Mechanical design of the Rotational Drum Spectrometer for the SolpeX

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Progress on EUV & X-ray spectroscopy and imaging II

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What is the SolpeX Spectrometer dopplerometer?

- It is one of the three SolpeX instruments to be mounted in the ISS.
- It will allow to investigate fast changes of solar spectra including lines and continuum.
- Measurements of precise line Doppler shift will be possible.
- Timing information on the photon arrival with accuracy of ~1 *microsecond* on the SDD detector will be used in order to assign the wavelength to each Bragg-reflected photon from the crystals.

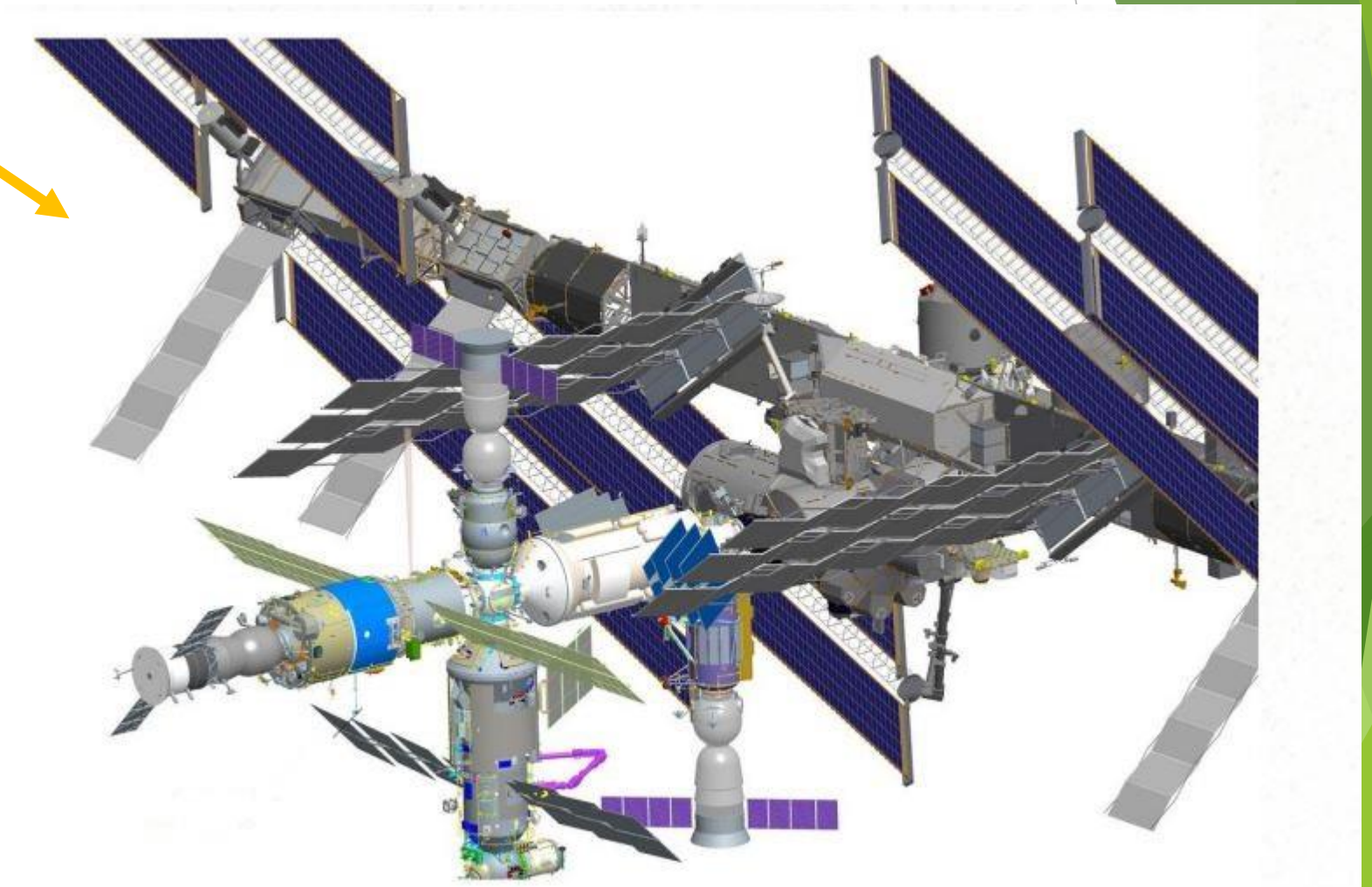
Where will be located?

ISS

Nauka

KORTES

SolpeX



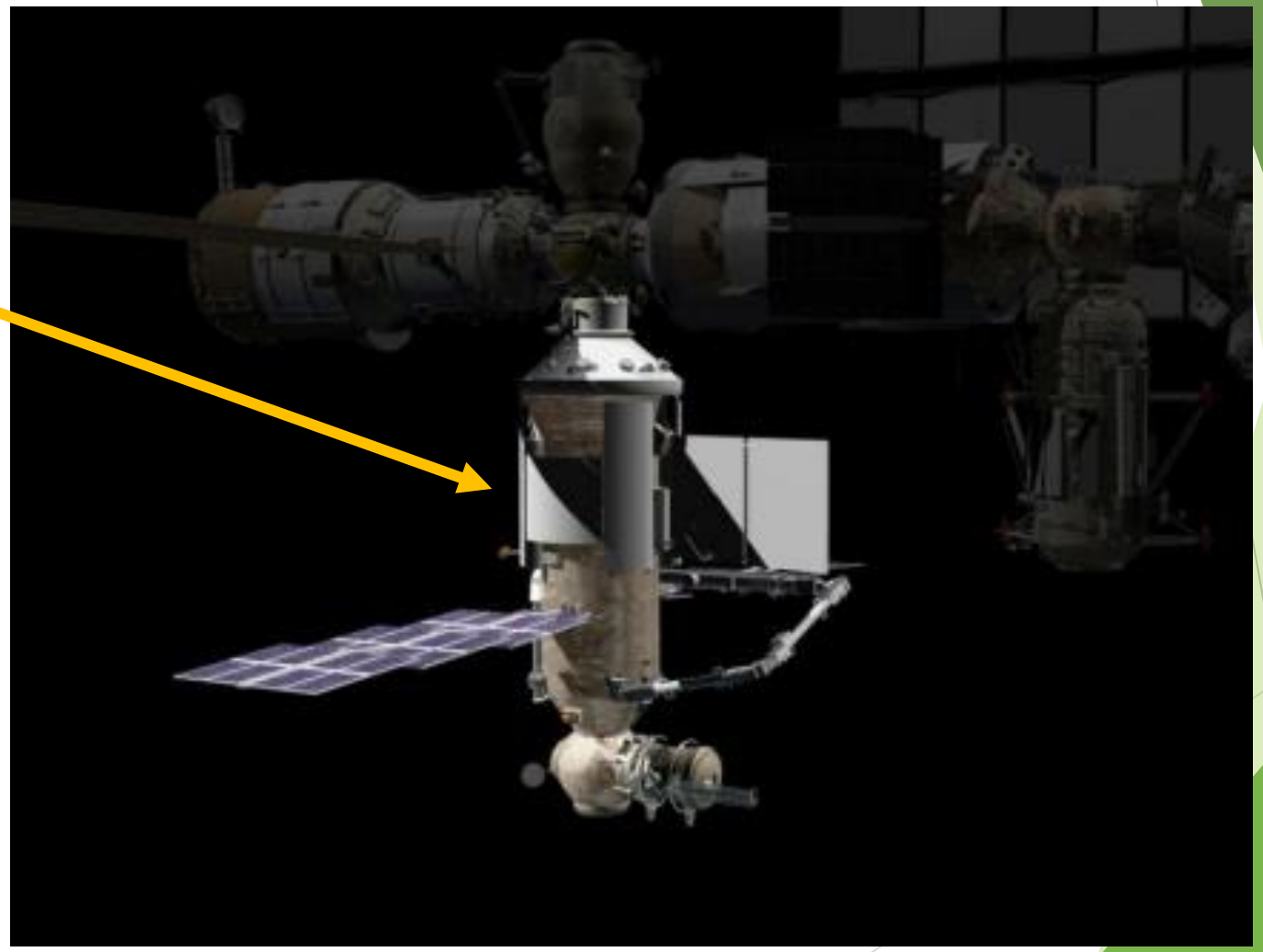
Where will be located?

