European Reasearch Council

ERC Synergy Grant 2012
Research Proposal (Part B1)

GG ("Galileo Galilei") and GG on Ground: a very high sensitive experiment to probe the foundations of General Relativity

GGonGround

Corresponding Principal Investigator: **Anna M. Nobili**
Principal Investigator: **Guido Zavattini**
Corresponding Host Institution: **EGO**
Proposal full title: **GG ("Galileo Galilei") and GG on Ground: a very high sensitive experiment to probe the foundations of General Relativity**
Proposal short name: **GGonGround**
Proposal duration in months: **72**

Proposal Summary

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1 Proposal Part B1–Section 1

Example of link to a webpage: Galileo Galilei Web Page. Example of link to a webpage: GGonGround Synergy Grant Web Page.

The scientific proposal [max 15 pages, excluding the Budget Tables (obligatory), Ethical Issues Table (obligatory) and Annex (only if applicable), and the Security Aspects Letter (only if applicable)] Describe the scientific, technical, and/or scholarly aspects of the project demonstrating the groundbreaking nature of the research, its potential impact and research methodology. Describe the significant synergies, complementarity and added value of the group beyond the current work of the Principal Investigators to enable it to jointly achieve the project's scientific objectives. Indicate the fraction of each PI's working time that will be devoted to this project, a full estimation of the real project cost and any ethical considerations raised by the project. Indicate innovative ways of working together and how the core time spent together will be utilised.

2 Proposal Part B1–A. State of the art and objectives

a. State of the art and objectives: Specify clearly the objectives of the proposal, in the context of the state of the art in the field. When describing the envisaged research it should be indicated how and why the proposed work is important for the field, and what impact it will have if successful, such as how it may open up new horizons or opportunities for science, technology or scholarship. Specify any particularly challenging or unconventional concepts and approaches of the proposal, including multi - or interdisciplinary aspects.

GG on Ground Noise Budget				
	Test Masses Differential acceleration a @ $1.7 \cdot 10^{-4}$ Hz	a (ms^{-2})	$r = a\frac{T_d^2}{4\pi^2}$ (m)	Integration Time (d)
1. GG goal	$a_{GG} = \eta g(h)$ upconverted to 1 Hz	$8 \cdot 10^{-17}$ $\eta = 10^{-17}$ $h \simeq 600$ Km	$6 \cdot 10^{-13}$ $T_d = 540$ s	1
2. GGonGround goal	$a_{GGG} = 10^2 a_{GG}$ upconverted to 0.2–3 Hz	$8 \cdot 10^{-15}$	$2 \cdot 10^{-13}$ $T_d = 32.4$ s	30
3. Tilts/horiz. accelerations	$a_{tilt} = \frac{k_c}{mL}\frac{k_{shaft}}{M_{tot}gL_{tot}}\theta_{tilt}$	$10^{-6} \cdot \theta_{tilt}$ $\theta_{tilt} = \theta_{terrain} + \theta_{bearings}$ $k_c = k_{shaft} = 0.04$ Nm/rad $m = 10$ Kg, $L = 0.4$ m $M_{tot} = 50$ Kg $L_{tot} = 0.8$ m $\theta_{terrain} \simeq 5 \cdot 10^{-9}$ rad $\theta_{bb} \simeq 150 \cdot \theta_{terrain}$ $\theta_{ab} \leq \frac{1}{2}\theta_{terrain}$ $10^{-6}(\theta_{terrain} + \theta_{ab}) = 7.5 \cdot 10^{-15}$	$2 \cdot 10^{-13}$	30 30
4. Capacitance Bridge Unbalance	$a_{bridge} \ll a_{tilt}$ if $\chi_{bridge} \ll \frac{T_d^2}{4\pi^2}\frac{k_c}{mL}$ (satisfied)			
5. Capacitance ReadOut Noise			$(\frac{r}{\sqrt{Hz}} = 3 \cdot 10^{-9}\frac{m}{\sqrt{Hz}})$ $1.9 \cdot 10^{-12}$	 30
6. Laser Gauge Noise			$(\frac{r}{\sqrt{Hz}} = 10^{-10}\frac{m}{\sqrt{Hz}})$ $6.2 \cdot 10^{-14}$	 30
7. Thermal Noise	Negligible			30

Table 1: GG on Ground Noise Budget

3 Proposal Part B1–B. Methodology

b. Methodology Describe the proposed methodology and feasibility in detail including, as appropriate, key intermediate goals. Explain and justify the methodology in relation to the state of the art, including any particularly novel or unconventional aspects addressing 'high-gain/high-risk' balance, i.e. if successful the payoffs will be very significant, but there is a higher-than- normal risk that the research project does not entirely fulfil its aims.

