EUROCORES Programme
European Collaborative Research

# EuroGENESIS

## Final report (Sections B and C)

**Deadline: 01/10/2013**

## Section B. Progress report

## B1. CRP progress and scientific highlights (max. 1500 words)

### 1. The collaborative work (c.400-750 words)

a. With reference to the CRP objectives and work plan, describe the work undertaken by the CRP and the contribution of each Individual Project to the collaboration in terms of its specific expertise and tasks/responsibilities. How closely did the partners work together?

The collaboration has been formed in summer 2010, with task distribution and collaboration setups settled during the first 7 months (including new APs Heidelberg, Dresden/Rossendorf). Annual progress meetings have been held (July 2010 Darmstadt, November 2010 Dubrovnik, November 2011 Basel, November 2012 Frankfurt, and December 2013 Darmstadt (even after the end of the program ).
Cross-CRP Miniworkshops, where members of our CRP participated or which were organized with a strong involvement of our CRP, include workshops on nuclear reaction rates, nucleosysnthesis, interstellar medium and chemical evolution issues, dust formation in stellar winds and stellar explosions, observational constraints, and the origin of heavy elements:
Madrid April 2011 (nuclear reaction rates) http://161.111.23.207/MaKaC/internalPage.py?pageId=0&confId=4http://161.111.23.207/MaKaC/internalPage.py?pageId=0&confId=4
Kocaeli May 2011 (p-process)
http://pprocess.kocaeli.edu.tr/sponsors.html
Basel November 2011 (chemical evolution of galaxies and nucleosynthesis input)
http://phys-merger.physik.unibas.ch/users/group/eurogenesis
Vienna November 2011 (cosmic dust grains as diagnostics for massive stars)
http://www.codustmas.eu/docs/First%20circular%20-%20workshop%20Vienna%2021_22%20Nov.pdf
Ascona November 2012 (Dust in core-collapse supernovae near and far)
http://www.codustmas.eu/index.php?view=details&id=4%3Adust-in-core-collapse-supernovae-near-and-far&option=com_eventlist&Itemid=56
Perugia November 2012 (Dust in EuroGENESIS environments: from primitive, massive stars to novae)
http://cosmicdust.fisica.unipg.it/index.html
Garching March 2013 (Observational constraints on nucleosynthesis sources)
http://www2011.mpe.mpg.de/gamma/science/lines/workshops/EuroGenesis_ObsConstraints2013.html
Debrecen April 2013 (Open Problems and Future Directions in Heavy Element Nucleosynthesis)
http://www.atomki.hu/heavyws/

Research visits of individual CRP scientists to other EuroGenesis sites have been arranged (Arcones, with CRP EXNUC Barcelona, implementation of hydrocode FLASH for neutrino wind simulations in supernovae; Krause with CRP FirstStars Geneva, chemical evolution of globular clusters).
Stellar models of structure and evolution have been compared in detail among the Rome/Keele/Basel groups, test cases simulated, and comparison criteria identified. Underground nuclear reaction experiments for reactions in early stellar evolution have been pursued by the Debrecen and Dresden groups. Nuclear reaction rate experiments and involved theory have led to discussions and collaborations among Basel/Kocaeli/Debrecen/Darmstadt/Heidelberg groups (workshops Kocaeli, Darmstadt, Basel, Debrecen) with respect to s-, p- and r-process studies. Supernova core collapse simulations, nuclear equation of state tests and predictions of nucleosynthesis ejecta have been performed in collaboration of the Basel and Darmstadt groups and with active information exchange with the Garching group. Chemical-evolution processes and building blocks were simulated and discussed among the Paris/Trieste/Garching groups and at the Basel Workshop. The connection of the combined knowledge from nuclear reactions, stellar evolution and supernova simulations to observations of the diffuse interstellar gas and individual objects and their imprint in galactic evolution have been scrutinized at the Garching workshop.
We had individual exchange with the three other CRPs, organized joint workshops, and many CRP members presented their results at international conferences. The EuroCores program EuroGenesis and our CRP MASCHE achieved to build and organize a European Community in our research fields and led to effective interactions and information flow across the communities of nuclear physics experimentalists, theorists, modelers and atrophysical observers. This permitted joint rather than isolated actions and possibly laid the ground work for future joint explorations within a COST ACTION or Horizon 2020.

## 2. Scientific highlights (c.400-750 words)

a. Describe the scientific highlights and main achievements of the CRP. What has been the most significant/valuable contribution to knowledge (e.g. results, breakthroughs)?

A detailed overview of achievements, highlights and priorities for future directions has emerged from the MASCHE annual meetings and joint workshops with the ExNuc, First Stars, and CoDustMas CRPs. We want to start here with an overall assessment and analysis which emerged before the midterm of the program. This includes already first achievements during the first 18 months, but mainly settled our understanding of the status of the field in order to steer our activities in important directions which addressed the remaining major open questions. After this first assessment/analysis, at the end of this section, we will then list the results/deliverables and point to the highlights/achievements achieved throughout the 36 months of our CRP.

***Assessment and analysis of the status of the field:***

**Chemical evolution issues:**
1. In order to obtain a correct understanding of chemical evolution it is important to have dense grids of stellar models in the mass ranges 18-22$M_{sol}$ and 8-10$M_{sol}$, where strong transitions in stellar structure occur, and present investigations of our stellar modelers implemented this strategy (this issue is addressed by the Keele and Rome groups).
2. For applications tracing feedback on time scales $<10^7$y (e.g. interaction with ISM), the time-resolved specification of ejected matter and its composition is needed from stellar models. This means that e.g. wind ejecta need to be given with their ejection time during stellar evolution, before the final explosion (this requirement was adopted by the stellar and supernova modeling groups).
3. Massive-star groups ionize and sweep up their surrounding interstellar clouds more rapidly than thought before; this explains why some energy is lost to cooling, and explains ISM cavity sizes. These studies and their refinements have been stimulated by EuroGenesis and Masche. They have, e.g., been applied to Globular Clusters, leading to a new model for their particular stellar population characteristics and will lead to are more global understanding of chemical *and dynamical* evolution of galaxies (involving mixing processes, undertaken by a collaboration between Garching and the First Stars group in Geneva).

4. Nucleosynthesis radioactive decay gamma-rays can be used to trace ejecta flows on the My time scale in our Galaxy.

**Globular clusters (in joint efforts with the First Stars CRP):**

1. The origin of second-generation stars (<1 $M_{sol}$) requires either a special IMF for the first generation stars, or a total initial stellar mass of the cluster 10 to 20 times larger than the present mass. GCs have strongly contributed to the stellar population of the Galactic halo.
2. There are indications of homogeneous metallicities within each GC, but also of self-enrichment and second generation stars with different ages and metallicties. GCs appear to be a special star formation mode early in a galaxy's evolution, and are found in all galaxy types.
3. Hydrodynamical ISM simulations which treat 1000 $M_{sol}$ within a 2 pc scale, see their evolution and the formation of second generation stars can lead to an understanding of these issues and are related to 3. In the previous section (chemical evolution).
4. The data gathered by Korn and collaborators (from First Stars) on GC stars can be used to constrain stellar models of Pop II stars, including atomic diffusion and transport processes (rotation-induced mixing, internal gravity waves).