ISS

Nauka

KORTES

SolpeX



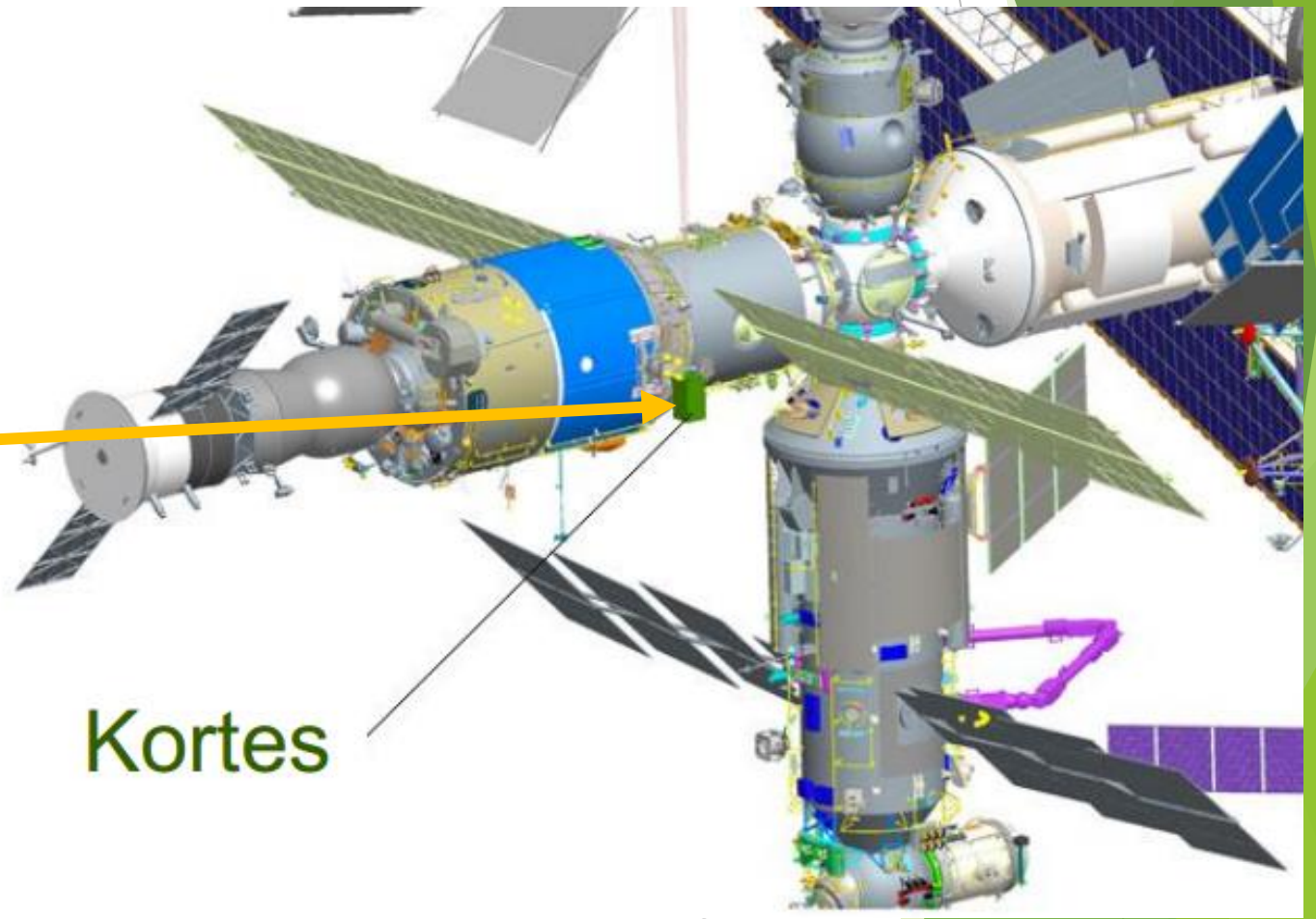
Where will be located?

ISS

Nauka

KORTES

SolpeX



Where will be located?

