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(54) DETECTION APPARATUS AND METHOD FOR DETECTION OF CHI ENERGY

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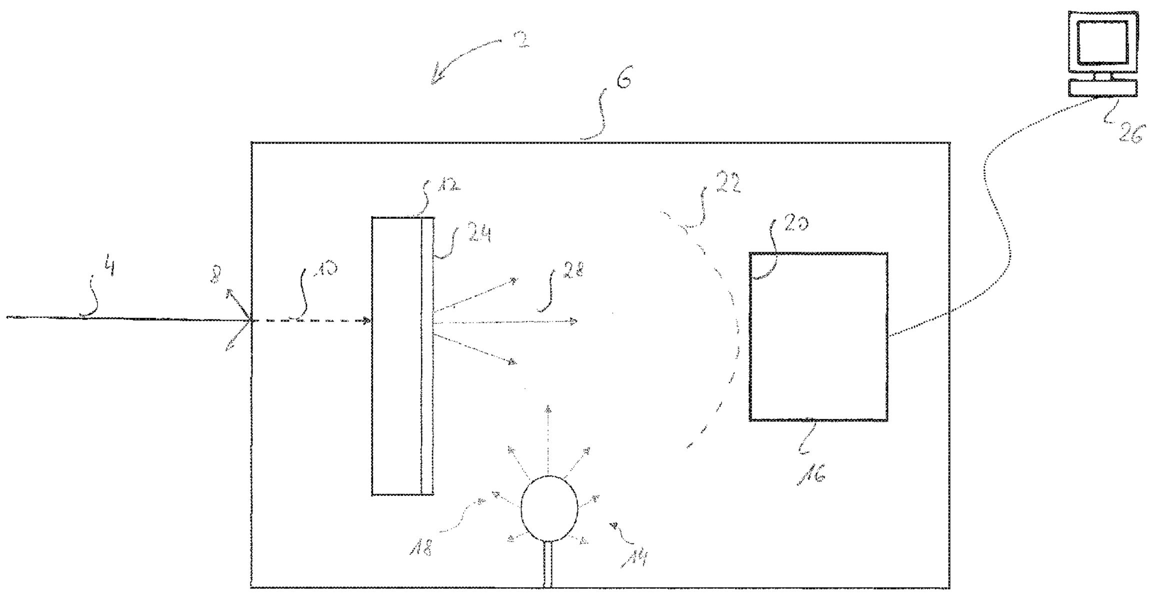
(57) ABSTRACT

Detection arrangement and method for detection of chi energy using TADF material as well as use of a detection arrangement for detection of chi energy.



