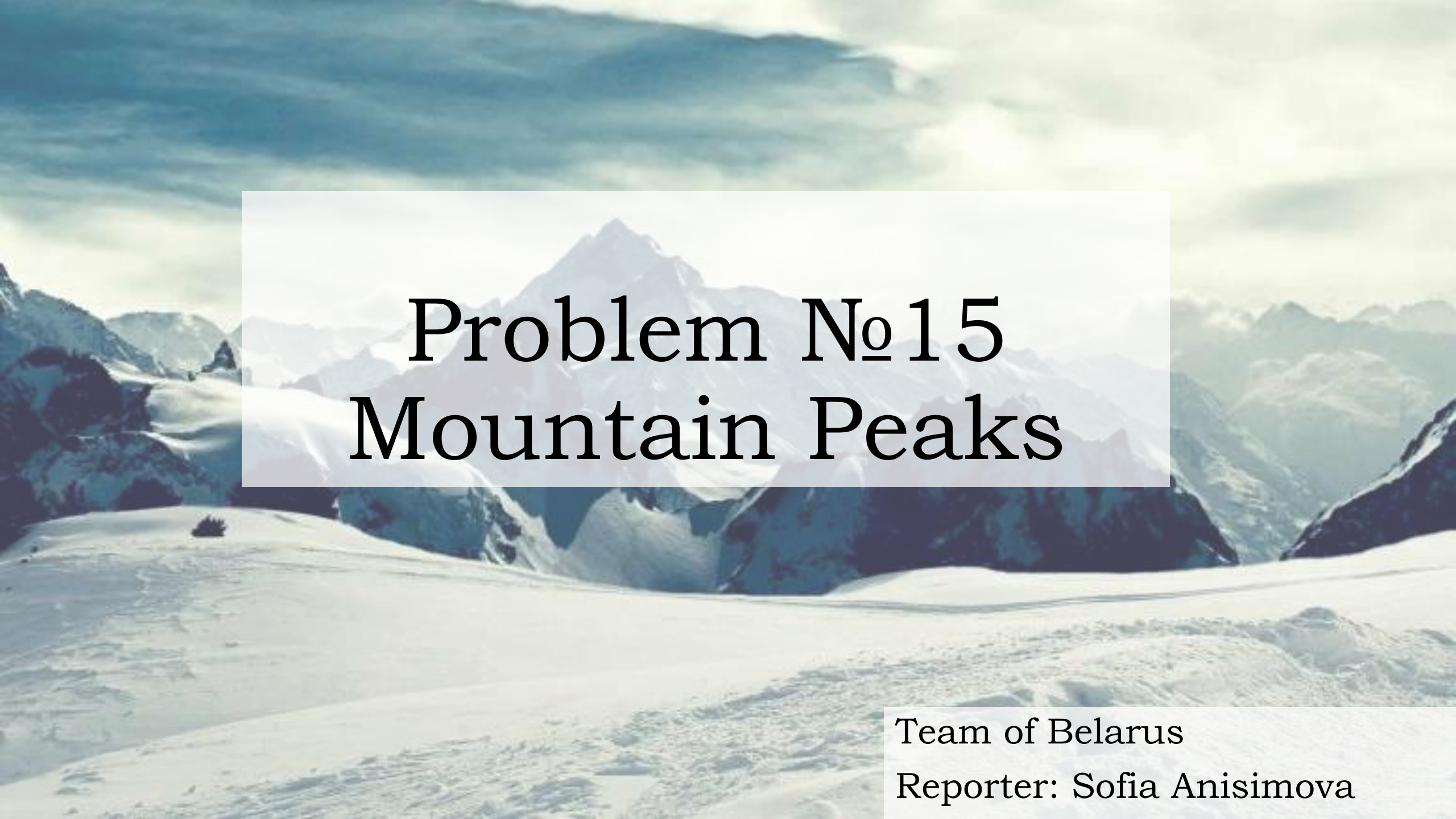


Problem №15
Mountain Peaks

Team of Belarus
Reporter: Sofia Anisimova

Problem

- What methods are used to determine the elevation of the World's highest mountains? Suggest your own experimental method and determine the height of a mountain or of a hill of your choice.