GG on Ground Roadmap		
Time (Months)		
		GG on Ground achieved performance
	t_0	$a_0 = 8.5 \cdot 10^{-11}\ ms^{-2}$ (in INFN lab San Piero a Grado, Pisa)
		First 18–month period targets
6	$t_0 + 6$	$a_1 = 2.8 \cdot 10^{-12}\ ms^{-2}$ ($T_d = 14.8\ s\ \ r_{cap} = 1.45 \cdot 10^{-8} m/\sqrt{Hz}$; can be done with capacitance readout and ball bearings, requires weaker joints by a factor 4)
12	$t_0 + 12$	$a_2 = 7.7 \cdot 10^{-14}\ ms^{-2}$ ($T_d = 40\ s\ \ r_{cap} = 3 \cdot 10^{-9} m/\sqrt{Hz}$; can be done with capacitance readout and ball bearings, requires 10 times longer suspension shaft)
18	$t_0 + 18 = t_1$	$a_3 = 5.6 \cdot 10^{-15}\ ms^{-2}$ ($T_d = 40\ s\ \ r_{laser} = 220\ pm/\sqrt{Hz}$; requires preliminary version of air bearings and laser metrology)
		Second 18–month period targets
24	$t_1 + 6$	
30	$t_1 + 12$	
36	$t_1 + 18 = t_2$	$a_4 = 7.7 \cdot 10^{-16}\ ms^{-2}$ ($T_d = 40\,s\ \ r_{laser} = 30\ pm/\sqrt{Hz}$; requires air bearings with full performance and improved laser metrology)
		Third 18–month period targets
42	$t_2 + 6$	Install rotating whirl control (as required in GG)
48	$t_2 + 12$	Demonstrate on bench laser gauge noise to $r_{laser} = 1\ pm/\sqrt{Hz}$ @ $1 - 2\ Hz$
54	$t_2 + 18 = t_3$	Optimize test masses different composition, manufacture test masses, measure their quadrupole moments and confirm sensitivity (test coating)
		Fourth 18–month period targets
60	$t_3 + 6$	Measure patch effects and demonstrate that they are not relevant; Phase Sensitive Detection @ 24 h in preparation for GG in space data analysis
66	$t_3 + 12$	Manufacture suspensions required for GG, meassure elastic constants and quality factors and confirm requirements of GG
72	$t_3 + 18 = t_4$	Test PZTs and inchworms to demonstrate feasibility of balancing in GG

Table 2: GG on Ground Roadmap

4 Proposal Part B1–C. Resources

c. Resources (incl. project costs) It is strongly recommended to use the budget table template to facilitate the assessment of resources by the panels (see Annex 3). The summary and the breakdown of the budget following the template is subdivided in personnel costs, equipment and infrastructure, consumables, travel, publication costs, and any envisaged subcontracts. This table has to be provided by each PI and a final table will summarise the overall budget breakdown for the roject. These figures should be summarised in the financial information form A3 as well (although according to host institutions and not according to PIs).

Describe the size and nature of the Synergy group, including each PI and where appropriate, their key team members and their roles. The participation of team members engaged by another institution besides that of the participating PIs should be justified in relation to the additional financial cost this may impose to the project (see section 1.1.3 of this guide). Describe other necessary resources, such as infrastructure and equipment. Specify any existing resources that will contribute to the project. It is advisable to include a short technical description of the equipment requested, a justification of its need as well as the intensity of its planned use. Please ensure that a short narrative description is provided for all budget lines for which funding is requested.