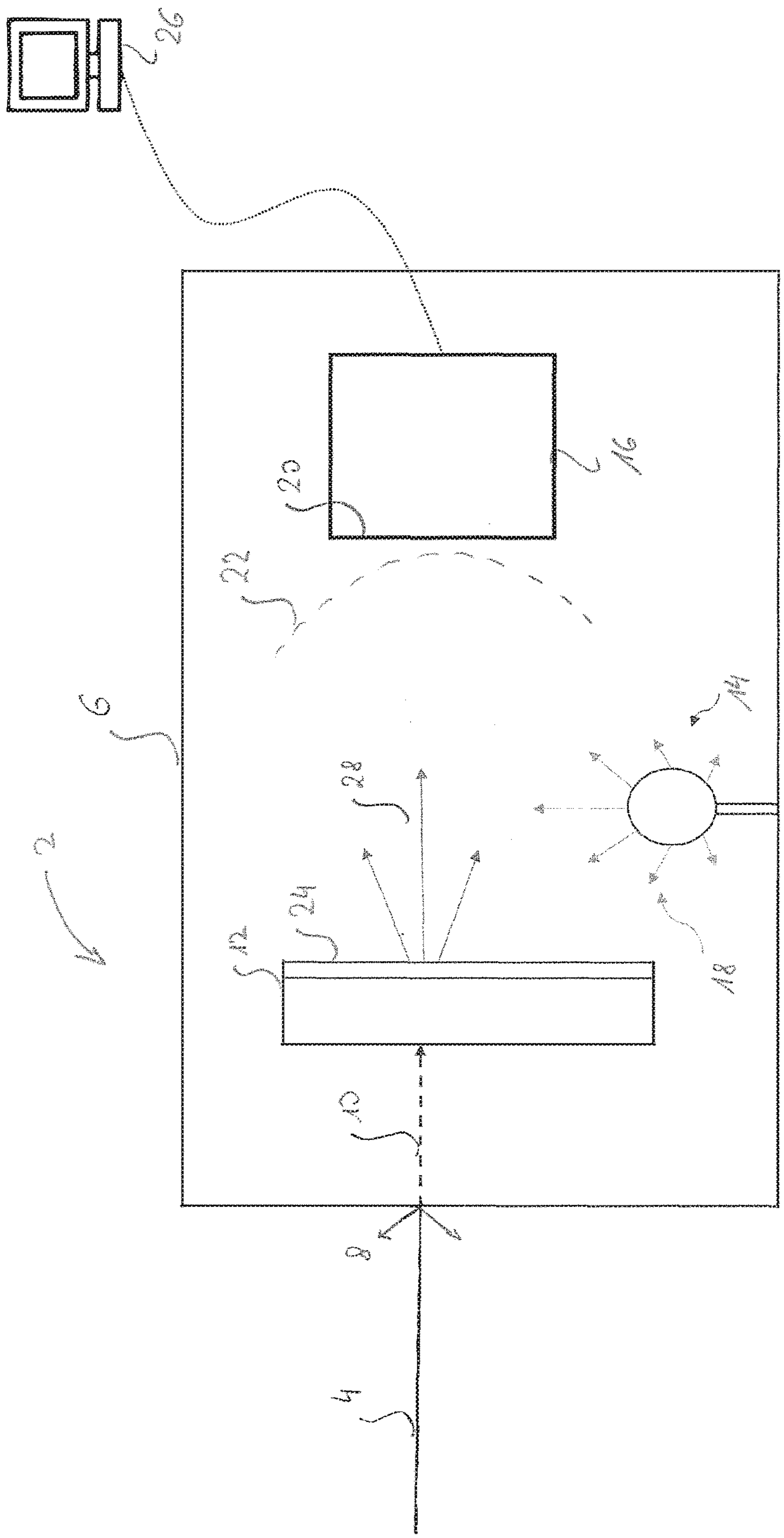


Fig. 1

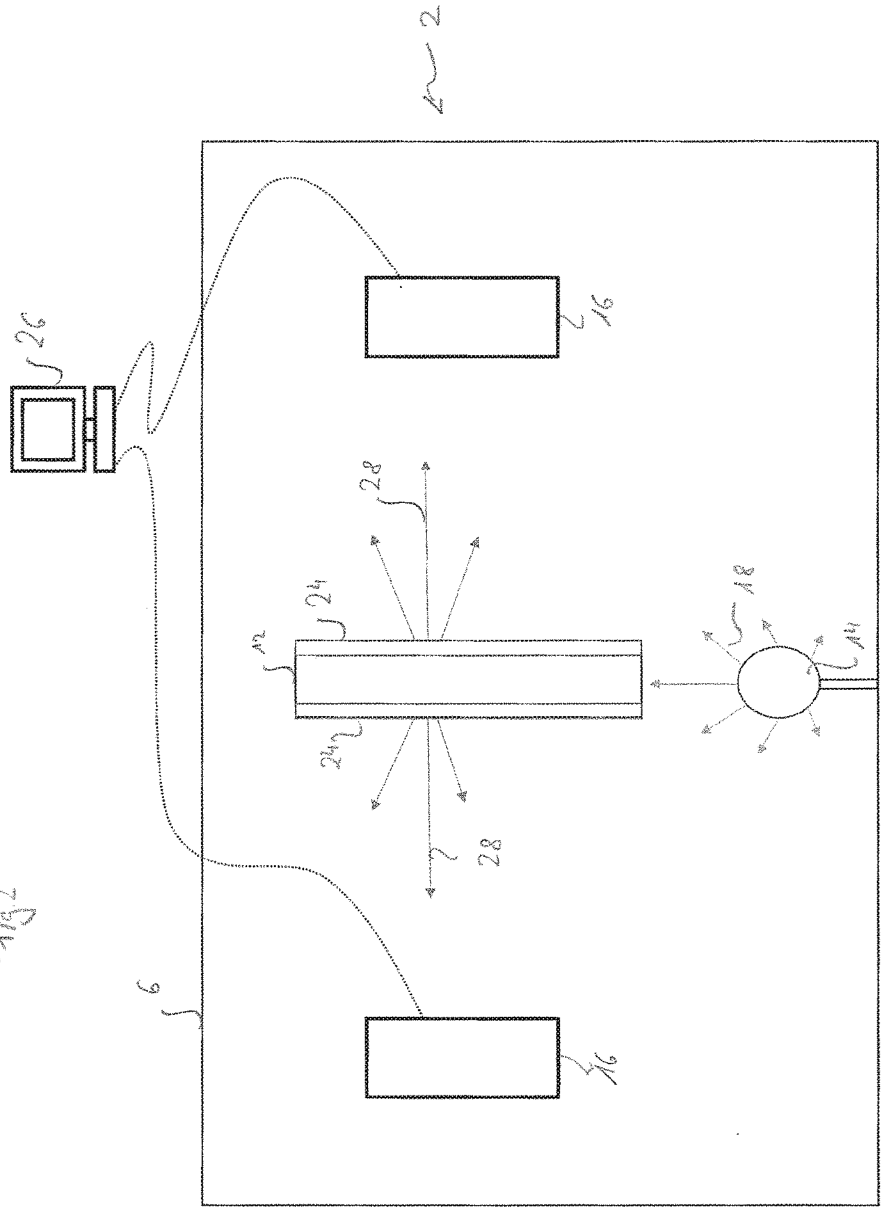


Fig 2

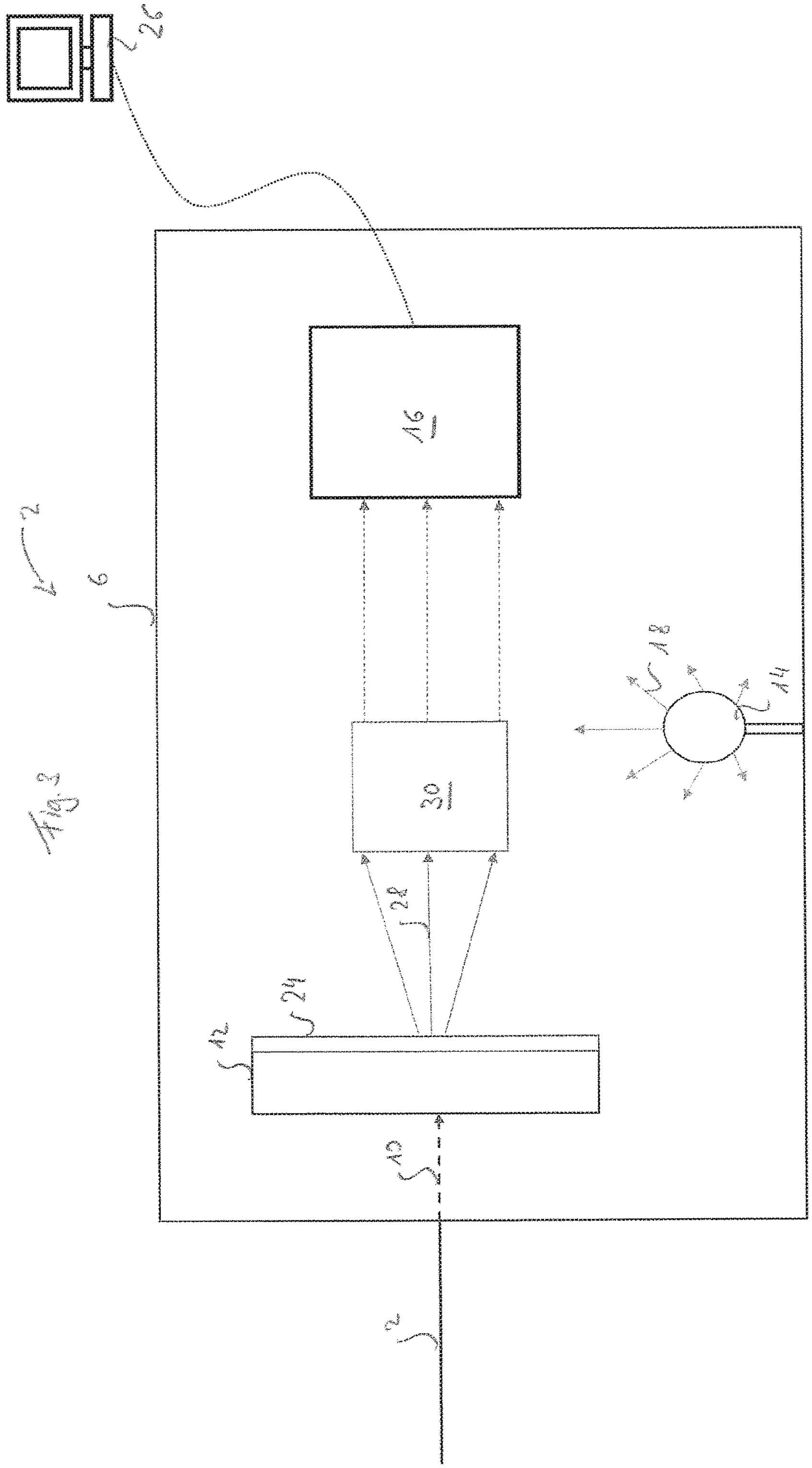


Fig. 3
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16
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24
12
10
18
14
6
2

