

## **X-ray and active millimetre-wave full-body scanning at airports: hazardous, needless, thoughtless, and inferior**

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In December 2009 and January 2010, the U.K. and U.S. Governments and some Australian state governments reacted to a failed attempt to ignite a bomb on board a jet on Christmas Day by promptly announcing their intent to divert limited security funding from methods that produce results to methods that the U.K. Government trialled for three years at Heathrow Airport before abandoning them: full-body scanners. The governments announced plans to introduce the scanners at airports without first making safety enquiries of any kind: two kinds of airport scanners, neither of which would have detected the bomb of concern. All governments involved claimed insignificant effect on human health by both kinds of scanners.

The two scanner technologies touted were (a) x-ray scanners and (b) active millimetre-wave (or "terahertz") scanners.

Government health public-relations science fiction assured us that normal human skin repels the x-rays of the first, and that the x-ray "back-scatter" would reveal everything hidden beneath the passenger's clothing; and that there were no concerns as to the safety of the second.

But there is no known "safe" dose of x-radiation; and certainly no known frequency at which it simply bounces off human skin. The safety of so-called terahertz radiation -- actually irradiating the passenger at 96 gigahertz -- though relatively untested, remains a significant concern amongst scientists and doctors beyond the financial influence of the administrations and companies seeking to use it. [1]

Civil-liberties watchdogs have long been concerned about privacy invasions by active-millimetre scanners, as they provide extremely detailed pictures of an effectively naked passenger, including genitalia, and reveal such private and potentially humiliating matters as colostomy bags [2].

Some commentators have expressed particular concern over the technology's use on children, by which it will inevitably break "kiddiporn" laws as a matter of course. Apologists for the technology -- including a recent head of U.S. Homeland Security, Michael Chertoff, now (despite the objections of FlyersRights.org [3]) lobbying his old colleagues on behalf of Rapiscan, a company that stands to gain billions in scanner sales -- have argued that they have addressed these concerns by using software to blur passengers' faces and by ensuring that the person viewing the kiddiporn is not the same person as the pornographer.

Though such steps treat the privacy problems as a joke, and though Privacy International, in an article of 31 December 2009 [4], has pointed out that the software can just as easily be switched off as switched on, the privacy debate creates for the relevant manufacturers and governments a welcome distraction from the more serious issues, which are these:

(1) Both technologies pose unnecessary radiation hazards. [5]

(2) Neither technology (a), the x-ray machine, nor technology (b), the active millimetre-wave scanner, would have been likely to detect the bomb it is supposed to protect us from, which took the form of a powder sewn, in a plastic bag, into the would-be bomber's underpants. [6]

(3) The billions spent on buying the technology and the hundreds of millions more required to be spent each year by the U.S. alone in manning it (leaving aside the many millions of dollars in wasted time annually by passengers and airlines in accommodating longer queues) could be better spent on the security measures that find these people before they even arrive at the airport, as well as enhancing ordinary measures at airports.

(4) If genuine security experts financially independent of the scanner manufacturers do determine that a scanner could be useful, an alternative scanner technology is available that emits no radiation of any kind: (c) the passive-millimetre scanner [7]. This takes a photograph of millimetre-wave radiation emitted by the person, and distinguishes other materials beneath the clothing by its differing temperature of radiation. This technology has the additional benefits that (i) it is low-resolution, producing an outline rather than a detailed picture; and (ii) it can detect bags of explosives in powder or liquid form sewn into clothing that are undetectable by the radiation-emitting scanners [8].

No government has yet addressed these matters in public. Perhaps it is time their citizens asked them to do so.

## Footnotes

[1] "Experts" paid to state that either the x-ray scanner or the active millimetre-wave scanner is safe are wilfully ignorant, unbelievably stupid, or lying through their teeth.

