CONFIDENTIAL

Referent nr. 01

Title: From theory to events in the LHC experiments within hours.
Code: 016.109.005
PI: Dr. M.G. Herquet

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1. Assessment of the quality of the researcher

a. What is your opinion on the past performance of the researcher (as demonstrated by his/her doctoral thesis, publications, and other relevant achievements)?

Good record for such a young researcher, just having started his first postdoc after PhD. He has contributed to the software project MadGraph/MadEvent which is a much used program in high energy physics theory/phenomenology. The report on this is a much cited "very well-known" publication. His other papers are quite reasonably cited. He has been very active in the community by participating in meetings and giving talks, often on MadGraph/MadEvent.

b. In what way does the applicant possess an outstanding talent for academic research and would you rank him/her among the most talented post-doctoral researchers you know in the area to which the proposal relates?

Since I have not met him or seen him in action at meetings or so, I can only judge based on his application and publications. I cannot really say whether he is really outstanding, but he seems to have a strong driving force and ability for software development based on theoretical physics. This is also the focus of his research plan.

2. Assessment of the quality of the proposal

a. Please comment on the scientific or technological relevance of the problem, as well as the originality and challenging content of the proposal.

The general content of the proposal is very good, since it is very worth while to develop such software tools. They will be extremely useful for analyzing complex theories and confronting them with data from the LHC. The proposal is certainly challenging since it requires to construct advanced programs to solve theoretical problems and simulate complex events. Since this is a further development of existing software, the originality is not a priory clear - that depends on how problems are solved, which is not described in detail.

b. To what extent is the proposed method suitable? Please comment.

The method is very suitable, being based on the well established MadGraph/MadEvent.

c. What are the innovative aspects of the proposal? Will the research break new ground by generating new concepts, a deeper understanding, new methods, etc.?.

This is harder to judge, since the section "Approach and Innovation" is not so specific when it comes to the details. The example given by "including automatic calculations of NLO corrections" is very good, but it is not specified how this difficult task will be solved and carried through.

d. What is your opinion on its potential to make a major contribution to the advancement of scholarship, science or technology (academic impact)?.

The planned software, if successfully developed, can certainly be much used and thereby have a substantial impact in the community of high energy physics research. Depending on whether new methods of more general applicability are developed, such methods could also become useful in other areas of science and technology. This is, however, hard to judge based on the available information at this stage.

3. Assessment of the non scientific research impact

a. What is your opinion on the indicated cultural, social, technological or economic impact of the research?

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b. Does the applicant realistically assess the non scientific impact of the proposed research?

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4. Final assessment

a. How do you assess the application in its entirety? Please comment.

Interesting and very worth while project. Somebody should fund this kind of development somewhere, so why not this project at NIKHEF?

b. Could you please summarize or briefly comment (point by point) on the strengths and weaknesses of the proposed research? Please give both strengths and weaknesses:

Strengths: excellent basis in terms of MadGraph/MadEvent, indicated development of great value, applicant has knowledge/training on this. Applicant shows strong activity and the driving force needed to carry through the project. Overall project plan is good and seems realistic. NIKHEF is a very good place for this project due to its infrastructure and people with expertise on computational theoretical physics.
Weaknesses: Not so detailed on what physics problems, theoretical methods and computational methods that may be used.

c. How Please give the scoring for your final assessment A+ / A / B / UF / U *

A, although I hesitate somewhat due to the stated weakness which might motivate a B.

CONFIDENTIAL

Referent nr. 02

Title: From theory to events in the LHC experiments within hours.
Code: 016.109.005
PI: Dr. M.G. Herquet

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1. Assessment of the quality of the researcher

a. What is your opinion on the past performance of the researcher (as demonstrated by his/her doctoral thesis, publications, and other relevant achievements)?

Despite the young age of the applicant, I think that he has already shown strong research capabilities, having 5 publications on international journals and quite an impressive number of talks, lectures and international seminars delivered around the world.

b. In what way does the applicant possess an outstanding talent for academic research and would you rank him/her among the most talented post-doctoral researchers you know in the area to which the proposal relates?

In the area he proposes to work, he is surely one of the best young researcher "on the market", having already demonstrated his capabilities during his PhD with publications and collaborations with the MadGraph/MadEvent team.

2. Assessment of the quality of the proposal

a. Please comment on the scientific or technological relevance of the problem, as well as the originality and challenging content of the proposal.

The complexity of nowadays calculations in quantum field theory applied to particle physics at hadron colliders, when trying to give quantitative predictions for final-state observables and analysis, has become very high. In fact, the number of Feynman diagrams that have to be considered and the complexity of the final state is such that no calculation done by hand is possible any longer. Only the use of automated computer programs can deal with this task. Under this perspective, the proposed project is very useful in view of the complex analysis that a collider like the LHC demands.

b. To what extent is the proposed method suitable? Please comment.

