Inventing with Sapienza
hints and tips from a personal experience

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VADASE: the third way to GNSS Seismology

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Outline

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How is a patentable idea born?

A patentable idea should solve (better) a practical problem

You must:

- identify an **interesting practical problem**
- with significant **societal benefits** involved by its (better) solution
- be **passionate with an idea**, out of the beaten track
- **not fear to fail**

You must aware that a patentable idea **cannot be a pure new theory**:

- a practical application must be foreseen from the very beginning
- maybe that other applications can be recognized later

Why patenting?

To turn a dualism:

- science vs. technology - theory vs. practice

in a **syneristic benefit for society**:

- **science and technology - theory and practice**

and in a **formal statement of personal competency**:

- *I/we know the theory and how it can work*

with possible personal benefits/incomes

A patent is a complement not a replacement of the standard research products (publications, presentations)

Outline

Which are the key ingredients?

You **must know exhaustively**:

- the related **scientific/technical literature** on that problem (**is the idea really new?** - it is important to know the theory!)
- if any, the **solution approaches in use** and their drawbacks
- how/at which extent your idea can overcome them
- which are the **performances** and the (possible) **drawbacks** of the new idea (**nothing is perfect! - but this does not hinder patenting**)
- similar problems whose solutions could be boosted by the new idea

Outline

PhD and patenting - opportunities

The **requirements** to get the key ingredients:

- are likely to be **satisfied during a doctoral research** project
- when a PhD candidate has the **right time to investigate** and
- to become very **expert of a particular field**

in addition:

- a patent is likely to be the **cornerstone to found a start up**, after PhD defence (or even during doctoral research)

PhD and patenting - issues

The highest attention must be paid to **keep the new idea strictly reserved** within inventor(s):

- **none kind of presentation is allowed** before the patent filing
  (oral - scientific/technical/even informal meetings
  written - reports/manuscripts/papers/posters)
- inventor(s) must **not be in rush to publish** research results
- **PhD thesis could be impacted too** (embargo)

Key persons and their essential roles:

- **PhD supervisor** - participation and/or agreement
- **patenting consultant** - idea explanation and valorization

Outline

After patent (filing)

The time has come to **make the idea**:
known:

- publications and presentations
- participation in **contests/competitions**

valorized:

- found a **start up**
- search for possible **industrial partners**
- **licensing**

further developed:

- idea evolution with/without new patent(s)

Outline

VADASE: the third way to GNSS Seismology

- **VADASE**
  Variometric Approach for Displacement Analysis Standalone Engine

- an **idea enterly developed during a doctoral research**
  Gabriele Colosimo (Leica Geosystems AG, Switzerland)

The main challenge: fast ground motions

Since middle '90s - early 2000s

- algorithms for kinematic post-processing (**one position per epoch**)
- a new idea: using **GPS** to estimate displacements and waveforms due to an earthquake (**GPS Seismology**)
- two approaches, very good for **positioning**:
  Differential Positioning (DP), Precise Point Positioning (PPP)

  drawbacks: infrastructures, post-processing, initialization, L1/L2 needed

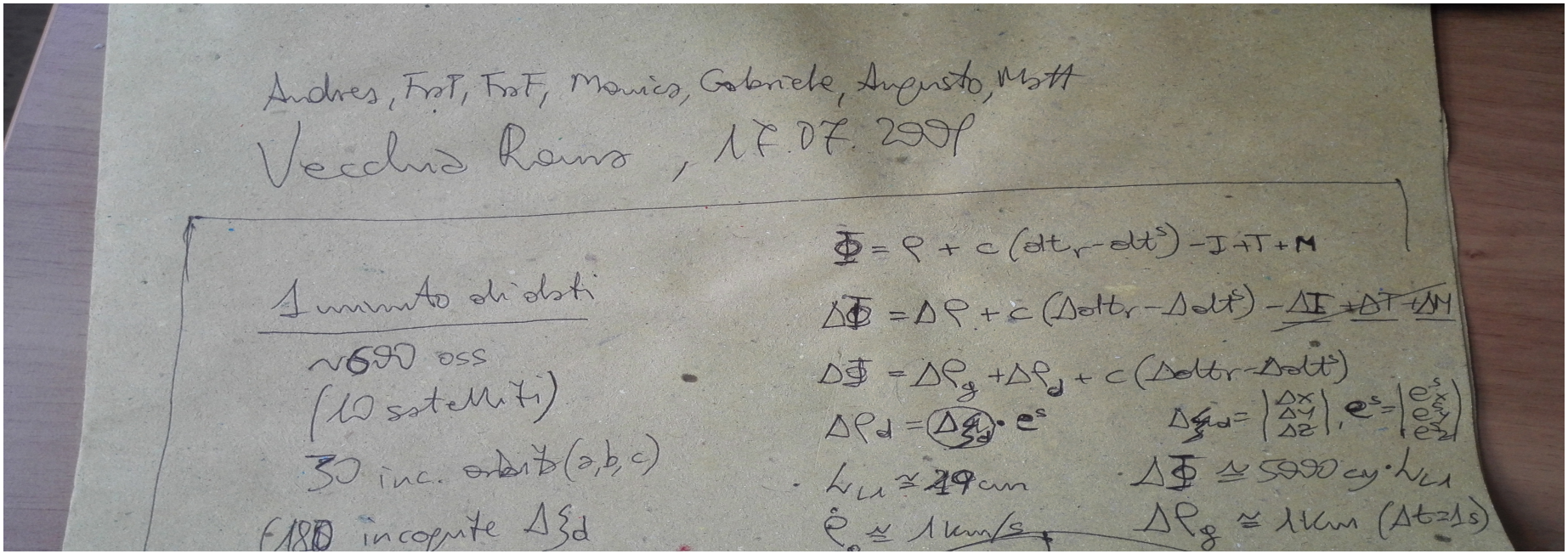
More recently . . . A major challenge to measure with

