International Journal of Scientific Research in Computer Science, Engineering and Information Technology
ISSN : 2456-3307 (www.ijsrcseit.com)
doi : https://doi.org/10.32628/CSEIT206556

Multiobjective Interior Optimization Computational Methods for Electronics BCS Superconductivity

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Article Info
Volume 6, Issue 5
Page Number: 280-293
Publication Issue :
September-October-2020

Article History
Accepted : 15 Oct 2020
Published : 23 Oct 2020

ABSTRACT

Interior Optimization (IO) software and algorithms-programming were primarily presented in previous articles [3,4]. The mathematical framework of this new method, [Casesnoves, 2018-2020], was also proven [3,4]. The links among Interior Optimization, Graphical Optimization [Casesnoves, 2016-7], and classical methods in Nonlinear Equations Systems were developed. This paper is focused on software engineering with mathematical methods implementation in Multiobjective Interior Optimization programming as a primary subject. Second subject is Electronics applications of software in the field of BCS Superconductivity. These applications not only constitute a proof of the method, but also an useful BCS electronics numerical framework. They comprise a series of new BCS Equation optimization for multiple Type I superconductors, based on previous research for other different Type I ones previously published [3,4]. A Dual Optimization for two superconductors is also simulated. Several deductions/findings in computational technique for Multiobjective IO are guessed. Results are acceptable with low errors and 3D imaging demonstrations of the Interior Optimization utility.

Keywords : Interior Optimization (IO) Methods, Graphical Optimization, Systems of Nonlinear Equations, Electronics Superconductors.

I. INTRODUCTION

In previous publications, the Interior Optimization Method (IO) was presented and demonstrated [3,4]. Basically, it is a separation of variables method combined with Graphical Optimization 3D imaging/graphs.

Interior Optimization is not designed exclusively for finding out a specific global minimum, local minimum, partial-global minimum or variants of these singular parameters. Not always in Engineering and Physics is necessary to find optimal values for a group of equations conditioned to particular constraints of a laboratory/industrial/specific problem. Then, IO provides with the facility to select desired optimal

parameters in subsequent stages ordered and set applying the method of separation of variables.

This computational contribution is focused on programming methods for Multiobjective IO and Dual IO. The Electronics applications in Superconductors constitute both a demonstrative part and a useful application at BCS superconductivity field. The type of BCS algorithm selected is simple and practical.

In optimization with objective functions based on nonlinear systems of equations [5,6,8,24,28], or multiobjective-parameters constraints and other conditions, the task is rather difficult. Specifically this occurs in Physics and Engineering nonlinear optimization problems [6,7,9,13-17]. Large-scale amount of empirical data for algorithms/models implementation have to be adapted/fitted to models that involve a high number of equations, nonlinear many of them [7,9,13], constraints added. Stochastic Optimization, Monte Carlo, and random Methods are useful to save time and programming complications. These methods are based on random samples without taking all amount of data.

Multiobjective IO and Dual IO software implementation is difficult because the task involves a number of vectors and matrices to be implemented/ordered in the program code. The number of operations among matrices and vectors increase significantly. This difficulty, specially in Multiobjective/Dual IO is sorted by using double precision, minimization of vector exponentials and multiplications, and Matrix Algebra Methods. It is explained in Sections II-III.
Graphical Optimization involves the objective function visualization in 2D and 3D [4,5,8,11,12,16]. This implies that multiparameter formulas initially cannot be easily set for the 3D Graphical Optimization, unless a choice of 2 or 3 variables is done among several ones. This apparent difficulty, was the base to develop Interior Optimization in previous contributions [3,4]. It was defined as Interior-Graphical Multiobjective/Dual Optimization Method [Casesnoves, 2018].

In summary, the improved-study shows an advanced contribution for the Interior Nonlinear Optimization Method previously presented in [3,4]. The research line of the study is towards getting a common parameters in BCS algorithm for several Type I superconductors. However, it is quite focused on programming software and computational 3D imaging results. The first part is a Multiobjective IO for Mo, Zr, and Ti. Computational base/technique is explained/proven. The introductory simulation is a Dual IO also for Superconductors Type I, namely, Pt and Sn. The scheme of the method is shown, with sharps proof in applications at the electronics field. The most important innovation is Interior Multiobjective/Dual Optimization. Biomechanics, Medical Physics, Radiation Therapy and other applications are overviewed.

