Dynamics of the vertical and horizontal pitch
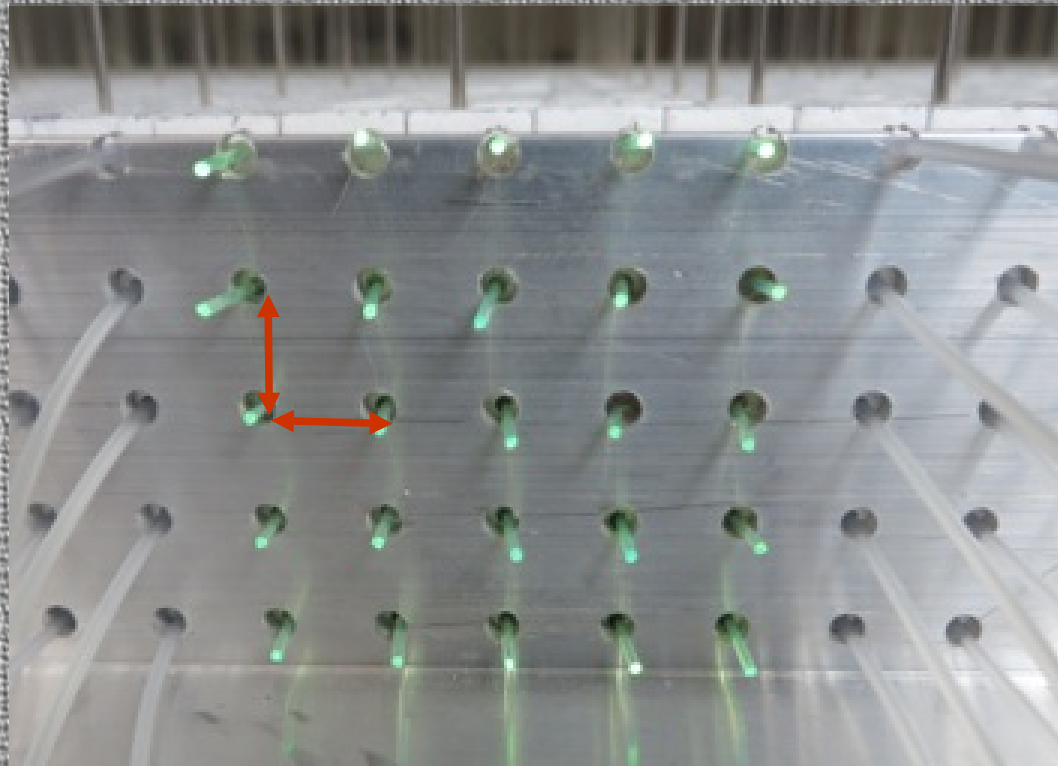