State the amount of funding considered necessary to fulfil the objectives for the duration of the project. This should be a reasoned estimate of the projects costs. Each PI should take into account the percentage of their dedicated time (each PI is expected to devote at least 30% of their total working time to the ERC-funded project while spending at least 50total working time in an EU Member State or Associated Country) to run the ERC-funded activity when calculating their personnel costs. Include the direct costs of the project plus a flat rate financing of indirect costs on the basis of 20% of the total eligible direct costs (excluding subcontracting and the costs of reimbursement of resources made available by third parties which are not used on the premises of the beneficiary) towards overheads.

The project cost estimation should be as accurate as possible. The evaluation panels assess the estimated costs carefully; unjustified budgets will be consequently reduced.

There is no minimum contribution per year; the requested contribution should be in proportion to the actual needs to fulfil the objectives of the project.

5 Proposal Part B1–D. Ethical and Security–Sensitive Issues

d. Ethical and Security-Sensitive Issues The Ethical Issues Table serves to identify any ethical aspects of the proposed work. This table has to be completed even if there are no issues (by confirming in the table that none of the ethical issues apply to the proposal).

If any of the issues in the Ethical Issues Table (in part B1) apply to the proposal, the Corresponding PI must provide a brief explanation of the ethical issue involved and how it will be dealt with appropriately. Annex 2 of this guide describes the ethics review process and gives guidance on the completion of the Ethical Issues Table. An Ethical Issues Annex template is provided in EPSS, which has to be uploaded in case there are any ethical implications in the proposal.

The PIs are encouraged to include any supporting documentation, such as any authorisation they may already have. This will allow a more effective ethical clearance and an accelerated granting process if the proposal is retained for possible funding (A full description of the Ethics Review is provided in the in ERC rules for the submission of proposals and the related evaluation, selection and award procedures relevant to the Ideas Specific Programme:
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:327:0051:0070:EN:PDF)

Please upload this Ethical Issues Annex and any related documents in the 'Extra Annexes Upload' section included in the EPSS tab 'part B & annexes'.

Please be aware that no grant agreement can be signed by ERCEA prior to a satisfactory conclusion of the ethical review.

A dedicated website that aims to provide helpful information on ethical issues is now available at: http://cordis.europa.eu/fp7/ethics_en.html

Security-Sensitive Issues

ERC actions may be classified if they are considered as security-sensitive. The proposal can be considered security-sensitive for a variety of reasons, most notably: if the proposed action may need to handle classified information as background;
if some foreground is planned to be classified.

In addition, a proposal may also be considered as sensitive, independently of any security classification, if it plans to exchange material subject to transfer or export licensing. If export licences (or intra EU licences) are required for carrying out the planned work, applicants must clarify the requirement to have such export or transfer licences and must provide a copy of export or transfer licences (or of the requests). For further information on security-sensitive issues relevant to this Call, see Annex 5 of this guide.

If your proposal is security-sensitive, describe (in your description of work) why, which are the participants concerned by the sensitivity and what are the measures foreseen to cope with it. Please annex to your proposal a first version of the Security Aspects Letter (SAL) and its annex, Security Classification Guide (SCG) as part of the proposal using the templates provided in Annex 5.

Describe also your experience in managing security-sensitive projects, if relevant.

Please note that these security related parts of the proposal are not considered as part of the scientific evaluation. These will only be considered in the scrutiny of security-sensitive actions.

The pages of the Budget Tables, the Ethical Issues Table included in part B1 and additional Annexes (separate documents) where relevant in the case of ethical issues and/or security-sensitive subjects do not count towards the maximum page limit for part B1.

6 Proposal Part B1–Budget Tables

In part B1 the use of the following budget table is strongly recommended. The budget table (including the declaration of the level of involvement) should be filled in for the Corresponding Principal Investigator and each Principal Investigator. Please include a summary table (using the same template) for the entire budget. Note that the budgets are broken down in 4 financial reporting periods of 18 months each. Name of Corresponding Principal Investigator or Principal Investigator (1 table /PI).

