No.	Description	Node	Secondments	Mark
1	The production of Higgs bosons in association with a b-quark is an important channel in scenarios, which are similar to supersymmetric or THDM extension of the Standard Model with a large \tan\beta. Similarly, charged Higgs bosons in such models may be produced in association with a top quark; both processes feature, at leading order, a b in the initial state. While, in principle, this process is fully known at NLO, including the dependence on the b-quark mass, its simulation in parton shower Monte Carlo event generators is not straightforward. This also holds true when the parton shower is matched to HO matrix elements. In all cases, the problem can be traced back to the consistent treatment of the b-mass in PDFs, matrix elements, and parton showers. The aim of this project is to investigate how different ways of incorporating the b-mass into the full simulation can be achieved, and how theoretical errors related to that treatment can be assessed. We therefore propose to have one ESR, based in Durham, to discuss solutions to that problem during secondments to UCL and Milan, and to implement solutions into the Sherpa event generator. The phenomenological implications of this result are then to be further investigated through a secondment to Freiburg, studying bg->Hb and gb->H^-t, including also anticipated results from b-associated photon, Z and W production.	Durham (Krauss)	UCL(Thorne) Milan (Forte) Freiburg (Jakobs, Schumacher)	
2	detailed study of H->gamma gamma channel with ATLAS , including VBF and associated production (and impact on the measurement of the various couplings of Higgs), and combination of various low mass channels (inside ATLAS and with CMS)	Orsay (Fayard)	Orsay (Djouadi) Oslo (Read)	
3	Higgs bosons in SUSY with non-minimal flavor violation Generation mixing in the squark sector is an important non-standard source of flavor violation. It has a significant impact also on the masses and couplings of the Higgs bosons induced by loop contributions, and on electroweak precision observables. The project aims on the calculation of the mass spectrum of Higgs bosons in the MSSM with general 3-generation squark mixing, and of the effective Higgs	MPI (Hollik)	Madrid (Herrerro) Santander (Heinemeyer)	

	couplings that are relevant for production and decay processes. Beyond one-loop order, also the leading 2-loop contributions will be included. Moreover, the effects on electroweak precision observables will be calculated and exploited for constraining the flavor-violating parameters (complementing flavor observables).			
4	Precision calculations and analysis strategies for WW scattering at the LHC The theory group in Freiburg is already working on vector-boson scattering at the LHC, specifically on the production of W+W+ + 2Jets final states including QCD, electroweak, and mixed NLO corrections, building upon the Monte Carlo generator Lusifer and the well established in-house loop machinery. In a next step we transfer the calculation for W+W+ + 2jets to the W+W- + 2jets. The experimental groups have investigated the LHC potential to determine Higgs-boson couplings and anomalous quartic gauge couplings using LO event generators. The aim of the PhD project is to merge the theoretical and experimental expertise to study WW scattering at a higher level of precision upon developing and using event generators that include NLO corrections. Specifically, we will optimize the selection strategy and the choice of observables. If a SM Higgs boson gets established, we can treat Higgs production via VBF with a decay to WW with high precision and explicitly test the SM prediction of weakly interacting weak gauge bosons. If no SM Higgs boson is in sight, the generator will serve as a platform to include and discriminate between alternative models for EWSB.	Freiburg (Dittmaier/Jakobs/Schumacher)	Torino (Passarino) Durham (Krauss	
5	Higgs bosons in the Next-to-Minimal Supersymmetric Standard Model In the NMSSM, the properties of the various Higgs bosons - masses, couplings, production cross sections and decays - can differ considerably from both the Standard Model and the MSSM. Given present constraints and using future results on Higgs searches, it will be verified whether and for which parameters the NMSSM provides a good fit to the data, and which additional analyses will be useful.	LPT Orsay (Ellwanger)	CERN (TH+EXP) Freiburg (TH+EXP)	
6	Probing electroweak symmetry breaking at the LHC	LAPTH (Bélanger,	LAPP ATLAS (exp) to	