II. MATHEMATICAL METHOD AND SOFTWARE IMPLEMENTATION

The problem approached was previously explained, [3,4]. It is compulsory, for scientific clarity, to include the algorithm development in this section [3,4]. For software implementation IO, Multiple, and Dual IO is a system of nonlinear equations of several variables that has not, in general, unique solution [3,4]. If the objective optimization function becomes a number of nonlinear functions [12,13,14,27], such as

minimize

$$f_i(\vec{x}) = f_i(x_{1i}, x_{2i}, \dots x_{ni}) \quad (1)$$

for i=1,….m and n≠m generally
subject to

$$a_{1i} \leq x_{1i} \leq b_{1i}$$

$$a_{2i} \leq x_{2i} \leq b_{2i}$$
$$a_{ni} \leq x_{ni} \leq b_n \qquad (2)$$

or,

$$\begin{bmatrix} a_{1i} \\ . \\ . \\ a_{ni} \end{bmatrix} \leq \begin{bmatrix} x_{1i} \\ . \\ . \\ x_{ni} \end{bmatrix} \leq \begin{bmatrix} b_{1i} \\ . \\ . \\ b_{ni} \end{bmatrix}; \qquad (3)$$

These constraints are selected as simple here, in general could be more complicated. Then, setting equations members such as

$$f_i(\vec{x}) = f_i(x_{1i}, x_{2i}, \ldots x_{ni}) = 0$$

And Objective Function with L_1 Chebyshev Norm, for every f_i

$$\sum_{i=1}^{i=n} \left| f_i\left(\vec{x}\right) \right|_1 = 0 ; \quad \text{[Casesnoves Algorithm, 2018]} \qquad (4)$$

For programming in the following section, a nonlinear system of 100 equations was chosen, that is n=100.

The algebraic software developed for this contribution had various programming difficulties related to previous papers. To adapt the programs on Chebyshev L_1 norm for objective function with matrices in Dual Interior Optimization was complicated. Additional difficulties were the algebra changes in the subroutines to get functional the program for surface Graphical Optimization visualization. As it is detailed, [Sketch1], this requires mathematical changes-background. The software was developed in Matlab and is almost equivalent for FREEMAT also. Programming was selected to use subroutines that let rotate 3D images to obtain best visualization, [Sketch 1]. With this tool it was possible to see in images the sharp minimum zone to prove the mathematical statements. Freemat also offers this possibility in 3D surfactal implementation. There are more types of software that can perform this task properly.

Range for surfactal simulations Delanuay tiles was 100. In previous contributions, higher values were taken for high-accuracy [3,4,6,8,11,13,14,15,16]. However, optimization programs were designed for double precision, since were based on engineering software of extent number of previous publications [3-17].

INTERIOR OPTIMIZATION/DUAL OPTIMIZATION MATRIX ALGEBRA PROGRAMMING AND VECTOR OPERATION			
TYPE OF MATRIX	**SIZE**	**SETTINGS**	**NUMERICAL SIGNIFICANCE**
vector	[1,n]	to implement intervals	the length of the equations nonlinear system
vector	[1,n]	to implement intervals	to adapt the vector at matrix algrebra (transpose)
square matrix	[n,n]	at programming body	for surfactal construction of OF
Non-symmetrical matrix	[n, m]	at programming body	intermediate matrix algebra calculations
Non-symmetrical matrix	[m, n]	at programming body	intermediate matrix algebra calculations
vector	[1,n] [n,1]	at several program parts	exponentials, multiplications transpositions dot products
PROGRAM PARTS			
INTERVALS SETTING FOR VARIABLES	OPERATIONS AMONG VARIABLES	OPERATIONS FOR MODIFIED VARIABLES	SETTING SURFACTAL IMAGING CODE

Sketch 1.-Brief of Interior Optimization Method Matrix Algebra programming. The programming parts are also explained. The particular characteristics for every type of matrix is detailed. The setting on the program-software [Casesnoves, 2019-20] development is included.

To check complementarily the numerical results, both Fortran and F# subroutines in optimization were used. While Fortran proved to match the Graphical Optimization results, F# showed restrictions and, obviously, limits that discarded this type of language for accurate results in nonlinear optimization. These numerical data, although significant for verification, were not included in publication.