The proposed project aims to complete the full automation of the generation
of unweighted events at a hadron collider, starting from a Lagrangian, going through the Feynman diagrams and the calculation of cross sections, down to the generation of events ready for the full-detector simulation.
In view of the study of signals of New Physics at the LHC, the possibility the easily go from a proposed Lagrangian down to the generation of differential cross sections is of paramount importance.

c. What are the innovative aspects of the proposal? Will the research break new ground by generating new concepts, a deeper understanding, new methods, etc.?.

The proposed project needs a lot of hard work in trying to merge different models into a unique scheme, in an easy and "friendly way" in order to ease the very prone-to-error task of the calculation of cross sections at tree level.

d. What is your opinion on its potential to make a major contribution to the advancement of scholarship, science or technology (academic impact)?.

I think that these kind of tools are very important for serious phenomenology studies at the LHC. In fact, with these tools available, most of the effort will no longer be devoted to the calculation of differential cross sections but to the study of the best ways to distinguish signals from backgrounds, to develop cuts and variables able to highlight any discrepancy with respect to the Standard Model predictions.

3. Assessment of the non scientific research impact

a. What is your opinion on the indicated cultural, social, technological or economic impact of the research?

Since this proposal has scientific bases, it is quite difficult to asses the non-scientific impact of this research. Although the project is very valid, I doubt it has "social or economic" impact. But I would say the same for any proposal in High Energy Phenomenology.

b. Does the applicant realistically assess the non scientific impact of the proposed research?

I do not think that there is a "non-scientific impact" to assess.

4. Final assessment

a. How do you assess the application in its entirety? Please comment.

I think that the applicant will give very valid contributions to Physics Phenomenology and that his project is very relevant in view of the start of the LHC and very welcome by both the experimental and the theoretical community.

b. Could you please summarize or briefly comment (point by point) on the strengths and weaknesses of the proposed research? Please give both strengths and weaknesses:

STRENGTHS
1) The applicant plans to work on the further development of very useful tools for the automatic generation of events and cross sections starting from a proposed Lagrangian or vertex/propagator Feynman rules.

2) This will produce quicker generation of events for experimental analysis and detector calibration, background and signal studies.

3) This will naturally bring a strong interplay between the experimental and the theoretical community.

WEAKNESSES
1) Maybe a point of weakness for such a project is the complete neglection of higher order terms, beyond the tree-level approximation. But I'm sure that this is the next project in line for the "MadGraph/MadEvent team".

c. How Please give the scoring for your final assessment A+ / A / B / UF / U *

A

CONFIDENTIAL

Referent nr. 03

Title: From theory to events in the LHC experiments within hours.
Code: 016.109.005
PI: Dr. M.G. Herquet

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1. Assessment of the quality of the researcher

a. What is your opinion on the past performance of the researcher (as demonstrated by his/her doctoral thesis, publications, and other relevant achievements)?

I do not know Dr Herquet personally, but - by judging his publications and achievements - I am reassured that he is a promising your researcher. He certainly deserves to pursue his post-doctoral career further, particularly because his current research interests may impinge greatly on the physics analyses to be carried out at the upcoming Large Hadron Collider (LHC).

b. In what way does the applicant possess an outstanding talent for academic research and would you rank him/her among the most talented post-doctoral researchers you know in the area to which the proposal relates?

Based on his publications and achievements to date I would not rank him amongst the most talented researchers I know, of similar experience and/or seniority. However, he is certainly amongst the top 20% of his peers. It is in my opinion too early to attempt establishing whether the applicant possesses an outstanding talent for academic research, primarily because he is rather young and has always worked with senior researchers. If it were the case though, I would have expected to see already some evidence of this outstanding talent, like publications as sole author, prestigious early appointments (e.g., individual Fellowships, to CERN, FP7 and the like), securing of substantial grants, (micro) management of research teams, etc. Also notice that I have not been submitted reference letters from his senior collaborators, which may have helped discerning the applicant's research contributions so far.

2. Assessment of the quality of the proposal

a. Please comment on the scientific or technological relevance of the problem, as well as the originality and challenging content of the proposal.