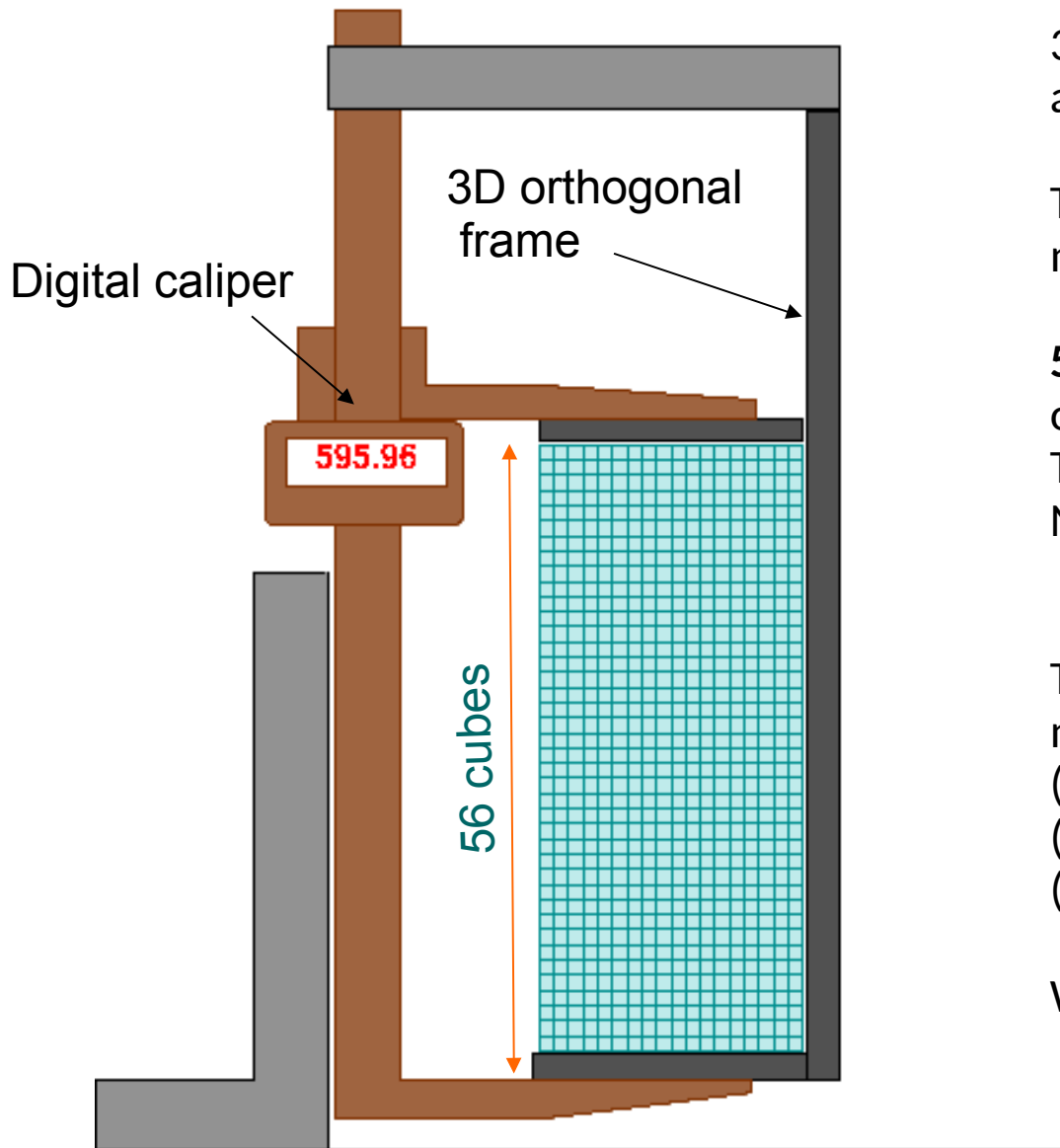
1. Average vertical pitch over time