III. Pt AND Sn DUAL INTERIOR OPTIMIZATION RESULTS

The Superconductivity Theory framework is rather extent and with large mathematical background. It involves Quantum Theory, Molecular Chemistry, Materials Physics, Electromagnetism and other specialities. For the magnetic interaction of superconductor materials the Electromagnetic BCS Theory is wide and essential—and not the objective of this contribution. All these areas converge together in Superconductors Theory and applications.

Superconductors developments in future stages of research involve a wide of theoretical and applied advances. Namely, in new materials compounds for Type II superconductors. Secondly, technical aspects for optimal implementation/usage could be developed. And the new technical/industrial applications for the future constitute an advance area to be worked out.

However, the most important industrial and scientific significances of superconductors are its essential property itself, resistivity cero at T_C. This fundamental property saves a loss of energy which constitutes the reason for their use/investigation. What is useful to prove in Interior Optimization, Multiobjective/Dual Method are the simple equations of Transition-Temperature-Critical and Isotope Effect [1,3,4,5, 18,19,20,24,25,26,29].

The applications of Superconductors in Nuclear Physics based devices, Medical Technology are described extensively in literature [21,29]. Main of them are Hadrontherapy (Protontherapy and/or Carbontherapy) and Nuclear Magnetic Resonance (NMR). Protontherapy [13], is a high-precision dose delivery technique based on the advantage of Bragg Peak radiation distribution. Carbon also shows a satisfactory dose delivery distribution compared to photons. Hadrontherapy constitutes an improvement of dosimetry compared to classical IMRT. These applications are related to the area of magnetic fields interaction with superconductors. Following possible/probable applications in the future are in investigation and development.

The classical Critical Temperature Equation BCS for superconductors reads,

$$M^{\alpha} T_C = K \; ; \qquad (K=E \text{ in Figures}) \tag{5}$$

Where K (E) is a constant, M Atomic Mass (AMU), and T_C is critical temperature (Kelvin). From the stage when the element reaches critical temperature, the superconductivity effect begins. T_C varies for every isotope element within a defined mass element, although not excessively in magnitude. There are metals, and transition metals, with isotopic homogeneus distribution centered on a high percent composition for one or two isotopes. While there are others that show a variety of rate-distribution of isotopes with different atomic mass.

This equation (5), although simple, remains useful. The evolution of this equation, for example, [21], involves extent mathematical background and mathematical-physics theory. Taking decimal of Neperian logarithms the equation (5) can be linearized for setting graphics related to different isotopes with

corresponding atomic proper mass. The linearization objective is to guess fast information about isotopic superconductivity characteristics. In the literature [19,20,24,25,26,29]., it is frequent data analysis of BCS equation with linearization plots for comparisons. The algorithm (4) was implemented with 100 equations and reads,

for (i=1, ...n) , i=100

$[M_i]^{\alpha}\ T_C - K_i = 0$, Tc fixed for simulations, and based on (4), it is set, as in [3,4],

$$\text{minimize}, \left| [M_i]^{\alpha} T_C - K_i \right|_1 \quad \text{for } i = 1,.....n ;$$

and $A_i = [M_i]^{\alpha}$ for first stage of optimization, e. g., Fig. 1 (6)

where i is the corresponding number within the range of simulations. Range of simulations for M [1,19,20,23,25] must be an interval that holds all the mass values of both Pt and Sn. The same occurs for alpha.They read,

$$M \in [175.0 , 200.0] \qquad \alpha \in [0.2 , 0.8] \qquad (7)$$

In the same way, range of constraints can be seen in axes ranges of Figs 1-7. That is, 100 divisions in M range, (7) that comprise the variation of atomic mass for all metal isotopes within. Therefore, with equation (6), a nonlinear system of equations is set. The variables are to get optimized. Extrapolation to large and complicated Electronic Physics equations, Electronics, Nuclear Physics applications, or any type of system can be guessed from these mathematical formulas.

Therefore, there are for simulations for two materials, Pt and Sn. They have similar atomic mass, although the isotopic distributions are different. It is extensively known, that Pt has two isotopes with percentage similar, about 33% (194 and 195 UAM). On the contrary, Sn shows about 100% isotopic distribution at 180 atomic mass isotope (UAM). The objective is to demonstrate the utility of Interior Optimization for several theoretical and experimental situations.