ISS

↓

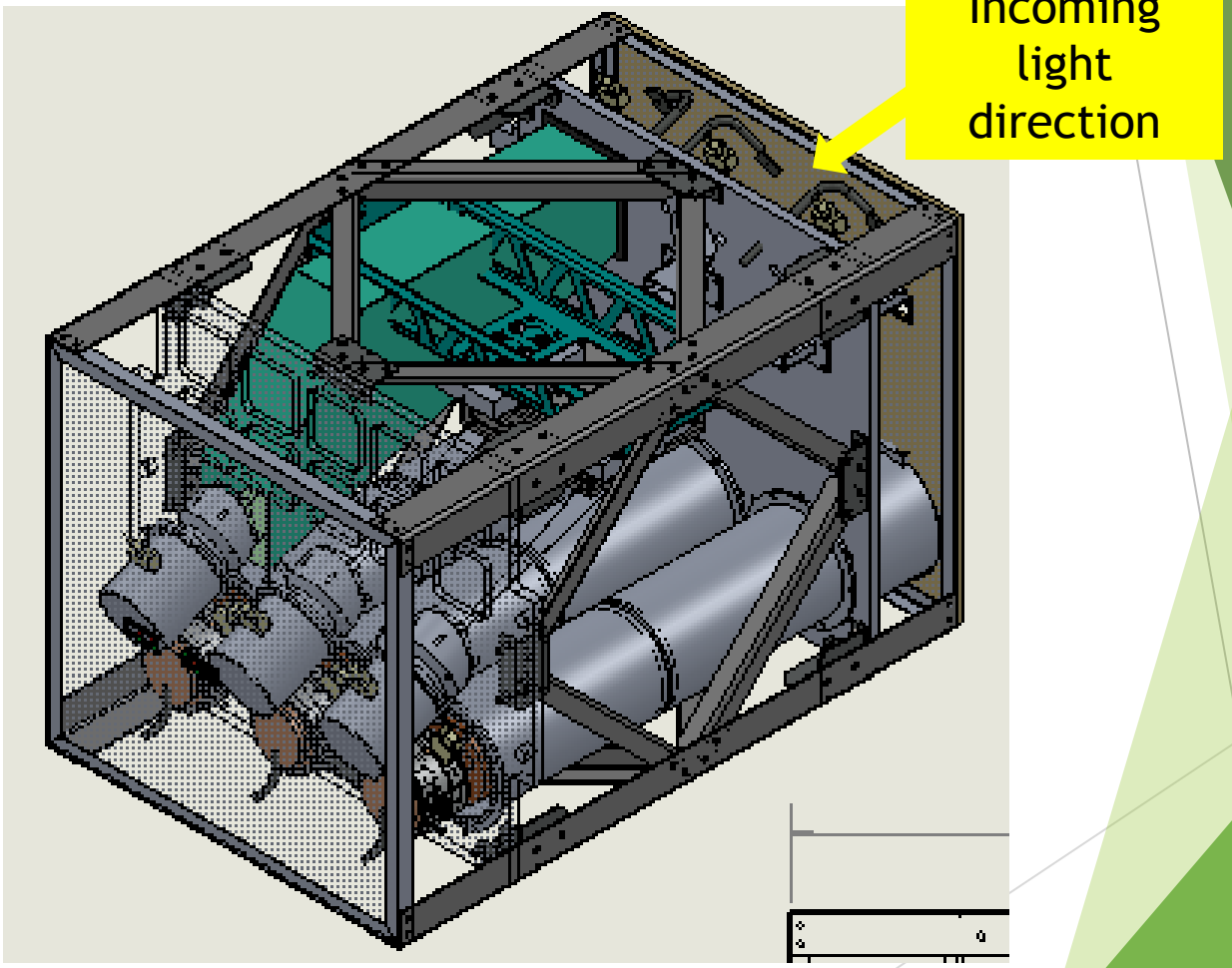
Nauka

↓

KORTES (inside)

↓

SolpeX



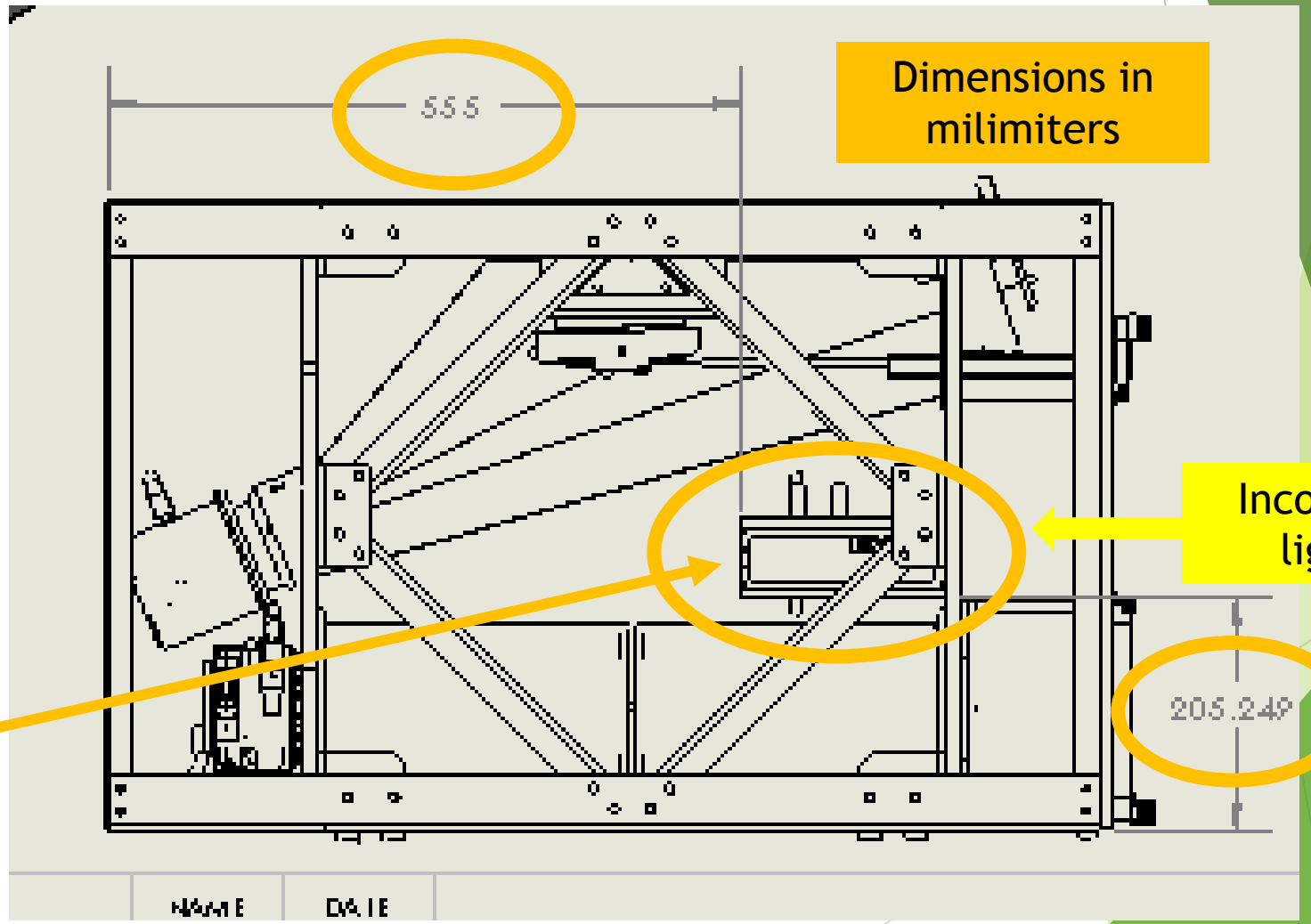
Where will be located?

ISS

Nauka

KORTES

SolpeX within KORTES



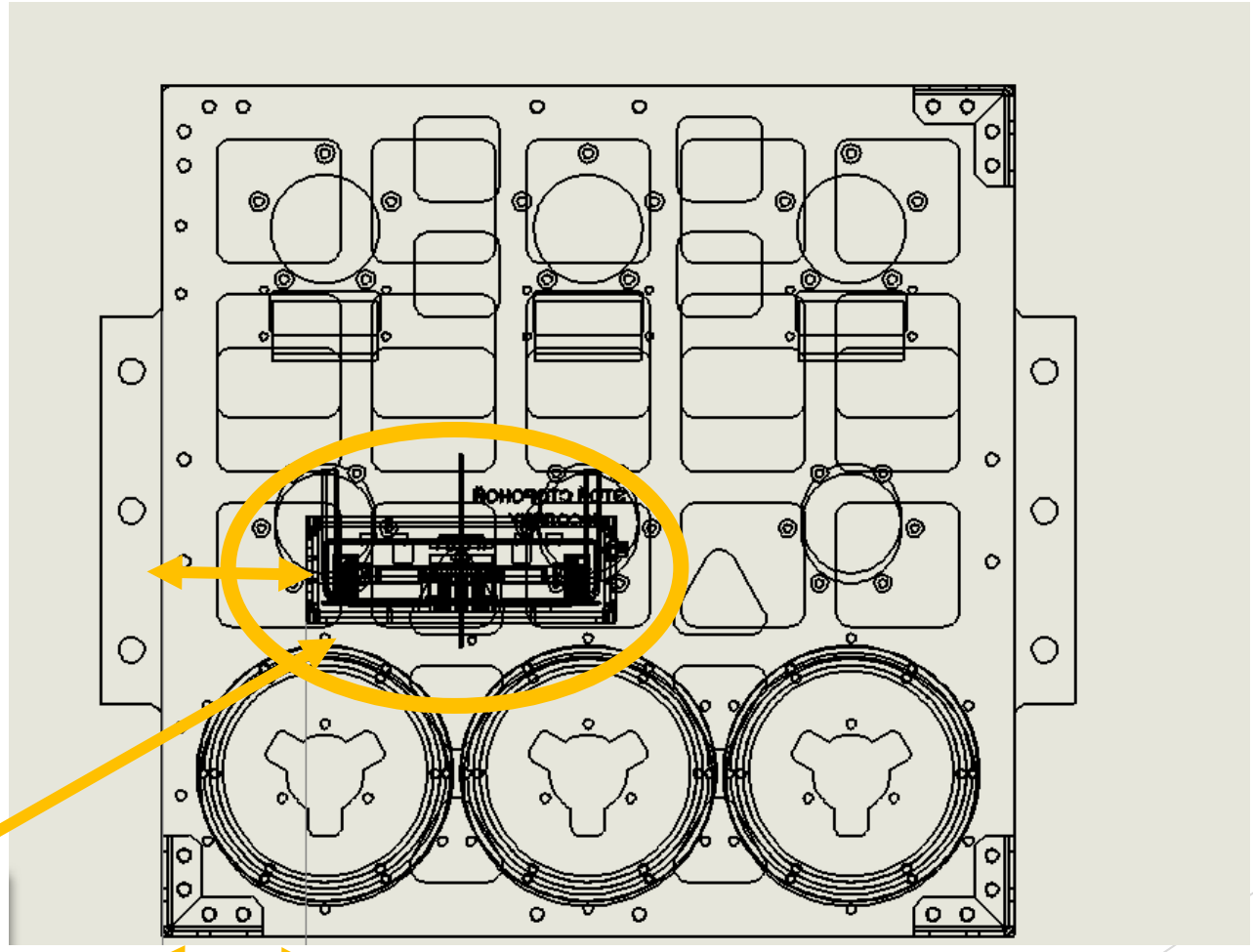
Where will be located?