2. Horyzontal pitch at 184x192 plane

Oleg Mineev (INR RAS, Moscow), 28th Sept. 2020

The setup scheme to measure the average vertical pitch and pitch gradient vs height

Digital caliper

3D orthogonal frame

595.96

56 cubes

3D orthogonal frame with high geometrical accuracy was built of milled steel plates.

The alignment was done with two steel measuring squares.

56 layers of **18x15** cube pads are assembled on **1 mm** fishing lines in horizontal direction. The 1 mm fishing line imitates the WLS fiber. No vertical fishing lines.

Three different samples of the cubes were measured:
(1) average pitch = **10.30 mm**
(2) average pitch = **10.28 mm**
(3) average pitch = **10.29 mm**

We'll observe the pitch vs time for the 3d set.

Result for the 3d set of cubes produced in August 2020
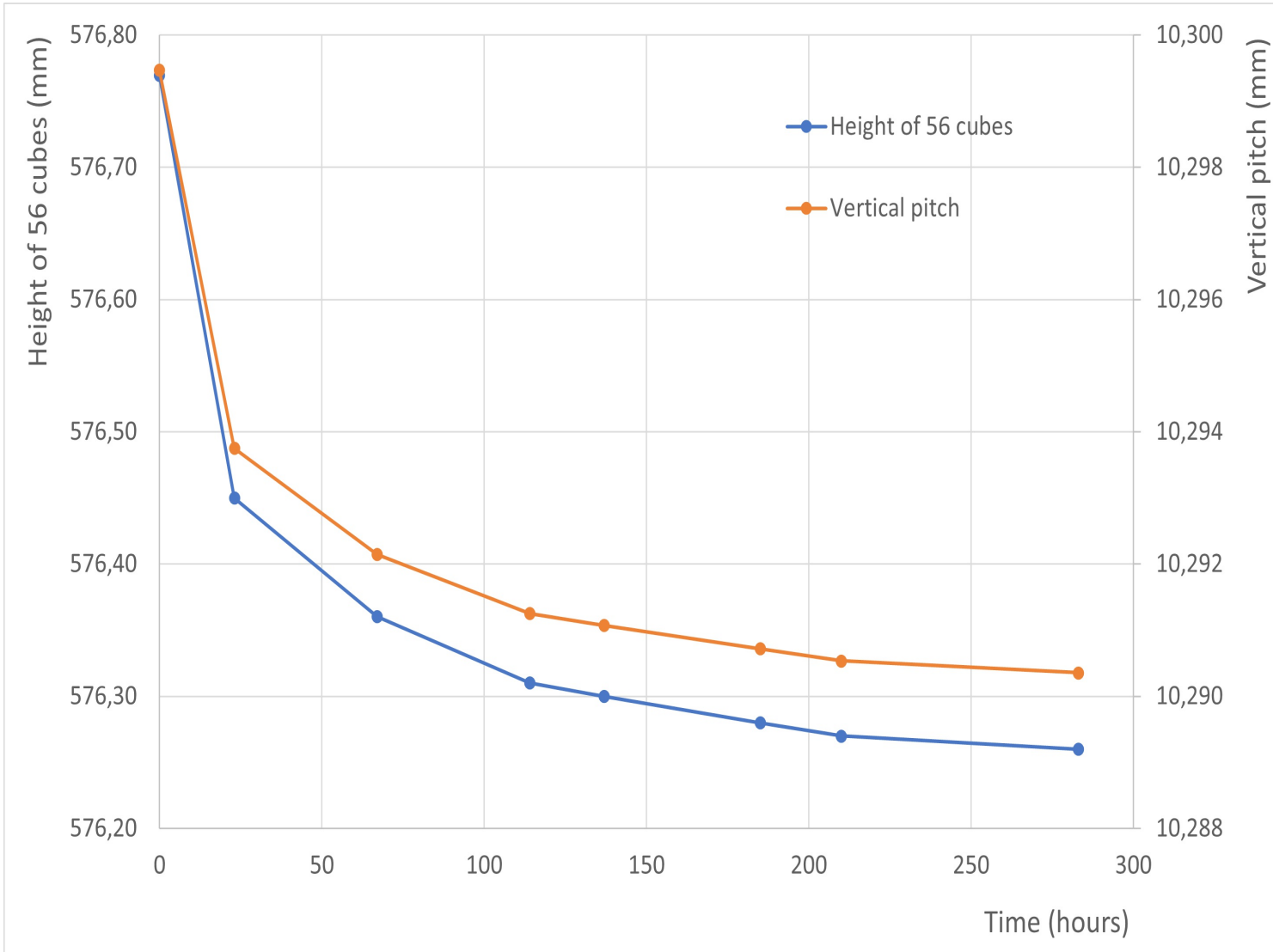
Before measurement 13 kg load was placed at the top to accelerate gravity effect.

The total height has been reduced by 0.5 mm after a few days.

Two factors involved:
1) Fishing lines springiness;
2) Elasticity of reflector.