Real-Time GPS Science Requirements Workshop (September 2007)

- **1 cm** GPS **displacements** accuracy
- in a **global reference frame**
- within **3 minutes** after an earthquake

exploiting advances in receivers technology (high acquisition rate - **10-50 Hz**)

The VADASE concept:
Can we use a GPS just as a seismometer?



The VADASE concept

The goal

Focus on

- (near) **real-time accurate displacements** (**NOT positions**)
- in a **global reference frame**

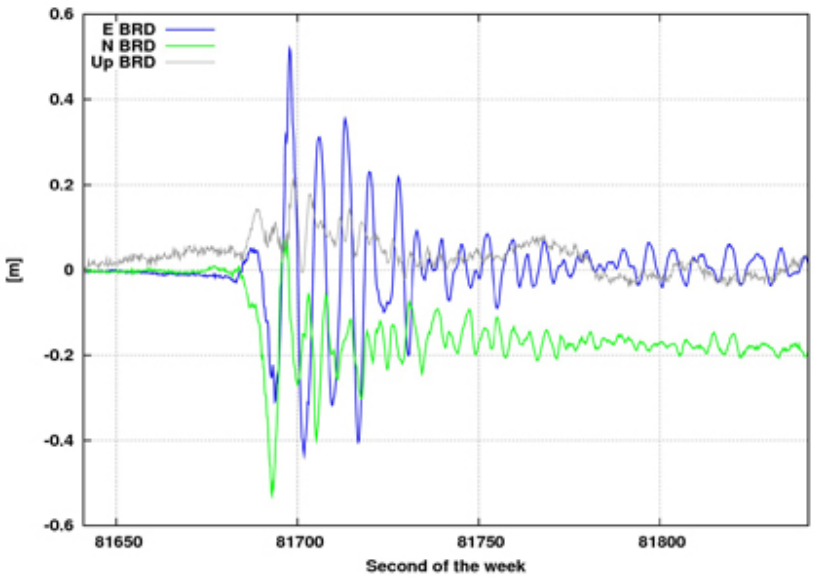
The idea: keep it fast, keep it simple!

- direct displacements estimation from the **observations of a stand-alone GNSS receiver** (single station approach)
- **advantages**: no infrastructure, no post-processing, no initialization needed; no clipping as standard seismometers

A patented idea

Since June 2010 VADASE idea was **protected by a patent pending**, thanks to the support of our University (patent released in 2014)

