Exploring fundamental physics with compact stars (NewComStar)
Action MP1304
Start date: 25/11/2013
End date: 24/11/2017
Year: *1*

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Scientific context and objectives (1/2)

- **Background / Problem statement:** Compact stars are unique laboratories to probe the building blocks of matter and their interactions at regimes that terrestrial laboratories cannot explore. They also are unique laboratories to study gravity under extreme physical conditions.

- **Brief reminder of MoU objectives:**The Action provides an innovative, interdisciplinary connection between the micro- and macrophysics of compact stars, exploring the behaviour of matter and spacetime under the most extreme physical conditions, joining expertise in astrophysics, nuclear and gravitational physics.

Scientific context and objectives (2/2)

Research directions:

- The Action addresses the physics of compact stars by carrying out research in three main WGs (astrophysics, nuclear/subnuclear physics, and gravitational physics). Those WGs reflect the present expertise of the different communities.

- The Action provides an innovative network between the micro- and macrophysics of compact stars.

- The work of the WGs is coordinated locally by the working group leaders and globally by the “synergy agents”, senior scientists with interdisciplinary expertise.

Working groups

1. WG1: Observations and modelling of compact stars
2. WG2: Physics of the strong interaction, theory and experiment
3. WG3: Gravitational physics theory and observation

Results vs. Objectives

- **Website** has been built describing in detail all of the activities of the Action: http://compstar.uni-frankfurt.de
- **Mailing list** has been setup with more than 150 members
- Essentially **all** European groups working on the physics and astrophysics of compact stars have joined the Action
- At first meeting in Florence, the three different communities (astrophysics, nuclear physics, gravitational physics) have met **for the first time** and attended each other's talks.
- List of papers acknowledging the Action is being built (40+ papers) some being collaborations among different groups.
- **All** planned planned **activities** have been or will be reached.

Significant Highlights in Science and Networking (1/4)

Scientific highlights: astrophysics

•**Understanding magnetars** (Gabler et al., MNRAS in press). Numerical simulations investigated how sudden rearrangements in magnetised neutron stars, can produce sudden large bursts of radiation.

•**Interpreting X-ray observations** (Andersson et al., MNRAS 442, 2, 2014). X-ray observations of a bursting neutron star can be used to place a constraint on the mass-radius relation of neutron stars.

•**What does a measurement of mass and/or radius of a neutron star constrain: EOS or gravity?** (Ekşi et al. PRD 89, 063003, 2014). Our ignorance of gravity within neutron stars suggests that a measurement of mass and/or radius constrains gravity rather than the EOS.

Significant Highlights in Science and Networking (2/4)

Scientific highlights: nuclear physics

- **Constraining neutron star matter with Quantum Chromodynamics** (Kurkela et al. ApJ **798**, 127, 2014). Restrictions can be placed on the EOS by requiring pressure to approach that of deconfined quark matter.

- **Towards a Metallurgy of Neutron Star Crusts (**Kobyakov and Pethick, PRL 112, 112504, 2014). A new approach to calculate the crustal properties reveals that many of the previous estimates may have to be revisited.

- **Neutron matter under strong magnetic fields: A comparison of models** (Aguirre et al. PRD 89, 035809, 2014). Thermal effects smear out sharpness for the compressibility and magnetic susceptibility at T =0.

Significant Highlights in Science and Networking (3/4)

Scientific highlights: gravitational physics

•**First high-order code in full general relativity** (Radice et al. CQG, 31, 075012, 2014). This code will provide the most accurate waveforms from inspiralling neutron-star binaries and the first exact solution for this problem.

• **Exploiting gravitational wave observations** (Bauswein et al., PRD 90, 023002, 2014). Computer simulations showed how observations of coalescing neutron stars can probe the high-density EOSs.

• **Low Latency search for gravitational waves from black-hole-neutron-star binaries in coincidence with short gamma-ray bursts** (Maselli and Ferrari, PRD 89, 064056 2014). A new approach is suggested to deduce the properties of the binary from the observations.

Significant Highlights in Science and Networking (4/4)

Networking highlights:

✓Annual Conference in Firenze, Italy, March 2014 (~100 participants, with many from outside the Action network).

✓ 2014: 4 WG meetings (1 WG1, 2 WG2, 1 WG3).

✓3 calls for STSMs: 28 applications, 16 approved, 1 declined, 11 pending for approval, 8 having been carried out successfully.

✓Upcoming Training School in Barcelona, Spain, September 2014 with 50 trainees and 8 trainers.

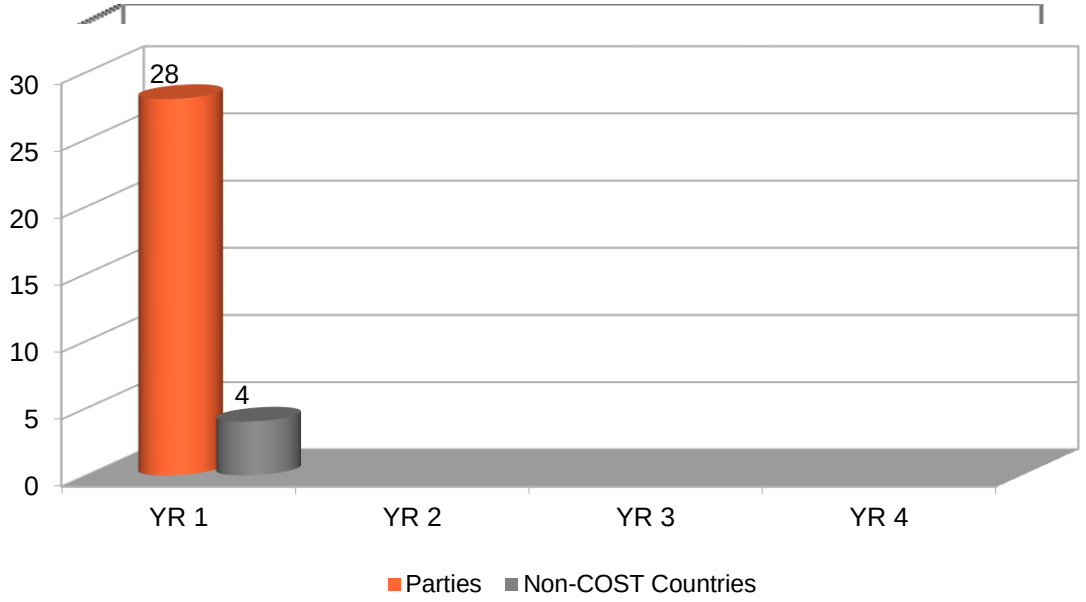
✓More than 40 publications since the start of the Action, including one “APS Physics Spotlight”.