Modern methods

- GPS
- Barometric leveling
- Triangulation
- Radiolocation

Height of mountain

The relative height

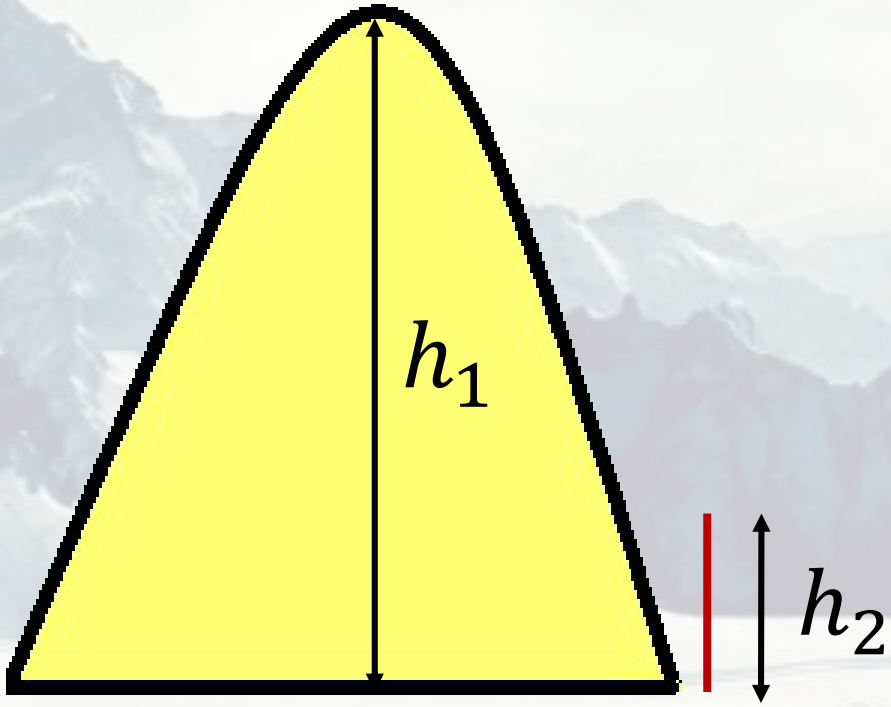
The altitude

Methods

- Photogrammetry
- Optical leveling

Photogrammetry

$$\frac{h_1}{h_2} = \frac{h_1'}{h_2'}$$



#1 Photogrammetry

#2 Optical leveling

#3 Top secret

The using of photogrammetry

$$\text{Result} = H_1 + H_2$$

#1 Photogrammetry | #2 Optical leveling | #3 Top secret

Resolving disadvantages

