POLITECNICO DI TORINO

DET
Department of Electronics and Telecommunications

Performance assessment of a fast temperature sensing system based on bare FBGs and fast spectrum analyzer

Wei Chen

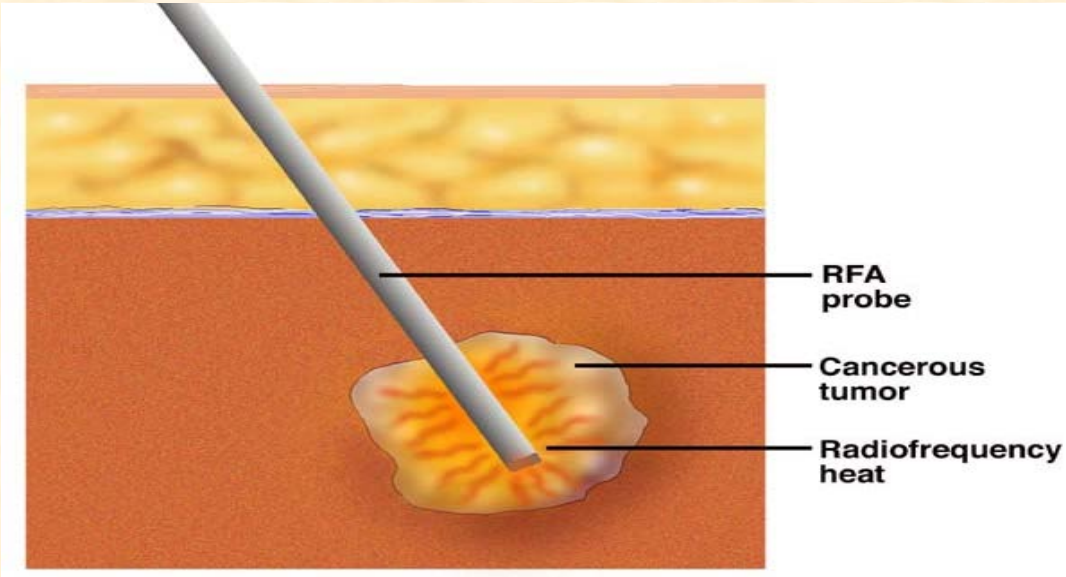
Guido Perrone

Alberto Vallan

Motivation/1

- Wide application of electrical conduction system for thermal ablation of tumor, heart and dysfunctional tissue using Radio Frequency or Micro-Wave for their advantages:

☺ Good precision
☺ Less bleeding
☺ Short time
☺ Painless



To avoid collateral damage to normal tissues, a precise control of instantaneous temperature in the reference point is mandatory…..

Motivation/2

- Solution — using temperature probe to monitor the local temperature

Choices:

1. Metallic temperature sensor, such as thermocouple

☺ Fast response

☺ Good accuracy

☺ Small in size

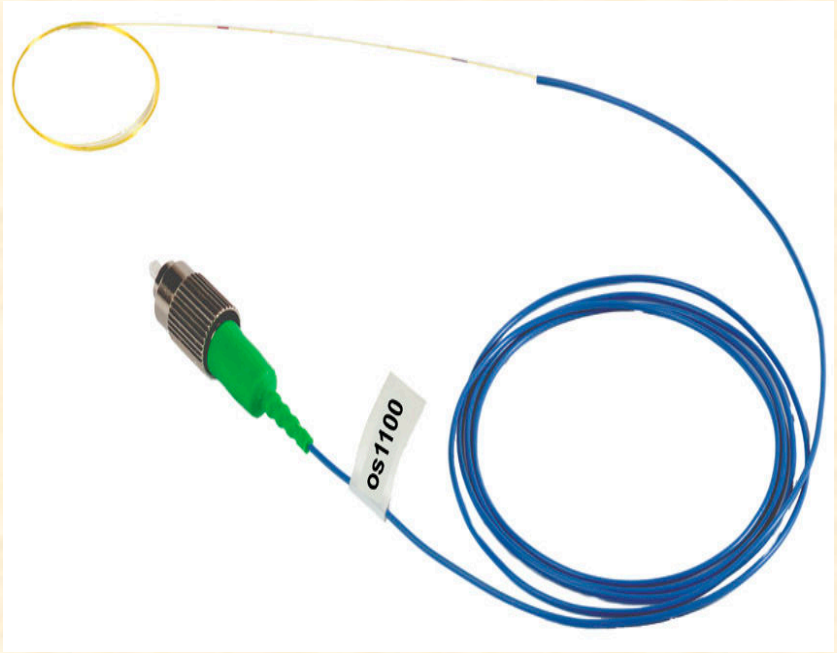
…… While fatal weakness,

☹ Sensitive to electromagnetic interference

Motivation/3

2. Bare Fiber Bragg Grating(FBG) sensors

- ☺ Miniature
- ☺ Light weight
- ☺ High Precision
- ☺ Short time constant
- ☺ Electromagnetic immunity
- ☺ Robust