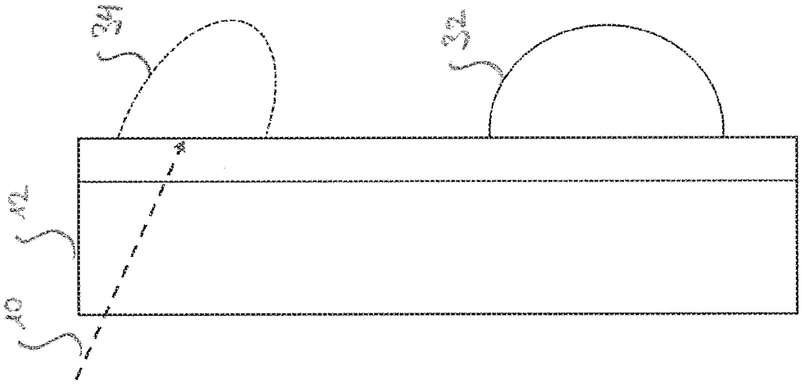

Fig. 4

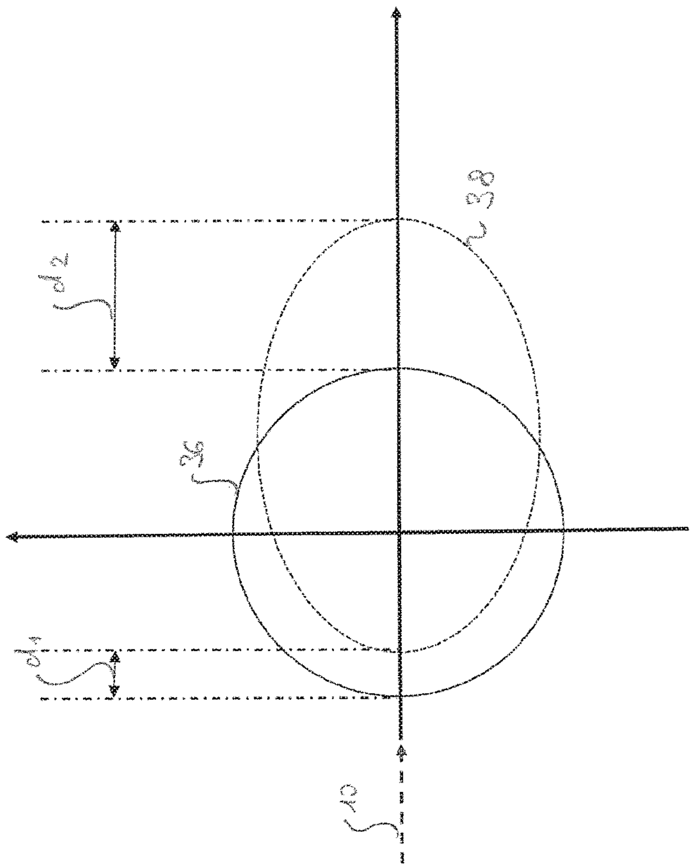

Fig. 5b

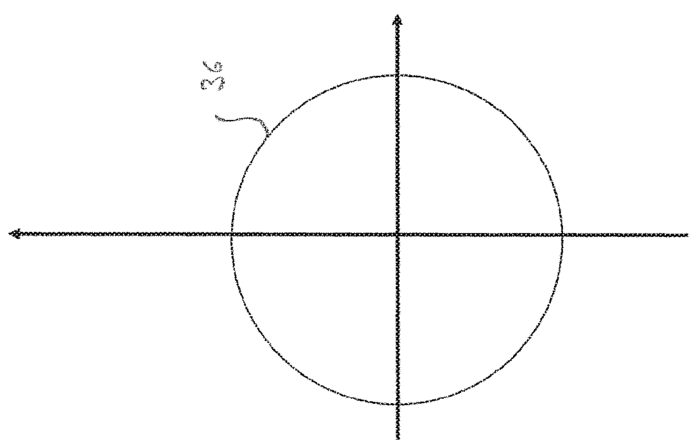

Fig. 5a

DETECTION APPARATUS AND METHOD FOR DETECTION OF CHI ENERGY

FIELD OF THE INVENTION

[0001] The present invention relates, generally, to the field of detection of energy flows, more particularly, to TADF (thermally activated delayed fluorescence) material based detection of chi energy.

BACKGROUND OF THE INVENTION

[0002] The ancient culture of Feng Shui is currently widely spread around the world. There exist complex and alternating configurations of flows of energy called chi energy. There are various sources and types of chi energy, such as chi energy coming from space, terrestrial sources, human sources or other types of chi energy. Many factors affect the flow of chi energy on Earth, such as landscapes, water flows and road networks/infrastructures, specific geological peculiarities, buildings, vegetation etc. Depending on the parameters of the flow of chi energy at a given place and time, the energy may have favorable, neutral or adverse effects on human health or other living organisms.

[0003] Nowadays, there are several schools of Feng Shui, differing by their way of determining the properties of flows of chi energy. All of them using indirect methods for the detection of chi energy.

[0004] The concept of chi energy or chi energy fluxes is widely used, for example in medicine, civil architecture and/or landscape design. However, a detection method of chi energy or chi energy fluxes, chi energy of low and very low energy as well as chi energy of low and very low intensity still does not exist.

OBJECTION OF THE INVENTION

[0005] An object of the present invention is to provide a solution for the detection or measurement of chi energy and/or fluxes of chi energy.

SUMMARY OF THE INVENTION

[0006] To solve the above object, the present invention provides subject-matter according to the accompanying independent claims, wherein variations, embodiments and examples thereof are defined in accompanying dependent claims.

[0007] More particularly, the present invention provides a detection arrangement for detection of chi energy, the arrangement comprising:

- [0008] a detection layer comprising thermally activated delayed fluorescence TADF material, the thermally activated delayed fluorescence TADF material having an excitation frequency range and, exhibiting upon excitation with radiation in the excitation frequency range, a thermally activated delayed fluorescence TADF emission, wherein
- [0009] the TADF material having a TADF emission pattern without exposure to chi energy and exhibiting a different TADF emission pattern with exposure to chi energy.

[0010] The detection arrangement may further comprise:

- [0011] a computing device,
- [0012] an excitation radiation source device adapted to emit excitation radiation in the excitation frequency range,
- [0013] a radiation detector device communicatively coupled with the computing device, the radiation detector device being adapted to detect TADF emission from the detection layer and provide respective detection data to the computing device.
- [0014] wherein the computing device is being adapted to:
  - [0015] compute detection data from the radiation detector device to determine a TADF emission pattern without exposure to chi energy and a different TADF emission pattern with exposure to chi energy,
  - [0016] compare the determined TADF emission patterns,
  - [0017] determine, on the basis of the comparison, exposure to chi energy onto the detection layer.

[0018] TADF (thermally activated delayed fluorescence) material based detection has an extremely low energy level or energy threshold.

[0019] The detection layer may be at least one of

- [0020] ,
- [0021] provided in a coating material,
- [0022] shaped as a part of a sphere,
- [0023] shaped as a hollow or solid sphere,
- [0024] shaped as a polyhedron.

[0025] The radiation detector device may comprise at least one of

- [0026] a discrete radiation detector,
- [0027] a radiation detector array including at least two detector elements,
- [0028] electro-optical transducer,
- [0029] image intensifier tube,
- [0030] vacuum tube,
- [0031] CMOS chip
- [0032] a CCD chip.

