Silicon Microfabrication of 3D Terahertz Waveguide and Optical Components

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StarTiger - Technology

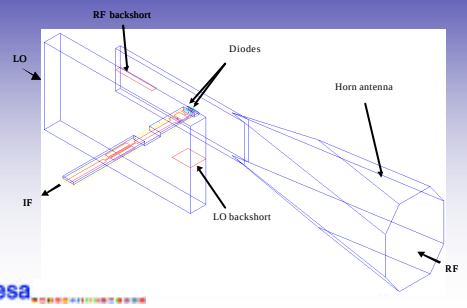
StarTigers ultimate goal was to realise an colour THz imaging array in four months

The task set was to capture an image of a hand

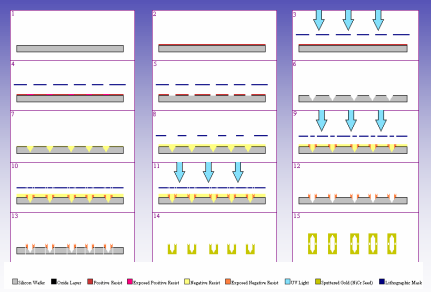
This would require key technology developments in the following areas:

- Complex detector circuitry design
- Complex fabrication processes
- Scanning optics design
- System Control/Data Acquisition

Conservative approach mixer configuration

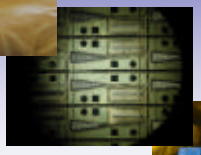


StarTiger – Si/SU-8 Process

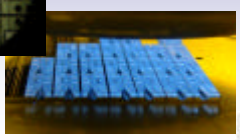


StarTiger - Technology

Two completed micromachined mixer halves waiting for assembly

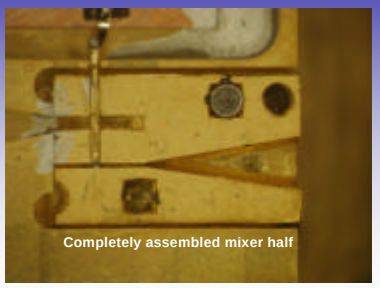


A diced wafer awaiting gold deposition



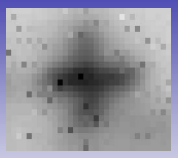
A UV post curing process for some diced mixers

StarTiger - Technology

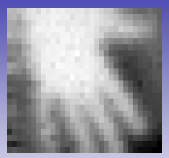


Completely assembled mixer half

Conservative System Results



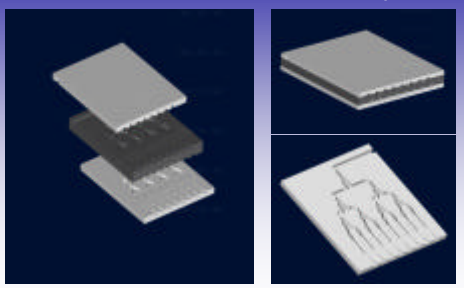
Calibration Cross



Hand

- Images taken using single pixel micro machined mixer
- Cold source background

Advanced Approach
250-300 GHz Power Splitter

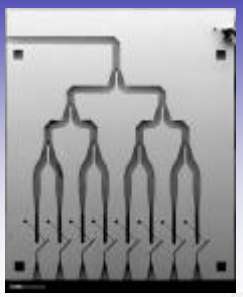


Twin Colour 8 Pixel Array

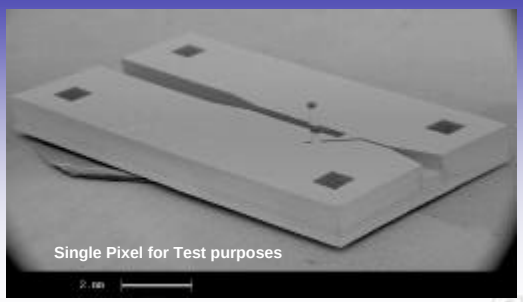
Fabrication required :

- •20 photomasks, 100s of processing steps
- •Optimisation of etching profiles
- •Cleaning, Dicing, Metallisation, Electroplating procedures
- •Dicing and assembly of 20 filters, 40 diodes
- •Assembly of 16 IF circuits
- •Assembly of array into housing

