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# Datasheet for the decision of 14 January 2010

**Case Number:** T 0657/08 - 3.4.02

**Application Number:** 99915124.4

**Publication Number:** 1090282

**IPC:** G01N 21/17

**Language of the proceedings:** EN

**Title of invention:**
A dispersive precompensator for use in an electromagnetic radiation generation and detection system

**Applicant:**
Picometrix, LLC

**Opponent:**
-

**Headword:**
-

**Relevant legal provisions:**
EPC Art. 56

**Relevant legal provisions (EPC 1973):**
-

**Keyword:**
"Claim 1 - inventive step (yes)"

**Decisions cited:**
-

**Catchword:**
-

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**Case Number:** T 0657/08 - 3.4.02

# D E C I S I O N
**of the Technical Board of Appeal 3.4.02**
**of 14 January 2010**

**Appellant**: Picometrix, LLC
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**Representative**: Solf, Alexander
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**Decision under appeal:** **Decision of the Examining Division of the European Patent Office posted 22 November 2007 refusing European application No. 99915124.4 pursuant to Article 97(1) EPC.**

**Composition of the Board:**

**Chairman:** A. G. Klein
**Members:** M. Rayner
M. J. Vogel

## Summary of Facts and Submissions

I. The applicant appealed against the decision of the examining division refusing European patent application number 99 915 124.4. The patent application concerns a terahertz electromagnetic emission and detection system. In the decision under appeal reference was made to documents including the following:

D1 US-A-5 729 017
D3 DE-A-19 622 359
D4 EP-A-0 727 671.

The examining division substantiated its refusal with lack of inventive step of the subject matter of the claim before it having regard to documents D1, D3 and D4. In particular, it argued document Dl discloses the general context of terahertz imaging but without giving details of the experimental setup. However, terahertz imaging is well known in the art and is illustrated by document D4.
Figure 1 of this document D4 shows that the femtosecond pulse of the source is split in two pulses. One pulse is sent to the transmitter to generate terahertz pulses, the second pulse is sent to the terahertz (gated) detector for synchronisation. This background being well known, the skilled person following the teaching given by document Dl, i.e. that the femtosecond pulse is directed to the transmitter using an optical fibre would have applied it to the receiver to obtain the same flexibility given by the fibre compared to a fixed optic setup of lenses and mirrors. It is well known in the art that an optical fibre is a dispersive medium and that a pulse propagating in it has its temporal

shape modified by the propagation in the fibre. Therefore the skilled person following document Dl would have realised that the optical fibre conducting the light to the emitter (and to the receiver) introduces a modification in the temporal shape of the pulse and that therefore the signal emitted by the terahertz emitter is different to the signal emitted were the pulse directly focussed on the emitter without the use of a fibre. The skilled person would then have sought a solution to this problem of dispersion of the signal in the fibre. Document D3 provides the solution by precompensating the pulse before entering the optical fibre i.e. introducing a dispersive element before the optical fibre to provide a negative dispersion to the pulse is equal and opposite to the dispersion induced by the optical fibre, so that after propagation through the fibre, the signal is restored to its original shape (see column 1, lines 61 to 66). In document D3 this solution is presented for a microscope, however the problem of dispersion in the fibre is linked to the use of an optical fibre in a system and not to the kind of system in which the fibre is used, be it a terahertz emitter or a confocal microscope. Therefore the skilled person would have been motivated to apply the solution to the problem of fibre dispersion proposed in document D3 to the device of document Dl and would have introduced a precompensator in front of the optical fibre of document Dl so that the shapes of the pulse are restored after propagation through the fibre and the pulse arrives at the emitter (and the receiver) with the original shape. The examining division did not agree with any argument that the fibre used in document Dl is very short, less than 200 mm or even less than

100 mm, or that document Dl only intended to ease the burden of spatial alignment and is thus not concerned with the use of long optical fibre. The division considered document D1 to disclose the use of optical fibre as an alternative to a complex optical system using lenses and mirrors. Such a system is much bigger than just 100 or 200 mm. When replacing such an optical system by a fibre, the fibre would be certainly much longer than 100 or 200 mm. However, as document Dl deals mainly with the generation of the terahertz radiation, no details about dispersion in the fibre is given. Nevertheless, it is certainly a problem that the skilled person would have identified when using optical fibre. The examining division was therefore of the opinion that the replacement of a complex optical system made of mirrors and lenses by an optical fibre allows a greater flexibility and independence of the terahertz transmitter from the laser source.

