The HadronPhysic2 Project

- Coordinator: INFN, Italy
- Project Coordinator: Carlo Guaraldo (INFN-LNF)
- Consortium: 46 European Organizations
- Other involved Institutions: 103
- Involved researchers: more than 2,500
- Involved Countries: 36
- EC requested contribution: 10 M€
- Contract duration: 36 months
NETWORKING ACTIVITIES (8) and MANAGEMENT

TRANSNATIONAL ACCESS ACTIVITIES (5)

JOINT RESEARCH ACTIVITIES (14)
COMPLETE PRESENTATIONS OF EACH WP CAN BE FOUND AT:

HTTP://HADRONPHYSICS2.EU/COLLABORATION-COMMITTEE-MEETING.HTML
QCDnet: Hadron physics in non-perturbative QCD

TORIC: Theory of Relativistic Heavy Ion Collisions
WP4 – QCDnet
Hadron physics in non-perturbative QCD
Ulf-G. Meißen, Univ. Bonn & FZ Jülich

www.itkp.uni-bonn.de/~QCDnet/
NETWORK PROJECTS

- 4 main research areas w/ specific tasks (deliverables)

**Hadron dynamics with light quarks**
Chiral symmetry and hadron properties, structure and dynamics of mesons, structure and dynamics of baryons, hadronic molecules and exotic states, quark model studies of hadrons, hadron-hadron interactions, GPDs, ...

**Hadron dynamics with heavy quarks**
Strong interaction corrections to weak decays, charm quark physics, bottom quark physics, final-state interactions and light quark dynamics, from strong to perturbative QCD

**Hadrons in nuclei**
Precision calculations for few-nucleon systems, hypernuclear physics, hadrons with charm quarks, medium modifications of hadrons in nuclei, meson production off nuclei, hadronic atoms and fundamental interactions

**EFT methods for continuum and discrete QCD**
Combining chiral perturbation theory with dispersion relations, unitary extensions of CHPT, chiral extrapolations for hadron properties and interactions, finite volume effects and hadron resonances, RG methods in hadronic systems
**PrimeNet**: Meson Physics in Low-Energy QCD

**FAIRnet**: A world-wide research networking activity for experiments on QCD at FAIR

**ReteQuarkonii**: Testing phases and non-perturbative features of QCD with quarkonium production
WP5 PrimeNet: Status

Andrzej Kupsc
Uppsala University

Main objective: Coordinate activities and exchange information from experiments, overlapping interests in light quark meson physics. Focus on $\eta - \eta'$ system.

Facilities for meson studies ($M \geq 1$ GeV):

- Crystal Ball, MAMI-C, Mainz ($\gamma N$)
- Crystal Barrel, ELSA, Bonn ($\gamma N$)
- KLOE-2, Daφne, Frascati ($e^+e^-$)
- WASA, COSY, Jülich ($pp, pd$)
FAIRnet

A worldwide research networking activity for experiments on QCD at FAIR

Paola Gianotti
FAIRnet activity

FAIRnet is a worldwide research network for experimental investigations at FAIR

It includes the scientists of the two biggest experiments foreseen at FAIR:

• Compressed Barionic Matter experiment CBM

• AntiProton ANnihilation At DArmstadt PANDA
Significant reports:

- PANDA first Technical Design Reports (TDR) for a few sub-detectors:
  - Electromagnetic Calorimeter (EMC) issued (arXiv:0810.1216v1)
  - Superconducting Solenoid and forward Dipole issued (arxiv:0907.0169)
  - The Computing Model of PANDA (http://panda-wiki.gsi.de/pub/Computing/PandaRootComputingModelBrainStorm/panda_cm.pdf)

**SPHERE:** Strange Particles in Hadronic Environment Research in Europe

**LEANNIS:** Low-Energy Antikaon-Nucleon and -Nucleus Interaction Studies
Low Energy Antikaon Nucleon Nucleus Interaction Studies
Some highlights ...