ISS

Nauka

KORTES

SolpeX within KORTES



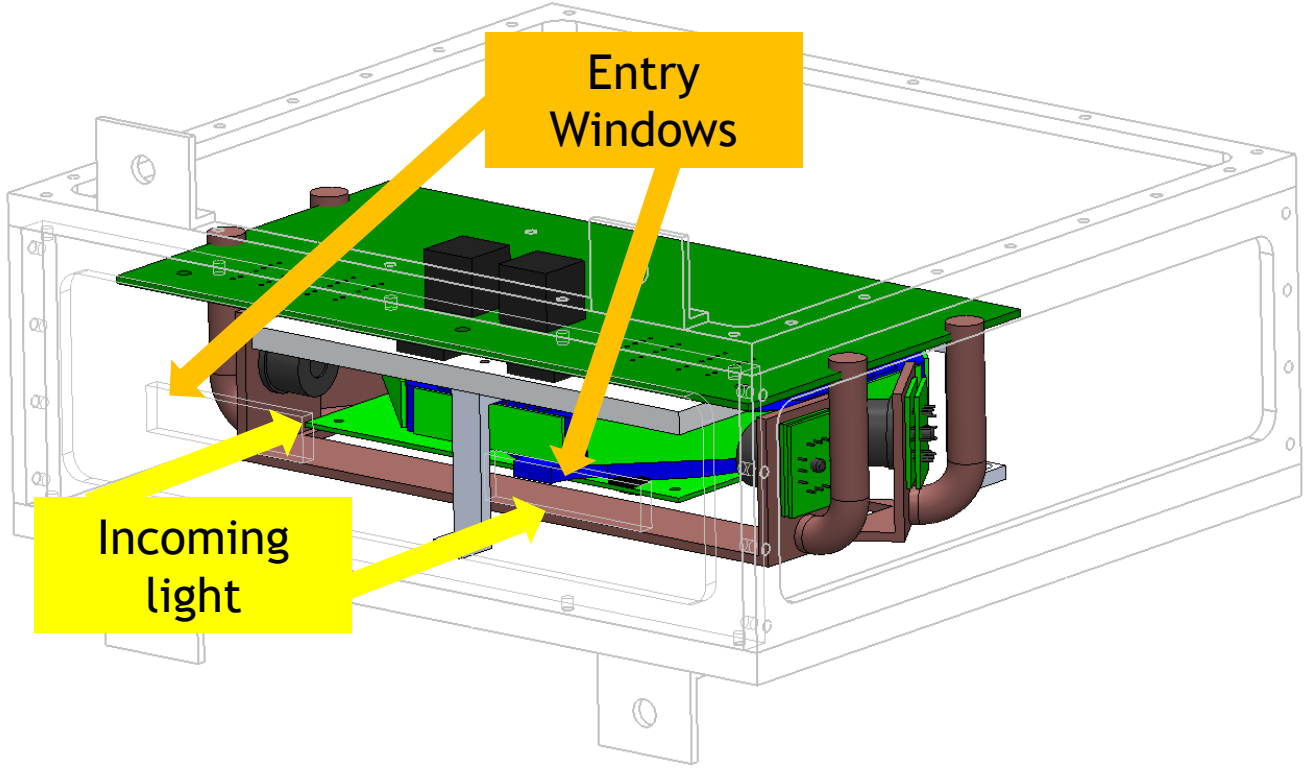
General Sketch

ISS

Nauka

KORTES

SolpeX Spectrometer



Advantages and disadvantages of this location

- Easy access to ISS, instrument mounting by cosmonauts
- Possibility of using large instruments
- No substantial limitation on power
- Large volumes of data storage on „popular" media
- Possibility of „repairs" and memory module transport to the ground