There is **no known safe dose for x-rays**, which do not merely bounce off the skin but pass through the body, ionizing sensitive molecules (such as DNA, which they can render unable to stop duplicating and thus cancerous) along the way. The smallest doses yet studied cause DNA damage leading to cancers and other degenerative diseases.

The so-called terahertz (i.e. 1,000,000,000,000 Hz) machines operate at 96 GHz (i.e. 96,000,000,000), in the microwave part of the spectrum. There is **no known safe dose for 96 GHz microwaves**. Think about how little you see anywhere about the effects of mobile-phone radiation in breaking DNA strands, triggering enzyme cascades, and doing other damage in the brain linked to many diseases now on the increase, despite thousands of published studies in the field. How much, then, are you likely to encounter casually about the dangers of 96 GHz microwaves?

Easily understandable details of the electromagnetic spectrum appear at: <[http://www.colourtherapyhealing.com/colour/electromagnetic\\_spectrum.php](http://www.colourtherapyhealing.com/colour/electromagnetic_spectrum.php)>. As you can see, the terahertz radiation that some "experts" allege is being used is borderline microwave-infrared.

<<http://www.reuters.com/article/idUSTRE60553920100106>> gives the usual pat assurances that we can all go back to sleep, but mentions something interesting: that a typical CT scan of the chest delivers 100 times as much radiation as the typical chest x-ray (discontinued after decades of use as a routine measure after government authorities became unable to avoid the finding that they caused cancers -- a political process still to mature in relation to mammograms, which have been proven to increase breast-cancer rates by 150% to 250% in susceptible women but are unlikely for some time to give way to alternatives such as discussed here <[http://journals.lww.com/oncology-times/Fulltext/2010/01250/Updates\\_on\\_Breast\\_Cancer\\_Screening\\_from\\_the\\_RSNA.7.aspx](http://journals.lww.com/oncology-times/Fulltext/2010/01250/Updates_on_Breast_Cancer_Screening_from_the_RSNA.7.aspx)>).

<<http://www.guardian.co.uk/uk/2010/feb/02/full-body-scanners-heathrow-baa>> mentions the use of both scanners in U.K. airports and gives further pat assurances (including the use of the scanners only for suspicious or profiled characters).

<<http://www.x-raytechniciantraining.org/blog/2010/full-body-airport-xrays-reveal-more>> gives much of the technical information stated in the summary above.

<<http://www.infowars.com/are-airport-full-body-scanners-a-health-menace>> gives a reasonable, if wandering, critical analysis of the pap that passes for communication of assuring results of responsible investigation -- and mentions conflicts of interest in the U.S. Specifically, the former head of Homeland Security is mentioned as making the case for the scanners via the revolving-door syndrome, meaning apparently that he now works for a scanner manufacturer.

[2] As long ago as October 2007, Barry Steinhardt, director of the American Civil Liberty Union's Technology and Liberty Program, who pointed out that the "strikingly graphic" images "reveal not only our private body parts, but also intimate medical details like colostomy bags", questioned "the supposed voluntary nature of this scan -- TSA's assumption that the people who 'consent' to this body scan really understand what they're consenting to, and that it will long remain something over which passengers will be allowed to exercise any choice at all: <<http://www.mindfully.org/Technology/2007/Active-Millimeter-Wave11oct07.htm>>.

[3] <<http://www.earthfiles.com/news.php?ID=1665&category=Environment>>.

[4] <<http://www.privacyinternational.org/article.shtml?cmd%5B347%5D=x-347-565802>>.

[5] The U.S. army places the same safety limit on radiation in both the 300MHz to 6GHz range *and* the 6 GHz to **96 GHz** range (the range the active millimetre-wave scanners work in): as of 1997, 10 mW per square cm of full-body exposure (<[Distribution Restriction Statement](#)>) (and double that intensity for exposure of any part of the body).

