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NORTON ROSE FULBRIGHT

TQT Lunch & Learn :
A Case Study in Patent Development

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April 12, 2018

Subject of case study : Invention

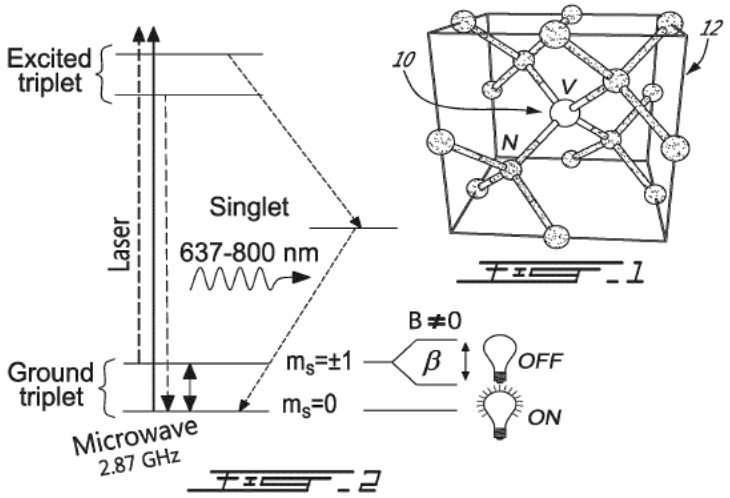

Fig 1 Fig 2

Vectorial magnetometry based on photon-induced Zeeman shift in energy levels of NV centers in a diamond lattice