[0033] The detection arrangement may comprise at least two radiation detector devices, wherein the detection layer is arranged between the at least two radiation detector devices.

[0034] The radiation detection arrangement may comprise a control device for controlling the operation of the excitation radiation source device, wherein the control devices is adapted to operate the excitation radiation source device in a constant emission mode and/or a variable/modifiable emission mode, comprising pulsed and/or periodical emission mode.

[0035] The computing device may be able to compute detection data from the radiation detector device during and/or following radiation emission from the excitation radiation source device.

[0036] The detection arrangement may comprise an optical system being arranged between the detection layer and the radiation detector device.

[0037] The detection arrangement may comprise a housing accommodating the components of the detection arrangement.

[0038] The housing may have shielding properties for shielding of at least one of:

- [0039] electro-magnetic radiation;
- [0040] X-ray radiation;
- [0041] ultraviolet radiation;
- [0042] Gamma radiation;
- [0043] corpuscular radiation, comprising alpha radiation, beta radiation, neutrons and/or protons.

[0044] The detection arrangement may comprise at least one temperature sensing device for sensing temperature of at least one of

[0045] the detection layer,

[0046] the TADF material,

[0047] the excitation radiation source device,

[0048] the radiation detector device,

[0049] the housing,

[0050] the optical system,

[0051] the computing device.

[0052] The detection arrangement or one or more parts thereof (particularly, the parts listed above) may be placed in a temperature-controlled environment.

[0053] For example, it is envisaged to use a passive temperature-controlled environment, where the detection arrangement or one or more parts thereof may be arranged in a box, container, housing and the like having thermal characteristics (e.g. walls with high thermal resistance) that maintain a temperature in its interior at least for some period of time. Examples for a passive temperature-controlled environment include a Dewar flask/container.

[0054] Further, it is also envisaged to use an active temperature-controlled environment, where the detection arrangement or one or more parts thereof may be arranged in a box, container, housing and the like for which the inner temperature may be actively controlled by using heating and/or cooling of the interior and at least one temperature sensor for temperature control.

[0055] Also, combinations of active and passive temperature-controlled environments may be used, wherein, for example, some parts of the detection arrangement may be in an active temperature-controlled environment and other parts of the detection arrangement are in a passive temperature-controlled environment.

[0056] Further, the present invention provides a method of detecting chi energy using a detection arrangement, wherein the method comprises the steps of:

[0057] providing a detection layer comprising thermally activated delayed fluorescence TADF material, the thermally activated delayed fluorescence TADF material having an excitation frequency range and, exhibiting upon excitation with radiation in the excitation frequency range, a thermally activated delayed fluorescence TADF emission,

[0058] detecting TADF emission from the detection layer by means of a radiation detector device, wherein

[0059] the TADF material having a TADF emission pattern without exposure to chi energy and exhibiting a different TADF emission pattern with exposure to chi energy.

[0060] The method may further comprise the steps of:

[0061] emitting excitation radiation in the excitation frequency range by means of an excitation radiation source device onto the detection layer in order to excite the TADF material, wherein

[0062] the radiation detector device is communicatively coupled to a computing device for the detection of TADF emission from the detection layer;

[0063] providing detection data from the radiation detector device to the computing device,

[0064] computing the detection data from the radiation detector device to determine a TADF emission pattern without exposure to chi energy and a different TADF emission pattern with exposure to chi energy,

[0065] comparing the determined TADF emission patterns,

[0066] determining, on the basis of the comparison, exposure to chi energy onto the detection layer.

[0067] The method may further comprise the steps of:

[0068] controlling the operation of the excitation radiation source device by means of a control device and

[0069] emitting radiation, by operating the excitation radiation source device, in a constant emission mode and/or a variable/modifiable emission mode, comprising pulsed and/or periodical emission mode; and/or

[0070] arranging an optical system between the detection layer and the radiation detector device for adjusting the TADF emission onto the radiation detector device; and/or

[0071] at least one of:

[0072] thermally calibrating the radiation detection arrangement for compensation of temperature related effects on the radiation detection device,

[0073] arrangement calibrating the radiation detection device as such for compensation of at least background radiation to which the radiation detection device is exposed.

[0074] According to the method of the present invention, in an excitation phase, phase excitation radiation may be emitted onto the detection layer in order to excite the TADF material and, in a detection phase subsequent to the excitation phase, TADF emission from the detection layer may be detected.

[0075] In some examples, the excitation phase and the detection phase may, at least partially, overlap. For example:

[0076] the excitation phase and the detection phase may start at the same time and may take place for the same period of time;

[0077] the excitation phase and the detection phase may start at the same time, wherein the excitation phase ends, while the detection is phase is still ongoing and is continued for some further period of time;

[0078] the detection phase takes place for a period of time, during which at least two excitation phases take place one after another with a pause therebetween (i.e. period of time without excitation), wherein the at least excitation phases may have the same duration or different durations;

[0079] the excitation phase may start and, at some point of time when the excitation phase takes place, the detection phase may also start, wherein the excitation phase may end earlier or at the same time, or later than the detection phase.

[0080] In further examples, there may a transition phase between the excitation phase and the detection phase, during which transition phase neither excitation nor detection takes place.

[0081] The method may further comprise the steps of:

[0082] providing a housing, having shielding properties to shield at least one of:

[0083] electro-magnetic radiation,

[0084] X-ray radiation,

[0085] Ultraviolet radiation,

[0086] Gamma radiation,

[0087] Corpuscular radiation,

[0088] alpha radiation,

[0089] beta radiation,

[0090] neutrons

[0091] protons.

[0092] Furthermore, the detection arrangement of the present invention is used for the detection of chi energy.

SUMMARY OF THE DRAWINGS

[0093] In the description of embodiment further below, it is referred to the following drawings, which show:

[0094] FIG. **1** a schematic illustration of a detection arrangement for detection of external radiation and/or chi energy,

[0095] FIG. **2** a schematic illustration of a further detection arrangement for detection of chi energy,

[0096] FIG. **3** a schematic illustration of a yet further detection arrangement for detection of chi energy,

[0097] FIG. **4** a schematic illustration of detection arrangement's emission patterns with and without chi energy,

[0098] FIGS. **5***a* and **5***b* schematic illustrations for explanation of emission distributions with and without chi energy,

DESCRIPTION OF EMBODIMENTS

[0099] Generally, features and functions referred to with respect to specific drawings and embodiments may also apply to other drawings and embodiments, unless explicitly noted otherwise.

[0100] Known conventional components, which are necessary for operation, (e.g. energy supply, cables, controlling devices, processing devices, storage devices, etc.), are neither shown nor described, but are nevertheless considered to be disclosed for the skilled person.

[0101] FIG. **1** schematically illustrates a detection arrangement **2** for detection of external radiation and/or chi energy having low intensity and/or energy. External radiation **4** refers to radiation impinging onto the radiation detection arrangement **2** and/or the radiation detection arrangement **2** is exposed to.

[0102] In the drawings, just a radiation beam along a direction (like from a single source) is illustrated. However, this is just for simplification. Rather, external radiation **4** may include more than one radiation beam, namely a plurality thereof, and/or radiation fronts. Also, external radiation **4** may impinge from more than a direction, e.g. a plurality of different directions, even opposing ones.