Future Plans

- Because basic structure has already been laid out, no **critical** steps are envisaged **for the upcoming year.**
- **No** new country is expected to join in the near future.
- Cooperation plans with similar networking activities in the **USA** and **Asia** will be started.
- Following plan of MoU, a major **training school** around themes on **nuclear physics** will be organized in 2015.
- As gravitational-wave detectors are being readied for first science runs, gravitational physics research will be intensified.

Appendix

Action Parties



Grant Holder :

GH Institution:
Goethe University Frankfurt

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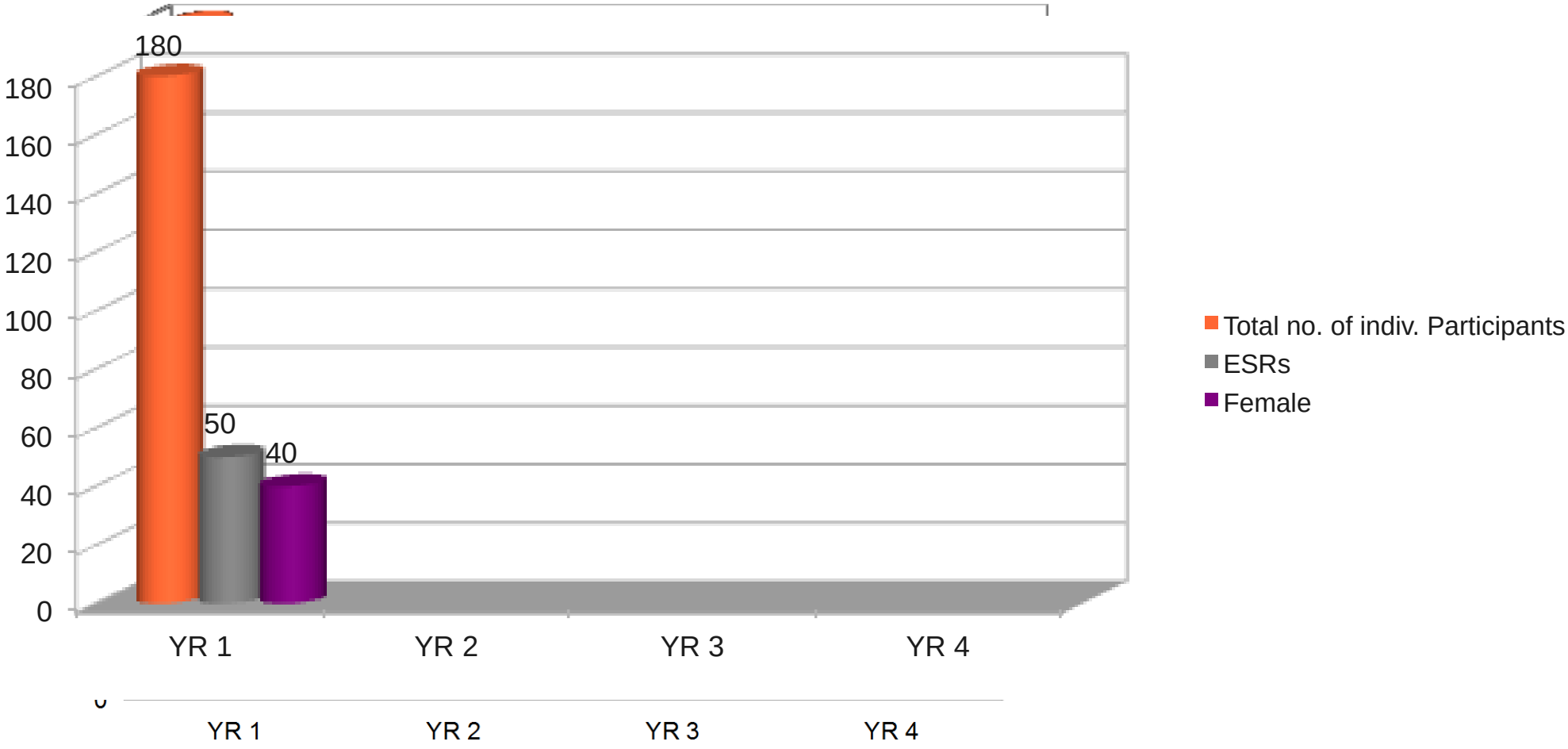
GH Country:
Germany

Action participants



Use of COST Instruments

Activity (No.)	Year 1	Year 2	Year 3	Year 4
MC/WG Meetings	1/4			
STSMs	16/28			
Training Schools	1			
Workshops or Conferences	1			
Working-group meetings	3			
Joint Publications	40			