	Depending on the outcome of the Higgs search by end 2012, we propose i) in the eventuality of a hint of a light Higgs, to reconstruct its properties through an effective approach working on the same time on the improvement of the calculations of backgrounds associated to this mass range exploiting for example our Diphox code. ii) In case of an exclusion, the interest is on electroweak corrections to multi-leg processes that could be associated to a strongly interacting sector of symmetry breaking.	Boudjema, Guillet, Herrmann, Pilon)	be confirmed MPI (Heinrich)	
7	part A: we have many NNLO codes on the market (Higgs or DY), with different interfaces, code bases. It would be of great utility to the community: unification of codes/interfaces, code optimization in terms of speed, to make them more accessible to the experimental community. part B: systematic comparison of recent NNLO (+NNLL) predictions (for WH, ZH, H->bb, H->gg, VBF; also with some focus on Higgs-pT) with MCs, and a systematic evaluation of Higgs coupling determinations at this order of perturbation theory.	Zurich (Grazzini, Dissertori)	Torino (Passarino) Freiburg (Jakobs, Schumacher)	
8	Accurate studies of Higgs Physics and EWSB phenomena at the LHC The aim of this project is applying the new generation of NLO tools built up on the MadGraph automation philosophy, such as MadLoop (http://arxiv.org/abs/arxiv:1103.0621) and aMC@NLO (http://amcatnlo.cern.ch) to perform realistic simulations of both Higgs signals and backgrounds at the Next-to-Leading order in QCD including parton shower and hadronisation effects. The Monte Carlo predictions will be directly confronted with the LHC data, also in connection with the activities of the ATLAS Experimental groups in Valencia and at CERN. In the case of no Higgs, a detailed 1-loop analysis of the SM experimental signatures will be performed to unravel possible signatures of alternative EWSB scenarios. If a particular New Model will be preferred by the data, the flexibility of the MadGraph-NLO framework allows to quickly produce the necessary Monte Carlo tools (including the dominant QCD corrections) needed for its final verification or exclusion.	Granada (Pittau) Valencia (Fuster Verdu) Louvain (Maltoni)	CERN (Mangano)	

9	After the discovery of a state compatible with a Higgs boson at the LHC the properties of this state will have to be investigated in detail. An analysis of Higgs-boson couplings to fermions and bosons at the LHC will be performed via an investigation of production cross-section times branching ratio channel by channel.	Santander (Heinemeyer, Martinez Rivero (CMS))	DESY (Weiglein, Raspereza (CMS), Tackmann (ATLAS)) CERN (Duehrssen (ATLAS))	
10	NLO electroweak corrections to triple-gauge-boson production Triple gauge-boson production processes are sensitive to quartic electroweak couplings and are a background to many new physics searches. Like vector-boson scattering they are of particular interestfor a heavy Higgs or if the Higgs boson is absent. The aim of this project is to calculate the electroweak NLO corrections for pp -> WWW and pp -> WWZ including leptonic vector-boson decays. The decays are treated in pole approximation. Off-shell propagators and spin-correlations are taken into account. The corrections are implemented into a Monte Carlo generator. Of particular interest are the electroweak corrections for differential distributions since these could fake anomalous gauge couplings.	Wurzburg (Denner)	Freiburg (Dittmaier) Torino (Passarino)	
11	VV scattering @ LHC as a probe of EWSB Torino is already home of a LO MC for 6-fermion final states. The main focus of the project will be on the gauge invariant definition and extraction of pseudo-observables like VV-scattering cross-section and partial waves (J=0,1), especially in the high mass region. A good understanding of these POs is essential to creating solid predictions, especially in the no-Higgs scenario; project handling requires development of sophisticated tools to convert experimental data into idealized but theoretically sound quantities. The principal goals of the project are to improve the LO environment, gradually extending it to NLO-level. At the same time one should note that the measurement of the VV scattering at the Atlas and CMS experiment is very challenging and statistically limited. Experimentally, all final states can be studied; while the fully leptonic ones have very little background, but a very small statistics, the semi-leptonic ones suffer from a very large background coming from top-top, VV +jets , V+jets production. A good quality (theoretical) control over the background is required and	Torino (Passarino)	Freiburg (Dittmaier) ETH (Dissertori)	

