New possibilities of Straw Tubes for DUNE STT Detector

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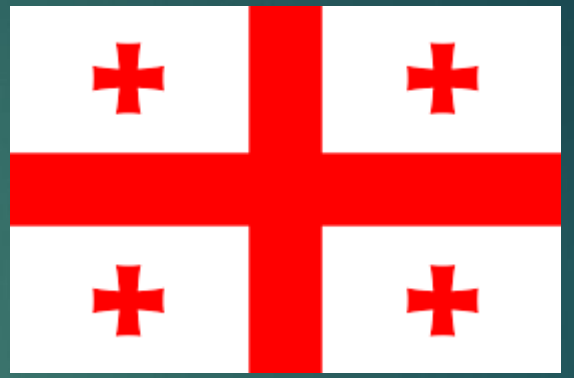
Outline

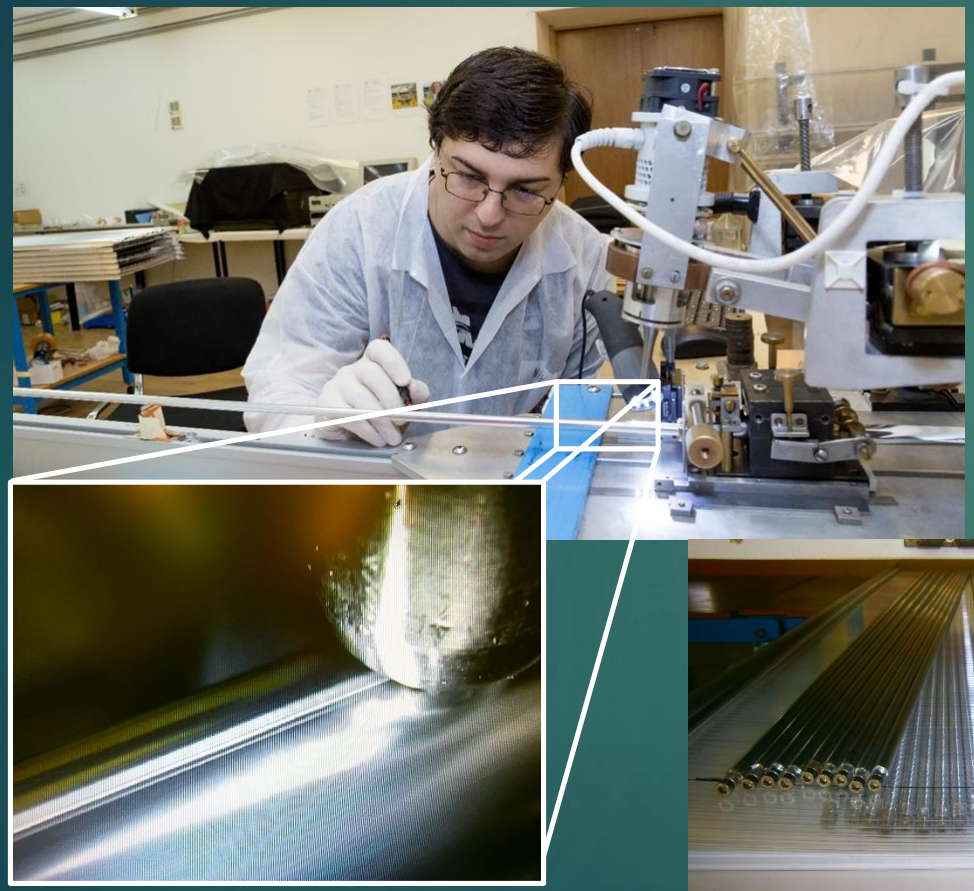
- About plans of the Georgian Technical University activity in DUNE near detector system
- Working experience
- R&D of new design 12 mic straw tubes and ultrasonic welding technology
- Testing and results
- New tapes for 5mm straw tubes
- Examination the quality of seam at CERN
- Future plans