Kaonic helium-4 X-ray measurement in SIDDHARTA

SIDDHARTA Collaboration

M. Bazzi\textsuperscript{a,} G. Beer\textsuperscript{b,} L. Bombelli\textsuperscript{c,} A.M. Bragadireanu\textsuperscript{a,} M. Cargnelli\textsuperscript{d,} G. Corradi\textsuperscript{e,} C. Curceanu (Petrascu)\textsuperscript{a,} A. d'Uffizi\textsuperscript{a,} C. Fiorini\textsuperscript{e,} T. Frizzi\textsuperscript{e,} F. Ghiò\textsuperscript{b,} B. Girolami\textsuperscript{f,} C. Guaraldo\textsuperscript{a,} R.S. Hayano\textsuperscript{g,} M. Iliescu\textsuperscript{a,} T. Ishiwatari\textsuperscript{h,} M. Iwasaki\textsuperscript{b,} P. Kienle\textsuperscript{a,} P. Levi Sandri\textsuperscript{a,} A. Longoni\textsuperscript{c,} V. Lucherini\textsuperscript{a,} J. Marton\textsuperscript{e,} S. Okada\textsuperscript{a,} D. Piret\textsuperscript{a,} T. Ponta\textsuperscript{d,} A. Rizzo\textsuperscript{a,} A. Romero Vidal\textsuperscript{a,} A. Scordia\textsuperscript{a,} H. Shi\textsuperscript{g,} D.L. Sirghi\textsuperscript{a,} F. Sirghi\textsuperscript{a,} H. Tatsuno\textsuperscript{g,} V. Tudorache\textsuperscript{d,} A. Tudorache\textsuperscript{d,} O. Vazquez Doce\textsuperscript{a,} E. Widmann\textsuperscript{c,} J. Zmeskal\textsuperscript{c,}

\textsuperscript{a} INFN, Laboratori Nazionali di Frascati, Frascati (Roma), Italy
\textsuperscript{b} Dip.
\textsuperscript{c} Elettronica, University of Brescia, Brescia, Italy
\textsuperscript{d} INFN, Laboratori Nazionali di Frascati, Frascati (Roma), Italy
\textsuperscript{e} INFN, INFN, Laboratori Nazionali di Frascati, Frascati (Roma), Italy
\textsuperscript{f} INFN, INFN, Laboratori Nazionali di Frascati, Frascati (Roma), Italy
\textsuperscript{g} INFN, INFN, Laboratori Nazionali di Frascati, Frascati (Roma), Italy
\textsuperscript{h} INFN, INFN, Laboratori Nazionali di Frascati, Frascati (Roma), Italy
\textsuperscript{i} INFN, INFN, Laboratori Nazionali di Frascati, Frascati (Roma), Italy
\textsuperscript{j} INFN, INFN, Laboratori Nazionali di Frascati, Frascati (Roma), Italy
\textsuperscript{k} INFN, INFN, Laboratori Nazionali di Frascati, Frascati (Roma), Italy

\[ \epsilon_{2p}^{K^4He} = 0 \pm 6 \text{ (stat.)} \pm 2 \text{ (syst.) eV} \]
Indication for kaonic nuclear cluster $K^- pp$ in the $pp$ reaction at 2.85 GeV

$B_X = 103 \pm 3$ (stat.) $\pm 5$ (syst.) MeV

$\Gamma_X = 118 \pm 8$ (stat.) $\pm 10$ (syst.) MeV
TMDnet: Mapping out the Transverse Structure of the Nucleon
WP10: Transnational Access to ECT* in the Period 01/01/09 – 30/06/10 and an Outlook upon HadronPhysics3

What is ECT*?
European Centre for Theoretical Studies

in Nuclear Physics…

Nuclear physics in a broad sense
(low energy nuclear physics and nuclear structure, quantum chromodynamics and hadron physics, physics of matter under extreme conditions and ultrarelativistic heavy ion collisions)

and Related Areas

Which includes topics in

- Astrophysics
- Particle physics
- Condensed matter physics
- Many-body theory, quantum field theory
- Bose-Einstein condensation