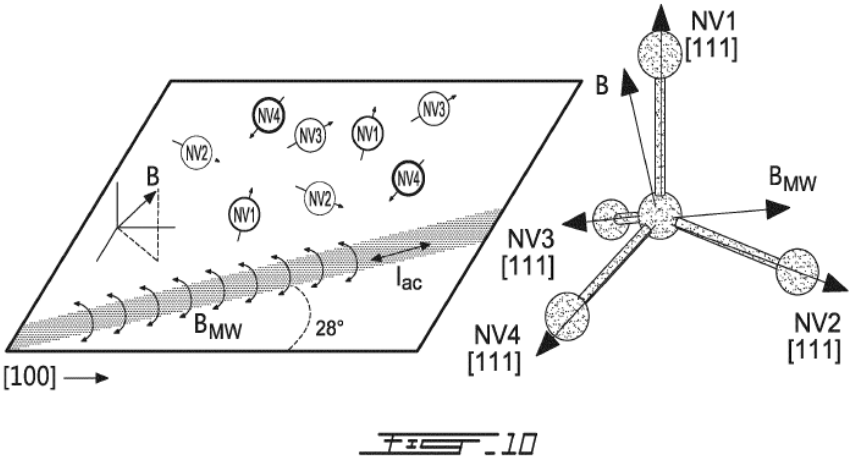

Fig 10

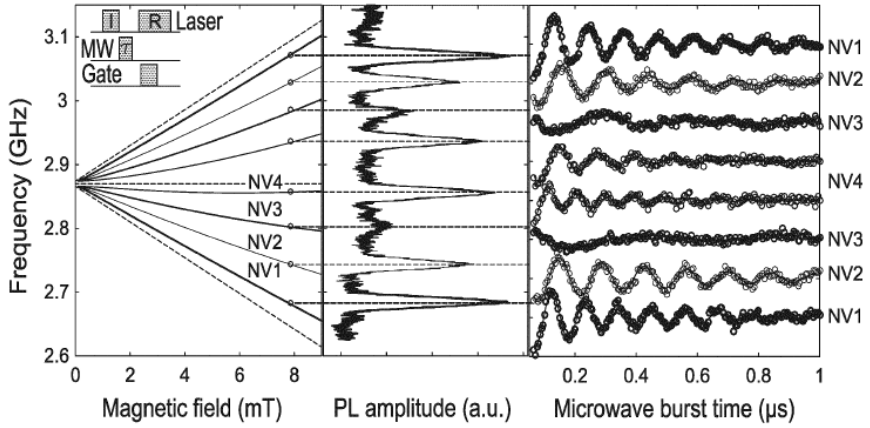

Fig 11

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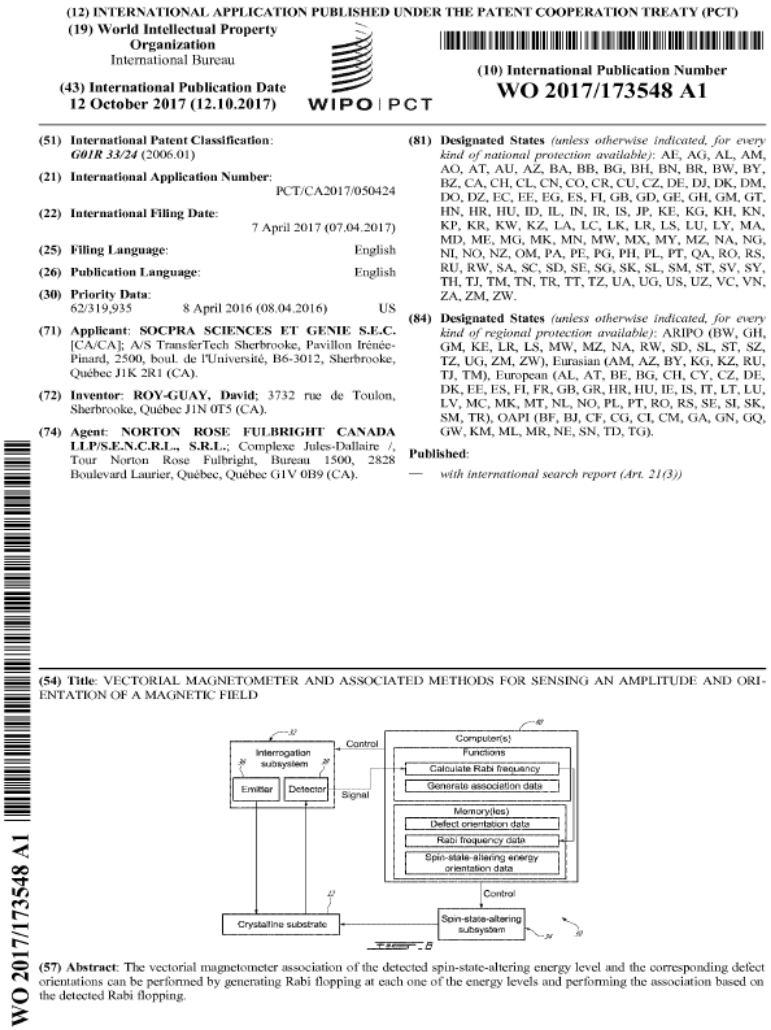
Subject of case study : Patent Application



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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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Published:
— *with international search report (Art. 21(3))*

(54) Title: VECTORIAL MAGNETOMETER AND ASSOCIATED METHODS FOR SENSING AN AMPLITUDE AND ORIENTATION OF A MAGNETIC FIELD

(57) Abstract: The vectorial magnetometer association of the detected spin-state-altering energy level and the corresponding defect orientations can be performed by generating Rabi flopping at each one of the energy levels and performing the association based on the detected Rabi flopping.

WO 2017/173548 A1

Published patent application

Filed under the Patent Cooperation Treaty (PCT)