We observe the saturation in height after a week, the pitch becomes **10.290 mm**.
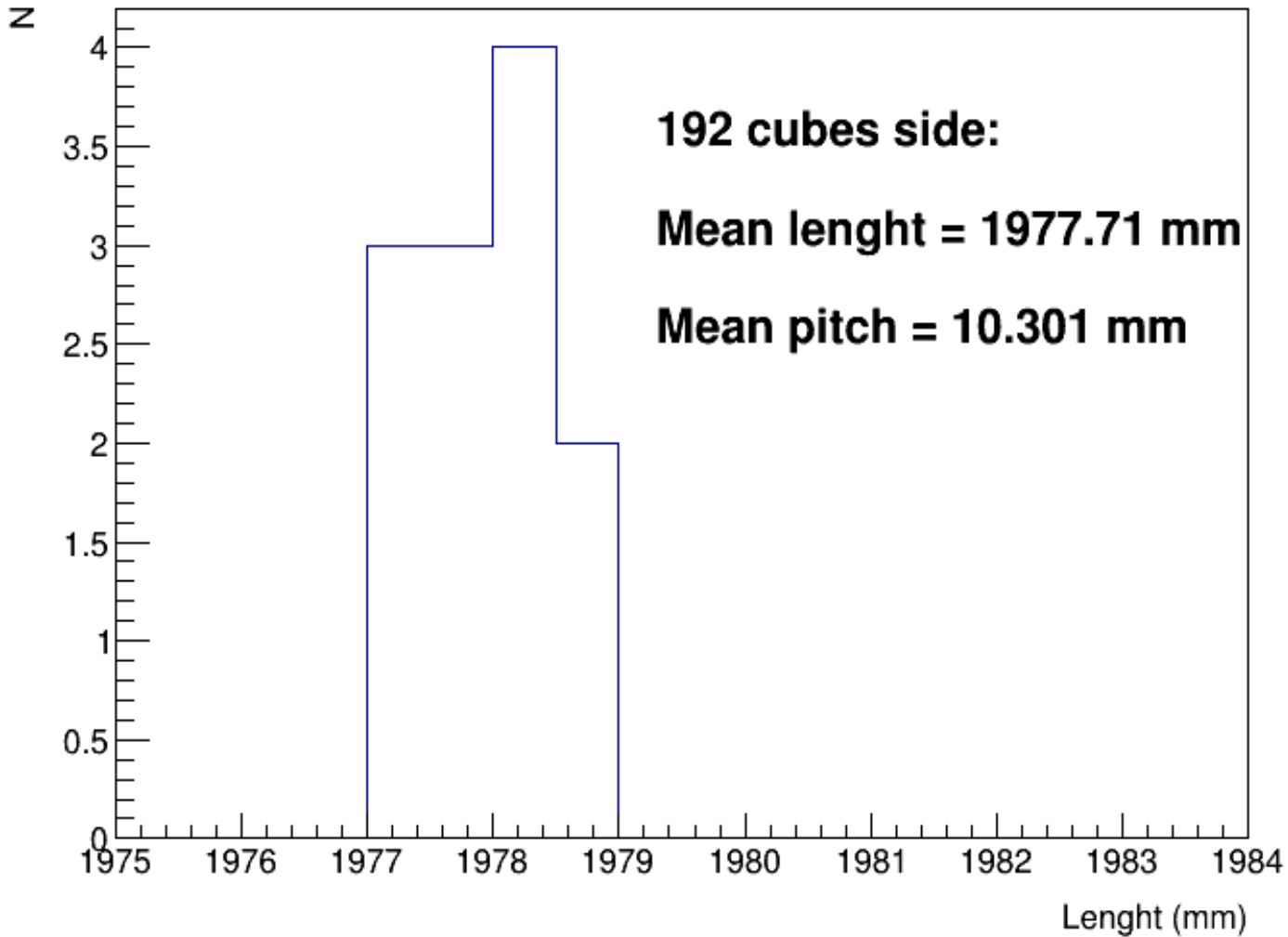
Measurement of size of 184x192 cubes plane