ECT* has been established in 1993 and is unique in Europe. It is similar in scope and mission to the INT in Seattle, USA
<table>
<thead>
<tr>
<th>DATE</th>
<th>TITLE</th>
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<tr>
<td>02/03/09</td>
<td>Sign Problems and Complex Actions</td>
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<tr>
<td>25/05/09</td>
<td>Heavy Quarkonia Production in Heavy-Ion Collisions</td>
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<tr>
<td>01/06/09</td>
<td>The 5th International Pion-Nucleon PWA Workshop and Interpretation of Baryon Resonances</td>
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<tr>
<td>20/07/09</td>
<td>Recent Advances in Perturbative QCD and Hadronic Physics</td>
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<td>07/09/09</td>
<td>QCD Green’s Functions, Confinement, and Phenomenology</td>
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<td>14/09/09</td>
<td>Flow and Dissipation in Ultrarelativistic Heavy Ion Collisions</td>
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<tr>
<td>12/10/09</td>
<td>Hadronic Atoms and Kaonic Nuclei - Solved Puzzles, Open Problems and Future Challenges in Theory and Experiment</td>
</tr>
<tr>
<td>19/10/09</td>
<td>Relativistic Description of Two- and Three-body Systems in Nuclear Physics</td>
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<td>26/10/09</td>
<td>Electroweak Interactions with Nuclei: Superscaling and Connections Between Electron and Neutrino Scattering</td>
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<td>09/11/09</td>
<td>Orbital Angular Momentum of Partons in Hadrons</td>
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<td>DATE</td>
<td>TITLE</td>
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<td>Diffractive and Electromagnetic Processes at the LHC</td>
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<tr>
<td>21/06/10</td>
<td>Workshop on Transverse Momentum Distribution</td>
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<tr>
<td>05/07/10</td>
<td>Confining Flux Tubes and Strings</td>
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<tr>
<td>19/07/10</td>
<td>Chiral Symmetry and Confinement in Cold, Dense Quark Matter</td>
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<td>02/08/10</td>
<td>QCD from the Bound States’ Perspective</td>
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<td>13/09/10</td>
<td>Electromagnetic Probes of Strong Interacting Matter: Status and Future of Low-Mass Lepton-Pair Spectroscopy</td>
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<td>27/09/10</td>
<td>QCD at LHC</td>
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<td>04/10/10</td>
<td>Strangeness in Nuclei</td>
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<td>11/10/10</td>
<td>Hard Meson and Photon Production</td>
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<td>08/11/10</td>
<td>Precision Tests of the Standard Model: from Atomic Parity Violation to Parity-Violating Lepton Scattering</td>
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<td>15/11/10</td>
<td>Searches for CP- and T-Violation in Atoms and Nuclei</td>
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<tr>
<td>22/11/10</td>
<td>Hadron-Hadron and Cosmic Rays Collisions at multi-TeV Energies</td>
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## Transnational Access activity to ECT* (January 2009 – June 2010)

<table>
<thead>
<tr>
<th>User-project acronym</th>
<th>Users</th>
<th>Number of days spent at the infrastructure</th>
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<td>02AARTS09</td>
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<td>04BLASCHKE09</td>
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<td>05GIANNINI09</td>
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<td>06WALKER09</td>
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<td>07ROTH09</td>
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<td>37</td>
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<tr>
<td>08BELITSKY09</td>
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<td>09BROWN09</td>
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<td>47</td>
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<td>10HOROWITZ09</td>
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<td>11BINOSI09</td>
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<td>12GREINER09</td>
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<td>36</td>
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<td>13RUBIO09</td>
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<td>26</td>
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<td>14CURCEANU09</td>
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<td>29</td>
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<tr>
<td>15SALME09</td>
<td>7</td>
<td>33</td>
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<td>12</td>
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<td>18BURKARDE09</td>
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<td>18</td>
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<td>01SCHICKER10</td>
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<td>02VAAGEN10</td>
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<td>03DICKHOF10</td>
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<td>37</td>
</tr>
<tr>
<td>04CARUSOTTO10</td>
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<td>06DIAZ-TORRES10</td>
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<td>70</td>
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<td>07BACCHETTA10</td>
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<td>40</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>n. 22 User-Projects</strong></td>
<td><strong>181</strong></td>
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</tbody>
</table>
• UMainz-MAMI
WP11: Transnational Access to MAMI

Hans-Jürgen Arends
Mainz University

Collaboration Committee Meeting

Paris, Sept. 16-17, 2010
A2 Crystal Ball/TAPS Detector

self-triggering hermetic photon spectrometer

Crystal Ball: 672 NaI Scintillators

PID and tracking:
24 plastic scintillators + MWPCs

TAPS:
384 BaF$_2$
72 PbWO$_4$
A2 Crystal Ball/TAPS Detector

Mainz/Dubna frozen-spin target

Glasgow Tagging Spectrometer
Transnational Access activity to MAMI (January 2009 – June 2010)

<table>
<thead>
<tr>
<th>User-project acronym</th>
<th>Users</th>
<th>Number of days spent at the infrastructure</th>
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<tbody>
<tr>
<td>MAMI_A2_PSPIN</td>
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</tr>
<tr>
<td>MAMI_A2_ETAPRIME</td>
<td>12</td>
<td>197</td>
</tr>
<tr>
<td>MAMI_A2_NRECOIL</td>
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<td>98</td>
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<tr>
<td>MAMI_A2_NGDH</td>
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<td>124</td>
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<tr>
<td>MAMI_A2_FROZENSPIN</td>
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<td>231</td>
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<tr>
<td>MAMI_A1_ROPER</td>
<td>2</td>
<td>71</td>
</tr>
<tr>
<td>MAMI_A1_SITRIPLE</td>
<td>4</td>
<td>188</td>
</tr>
<tr>
<td>MAMI_A4_SSA</td>
<td>6</td>
<td>194</td>
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<tr>
<td>MAMI_B1_CSHAPE</td>
<td>3</td>
<td>12</td>
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<tr>
<td><strong>TOTAL n. 9 User-Projects</strong></td>
<td><strong>53</strong></td>
<td><strong>1893</strong></td>
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HADRONIC PROBES