The IO application in this case, involves three subsequent stages. These steps are compulsory since Pt and Sn have different T_C . These stages are applied also in Multiobjective IO. Hence, it is searched what follows

Optimal T_C for both metals within an optimal range of T_C

Optimal E (K in some graphs/formulas of previous papers) in BCS equation for both metals Optimal alpha value for BCS equation applicable on both metals

Pt has a T_C of 0.0019 K, while Sn T_C is 3.72 K. In simulation, is is taken a range $T_C \in [0.0001,0.0019]$. Therefore, once reached this range of temperatures, it is assured that the superconductivity effect will happen in both elements. The software engineering programming is more complicated and was done in double precision. Matrix Algebra changes, [Sketch 1], are frequent and rather complicated. It was mandatory a strict order in programming sentences to avoid problems when running the program [Casesnoves software, 2020], and save functional time. In Tables IV and VI, numerical results are presented. In graphs 1, 2, and 3, the sharp IO in three stages is shown and clearly demonstrated. Explanations of results are included at everyone. Just remark that this is a theoretical simulation based on rational experimental situations in lab. That is, the necessity of bending cables of powered-superconductors for an eventual device settings/manufacturing.

In Dual IO, the more smooth and parallel to Z=0 plane the surface is, the better. The reason to obtain smooth surfaces is that when doing so, residuals are constant—

and all low if the surface is close to Z=0. For example, if graphical-optimization surface is similar to Figures 1 and 3, it is guaranteed that for Fig 1 E and M^{α} T_C show similar errors for all isotopes. The same occurs in Fig 3, optimal alpha is equal for all isotopic masses, but the other values that can be chosen for alpha do not show large errors because the graphical-optimization surface is smooth and parallel to Z=0. This implies that perhaps in some laboratory circumstances, other values of alpha are more convenient, not exactly the global minima. This also means that to get refinements at first stage, it is necessary to vary tentatively E within an interval. In first, and third stage, also alpha. With E and alpha suitable numerical combinations it's possible to decrease errors and get a smooth surface. The inconvenient is that carry out tentative variations in the program, increases programming time.

Other problem for accurate results is the propagation of errors. When working with exponentials and high number of equations, propagation or errors are important. For that reason, selecting double precision can be useful.

Residuals can be considered acceptable at this first dual IO. The time consuming for designing program is about 5 seconds. The time for selecting optimal values is not short with the Matlab graphical cursor as there are 3 stages. In engineering practice, this simulation is a significant advantage that gives many options for fast on-site superconductivity dual-data management at laboratory. Results confirm useful utility of equation (5).

TABLE I
DUAL SOFTWARE ENGINEERING
OPTIMIZATION

NUMERICAL INTERIOR OPTIMIZATION RESULTS I Pt AND Sn		
STAGE OF OPTIMIZATION	OPTIMAL RESULTS FOR PARAMETERS	OBJECTIVE FUNCTION RESIDUAL
FIRST STAGE	E=0.1317 M^{α} T_C =0.1388	0.008302
SECOND STAGE	T_C = 0.0005909 M^{α} =69.31	2.48e-6
THIRD STAGE	Alpha=0.7 K M ϵ [175.0,200.0] (UAM)	0.1076

Table 1.-Numerical results of Dual Interior Optimization for Pt and Sn together. Residuals can be considered acceptable. The value of Alpha is applicable for both metals at BCS equation. Optimal isotope mass that can fit better in BCS equation is 189.7 UAM fro first stages. At third stage, all isotope masses, both Pt and Sn, M ϵ [175.0,200.0] are optimal with good residual, and alpha value 0.7.

TABLE II
DUAL SOFTWARE ENGINEERING
OPTIMIZATION

NUMERICAL INTERIOR DUAL OPTIMIZATION RESULTS II		
STAGE	PARAMETER FIXED	OPTIMAL PARAMETER DETERMINED
FIRST STAGE	E TENTATIVE	E
SECOND STAGE	E FIXED	T_C
THIRD STAGE	T_C E	ALPHA

Table 2.- The development of optimization of parameters in Dual Interior Optimization. These stages correspond with Figs 5,6,and 7. The numerical results for these parameters are in Table 5.