- Standard and mountain have different scale
- Aberration

#1 Photogrammetry | #2 Optical leveling | #3 Top secret

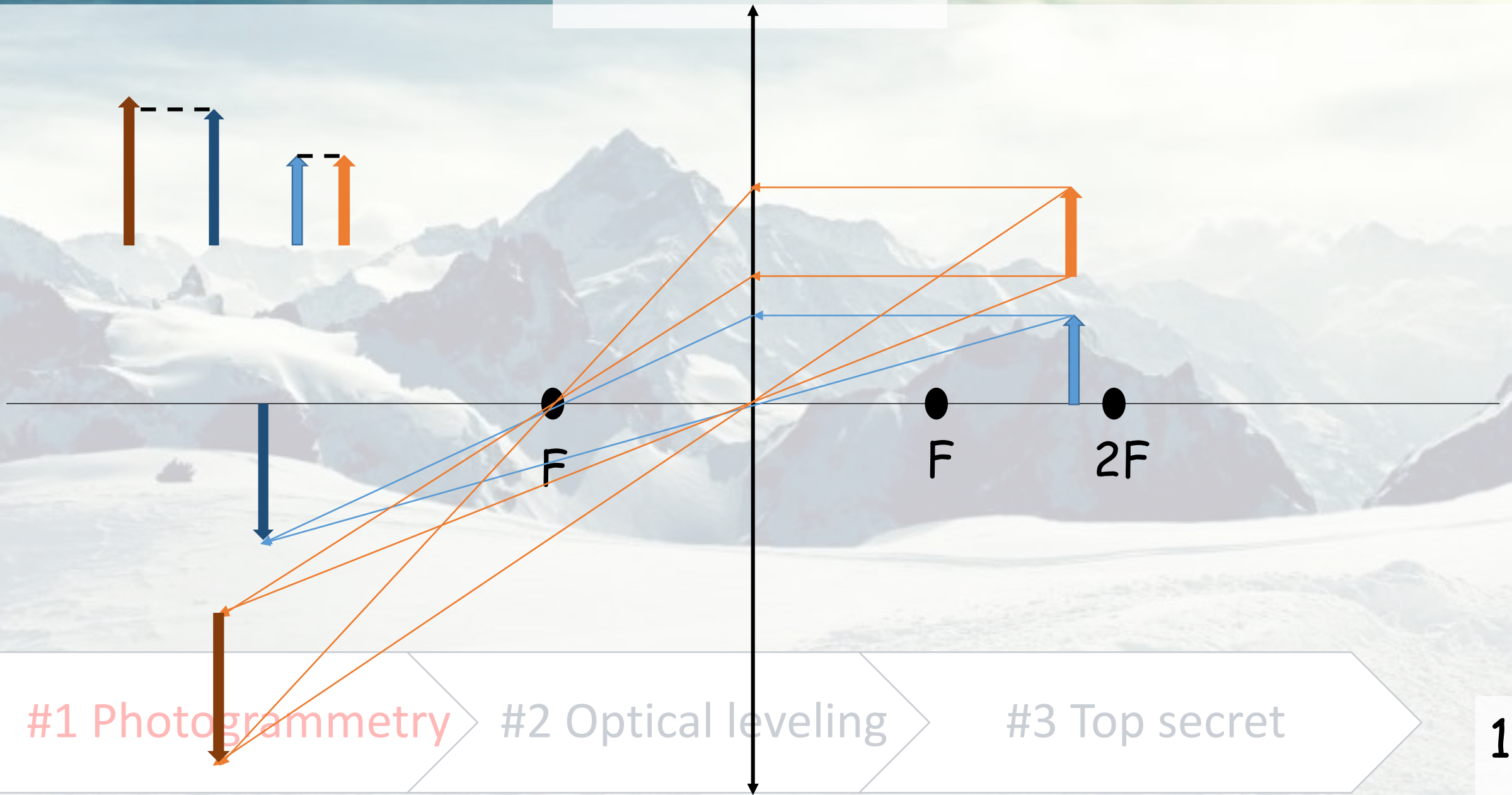
Ideal model

Our result: 8,1 m

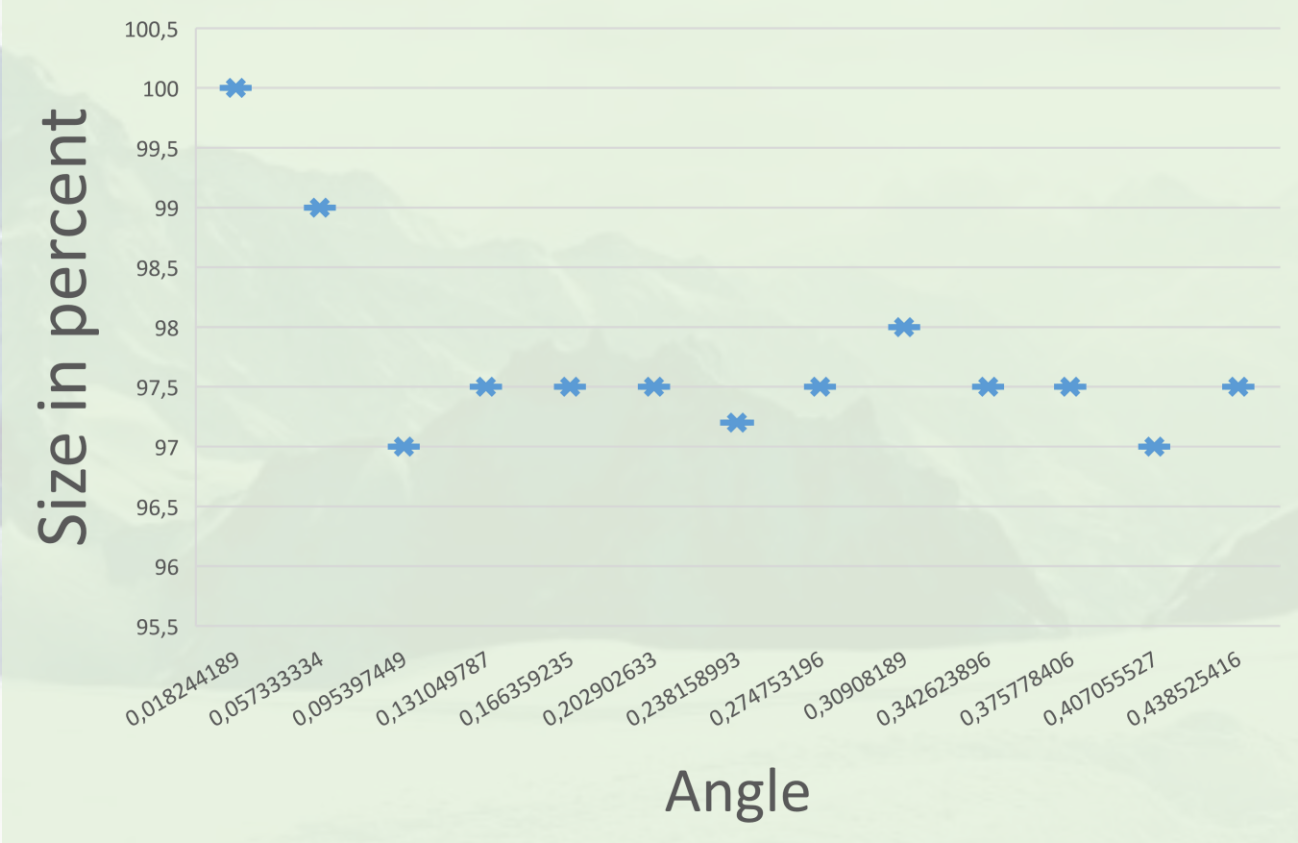
Passport data: 8

#1 Photogrammetry | #2 Optical leveling | #3 Top secret

Aberration



Aberration



#1 Photogrammetry | #2 Optical leveling | #3 Top secret

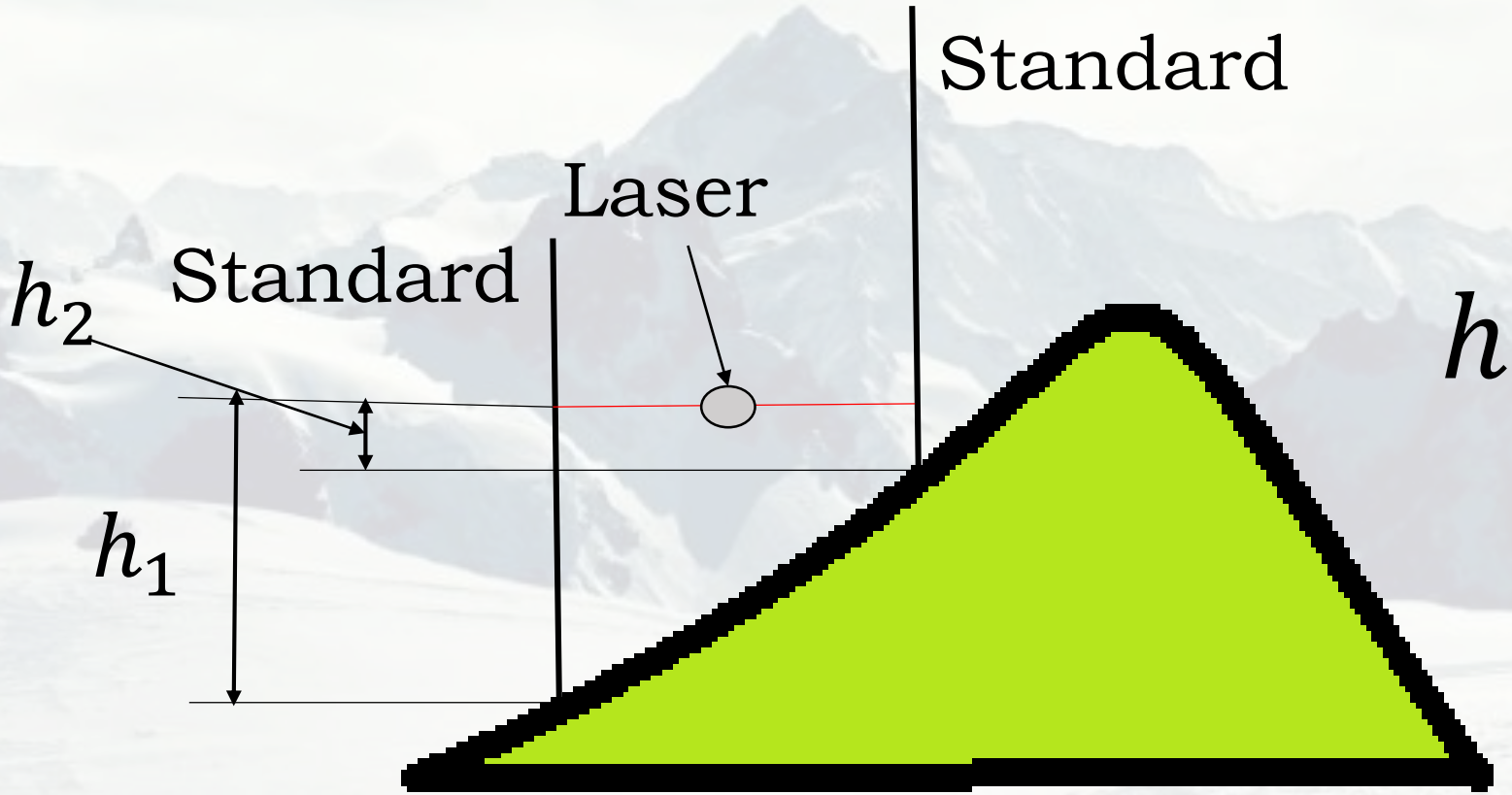
Advantages

- Understandable
- Simple set-up

Disadvantages