The boost: European Satellite Navigation Competition 2010



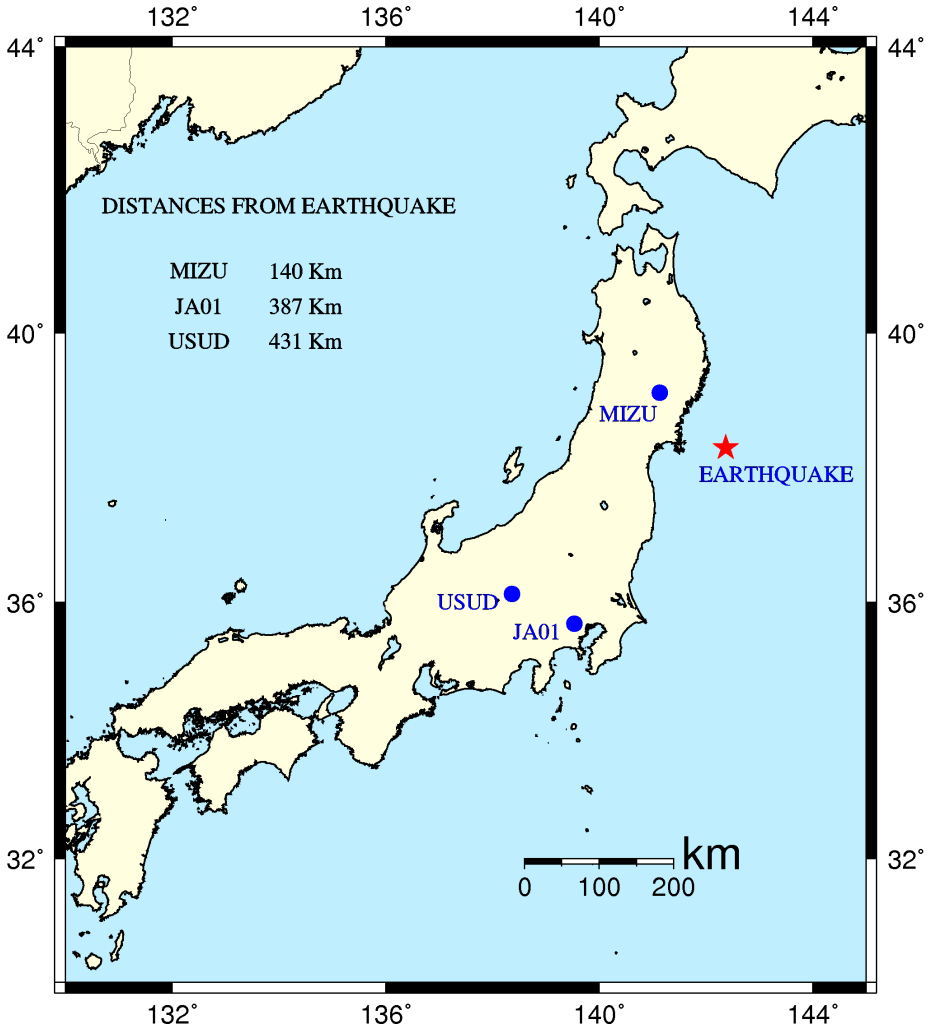
Baja California (Mexico) earthquake
4 April 2010, $M_w = 7.2$

- **VADASE waveforms successfully compared** with solutions from standard approaches
- the results supported VADASE submission for ESNC 2010

VADASE, the winning idea of

- **DLR Special Topic Prize**
- First Audience Award ($>$ 100 ideas)

Tohoku-Oki earthquake - March 11, 2011 ($M = 9.0$)