**Stellar evolution models:**

1. A major effort has been undertaken in comparisons of different stellar evolution codes (mainly Rome/Keele). This includes a critical examination of the implementation of mixing, such as rotation-induced mixing, semiconvection, or overshoot and mass loss prescriptions.
2. As the evolution during H- and He-burning is affected tremendously by mass loss, initial progenitor masses can lead to quite different advanced stages of stellar evolution. Therefore the size of the C/O-core is the best indicator for the final evolutionary stages and explosion properties.
3. Besides convergence on the way to utilize mixing and mass loss prescriptions, emphasis has been put on a best choice set of key nuclear reaction inputs, such as in $^{14}N(p,\gamma)$,$^{12}C(\alpha,\gamma)$, $^{22}Ne(\alpha,n)$, $^{17}O(n,\alpha)$.. supported by input from experimental groups, $^{12}C+^{12}C$ (where a major study has been undertaken), and reactions for heavy nuclei, based on theoretical investigations (see below) .

**Supernovae:**

1. A major aim for our modelers of massive star evolution is to follow the evolution up to the very late stages of Si-burning, when contraction and collapse are initiated already, in order to make the best possible transition to core collapse studies.
2. There are good comparison tests between the Garching and Basel, as well as the Tokyo and Oak Ridge groups. Key issues are:
- The equation of state during collapse
  (a) improved equations of state at high densities (quark-hadron phase transition)
  (b) the treatment of an NSE distribution of heavy nuclei
- full 3D neutrino transport and/or simplifications/approximations
- full 3D general relativity or effective Newtonian potentials
- the role of instabilities, e.g. standing accretion shock instability, magnetic instabilities
- the role of rotation and magnetic fields, possibly leading to jet explosions
- the p/n ratio in neutrino winds (including effects of nucleon interactions), role of sterile neutrinos, effect of collective neutrino oscillations.

3. Further lightcurve observations as a function of progenitor mass are needed to constrain the nucleosynthesis ejecta of $^{56/57}Ni$,Co,Fe, and $^{44}Ti$.
4. Ti results from Cas A and SN1987A demonstrate that observed yields for these supernovae exceed (spherically-symmetric piston-based) model predictions by factors of several. On the other hand, from the Galactic core collapse supernova rate one would then expect to see more objects in $^{44}Ti$ radioactivity. Combining these facts, one possible explanation is that strong $^{44}Ti$ ejection is restricted to supernova explosions which develop profound asymmetries deep in their interior.
5. The low brightness of the radioactive afterglow of $^{60}Fe$ ejected from supernovae, as compared to $^{26}Al$ afterglow brightness from $^{26}Al$, presents a challenge for explosion models: One way out would be that EC supernovae are relatively more important globally than thought before, and very massive stars above ~20 $M_{sol}$ (which in current massive-star model predictions would result in large amounts of $^{60}Fe$ ejecta) may not explode as supernovae at all and form compact remnants immediately.

**Nuclear reactions:**
These are directly related to stellar evolution (and explosions, see above). As a result:
1. A new $^{22}$Ne(p,γ) measurement has been planned
2. Given the importance of $^{22}$Ne(a,γ) and $^{17}$O(n,α), the feasibility of an experiment is has been checked
3. Dresden investigated $^{14}$N(p,γ) (H-burning in stellar evolution) and $^{40}$Ca(α,γ)$^{44}$Ti (explosive Si-burning in supernovae)
4. The GSI/Frankfurt n-capture rates are already incorporated in Basel/Keele s-process studies
5. Close collaborations occurred among Debrecen/Basel/GSI/Giessen on the KADONIS data base for p-process studies
6. Basel provided consultation/collaboration on theoretical rate investigations and comparison with experiments (Dresden/Debrecen/GSI/Kocaeli)

**Heavy element synthesis (key open questions/achievements):**
1. Site of the (main) r-process (neutron star mergers, polar jets in explosions with rotation and strong magnetic fields, accretion disks around black holes, ways out with sterile neutrinos in neutrino winds)? Investigations on several of these scenarios have been undertaken with focus on n/p-ratios (Ye) and entropy in the supernova neutrino wind, neutron star mergers, and jet ejecta from core collapse supernovae with fast rotation and magnetic fields. Applications of these yields and their effect on galactic chemical evolution are underway.
2. What is the origin of the weak r-process?
3. Which processes contribute to the so-called LEPP region (lighter (heavy) elements primary process), (weak) r-process, νp-process, s-process (s-process uncertainties due to convective-boundary mixing and $^{13}$C pocket, νp-process dependence on strength of neutrino wind and neutrino spectra, r-process source?)
4. Observations (direct link to chemical evolution) play a key issue. How are element features correlated (e.g. Fe-group, LEPP or weak r-process, heavy or main r-process)?

This long and detailed analysis of the status of the field, the main open questions, and already partial achievements has led to the results which are listed in the remaining part of this section, i.e. in

***Deliverables and Highlights/Achievements:***

**Results and Deliverables**
- A highly improved nuclear input basis, from low energy fusion reactions, n-captures, charged-particle reactions for explosive conditions (from experiment and theory), nuclear masses far from stability, fission barriers and fission fragment distributions, e-captures and neutrino induced reactions
- Improved understanding of uncertainties in stellar evolution, comparing different evolution codes, strong progress in modeling stellar evolution with rotation, including the effect on hydrostatic nucleosynthesis ejecta and wind composition
- strong progress in supernova modeling and successful explosions, close to being able to perform nucleosynthesis calculations in multi-D models
- intermediate approach in 1D with approximated neutrino treatment which permitted to account for weak interactions in innermost ejected zones
- Thus, close to provide full set of supernovae yields to be tested in chemical evolution modeling
- Test in direct supernova observations and remnants
- Progess in understanding r-process site, addressing neutrino winds, jets from fast rotating highly magnetized core collapse, and neutron star mergers

**Highlights/Achievements**
- $^{197}$Au(n,γ) - towards a new standard for energies relevant to stellar nucleosynthesis
- alpha potentials from low energy scattering experiments and the influence of Coulomb excitations in capture reactions
- precise nuclear mass measurements and composition of the neutron star crust
- comparing different stellar evolution codes and understanding their results

- the fate of 8-10$M_{sol}$ stars with improved weak interactions
- s-process in rotating low metallicity stars and the $^{17}O(n,\alpha)$ reaction
- strong progress in supernova modeling and successful explosions (close to perform nucleo-synthesis calculations in multi-D models)
- equation of state and effect of neutrinos on Ye in ejecta
- supernovae from fast rotators with high magnetic fields as a possible site of the r-process
- progress in understaning r-process site, neutrino winds only “weak“ r-process, jets from fast rotating highly magnetized core collapse or neutron star mergers identified as main sources.
- tests in direct supernova observations and remnants, hints on explosion energy from presolar grain composition?
- sources of $^{60}Fe$ and also main r-process actinides in ocean sediments
- 3D hydrodynamic simulations, showing the effects of wind- and supernova cavity mergings for the first time.
- A population-synthesis tool similar to STARBURST99 was established and applied, for the first time including the tracing of nucleosynthesis ejecta over 30 My.
- Nucleosynthesis radioactive decay gamma-rays have been used to trace ejecta flows on the My time scale in our Galaxy. Ejecta flows must stream away from spiral arms in their forward regions towards the interarm regions. Impact of those asymmetries in superbubble dynamics evident on global gas flows in the Galaxy and its halo.

b. List up to five of your CRP’s most significant joint publications (i.e. involving co-authors from at least two IPs in your CRP or co-authors from other CRPs in the programme).