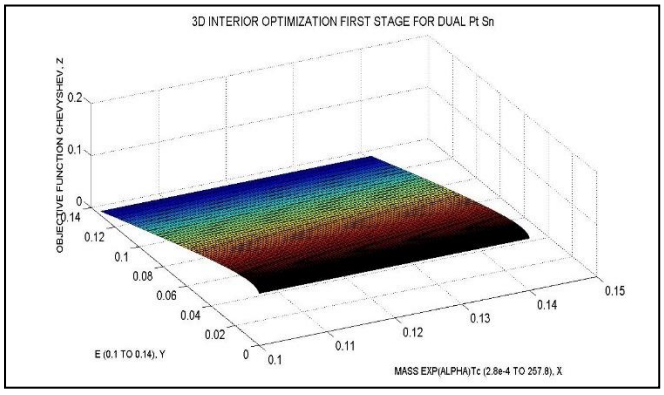

Fig. 1.-First stage of Interior-Graphical Dual Optimization. It was determined the optimal E value and the optimal $A= M^{\alpha} T_C$ values. The interval selected for T_C is [0.0001,0.0019]. Intervals are in legends of graphs 1, 2, and 3. Numerical results are in Table 1.

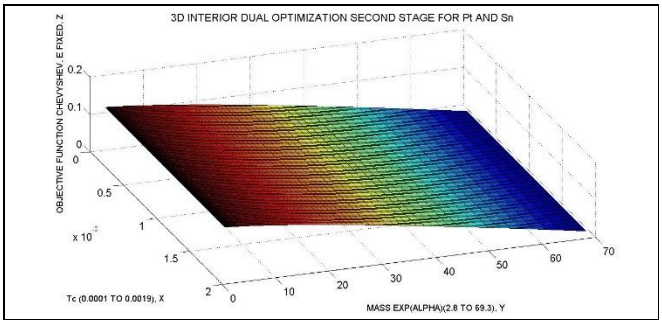

Fig 2.- Second stage of Interior-Graphical Dual Optimization. It was determined the optimal E value was fixed from first stage, E=0.1. Intervals are in legends of graphs 1, 2, and 3. Numerical results are in Table 1.

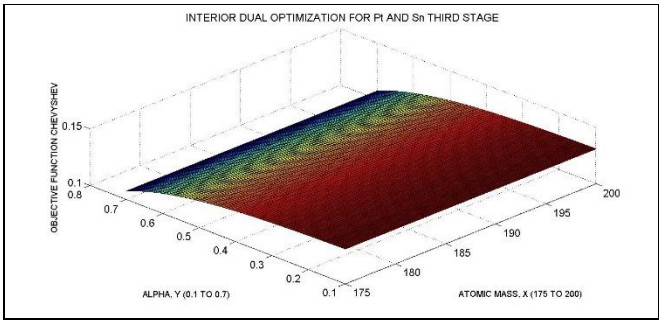

Fig 3.-Third stage of Interior-Graphical Dual Optimization. It was determined the optimal Alpha value. Intervals are in legends of graphs 1, 2, and 3. Numerical results are in Table 5. Note the smooth curvature of the surface. This mathematically implies that the OF is differentiable, derivable continuously. The homogeneity for all the isotope atomic masses is excellent with alpha value of 0.7.

IV. Mo, Zr, Ti, MULTIOBJECTIVE INTERIOR OPTIMIZATION RESULTS

This section deals with a theoretical simulation of BCS equation for three materials, Mo, Zr and Ti. They have similar atomic mass, although the isotopic distributions are different. It is extensively known, that Mo and Zr have several isotopes with similar percentage. Ti shows its high percentage at 48 UAM

(73.72%). The objective is to demonstrate the utility of Interior Multiobjective Optimization for several theoretical and experimental situations.

The purpose is a Interior Multiobjective Optimization (MO) for three materials in three stages—namely, separation of variables. It is supposed, for instance, that at laboratory cables with powder of these two materials are being manufactured. That is, cables can be bent, since it is powder of both materials mixed. Therefore, cables could adapt on any convenient lab device. The refrigeration of cables then become a technical problem. It is also supposed that in the mixture there is no chemical interaction between the two different powered metals. And also there is absence of Electromagnetic fields at the set up device. The MO application in this case, involves three subsequent stages. These steps are compulsory since all of them have different T_C . It is searched as follows

Optimal T_C for both metals within an optimal range of T_C

Optimal E (K in some graphs/formulas of previous papers) in BCS equation for both metals

