CSN4 2005

Andrea Romanino
SISSA & INFN
FTE 05

Total = 714

"Young" = 35%

INFN: 4% to 38%
Triennial Evaluation of Italian Research

* Evaluation of scientific performance of research structures (MIUR planning and resource distribution)
* Evaluation period: 01-03; data produced in 04; evaluation in 05; results 01/06
* CSN4: 96/100
  - best in INFN
  - best when compared with mega structures (physics)
  - best when compared with large structures = largest universities (physics)
The results reinforce the conclusions of the CSN4 GLV on 2001-2003

* 2005 update on CSN4 productivity
  * (CSN4 ISI papers)/FTE = 1.55
  * Papers 2005: 1104 CSN4 out of 2135 INFN: > 50%
  * (CSN4 authors)/(all authors) = 0.54
  * Scientific events organized: 46 CSN4 out of 120 INFN: 38%
  * Presentations at international conferences: 606 CSN4 out of 1509 INFN: 40%
  * CERN: ~2 papers/FTE/year (only research, visitor program)

* Quality (2001-2003):
  * the paper selected for the VTR (110 out of about 2400) all turned out to be among the 10 top cited in their field

* More evaluations: the IS’s are evaluated every 3 years by anonymous international referees, which affects the distribution of resources
Training

- INFN 05: 623 “Laurea” theses; 201 PhD theses. INFN/(tot. physics) 04:
  - Laurea: 509/1725 = 30%
  - PhD: 164/313 > 50%
- CSN4 contribution CSN4/INFN (04)
  - Laurea: 195/509 = 38%
  - PhD: 83/164 = 50%
- Jobs CSN4/INFN (05): 6/50 = 12% (FTE ratio: 26%)
- INFN schools: 8 out of 14 have TH participation
- Support for participation to GGI
- Sergio Fubini’s prize to best 3 PhD TH theses
  - 2005: Paolo Creminelli (PP), Pierpaolo Mastrolia (PP), Laura Tamassia (S&FT)
  - 2006: Cristian Bisconti (NP), Cecilia Tarantino (PP), Giovanni Villadoro (PP)
The postdoc market

Opening 2005 for 6 non-permanent researcher positions; analysis on the 31 ‘idonei’ (120 applicants)

J.E. Hirsch, [physics/0508025]
Internationalization

- Estimate of the research budget allocated for international collaborations: 50% (missions + invitations + ½ seminars)
- In particular: 300 month*person foreign researchers visiting every year (10% of the budget)
- 60% of papers have at least 1 foreign affiliation
- Collaboration agreements with ITEP, JINR, IHEP-Dubna (Russia), CYCIT (Spain), CTP-MIT (USA), ICTP, ECT-Trento, MIT (including exchange of senior and young scientists, graduate training)
- APE project: DESY & NIC (Zeuthen) + Univ: Beaulieu (Rennes), Paris-Sud (Orsay), Blaise Pascal (Clermont)
Research projects (IS’s)

Are grouped in scientific Sectors:

<table>
<thead>
<tr>
<th>Sector</th>
<th>IS 2005</th>
<th>IS 2006</th>
<th>Fate</th>
</tr>
</thead>
<tbody>
<tr>
<td>String and Field Theory</td>
<td>20</td>
<td>12</td>
<td>$7 \rightarrow$ Stat Phys, 1</td>
</tr>
<tr>
<td>Particle Phenomenology</td>
<td>17</td>
<td>13</td>
<td>3 eaten up, 1</td>
</tr>
<tr>
<td>Nuclear Physics</td>
<td>12</td>
<td>11</td>
<td>1 evolved, 1</td>
</tr>
<tr>
<td>Mathematical Methods</td>
<td>10</td>
<td>7</td>
<td>$2 \rightarrow$ Stat Phys, 1</td>
</tr>
<tr>
<td>Astroparticle &amp; Cosmology</td>
<td>5</td>
<td>5</td>
<td>3 new in past years</td>
</tr>
<tr>
<td>Statistical Field Theory</td>
<td>-</td>
<td>9</td>
<td>Rib of S&amp;FT (and MM)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>64</strong></td>
<td><strong>57</strong></td>
<td><strong>4 &amp;, 3 eaten up, 1 evolved</strong></td>
</tr>
</tbody>
</table>

FTE 05 in the scientific Sectors

FTE 2005

String and Field Theory
Particle Phenomenology
Nuclear Physics
Mathematical Methods
Astroparticle & Cosmology
Statistical Field Theory

INFN
university
postdoc
PhD students

220 130 96 85 90 94
VTR of scientific areas

% of FTE  % of Papers  Rating

String and Field Theory  Particle Phenomenology  Nuclear Physics  Mathematical Methods  Astroparticle & Cosmology  Statistical Field Theory
String and Field Theory