1. Szücs, T., Bemmerer, D., Cowan, T., Degering, D., Elekes, Z., Fülöp, Z., Gyürky, G. Junghans, A., Köhler, M. Marta, M. Schwengner, R., Wagner, A., Zuber, K., Shallow-underground accelerator sites for nuclear astrophysics: Is the background low enough? Eur. Phys. J. A, 48, 8 (2012) (Debrecen, Dresden)
2. Kiss G. G., P. Mohr, Zs. Fülöp, Gy. Gyürky, Z. Elekes, J. Farkas, E. Somorjai, C. Yalcin, D. Galaviz, R. T. Güray, N. Özkan, and J. Görres, $^{110,116}Cd(\alpha,\alpha)^{110,116}Cd$ elastic scattering and systematic investigation of elastic α cross sections along the Z = 48 isotopic and N = 62 isotonic chains”, Phys. Rev. C 83, 065807 (2011) (Debrecen, Kocaeli)
3. Lederer, C., Colonna, N., Domingo-Pardo, C., Dillmann, I., Giesen, U., Gunsing, F., Käppeler, F., Heil, M., Massimi, C., Mengoni, A., Mosconi, M., Nolte, R., Reifarth, R., Schmidt, S., Wallner, A., and the n_TOF Collaboration: $^{197}Au(n,\gamma)$- towards a new standard for energies relevant to stellar nucleosynthesis, J. Phys. Conf. Ser. 337, 012045(2012) (Darmstadt, Frankfurt, Giessen, Vienna)
4. Bennett, M.E. , Hirschi, R., Pignatari, M. et al, The effect of $^{12}C$ + $^{12}C$ rate uncertainties on the evolution and nucleosynthesis of massive stars. MNRAS 420, 3047 (2012) (Keele, Basel)
5. Jones, S., Hirschi, R., Nomoto, K., Fischer, T., Timmes, F.X., Herwig, F., Paxton, B., Toki, H., Suzuki, T., Martinez-Pinedo, G., Lam, Y.H., Bertolli, M.G.: Advanced Burning Stages and Fate of 8-10 $M_\odot$ Stars, Ap, J. 772, 150 (2013) (Keele, Darmstadt)
6. Fischer, T., Martinez-Pinedo, G., Hempel, M., Liebendörfer, M.: Neutrino spectra evolution during proto-neutron star deleptonization, Phys. Rev. D 85, 083003 (2012) (Darmstadt, Basel)
7. Winteler, C., Käppeli, R., Perego, A., Arcones, A., Vasset, N., Nishimura, N., Liebendörfer, M., Thielemann, F.-K., Magneto-rotationally driven Supernovae as the origin of early galaxy r-process elements? Ap. J. Lett., 750, L22 (2012) (Basel, Darmstadt)
8. Petermann, I., Langanke, K., Martinez-Pinedo, G., Panov, I.V., Reinhard, P.-G., Thielemann, F.-K.: Have superheavy elements been produced in nature?, Eur. Phys. J. A. 48, 122 (2012) (Darmstadt, Basel)
9. Chiappini, C., Frischknecht, U., Meynet, G., Hirschi, R., Barbuy, B., Pignatari, M., Decressin, T., Maeder, A., Imprints of fast-rotating massive stars in the Galactic Bulge, Nature 474, 666 (2011) (Geneva, Keele, Basel; First Stars, MASCHE)
10. Krause, M., Charbonnel, C., Decressin, T., Meynet, G., Prantzos, N., Diehl, R.: Superbubble dynamics in globular cluster infancy. I. How do globular clusters first lose their cold gas?, A & A Volume 546, L5, 4 (2012) (Garching, Genf, Paris; MASCHE, First Stars)
11. Pignatari, M., Zinner, E., Bertolli, M. G., Trappitsch, R., Hoppe, P., Rauscher, T., Fryer, C., Herwig, F., Hirschi, R., Timmes, F.X., Thielemann, F.-K.: Silicon Carbide Grains of Type C Provide Evidence for the Production of the Unstable Isotope $^{32}Si$ in Supernovae, Ap. J. Lett. 771, L7 (2013)

12. Diehl, Hartmann, Prantzos (editors): Astronomy with Radioactivities, Springer LNP 812 (2011), with articles by Busso, Chieffi, Diehl, Hirschi, Liebendörfer, Limongi, Prantzos, Rauscher, Thielemann (Perugia, Rome, Garching, Keele, Basel, Paris; MASCHE, CoDustMas)

## B.2. Integration of the CRP in the programme (300-600 words)

1. Describe the contribution of your CRP to the EUROCORES programme. What was the place and role of the CRP in the framework of the programme? From a scientific perspective, how well integrated was your CRP in the programme? How would you describe the intensity of interaction between your CRP and other CRPs in the programme?