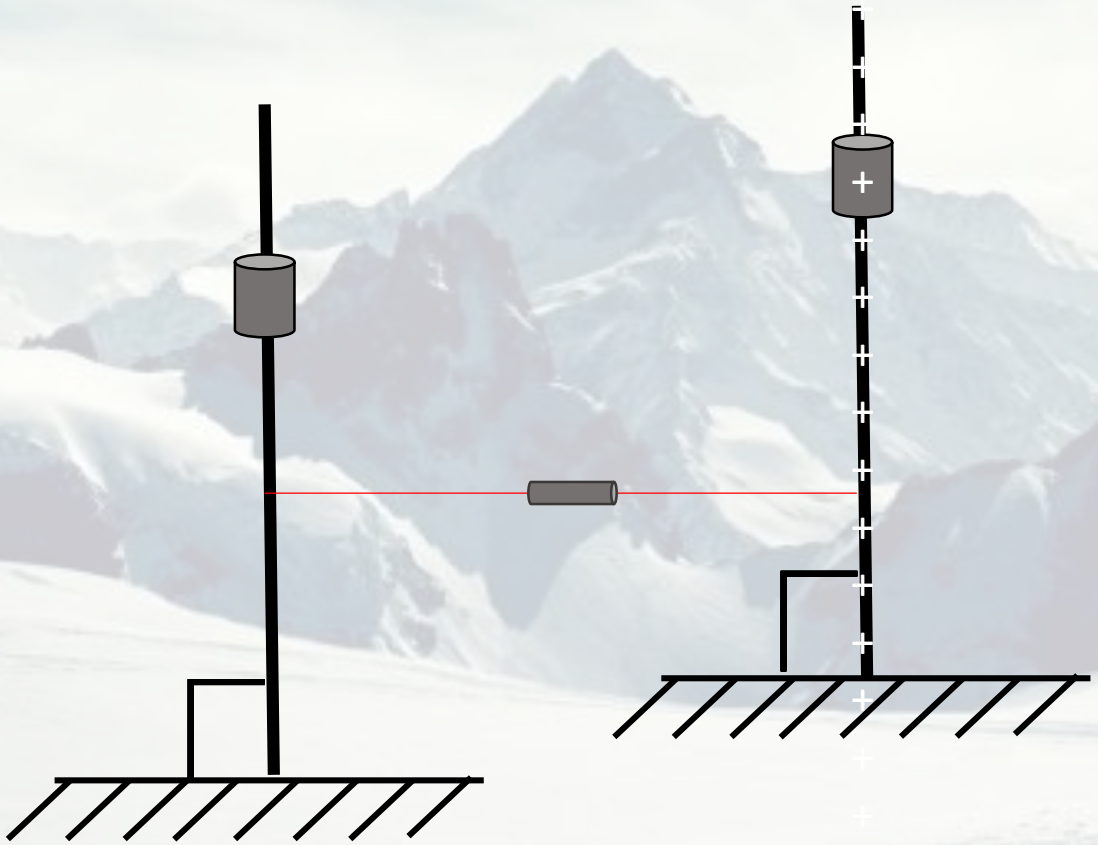
- Computer is required
- Lots of separate steps
- Aberration

Optical leveling



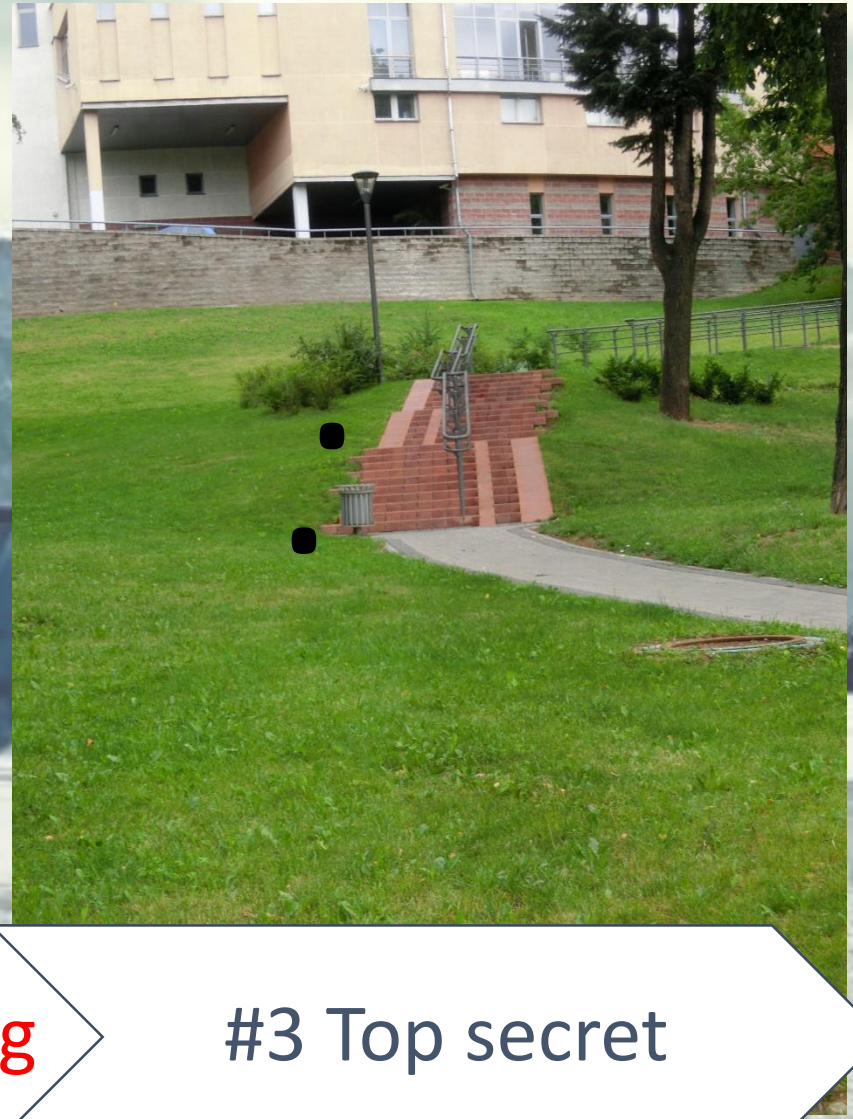
$$h = h_1 - h_2$$

Set-up



#1 Photogrammetry | #2 Optical leveling | #3 Top secret

Experiments



#1 Photogrammetry | #2 Optical leveling | #3 Top secret

Results

	Optical	Photogrammetry
Building	18 steps H = 8,1 e = 9%	1 step 8,14 e = 6%
Hill	26 steps 14,4 e = 1,5%	3 steps 14,37 e = 4%
Car	Not available	1 step 1,91 e = 4%

