Language

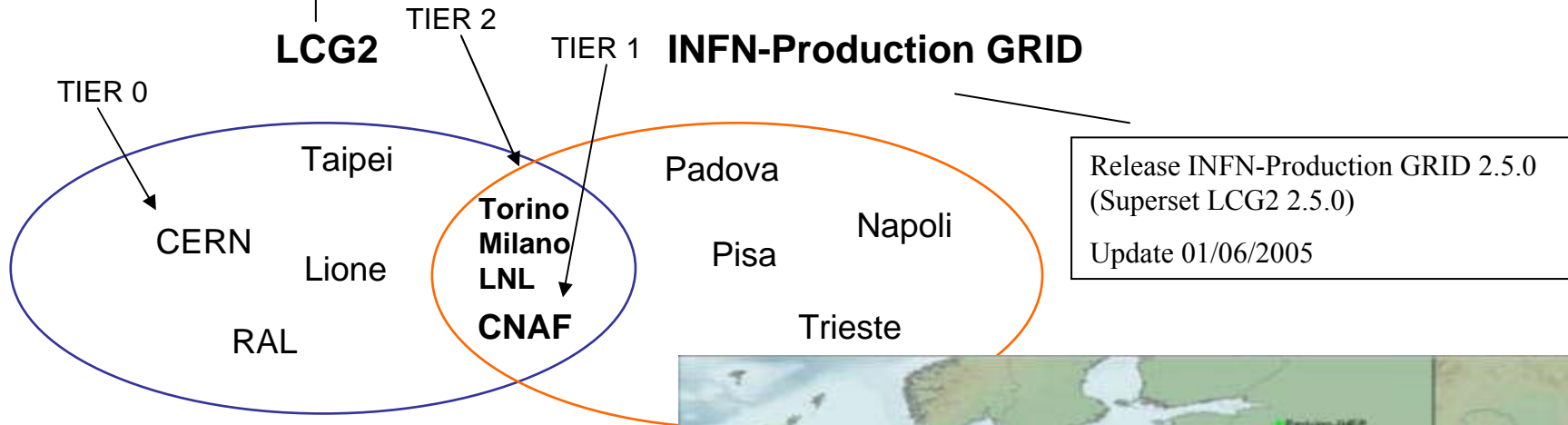VO, Code, Info, Release

FARM 1
- GIIS ← GRIS ← CE
- GRIS ← SE
- WNs

FARM 2
- GIIS ← GRIS ← CE
- GRIS ← SE
- WNs

FARM 3
- GIIS ← GRIS ← CE
- GRIS ← SE
- WNs

Output .root

Software HEP

JOB SUBMISSION

The experiment software is installed by "VO-sgm" user in the /opt/exp_software directory of the CE

LCG2 and INFN Production GRID

Release LCG2 2.5.0

LCG2

TIER 2

TIER 1 **INFN-Production GRID**

TIER 0

Taipei

Padova

CERN

Torino
Milano
LNL

Pisa

Napoli

Lione

CNAF

Trieste

RAL

Release INFN-Production GRID 2.5.0
(Superset LCG2 2.5.0)