But the Salzburg Resolution by health experts from around the world, on June 7–8 2000, noting that "**There is at present evidence of no threshold for adverse health effects**", recommended a cautionary limit on "the total of all high-frequency radiation" of 1/1000 of that figure: 10 microwatts per square cm ([http://findarticles.com/p/articles/mi\\_m0ISW/is\\_2002\\_July/ai\\_87720001](http://findarticles.com/p/articles/mi_m0ISW/is_2002_July/ai_87720001)).

To see what this means in terms of a whole person, let's take two people:

(1) a person of mass 50 kg (110 lb) and height 167 cm (5' 6"), who will typically have a body surface area, in square cm, of about  $10,000 \cdot \text{SQRT}(50 \cdot 167 / 3600)$ , or 15,230 square cm; and

(2) a person of mass 75 kg (165 lb) and height 180 cm (5' 11"), who will typically have a body surface area, in square cm, of about  $10,000 \cdot \text{SQRT}(75 \cdot 180 / 3600)$ , or 19,365 square cm.

The **U.S. Government's** safety limit on total body exposure to mobile phone radiation of 10 microwatts per square cm would allow a total body exposure (calculated using 80 mW per kg of body mass for exposure of the whole body, or 1600 mW per kg of body mass for any particular gram of your body) are:

- for person #1:  $80 \text{ mW/kg} \cdot 50 \text{ kg} = 4000 \text{ mW}$  (whole body), and,
- for person #2:  $80 \text{ mW/kg} \cdot 75 \text{ kg} = 6000 \text{ mW}$  (whole body).

The **Salzburg Resolution's** safety limit on total body exposure of 10 microwatts per square cm would allow a total body exposure

- for person #1 of  $10 \text{ microwatts} \cdot 15,230 = 150 \text{ mW}$ , and,
- for person #2, of  $10 \text{ microwatts} \cdot 19,365 = 190 \text{ mW}$ .

In summary,

(1) International health experts agree that a teenager or small adult of height

167 cm and mass 50 kg should not be exposed to a total electromagnetic radiation intensity (including mobile phones, radio, television, and full-body scanner) of more than 150 mW; but your government is already prepared to expose that person to 4000 mW from her mobile phone alone, **more than 2500% in excess of the safety recommendation.**

(2) International health experts agree that a large adult of height 180 cm and mass 75 kg should not be exposed to a total electromagnetic radiation intensity (including mobile phones, radio, television, and full-body scanner) of greater than 190 mW; but your government is already prepared to expose that adult to 6000 mW from his mobile phone alone, **more than 3000% in excess of the recommendation.**

Given such a cavalier attitude to a device that is *already* linked with brain tumours, cancers, Alzheimer's disease, autism, multiple sclerosis, Parkinson's disease, and a host of other intractable ills, I'd be placing no bets on any care by your government or mine about limiting microwave hazards from body scanners on the basis of our health. The carefully confusing reports about the scanner technologies to be used, the absence on the web of all technical detail concerning power output of the microwave scanners, and the ludicrous claims of x-rays too weak to penetrate skin merely confirm that the only grave concern that these technologies presently cause the colluding governments is concern lest we begin thinking clearly about the repercussions of its implementation.

A brief, comprehensible summary of recent suggestive research may be found here: <<http://www.technologyreview.com/blog/arxiv/24331>>, and a slightly briefer version with different graphs, here: <[http://medgadget.com/archives/2010/01/study\\_looks\\_into\\_potential\\_side\\_effects\\_of\\_terahertz\\_full\\_body\\_scanner\\_technology.html](http://medgadget.com/archives/2010/01/study_looks_into_potential_side_effects_of_terahertz_full_body_scanner_technology.html)>.

The study itself, "DNA Breathing Dynamics in the Presence of a Terahertz Field", by B.S. Alexandrov, V. Gelev, A.R. Bishop, A. Usheva, and K.Ø. Rasmussen, may be found at <<http://arxiv.org/abs/0910.5294>>.