	understanding of the pile-up is mandatory, so that clever methods of analysis should be developed. Another experimental challenge is the discrmination of V polarization since it would allow to discriminate the presence of not of a Higgs boson.			
12	Development of automated NLO (+full EW) tools (HELAC), based on OPP, interfaced to patron showers (POWHEG) and phenomenological applications (e.g. top-Higgs associated production) Based on OPP develop automated NLO tools including tree-order, virtual and real corrections (HELAC-NLO). Work towards a full EWK NLO tool as well. Develop generic interfaces to patron shower algorithms matching at NLO (POWHEG). Develop phenomenological applications, for instance Higgs in association with heavy flavors: signals and relevant backgrounds. Work with experimenters interfacing tools and calculations to LHC data analysis. - Search for Higgs bosons in supersymmetric extensions of the standard model Description: start with current searches for SUSY particles and extend to searches for exclusive decays of Higgs bosonsin which the next-to-lightest gauging decays into the SUSY LSP and a light higgs boson. The signature is general enough to probe several other physics scenarios. The search will make use of the latest theoretical calculations of the topological properties of events with a very high mass scale and b-quarks in the final state. The project has very high training value because involves work which is on the boundary between electroweak symmetry breaking (highs search) and extensions of the standard model (supersymmetry). In addition, because of the nature of the final state, it is a good example of interplay between theory and experiment. into b-bbar states. These would be identified in cascades of SUSY particle decays,	NCSR (Papadopoulos) Athens (Sphicas)	Granada (Pittau) IFJ-PAN (van Hameren) Czakon/Worek in D Nijmegen (Kleiss)	
13	Single top and Charged Higgs In the Atlas/Nikhef single top group, we envisage a research project on the isolation of single top events as a background to charged Higgs production at LHC. In particular the work will be focused on the Wt channel, using the event weight package MadWeight. The driving motivation is to assess the precise NLO	NIKHEF (Laenen, Bentvelsen (ATLAS))	PSI (Signer)	

	corrections to this event weight and feed it back in the event weight tools. They can subsequently be used to search for charged Higgs particles. The Nikhef theory part of the project would involved carefully simulating the various signals, through the partly locally developed MC@NLO framework. This framework computes NLO cross section for both Wt and Ht, and includes decays with spin correlations. This would then be contrasted with the MadWeight approach. Here the expertise of Nikhef postdoc Pierre Artoisenet is important. The theoretical work would involve assessing how such correlations can help separate signal from background.			
14	One shared student between Nikhef/Louvain/Nijmegen @Louvain: pushing the automation of the MC@NLO approach and also the case of multi-parton final state matching at NLO. This could be provide also a contribution to better predictions for inclusive higgs production. @Nikhef: computing the non-leading next-to-eikonal corrections for the Higgs production cross section to all orders. Plus, FORM training. @Nijmegen: nonstandard Higgs, or possibly the `heretical Higgs' model (with Mexican bucket rather than Mexican hat).	NIKHEF (Laenen)	Nijmegen (Kleiss) Louvain (Maltoni)	
15	Study of spin correlations through top W or tau decas in decays of heavy states predicted from BSM models Several correlated skills are needd for such studies. - development or adaptation of tools such as Hdecay of J Kalinowski et al. or TAUOLA universal interface of Z. Was et al. This includes use of specally prepared weighted events methods. There is on-going work and collaboration on that directions already now between Cracow and Atlas, but research call for students. - design of `theoretical observables' sensitive to correlations constraining new physics. - validation how such observables survive inclusion of detector smearings, higher order effects due to extra jets or background contamination and if (what kind of adaptations) can be proposed.	IFJ-PAN(Kalinowski Richter-Was, Was)	Froidevaux experiment, Jakobs experiment, Desch experiment, Wermes experiment, Belanger, Atlas group in Annecy, A. Stahl CMS Aachen, Butterworth, Spira theory	