The plane of the cubes was pushed into the corner made of two steel linear scalers. The moderate force was applied only to form the rectangular shape of the plane.
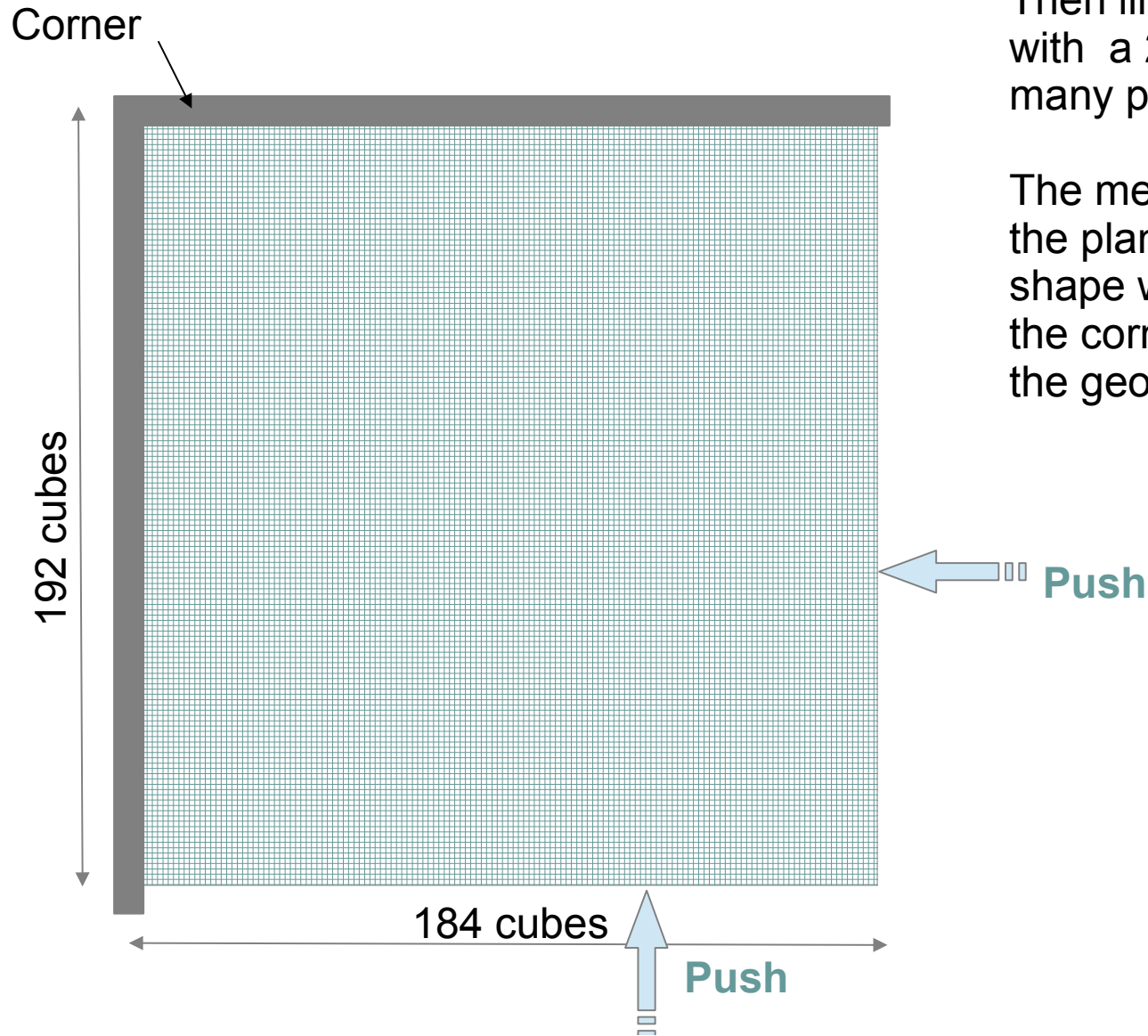
Then linear size was measured with a 2-m long linear scaler in many points along the array.