Filed : April 7, 2017

Priority : April 8, 2016

Published : Oct. 12, 2017

30 month date : Oct. 7, 2018

Title : Vectorial Magnetometer and Associated Methods

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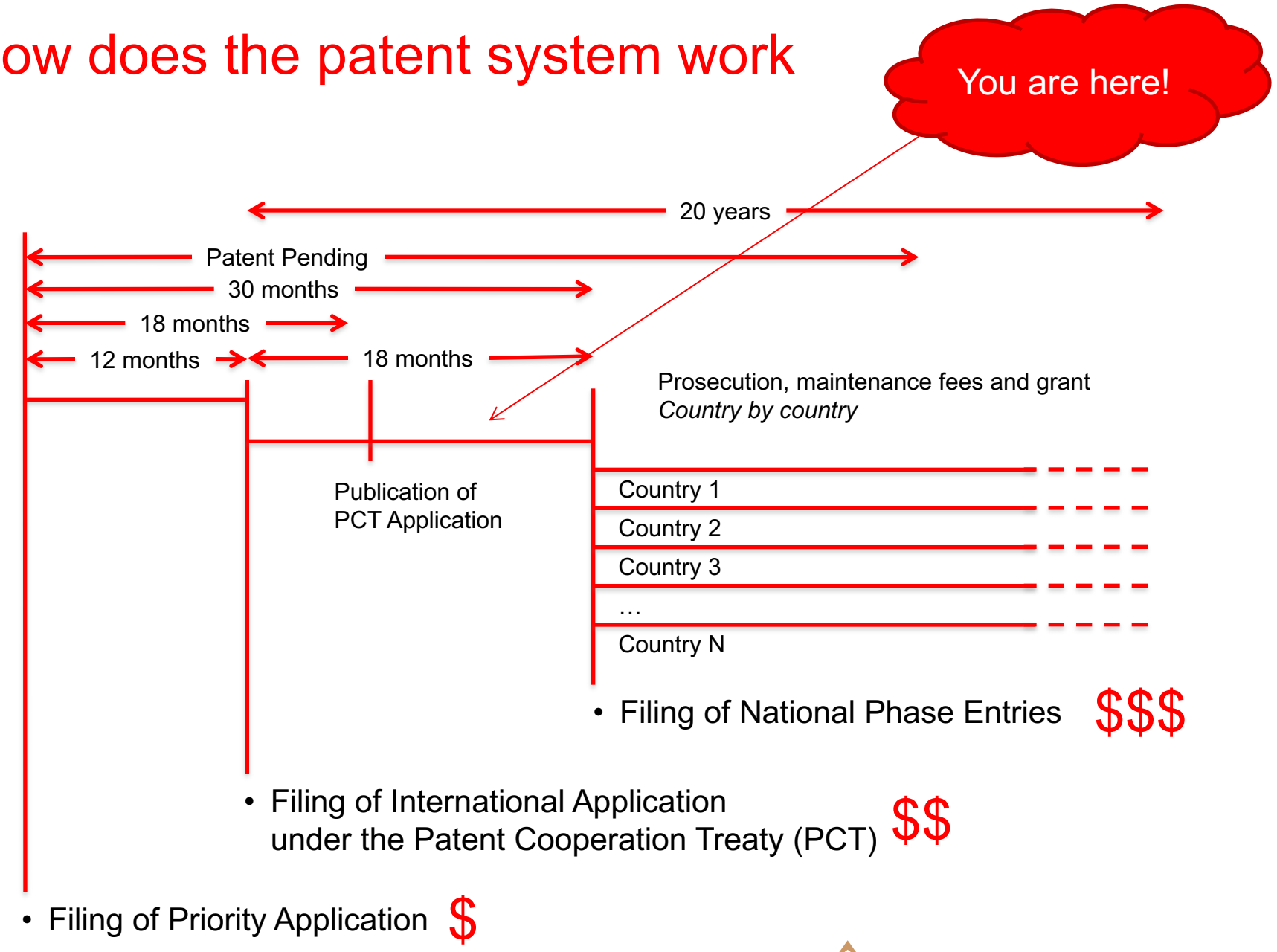
How does the patent system work



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Contents

- Value point 1 : Is it patentable (valid?)
- Value point 2 : Do we have broad coverage?
- Value point 3 : Do we have freedom to operate?