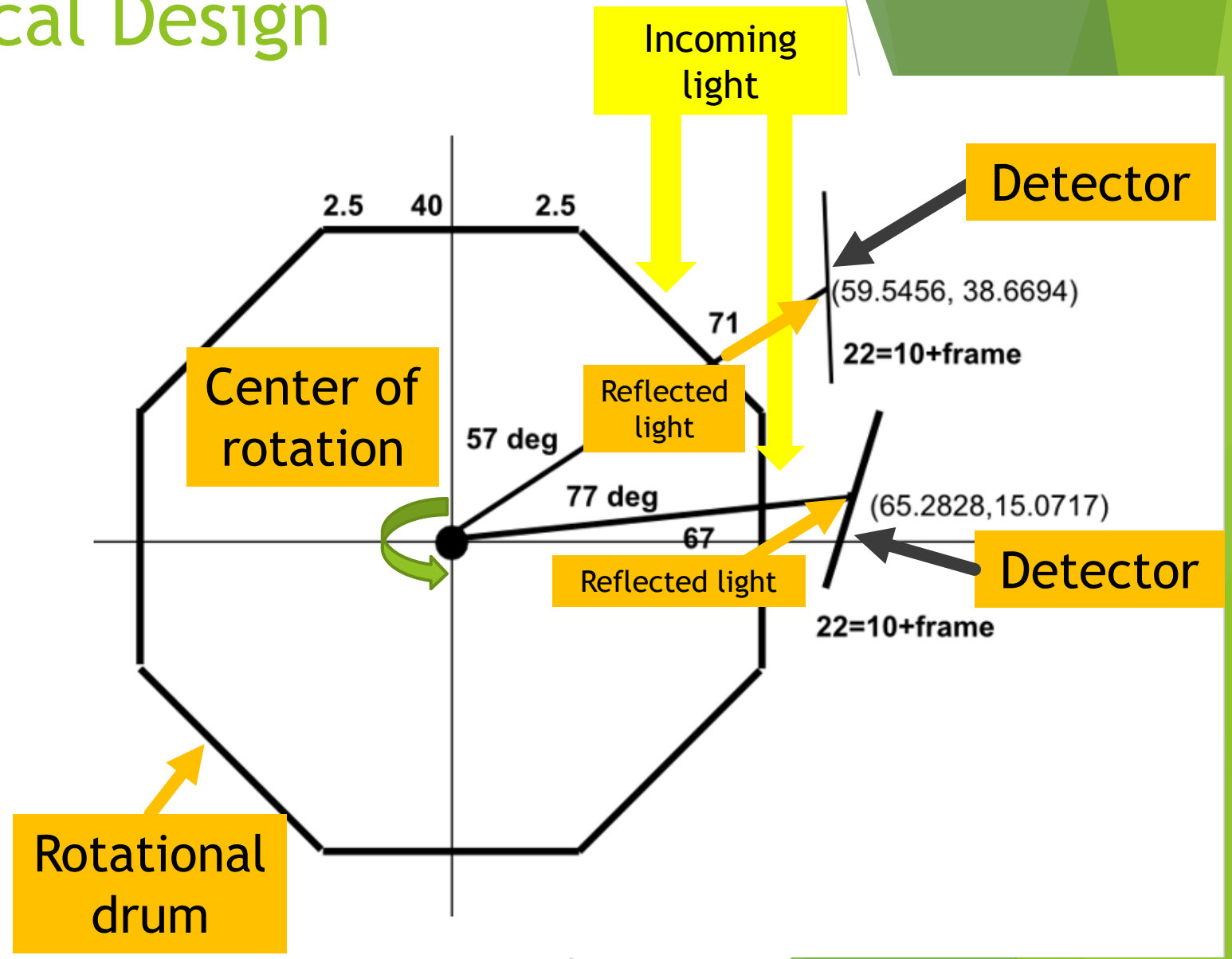
- Rough Pointing- few arcmin due to ISS motions
- Spacecraft day/night shifts (16 nights/24h)
- Vignetting by various ISS structures: only ~10 min of uninterrupted measurements per orbit possible

Main Requirements

- Constant Speed of 10 RPS
- Operation in Vacuum
- Temperatures for detectors: less than -15°C

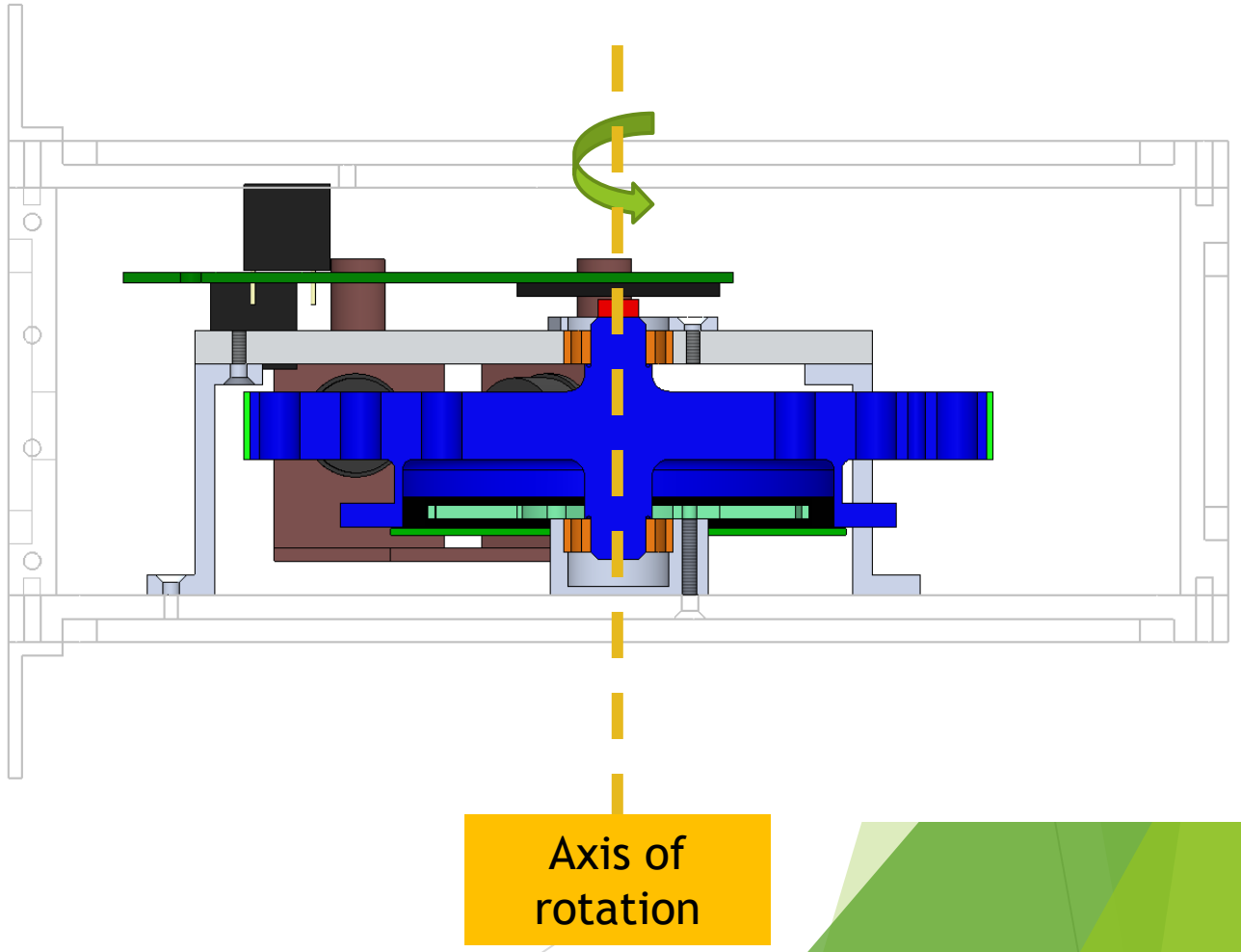
Optical Design

- The optical design was proposed by Stefan Płocieniak and Żaneta Szaforz. This picture shows the top view of the current design proposal. It includes the position and orientation of the center of the window's detector regarding the center of the drum. (dimensions in milimiters)
- The flat crystals sizes are also specified in the drawing (Silicon, Quartz, KAP and ADP crystals).
- The mechanical design is driven by the geometry and location of the crystals with respect to the detectors.