• FZJ - COSY
• GSI
• INFN – LNF
HadronPhysics2
MidTerm review

WP13
Transnational Access to COSY-Jülich

Dieter Grzonka
WP13
Transnational access to COSY-Jülich

proton, deuteron:
$P \leq 3.7$ GeV/c
ANKE

TOF

WASA

Superconducting Solenoid Control Dewar Pellet Target Generator

Central Detector Forward Detector

PAX: preparation of polarized antiproton beams by spin filtering

EDM: measurement of the electric dipole moments of the deuteron
Transnational Access activity to COSY (January 2009 – June 2010)

<table>
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<tr>
<th>User-project acronym</th>
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<td>dEDM-pol</td>
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<td>155</td>
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<tr>
<td>eta-He-bs</td>
<td>4</td>
<td>92</td>
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<tr>
<td>pd-eta-decay</td>
<td>22</td>
<td>308</td>
</tr>
<tr>
<td>pp-eta-decay</td>
<td>16</td>
<td>268</td>
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<tr>
<td>pp-pi0-decay</td>
<td>11</td>
<td>85</td>
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<td><strong>TOTAL</strong></td>
<td><strong>66</strong></td>
<td><strong>908</strong></td>
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HadronPhysics 2

WP12: Transnational Access to GSI

Spokespersons: K.D. Groß, K. Füssel

Collaboration Meeting, Paris, September 16-17, 2010
<table>
<thead>
<tr>
<th>Accelerator</th>
<th>Ions</th>
<th>Energy Range</th>
</tr>
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<tbody>
<tr>
<td>UNILAC</td>
<td>p to U</td>
<td>11.4 AMeV</td>
</tr>
<tr>
<td>SIS</td>
<td>p to U</td>
<td>10-4500 AMeV</td>
</tr>
<tr>
<td>ESR</td>
<td>p to U</td>
<td>up to 560 AMeV (for U)</td>
</tr>
<tr>
<td>PHELIX laser</td>
<td>laser beam</td>
<td>high-energy, high power laser system</td>
</tr>
</tbody>
</table>
Unique equipment

- **HADES** spectrometer (to study properties of vector mesons in nuclear matter)

- 4π detector **FOPI** (to study properties of compressed heated and highly excited nuclear matter)

- Secondary beam facility for **pion beams** (to study field of medium-energy hadron physics; supported within a TMR-RTD project)

- **Detector test facility** with mixed electron, proton and pion beams (used e.g. by CBM and PANDA)

- high-intensity upgrade up to the SIS space charge limit (e.g. for $^{238}\text{U}^{26+}$: $2 \times 10^{10}$ ions/burst)
Di-electron production in nucleus-nucleus collisions at SIS/GSI

ToF Upgrade with RPCs:
- time resolution: $\sigma_{\text{average}} \leq 78$ ps
- position resolution: $\sigma_{\text{average}} \leq 7.8$ mm
- efficiency: $\varepsilon \sim 97\%$
# Transnational Access activity to GSI (January 2009 – June 2010)

<table>
<thead>
<tr>
<th>User-project acronym</th>
<th>Users</th>
<th>Number of days spent at the infrastructure</th>
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<tbody>
<tr>
<td>CARAT/Morse</td>
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<tr>
<td>Cluster/Macri</td>
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<tr>
<td>DielecPro/Kugler</td>
<td>14</td>
<td>215</td>
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<tr>
<td>ElipFlow/Russott</td>
<td>16</td>
<td>152</td>
</tr>
<tr>
<td>Kaon/Marton</td>
<td>4</td>
<td>28</td>
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<tr>
<td>KaonClust/Marton</td>
<td>5</td>
<td>86</td>
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<tr>
<td>KaonClust/Matulew</td>
<td>11</td>
<td>149</td>
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<tr>
<td>Strange/Matulewicz</td>
<td>7</td>
<td>68</td>
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<td><strong>TOTAL n. 8 User-Projects</strong></td>
<td><strong>66</strong></td>
<td><strong>730</strong></td>
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WP14 – Transnational Access to INFN-LNF

