The research project was extended - at our request - to a fifth year thus this report covers the complete period. The scientific activity is reviewed below according to the main research topics instead of the chronological order.

(I) AdS/CFT integrability

This research topic is a new one, it is not mentioned in the proposal. The AdS/CFT duality states the equivalence between a closed (ten dimensional) string theory on AdS^5XS_5 and $N = 4$ super Yang Mills theory in four dimensions. Our main purpose was to compute some effects that are beyond the planar limit exploiting integrability. The tool we used are appropriate generalizations of Luscher's formula describing the finite size effects for masses (energies) of various particles (states). We also investigated how these quantities can be extended to the boundary situation corresponding to open string states or determinant type operators in SUSY Yang-Mills. We think it is a great success that Z. Bajnok was invited to give a plenary talk on his results on the international conference "Integrability in Gauge and String Theory" held at AEI Potsdam June 2009 and was also asked to write a summary chapter in the review devoted to the field [32]. The papers belonging to this topic are: [26] [25] [27] [28] [34] [36] [35] [30] [32]

(II) Form factor studies

This is also a major topic of our research, where we deal with the problematic of form factors (multi-particle matrix elements of local operators) in bulk and boundary integrable theories. We investigated thoroughly the finite volume effects on the form factors and were among the first ones to study form factors in boundary theories. Usually the information gained from form factors and integrability is checked against numerical results obtained from TCSA (truncated conformal space approximation). Using the finite volume form factors finite temperature quantities (correlators, one point function etc.) become available for studies. We also derived form factor axioms in two dimensional integrable defect theories. The papers belonging to this topic are: [1] [6] [10] [12] [13] [14] [16] [17] [18] [22] [31] [33] [29]

(III) Casimir effect

Our contribution is to describe the Casimir effect as a boundary phenomena thus giving a new angle on the effect. This viewpoint proved to be useful to deal with the boundary states. The papers belonging to this topic are: [5] [11] [20]

(IV) Study of (boundary) renormalization group flows

In the space of boundary theories the (super) conformal ones play the role of fixed points. Various flows between two such points can be generated by adding appropriate perturbations to the conformal models. Some of these flows are investigated by combining integrability and TCSA. The papers belonging to this topic are: [2] [3] [9] [7]

(V) Defects

Several aspects of defect theories are studied in [19] [33] [4]

(VI) Miscellaneous studies of integrable structures

In these investigations the use of NLIE and TBA is extended to previously un-investigated interesting (mainly boundary) questions. The papers belonging to this topic are:[15] [21] [23] [24]

Finally the results of two younger members of our group were summarized in their thesis-is [8] [22]

In the last (fifth) year of the research project we made progress on various subjects belonging to items (I) and (II) above. In [36] we proposed formulas for the Lüscher type finite size energy correction of multiparticle states on the *interval* and evaluated them for the simplest case in the

AdS/CFT setting. By this we determined the leading wrapping correction to the anomalous dimension of the simplest determinant type operator, which corresponds to a one particle state on the Y=0 brane.

In [35] we determined the anomalous dimension of the simplest nontrivial single impurity operator in the $\beta = 1/2$ deformed theory at six loops from the AdS/CFT correspondence. We evaluated the Lüscher correction at next-to-next-to-leading order (NNLO) in terms of multiple zeta values. The result can be simplified into the products of simple zeta functions and the same form of the correction is expected for the Konishi operator at six loops, too.

In [30] we propose that certain twists of the $su(2|2)$ S-matrix elements describe the beta-deformation of N=4 supersymmetric Yang-Mills theory. We compute the perturbative four-loop anomalous dimension of the Konishi operator of the deformed gauge theory from the Luscher formula based on these twisted S-matrix elements. The result agrees exactly with the perturbative gauge theory computations.

The aim of [32] is to introduce in a pedagogical manner the concept of Thermodynamic Bethe Ansatz designed to calculate the energy levels of finite volume integrable systems and to review how it is applied in the planar AdS/CFT setting.

In [29] we consider finite temperature correlation functions in massive integrable Quantum Field Theory. Using a regularization by putting the system in finite volume, we develop a novel approach (based on multi-dimensional residues) to the form factor expansion for thermal correlators. The first few terms are obtained explicitly in theories with diagonal scattering. We also discuss the validity of the LeClair-Mussardo proposal.