Optimal alpha value for BCS equation applicable on both metals

MO has a T_C of 0.915 K, Zr is 0.61 K, while Ti T_C is 0.40 K. In simulation, is is taken a range $T_C \in [0.1,0.4]$. The software engineering programming is more complicated and was done in double precision. Matrix Algebra changes are frequent and rather complicated. There are exponentials, dot products, and constants that multiply all the matrix. It was mandatory a strict order in programming sentences to avoid problems when running the program [Casesnoves software, 2020], and save functional time. In Tables III and IV, numerical results are presented. In Graphs 4, 5, and 6, the sharp MO in three stages is shown and clearly demonstrated. Explanations of results are included at everyone. This is a theoretical simulation based on rational/realistic experimental situations in lab. That is, the necessity of bending cables of powered-superconductors for an eventual device settings/manufacturing.

Residuals can be considered acceptable at this first MO. The time consuming for designing program is about 30 minutes. The time for selecting optimal values is not short with the Matlab graphical cursor as there are 3 stages. In engineering practice, this simulation is a significant advantage that gives many options for fast on-site superconductivity multiple-data management at laboratory. Results confirm useful utility of the mathematical development.

TABLE III
MULTIOBJECTIVE SOFTWARE ENGINEERING OPTIMIZATION

NUMERICAL INTERIOR MULTIOBJECTIVE OPTIMIZATION RESULTS III Mo Zr Ti		
STAGE OF OPTIMIZATION	OPTIMAL RESULTS FOR PARAMETERS	OBJECTIVE FUNCTION RESIDUAL
FIRST STAGE	E_1= 2.909/ E_2=0.1212 $[M^{\alpha} T_C]_1$ =0.1497 $[M^{\alpha} T_C]_2$ =0.1173	RES_1 = 0.003802 RES_2 = 0.002251
SECOND STAGE [For E_1= 2.909]	T_C = 0.399 K M^{α} =5.971	0.003893
THIRD STAGE	Alpha=0.4 M ∈ [41.0,102.0] (UAM)	0.3751

Table 3.-Numerical results of Multiobjective Interior Optimization for Pt and Sn together. Residuals can be considered acceptable. The value of Alpha is applicable for both metals at BCS equation. Optimal isotope mass that can fit better in BCS equation is 189.7 UAM fro first stages. At third stage, all isotope masses, both Pt and Sn, M ϵ [175.0,200.0] are optimal with good residual, and alpha value 0.7.

TABLE IV
MULTIOBJECTIVE SOFTWARE ENGINEERING OPTIMIZATION

NUMERICAL INTERIOR MULTIOBJECTIVE OPTIMIZATION RESULTS IV Mo Zr Ti		
STAGE	PARAMETER FIXED	OPTIMAL PARAMETER DETERMINED
FIRST STAGE	E TENTATIVE	E
SECOND STAGE	E FIXED	T_C
THIRD STAGE	T_C E	ALPHA

Table 4.- The development of optimization of parameters in Multiobjective Interior Optimization. These stages correspond with Figs 5,6,and 7. The numerical results for these parameters are in Table 5.

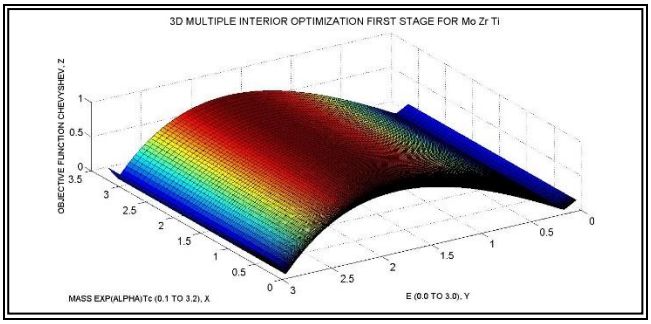

Fig. 4.-First stage of Interior-Graphical Multiobjective Optimization (MO). It was determined the optimal E value and the optimal A= M^{α} T_C values. However, there are two optimal values of E. The interval selected for T_C is [0.1,0.5]. Intervals are in legends of Graphs 3, 4, and 5. Numerical results are in Table 3. This stage is complicated, surface shows rather significant curvature..