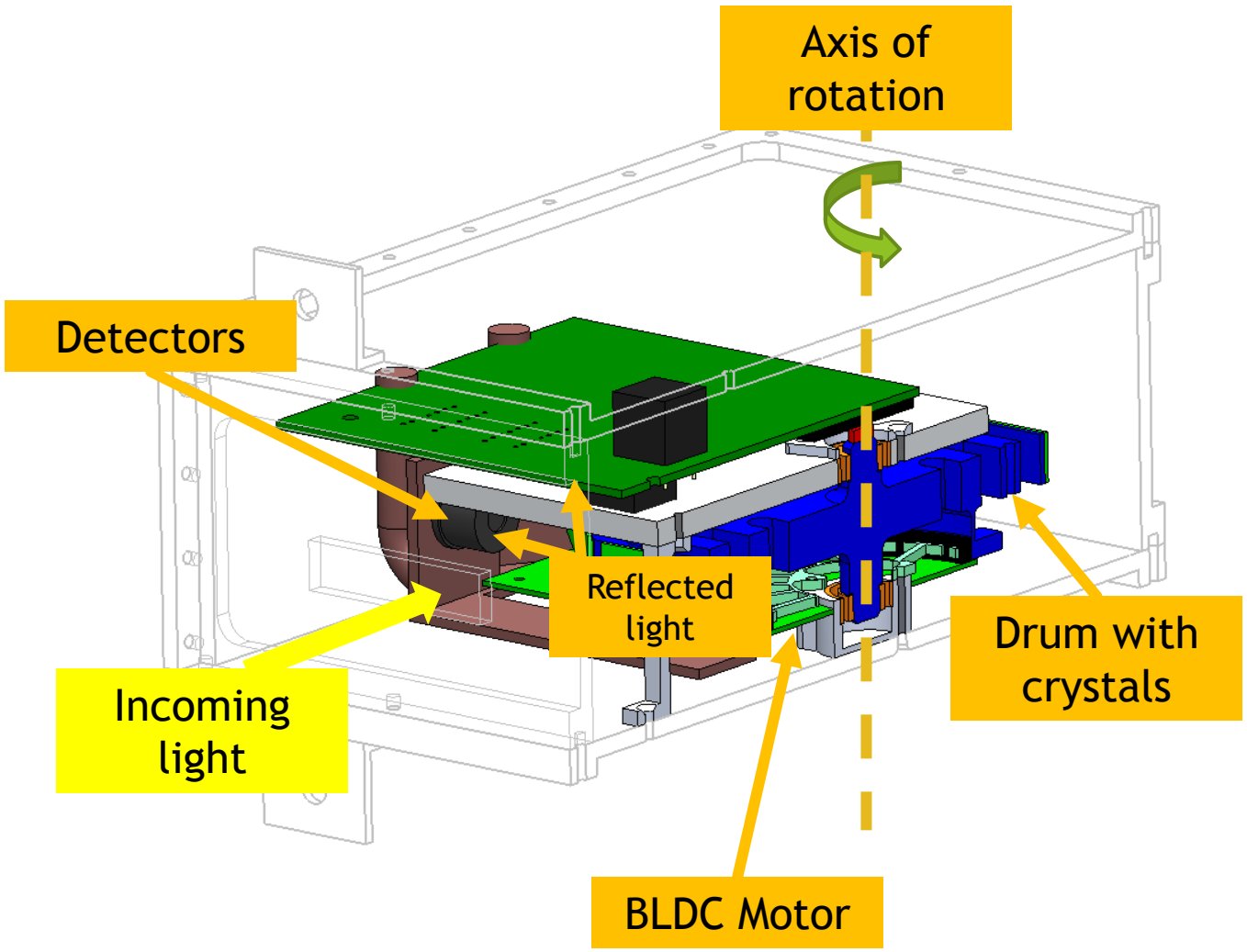


Main Components

- 8 flat crystals
- 4 silicon drift detectors
- Octagonal drum
- Ceramic Bearings
- Brushless electric motor
- 2 Printed circuit boards
- Detector heatsink
- Structural components
- Power/Data connectors

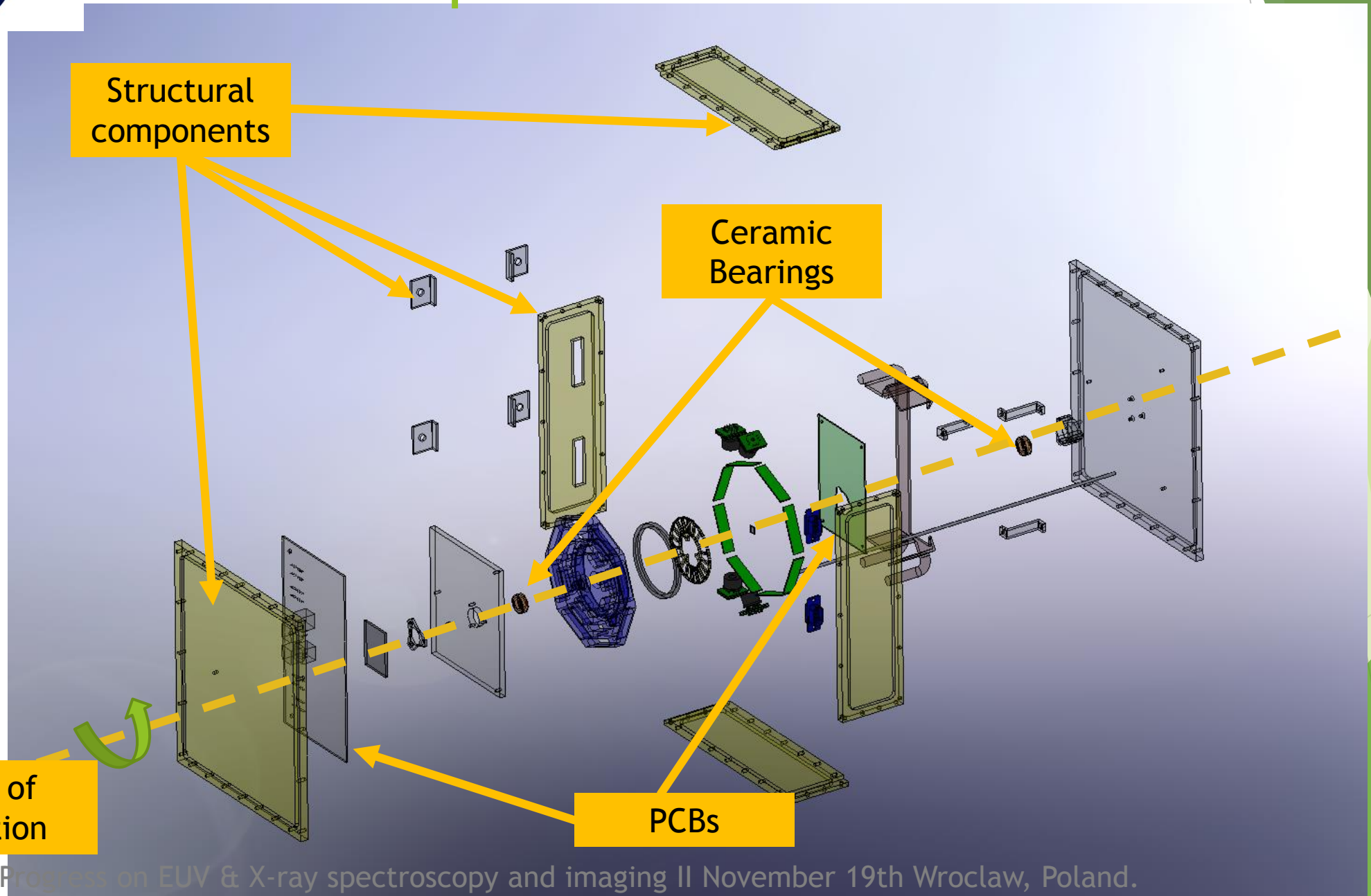


How it will work?