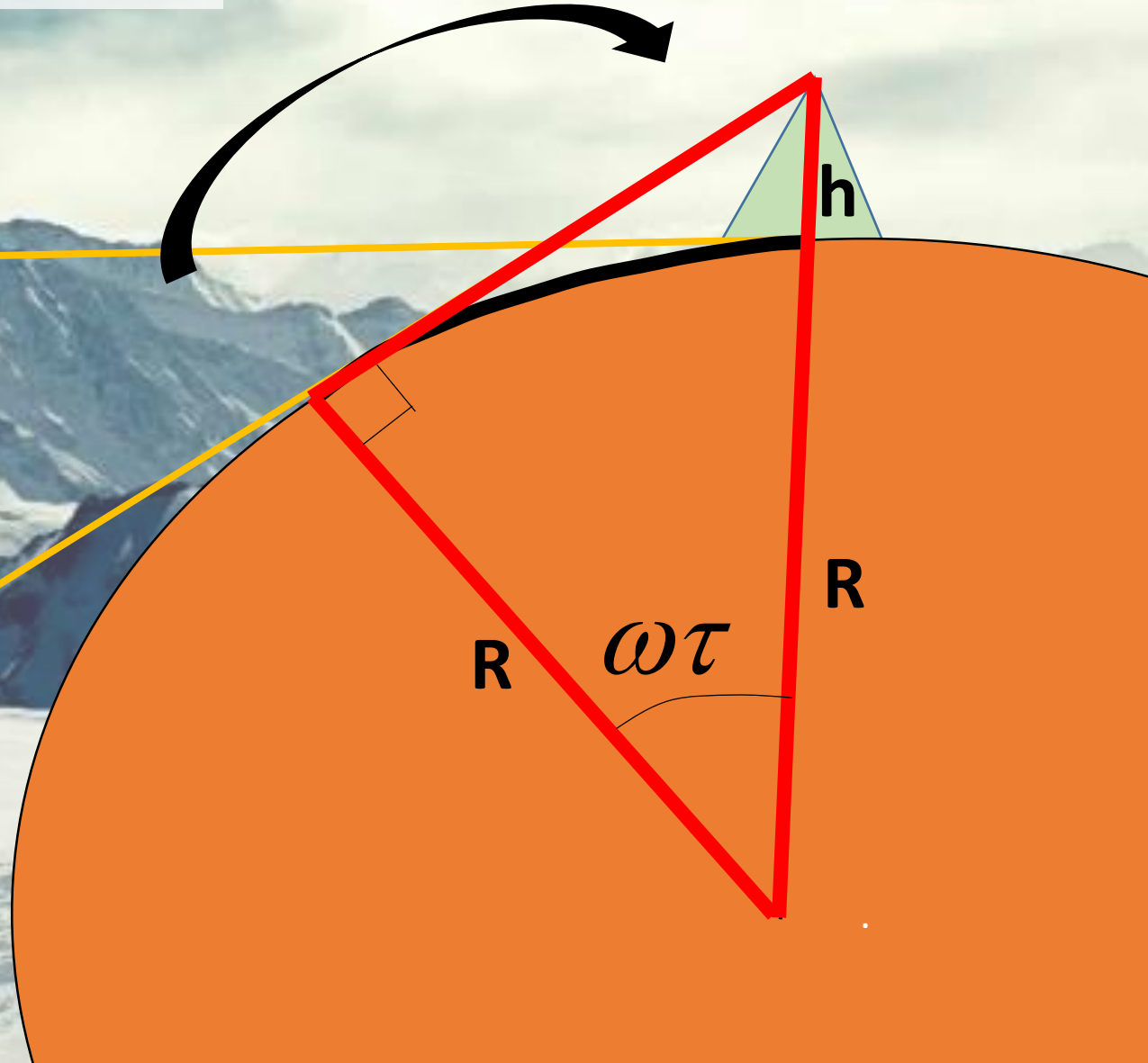
The second part- the altitude

(Top secret)

Sunset

$$(R+h)*\cos(\omega\tau)=R$$

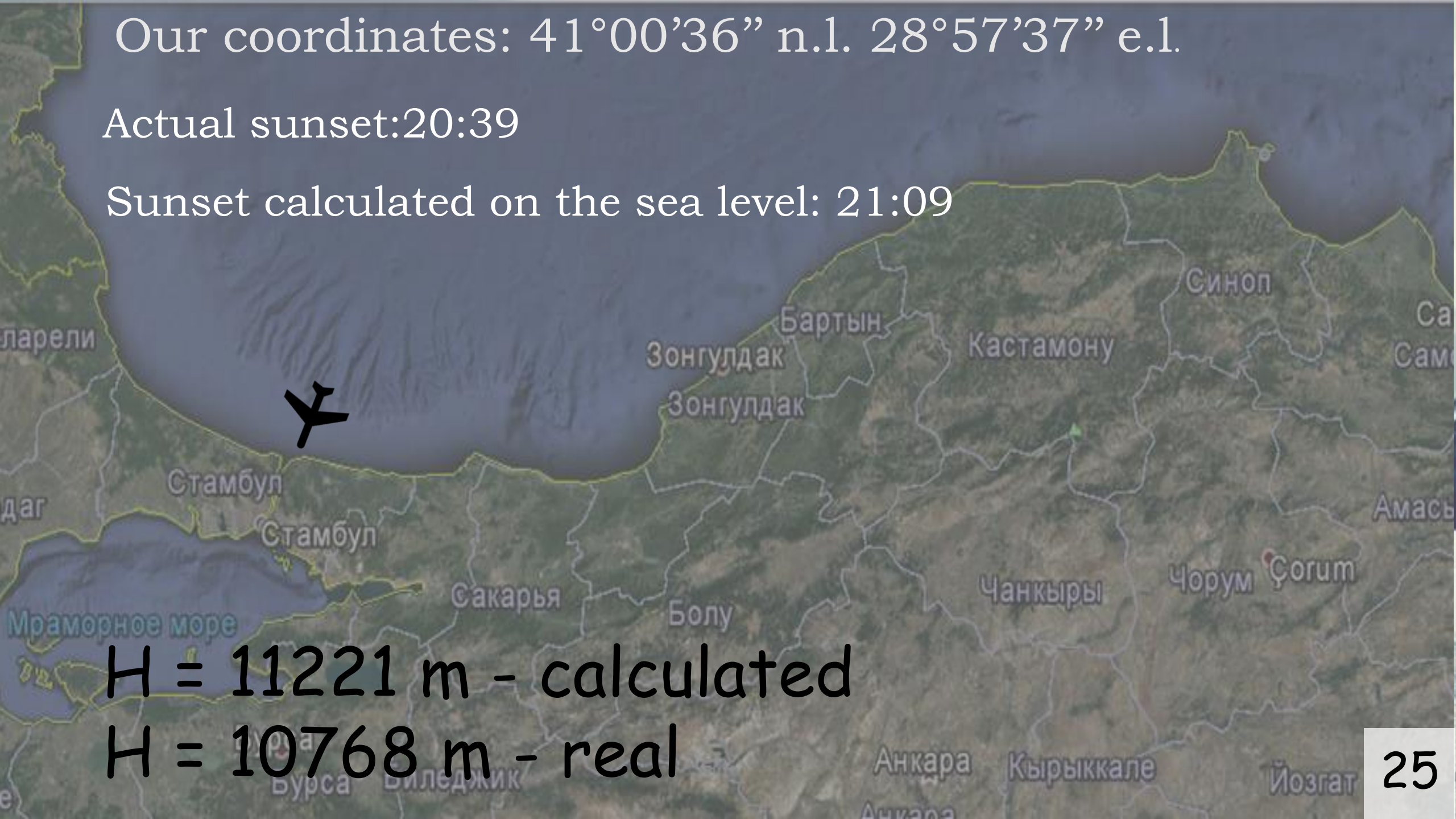
$$h=(R/\cos(\omega\tau))-R$$



Our coordinates: 41°00’36” n.l. 28°57’37” e.l.