MASCHE addresses all issues related to massive stars and their core-collapse supernovae, contributing to EuroGenesis' goal of cosmic nucleosynthesis investigations, aiming at a better understanding of the origins of the elements and isotopes we are made of. MASCHE contributes with respect to theories, models, and simulations of massive stars in their structure and evolution, and of core-collapse supernovae. In both these objects, characteristic nuclear reactions are addressed, the requirements for determinations of reaction rates are converted into activities in theoretical nuclear physics investigations and in experimental efforts to measure specific nuclear reaction properties in laboratory experiments. The Debrecen and Dresden groups are involved in underground accelerator activities to determine stellar reaction rates at low energies (at lowest possible background). The Kocaeli, Debrecen, and GSI/Giessen groups are strongly involved in determining reactions for explosive burning phases, with a special emphasis on the p-process. The GSI/Frankfurt group is actively pursuing neutron capture cross section measurements for s-process studies. GSI/Theory and Basel provide theoretical cross section predictions and comparisons with the experimental group. All of these results enter into stellar evolution calculations (Keele, Rome, Basel). Core collapse supernova calculations are performed at Basel, GSI and Garching, requiring weak interaction reactions and a nuclear equation of state at high densities. This leads (after successful explosions) to explosive nucleosynthesis, exploration of the role of neutrinos and weak and main r-process calculations. Such explosions can be observed in light curve observations (Stockholm) and in supernova remnants, the latter and their mixing of matter with the interstellar medium being modelled with simulations (Garching). [The dust formation in such objects is the topic of the CoDustMas CRP.] Finally, the results of stellar winds and explosive nucleosynthesis are the ingredients to understand the chemical evolution of galaxies (Paris, Trieste, and Garching). This closes the full circle to low metallicity stellar abundance observations (undertaken by the First Stars CRP). The ExNuc CRP focuses on the evolution of binary systems (with one compact object), where there exists overlap with the neutron star equation of state or explosive nucleosynthesis in novae, X-ray bursts and type Ia supernovae (in terms of nuclear reactions as well as nucleosynthesis input to chemical evolution).
The overall interpretation within the chemical and dynamical evolution of galaxies is relying heavily on astronomical observations, their interpretation with respect to constraints on the input of massive stars and supernovae. This permits a description of the cosmic evolution of abundances of elements and their isotopes, based on the processes how massive stars and supernovae feed the interstellar gas, which can be studied through astronomical observations and also hydrodynamical simulations. MASCHE has on the one hand direct contact to all other CRPs as described above and the chemical evolution part combines input or observations from all other CRPs.

2. Describe the benefit to your CRP of being part of the EUROCORES programme (e.g. achieving critical mass of expertise, scale and scope, visibility, collaborative opportunities, ideas, etc.).

Within EuroGenesis, the astrophysical processes discussed above also play a role in other CRPs, which is why we organize and support cross-CRP activities. Specifically, nuclear reaction rates under various astrophysical conditions are a major overlap, but also hydrodynamical modelling of stars and explosions. MASCHE emphasizes massive stars and core-collapse supernovae, which are characterized by a variety of observational constraints, as these objects are frequent and have been observed in abundance. They also are short-lived, and present a current view of

cosmic nucleosynthesis, which ties in with the delayed explosions of SNe Ia addressed in EXNUC, and the metal-poor star observations in FIRST STARS. CoDustMas supports MASCHE through its focus on the complex role of dust grain formations from massive stars and supernovae, which is one of the astronomical, more indirect constraints which we wish to exploit for our understanding of massive stars and their supernovae.

## B.3. Cross-CRP networking, training and dissemination (max. 750 words)

1. Which networking/training/dissemination activities did you or your CRP members participate in? Indicate how many team members participated in each activity.

Networking activities in which MASCHE members participated:
Madrid April 2011 (nuclear reaction rate workshop), participation of 1 MASCHE member
Kocaeli May 2011 (p-process workshop), 9 MASCHE members
Basel November 2011 (chemical evolution of galaxies and nucleosynthesis input), 18 MASCHE members
Vienna November 2011 (cosmic dust grains as diagnostics for massive stars), 6 MASCHE members,
Basel September 2012 (brain storming) 13 MASCHE members,
Ascona November 2012 (Dust in core-collapse supernovae near and far), 9 MASCHE members,
Peruga November 2012 (Dust in EuroGENESIS environments: from primitive, massive stars to novae), 3 MASCHE members,
Garching March 2013 (Observational constraints on nucleosynthesis sources), 10 MASCHE members,
Debrecen April 2013 (Open Problems and Future Directions in Heavy Element Nucleosynthesis), 10 MASCHE members,
Barcelona June 2013 (THE ORIGIN OF COSMIC ELEMENTS: Past and Present Achievements, Future Challenges), 20 MASCHE members.

Research visits of individual CRP scientists to other EuroGenesis sites have been arranged (A. Arcones, with CRP EXNUC Barcelona, implementation of hydrocode FLASH for neutrino wind simulations in supernovae; M. Krause with CRP First Stars Geneva, chemical evolution of globular clusters)

2. **Networking activities.** Describe *the most important networking activity* for your CRP (in terms of impact, outcome, creation of synergy and cooperation within or outside the programme).

All of the above, probably most important the chemical evolution workshop in Basel, the p-process workshop in Istanbul, the Ascona workshop on dust, the Garching workshop on observational constraints, and the Debrecen workshop on the production of heavy elements, covering all aspects from nuclear experiments, theoretical (stellar and galaxy) models, over observational constraints (from individual events to galactic evolution) to the formation of dust.

3. **Training activities.** Describe *the most useful training activity* to date (workshop, course, school, etc.) undertaken by senior or junior researchers of your CRP.

Outside of Eurogenesis, MASCHE members participated in training events which address similar topics and are especially tuned to training PhD students:
Thermonuclear Reaction Rates for Astrophysics Applications, Demokritos Institute Athens (Greece), November 24-25, 2011
JINA/Universe Cluster workshop/school on nuclear reaction rates, Frauenwörth (D), organizers S. Bishop (MASCHE), H. Schatz (JINA), April 10-17, 2011
Helmholtz International Summer School "Nuclear Theory and Astrophysical Application" Dubna (Russia), July 24 - August 2, 2011, organizer David Blaschke (COMPSTAR, cross connection to an ESF research network),
Nuclei in the Cosmos XII, International Symposium in Cairns, Australia, organizers from MASCHE F. Thielemann.., August 2012
Reactions of Exotic Nuclei and the Impact of Nuclear Structure, October 2012, ENSAR/THEXO (EU/FP7) Workshop at ECT* Trento, Italy, organizers from MASCHE: F. Thielemann

Heraeus Foundation workshop “Astrophysics with Modern Small-Scale Accelerators”, February 6-10, 2012, Bad Honnef, Germany, organizers from MASCHE: R. Reifarth, D. Bemmerer
Russbach School in Nuclear Astrophysics, March 2012, Russbach, Austria, organizers from MASCHE: S. Bishop, R. Diehl, T. Rauscher
Heraeus Foundation workshop “Astrophysics with ion storage rings”, January 14-18, 2013, Bad Honnef, Germany, organizers from MASCHE: Y. Litvinov, R. Reifarth, K. Sonnabend
Russbach School in Nuclear Astrophysics, March 2013, Russbach, Austria, organizers from MASCHE: S. Bishop, R. Diehl, F.-K. Thielemann
Heraeus Foundation workshop “Nuclear Masses and Nucleosynthesis”, April 23-26, 2013, Bad Honnef, Gemany, organizers from MASCHE: A. Arcones, K. Blaum
Nuclear Physics in Astrophysics Conference, May 2013, Lisbon, Portugal, organizers from MASCHE: Z. Fülöp, M. Heil, F.-K. Thielemann, G. Martinez-Pinedo, A. Wallner
Nuclear Structure and Astrophysical Applications, July 2013, ENSAR/THEXO (EU/FP7) Workshop at ECT* Trento, Italy, organizers from MASCHE: F. Thielemann
MICRA (Microphysics in Computational Relativistic Astrophysics) Workshop, September 2013, ECT* Trento, Italy, organizers from MASCHE: A. Arcones
Introduction to Observational Nuclear Astrophysics, November 2013, Lecture Series by R. Diehl, University of Tokyo, Japan
Asian Winter School, November 2013, with lecture R. Diehl: Gamma-ray line astronomy, Mitaka, Japan

4. **Dissemination activities.** Describe the *most valuable dissemination activity (or activities)* your team undertook, with respect to (i) the scientific community and (ii) the wider public. Describe the outcome and impact of these activities in terms of promoting your field of research and the EUROCORES programme.