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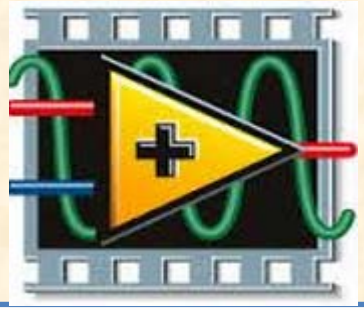
→ final solution: bare FBG

Methodology



- Interface between the spectrum analyzer and Labview
- Fitting algorithm written in Matlab embedded in Labview to improve precision

Design the whole system

Characterization

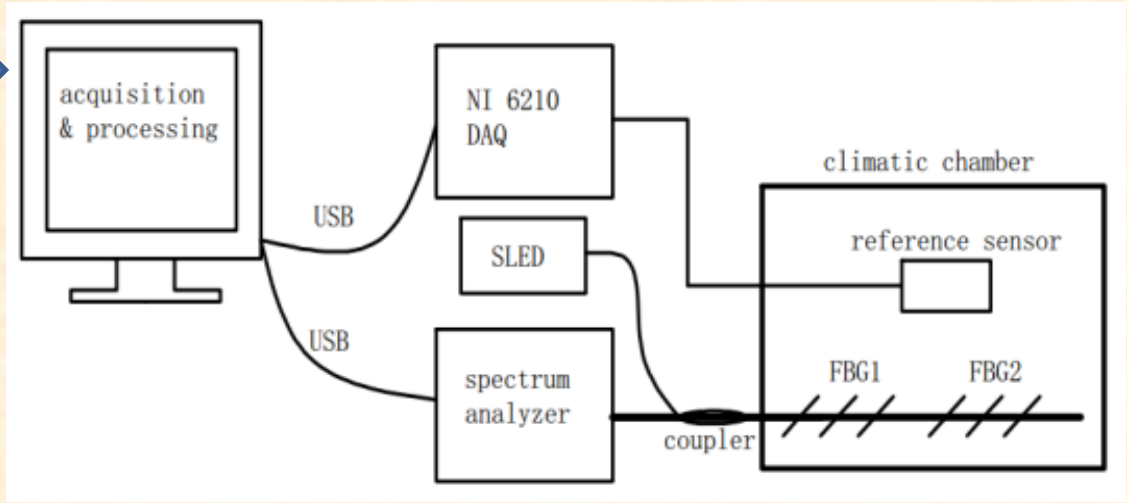
- Unknown temperature behavior of bare FBG
- Linear fitting taking LM35 as reference in climatic chamber