	- participation in data analysis for discovery or establishing limits.			
16	Radiative corrections and spin correlations for H->ZZ->4e and its separation from ZZ->4e (interfering) background. Again 3 steps of work can be defined: - development of special tools (correlated samples weighted events etc) - design of observables, see [1] and [2] above - validation when detector effects are taken into account - study how bremsstrahlung affects detector responses and background studies and finally data analysis of the signature itself	IFJ-PAN (Richter-Was, van Hameren, Was)	Papadopoulos, Butterworth, Froidevaux experiment, Fayard Orsay, experiment	
17	Precision measurements of W's and Z's through double differential distributions - development of special tools (correlated samples weighted events etc) - study of strategies for matching EW [2] (vaccum polarization resummed to all orders) with QCD, [3] - study of matching QED FSR with detector responses - study of precision of solutions based on such tools [2] - design of detailed observables (selection cuts etc) and validation of systematic errors. - participation in data analysis	IFJ-PAN (Richter-Was, Placzek,Was)	Dittmaier Butterworth, Froidevaux experiment, Boonekamp experiment	
18	Colour-neutral final states in LHC data within SM and beyond High statistic data samples at LHC exeriments for colour neutral final states like W/Z, WW, Higgs, Z' and other ones will inevitably require developing specialized Monte Carlo program(s) for this class of processes, incorporating MC parton shower, higher order QCD effects, QED+electroweak corrections, spin effects, database of PDFs, and BSM modelling. The treatment of initial state QCD is still not satisfactory (in spite of the recent progress) and requires fresh ideas. The proposed PhD would cover: (a) practical implementatation of the newly defined scheme of combining NLO QCD corrections and MC parton shower outlined in [3] (b) testing it against other calculations and experimental data	IFJ-PAN (Jadach, Placzek, Skrzypek)	Boonekamp experiment Thorne, Bluemlein, theory Hollik theory.	

	(c) Inclusion of QED+EW corrections in the hard process part (d) adjusting database of PDFs to the new factorization scheme used in [3] (s) implementing BSM extensions, following the needs of experiments.			
19	Improving tau decay Monte Carlo on the basis of data from low energies and consequences for phenomenology of LHC. High statistic data of Belle BaBar since long awaits analysis. This embarassing situation requires common effort form experimental community of low energies, Monte Carlo developpers and phenomenologists involved eg in work on Resonance Chiral Theory. Work in that direction is started already [4] and results of low energy work should be a good starting point for studies at LHC of: - backgrounds for rare B decays - improved analysis of signatures involving tau leptons, in particular improved systematic errors due to knowledge of tau decays.	IFJ-PAN (Was)	S. Eidelman, Nagoya group of Belle and Novosibirsk A. Stahl CMS Aachen A. Pich Madrid, J. Portoles Valencia theory Butterworth	
20	WW scattering and electroweak symmetry breaking mechanism The longitudinal W W scattering carries the most direct information about the mechanism of electroweak symmetry breaking, no matter whether a physical Higgs particle exists or some kind of strongly interacting physics is responsible for this breaking. Its experimental investigation as a function of its center-of-mass energy M_WW becomes feasible at the LHC. - theoretical work on models of WW unitarisation - development of new ideas for selection criteria for WLWL scattering - adaptation of existing computer codes to implement two above points - definition or adaptation of experimental signatures necessary for such purpose. Study of backgrounds.	IFJ-PAN(Kalinowski, Rosiek (th), M. Szleper (ex))	K. Desch, experiment C. Papadopoulos, theory K. Jakobs, experiment E. Richter-Was experiment	
21	The search for Higgs bosons or other states associated with electroweak symmetry breaking at the LHC can in general not be treated independently of possible other new physics beyond the Standard Model. The aim of this project is to explore the connection between these two new sectors by investigating processes at the LHC in which both are involved.	DESY (Weiglein, Raspereza (CMS))	Santander (Heinemeyer, Marco (CMS)) CERN (de Roeck (CMS))	