Corresponding Principal Investigator **Anna M. Nobili**						
	Cost Category	Months 1–18	Months 19–36	Months 37–54	Months 55–72	Total
Direct Costs	Personnel:					
	PI					
	Senior Staff					
	Post Docs					
	Students					
	Other					
	Total Personnel:					
	Other Direct Costs:					
	Equipement					
	Consumables					
	Travel					
	Publications, etc					
	Other					
	Total Other Direct Costs					
	Total Direct Costs					
Indirect Costs	Max 20% of Direct Costs					
Subcontracting Costs	(No Overheads)					
Total Costs of Project:	(By Year and Total)					
Requested Grant:	(By Year and Total)					
Working time the PI dedicates to the project over the period of the grant						
		Months 1–18	Months 19–36	Months 37–54	Months 55–72	
		100%	100%	100%	100%	

Table 3: Budget Table 1 for the Corresponding Principal Investigator Anna M. Nobili

Principal Investigator **Guido Zavattini**						
	Cost Category	Months 1–18	Months 19–36	Months 37–54	Months 55–72	Total
Direct Costs	Personnel:					
	PI					
	Senior Staff					
	Post Docs					
	Students					
	Other					
	Total Personnel:					
	Other Direct Costs:					
	Equipement					
	Consumables					
	Travel					
	Publications, etc					
	Other					
	Total Other Direct Costs					
	Total Direct Costs					
Indirect Costs	Max 20% of Direct Costs					
Subcontracting Costs	(No Overheads)					
Total Costs of Project:	(By Year and Total)					
Requested Grant:	(By Year and Total)					
Working time the PI dedicates to the project over the period of the grant						
		Months 1–18	Months 19–36	Months 37–54	Months 55–72	
		100%	100%	100%	100%	

Table 4: Budget Table 1 for the Principal Investigator Guido Zavattini

Summary Table for the Entire Budget						
	Cost Category	Months 1–18	Months 19–36	Months 37–54	Months 55–72	Total
Direct Costs	Personnel:					
	PI					
	Senior Staff					
	Post Docs					
	Students					
	Other					
	Total Personnel:					
	Other Direct Costs:					
	Equipement					
	Consumables					
	Travel					
	Publications, etc					
	Other					
	Total Other Direct Costs					
	Total Direct Costs					
Indirect Costs	Max 20% of Direct Costs					
Subcontracting Costs	(No Overheads)					
Total Costs of Project:	(By Year and Total)					
Requested Grant:	(By Year and Total)					

Table 5: Summary Table for the Entire Budget

7 Host Commitment Letter

The (Please enter name of the legal entity that is associated with the proposal and may host the corresponding principal investigator and the project in case the application is successful),.... see page 66 of the guide

8 Ethical Issue Table

On page 59: The Ethical Issues Table (see Annex 2b) has to be completed even if there are no ethical issues in part B1 (simply confirming that none of the ethical issues apply to the proposal).

	Research on Human Embryo/ Foetus	YES	Page
	Does the proposed research involve human Embryos?		
	Does the proposed research involve human Foetal Tissues/ Cells?		
	Does the proposed research involve human Embryonic Stem Cells (hESCs)?		
	Does the proposed research on human Embryonic Stem Cells involve cells in culture?		
	Does the proposed research on Human Embryonic Stem Cells involve the derivation of cells from Embryos?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	**YES**	

	Research on Humans	YES	Page
	Does the proposed research involve children?		
	Does the proposed research involve patients?		
	Does the proposed research involve persons not able to give consent?		
	Does the proposed research involve adult healthy volunteers?		
	Does the proposed research involve Human genetic material?		
	Does the proposed research involve Human biological samples?		
	Does the proposed research involve Human data collection?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	**YES**	

	Privacy	YES	Page
	Does the proposed research involve processing of genetic information or personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?		
	Does the proposed research involve tracking the location or observation of people?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	**YES**	

	Research on Animals	YES	Page
	Does the proposed research involve research on animals?		
	Are those animals transgenic small laboratory animals?		
	Are those animals transgenic farm animals?		
	Are those animals non-human primates?		
	Are those animals cloned farm animals?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	**YES**	