- Ambient long time test
- Time response comparison with thermocouple

Performance assessment

Experimental set-up

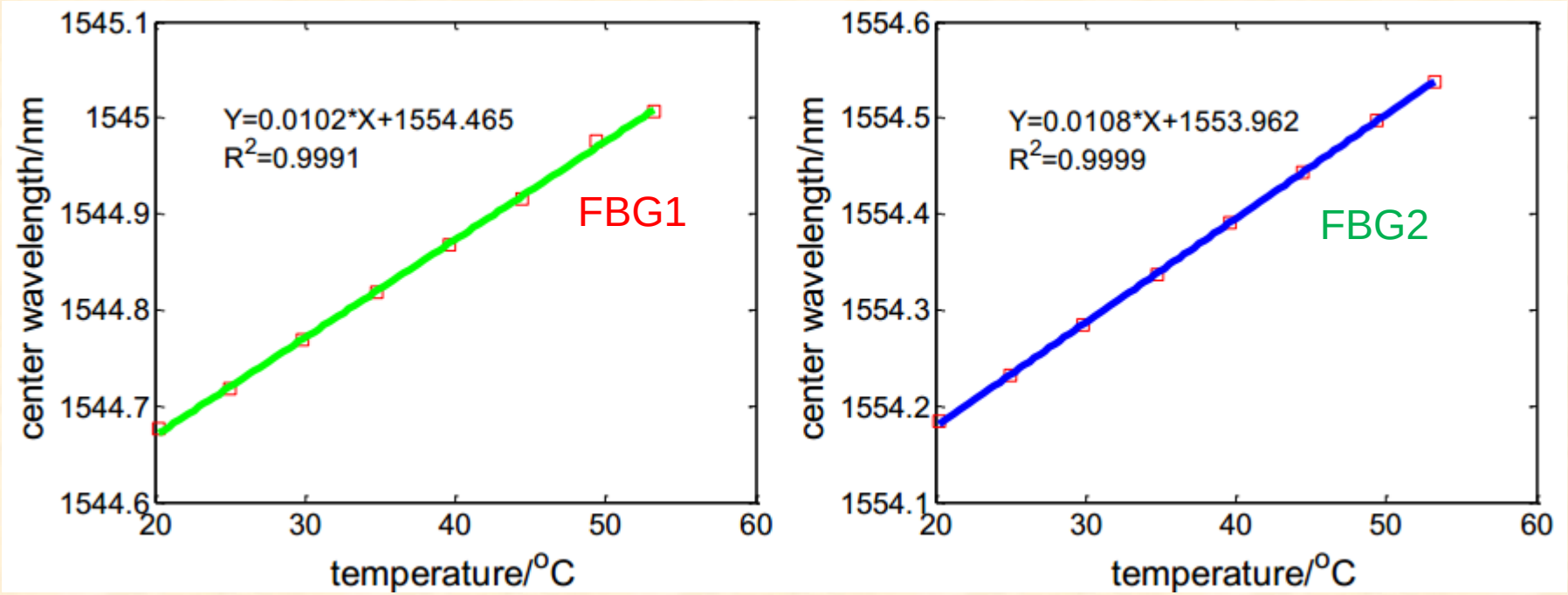
- Schematic



- Two FBGs, one bare FBG the other commercial one as comparison;
- Another electronic sensor as reference in characterization;
- Fast spectrum analyzer adopted to reducing scanning time;
- Program in Labview to realize simultaneously acquisition and processing.

Results/1

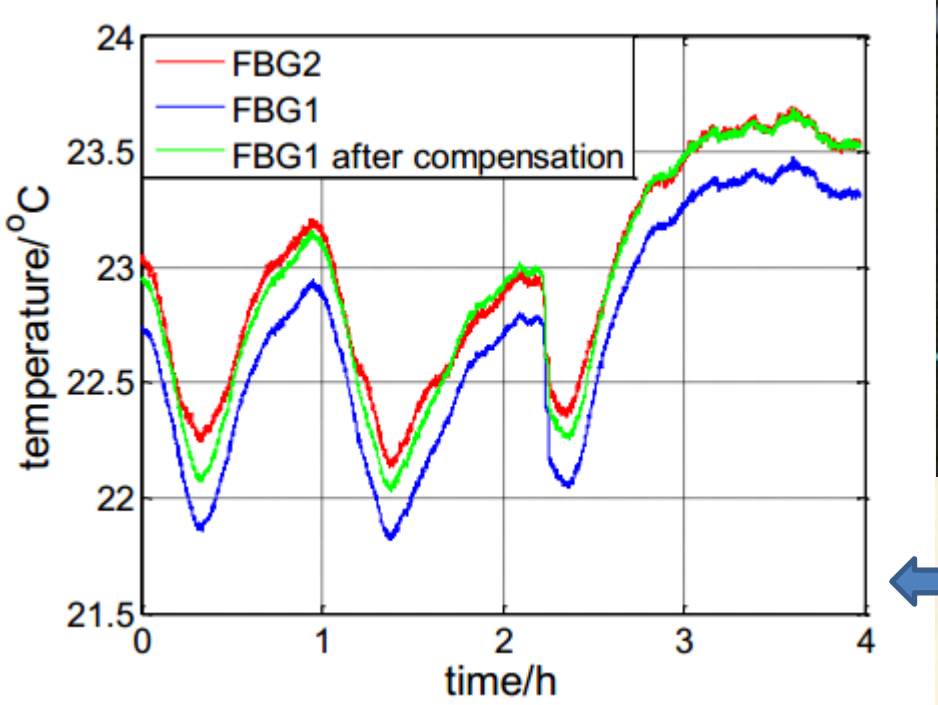
- Characterization for the bare FBG(left) and commercial FBG(right) using climatic chamber