II. The appellant requests that the decision under appeal be set aside and a patent granted on the basis of claims 1-16 as filed on 29.12.2009. Oral proceedings were also requested if the board was unable to follow the argumentation of the appellant.

III. The appellant argued that neither document Dl nor document D4 make reference to a dispersion problem that optical pulses encounter as they propagate through the glass fibre. Unless a precompensator were utilized before the pulse is launched into fibre, even a 1 terahertz bandwidth would necessitate a fibre length shorter than 200 mm. For a bandwidth of 3 terahertz, a length of less than 100 mm is required. Such short lengths greatly hinder the utility of terahertz systems

for field operation and manufacturing applications. Documents Dl is only intended to ease the burden of spatial alignment and is not concerned with the use of long optical fibres, such as necessary to couple a splitter to a terahertz transmitter of receiver.

IV. Document D3 discloses a device for coupling radiation for a microscope application and is not concerned with terahertz imaging systems. Document D3 teaches that by adding a precompensator in the form of a grating pair or a combination of grating pair and prism pair, a reduction in the amount of dispersion experienced by a broadband optical pulse as it propagates through the fibre for application in microscopy. Document D3 specifically relates to the application of a fibre delivery technique for microscopy (primarily two-photon microscopy) and pertains to a single fibre path or link and not to two optical paths. Document D3 does not disclose splitting the optical pulse along two distinct optical paths while maintaining a timing relationship between them for the purpose of generating and time-resolving transient events.

V. In previous applications like that of document D4, such as in a lab environment, a laser can be pointed directly through space at a terahertz transmitter or receiver with negligible dispersive effects. To allow the commercial use of such a system, the present invention must be industrially hardened and packaged. A laser pulse in a room environment may be deflected by objects or people and will suffer degradation from atmospheric effects, unacceptable conditions in an industrial environment. By utilizing the precompensator of the invention, the receiver and transmitter optical

fibres are able to achieve a transform-limited pulse at their outputs because the precompensator adds dispersion of a sign opposite to the dispersion experienced in the fibres. This system claimed can then be easily packaged, so as to be suitable for use in an industrial environment.

VI. Oral proceedings were appointed consequent to the request of the appellant. In a communication attached to the summons, the board informed the appellant that it considered Figure 1 of document D4 to show a femtosecond pulse source 1, split to an optically gated terahertz transmitter 2 and detector 5. A display 8 is shown with appropriate circuitry 7. It is not explicit in the figure that optical fibres are used. However, this feature seemed at least obvious in view of the disclosure of document D1. The case therefore turned on whether providing a precompensator is enough to support an inventive step. The precompensator addresses the problem of dispersion and the same problem is addressed in document D3. While document D3 concerns confocal microscopy, it seemed the examining division was correct to consider the problem not to be specific either to confocal microscopy or to terahertz imaging systems but to be related to optical fibres application as such in these types of equipment.

VII. During the oral proceedings, the appellant argued that the closest prior art document should be considered to be document D4 and not document D1 as the former concerns a terahertz electromagnetic emission and detection system, whereas the thrust of document D1 is towards an antenna system. The problem solved by the invention is to provide a packaged system for

industrial environments, where a relatively long optical path is not affected by that environment nor optical adjustment between the splitter and transmitter or receiver necessary. In the case of document D1, even were its teaching applied to a system not unlike that of document D4, such as that disclosed in column 2, lines 35-36, there would be no relatively long optical path, as in such a case the fibre would have to be about 10 mm, it being used to hit sharp features of the antenna. Moreover, relatively long parts of the optical path between the splitter and the transmitter or receiver would remain exposed to the industrial environment. The disclosure has therefore nothing to do with the problem addressed by the invention.

VIII. Claim 1 is worded as follows.

"1. A terahertz electromagnetic radiation emission and detection system (10), comprising
- an optical short pulse laser source (12) producing femtosecond output pulses
- a precompensator means (14) coupled to the laser source (12)
- a fiber splitter (15) coupled to the precompensator means (14) to split the precompensated optical pulse for entering a first optical fiber (18) and a second optical fiber (19) which are coupled to the splitter (15)
- wherein the precompensator means (14) adds opposite sign dispersion to said optical pulses to correct for a stretching of the optical pulses as they travel through the first optical fiber (18) and the second optical fiber (19) to achieve transform limited pulses or closely reproduce the original pulse

- a terahertz transmitter (16) which is coupled to the splitter (15) via the first optical fiber (18) and struck by the optical pulse which exits the first optical fiber (18) and which emits electromagnetic radiation pulses Co a sample (30) an electromagnetic radiation receiver (20) which is coupled to the splitter (15) via the second optical fiber (19) to detect electromagnetic radiation in the terahertz range after being conditioned by the sample (30) and then generate an electrical signal which can be interpreted, scaled and/or digitised by a data acquisition system (28), coupled to the receiver (20), whereby the receiver (20) is synchronized to the transmitter (16) by the optical pulses traveling through the second optical fiber (19)."