22	Knowledge of PDFs is crucial for the study of signal and background processes for Higgs discovery at the LHC: it affects cross-section calculations and experimental measurements. Promising subprocesses include gluon fusion and associated production with W/Z bosons or ttbar pairs,with the Higgs decaying into photon or b pairs associated with high-pt leptons or jets. For gluon fusion the main issue is the uncertainty on the gluon luminosity, which can be constrained from the study of dijet production. This involves the search for optimal observables, the problem of scale choices and several experimental issues related to jet reconstruction. For the WH and ttH analyses the main issue is the modeling of features such as the energy flow structures inside and between hadronic jets, which involves accounting for perturbative and non-perturbative aspects of event generation and specifically jet substructure studies. A common aspect is the use of cleaning techniques to deal with the subtraction of underlying event and pileup contributions. This project will systematically characterise the interplay between MC effects, experimental issues and PDF uncertainties using the bias-free approach of the NNPDF group.	Milano (Forte, Ferrra, Carminati (ATLAS))	Edinburgh (Ball, Del Debbio, Buckley) CERN (Mangano)	
23	The aim of the project is to study and develop experimental strategies to detect the contribution to H->ZZ->4l and ZZ->4l final state coming from the interference effects between gg->H->ZZ and gg->ZZ. Current studies form thoerists show that the interference can produce effects at the level of 5-10% when the Higgs search selection cuts are applied or for mH<<mZZ. From the experimental point of view hints related to the pointed interference can come from the precise knowledge of the invariant mass spectrum of 4 leptons from data and the accuracy of the estimation of the ZZ background. About 10fb-1 of integrated luminosity collected by the CMS experiment could be enough to know details about the ZZ to 4 leptons spectrum and unfold the experimental uncertainties. Analysis criteria to inspect the low 4l mass spectum need to be designed after performing a full sumulation of the processed and a complete reconstruction with the CMS tools. Background from Z+jets events affects the reconstruction of the signal events at low 4l mass and needs to be carefully estimated from data by inspecting several techniques like sidebands, matrix element, ABCD-based methods. Sensitivity to the interference effects can be gained by inspecting the using angular distributions between leptons from the 4l composite object decay in the 4l rest frame.	Bari (De Filippis)	Durham (Krauss) CERN	

	A 36 months full time person is required to inspect all the experimental issues connected to the reconstruction and of the 4l final state with an appropriate analysis and the evaluation of the background from data. An effective interaction with theorists and a well detailed simulation with appropriate MC generator programs is mandatory. For that reason 3 months of grant each for a couple of students to be spent with the collegues from the University of Durham and/or at CERN could be very useful to reach that target			
24	Higgs to 4 leptons precision study The aim is to provide a complete program package for the calculation of four lepton production at NLO in QCD, where the leptons originate from the decay of W or Z bosons. The program will include all interference effects of gg -> H -> VV -> 4l with the continuum background gg -> VV -> 4l, where V denotes a W or Z boson, and the leptons can have all possible flavours.Photons can also be included, as well as non-leptonic decays of W/Z if required. Massive quarks in the loops will also be included. At a later stage, form factors for anomalous couplings, and non-Standard-Model particles in the loops can also be added to the program.The virtual loop corrections, calculated with the program GOSAM, will be combined with the Monte Carlo program SHERPA to produce fully differential results which can be compared to experiment straightforwardly.The direct link to experiment is given by the project proposed by Nicola De Filippis (CMS collaboration, CERN and University of Bari).	MPI (Heinrich)	Bari (De Filippis (CMS)) Durham (Krauss) CERN	
25	Study of Higgs plus multi jet events We aim to produce a package for studying Higgs + jet cross sections at O(alphas^4) starting with H+1jet at NNLO, H+2jets at NLO and then H+0jet at NNNLO. This will enable a consistent description across event topologies and give reduced scale uncertainties as well as better handle on how the uncertainties are linked across jet multiplicities.	Durham (Glover)	Zurich (Gehrmann, Gehrmann De Ridder, Anastasiou) RAL (Murray)	
26	Multivariate methods in perturbative QCD. Experimental searches, cross-section measurements of small signals and coupling	ETH (Anastasiou, Dissertori (CMS))	Freiburg (Jakobs) Durham (Glover)	