(i) All of the workshops, schools, and conferences mentioned above, which went beyond Eurogenesis networking, have been utilized to advertise the Eurogenesis activities and disseminate the results obtained within the Eurogenesis CRPs. This includes the most important series of conferences in our field: Nuclei in the Cosmos (global), Nuclear Physics in Astrophysics (European), and OMEG=Origin of Matter and Evolution of Galaxies (Japan), where also MASCHE members are part of the organizing or advisory committees. A more detailed list of talks at international meetings can be found further down.
(ii) Astrobiology Exhibition, organized by N. Mason (OPEN University, UK), with Exhibits of CompStar and EuroGenesis programmes of EuroCores/ESF, Museum of National Science, Brussels, 23-25 Jun 2011, as part of the International Year of Chemistry (YC 2011), a UN approved initiative of the International Union of Pure and Applied Chemistry (IUPAC) and the United Nations Educational and Cultural Organisation (UNESCO).
(iii) Science Policy Briefing on Nuclear Astrophysics, organized by G. Martinez-Pinedo (GSI/TU Darmstadt), 2-3 December 2013, with participation of MASCHE and other CRP team leaders, eminent outside experts and a science writer, to prepare summary of Eurogenesis achievements and work out priorities for future directions.

5. List the cross-CRP activities your CRP organised or co-organised.

Nucleosynthesis reactions and the p-process, EuroGenesis workshop, May 25-27, 2011, Istanbul (Turkey), Organizers N. Özkan, T. Güray and C. Travaglio (CoDustMas)
Chemical Evolution of Galaxies, EuroGenesis workshop, Nov. 13-15, 2011, Basel (CH), Organizers F.-K. Thielemann, R. Diehl and A. Korn/C. Charbonnel (First Stars)
Dust in Massive Stars, EuroGenesis workshop, Nov 21-23 2011, Vienna (A), Organizers I. Cherchneff (CoDustMas) and A. Wallner (CoDustMas/MASCHE)
Dust in core-collapse supernovae near and far, Eurogenesis workshop, November 2012, Ascona (Switzerland), organizers Cherchneff (CoDustMas), F.-K. Thielemann (MASCHE)
Dust in EuroGENESIS environments: from primitive, massive stars to novae, Eurogenesis workshop, November 2012, Peruga (Italy), organizers M. Busso (CoDustMas) and A.

Wallner (CoDustMas/MASCHE)

Observational constraints on nucleosynthesis sources, Eurogenesis workshop, March 2013, Garching (Germany), organizers R. Diehl, F.-K. Thielemann, C. Fransson, M. Asplund (First Stars), I. Cherchneff (CoDustMas), and J. Jose (ExNuc)

Open Problems and Future Directions in Heavy Element Nucleosynthesis, Eurogenesis workshop, April 2013, Debrecen (Hungary), among the organizers G. Gyürky, R. Diehl, I. Dillmann, N, Özkan, T. Rauscher, F. K. Thielemann and J. José (ExNuc)

There exist additional activities which were organized by MASCHE members and led to cross-CRP interactions, but were funded by other means:

Helmholtz International Summer School "Nuclear Theory and Astrophysical Application" Dubna (Russia), July 24 - August 2, 2011, organizer David Blaschke (COMPSTAR, cross connection to an ESF research network)

JINA/Universe Cluster workshop/school on nuclear reaction rates, Frauenwörth (D), April 2011, organizers S. Bishop (MASCHE), H. Schatz (JINA)

Nucleosynthesis beyond iron and the lighter element primary process, workshop supported by the Extreme Matter Institute, October 10-12, 2011, GSI Darmstadt, Germany, organizers from MASCHE: A. Arcones, M. Pignatari

The Origin of the Elements: A Modern Perspective, workshop supported by ECT*, Trento, Italy, May 16-20 (2011), organizers from MASCHE: G. Martinez-Pinedo, F.-K. Thielemann

2nd workshop on Exotic Radionuclides from Accelerator Waste for Science and Technology (ERAWAST II), workshop supported by PSI, August 29- September 02, 2011, Villigen, Switzerland, organizers from MASCHE: R. Reifarth, D. Bemmerer

The Origin of the Elements: A Modern Perspective, workshop supported by ECT*, Trento, Italy, May 16-20 (2011), organizers from MASCHE: G. Martinez-Pinedo, F.-K. Thielemann

Astrophysics with Modern Small-Scale Accelerators, workshop supported by the Heraeus Foundation, February 6-10, 2012, Bad Honnef, Germany, organizers from MASCHE: R. Reifarth, D. Bemmerer

Astrophysics with Modern Small-Scale Accelerators, Heraeus Foundation workshop, February 6-10, 2012, Bad Honnef, Germany, organizers from MASCHE: R. Reifarth, D. Bemmerer

Russbach School in Nuclear Astropphysics, March 2012, Russbach, Austria, organizers from MASCHE: S. Bishop, R. Diehl, T. Rauscher

Heraeus Foundation workshop “Astrophysics with ion storage rings”, January 14-18, 2013, Bad Honnef, Germany, organizers from MASCHE: Y. Litvinov, R. Reifarth, K. Sonnabend

Heraeus Foundation workshop “Nuclear Masses and Nucleosynthesis”, April 23-26, 2013, Bad Honnef, Gemany, organizers from MASCHE: A. Arcones, K. Blaum

Russbach School in Nuclear Astrophysics, March 2013, Russbach, Austria, organizers from MASCHE: S. Bishop, R. Diehl, F.-K. Thielemann

Heraeus Foundation workshop “Nuclear Masses and Nucleosynthesis”, April 23-26, 2013, Bad Honnef, Gemany, organizers from MASCHE: A. Arcones, K. Blaum

Nuclear Physics in Astrophysics Conference, May 2013, Lisbon, Portugal, organizers from MASCHE: Z. Fülöp, M. Heil, F.-K. Thielemann, G. Martinez-Pinedo, A. Wallner

Nuclear Structure and Astrophysical Applications, July 2013, ENSAR/THEXO (EU/FP7) Workshop at ECT* Trento, Italy, organizers from MASCHE: F. Thielemann

MICRA (Microphysics in Computational Relativistic Astrophysics) workshop, September 2013, ECT* Trento, Italy, organizers from MASCHE: A. Arcones

## B.4. Publications, dissemination and outreach

***Important**: In your lists, include only those publications which resulted* to a significant extent *from work undertaken in the framework of the CRP or from collaboration with other CRPs. Note that all such publications should bear an acknowledgement of the EuroGENESIS programme.*