Actual sunset:20:39

Sunset calculated on the sea level: 21:09



H = 11221 m - calculated

H = 10768 m - real

Conclusions

- Two methods of height measurement are investigated and improved.
- Our own method proposed and confirmed.
- Photogrammetry isn’t very effective method for determining hill.
- Methods used for measurements of hills in Belarus differ from the ones for the highest mountain peaks.
- Optic levelling appears to be the most precise method in Belarus

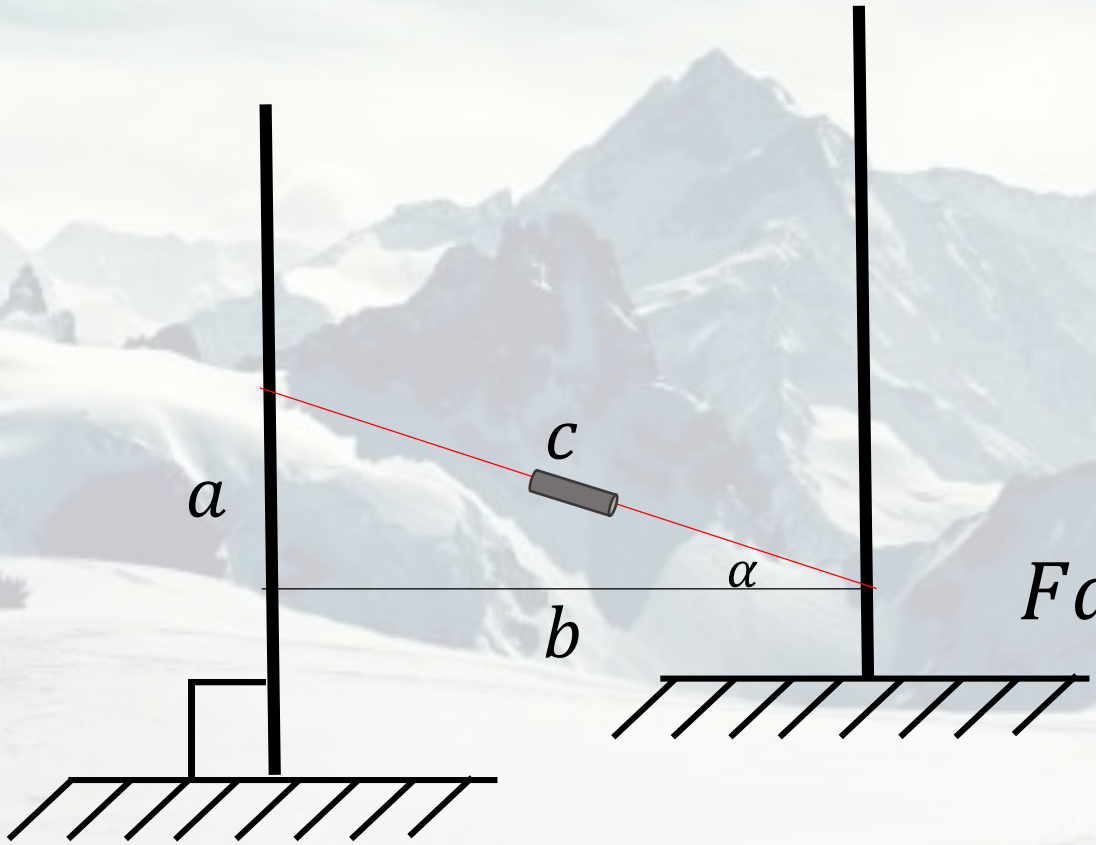
Thank you
for attention!

Disadvantage of this method

- Low accuracy of angle between ground and lasers measurement

#1 Photogrammetry | #2 Optical leveling | #3 Barometric leveling

Angle dispersion



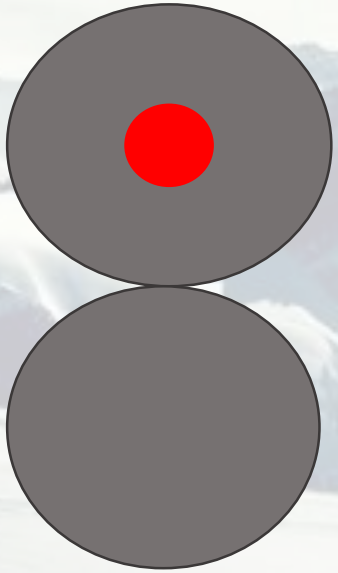
$$a = b \tan \alpha$$

$$Fault_1 = \frac{b \tan \alpha}{2}$$

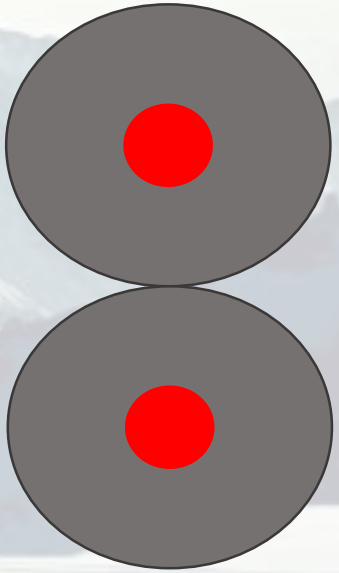
$$Fault = 2\frac{b \tan \alpha}{2} = b \tan \alpha$$