Why are points 1 and 3 not the same

Invention A

Patent A

Selection of countries A

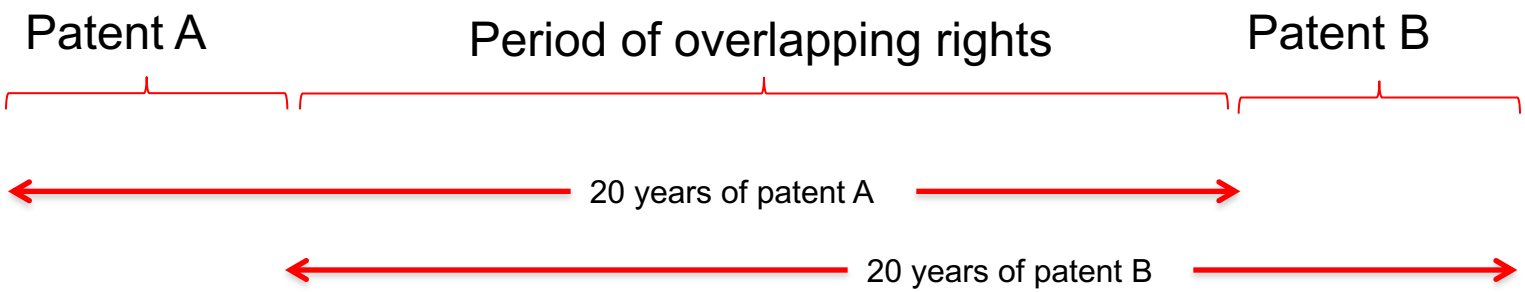
Owner A

Invention B

Patent B

Selection of countries B

Owner B



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Value point 1 : is it patentable (valid?)

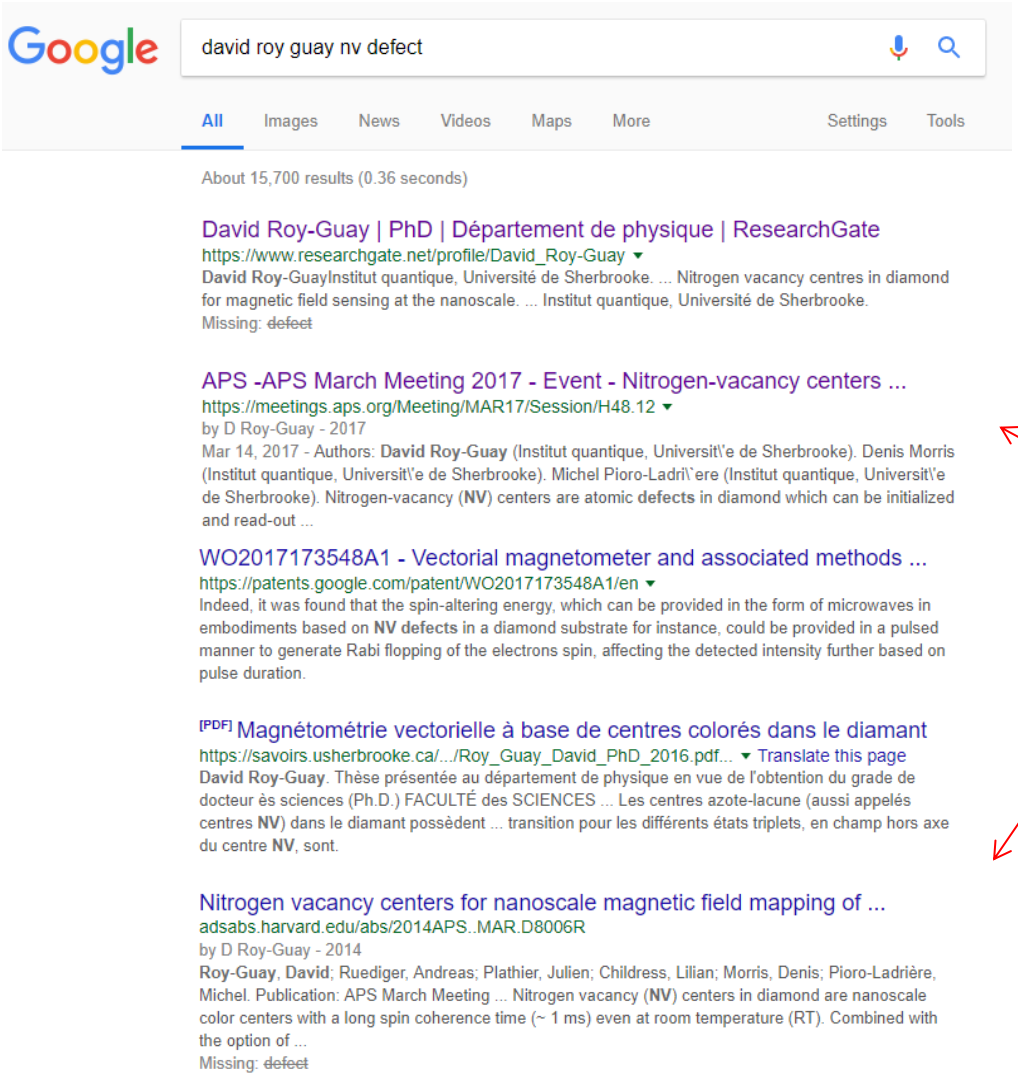
Patentability criteria

- Novelty
- Inventiveness (non-obviousness)
- Patent-eligible (system/device, method/process, composition of matter)

Not patent eligible :

- “Mere” abstract idea
- “Mere” discoveries

Value point 1 : is it patentable (valid?)