The scientific relevance of the project is assured by the fact that the LHC experiments will be in great need of researchers like Dr Herquet, who can provide, maintain, upgrade, etc. a set of tools that are absolutely necessary to perform data analyses to test old and new physics theories. So, I am entirely convinced by the `Validation, improvement and development of new tools' part of the project. Somewhat less so in the case of the `Appllication of existing and newly developed techniques to phenomenological studies at hadron colliders'. Here, the description of the approach is rather generic. Taken for granted the availability of a suitable tool in the MadGraph/MadEvent environment for whichever physics models, it is not clear to me how the candidates intends to use it in order to tackle the real problem that we may encounter at the LHC, i.e., that some new physics may indeed be manifest in the data, yet, this may be ascribed to a variety of different models. Dr Herquet sheds little light on this, rather he simply lists several beyond the Standard Model scenarios without dwelling on how to distinguish between them, how to measure their fundamental parameter, etc. Overall, while the content of the proposal is certainly technically (but somewhat less so intellectually) challenging, it lacks in originality, as the development of this kind of (automated) tools is being pursued since several years by many researchers worldwide. Besides, there are competitor groups to the MadGraph/MadEvent one, who predate it, are equally established and whose tools have achieved a similar level of automatisation and sophistication

(e.g., the LanHEP/CalcHEP or CompHEP environment), which are not even mentioned in the proposal.

b. To what extent is the proposed method suitable? Please comment.

The method proposed is certainly suitable to attack the problem at hand, that is, the one of emulating signals (in a variety of new physics scenarios) and backgrounds in a hadronic collider environment. However, the one described is not the only approach possible. In fact,
while the one advocated here refers to the case of multipurpose tools, able to generate any physics process (in a rather automated way), there are also many dedicated tools on the market, which deal with a limited set of physics processes. There are pros and cons to either approach, to the extent they are both equally used within the particle physics community, which have not been discussed here, which I believe is inappropriate.
Finally, the speculation about automatising NLO calculations is appealing but very far fetching at the present moment or, at the very least, not dwelt upon here to make it credible.

c. What are the innovative aspects of the proposal? Will the research break new ground by generating new concepts, a deeper understanding, new methods, etc.?.

The answer to the second question is essentially not. The candidate intends to further develop a well establish tool along beaten tracks by several competing groups of researchers. The possibly innovative aspects of the proposal (automated development of NLO computations, generalisation to arbitrary theories) are not elaborated upon. The core activities of this research proposal are extremely necessary, no doubt, yet they build upon previous experience of the candidate with little innovation.

d. What is your opinion on its potential to make a major contribution to the advancement of scholarship, science or technology (academic impact)?.

The potential here is very strong. As the candidate spells out, the kind of tools being developed within this proposal will put the high energy particle physics community at large in the unprecedented position of confronting theory and data on a very short timescale, accurately (and possibly, depending on the actual tool) efficiently. This may well advance scholarship, but the merit of this will have to be schared across a large number of physicists as by no means the MadGraph/MadEvent environment alone will be able to see the entire process through. After all, it is basically a parton-level generator and ought to be combined with parton shower programs, emulators of the underlying event and of multiple scatterings, structure functions evolution, detector software, etc.

3. Assessment of the non scientific research impact

a. What is your opinion on the indicated cultural, social, technological or economic impact of the research?

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b. Does the applicant realistically assess the non scientific impact of the proposed research?

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4. Final assessment

a. How do you assess the application in its entirety? Please comment.

It would be a worthwhile effort carried out by a talented and enthusiastic young researcher, which will see fast advances over the years of funding provided under the Veni scheme, which will engage both sides of the particle physics community (theory and experiment) and that has the potential to greatly impact on the physics exploitation of LHC data. However, it collocates itself within a well established research stream, which predates the candidate efforts, with limited individual originality. This may well be compensated though by a significant expertise of the candidate in the chosen research field.

b. Could you please summarize or briefly comment (point by point) on the strengths and weaknesses of the proposed research? Please give both strengths and weaknesses:

Strenghts: 1) the complete, or even partial, accomplishment of this research programme is most important for the exploitation phase of the LHC; 2) it is technically challenging and has the potential to reach a wide range of users and enlist more developers, thereby generating a so-to-say cascade effect that would be extremely beneficial for the thorough investigation of forthcoming new physics data; 3) the candidate is probably amongst the top 20% of his peer group and clearly has the expertise needed to carry out the proposal and a significant track record in this connection.

Weaknesses: 1) the choice of topic is not original, as it mostly corresponds to further developing already existing tools; 2) elements of innovatation which may be intrinsic to the development of such tools have not been spelled out or dwelt upon in detail; 3) this research effort ought to be concerted with that of other groups on complementary physics aspects (related to event generation) and progress can be achieved only if common progress can be made (e.g., there is no point in being able to generate very complicated multiparticle processes, especially those in presence of QCD interactions, if this cannot be properly interfaced to parton shower programs, which in turn may require lengthy tuning to data, invalidating of erroneous assumptions, etc. 4) the proposal puts on equal footing both the development and exploitation side of the tool, yet, while I can recognise the candidate's strong credentials in the first respect I could not see guarantees of success on the candidate's part in the second respect, neither in the vision put forward in this application nor in his past accomplishments.

c. How Please give the scoring for your final assessment A+ / A / B / UF / U *

B to start with, but I am willing to upgrade to A if the candidates respond constructively to my criticisms.