	Research Involving non-EU Countries (ICPC Countries)	YES	Page
	Is the proposed research (or parts of it) going to take place in one or more of the ICPC Countries?		
	Is any material used in the research (e.g. personal data, animal and/or human tissue samples, genetic material, live animals, etc) : a) Collected in any of the ICPC countries?		
	b) Exported to any other country (including ICPC and EU Member States)?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	**YES**	

	Dual Use	YES	Page
	Research having direct military use		
	Research having the potential for terrorist abuse		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	**YES**	

9 Proposal Part B2–Section 1

The Principal Investigators

Each of the Principal Investigators must provide a list reflecting their track record. This can be either an 'early achievement track-record' (for PIs 2 to 12 years after their PhD) or a '10-year track-record' (for advanced researchers) chosen by the applicants based on which is most appropriate for their career stage. The evaluation experts will be instructed to judge each PI against the benchmarks relevant to his/her career stage. The experts will also pay particular attention to the joint effort of the group that may be built around specialised infrastructure, or that allow for new combinations of skills and disciplines, or the bringing together of researchers from different institutions, sectors or countries.

10 Proposal Part B2–A. Curriculum Vitae

a. Curriculum Vitae (max 2 pages for each PI):

In addition to the standard academic and research record, the CV should include a succinct 'funding ID' which must specify any current research grants and their subject, as well as any ongoing application for work related to the proposal. This facilitates the proper assessment of the proposal and the granting process in case the proposal is retained for funding. Any research career gaps and/or unconventional paths should be clearly explained. Peer reviewers will take this into consideration when assessing the PI's quality and career progression.

11 Proposal Part B2–B Track-Record

b. Track-Record

Early achievement track-record (max 2 pages for each PI):
The PI should list: his/her activity as regards: 1. Publications in major international peer-reviewed multi-disciplinary scientific journals and/or in the leading international peer-reviewed journals, peer-reviewed conferences proceedings and/or monographs of their respective research fields, indicating the ten best, those without the presence as co-author of their PhD supervisor, and information about the citation response they have attracted. 2. Granted patent(s) (if applicable).
3. Invited presentations to peer-reviewed, internationally established conferences and/or international advanced schools (if applicable).
4. Prizes and Awards (if applicable).
or
10-Year track-record (max 2 pages for each PI):
The PI should list his/her activity over the past 10 years (dated from the deadline of the call) as regards:
1. A list of the top 10 publications, as senior author (or in those fields where alphabetic order of authorship is the norm, joint author), listing all authors, in major international peer- reviewed multi-disciplinary scientific journals and/or in the leading international peer-reviewed journals and/or peer-reviewed conferences proceedings of their respective research fields, also indicating the number of citations (excluding auto-citations) they have attracted.
2. Research monographs, chapters in collective volumes and any translations thereof (if applicable).
3. Granted patents (if applicable).
4. Invited presentations to peer-reviewed, internationally established conferences and/or international advanced schools (if applicable).
5. Research expeditions that the applicant has led (if applicable).
6. Organisation of International conferences in the field of the applicant (membership in the steering and/or programme committee) (if applicable).

7. International Prizes/Awards/Academy memberships (if applicable).
8. Memberships to Editorials Boards of International Journals (if applicable).

The above mentioned page limits for sections 2a and 2b apply individually, i.e. maximum 4 pages per PI.

12 Proposal Part B2–C. Extended Synopsis

c. Extended Synopsis of the scientific proposal (max 5 pages)

The extended synopsis should be a stand-alone description of the scientific proposal, including the scientific feasibility of the project, with particular attention to its ground-breaking nature and how it may open up new horizons or opportunities for research. Describe the proposed work in the context of the state of the art of the field. References to literature should also be included. It is important that the extended synopsis contains minimum information relevant to the evaluation criteria (working arrangements, core time and resources, methodology), since the panel may only evaluate part B2 at step 1 in case of oversubscription49 (see section 1.3.2 on the evaluation process).

Specify briefly the commitment of each PI to the project. (According to the evaluation criteria specified in the Work Programme 2012 the Principal Investigators have to be strongly committed to the project and expected to devote at least 30% of their total working time to the ERC-funded project and spend at least 50% of their total working time in an EU Member State or Associated Country.)