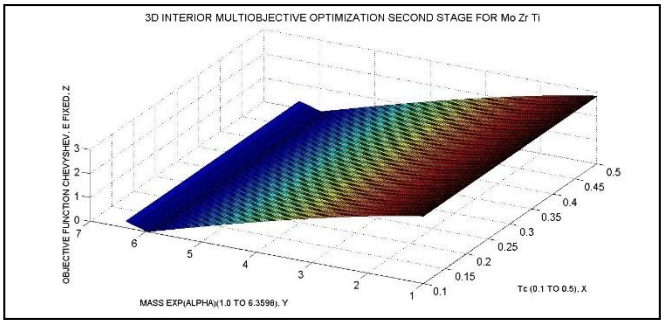

Fig 5.- Second stage of Interior-Graphical MO. It was determined the optimal E value was fixed from first stage, E=2.909. It was selected the E_1 value of Table 3. Intervals are in legends of graphs 4, 5, and 6. Numerical results are in Table 3.

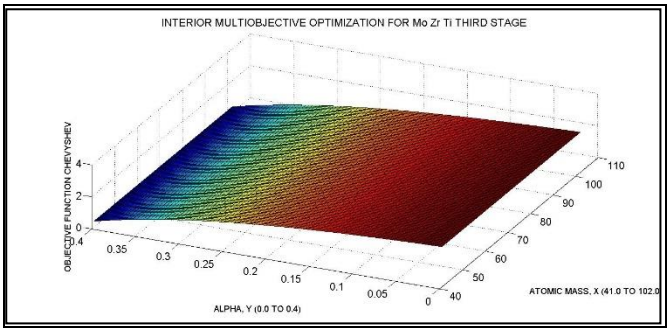

Fig 6.-Third stage of Interior-Graphical MO. It was determined the optimal Alpha value. Intervals are in legends of graphs 4, 5, and 6. Numerical results are in Table 3. Note the smooth curvature of the surface. Surface extends along all values of alpha with low gradient. This mathematically implies that the OF is differentiable, derivable continuously. The homogeneity for all the isotope atomic masses is excellent with alpha value of 0.4.

V. DISCUSSION AND CONCLUSIONS

The aim of this paper was to show Multiobjective Interior Optimization software programming with an introduction of simpler Dual IO. It is different from previous contributions [3,4], because what is intended is to obtain optimal constants in BCS Electtronics equation for several elements with their proper isotopes. Therefore, the superconductors applications for Pt, Sn, Mo, Zr and Ti are confirmation examples of the method previously demonstrated. The equation is simple, but technique is extrapolable to more sophisticated Electronics Physics equations.

Multiobjective and Dual IO simulation, therefore, [Casesnoves, 2019-2020] is a new tentative perspective for theoretical applications in Electronics Physics. The basic stages of IO were detailed with simulations and Graphical Optimization 3D imaging. In both, Multiobjective and Dua Interior Optimization, even some refinements were implemented.

An important conclusion obtained is that when trying Multiobjective/Dual IO, the difficulties increase compared to simple IO. This implies that Multiobjective IO has to be adapted in programming siftware for each and every type of mathematical problem [Table 3,Fig 4].

Therefore, Interior Optimization Method base with algorithms and mathematical definitions that was explained/presented formally in [3,4], was developed and proven for several elements of these different Type I superconductors. One important feature of this method is its speed in running time even working with double precision. The utility, although simple, of the BCS equation was proven for Pt, Sn, Mo, Zr, and Ti. The Matrix Algebra and program structure is rather more difficult compared to previous contributions [3,4]. The difficulties were sorted by using several combined code-sentences.

As a demonstration of the mathematical and practical engineering applications, electronics in superconductors equations were presented. Computational electronics simulations with 3D graphical optimization images were made correctly. Numerical results were explained in tables and schemes.

Numerical results for Multiobjective IO show alpha value of 0.4 and common T_C 0.399 K. In Dual Interior Optimization, the optimal value $T_C \approx 0.0006$ K guarantees the superconducting effect for Pt and Sn at the same time.

In summary, original Software Engineering method of Multiobjective and Dual Interior Optimization was explained/demonstrated with a number of examples. Software techniques are supported by numerical results and 3D images/graphs. Several useful numerical consequences from the surfactal shapes are guessed.

Practical Electronics applications in Superconductor Electronics field BCS equation are presented. The simulation of Multiobjective/Dual Interior Optimization was carried out as much realistic as possible. Nuclear Physics applications in Radiation Therapy (Hadrontherapy), Diagnostic Imaging (NMR) emerge from these findings. Applications in other areas of Electronic Physics, Physics, Bioengineering, Medical Radiation-diagnosis Technology, Tribology, and Engineering come from this Interior Optimization/Dual Optimization Method.