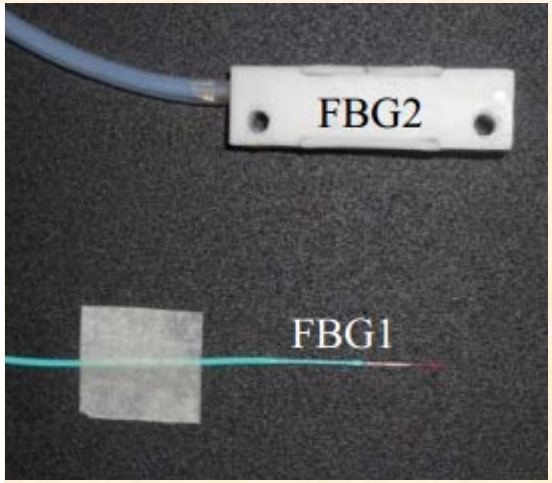


Both good linearity, temperature coefficient 0.01nm/℃

Result/2

- Performance assessment
  - Ambient temperature monitoring for about 4 hours



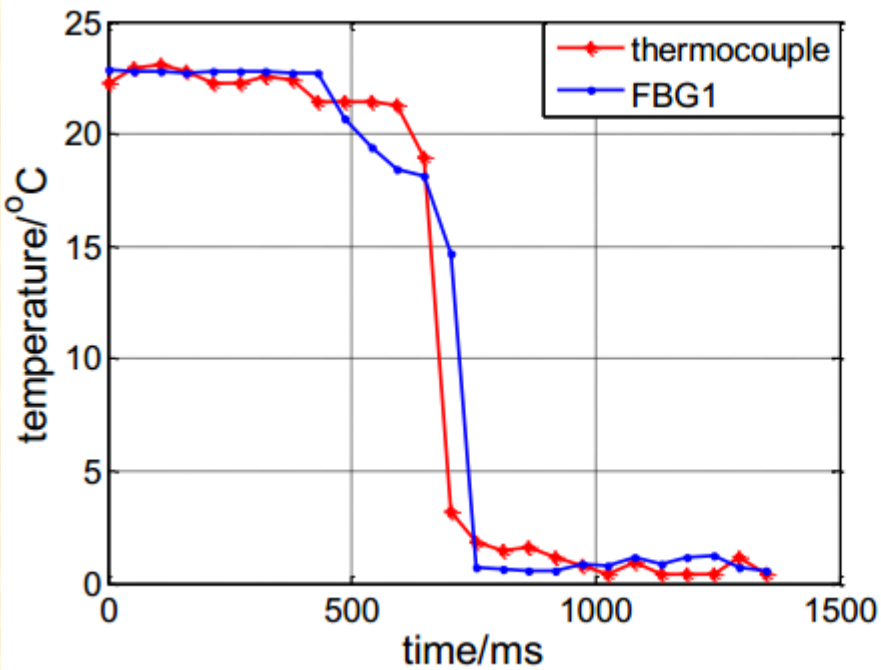


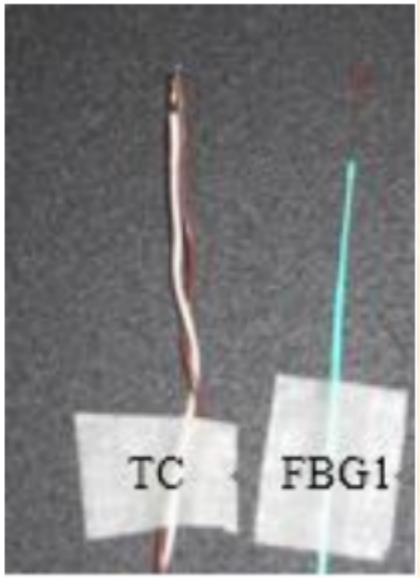
For bare FBG sensitive to external strain, always a compensation is required to get absolute temperature.

After compensation, good agreement of both FBGs

Result/3

- Bare FBG and thermocouple comparison during fast thermal transient

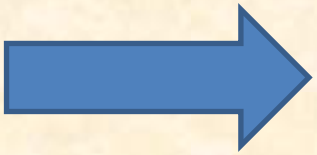




Shorter time response compared with thermocouple

Conclusions

- High acquisition rate
- Small footprint
- Electromagnetic immunity
- Good resolution
- Temperature compensation required
- Linearity
- Fast time response



Satisfy the requirements as a temperature probe in medical field such as RF or MW ablation of dysfunctional tissues.

thanks