***In addition:***

- List *all* authors.
- Identify with an asterisk (*) publications which acknowledge the EUROCORES programme.
- Underline publications/presentations involving co-authors from at least two IPs within your CRP.
- **Mark in bold publications/presentations involving co-authors from other CRPs in the programme.**

### Publications

- Articles

*Peer-reviewed articles in journals (published, in press or submitted)*


most publications listed acknowledge EuroGenesis

Arcones, A., Janka, H.-T.: Nucleosynthesis-relevant conditions in neutrino-driven supernova outflows. II. The reverse shock in two-dimensional simulations, A&A 526, A160 (2011)

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## Presentations in scientific meetings

- Oral presentations (indicate invited / keynote talks)

Only invited talks (selected)
A. Arcones: Explosive nucleosynthesis: nuclear physics impact using neutrino-driven wind simulations, NUSTAR annual meeting Darmstadt, Germany (2011)
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A. Arcones: The r-process as a source of new elements, energy and optical transients, Heavy elements in galactic chemical evolution and NLTE effects, Odessa, Ukraine (2011)
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A. Arcones: Core-collapse supernovae and r-process, The Chemical Evolution of Galaxies, Basel, Switzerland (2011)
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K. Blaum: *High-precision mass measurements for nuclear astrophysics,* The 11th International Symposium on Origin of Matter and Evolution of Galaxies (OMEG11), Wako, Japan (2011)
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K. Blaum: *Precision Penning Trap Experiments with Exotic Ions,* EMMI Physics Days 2011, GSI Darmstadt, Germany (2011)
K. Blaum: *g-factor of hydrogenlike silicon $^{28}Si^{13+}$ - The most stringent test of bound-state quantum electrodynamics*, 8th International Topical SPARC Workshop, Moscow, Russia (2011)
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M. Krause: Superbubbles as a physical process in the ISM, Conf. “Physical processes in the ISM”, ISM-SPP, Garching, Germany, Oct 21-25 (2013)
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M. Pignatari: MESA/NuGrid Physics Package, Nuclei in the Cosmos XII, Cairns, Australia (2012)
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M. Pignatari: The slow neutron capture process in intermediate mass stars: warnings and perspectives, JINA Frontiers meeting, East Lansing, USA (2012)
M. Pignatari: Presolar carbide grains from supernovae: a new scenario for their nucleosynthesis signature, Dust in Core Collapse Supernovae near and far: Understanding its formation and evolution, Asona, Switzerland (2012)
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M. Pignatari: The slow neutron capture process in stars, "Nuclear Physics in Astrophysics - VI", Lisbon, Portugal (2013)
M. Pignatari: Presolar grains from massive stars, tracers of the supernova explosive conditions, "NAM2013", St Andrews, UK (2013)
N. Prantzos: Nucleosynthesis and gamma-ray lines, 8th INTEGRAL Workshop "The Restless Gamma-ray Universe", Dublin, Ireland (2010)
N. Prantzos: Topics on Galactic Chemical Evolution, 11th Symposium on Nuclei in the Cosmos, Heidelberg, Germany (2010)
N. Prantzos: Composition and acceleration of Galactic Cosmic Rays, Cosmic Rays and their InterStellar Medium environment: CRISM, Montpellier, France (2011)
N. Prantzos: Nuclear Astrophysics: Past and Present Achievements, "The Origin of Cosmic Elements" Barcelona, Spain (2013)
F. Primas: Present and future perspectives of astronomical observations, Russbach School on Nuclear Astrophysics, Russbach, Austria (2013)
T. Rauscher: Astrophysical reaction rates for proton- and neutron-rich nucleosynthesis (and connections to experiments), The Origin of the Elements: A Modern Perspective, Trento, Italy (2011)
T. Rauscher: Origin of the p-Nuclides and Relevant Astrophysical Reaction Rates, The p-Process: Present Status and Outlook, Istanbul, Turkey (2011)
T. Rauscher: Complications in Determining Stellar Reaction Rates for Explosive Nucleosynthesis, 10th Int. Symp. on Origin of Matter and Evolution of the Galaxies (OMEG11), Osaka, Japan (2011)
T. Rauscher: Reaction Rates between the Driplines for Astrophysics, The shell evolution and the role of correlations in very neutron rich nuclei, Trento, Italy (2011)
T. Rauscher: Astrophysical reaction rates shape proton-rich, explosive nucleosynthesis, NIC XII, Cairns, Australia (2012)
T. Rauscher: New Insights into the α-Potential Mystery in the γ-Process, EU FP7 ENSAR/THEXO Workshop, ECT* Trento, Italy (2012)
T. Rauscher: Network calculations and nuclear inputs for astrophysics close to stability, WE-Heraeus-Workshop on Astrophysics With Modern Small-Scale Accelerators, Bad Honnef. Germany (2013)
T. Rauscher: Explosive nucleosynthesis and its connection to astrophysical reaction rates for unstable nuclei, 11th Int. Conf. on Nucleus-Nucleus Collisions, San Antonio, USA (2013)
T. Rauscher, Solving the Eu s-correlation problem in CEMP stars by using correctly defined stellar reaction rates, Open problems and future directions in heavy element nucleosynthesis , Debrecen, Hungary (2013)
T. Rauscher: Revision of the derivation of stellar rates from experimental data and its impact on Eu s-process contributions, NPA 6, Lisbon (2013)
R. Reifarth: Current experimental aspects of the s-process research, Workshop on Nuclear Physics in Hot Dense Plasmas, London, UK (2011)
R. Reifarth: Measurements of proton-induced reaction at the Experimental Storage Ring at GSI, p-process workshop, Istanbul, Turkey (2011)
R. Reifarth: Nuclear astrophysics at FRANZ (neutron-induced reactions for nuclear astrophysics), International Summer School "Nuclear Theory and Astrophysical Applications", Dubna, Russia (2011)
R. Reifarth: Current experimental developments for s-process nucleosynthesis, 14th International Symposium on Capture Gamma-Ray Spectroscopy and Related Topics (CGS14), Guelph, Canada (2011)
R. Reifarth: Approaches to LEPP measuring nuclear reactions, EMMI-JINA Workshop "Nucleosynthesis beyond iron and lighter element primary process", Darmstadt, Germany (2011)
R. Reifarth: Astrophysics with unstable nuclei at FAIR and FRANZ, ISPUN 2011 "The International Symposium on Physics of Unstable Nuclei", Hanoi, Vietnam (2011)
R. Reifarth: The Stellar neutron capture of $^{60}$Fe, 2nd workshop on Exotic Radionuclides from Accelerator Waste for Science and Technology (ERAWAST II), Villigen, Switzerland (2011)
R. Reifarth: Direct measurements of reactions for p-process nucleosynthesis, Open problems and future directions in heavy element nucleosynthesis , Debrecen, Hungary (2013)