Georgian technical university



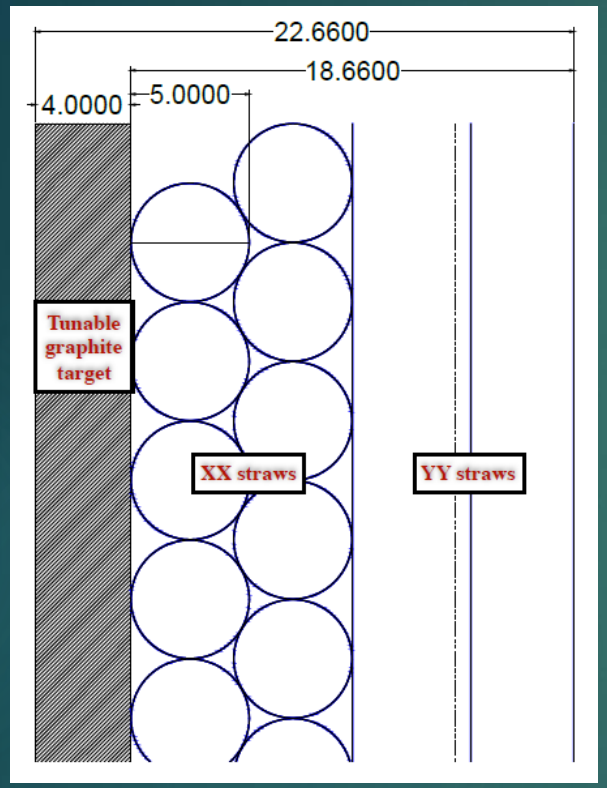
One of the oldest and biggest state universities in Georgia, hosting 15 Scientific-Research Institutes, taking part in world-wide scientific collaborations like CERN (CMS, ATLAS) and in KEK, J-PARC (COMET experiment)

Working experience



- GTU group has 5 year working experience of straw R&D with international institutes like KEK, JINR,CERN
- Started with NA62 JINR-Group collaboration
- Main activity in R&D and production of new thin wall straw tubes for phase-1and R&D of 5 mm diameter for Phase-2
- Testing and measuring properties of straws

DUNE near detector complex

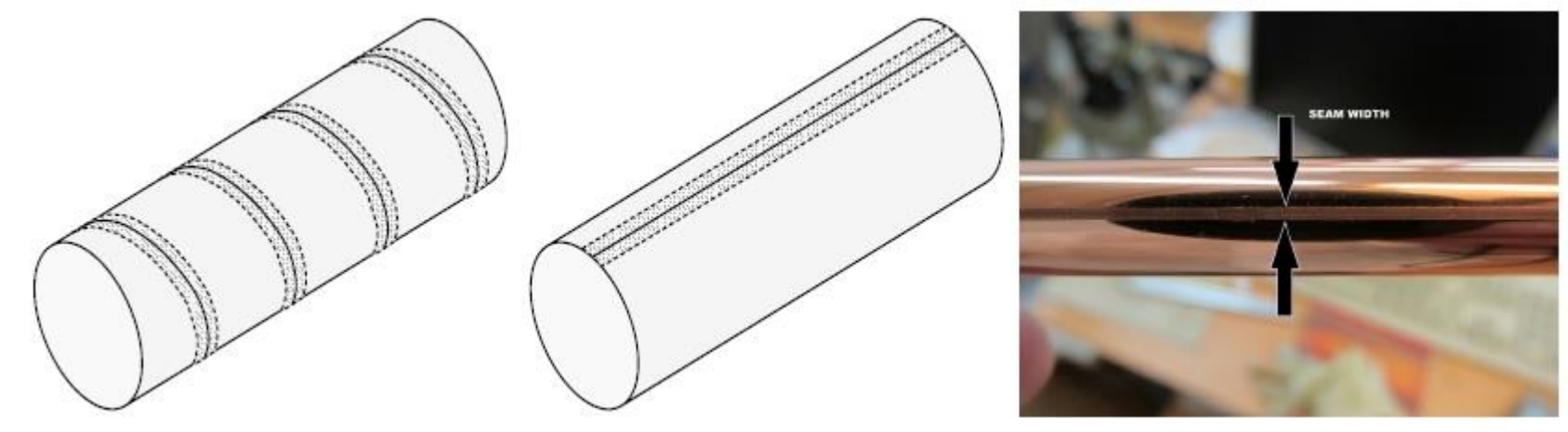


Drawing of one compact STT module equipped with graphite (pure C) target

- The key detector element is a central Straw Tube Tracker (STT)
- The main parameters of the proposed STT are:
  - magnetic field B = 0:6 T
  - average density 0:17 g/cm3,
  - straw tube traditional winding technologies or made singl ultrasonic welding technologies
  - A conservative requirement on the single hit spatial resolution < 200 μm