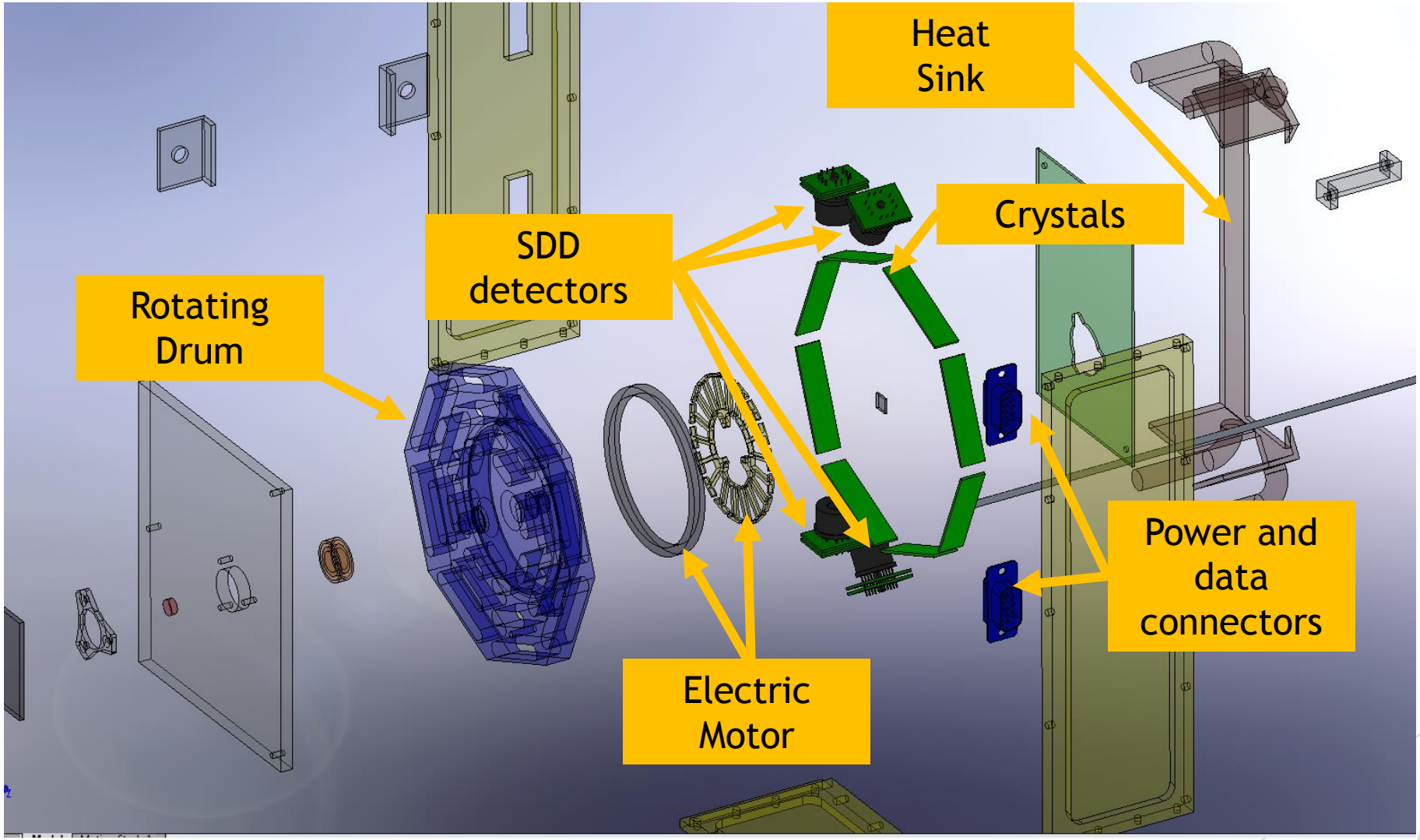


- A Brushless DC motor will rotate the mechanical drum that holds 8 flat crystals.
- The incoming photons will be reflected following the Bragg law in a desired range of the X-ray spectrum.
- Using several different crystals will allow to have a wider coverage of the spectrum.
- 4 SDD detectors will register the photons for the measurement.

Exploded view



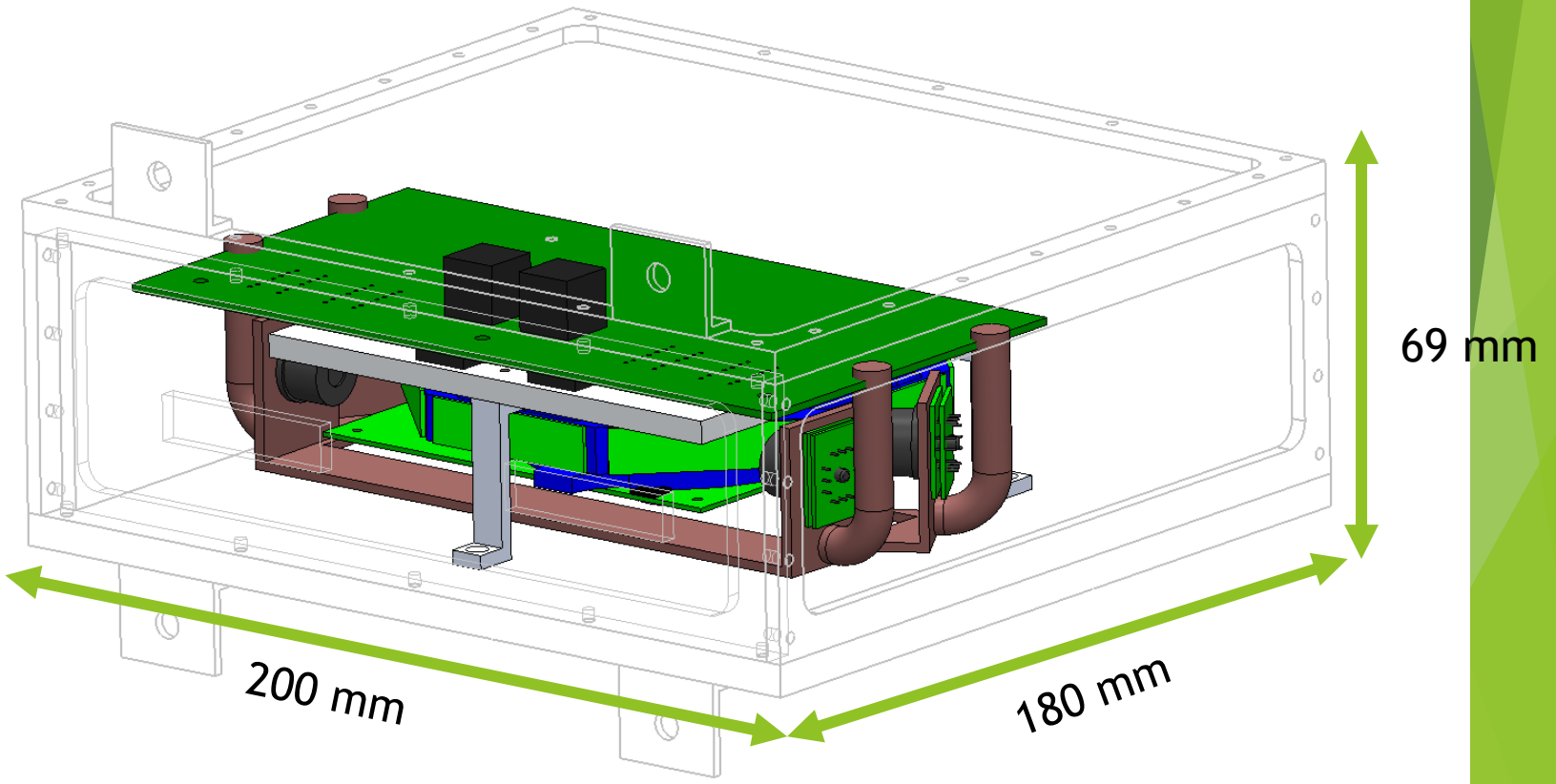
Exploded view



Basic Packaging, mass and power of the instrument

Approximate
Mass: 2 Kg

Approximate power consumption:
1 W electric motor
1 W per detector
1 W Electronics