[0103] The detection arrangement **2** comprises a housing **6**. The housing **6** acts as shield against external radiation **6** that shall not be detected by the detection arrangement **2**. Such radiation is referred to as shieldable radiation **8**. Examples for shieldable radiation **8** include one or more of the following: visible light, neutrons, electrons, protons, myons, cosmic radiation, electro-magnetic radiation, X-ray radiation, ultraviolet radiation, Gamma radiation, corpuscular radiation, alpha radiation, beta radiation, thermal radiation, thermal disturbances.

[0104] Shieldable radiation **8** is blocked by the housing **6** so that no part of shieldable radiation **8** can enter the space defined the housing **6**. This is illustrated in the drawings by arrows **8** indicting reflected shieldable radiation. However, shielding effected by the housing **6** may be (additionally or alternatively) provided by absorption or any other way ensuring that no shieldable radiation reaches the inner of the housing.

[0105] Contrary thereto, the housing **6** does not block, shield off or prohibit in any other way external radiation that may be measured. Such radiation is referred to as measurable radiation **10**. Examples for measurable radiation **10** may include one or more of the following: neutrinos, neutralinos, WIMPS (Weakly interacting massive particles), high penetrating cosmic rays and particles, high penetrating radiation from nuclear reactors and nuclear sets or any other particle(s), rays or radiation chi energy is composed of.

[0106] According to such a configuration, the detection arrangement **2** is able to detect external radiation of low energy and/or intensity that is e.g. due to solar events like solar flares, or cosmic events of different nature.

[0107] However, in case of the absence of such events and/or the effects of such events on the detection arrangement are compensated, the detection arrangement **2** may be used to detect or measure the (natural) radiation or radiation flows/fluxes on the Earth's surface or also radiation flows/fluxes of the nearby space.

[0108] In particular, the detection arrangement **2** may be placed at the point or region of interest, e.g. on the ground. Additionally, the detection arrangement **2** may be equipped with an (optional) EM shielding. The radiation level on the point of interest, e.g. in the absence of cosmic events, may be compensated, for example by subtracting the longtime mean value or reference data.

[0109] To this end, the detection arrangement **2** may be placed on the ground and radiation will be detected or collected for a certain time period. Afterwards, either a longtime mean value, e.g. calculated by a series of different measurements is to be subtracted, or, reference data, e.g. collected from other measurements or common to a particular region, may be subtracted.

[0110] Additionally, a possible signal related to a cosmic event may also be compensated, i.e. if required. To do so, a second (stationary) detection arrangement **2** may be located nearby the detection arrangement **2** in the point or region of interest. The data of the second detection arrangement **2** may be used to compensate a signal of a cosmic event. Also, a detection network, comprised of more than 1 additional detection arrangement **2** may be used for such a compensation.

[0111] Chi energy, or flows, beams or fluxes of chi energy exhibit singularities e.g. near to natural or artificial water streams, e.g. at specific or characteristic points in landscape, e.g. in areas of active orogeny (e.g. mountain formation) and e.g. at industrial landscapes such as peaks, hills, buildings or the like. Numerous empirical datasets show a correlation between such environmental conditions and/or landscape and/or flora and/or fauna conditions or an influence thereof. Such influence is considered to be rather weak (i.e. of low or very low energy and/or intensity), because otherwise it could/would be found in other experiments, e.g. at time scales of landscape and biocenosis formation.

[0112] However, as discussed further above, the detection arrangement **2** is able to detect external radiation having low intensity and/or energy. As such, by compensating the effect of cosmic events and/or the natural radiation value (e.g. background) a measurement of (other) low energetic flows, fluxes, beams becomes possible that can eventually be related to chi energy.

[0113] As such, the detection arrangement **2** according to FIG. **1**, is able to measure chi energy, chi energy beams/flows/fluxes having low intensity and/or low energy. Chi energy **4** refers to radiation impinging onto the detection arrangement **2** and/or the detection arrangement **2** is exposed to. Further, it should be noted that chi energy, chi energy fluxes, chi energy beams and/or chi energy fronts may be detected by the detection arrangement **2**.

[0114] As set forth, when the detection arrangement **2** is placed at a point or region of interest and in the absence of flows of chi energy, i.e. without chi energy impinging on the detection arrangement **2**, the output of the detection arrangement **2** will merely show fluctuations around the background radiation value. During this time, the detection arrangement **2** may be kept stationary.

[0115] Contrary thereto, i.e. when the detection arrangement **2** is moved, and e.g. placed in a chi energy stream/beam/flux, for example by moving the detection arrangement **2** along natural/environmental conditions or peculiarities, a signal proportional to the power of the chi energy stream/beam/flux can be observed, measured or detected at the output of the detection arrangement **2**.

[0116] As the detection arrangement **2** moves (e.g. along natural water networks and/or for example in areas of active orogeny, e.g. mountain formation) the detection arrangement **2** detects and shows output patterns and radiation streams along and repeating the peculiarities of their energy flow indicating the measurement of chi energy or flows/fluxes/beams of chi energy.

[0117] Starting therefrom, FIG. **1** further schematically illustrates a detection arrangement **2** for detection of chi energy **4** having low intensity and/or energy. Chi energy **4** refers to radiation impinging onto the radiation detection arrangement **2** and/or the radiation detection arrangement **2** is exposed to. The shielding and measuring properties for detection of chi energy may be the identical to the shielding and measuring properties for the detection of external radiation, but may also be different.

[0118] In the drawings, just a chi energy beam along one direction (like from a single source) is illustrated. However, this is just for simplification. Rather, chi energy **4** may include more than one beam or stream, namely a plurality thereof, and/or radiation fronts. Also, chi energy **4** may impinge from more than one direction, e.g. a plurality of different directions even opposing ones.

[0119] With respect to chi energy measurement, shieldable radiation **8** is blocked by the housing **6** so that no part of shieldable radiation **8** can enter the space defined the housing **6**. This is illustrated in the drawings by arrows **8** indicting reflected shieldable radiation. However, shielding effected by the housing **6** may be (additionally or alternatively) provided by absorption or any other way ensuring that no shieldable radiation reaches the inner of the housing.

[0120] Contrary thereto, the housing **6** does not block, shield off or prohibit in any other way chi energy that may be measured. Accordingly, chi energy is referred to as measurable radiation **10**.

[0121] When reference is made to chi energy, chi energy fluxes, flows, beams and streams having low intensity and/or energy are also comprised therein.

[0122] The housing **6** may be adapted to act as at least one of the following:

[0123] optically non-transparent shield,

[0124] thermal shield,

[0125] electromagnetic shield,

[0126] shield against at least one of UV radiation, gamma radiation, corpuscular radiation, X-rays, alpha radiation, beta radiation.