R. Reifarth: Nuclear astrophysics with radioactive ions at FAIR, NPA6, Lisbon (2013)
R. Reifarth: The s-, i- and r-process in the laboratory, Russbach workshop on nuclear astrophysics, Russbach, Austria (2013)
K. Schmidt: by activation and in-beam gamma-spectroscopy,Precise study of the supernova reaction $^{40}Ca(\alpha,\gamma)^{44}Ti$ Open problems and future directions in heavy element nucleosynthesis , Debrecen, Hungary (2013)
K. Sonnabend: Investigations of neutron-capture reactions at FRANZ, NPA6, Lisbon (2013)
K. Szücs: KADoNiS-p: The astrophysical p-process database, Open problems and future directions in heavy element nucleosynthesis , Debrecen, Hungary (2013)
Thielemann F.-K.: The Astrophyisical Site(s) for Producing the Heavy Elements: Hints for solving the puzzle, Nuclear and Particle Astrophysics, Erice, Italy (2010)
Thielemann F.-K.: The Interplay of Nuclear Properties and Astrophysical Conditions in Stellar Evolution and Explosive Nucleosynthesis, Merging Particle Physics, Nuclear Physics and Astrophysics, From Quarks to Supernovae, Atagawa, Japan (2010)
Thielemann F.-K.: Did Nature produce superheavy elements? TAN 11, Physics and Chemistry of Transactinide Nuclei, Sochi, Russia (2011)
Thielemann F.-K.: Nucleosynthesis in Astrophysical Explosions and the Origin of Heavy Elements, Advanced Topics in Astrophysics Llafranc, Spain (2011)
F.-K. Thielemann: Nuclear Input, Stellar Simulations, Explosions, Remnants, Chemical Evolution, Observational Constraints, The Chemical Evolution of Galaxies, Basel, Switzerland (2011)
Thielemann F.-K.: Radioactivity and Nucleosynthesis as Probes of (core collapse) Explosion Models, Explosive Ideas about Massive Stars - from Observations to Modeling, Stockholm, Sweden (2011)
Thielemann F.-K.: Stellar Nucleosynthesis: the key to galactic evolution, Symmetries and Phases in the Universe, Kloster Irsee, Germany (2012)
F.-K. Thielemann: Supernovae and the r-process, Supernovae Illuminating the Universe, from Individuals to Populations Garching, Germany (2012)
F.-K. Thielemann: r-Process From Jet Ejecta of Magnetorotational Core Collapse Supernovae, Nuclei in the Cosmos XII, Cairns, Australia (2012)
F.-K. Thielemann: Magnetohydrodynamically-driven Supernova Jets, Ringberg Workshop on Nuclear Astrophysics, Tegernsee, Germany (2012)
F.-K. Thielemann: Nucleosynthesis of Massive Stars and Their Supernovae, Dust in Core Collapse Supernovae near and far: Understanding its formation and evolution, Asona, Switzerland (2012)
F.-K. Thielemann: Massive Stars and Their Supernovae, Workshop on Nuclear Astrophysics, Russbach, Austria (2013)
F.-K. Thielemann: How to disentangle the influence of mass models and astrophysical environment conditions, responsible for producing the r-process abundance pattern(s), Nuclear Masses and Nucleosynthesis, Bad Honnef, Germany (2013)
F.-K. Thielemann: Nucleosynthesis in Core Collapse Supernovae: Knowns and Unknown, Fifty-One Ergs, Raleigh/North Carolina, USA (2013)
F.-K. Thielemann: Understanding Massive Stars, “The Origin of Cosmic Elements”, Barcelona, Spain (2013)
F.-K. Thielemann: The Hunt for the Site(s) of the r-Process, Chemical evolution in the Universe: the next 30 years, Castiglione della Pescaia, Italy (2013)
M. Ugliano: Progenitor-explosion connection and remnant birth masses for neutrino-driven supernovae, NPA 6, Lisbon (2013)
A. Wallner: SUPRATEAMS: Supernova-produced radionuclides and trace elements studied by AMS, EuroGenesis Workshop, Dubrovnik (2010)
A. Wallner: Accelerator Mass Spectrometry - Applications within CoDustMas, Cosmic Dust as Diagnostics of Massive Stars, Vienna, Austria (2011)
A. Wallner: $^{60}Fe$, $^{244}Pu$ and nanodiamonds, "The Origin of Cosmic Elements”, Barcelona, Spain (2013)
K. Zuber: Metallicities in Stars - what solar neutrinos can do, NIC XII, Cairns, Astralia (2012)

- Posters

Farkas J., Gyürky Gy., Halász Z., Szücs T., Fülöp Zs., Somorjai E.: Half-life determination of 133mCe for activation cross section measurements (Abstr.: p. 233). 11th International Symposium on Nuclei in the Cosmos. NIC XI. Heidelberg, Germany, 19-23 July, 2010
Güray R. T.: EuroGENESIS (Origin of the Elements and Nuclear History of the Universe): Massive Stars as Agents of Chemical Evolution, NUFRA2011 (Third International Conference on Nuclear

Fragmentation From Basic Research to Applications), October 2 - 9, 2011, Kemer (Antalya), Turkey. (invited / talk)

Gyürky Gy., Halász Z., Farkas J., Fülöp Zs., Somorjai E., Szücs T.: Target characterization for the $^{130}$Ba(α,α)$^{134}$Ce gamma-process experiment. 11th International Symposium on Nuclei in the Cosmos. NIC XI. Heidelberg, Germany, 19-23 July, 2010

Halász Z., Gyürky Gy., Somorjai E., Szücs T., Farkas J., Takács M.P., Fülöp Zs.: In-beam (α,γ) cross section measurement for the astrophysical p-process. Nuclear Physics in Astrophysics. NPA 5. Eilat, Israel, 3-8 April, 2011

Halász Z., Gyürky Gy., Szücs T., Farkas J., Fülöp Zs., Somorjai E.: Alpha-induced activation reaction cross section measurement $^{130}$Ba relevant for the astrophysical p-precess (Abstr.: p. 238), 11th International Symposium on Nuclei in the Cosmos. NIC XI. Heidelberg, Germany, 19-23 July, 2010

Kiss G.G., Fülöp Zs., Gyürky Gy., Elekes Z., Farkas J., Somorjai E., et al.: Experimental investigation of alpha nucleus potential parameterizations along the Cd isotopic chain. Nuclear Physics in Astrophysics. NPA 5. Eilat, Israel, 3-8 April, 2011

Kiss G.G., Gyürky Gy., Szücs T., Kertész Zs., Farkas J., Fülöp Zs., Somorjai E., et al.: Measuring alpha-induce cross sections in the region of heavy p-nuclei: The case of $^{169}$Tm+alpha (Abstr.: p. 237). 11th International Symposium on Nuclei in the Cosmos. NIC XI. Heidelberg, Germany, 19-23 July, 2010