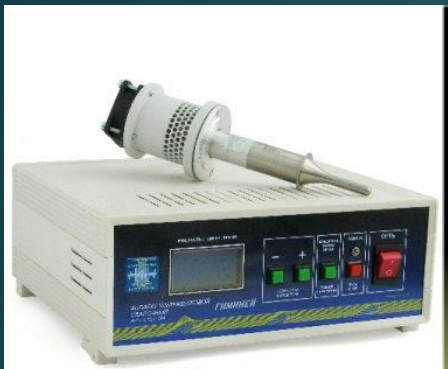
- COMET Straw tracker prototype
- X & Y coordinates measurements
- Contains 32 straw tubes channels
- Spatial resolution < 150 μm
- Momentum resolution σp< 200 keV/c

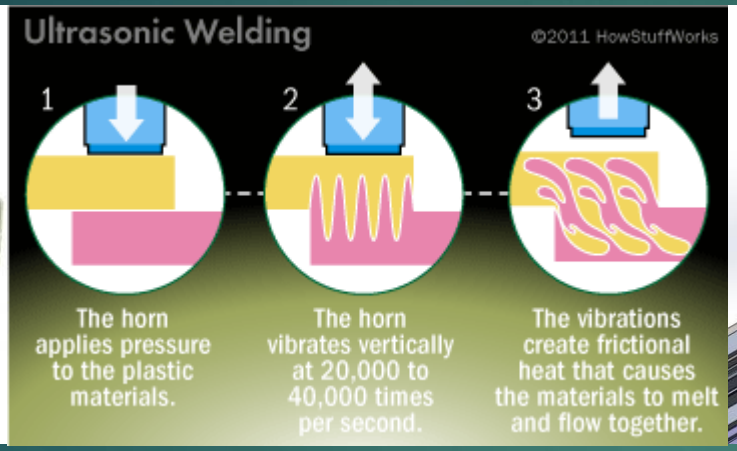
New straw tubes design

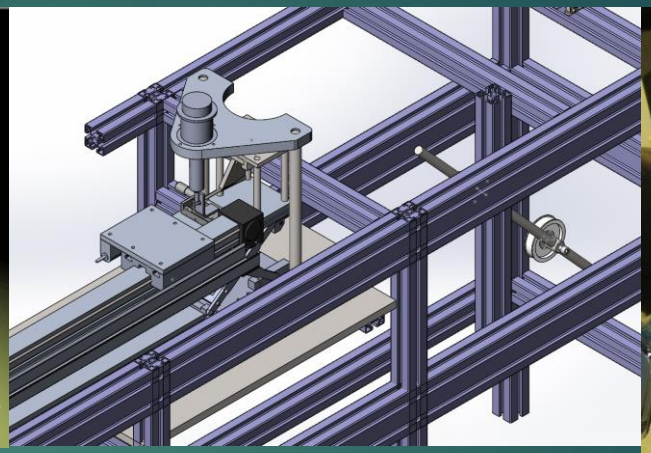


- Traditional two tape double winded glued straw tube
- Single-layer straw from a single tape, made by ultrasonic welding technology
- Advantage: low mass and ability to work in vacuum
- Ultrasonic welded straw tube evolution:
  36 μm thickness 9,8 mm diameter for NA62 experiment
  20 μm thickness 9.8 mm diameter for COMET Phase-1 experiment
  12 μm thickness 5 mm diameter for COMET Phase-2 experiment (challenge)