Carlo Guaraldo

Collaboration Committee Meeting

CNRS, 16-17 September 2010
**Hadronic contribution to muon g-2**

Discrepancy between $a_{\mu}^{SM}$ and $a_{\mu}^{EXP}$ at 3.2$\sigma$ level

New KLOE analysis, with different selection criteria, confirms KLOE08

**Fractional difference:**

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Value (GeV$^2$)</th>
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<tbody>
<tr>
<td>DEHZ03 ($\tau$ based)</td>
<td>195.6±6.5</td>
</tr>
<tr>
<td>DEHZ03 ($e^+e^-$ based)</td>
<td>180.9±8.0</td>
</tr>
<tr>
<td>DEHZ06 ($e^+e^-$ based)</td>
<td>180.5±5.6</td>
</tr>
<tr>
<td>HMNT06 ($e^+e^-$ based)</td>
<td>180.4±5.1</td>
</tr>
<tr>
<td>JEG06 ($e^+e^-$ based)</td>
<td>180.8±7.2</td>
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<tr>
<td>JEG08 (inc KLOE08)</td>
<td>179±9.5</td>
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<tr>
<td>DHMYZ09 (inc BaBar)</td>
<td>193±4.9</td>
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<tr>
<td>DHMYZ09 ($\tau$ based)</td>
<td>193.2±5.2</td>
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**Band:** KLOE09 error
SIDDHARTA SETUP on upgraded DAFNE
Kaonic Helium 4 spectrum

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<tr>
<th>transition</th>
<th>e.m. energy</th>
<th>events</th>
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<td>(3-2)</td>
<td>6.464</td>
<td>1047 ± 37</td>
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<tr>
<td>(4-2)</td>
<td>8.722</td>
<td>154 ± 21</td>
</tr>
<tr>
<td>(5-2)</td>
<td>9.767</td>
<td>91.8 ± 19</td>
</tr>
<tr>
<td>(6-2)</td>
<td>10.333</td>
<td>82.4 ± 25</td>
</tr>
<tr>
<td>higher</td>
<td>&lt; 11.63</td>
<td>131 ± 41</td>
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shift => ± 2.9 eV (stat.)
<table>
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<th>User-project acronym</th>
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<td>KLOE HADRONS</td>
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<td>C-SHAPE</td>
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<td>AMADEUS R&amp;D</td>
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<td>RICCE</td>
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<td>DECOHERENCE AT KLOE-2</td>
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<td>SMI-KN</td>
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<td>96</td>
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<td>ETA, ETA' AT KLOE-2</td>
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<tr>
<td>HAND-SDD&amp;SiPM</td>
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<td>RICCE2</td>
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<td>TOTAL n. 11 User-Projects</td>
<td>55</td>
<td>1360</td>
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Joint Research Activities
**CARAT**: Characterization of Advanced Diamond for Particle Detection

**FPCC**: Frontier Photon detectors for Cherenkov Counters

**FutureGas**: Detector and electronics development for large-area low-mass self-triggered gaseous detectors

**DIRCs**: Development of fast, compact Cherenkov counters based on the Detection of Internally Reflected Cherenkov light

**SciFi**: Frontier scintillation detectors: inorganic scintillating fibers and performance control
CARAT

Advanced Diamond Detectors

Elèni Berdermann,
GSI Helmholtz Zentrum für Schwerionenforschung

HP2 CC, Paris Sep 2010
ENGINEERING OF DIA-on-IR MATERIALS (UA)

Heteroepitaxial ‘single crystal’ diamond growth and post-processing

The best way

1) IRIDIUM ELECTRODE (growth side polished)
   - Dia
   - Ir
   - YSZ
   - Si

2) FREESTANDING (both sides polished)
   - Dia
   - Ir
   - YSZ

3) MULTIPLE IRIDIUM ELECTRODES
   - Dia
   - Ir

Dol 724b, d = 12 μm; Multilayer detectors
SUMMARY and CONCLUSIONS

- Dia-on-Ir material: significantly improved
  - further reduction of dislocations density desirable
- CCE: from 28% to ≈ 90% (CS tests)
- ΔE/E: from 30% to ≈ 4% (α-resolution)
- FEE (BB)
  - new amplifier developments have been started
- Δt/t; σi ≈ 25ps (HIs, A = 40)

THIS IS THE WAY TO LARGE-AREA DIAMOND DETECTORS OF QUASI SINGLE_CRYSTAL QUALITY!
Highlights of significant results

• design, construction and commissioning of radiators in bar geometry suitable for test

• development and initial testing of a combined time-of-flight and focusing scheme using dichroic mirrors for dispersion correction

• first test beam campaign was successfully completed ahead of schedule
The need for DIRCs

Barrel DIRC

Forward DIRC
Construction of Radiator Disc
Dispersion Correction
Workshop on Fast Cherenkov Detectors
04 - 06 April 2011, University of Giessen

DIRC designs
Photon detection
Frontend electronics
Data acquisition
DIRC reconstruction
**HardEx**: Hard Exclusive Reactions