Update 01/06/2005

Total Sites 82
Total CPUs 7269
Total Storage 6558 (TB)
Wed September 22 2004

FARM LCG and INFN-GRID TORINO

BIPROCESSOR HOST (P4 XEON 2,4 GHz – 1 GB RAM)
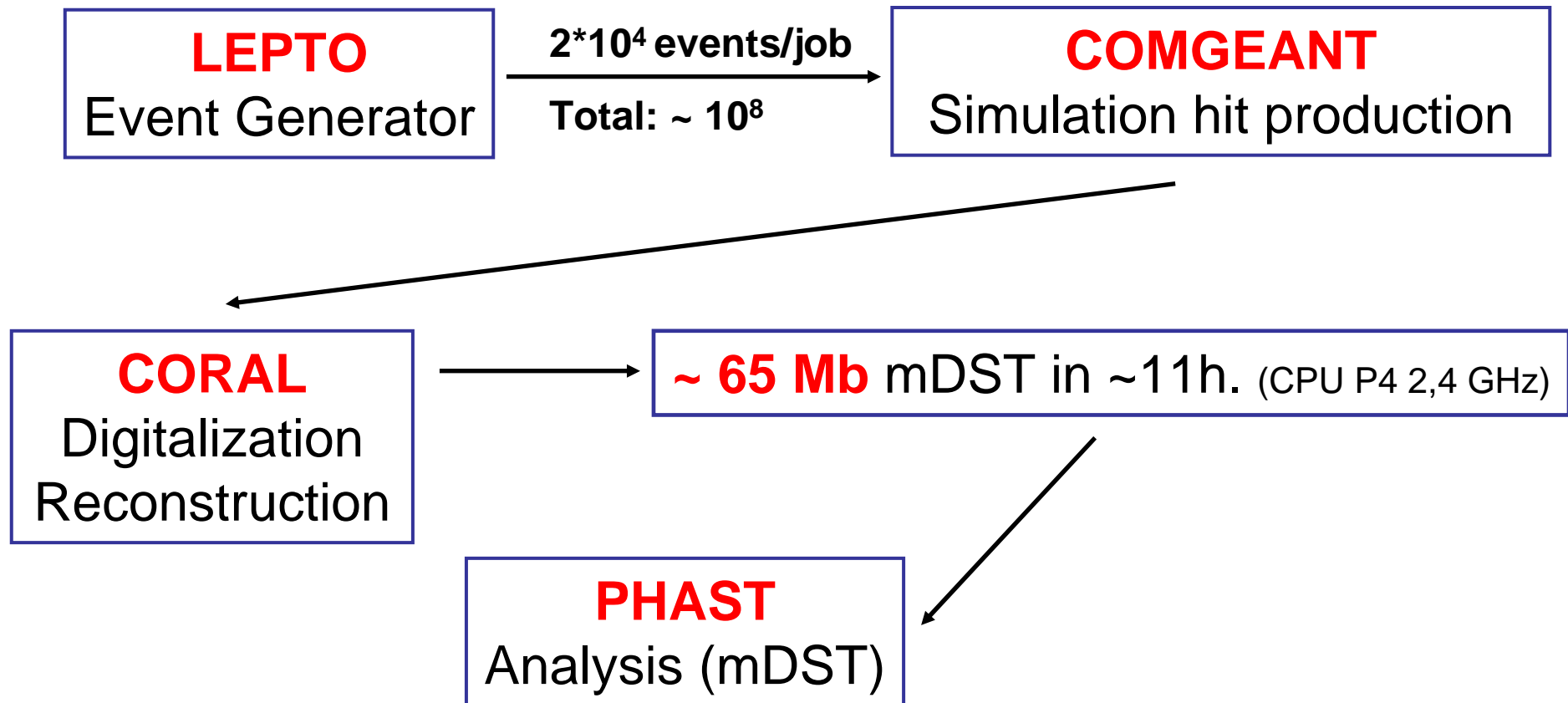
1 CE
1 SE (2TB)
1 UI
35 WNs

Release LCG2 2.5.0

OS SL 3.0.4

Installation and managing as Turin Site Manager

Analysis chain for Λ transverse production

LEPTO
Event Generator

$2*10^4$ events/job

Total: ~ 10^8

COMGEANT
Simulation hit production

CORAL
Digitalization
Reconstruction

~ 65 Mb mDST in ~11h. (CPU P4 2,4 GHz)

PHAST
Analysis (mDST)

Simulation vs Analysis for one job ($2*10^4$ events)

Program	TIME
LEPTO	< 4 min
COMGEANT	~ 300 min
CORAL	~ 350 min
Simulation Chain	~ 660 min x CPU

CPU P4 2,4 GHz – 1GB RAM

Program	TIME
PHAST	< 5 min

$2*10^4$ simulated and reconstructed events
give a mDST~65 MB

A complete simulation of required events (~ 10^8) takes ~60.000 h/CPU

Installation procedure on GRID resources

- edg-job-list-match: search the resources where SGM user wants to install the software