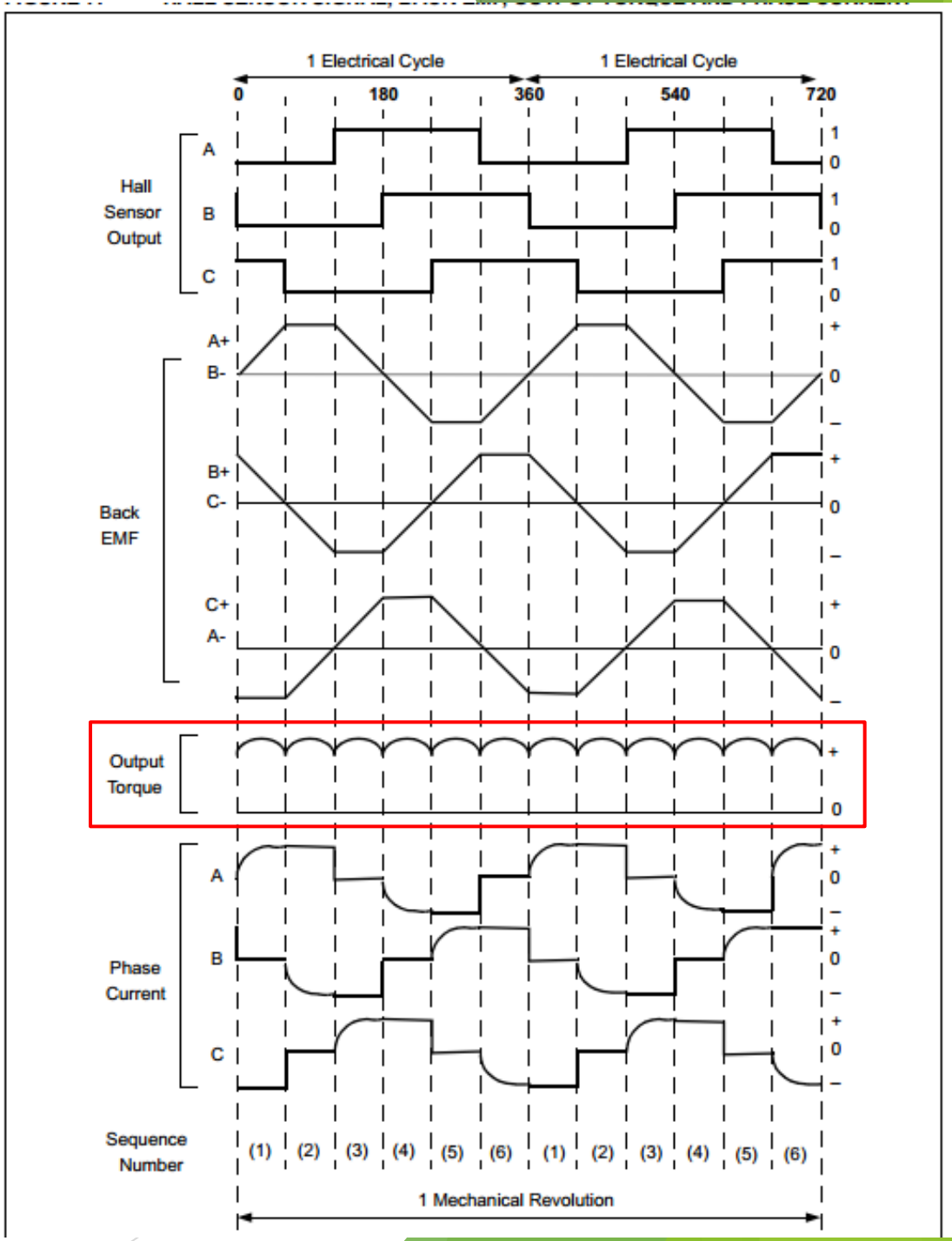
Why do we need speed test?

The next graphics shows the typical behavior of a brushless motor.

The motor torque in a function of rotor angle is not constant. The torque modulation depends on number of motor poles and driving signals.

So, there is a need of the speed test to find if the torque is smooth enough to ensure the constant angular speed required by the system.

The goal: 10 RPS average speed with a maximum variation of 1E-5.



Summary

- The next challenges will be to make an accurate test for the rotating drum. It can include to look for a better electrical motor with less torque fluctuation or some design changes in the drum to increase the moment of inertia so that make the speed more constant.
- Thermal system is also very critical for the SDD detectors. Cooper straps may not be enough and a more efficient passive system may be required (i.e. heat pipes) This will depend of the distance to the external radiator in SolpeX and how cold it will be.
- Further design changes can be driven by external factors such as new position in external radiators, or changes in position of components inside KORTES.

Thank you!

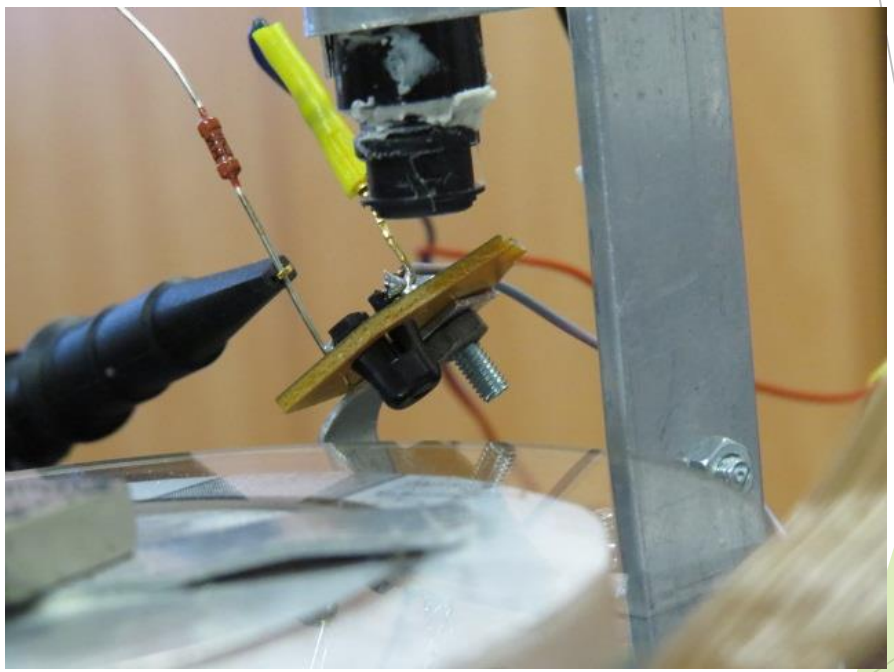
Спасибо!

Gracias!

Dziękuję!

Speed Test

- The speed test/calibration for the uniform speed was proposed by Stefan Płocieniak .
- It includes the use of a laser diode, focusing lens, a glass transparent disc with 400 equally distributed stripes, PIN photodiode, an oscilloscope and the components to test (electric motor and drum)



Speed Test

- The disc is powered by the electric motor.
- The area with the stripes in the disk is lighted with the laser
- The focused laser light is scattered in the stripes and then registered by the PIN photodiode
- The oscilloscope records the analogue signal
- The signal is processed with Fourier and Gaussfit analysis
- Strips arriving times is obtain below 1 μsec accuracy