Novelty :
Must not have been
Publicly disclosed
(in most cases, even
by ourselves)
Before filing application

Here, invention was
Discussed at APS and
Full thesis is available
Online!

But our priority is April 8,
2016, and these
Publications are 2017,
So OK!

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Value point 1 : is it patentable (valid?)

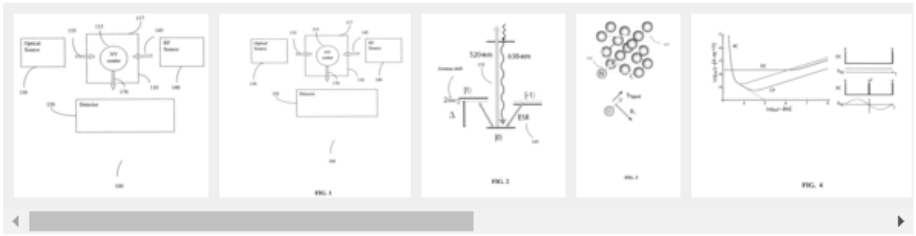
Google Patents 2010/0315079

Electronic spin based enhancement of magnetometer sensitivity

Abstract

A method is disclosed for increasing the sensitivity of a solid state electronic spin based magnetometer that makes use of individual electronic spins or ensembles of electronic spins in a solid-state lattice, for example NV centers in a diamond lattice. The electronic spins may be configured to undergo a Zeeman shift in energy level when photons of light are applied to the electronic spins followed by pulses of an RF field that is substantially transverse to the magnetic field being detected. The method may include coherently controlling the electronic spins by applying to the electronic spins a sequence of RF pulses that dynamically decouple the electronic spins from mutual spin-spin interactions and from interactions with the lattice. The sequence of RF pulses may be a Hahn spin-echo sequence, a Can Purcell Meiboom Gill sequence, or a MREV8 pulse sequence, by way of example.

Images (10)



Classifications

G01R33/032 Measuring direction or magnitude of magnetic fields or magnetic flux using magneto-optic devices, e.g. Faraday, Cotton-Mouton effect

US20100315079A1
US Application

Download PDF | Find Prior Art | Similar

Inventor: Mikhail Lukin, Ronald L. Walsworth, Amir Yacoby, Paola Capellaro, Jake Taylor, Liang Jiang, Lillian Childress

Current Assignee : Harvard College

Original Assignee: Harvard College

Priority date : 2007-12-03

Family: US (2) WO (2)

Date	App/Pub Number	Status
2008	US12746020	Active
2008-12-03	US12746128	Active
2010-12-16	US20100315079A1	Application
2013-10-01	US8547090B2	Grant

Info: Patent citations (33), Non-patent citations (1), Cited by (75), Legal events, Similar documents, Priority and Related

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Value point 1 : is it patentable (valid?)

- Vectorial magnetometry based on photon-induced Zeeman shift in energy levels of NV centers in a diamond lattice with RF pulse based detection was formerly known. However :
- (see “background”) the assignment of the crystalline defect orientations in this technology was performed by a method which includes sequentially generating a magnetic field in each one of three different orientations. This was found somewhat unsatisfactory or burdensome in at least some applications.

Value point 1 : is it patentable (valid?)

- We claim a method where the assignment of the crystalline defect orientations can be performed without the sequence of three magnetic field orientations. More specifically :
- (see Summary) it was found that the spin-altering energy, which can be provided in the form of microwaves, could be provided in a pulsed manner to generate Rabi flopping of the electrons spin, affecting the detected intensity further based on pulse duration. The Rabi frequency of this flopping was affected by the amplitude of the received microwave power, and the spin-state-altering energy can be provided in a manner to provide different amplitudes to the different defect orientations, therefore providing all the information required to perform orientation assignment.

Value point 2 : do we have broad coverage?