- edg-job-submit –resource: submit the job forcing to a particular resouce

- Step 0: checking for /var/spool/pbs/server_name

- Step 1: removing old lambda_trans.tgz

- Step 2: disk space availability

- Step 3: Downloading ARCHIVE lambda_trans.tgz

- Step 4 : Unpack the ARCHIVE lambda_trans.tgz

- Step 5: setting envar

- Step 6: Removing ARCHIVE lambda_trans.tgz
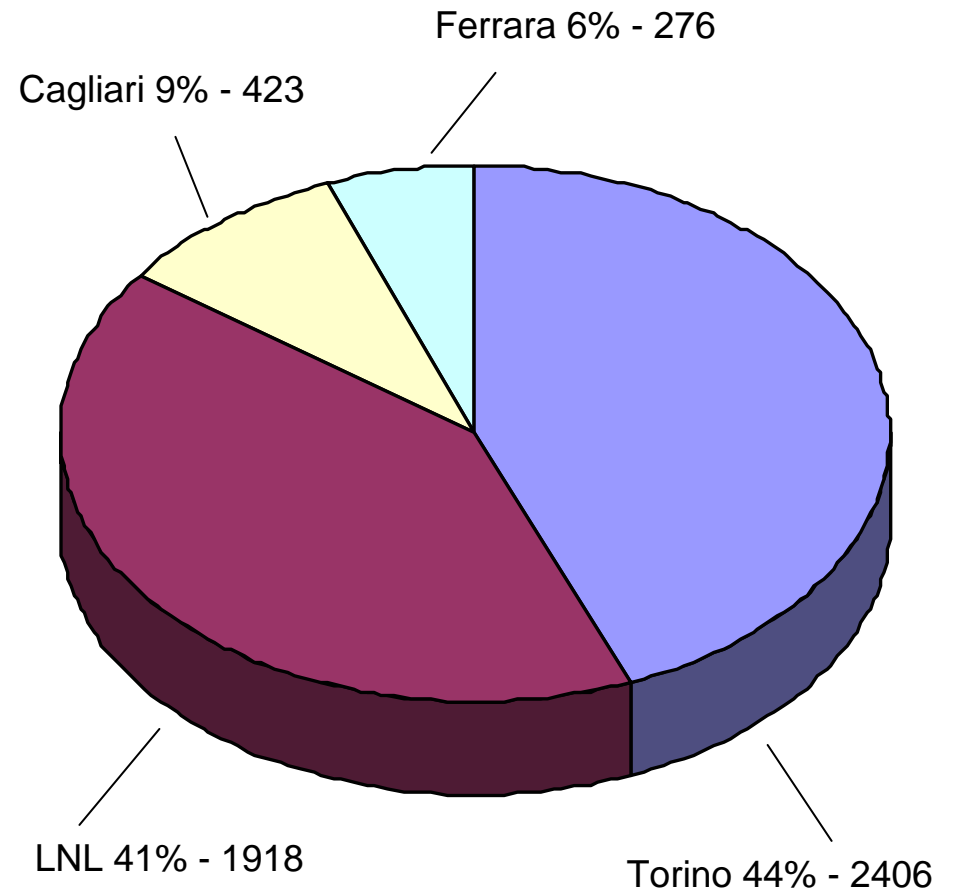
- Submit of a test job (20 events simulation)

Job distribution: <u>5356</u> jobs submitted on GRIDIT resources

Ferrara 6% - 276

Cagliari 9% - 423

LNL 41% - 1918

Torino 44% - 2406

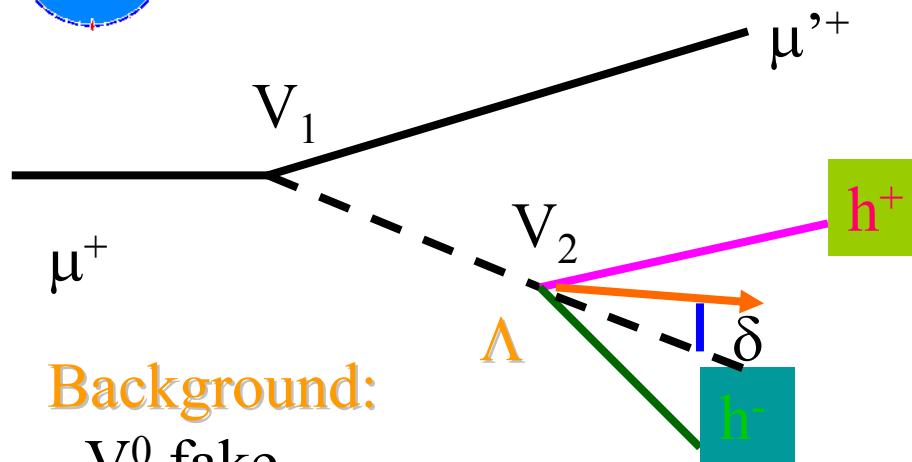# Lambda transverse production using INFN Prod. GRID infrastructure

- CPU used: 126 max simultaneous
- CPU Time :~63900 h/cpu (P4 2,4 GHz)
- Events produced: ~10^8 lambda generated
- Disk usage: ~320 GB on SE grid009.to.infn.it
- RB: CNAF, Catania, Padova

Software Release

- Lepto 6.5.1
- Comgeant: 0-0-7.01
- Coral: prod-200303
- Phast: 5.130

Event selection

Request:
- μ in
- μ out
- V^0 vertex ($\Lambda \rightarrow p\pi^-$ (Br~64%))

Background:
- V^0 fake
- $\gamma \rightarrow e^+ e^-$
- $k^0 \rightarrow \pi^+ \pi^-$
- $\overline{\Lambda} \rightarrow \overline{p} \, \pi^+$