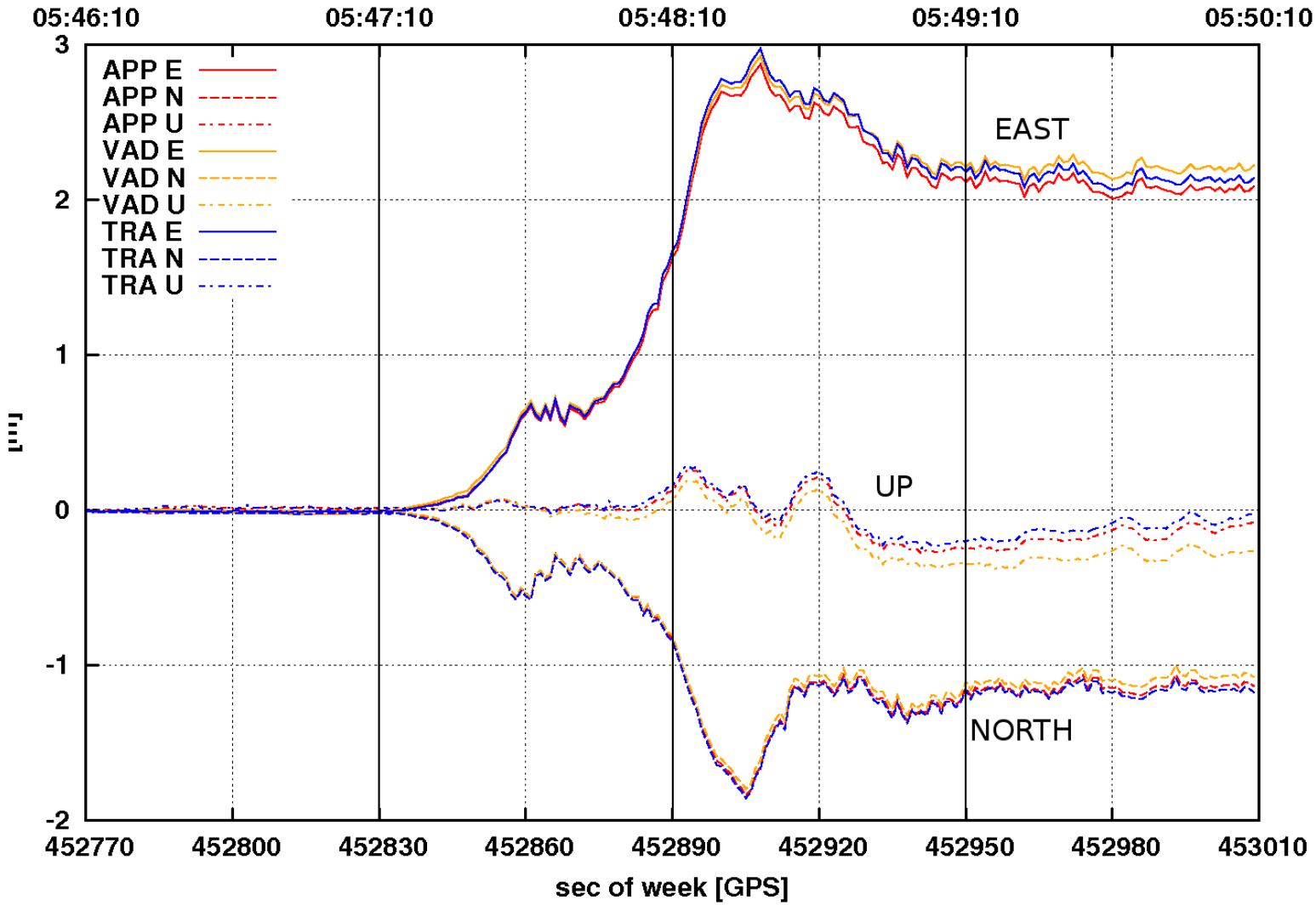


What is new

- VADASE provided the **first displacements computation**
  - **[IGSMAIL-6358]** - March 11, 04:13:35 PST 2011
  - solutions published on the **Tohoku-oki Event Supersite Website** - March 12, 2011
- **comparison** with other sw (DP: Track - PPP: APP)

Cover story
GIM International
vol 25, 5, May 2011

Tohoku-Oki earthquake - MIZU



Application to low-cost Galileo L1 receivers

Receiver

E1 observations collected through NV08C-EVK-CSM evaluation Kit

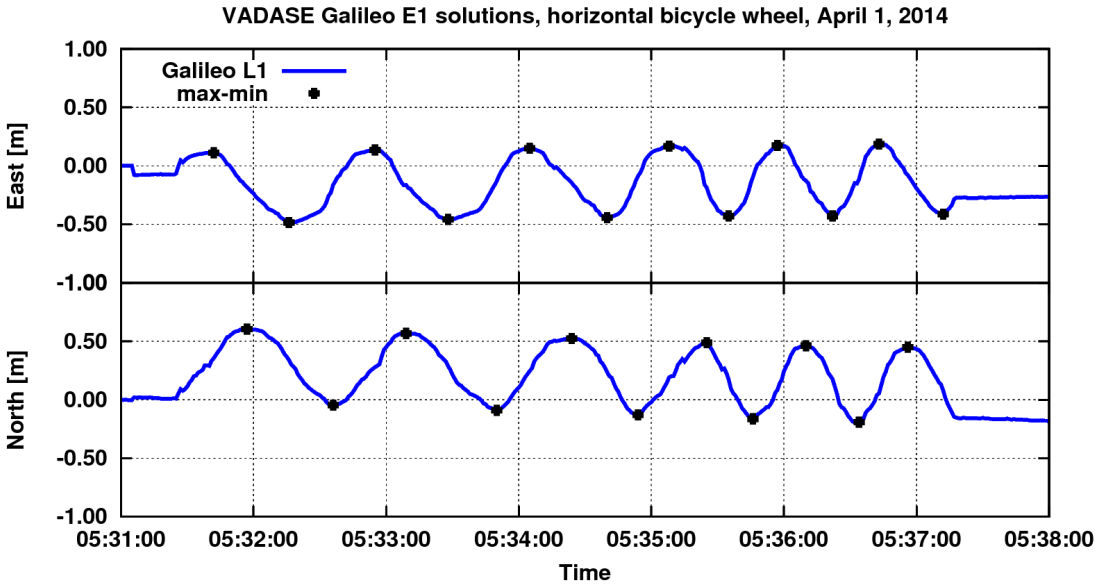
Navigation Message

- still not created by the receiver
- taken from a MGEX permanent station

Receiver motions

- stationary
- oscillations
- **circular motion**

Low-cost Galileo L1 - circular motion



Bicycle wheel diameter

- manually measured **0.62 m**
- average oscillation amplitude (max-min in East and North) **0.63 m**