**JointGEM**: Ultra-light and ultra-large tracking systems based on GEM technology

**ULISI**: Ultra-light silicon tracking and vertex detection systems for frontier precision experiments

**JETCAL**: Electromagnetic Calorimeter for Jet Quenching Study

**SiPM**: Silicon Multiplier-Matrix Geiger-Mode Avalanche Micro-Pixel Photo Diodes for Frontier Detector Systems
WP23 HardEx

Hard Exclusive Reactions

Ralf Kaiser, University of Glasgow

Thursday, 16 September 2010
1. COMPASS Recoil Detector

2. CLAS Central Detector

3. PAX Target Region

4. Global Analysis of Hard Exclusive Reactions

5. Preparation of Future Experiments with PANDA
Present 1m long Recoil Proton Detector in COMPASS for the hadron program (spectroscopy)
CLAS12 Central Detector

Outer Detector Layers

Neutron Detector

Time-of-Flight Detector

Inner Detector Layers

Micromegas Tracker

Silicon Detector
WP24 Joint GEM
Ultra-light and ultra-large tracking systems based on GEM technology

HadronPhysics2
Collaboration Committee Meeting and Mid Term Review
16th – 17th September 2010
CNRS, Paris

Johann Zmeskal,
Stefan Meyer Institute for subatomic Physics
Vienna, Austria
Mid term report – WP24

Progress towards the objectives of WP24:

- **TPC GEM**
  high-rate TPC with GEM readout as planned for the inner tracker of PANDA at FAIR;

- **Cylindrical GEMs**
  multilayer self-supporting as foreseen for AMADEUS and KLOE2;

- **Large-area planar GEMs**
  capable of withstanding very high beam rates as envisaged for the forward tracking system of PANDA and for the muon system of CBM.
Proto ANtiproton DAarmstadt Experiment Overview

- **p Target**
- **Superconducting solenoid (2T) + iron return yoke**
- **Silicon Microvertex Detector**
- **Central Tracker**
  - Straw tubes
  - GEM-TPC
- **GEM-Tracker**
  - Planar GEM-DISCs
- **Target Spectrometer**
- **Forward Spectrometer**
- **~12 m**
KLOE2 IT- CGEM

Each CGEM is composed by five concentric cylindrical structures: each one realized with the "vacuum bag" technique.

Proto0.1: Ø=300mm, L=350mm; 1538 longitudinal strips only, 650 μm pitch.
SPINMAP: Spin Oriented Nuclei for Structure Mapping

PolAntiP: Polarized Antiprotons
Joint Research Activity

WP25: PolAntiP – Polarized Antiprotons

Work progress and achievements during the period

September 16, 2010

Frank Rathmann, spokesperson of the JRA

Collaboration Committee Meeting and Mid Term Review
CNRS, Paris, France
Progress and achievements

- How the electron spin-flip idea disappeared from the map
- Preparations for Spin-filtering at COSY
  - Development, implementation, and commissioning of the low-β section
  - Development and commissioning of an openable cell
  - Implementation and commissioning of the experimental setup
- Spin-filtering at COSY (and AD)
- Conclusion
Production of polarization in a stored beam

Two Methods: Loss versus spin flip

For an ensemble of spin $\frac{1}{2}$ particles with projections $+ \uparrow$ and $- \downarrow$

- **selective loss**: discard (one) substrate (more than the other)
- **selective flip**: reverse (one) substrate (more than the other)
No effect observed: measured cross sections at least 6 orders-of-magnitude smaller than predicted $10^{13}$ b.

Meanwhile, Mainz group discovered numerical problems in the calculation → two errata.
Polarization Buildup

The ep spin-flip experiment settled a long-standing controversy: Only nucleon-nucleon interaction contributes to polarization build-up.

\[ \sigma_{\text{tot}} = \sigma_0 + \sigma_1 \cdot \vec{P} \cdot \vec{Q} + \sigma_2 \cdot (\vec{P} \cdot \vec{k})(\vec{Q} \cdot \vec{k}) \]

- \( \sigma_{\text{tot}} \): Total cross-section
- \( \sigma_0 \): Background cross-section
- \( \sigma_1 \): Nucleon-nucleon interaction contribution
- \( \sigma_2 \): Additional contribution
- \( \vec{P} \): P beam polarization
- \( \vec{Q} \): Q target polarization
- \( k \parallel \): Beam direction

For initially equally populated spin states: \( \uparrow (m=+\frac{1}{2}) \) and \( \downarrow (m=-\frac{1}{2}) \)

**Transverse case:**

\[ \sigma_{\text{tot}^\pm} = \sigma_0 \pm \sigma_1 \cdot Q \]

**Longitudinal case:**

\[ \sigma_{\text{tot}^\pm} = \sigma_0 \pm (\sigma_1 + \sigma_2) \cdot Q \]