Development of ultrasonic technology

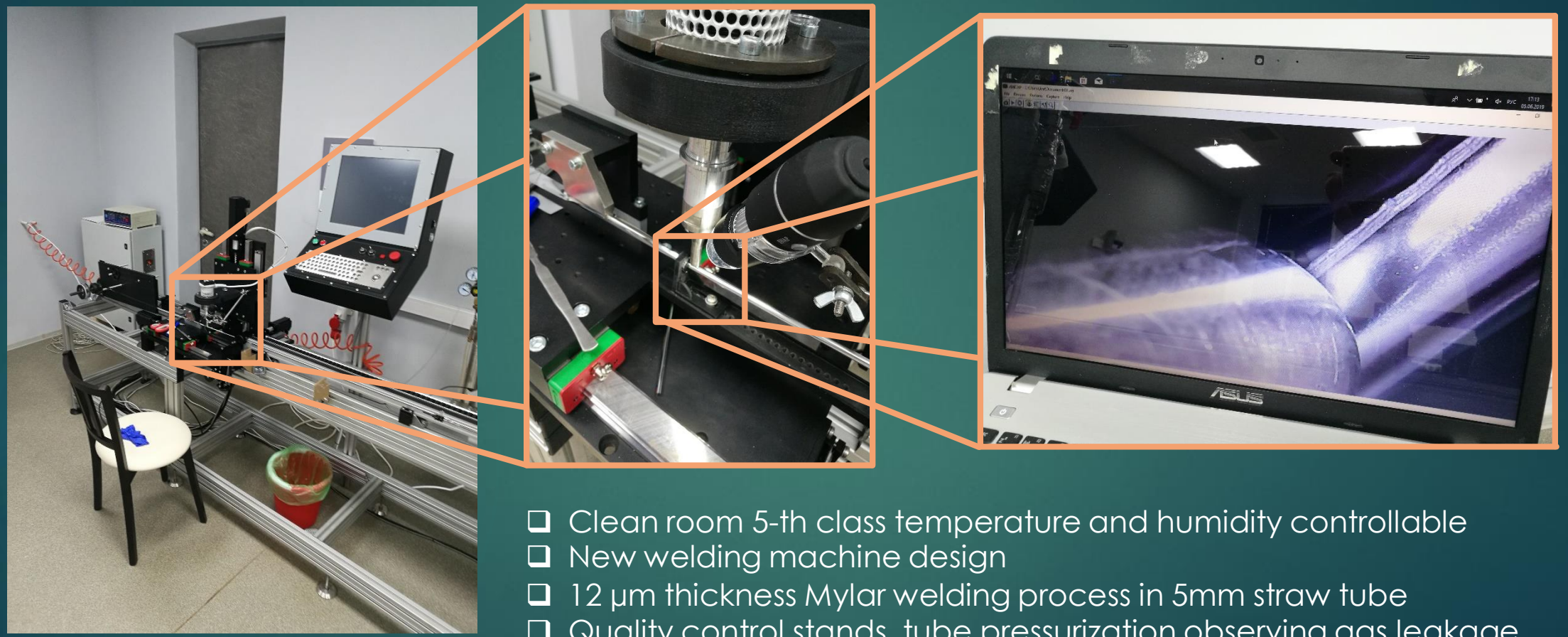






- 27 kHz Ultrasonic generator Giminey AVC-0,1/27-OMA with welding head
- Ultrasonic welding process, melting Mylar in local point and attaching edges of tape to each other forming cylindrical shape straw tube
- Principal welding machine design
- Welding machine in development process

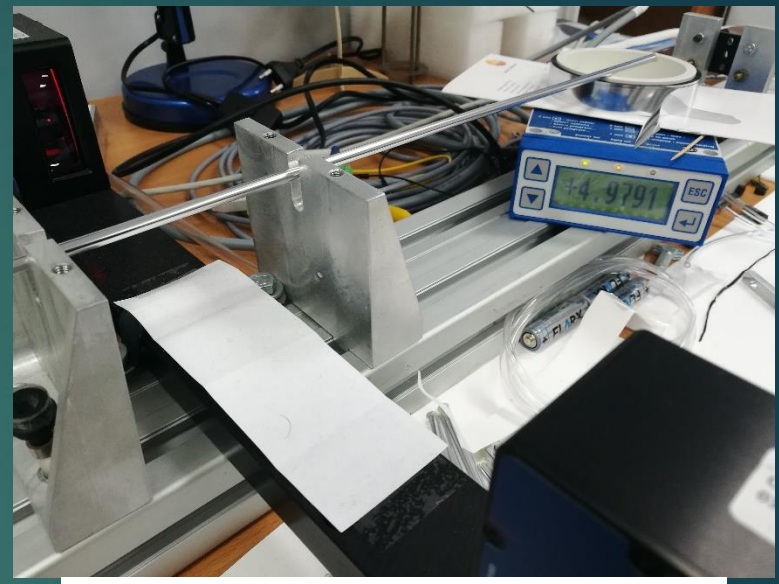
For producing and R&D of 12 μm straw tube the new machine were design and build at JINR with the Georgian group participation