Here is an excerpt from the summary:

"The evidence that terahertz radiation damages biological systems is mixed. 'Some studies reported significant genetic damage while others, although similar, showed none', say Boian Alexandrov at the Center for Nonlinear Studies at Los Alamos National Laboratory in New Mexico and a few buddies. Now these guys think they know why.

"Alexandrov and co have created a model to investigate how THz fields interact with double-stranded DNA and what they've found is remarkable. They say that although the forces generated are tiny, resonant effects allow

THz waves to unzip double-stranded DNA, creating bubbles in the double strand that could significantly interfere with processes such as gene expression and DNA replication. That's a jaw dropping conclusion.

"And it also explains why the evidence has been so hard to garner. Ordinary resonant effects are not powerful enough to do do this kind of damage but nonlinear resonances can. These nonlinear instabilities are much less likely to form which explains why the character of THz genotoxic effects are probabilistic rather than deterministic, say the team.

"This should set the cat among the pigeons. Of course, terahertz waves are a natural part of environment, just like visible and infrared light. But a new generation of cameras are set to appear that not only record terahertz waves but also bombard us with them. And if our exposure is set to increase, the question that urgently needs answering is what level of terahertz exposure is safe."

The study itself makes mention of several points worth noting for discussions of this topic:

(1) Previous research on the possible health effects has been based "mostly at frequencies below 0.01 Terahertz [i.e. 10 gigahertz], power below 1 mW/ square cm, and short exposure times. The data collected in these conditions led to mixed conclusions: some studies reported significant genetic damages while others, although similar, showed none [4]. The major international research project, "THz-bridge" [5], which was specifically concerned with THz radiation genotoxicity concluded that: under some specific conditions of exposure, change in membrane permeability of liposomes was detected and an induction of genotoxicity was observed to occur in lymphocytes."

(2) "It is clearly seen that for driving frequencies below  $\Omega \sim 2.5$  THz spatially homogeneous ( $k = 0$ ) perturbations lead to the strongest instability (occurring at the lowest value of the driving amplitude). However, above  $\Omega \sim 2.5$  THz the staggered ( $k = \pi$ ) perturbation becomes the primary instability mode."

**In other words, it is worth asking the authorities claiming that these active terahertz transmitters are *safe* to state:**

**(a) what frequency they emit at;**

**(b) the maximum wattage per square centimetre with which they irradiate the subject;**

**(c) whether the emissions are spatially homogeneous or staggered; and**

**(d) whether under these conditions the emissions are definitively known**

**and can be guaranteed to be free of the mutational effects described in October 2009 by Alexandrov et al. of the Los Alamos National Laboratory, in the paper "DNA Breathing Dynamics in the Presence of a Terahertz Field", available at <<http://arxiv.org/abs/0910.5294>>.**

It seems probable that references to emissions as being either "spatially homogeneous" or "staggered" are merely translations of what we'd more usually call "coherent" (with the photons all in phase, as light from a laser is) and "incoherent" (in mixed phases).

And for those of a more technical bent: though the text describes the DNA-pair susceptibility to "staggered" radiation as occurring primarily at frequencies above 2.5 THz (2500 GHz), the second part of the paper's Figure 2 shows instability also below 0.4 THz (400 GHz) and in the region between 1.5 THz (1500 GHz) and 2.2 THz (2200 GHz). In those regions, it would seem, both "spatially homogeneous" and "staggered" radiation induce instability and pair-breaking.

[6] <<http://www.independent.co.uk/news/uk/home-news/are-planned-airport-scanners-just-a-scam-1856175.html>> discusses in detail the uselessness of the scanners for their intended purpose.

[7] <<http://www.newscientist.com/article/dn18343-deployment-of-airport-full-body-scanners-could-be-delayed.html>>.

[8] <<http://www.karachicity.net/international-news/airport-body-scanners>>. Presumably the passive millimetre-wave machines cost a little more than the others, or there are bigger kickbacks for the other machines because *they* cost far more; I haven't explored this at all.