Two lasers

Our set-up for determining elevation



Our set-up for dispersion determining



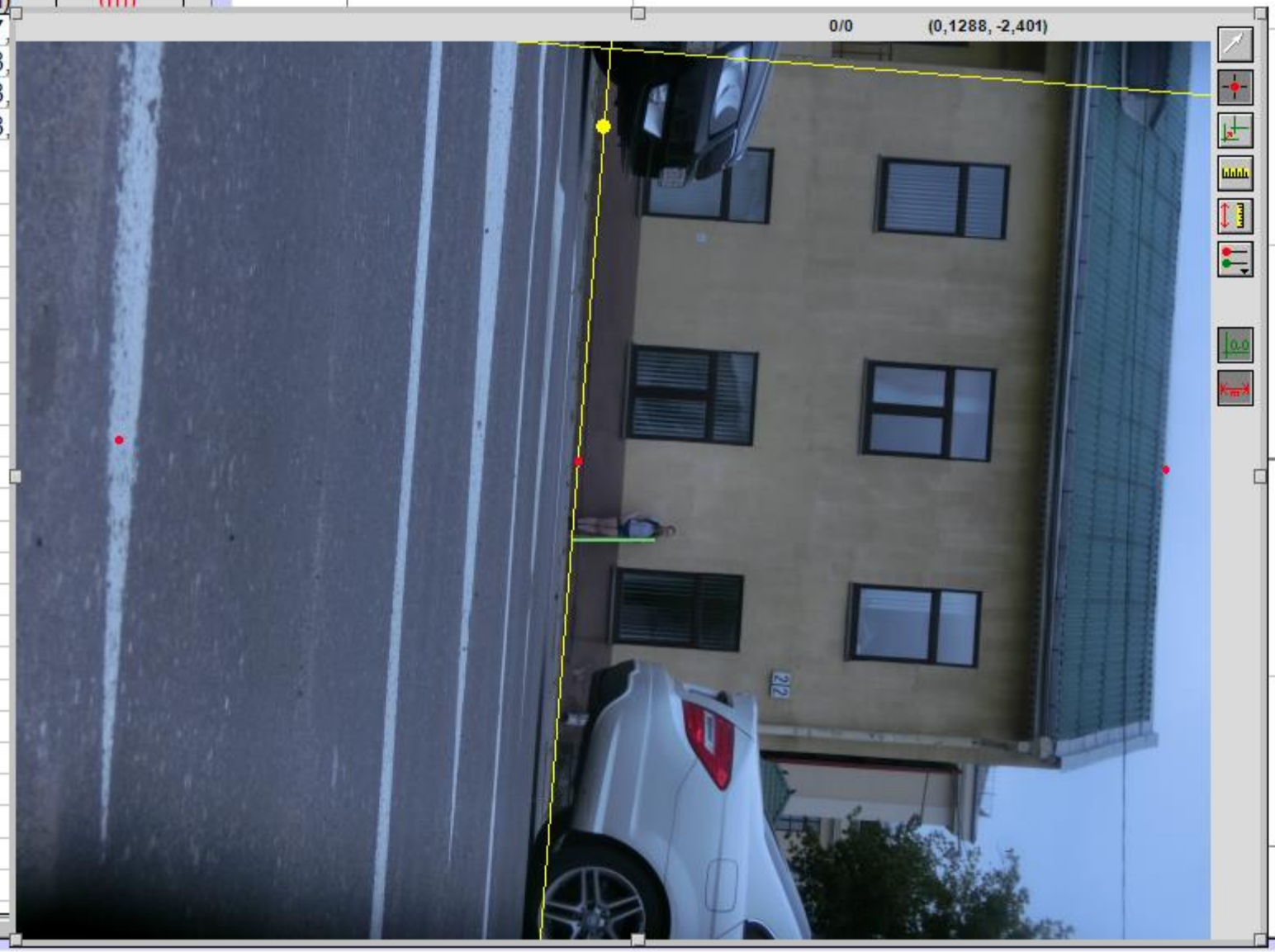
Правка Эксперимент Данные Анализ Вставка Параметры Страница Справка