Cuts:
- $-100 < z_1 < -40$ & $-30 < z_1 < 30$ cm
- $V_2 > 35$ cm
- $p_T^+ > 23$ MeV/c
- $p_{p,\pi} > 1$ GeV/c
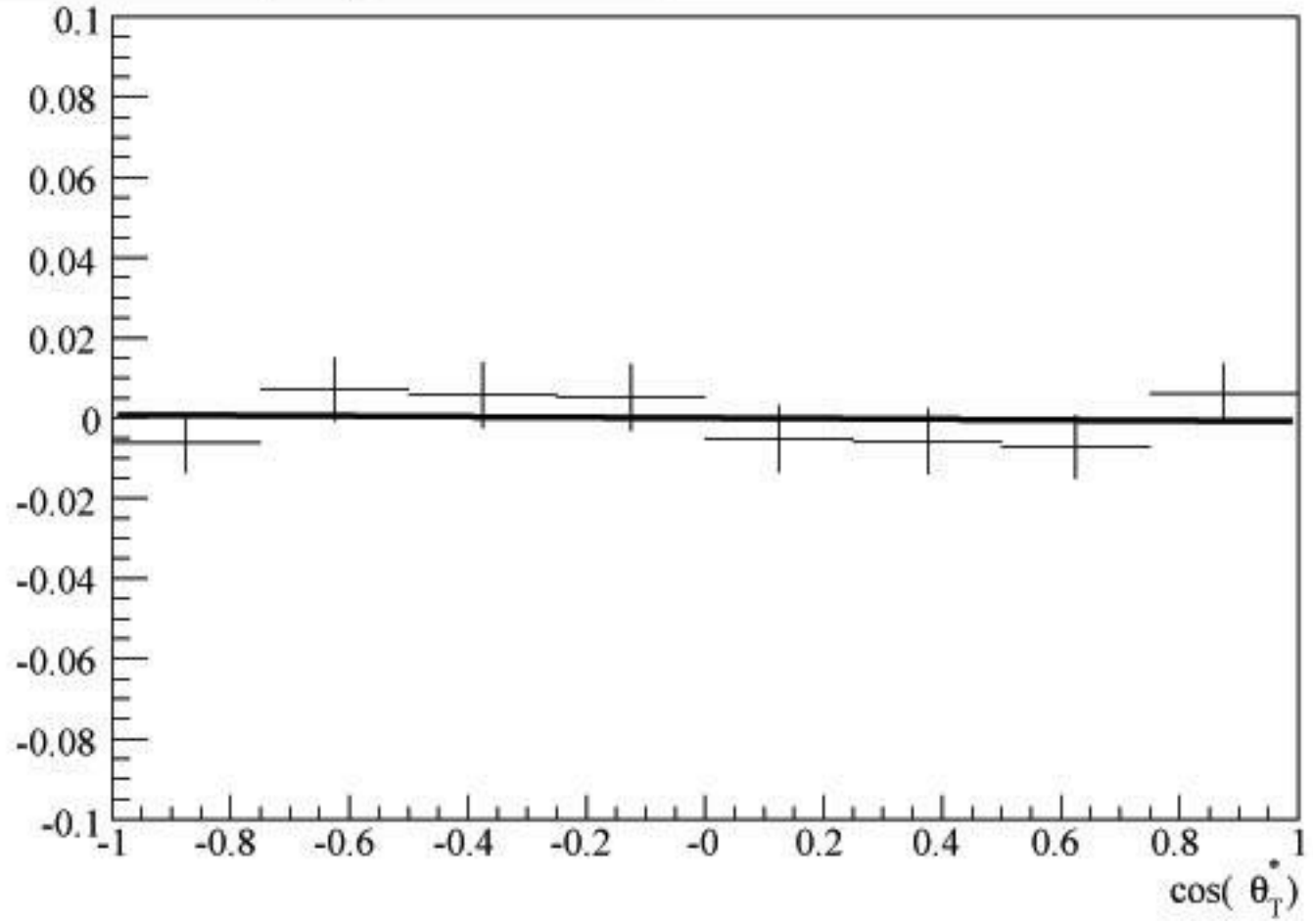- $\delta < 10$ mrad

optimized using MC simulation

The data set contains only events with at least one Λ in the final state.

Corrected cos(θ_T^*) distribution

WORK DONE:

- Installation and management of the grid farm on the Torino site

- Development of the software for job running control and remote installation on GRID resources

- Setup and test of the COMPASS software on the grid farm

- Test of the simulation and analysis codes with the longitudinally polarized data

- Production of 10^8 events of unpolarized SIDIS Λ events with transversely polarized target configuration

- Analysis of MC samples with the COMPASS code

- Comparison with real data