- Clean room 5-th class temperature and humidity controllable
- New welding machine design
- 12 μm thickness Mylar welding process in 5mm straw tube
- Quality control stands, tube pressurization observing gas leakage

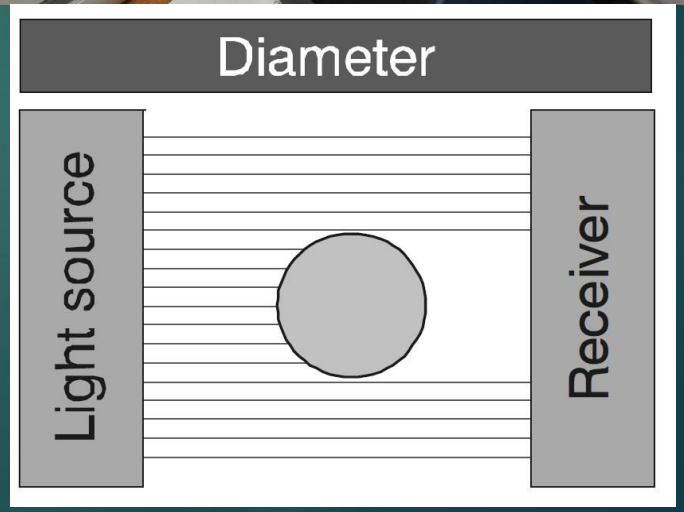
R&D of new 12 mic straw tubes and quality test results