The measurements proove that the plane keeps rectangular shape with accuracy 1.5 mm, i.e. the corner is effective to provide the geometry of a cube plane.
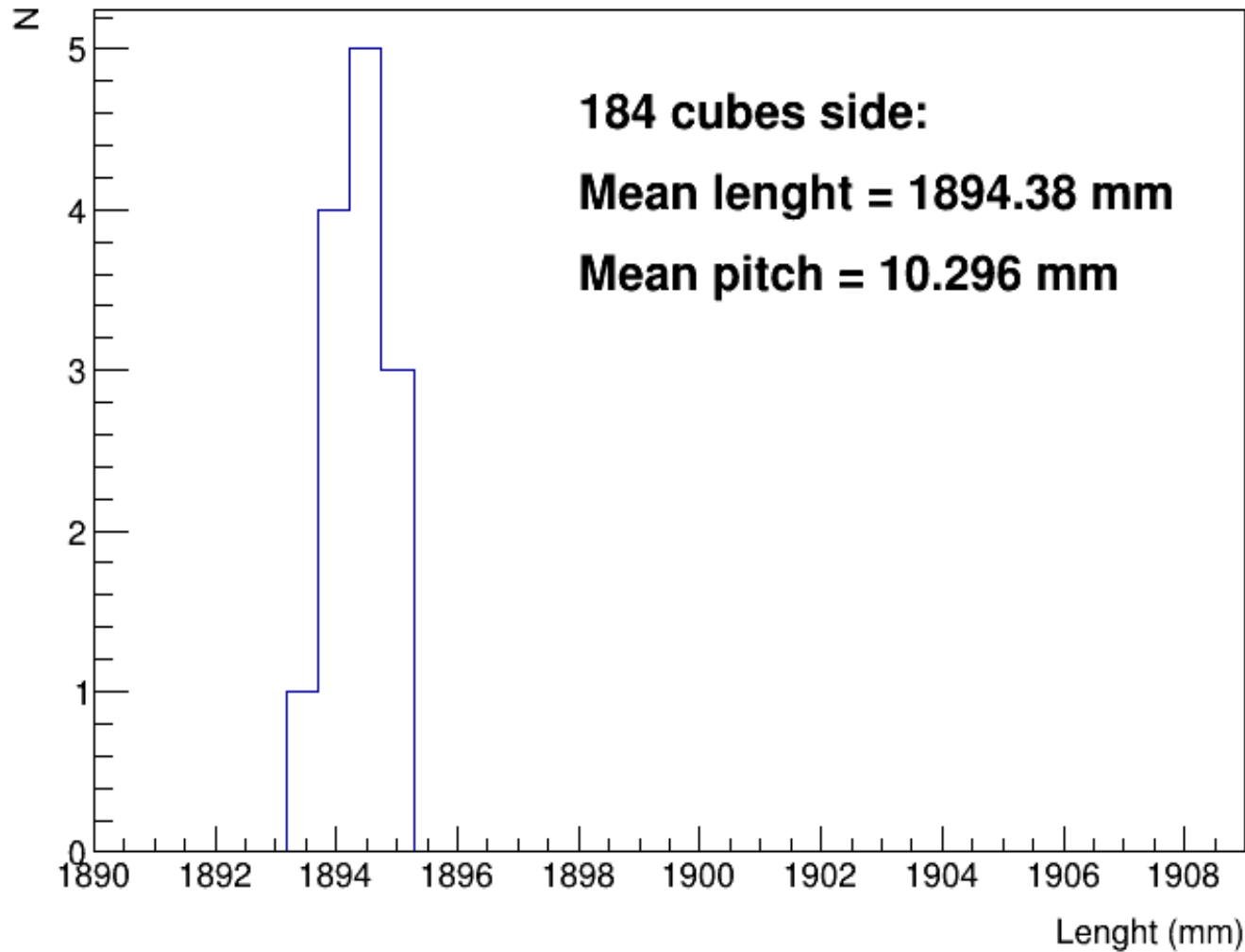
Corner

192 cubes

184 cubes

Push

Push

4

The length of of 192 cube long side

192 cubes side:

Mean lenght = 1977.71 mm

Mean pitch = 10.301 mm

Measurement error is 0.5 mm.

The total average pitch is
10.301 mm.

The length of of 184 cube long side

184 cubes side:

Mean lenght = 1894.38 mm

Mean pitch = 10.296 mm

Measurement error is 0.5 mm.

The total average pitch is
10.296 mm.