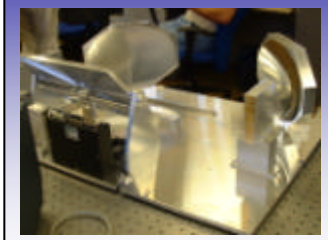
Twin Colour 8 Pixel Array

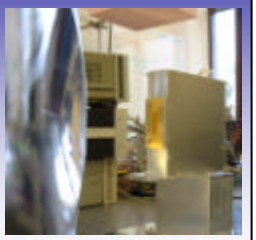


Single Pixel



Final Model Pictures





Powder Blasting

Powder Blast Experiments: Micro bubbles caused poor lithography. Dilution of the photo resist produced good results. Particle size is ~12 µm giving line features of < 100 µm with a depth of >50 µm [so far].

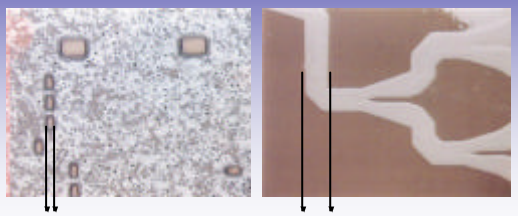
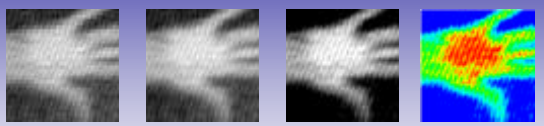


Image Processing



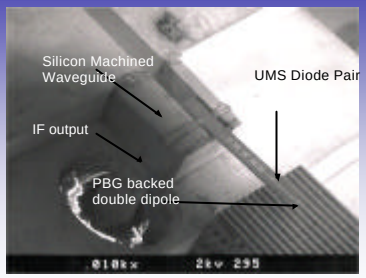
- Raw data - shows pixellation and lines
- Bi-linear resampling to reduce line structure
- Change dynamic range - use display fully
- Use false colour - brings out more subtle features

Additional Technology

As well designing, fabricating and assembling the array the team carried out additional technology developments

- •PBG mixer design
- •PBG circuit design and demonstration
- •Optical controlled THz phase shifter
- •Silicon Machined Fresnel and GRIN lens
- •Room temperature bolometer investigation

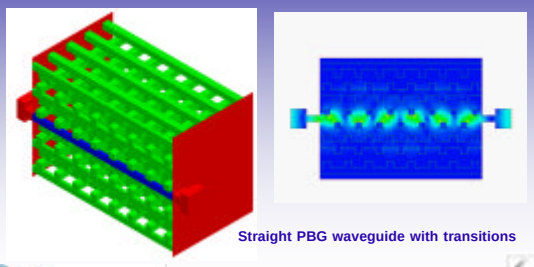
Worlds First PBG Heterodyne Mixer



Complete PBG Mixer Circuit

Future Technologies

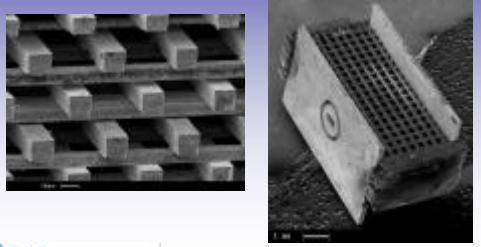
Integrated 3 Dimension PBG Circuit Architecture



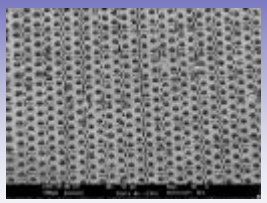
Straight PBG waveguide with transitions

Future Technologies

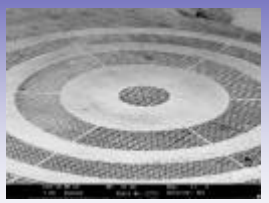
Manufactured PBG waveguide



Fresnel lens



The Artificial Dielectric Material



One Layer Of The Fresnel Lens

Conclusions

- **STARTIGER was an effective way of rapid R&D**
- **Provided key technology for the realisation of a MEMS THz imaging array**
- **Achieved Multiple advances in technology**
- **Enhanced collaboration across the European community**

Questions