[0127] The material of the housing **6** may comprise, for example, at least one of the following:

[0128] metal (e.g. for optically non-transparent shielding),

[0129] plastic (e.g. for optically non-transparent shielding),

[0130] gas gap and/or low thermal conductivity polymers (e.g. for thermal shielding),

[0131] multi layered construction including layers of different material, for example alternating layers of material having low and high thermal conductivity, like copper foil, (e.g. for thermal shielding),

[0132] low thermal conductivity material, like polymer, (e.g. for thermal shielding),

[0133] closed (e.g. complete and/or hermetic) grounded metal coating (e.g. Al, Cu) (e.g. for electromagnetic shielding)

[0134] UV/gamma/corpuscular/X-rays/alpha/beta shield:

[0135] Aluminum (e.g. for shielding of at least one of UV radiation, gamma radiation, corpuscular radiation, X-rays, alpha radiation, beta radiation),

[0136] glass (e.g. for shielding of at least one of UV radiation, gamma radiation, corpuscular radiation, X-rays, alpha radiation, beta radiation),

[0137] textolite (e.g. for shielding of at least one of UV radiation, gamma radiation, corpuscular radiation, X-rays, alpha radiation, beta radiation),

[0138] concrete (e.g. for shielding of at least one of UV radiation, gamma radiation, corpuscular radiation, X-rays, alpha radiation, beta radiation).

[0139] An exemplary housing may have walls comprising an Aluminum sheet/layer with a thickness of at least about 10 mm; one, two or three glass layers each having a thickness of at least about 2 mm; a textolite layer with a thickness of about 1 mm with an optional cooper foil at least at one side of the textolite layer.

[0140] The distance between the inner surface of the housing **6** and the detection layer **12** may be 0 mm (i.e. no distance) or, for example, in the range of at least about 30 mm.

[0141] Further shielding can be achieved by providing a housing that—in addition to at least one of the above mentioned examples or as option thereto—is made of concrete and completely surrounds the detection arrangement. This can be accomplished by, for example, positioning the detection arrangement in a hollow concrete cube having 6 concrete walls with a thickness of, e.g., about 3 meters and more.

[0142] Inside the housing **6**, the detection arrangement **2** comprises a detection layer **12**, which comprises at least a TADF material, i.e. material exhibiting thermally activated delayed fluorescence. The TADF material of the detection layer **12** has an excitation frequency range, where the TADF material, if being excited by radiation in the excitation frequency range, exhibits a thermally activated delayed fluorescence.

[0143] Also inside the housing **6**, the detection arrangement comprises a excitation radiation source **14** and a radiation detector device **16**.

[0144] The excitation radiation source device **14** is capable of providing radiation (at least) in the excitation frequency range of the TADF material. Such radiation is referred to as excitation radiation **18**. The excitation radiation source device **14** can be controlled to provide continuous excitation radiation **18**, i.e. to be operated in a constant emission mode. The excitation radiation source device **14** can be controlled to provide non-continuous excitation radiation **18**, i.e. to be operated in a variable emission mode, to provide, for example, pulsed and/or periodical excitation radiation.

[0145] The excitation radiation source device **18** can comprise one or more excitation radiation sources, for example, one or more LEDs. The drawings show a single excitation radiation source device **18**. However, two and more excitation radiation source devices arranged adjacent to each other or spaced from each other can be employed.

[0146] The radiation detector device **16** is capable of detecting (at least) radiation provided by the detection layer **12**, particularly thermally activated delayed fluorescence from the TADF material in response to excitation by excitation radiation from the excitation radiation source device **18**.

[0147] The radiation detector device **16** can comprise one or more radiation detectors, for example photo detectors being sensitive to a least fluorescence that the TADF material can emit.

[0148] As illustrated in FIGS. **1** and **3**, one radiation detector device **16** can be employed, while FIG. **2** illustrates an embodiment employing two radiation detector devices **16**. However, more than two radiation detector devices **16** can be used, in order to, for example, detect radiation from the detection layer at different locations in the housing **6**.

[0149] The radiation detector device **16** can have a planar detection surface **20**, as illustrated in the drawing. However, radiation detector devices having a, for example, curved detection surface as indicated by the dashed curved detection surface **22** in FIG. **1**.

[0150] The size and form of the detection surface can be designed such that it conforms the size and form of a detection layer's emission surface **24** from where detection layer radiation and, particularly, TADF fluorescence can be emitted. This allows capturing and detecting as much radiation from the detection layer as possible.

[0151] According to the illustrations of FIGS. **1** and **3**, the detection layer **12** has a single emission surface **24**, while the detection layer **12** of FIG. **2** has two emission surfaces **24**.

[0152] The radiation detector device **16** is capable of outputting detection data indicating radiation detected by the radiation detector device **16**.

[0153] In addition or as alternative, an optical system can be arranged between the detection layer **12** and a radiation detector device **16**, as explained further below with reference to FIG. **3**.

[0154] The radiation detection arrangement **2** further includes computing device **26**. The computing device **26** is communicatively coupled with the radiation detector device **16** to, at least, obtain detection data outputted from the radiation detector device **16**. Further, the computing device **26** may be arranged to control the radiation detector device **16** and its operation, respectively.

[0155] The computing device **26** may be also communicatively coupled with the excitation radiation source device **14** to control the operation thereof.

[0156] A communicative coupling between the computing device **26** and another part of the radiation detection arrangement (e.g. the radiation detection device **16** and excitation radiation source device **14**) may be wired and/or wireless.

[0157] The computing device **26** is adapted, e.g. in the form of respectively designed hardware and/or software, to compute detection data from the radiation detector device **26** in a manner to determine one or more emission patterns resulting from radiation emitted by the detection layer and, particularly, from thermally activated delayed fluorescence from the TADF material.

[0158] If applicable, the computing device **26** may control the operation of the excitation radiation source device **14**. For example, the excitation radiation source device **14** may be controlled such that it emits excitation radiation **18** synchronized with detection operation of the radiation detector device **16**. In some examples, the following procedure may be used: The excitation radiation source device **14** may be operated to emit excitation radiation for a predefined first period of time (e.g. a phase of 1 ms).

[0159] Then, during a second predefined period of time (e.g. a phase of 1 ms) no excitation radiation is emitted and the radiation detector device **16** is not activated/operated to detect radiation from the detection layer **12** and, particularly thermally activated delayed fluorescence from the TADF material. This period of time and phase, respectively, allows transition processes to take place in, e.g., the TADF material and/or the hardware components of the arrangement.

[0160] After that, during a third predefined period of time (e.g. a phase of 3 ms) the radiation detector device **16** is activated/operated to detect radiation from the detection layer **12** and, particularly thermally activated delayed fluorescence from the TADF material.

[0161] This procedure can be referred to as radiation detection based on pre-excited TADF material, because in a first phase (also referred to a excitation phase) TADF material is excited by excitation radiation and in a second phase (also referred to a detection phase) TADF emission is detected/sensed on the basis of which measurable radiation can be detected. Preferably, as indicated above, there is an intermediate phase (also referred to as transition phase) between the excitation phase and the detection phase

[0162] In other examples, the excitation radiation source device **14** may be operated to emit excitation radiation as pulses of the same or different level and/or with predefined time intervals of the same or varying length in between. Also, the excitation radiation source device **14** may be operated to emit constant excitation radiation (without periods without excitation radiation) of the same level or of at least two different levels (e.g. like a waveform or stepwise).