- While all the details of example implementations are presented in the disclosure and figures, the breadth of the claimed coverage is defined by the claims (page 26-31)

- Claims 1, 16 and 18 are independent, they do not refer to, nor are limited by, other claims.
- They may eventually be split up by patent examiners into different patents, if the patent examiner considers that they do not claim the same invention.
- The other claims are dependent, and therefore necessarily narrower in scope than the claims on which they depend.

Value point 2 : do we have broad coverage?

- Claim 1 describes a complete vectorial magnetometer system.
  - While it does specify that the association data is generated based on the detected Rabi frequencies (the point of novelty which distinguishes the invention from the prior art), it does not specify unnecessary details such as the type of sensory crystalline material, the details of the spin-state-altering subsystem, nor the details of the interrogation subsystem.
  - Many of these details, however, are presented in dependent claims and can offer fallback positions if ever the broad independent claim was later discovered to be too broad.
- Claim 8 focusses on the method of interrogating the spin-state energy values.

Value point 2 : do we have broad coverage?

By identifying the uncovered references as « A », rather than « X » or « Y », the International Search Report (page 45) indicates that even the broadest claims are currently considered to be patentable

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2017/050424

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***G01R 33/24*** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01R 33/24 (2006.01) (in combination with keywords)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Canadian Patent Database and Questel Orbit and Google Patent:
magnetometer, optically detected magnetic resonance (ODMR), NV defects, microwave, Rabi, defect orientation, magnetic field, electron spins

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US2015001422A1, (ENGLUND et al.) 01 January 2015 (01-01-2015) *Whole document*	1-19
A	US2010308813A1, (LUKIN et al.) 09 December 2010 (09-12-2010) *Whole document*	1-19
A	Aman et al., "Accuracy in the measurement of magnetic fields using nitrogen-vacancy centers in nanodiamonds." JOSA B 33.3 (2016): B19-B27. *Whole document*	1-19
A	Steinert et al., "High sensitivity magnetic imaging using an array of spins in diamond." Review of scientific instruments 81.4 (2010): 043705. *Whole document*	1-19
AP	US2016216340A1, (EGAN et al.) 28 July 2016 (28-07-2016) *Whole document*	1-19
AP	US9551763B1, (HAHN et al.) 24 January 2017 (24-01-2017) *Whole document*	1-19

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be

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Value point 2 : do we have broad coverage?

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Value point 3 : do we have freedom to operate?

- It is impossible to have an absolute certainty that we have freedom to operate, and attempting to ascertain this question broadly can be extremely expensive
- Apart from looking into an odd patent here and there, it is uncommon for early stage companies to have performed a freedom-to-operate analysis
- The best answer to an investor's question on this point is often : "well, we have not received any cease and desist letters"!
- This being said, an investor may wish to invest a reasonable amount of money in assessing freedom-to-operate if they are about to invest a sizeable sum, especially if the later discovery of a barring patent would jeopardize their investment, and entrepreneurs may wish to have at least a summary look into relevant patents which they come across

Value point 3 : do we have freedom to operate?

Levels of verification for freedom-to-operate

- First Level : Status
  - Is there a patent in the country where I intend to make, use or sell?
  - Is it an issued patent, or a published patent application?
  - Has it been abandoned? Have the maintenance fees been paid?
- Second level : Analysis of scope
  - Is there more than one independent claim?
  - Is there clearly an element, for each independent claim, that our device/system/method would not have?
- Third level : Analysis of validity

Who are the inventors?

- Patents include detailed disclosures and claims
- The detailed disclosure presents the invention to the public, the claims specify what others are not allowed to do while patent is in force
- The claims are examined for patentability
- To be an inventor, a person must have contributed to inventing that which is claimed
- Simply “reducing to practice” does not make someone an inventor (e.g., executing inventor’s instructions using ordinary skill and common knowledge)

Who is the owner?

- In theory, the inventors are the first owners, but in practice, they typically have transferred their rights to an organization (e.g., University or Corporation) by way of agreement at the time of invention.

- The owner is typically the one who has the right and responsibility to exclude other parties from the market. However, in practice, Universities typically transfer this role over to a corporate partner by virtue of a “licensing agreement”.

- Co-ownership can be an invention killer when it is not clearly frameworked by an agreement

QUESTIONS?

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