Unpolarized anti-p beam

Polarized target
Spin-filtering studies at COSY

**Main purpose:**
1. Commissioning of the experimental setup for AD
2. Quantitative understanding of the machine parameters

**Phases of COSY installation:**
1. July 2009: Installation of quadrupole magnets (✔)
2. July 2010: Installation of rest of equipment (✔)
3. After July 2010: Spin-filtering studies with protons
Experimental setup

- low-ß section
- Atomic Beam Source
- Breit-Rabi polarimeter
- Openable storage cell
- Si tracking telescopes
**FutureJet:** Cryogenic jets of nano- to micrometer-sized particles for hadron physics
WP19: FutureJet – Cryogenic Jets of Nano- and Micrometer-Sized Particles for Hadron Physics

HadronPhysics2: Collaboration Committee Meeting
CNRS Paris, 16th-17th September 2010

Institut für Kernphysik

Alfons Khoukaz
Cluster-Source at Münster

- scattering chamber
- cluster beam dump
- detection system (velocity/mass)
- cluster source behind the wall
- vacuum beam pipe
Pellet Tracking System at the Uppsala Pellet Station

Synchronized measurements in xz-plane

2d profile of the pellet beam

Cameras A&B

laser beam exit

X coordinate

Z coordinate
LatticeQCD: Lattice Quantum Chromo Dynamics
WP22: LatticeQCD

• It has proven more cost effective to build dedicated computers rather than to make use of general purpose machines.

• This JRA will pioneer the design of massively parallel capability computers based on multi-core processors, including high-end graphic cards (GPUs).
Highlights of significant results

- QPACE has been successfully installed at Jülich and Wuppertal and is now running for production. It ranks first place on the Green500 list (i.e. the list of the most energy efficient supercomputers), and 110^th^ place on the Top500 list.

- A medium-sized cluster of Nvidia 280 GTX GPUs has been assembled in Wuppertal.
The HadronPhysics3 project

- Coordinator: INFN, Italy
- Project Coordinator: Carlo Guaraldo (INFN – LNF)
- Consortium: 49 European Organizations
- Other involved Institutions: 118
- Involved researchers: more than 2500
- Involved Countries: 35
- EC request contribution: 10 M€
- Contract duration: 36 months
Blocks of activities

- Transnational Access Activities (5)
- Joint Research Activities (14)
- Networking Activities (9) And Management
NETWORKING ACTIVITIES

WP1: MAN
WP6: SPHERE

WP2: TURHIC
WP7: FAIRnet

WP3: ENCStudy
WP8: SaporeGravis

WP4: EPOS
WP9: LEANNIS

WP5: MesonNet
WP10: LatticeQCD
| WP5: MesonNet | Meson Physics in Low Energy QCD |
| WP7: FAIRnet | A worldwide research networking activity for experiments on QCD at FAIR |
| WP8: SaporeGravis | Network for the heavy flavoured probes of deconfined QCD matter formed in heavy ion collisions at relativistic energies |
NETWORKING ACTIVITIES

WP6: SPHERE
Strange particles in hadronic environment research in Europe

WP9: LEANNIS
Low energy antikaon-nucleon and -nuclei interaction studies

Carlo Guaraldo
WP3: ENCstudy

Feasibility study for an electron-nucleon collider in Europe
TRANSNATIONAL ACCESS

HADRONIC BEAMS

WP13: GSI
WP14: FZJ-COSY
WP15: INFN-LNF
TRANSNATIONAL ACCESS

ELECTROMAGNETIC BEAMS

WP12: UMainz-MAMI
TRANSNATIONAL ACCESS

THEORETICAL STUDIES

WP11: FBK-ECT*
JOINT RESEARCH ACTIVITIES

**WP16:** ADAMAS
**WP17:** DNPMag
**WP18:** FPD
**WP19:** FuturePID
**WP20:** FutureJet

**WP21:** CherenkovImaging
**WP22:** LYSOFiber
**WP23:** GP Dex
**WP24:** JointGEM

**WP25:** PolAntiP
**WP26:** ULISINT
**WP27:** Di-JETCAL
**WP28:** SiliconMultiplier
**WP29:** 3D-Mom
JOINT RESEARCH ACTIVITIES

INNOVATIVE DETECTION DEVICES 1/2

WP16: ADAMAS
Advanced Diamond Assemblies

WP18: FPD
Frontier Photon Detector

WP19: FuturePID
Future Particle Identification Techniques

WP21: CherenkovImaging
Development of high rate, compact Cherenkov imaging technology

WP22: LYSOFiber
Frontier scintillation detectors based on inorganic fibers

Carlo Guaraldo
WP24: JointGEM
Ultra-light and ultra-large tracking systems based on GEM technology

WP26: ULISINT
Integration of ultra-light silicon tracking and vertex detection systems for frontier precision experiments

WP28: SiliconMultipliers
Matrix Geiger-Mode Avalanche Micro-Pixel Photo Diodes for Frontier Detector Systems
WP17: DNPMag
Internal Magnets for DNP

WP20: FutureJet
Cryogenic jets of nano- and micrometer-sized particles for hadron physics
JOINT RESEARCH ACTIVITIES

EXPERIMENTAL SPECIFIC DEVELOPMENTS

WP23: GPDex
Generalized Parton Distributions

WP27: Di-JETCAL
A Di-Jet Electromagnetic Calorimeter for Jet Quenching Study.