[0163] Generally, any type of one or more TADF material and combinations thereof may employed. An exemplary TADF material used in experiments included an organic luminofor comprising a mixture of fluorescein Natrium and boric acid.

[0164] A possible mass ration of the components can be in the range of 1:100,000-1:500.

[0165] The components can be mixed and heated to manufacture the exemplary TADF material, for example according to a specific heating profile. The mixed materials are for example heated up to a maximal temperature in the range between 200° C. and 260° C. for at least 20 minutes under a pressure below 0.8 bar.

[0166] The heating may be performed in pre-molded forms to obtain TAFD material having a predefined shape. Also, after heating the material can be grounded and mixed with a carrier material (e.g. epoxy), after which the resulting material can be formed to get any desired shape (e.g. by applying onto a support surface).

[0167] In the detection device of FIG. **1**, the TADF material of the detection layer **12** is excited by excitation radiation **18** from the excitation radiation source device **14**, and in response thereto, emits thermally activated delayed fluorescence **28**. The emitted thermally activated delayed fluorescence **28** impinges onto the radiation detector device **16**, which generates respective detection data. The detection data generated by the radiation detector device **16** are computed by the computing device **26** to determine one or more emission patterns resulting from thermally activated delayed fluorescence from the TADF material.

[0168] In general, this is also the case with the radiation detection devices of FIGS. **2** and **3**.

[0169] However, in the detection device of FIG. **2**, two radiation detector devices **16** are used to detect thermally activated delayed fluorescence **28** emitted by the TADF material of the detection layer **12**. The detection data respectively generated by the radiation detector devices **16** are computed by the computing device **26** to determine one or more emission patterns resulting from thermally activated delayed fluorescence from the TADF material. Since detection data from two radiation detector devices **16** are available, the detection data from the different radiation detector devices **16** can be used to compare the one or more emission patterns on one of radiation detector devices **16** with the one or more emission patterns of the other radiation detector device **16**.

[0170] For example, two and more radiation detector devices **16** can be used for a correlated detection of measurable radiation **10**, wherein, e.g., only synchronized detection data from different radiation detector devices **16**. Synchronization may include to operate the radiation detection devices **16** such that their respective detection data are provided at the same time or processed such that detection data generated at the same time and/or in the same time period are processed together. In addition or as alternative, synchronization may include to use together detection data being generated at/in corresponding areas of the respective detection surfaces of the radiation detection devices **16**. In addition or as alternative, synchronization may include using detection data being indicative of TADF emission coming from different parts/surfaces of the detection layer **12** and TADF material, respectively, in order to, for example, detect TADF emission from opposing detection layer's surfaces as illustrated in FIG. **2**.

[0171] As further example, two and more radiation detector devices **16** can be used to distinguish different types of measurable radiation **10**, wherein, e.g., differences between detection data from different radiation detector devices **16** are calculated. More detailed observations in this respect can be find further below with reference to FIGS. **5***a* and **5**.

[0172] In the radiation detection device of FIG. **3**, an optical system **30** is used to collect and/or focus thermally activated delayed fluorescence from the TADF material onto the radiation detector device **16**, in order to, for example, avoid "loosing" such radiation from being captured by the radiation detector device.

[0173] In any case, the pattern in which thermally activated delayed fluorescence is emitted from the TADF material depends on chi energy reaching the TADF material. As illustrated in FIG. **4**, without chi energy reaching the detection layer **12** (i.e. without measurable radiation **10**), the TADF material exhibits a more or less homogenous emission pattern **32**. If chi energy reaches the detection layer **12** (i.e. case with measurable radiation **10**), the TADF material exhibits a shifted emission pattern **34**, wherein the pattern shift depends from the direction of the measurable radiation **10**.

[0174] This is further illustrated in FIG. **5***b*, which shows that measurable radiation **10** "deforms" the homogenous emission pattern **32**/**36** to the shifted emission pattern **34**/**38**. This deformation can be used to determine the direction of incoming measurable radiation **10**.

[0175] As shown in FIG. **5***a*, without measurable radiation **10**, thermally activated delayed fluorescence from the TADF material results in a uniform distribution **36** of photon emission. As illustrated in FIG. **5***b*, measurable radiation **10** shifts and deforms the emission pattern such that a shifted and deformed distribution **38** of photon emission results. For example, in the illustration of FIG. **5***b* the distances d**1** and d**2** between corresponding areas of the uniform distribution **36** and the shifted and deformed distribution **38** indicate that the direction along which the underlying measurable radiation **10** comes from.

[0176] As known, in response to excitation radiation, generally TADF material exhibits two effects, namely TAFD emission and phosphorescence emission. While phosphorescence emission results from an inter system crossing (ISC) transition, i.e. a transition from the S1 state to the T1 state, TADF emission results from a reverser ISC transition, i.e. a transition from the T1 state to the S1 state.

[0177] However, experiments have demonstrated that phosphorescence emission does not show a reaction to chi energy and measurable radiation, respectively; at least the reaction has not impact on the radiation detection based on TAFD emission.

[0178] Particularly, chi energy/measurable radiation does not affect phosphorescence emission of TADF material such that a shifted emission pattern as shown in FIGS. **4**, **5***a* and **5***b* results.

[0179] Rather, the phosphorescence emission pattern remains essentially the same. Therefore, phosphorescence emission impinging on the radiation detection device **16** can be considered as essentially constant background light.

[0180] Data outputted by the radiation detection device **16** in response to received phosphorescence emission can be compared with background noise and treated in the same way. For example, overall data output from the radiation detection device **16** may be filtered to remove phosphorescence emission related data in order to obtain an effective radiation detection device output, detection data being indicative of TADF emission.

[0181] In general, TADF material is temperature sensitive and, as a result, has temperature dependent TADF emission. Therefore, a thermal calibration method may be used to compensate temperature related effect.

[0182] For example, the whole detection arrangement **2** may be set up in a thermally controlled thermal chamber, in which the temperature is controlled to change from a low/minimum level to a high/maximum level, preferably with constant speed. The temperature may be changed so slow that, inside the thermal chamber, a quasi thermal equilibrium is achieved. For example, the temperature change may be such that the time constant of the thermal calibration method time constants of the thermal calibration method are smaller than dynamics of the thermal chamber of the thermal calibration setting. For example, in some cases the time constant of the thermal calibration method can be in the range of about two seconds and measuring time constant of the thermal calibration setting can be in the range of about two minutes. As further example, the thermal dynamics of the thermal calibration setting can be a thermal change in the range of about 20° C. in about one hour.

[0183] The above temperature change process may carried out once or may be repeated for two or more different temperature change profiles (e.g. different constant speeds, stepwise including using different step sizes). Experiments have shown that one or more temperature change processes lasting about five to seven hours provide a good basis for thermal calibration.

[0184] During thermal calibration, the detection arrangement **2** may be operated normally, for example, so that the TADF material is excited by excitation radiation and TADF emission is detected by the radiation detector device **16**.