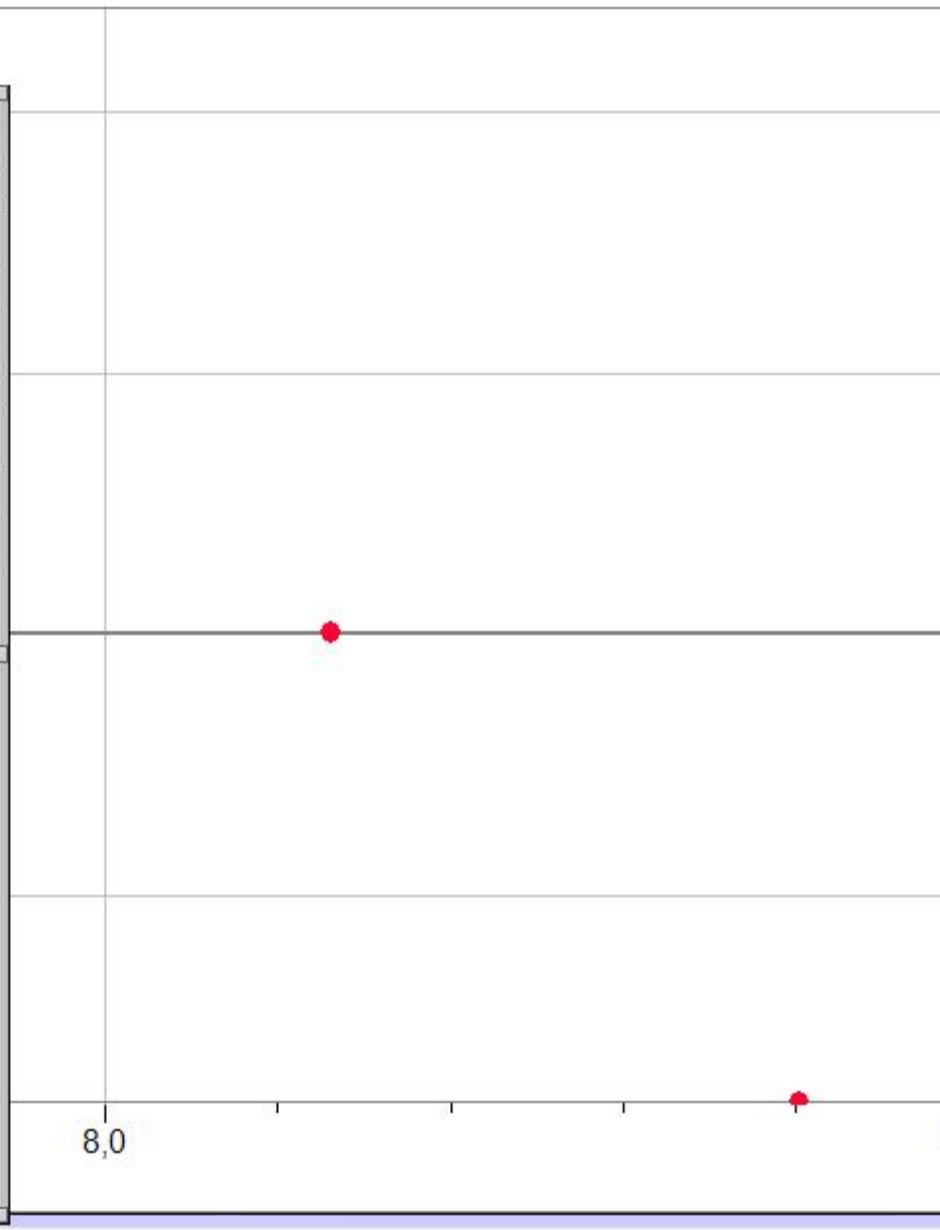
Страница 1

Измерения

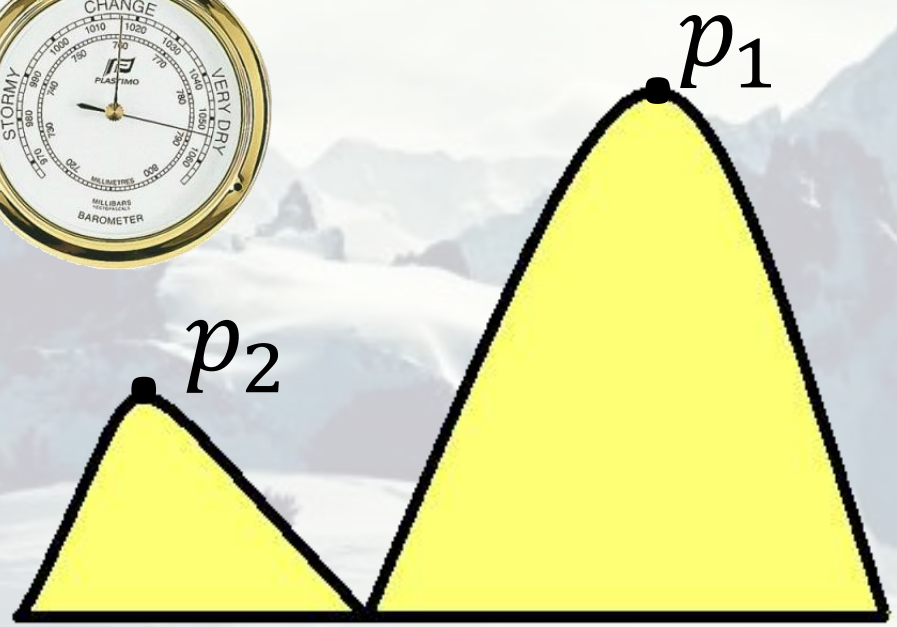
одключенных устройств.

ВидеоАнализ	
X (m)	Y (m)
7,	
8,	
8,	
8,	





Barometric leveling



$$\Delta p = p_2 - p_1$$

$$\Delta h = 18400\,(1 + \alpha t) \times \lg\left(\frac{p_1}{p_2}\right)$$

$$\alpha = 0{,}00366\ °\mathrm{C}^{-1}$$

#1 Photogrammetry | #2 Optical leveling | #3 Barometric leveling

Experimental part

p_1=735,25 mm
p_2=734,75 mm
t = 12°C
h = 5,7m

Problem of this method

- The pressure dependence on other factors
- Unideal equipment

#1 Photogrammetry | #2 Optical leveling | #3 Barometric leveling

Advantages

- Highly accurate
- Suits gentle slopes

Disadvantages

- Lots of separated steps
- 3 people are required
- Complicated set-up

Notes from our problem

- We have to use this method
- We have to take account instrumental dispersion. (We can read this information in the passport of barometer).

We can’t determine Everest

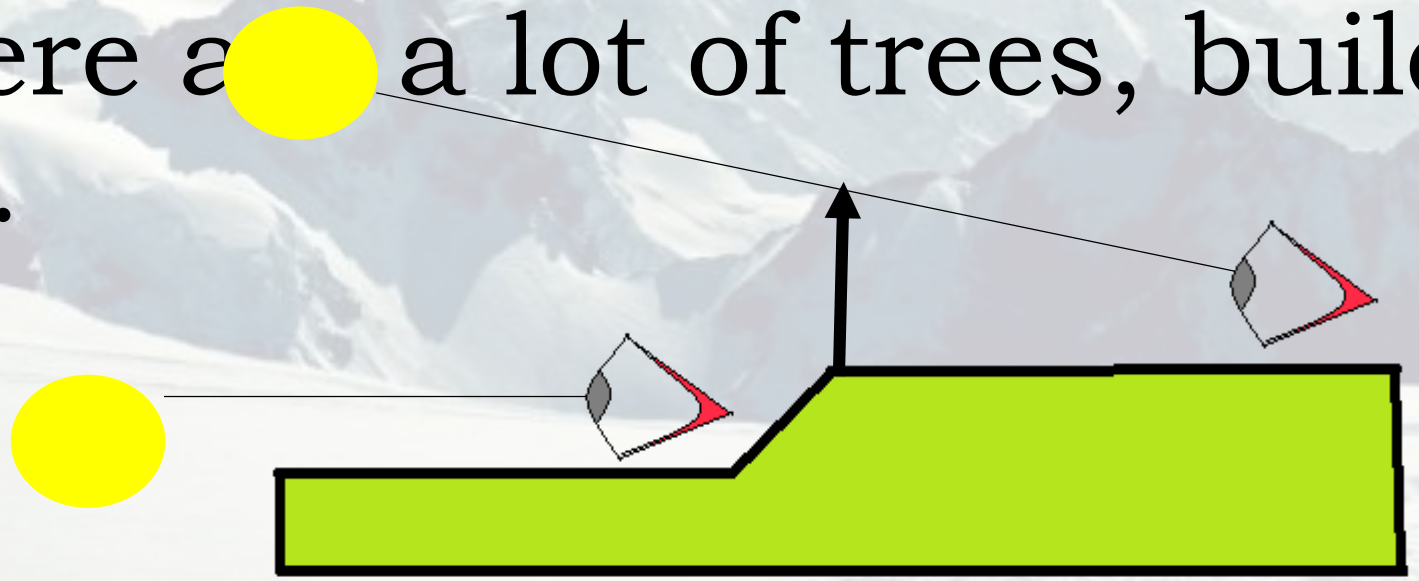
- The different humidity at the peak and at the of Bay of Bengal
- The different density of air
- The different temperature and etc.

Advantages

- Simple to using

Disadvantages

- Unideal equipment
- Method can’t be applied to the high mountains and to the large distances.
- Difficult mathematics

Impossibility to use in Belarus

- Elevations from 350 m give a very small time difference.
- There a a lot of trees, buildings etc.