* Strings and string-inspired QFT models
  - D-branes, flux compactifications, higher spins...
* String-gauge duality
  - AdS/CFT, duals of non-conformal, non-SUSY theories
* Cosmological applications
  - pre big-bang cosmology, string-inspired inflationary models
* General relativity
  - quantum gravity, black holes
* NP dynamics of gauge theory
  - instantons, confinement, dynamical symmetry breaking, FT in NC space-time
* Lattice studies of NP dynamics
  - QCD vacuum, QCD @ high T or ρ
A few highlights

* String compactification with fluxes
  - understanding geometry of CY spaces with fluxes [MI, RM2, LNF, TO]

* BH entropy and topological strings
  - checks of conjecture and study of implications [PR, TO, LNF]

* Dynamical supersymmetry breaking in string theory and AdS/CFT [TS, MI]
  - CFT: conformal and too supersymmetric
  - combine fractional D3-branes and a new type of CY: dynamical SUSY breaking in non conformal theory

* compelling spontaneous supersymmetry breaking mechanism in string theory and implications for low energy supersymmetry
Particle Phenomenology

* **LHC**: particle physics at the verge of a revolution? Prominent role of INFN TH in paving the way to the LHC era
  - taking full advantage of experimental constraints to investigate LHC scenarios
  - making the interpretation of LHC results possible
  (both necessary, see also MCWS)

**Research lines**

* **SM and Beyond**
  - Scenarios for LHC (and beyond). Origin and stability of the EW scale
    - Supersymmetry
    - Models with (accessible) extra-dimensions
    - Strong interactions at the multi-TeV scale
    - Implications of LEP and Tevatron physics (PTs, mass bounds, light Higgs)
  - EW effects at colliders and other corrections (H, t, g-2...)
Flavour Physics

- Lepton masses and mixings
- Quark masses and mixings
  - Origin of mass and mixing pattern
  - Indirect NP effects

http://www.utfit.org/
Flavour Physics

- Lepton masses and mixings
- Quark masses and mixings
  - Origin of mass and mixing pattern
  - Indirect NP effects
  Lattice, EFT (ChPT, Heavy Quark, EW) crucial
- CP, T, Li violation, rare decays
- Flavour effects at and constraints from the LHC
QCD

- Perturbative QCD at colliders
  - Higher order corrections (H, t, W, Z)
  - Resummation (Heavy Flavours, Higgs Production, multi-jets,...)

- Montecarlo simulations (LHC, Tevatron, HERA)
  - NLO and multileg matching
  - HERWIG, MC@NLO, CKKW, ALPGEN, validation

- EFT methods for heavy flavour decays (Daphne, Babar, Belle)

- Lattice
  - Quark masses
  - Decay constants and matrix elements
  - Finite T QCD
  - Other NP physics (QCD vacuum, chiral lagrangian, NP symmetry breaking)
Nuclear Physics

- **Nuclear structure**
  - Exotic nuclei, systems with few nucleons
  - EoS of nuclear matter, neutron stars, superfluid pulsars
  - Collective excitations in multi-fermion systems

- **Nuclear reactions**
  - Giant resonance excitations, isotopic spin effects in liquid-vapor transitions
  - Effective lagrangians, transport equations
  - EW probes of nuclei

- **Quark-gluon plasma and heavy ions**
  - Testing deconfinement at SpS, RHIC, LHC (Alice)
  - $T$-$\mu$ phase diagram (lattice QCD, EFT)
The QCD phase diagram

Strangeness enhancement, Charm suppression, Jet quenching
Hadronization models (exotic diquark-antidiquark states)
Deconfinement and chiral symmetry restoration (LQCD, EFT)

QGP (SPS, RHIC, ALICE)

~150 MeV

~10 MeV

1 GeV

Nuclear Matter

Hadronic Matter

Astrophysics

Color Superconductivity
Gravitational waves
Glitches
Astroparticle and Cosmology

- **Neutrino physics**
  - oscillation physics and $0\nu2\beta$ decay
  - cosmology and astrophysics
- **Dark matter and dark energy**
  - models and signals
- **Early universe**
  - inflation, CMB, baryogenesis, BBN, LSS
  - brane cosmology, extra-dimensions
- **UHE cosmic rays, high energy neutrinos, $\gamma$-ray bursts**
- **Nuclear astrophysics**
- **Cosmological and astrophysical sources of gravitational waves**
Mathematical Methods

* Foundations of quantum mechanics and applications
  - entanglement and quantum information
  - interpretation
* Non commutative geometry and quantum groups
* Integrable models
* Non linear dynamics
* Constrained systems
Statistical Field Theory

TH particle physics methods applied to statistical mechanics, biological systems

* Fundamental Physics
  - Integrable models and low dimensional systems
    - e.g.: Ising model with CFT & integrable systems methods: spectra and widths of stable excitations
  - Complex and out of equilibrium systems
    - e.g.: disordered and frustrated systems also with large N, MC methods, and lattice simulations (APE)