[0185] During the temperature change process(es), temperature and changes thereof of at least one of the detection layer **12**, the TADF material, the excitation radiation source device **14** (and/or components thereof), the radiation detection device **16**, the detection surface (e.g. detection surface **20** or **22**), the detection layer's surface, the optical system **30**, the housing **6** and electrical and/or electronic components (e.g. cables, amplifiers, signal conditioners, ADCs etc.) in the housing and/or in the thermal chamber are measured. This may be accomplished by one or more temperature sensors respectively arranged in/on the housing and/or the thermal chamber.

[0186] The thusly measured temperatures and changes thereof (e.g. in form of respective time series) and, particularly, information on the TADF material temperature and changes thereof, can be used to determine information (e.g. in form of regression curves) indicative of the temperature dependency of the detection arrangement **2** and parts thereof, for example data output by the radiation detector device **16** and/or data received by the computing device **26**.

[0187] Such information may be used to compensate temperature dependent effects in radiation detection by the detection device **2**.

[0188] In this context, it is noted that it can be assumed that generally there is no correlation between, on the one hand, chi energy **4** reaching the detection arrangement **2** and chi energy/measurable radiation reaching the detection layer **12** and, on the other hand, temperature changes affecting the detection arrangement **2**. Nevertheless, it is preferred to not carry out calibration during unusual cosmic events, like full/new moon, solar flares and/or storms, Midheaven (Milky Way at MC point), for avoiding impacts thereof onto calibration.

Reference numeral list	
2	Detection arrangement
4	Chi energy
6	Housing
8	Shieldable radiation
10	Measurable radiation

-continued

Reference numeral list	
12	Detection layer
14	Excitation radiation source device
16	Radiation detector device
18	Excitation radiation
20	Planar detection surface
22	Curved detection surface
24	Detection layer's surface
26	Computing device
28	Thermally activated delayed fluorescence
30	Optical system
32	Homogenous emission pattern
34	Shifted emission pattern
36	Uniform distribution pattern
38	Shifted and deformed distribution pattern

1. Detection arrangement for detection of chi energy, the arrangement comprising:

a detection layer comprising thermally activated delayed fluorescence TADF material, the thermally activated delayed fluorescence TADF material having an excitation frequency range and, exhibiting upon excitation with radiation in the excitation frequency range, a thermally activated delayed fluorescence TADF emission, wherein

the TADF material having a TADF emission pattern without exposure to chi energy and exhibiting a different TADF emission pattern with exposure to chi energy.

2. Detection arrangement according to claim **1**, further comprising:

a computing device,

an excitation radiation source device adapted to emit excitation radiation in the excitation frequency range,

a radiation detector device communicatively coupled with the computing device, the radiation detector device being adapted to detect TADF emission from the detection layer and provide respective detection data to the computing device.

wherein the computing device is being adapted to:

compute detection data from the radiation detector device to determine a TADF emission pattern without exposure to chi energy and a different TADF emission pattern with exposure to chi energy,

compare the determined TADF emission patterns,

determine, on the basis of the comparison, exposure to chi energy onto the detection layer.

3. The detection arrangement of claim **1**, wherein the detection layer is at least one of

planar,

provided in a coating material,

shaped as a part of a sphere,

shaped as a hollow or solid sphere,

shaped as a polyhedron.

4. The detection arrangement of claim **2**, wherein the radiation detector device comprises at least one of

a photo detector,

a discrete radiation detector,

a radiation detector array including at least two detector elements,

electro-optical transducer,

image intensifier tube,

vacuum tube,

CMOS chip

a CCD chip.

5. The detection arrangement of claim 1, comprising

at least two radiation detector devices wherein the detection layer is arranged between the at least two radiation detector devices;

a control device for controlling the operation of the excitation radiation source device, wherein the control devices is adapted to operate the excitation radiation source device in a constant emission mode and/or a variable/modifiable emission mode, comprising pulsed and/or periodical emission mode, wherein, preferably,

the computing device is able to compute detection data from the radiation detector device during and/or following radiation emission from the excitation radiation source device and/or

an optical system being arranged between the detection layer and one or more of the radiation detector device.

6. The detection arrangement of claim 1, comprising a housing accommodating the components of the detection arrangement.

7. The detection arrangement of claim 1, wherein the housing has shielding properties for shielding of at least one of:

electro-magnetic radiation;

X-ray radiation;

ultraviolet radiation;

Gamma radiation;

corpuscular radiation, comprising alpha radiation, beta radiation, neutrons and/or protons.

8. The detection arrangement of claim 1,

comprising at least one temperature sensing device for sensing temperature of at least one of

the detection layer,

the TADF material,

the excitation radiation source device,

the radiation detector device,

the housing,

the optical system,

the computing device, and/or

wherein the detection arrangement or at least one part thereof is arranged in a temperature controlled environment.

9. Method of detecting chi energy using a detection arrangement, comprising:

providing a detection layer comprising thermally activated delayed fluorescence TADF material, the thermally activated delayed fluorescence TADF material having an excitation frequency range and, exhibiting upon excitation with radiation in the excitation frequency range, a thermally activated delayed fluorescence TADF emission,

detecting TADF emission from the detection layer by means of a radiation detector device, wherein

the TADF material having a TADF emission pattern without exposure to chi energy and exhibiting a different TADF emission pattern with exposure to chi energy.

10. Method of detecting chi energy according to claim 9, further comprising the steps of

emitting excitation radiation in the excitation frequency range by means of an excitation radiation source device onto the detection layer in order to excite the TADF material, wherein

the radiation detector device is communicatively coupled to a computing device for the detection of TADF emission from the detection layer;

providing detection data from the radiation detector device to the computing device,

computing the detection data from the radiation detector device to determine a TADF emission pattern without exposure to chi energy and a different TADF emission pattern with exposure to chi energy,

comparing the determined TADF emission patterns,

determining, on the basis of the comparison, exposure to chi energy onto the detection layer.

11. Method of detecting chi energy according to claim 9, further comprising:

controlling the operation of the excitation radiation source device by means of a control device and

emitting radiation, by operating the excitation radiation source device, in a constant emission mode and/or a variable/modifiable emission mode, comprising pulsed and/or periodical emission mode; and/or

arranging an optical system between the detection layer and the radiation detector device for adjusting the TADF emission onto the radiation detector device; and/or

at least one of:

thermally calibrating the radiation detection arrangement for compensation of temperature related effects on the radiation detection device,

arrangement calibrating the radiation detection device as such for compensation of at least background radiation to which the radiation detection device is exposed.

12. Method of detecting chi energy according to claim 10, wherein, in an excitation phase, phase excitation radiation is emitted onto the detection layer in order to excite the TADF material and, in a detection phase subsequent to the excitation phase, TADF emission from the detection layer is detected, wherein the excitation phase and the detection phase may overlap or there may be a transition phase between the excitation phase and the detection phase, during which transition phase neither excitation nor detection takes place.

13. Method of detecting chi energy according to claim 9, further comprising:

providing a housing, having shielding properties to shield at least one of:

electro-magnetic radiation,

X-ray radiation,

Ultraviolet radiation,

Gamma radiation,

Corpuscular radiation,

alpha radiation,

beta radiation,

neutrons

protons.

14. Use of a detection arrangement according to claim 1 for the detection of chi energy.

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