Kiss G.G., Mohr P., Fülöp Zs., Gyürky Gy., Elekes Z., Farkas J., Somorjai E., et al.: Investigating the variation of elastic alpha scattering cross sections in the A ~ 100 region. Nuclear Physics in Astrophysics. NPA 5. Eilat, Israel, 3-8 April, 2011

Özkan N.: Proton and alpha capture measurements on higher masses related to the p-process, First EuroGENESIS Workshop: Origins of the elements and nuclear history of the universe, Grand Hotel Park, Dubrovnik, Croatia ,24-26 November 2010

And many more

- Other (*please define*)

## Public outreach

- Press releases

Fülöp Zs.: Interview, and election as "researcher of the month", see OTKA (Hungarian Funding Agency) web page (Oct 2010)
Die Welt der Sterne im Untergrundlabor „Felsenkeller“,
http://tu-dresden.de/aktuelles/newsarchiv/2010/4/felsenkellertxt/newsarticle_view?set_language=en
(2012)
INTEGRAL helps unravel the tumultuous recent history of the solar neighbourhood,
http://sci.esa.int/jump.cfm?oid=48042 (2010),
New Helmholtz Young Investigators Groups Selected ( .. to Masche Member A. Arcones)
http://www.helmholtz.de/en/hermann/archive/2011/november_2011/artikel/19/neue_helmholtz_nachwuchsgruppen_ausgewaehlt/ (2011)
Helmholtz-Preis für den genauesten Test der Quantenelektrodynamik mit wasserstoffähnlichen Ionen,
http://www.ptb.de/de/aktuelles/archiv/presseinfos/pi2012/pitext/pi120109.html (2012)
Karlheinz Langanke und Friedrich-Karl Thielemann erhalten Lise Meitner Preis der European Physical Society,
http://idw-online.de/en/**news**486069 (2012)
Zwei «ERC Advanced Grants»: Universität Basel erhält 5,4 Mio. Franken (Adcanced Grants an F.-K. Thielemann und U. Jenal) (2012)
http://www.noodls.com/view/128D18A011CB77DFA12FBCA9B95B84CB55641B38#sthash.2tHKJT7n.dpuf
Klaus Blaum wird mit dem „Advanced Grant“ des Europäischen Forschungsrats ausgezeichnet,
http://www.mpi-hd.mpg.de/mpi/de/aktuelles/meldung/detail/klaus-blaum-wird-mit-dem-advanced-grant-des-europaeischen-forschungsrats-ausgezeichnet/
Klaus Blaum, G.N.FLEROV Prize winner 2013,
http://flerovlab.jinr.ru/flnr/history/flerov_prize_win2013.html
Mit Ionen-Pingpong Kräfte in Atomkernen sichtbar gemacht,
http://idw-online.de/en/news?print=1&id=539615 (2013)
ERC grant for Raphael Hirschi (online, relying on collaborations within Eurogenesis):
http://www.scientific-computing.com/news/news_story.php?news_id=1807 (2012)
ESO press release concerning the most massive stars: Stars just got bigger
http://www.eso.org/public/news/eso1030/ (2010)
INTEGRAL: Debris from stellar explosions in the Galaxy's fast lane, ESA Web story,
http://sci.esa.int/jump.cfm?oid=53245 (2013)

- National / international newspaper articles (presenting your CRP or part of your work)

Articles covering the press releases listed above,
e.g. first page of China Daily on July 23 2010 as well as in major UK newspapers after ESO press release.

- TV appearance

The discovery “Stars just got bigger” was reported on major TV news program (euronews, BBC, Channel4, Telesur, Hong Kong TV Pearl, ...)

- Radio appearance

Thielemann F.-K.: Element formation in the Universe, Deutschlandfunk
http://www.dradio.de/dlf/sendungen/forschak/1689284/

- Other (*please define*)

Weltenreise, a public theater event in Basel, University of Basel, http://www.weltenreise.unibas.ch/
A conversation about astrophysics with Mark Inglin, Science Time, University of Basel 19.11.2012, https://itunes.apple.com/ch/podcast/sciencetime-audio-podcast/id534526912
M. Hempel: Materie am Limit, Physik in unserer Zeit (1/2014), in press
M. Pignatari: “Swiss Pioneers”, International Innovation, issue 10/2012, pag. 16. Title: “Seeing stars”
Astronomical Complexity : “The Origin of the Elements”, Projects Magazin April 2013, p. 56, Insight Publishers
Keele University outreach programme http://www.astro.keele.ac.uk/Observatory/

## Other activities / outputs

- Patents

- Websites

http://www.mpe.mpg.de/gamma/science/lines/eurogenesis/MASCHE_home.html

- Other (please define)

## B.5. Feedback on the EUROCORES programme and EUROCORES scheme (up to 300 words)

Any other comments on the EUROCORES programme in particular or the EUROCORES scheme in general.

The EuroGenesis program in general plus our MASCHE CRP made it possible not only to meet at international conferences and discuss interesting issues of joint interest, it actually initiated joint planning, coordination and collaboration. This was a very positive experience.
The “technical/formal” way how everything started (how many funding agencies are needed to start a program? How many IP from how many different countries are required to form a CRP, how many APs are permitted) were to some extend actually a hindrance of productive and creative work.

## Section C. Self-assessment and follow-up

### C.1. Overall self assessment on the accomplishments of the CRP (up to 600 words)

Please provide your self assessment of the overall CRP from beginning to end in relation to your Full Proposal. Please describe how well the CRP has achieved its stated objectives and milestones as well as any changes or deviations that may have occurred.

While all groups, assembled within the CRP, had done research in the respective fields already, past research was performed by getting motivation for activities from the participation in conferences and from the literature. This has led (summarized over all groups) to a sizable output of innovative research results. But, the new aspect, emerging from our workshops, exchanges and annual meetings, was the joint planning of cross-subfield activities. This way, nuclear experiments entered into stellar models and explosion simulations, comparisons of different techniques for modelling stellar evolution have been performed in great detail, observational constraints were understood in a better way due to direct discussions with the observers, and the most important part was that due to our discussions, priorities and new research activities were started. This acting in a joint community with mutual exchange, led to much more productive and directed research efforts.

### C.2. Follow-up activities emerged as a result of the CRP and the programme (up to 300 words)

Please provide details of the most important new initiatives either in the national or an international context that have emerged as a result of the collaboration of this CRP and the programme.

Eurogenesis made it possible to gather the whole community. After this experience in large scale collaboration we had gathered the initiative to apply for a COST ACTION (pending), which does not have many of the restrictions mentioned above.

A dissemination meeting, to report on the overall successes of the program and discuss future directions (planned in Darmstadt in December) will hopefully also prepare the whole community to utilize Horizon 2020 in an effective way.

### C.3. Forward looking perspectives enabled by the programme (up to 300 words)

Please provide your views on how the CRP or the programme may have paved the way for enabling future initiatives, possibilities or breakthroughs.

As mentioned above: A COST ACTION and possibly utilization of Horizon 2020 calls.