European Space Agency award
Fix certification for VADASE Galileo solutions

ESA fix certification

VADASE Team was recognized as **one within the first 50 companies/institutions worldwide** having made a ***fix*** with Galileo

From Academy to Industry: Leica Geosystems partnership

The vision: VADASE onboard a commercial GNSS receiver

- an **autonomous, real-time monitoring solution**

Win-Win situation

- combine the **innovative algorithm** from Academia and the **experience and resources** from Leica Geosystems to turn VADASE into an accessible, usable, customer-oriented product

Leica Geosystems VADASE: Use Cases

Seismology

- co-seismic displacement retrieval
- waveforms reconstruction and analysis

Early Warning Systems

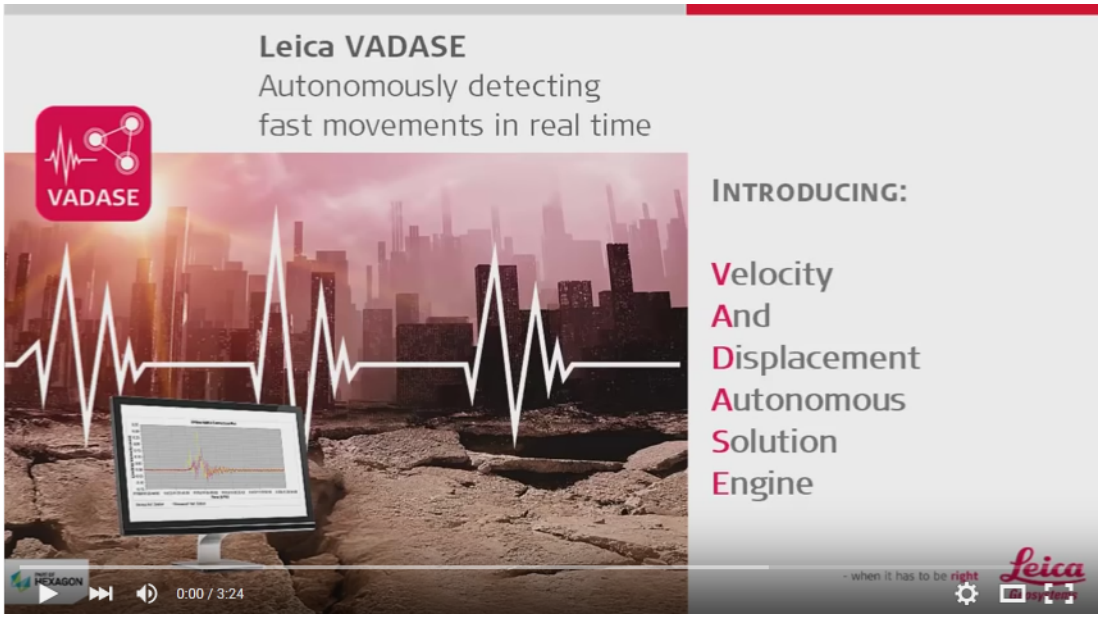
- **natural or man-made hazards** (volcanic, earthquake / tsunami, fracking, ...)
- safety monitoring for infrastructure elements close to potential hazards (landslides, ...)

Structural Monitoring and reference stations

- enhances structural and geotechnical engineering monitoring
- permanent **reference stations** "accident" monitoring

Leica Geosystems VADASE in action

https://www.youtube.com/watch?v=kQsLBSLOKS0



VADASE after the patent

New non-patentable ideas, all developed during other doctoral researches:

- **kin-VADASE** - Mara Branzanti (Leica Geosystems AG, Switzerland)
- **Integrated VADASE** - Elisa Benedetti (NSL, UK)
- **VARION** - Giorgio Savastano (JPL NASA-Caltech, USA; Spire, Luxembourg)
- **VADASE+VARION** - Michela Ravanelli (IPGP, France)
- **POWER** - Marco Fortunato (Thales Alenia Space, Italy)
- **VARION for tsunami early warning** - Federica Fuso (PhD Candidate)

Thank you very much for your kind attention