WP29: 3D-Mom
Three-dimensional momentum structure of hadrons
JOINT RESEARCH ACTIVITIES

WP25: PolAntiP  Polarized Antiprotons

Carlo Guaraldo
EC FUNDS

1) Total EC requested contribution
2) Distribution of the EC requested contribution per beneficiary
3) Distribution of the EC requested contribution per country
1) **Total EC requested contribution**

<table>
<thead>
<tr>
<th>TYPE OF ACTIVITY</th>
<th>EC requested contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management of the consortium</td>
<td>1,000,999</td>
</tr>
<tr>
<td>Networking Activities</td>
<td>2,345,000</td>
</tr>
<tr>
<td>Transnational Access Activities</td>
<td>2,088,000</td>
</tr>
<tr>
<td>Joint Research Activities</td>
<td>4,566,000</td>
</tr>
<tr>
<td><strong>GRAND TOTAL</strong></td>
<td><strong>9,999,999</strong></td>
</tr>
</tbody>
</table>

Carlo Guaraldo
2) Distribution per beneficiary

- INFN
- GSI
- UMainz
- FZJ
- CNRS
- FBK
- UBO
- UGlasgow
- OeAW
- UU
- WWU
- RUB
- JLU
- CEA
- TUM
- IFIN-HH
- UHEI
3) Distribution per country

- Germany
- Italy
- France
- Netherlands
- Czech Republic
- Austria
- United Kingdom
- Sweden
- Poland
- Romania
- Spain
- Poland
- Romania
- Netherlands
- Czech Republic
- Austria
- United Kingdom
- Sweden
- Poland
- Romania
- Spain
- Italy
## Indicative Timetable

### OVERALL SCHEDULE

<table>
<thead>
<tr>
<th>Event</th>
<th>Dates</th>
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<tbody>
<tr>
<td>Publication of call</td>
<td>20 July 2010</td>
</tr>
<tr>
<td>Deadline for submission</td>
<td>25 November 2010</td>
</tr>
<tr>
<td>Evaluation of proposals</td>
<td>from 9 December to 17 February 2011</td>
</tr>
<tr>
<td>Sending of evaluation summary reports (ESR)</td>
<td>March 2011</td>
</tr>
<tr>
<td>Invitation letter to launch negotiations</td>
<td>April 2011</td>
</tr>
<tr>
<td>Signature of first grant agreements</td>
<td>From autumn 2011</td>
</tr>
</tbody>
</table>
## Budget split per sub-panel for the Integrating Activities

<table>
<thead>
<tr>
<th>Sub-panel</th>
<th>No of eligible proposals</th>
<th>Requested EU contribution (M€)</th>
<th>Available Funding (M€)</th>
<th>Indicative proposals to be funded</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSH</td>
<td>3</td>
<td>23</td>
<td>8 – 10</td>
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<tr>
<td>Life Science</td>
<td>5</td>
<td>46</td>
<td>18 – 20</td>
<td>2</td>
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<tr>
<td>Environment</td>
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<td>46</td>
<td>18 – 20</td>
<td>2</td>
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<tr>
<td>Energy</td>
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<td>30</td>
<td>8 – 10</td>
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<tr>
<td>Physics/Astronomy</td>
<td>4</td>
<td>40</td>
<td>18 – 20</td>
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<tr>
<td>Material/Analytical</td>
<td>3</td>
<td>40</td>
<td>20 – 26</td>
<td>2</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>23</strong></td>
<td><strong>214</strong></td>
<td><strong>104</strong></td>
<td><strong>10</strong></td>
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Physics and Astronomy

- INFRA-2011-1.1.20. Research Infrastructures for hadron physics: Studying the properties of nuclear matter at extreme conditions
- INFRA-2011-1.1.21. Research Infrastructures for advanced radio astronomy
- INFRA-2011-1.1.22. Research Infrastructures for optical/IR astronomy
- INFRA-2011-1.1.23. Research Infrastructures for astroparticle physics: High energy cosmic rays, multi-messenger approach