IX. At the end of the oral proceedings, the board gave its decision.

## Reasons for the Decision

1. The appeal is admissible.

2. *Prior Art*

2.1 Document D4 discloses a terahertz electromagnetic radiation emission and detection system as set out in section VI of the Facts and Submissions above. No optical fibres are disclosed in document D4 and nor, consequently, is any precompensator disclosed.

2.2 Document D1 refers to optical fibre as follows:

(a) column 3, lines 59-61

"FIG. 7 is a schematic representation similar to FIG. 1 showing the optical pump signal focused on the sharp gap features using an optical fiber."

(b) column 4, lines 53-59

"While the descriptions of the prior art devices envision a single pump beam, according to our invention multiple pump beams may be used. They may be directed on the sharp features by simple optics, i.e. lenses or mirrors. In a preferred embodiment they are directed to selected regions of the gap by optical fibers. This embodiment will be described in more detail below."

(c) column 6, lines 23-31

"In FIG. 7 we show the use of an optical fiber 70 for focusing the optical pump spot on the sharp features of the electrode gap. The fiber end that is attached to the semiconductor substrate is stripped of its coating leaving cladding layer 71 and core 72. The core is shown directed onto the sharp features 73 of the electrode 16. The electrode gap geometry in this figure has an anode like the one shown in FIG. 4 and a conventional straight cathode, i.e. a gap having a geometry with 7 sides and four re-entrant angles."

(d) claim 6

"6. The device of claim 5 in which the means for directing input radiation onto the said electrode gap comprises an optical fiber."

(e) Figure 7, showing the features referred to in sections 2(a) and (c) above.

2.3 Document D3

The disclosure of this document is as set out in section IV of the Facts and Submissions above.

3. Patentability

3.1 Since document D4 discloses a terahertz electromagnetic radiation emission and detection system, the board concurs with the appellant that it can be considered to represent an appropriate staring point for the present invention. The novel features, i.e. those involving optical fibre, solve the problem of providing a device compatible with use in an industrial environment.

3.2 The disclosure of document D1 gives no teaching as to how long the optical fibre therein disclosed is. Moreover, as only one end of the fibre is shown in the Figure, there can be no suggestion that the other end should be attached to a splitter, nor would this be necessary in the preferred embodiment involving directing multiple pump beams to selected regions of the electrode gap by optical fibres. Accordingly, while dispersion is a known problem with long optical fibres, the appellant convinced the board there was no reason

to think, in the case of document D1, that the skilled person would have considered any pre-compensation for dispersion to be necessary.

3.3 In view of the technical field of document D3 and since the board does not agree with the examining division that the skilled person would have sought to address a problems of dispersion in carrying out the teaching of document D1, the board can see no reason why the skilled person would have turned to document D3. Therefore, the chain of reasoning advanced by the examining division to reach the subject matter claimed is broken by the precompensation not being reached, leading the board to consider that the subject matter claimed in claim 1 can be considered to involve an inventive step having regard to these prior art documents. Furthermore, no other available prior art came closer to the subject matter concerned and none gave any clear incentive towards transmitting the femtosecond pulse generated in the apparatus of document D4 through lengths of fibre sufficient to cause dispersion to a degree requiring compensation. The appellant in this respect also showed a model of the claimed system as actually marketed during the oral proceedings and explained how it was being a commercial success and - consequent to the use of pre-compensated optical cables - had realised terahertz femtosecond pulse imaging in truly industrial environments going beyond known laboratory or table top applications as disclosed for instance in document D4. A corresponding situation in relation to inventive step exists in relation to the dependent claims by virtue of their dependency.

4. In view of the foregoing, the board reached the conclusion that Article 56 EPC can be considered satisfied by the subject matter claimed. Moreover, the board has not identified any defect in the application papers giving rise to objection preventing grant of a European patent under the EPC.

## Order

## For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent in the following version:

- claims 1-16, filed on 29 December 2009,
- description pages 1,2,2a,2b,2c and 3, filed during the oral proceedings,
- description pages 4-11 as published,
- drawings sheets 1/3-3/3 as published.

The Registrar The Chairman

M. Kiehl A. G. Klein