* Applied physics
  - Quantitative biology (with biologists, physicians, chemists, APE)
  - Turbolence (APE)
  - Strongly correlated systems
APE

* apeNEXT installation completed: 13 towers in RM1, 10 TFlops overall: x10
* CSN4 involved in software and hardware: an expertise asset for INFN
* International collaborations: INFN + DESY & NIC (Zeuthen) + Univ: Beaulieu (Rennes), Paris-Sud (Orsay), Blaise Pascal (Clermont)
* Architecture adopted e.g. by IBM Blue Gene
* Collaboration with high tech industry; in general: excellent (VTR) example of technology transfer
* Applications (BA, FE, LNF, LNGS, MIB, PR, PI, RM1 23):
  - Lattice Gauge Theory (SM & Beyond, NP aspects of GT, QCD @ high T or ρ)
  - Statistical Field Theory and complex systems
  - Turbulence
  - Quantitative biology
**Use of APE: Lattice 04**

- apeNET
  - fast PC interconnection
  - completed (16 PC cluster in RM2)
  - commercial applications (PC clusters)

**Next?**

- Hadron spectroscopy
- Weak Matrix Elements
- Heavy quark physics
- Finite T and density
- Colour confinement
Organizes and hosts TH particle physics (in a broad sense) workshops (unique in Europe)

- 2-3 2-3 month workshops/year
- ~20 high profile participants at any time, stay 3 weeks or more
- Additional CSN4 support for shorter participation of young researchers (‘days-person’)
- Workshop cost: ~50k€/month (~5 months in 2006, ~7 months in 2007)

Oct 2004: Agreement between INFN and Florence University
Dec 2004: Report of Launching Committee
Feb 2005: Advisory and Scientific Committee appointed
Feb 2005: Call for workshop proposals
Apr 2005: Selection of the 2006 workshops:
  - New directions BSM in Field and String Theory (2/5-30/6)
  - Astroparticle and Cosmology (28/08-11/11)
Sep 2005: GGI inaugural conference
Sep 2005: Selection of the 2007 workshops
  - High Density QCD (15/01-9/03)
  - String and M Theory Approaches to Particle Physics and Cosmology (19/03-22/06)
  - Advancing Collider Physics: from Twistor to Monte Carlos (27/08-26/10)
May 2006: First workshop
Sep 2006: Selection of the 2008 workshops
New directions BSM in Field and String Theory

- **Statistics**
  - 9 weeks (2/5-30/6), 73 selected participants + 4 + 6 (~150 apps)
  - 77 = 37 Europe + 35 North America + 5 Others (25% Italians)
  - Average stay: 19 days

- **High scientific and organizational standards**
  - Participants
  - Seminars + colloquia + joint conference with Johns Hopkins Workshop (30th)
  - Stimulating scientific atmosphere, (very!) lively discussions
  - Positive feedback from the participants (come-backs), papers are being produced

- **Benefits for Italian theoretical physics:**
  - Top level international implant in the fertile Italian context
  - Participants from TO, LNGS, RM1, RM2, TS, FI, MIB, PD, PI, LE, SA
  - Other Italian activities of participants

- **Minor issue:** reimbursements (Italians)
- 3-4 short workshops in 2006- in preparation for LHC (27-28/02, 22-24/06, 23-25/10)
- A framework for integration (including pedagogical efforts) and interactions of
  - Theorists interested in LHC physics (Montecarlo + Models)
  - Experimentalists (mostly ATLAS + CMS)

Taking advantage of the vast experience of the Italian MC community (COJET, HERWIG, MC@NLO, CKKW, ALPGEN, ...) and the traditional attention paid by the Italian BSM community to the experiment

- Test of Models for LHC physics involve:
  - prediction for production cross section of new particles and their decays into SM particles ($\tau < t_{\text{had}}$)
  - fragmentation, hadronization, more decays ($\tau > t_{\text{had}}$)
  - trigger and signals in the detector
  - comparison with SM background
Topics:

- **Shower MC**: development, interface with tree level and NLO calculations
- **Matrix elements**: automatic computation of complex microscopic amplitudes (multilegs, loops)
- **BSM**: Signals and BKGS
- **Experimental studies**: detector simulations and calibration with SM physics

Stimulates

- interactions over the whole range of expertise (string-experimentalist!)
- the MC community to implement a variety of options currently studied by the BSM community in their codes
- the BSM community to focus on signatures
Summary

* Research (spectrum and leadership)
* Evaluation
* People: 35% fixed-term (15% INFN, 50% university staff)
* Training, young researchers, jobs and postdoc market
* Internationalization

* Developments
  * RM31 and Alice
  * GGI
  * MCWS
  * APE next?