	extractions are nowadays based on multivariate methods, such as artificial neural networks. On the other hand, computations in fixed order perturbation theory are traditionally restricted to simple differential distributions. We will develop a systematic method to evaluate multivariate observables, such as the output of Artificial Neural Networks or Boosted Decision Trees, at higher orders in perturbation theory. This will serve as the most qualified estimate of the theoretical uncertainty of such crucial observables.			
27	The student will work on experimental and phenomenological issues around extracting maximum information from boosted SM and BSM Higgs channels with 7 TeV ATLAS data, including exploring vector boson fusion and gluon-gluon production. They will also work on optimising the analysis in preparation for 14 TeV data. The student would be based primarily at UCL and would be a member of ATLAS, but would work very closely with, and be jointly supervised by Spannowsky.	UCL (Butterworth (ATLAS))	Durham (Krauss, Spannowsky)	
28	The precision electro-weak data and the recent LHC results all point to the mass of the Higgs boson being low, if it exists. In this region the most promising channel for its discovery, and subsequent study, is via its decay mode to two photons. The experimentalists (T. Virdee and P. Sphicas) have been lead players in the construction, and now in the physics exploitation in the CMS experiment. We would like to develop MVA analysis techniques in the search for the Higgs boson. We would extend our work into increasing the power of the search by combining results from all the other decay channels, firstly from CMS and then from ATLAS. Finding, or not, the Higgs boson will have far-reaching consequences for particle physics and physics in general. Theoretical input (2nd secondment, F. Krauss) will be needed for a full interpretation and understanding of whatever is the outcome. A doctoral student would learn much from the members of nodes and indeed from helping to carry out the work involved.	IC (Virdee (CMS))	Athens (Sphicas (CMS)) Durham (Krauss)	
29	Bottom quarks and Higgs Bosons The detailed understanding of the Higgs boson production cross sections in the Standard Model and its extensions includes bottom quark initial states. In the project reliable NLO and NNLO charm and bottom quark pdfs shall be provided,	DESY (Bluemlein, Riemann, Naumann (ATLAS))	ETH (Dissertori (CMS)) Durham (Glover)	

	extending present calculations w.r.t. an associated variable flavor number scheme (VFNS). This includes the multi-leg study of massless parton initial states, which, through loop effects including multi-leg functions with different masses, couple to bottom quarks forming Higgs bosons. On the phenomenological side, the VFNS and massless parton-loop approaches have to be compared w.r.t. to their reliability in inclusive production rate and kinematic distribution predictions. The latter analysis shall be performed together with the experimental groups. There are possibilities to study for other bosons in the SM and MSSM related studies for charm-strangebar initial states, with closely related technologies. The multi-leg and multi-loop expertise, including also pdfs, of the DESY-Z team provide a unique possibility for this project.			
30	Investigation of Jet Veto Efficiencies for Determination of Higgs Boson Properties in Vector Boson Fusion Higgs production in Vector Boson fusion is extremely important for the determination of Higgs boson couplings at the LHC. The experimental groups in Freiburg have a long experience in the investigation of the LHC potential using LO event generators and are currently involved in the analysis of the LHC data, covering several important channels including WW and tau tau final states. Precise measurements of couplings, the tensor structure of the HVV vertex and the CP properties require a very good understanding of the jet veto survival probabilities for Higgs boson production in association with two jets, both from vector boson fusion and gluon fusion. The goal of the ESR project is to optimize the sensitivity and to minimize the systematic uncertainties of a coupling measurements (selection strategy, uncertainty determination also from underlying event and pileup). Special focus will be given to a careful evaluation of theoretical uncertainties especially related to the acceptance of the jet veto, by comparing the simulations of the signal processes with MC event generators like SHERPA, MADGRAPH, aMC@NLO (including PS+ME matching at NLO level) and fixed order calculations as realized in HAWK etc. First comparisons between data and Monte Carlo simulation will already be performed using exisiting data on W/Z+jet production. In case no Higgs boson will be discovered equivalent studies will be performed for the determination of quartic gauge boson couplings in WW scattering at the LHC.	D2 (Jakobs, Schumacher, Dittmaier)	Durham (Krauss) Louvain (Maltoni)	