The length of of 192 cube long side after manual compression

192 cubes side:
Mean lenght = 1976.67 mm
Mean pitch = 10.295 mm
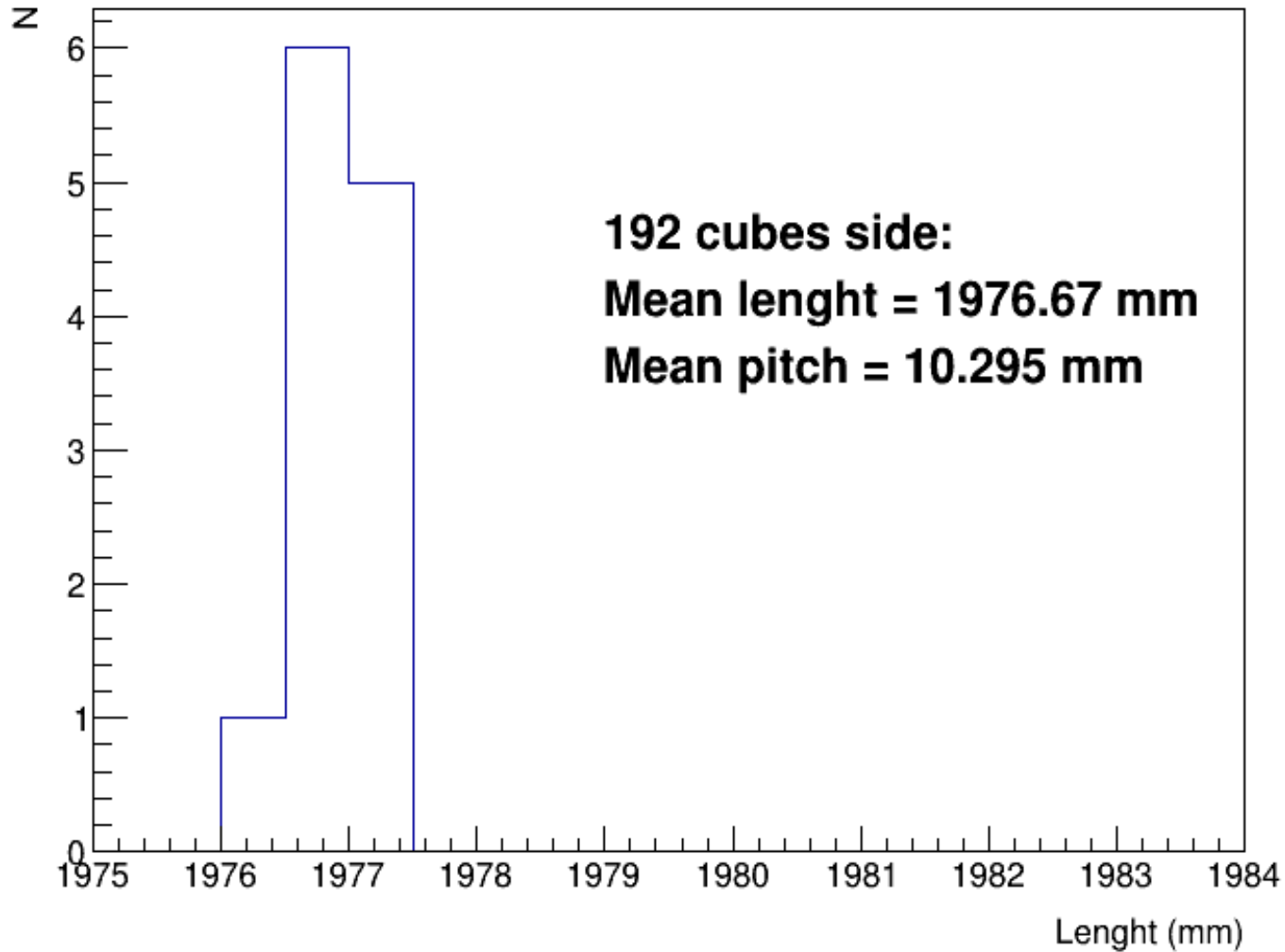
Two persons have pushed by hands one side of the array using a 2-m long bar.

The total average pitch becomes **10.295 mm.**

We can compress linear size of the plane by 1 mm using pure human strength.

SUMMARY

We propose to have the following values for the pitches:

Horizontal direction – 10.301 mm

We do not need to provide the pitch accuracy of 1 μm.
We need to build the total length of detector array with accuracy of better than 0.5 mm using 10.301 mm value of the pitch as the parameter for calculation of total size.
We can compress the total size of the planes within range of 1 mm but this puts additional tension on the fishing lines.

Vertical direction   –   10.28 mm in average

The total height is reduced with time but the effect is rather small.
In vertical direction the pitch between holes must be variable to conform two factors:
- 10.30 mm pitch between 8 MPPCs within an MPPC board;
- 10.28 mm average pitch value for a column of 56 cubes.