VI. SCIENTIFIC ETHICS STANDARDS

Interior Graphical-Optimization Methods were created by Francisco Casesnoves on 3rd November 2018, while he was preparing his Doctoral Thesis

Defence and publishing some papers in IMRT Radiation Therapy. The denomination of 'Interior' comes from the fact that variables optimization are extracted by separation method from the 'interior formula' of explicit/implicit function(s) one by one to be optimized. First implementation of algorithms and verification of simulations were carried out in the morning of April 1st, 2020. Multiple-Dual Interior Optimization was definitely implemented in October 16th about 14pm.This third article has previous paper information and figures, whose inclusion is essential to make the contribution understandable. This study was carried out, and their contents are done according to the European Union Technology and Science Ethics. Reference, 'European Textbook on Ethics in Research'. European Commission, Directorate-General for Research. Unit L3. Governance and Ethics. European Research Area. Science and Society. EUR 24452 EN [30,31]. This research was completely done by the author, the software, calculations, images, mathematical propositions and statements, reference citations, and text is original for the authors. When anything is taken from a source, it is adequately recognized. Ideas from previous publications were emphasized due to a clarification aim, [30,31].

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VIII. AUTHOR'S BIOGRAPHY

Francisco Casesnoves is Engineering and Natural Sciences PhD by Talllinn University of Technology (started thesis in 2016, thesis defence/PhD earned Defence in December 2018, official graduate Diploma 2019), Estonia, and computational-engineering/physics independent researcher at COE, MSc-BSc, Physics/Applied-Mathematics (Public Eastern-Finland-University), Graduate-with-MPhil, in Medicine and Surgery (Public Madrid University Medicine School). Casesnoves studied always in public-educational institutions. His education/scientific vocation was motivated very young, by Profs Candida Navamuel and Isabel Vela, in Renaissance-Humanism ideas—later on with the motivation manuscripts of Nobel and Von Helmholtz prizes Santiago Ramon y Cajal. His constant service to International Scientific Community and Estonian technological progress (2016-present) commenced in 1985 with publications in Medical Physics, with further specialization in optimization methods in 1997 at Finland—at the moment approximately 100 recognized publications with 50 papers. His main branch is Computational-mathematical Nonlinear/Inverse Optimization. His service to International Scientific community also comprises the publication of two recent books with Estonian affiliation, the first is the computational dynamics book, 'The Numerical Reuleaux Method' (200 pages, first part book, 2019), the second is a sociological and medical philosophy book (300 pages, 2019). Casesnoves best-achievement is the Numerical Reuleaux Method in dynamics and nonlinear-optimization. This Numerical Reuleaux Method constitutes, among others, an advance in Space Aerodynamics Computational Methods and Bioengineering. Casesnoves speaks, reads, and writes Estonian language at B1-2 levels, with corresponding official diplomas. Also participates/registers in sporting Estonian activities such as Tallinn Marathon. Casesnoves played as defender and middle-fielder at Junior Madrid Football League, and as physician is supporting agnostic healthy life and all sporting activities. Casesnoves publications are always according to International Scientific Standards. He sets

his medical technology papers, specially in cancer radiotherapy methods, always in open access for benefit and use of any public health system according to the Fundamental Right for health care. Recently has written new mathematical modelling radiotherapy articles affiliated to Estonia, Tallinn (2019). Casesnoves scientific service since 2016 to the Free and Independent Republic of Estonia for technological development (and also at Riga technical University, Power Electrical and Electronics Department) is about 24 physics-engineering articles, two books, and 1 industrial project associated to Europa Union EIT Health Program (Tartu University, 2017). In EIT Europa Union Program, Tartu University, Casesnoves developed his invention of the radiotherapy conformal wedge based on AAA radiotherapy model (Anisotropic Analytical Algorithm) with implemented Software-Engineering ha simulations in Matlab-Freemat, Fortran, and F# tururu.

Cite this article as :

Francisco Casesnoves, "Multiobjective Interior Optimization Computational Methods for Electronics BCS Superconductivity", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 6 Issue 5, pp. 280-293, September-October 2020. Available at doi : https://doi.org/10.32628/CSEIT206556
Journal URL : http://ijsrcseit.com/CSEIT206556