Seam inner and outer structure in optical microscope

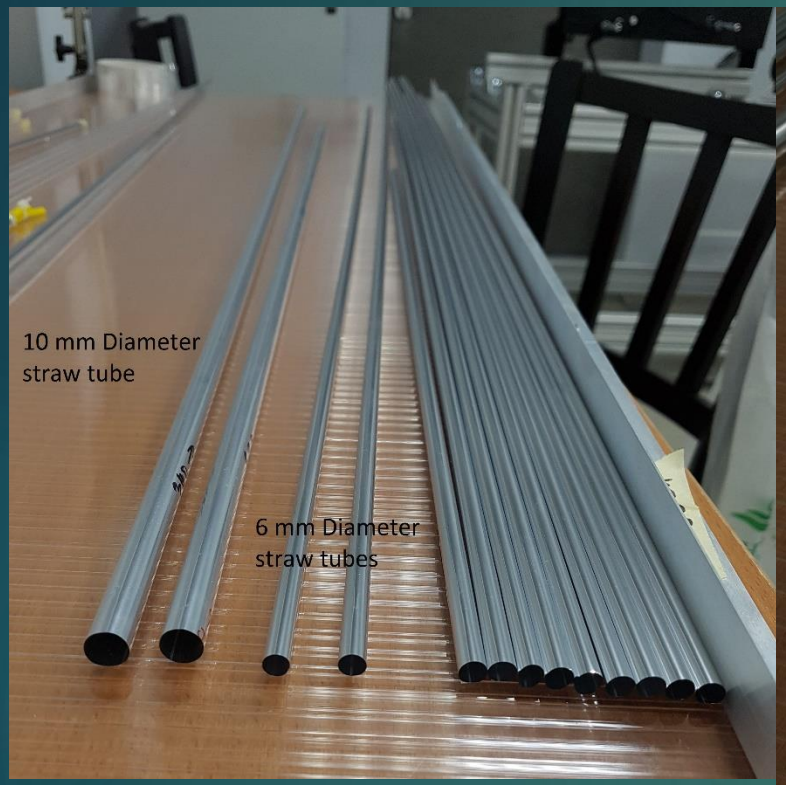


Quality check control

1 bar overpressure straw tube diameter measurement with 0.1 μm accuracy

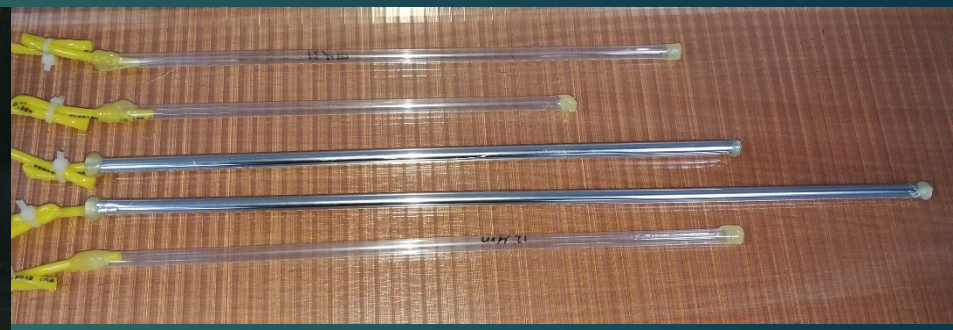


First in the world ultrathin 12 μm thick wall 5 mm diameter straw tubes



12 μm thickness straw tubes
6-10 mm diameter
length 1200 mm

12 μm and 4.8 mm
diameter straw tubes



3 bar absolute presurization

Samples prepared for
testing

R&D of new 12 μm straw tubes and quality test's results for Phase-1 and Phase-2

Straw tubes thickness	20 μm	12 μm
Diameter	9.8±0.04mm	4.8-6 mm
Length	1600 mm	50-1600 mm
Test pressure	2 bar absolute	2 bar absolute
Max. pressure	7±1.2 bar absolute	4+? bar absolute
Seam width	~500 μm	~ 350 μm ?
Production speed per/day	80 units	80 units
Requirement amount	2700	~?

Over pressurization test holding more then 4 bar

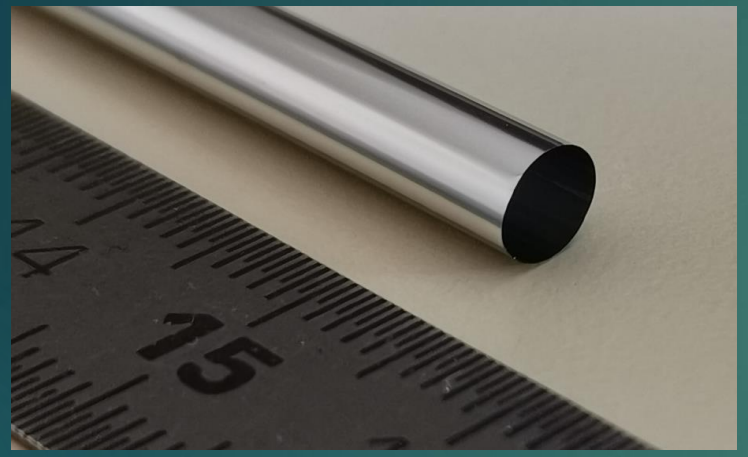
New tapes for 5mm straw tubes

- RNK Hostaphan Mitsubishi production
- 12 μm thickness Al 70 nm metallization
- Roll size : 430 m length, width 0.6 m

- Moscow production
- 12 μm thickness Al 70 nm metallization

- Currently looking for a company that can cut large RNK roll into strips for 5 mm straw pipes

Precise examination of seam welding quality of both thickness straw tubes at CERN laboratory of material research



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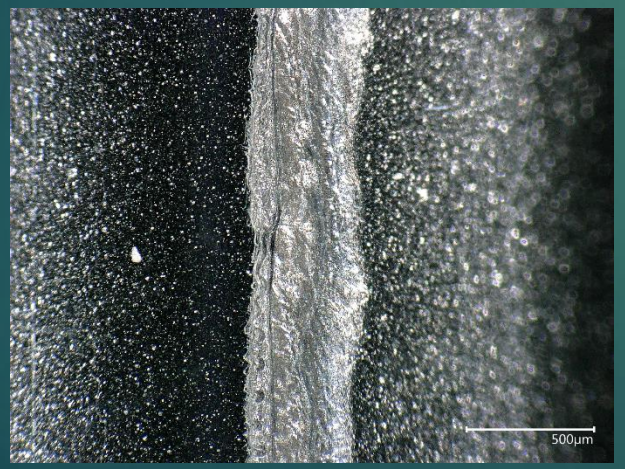

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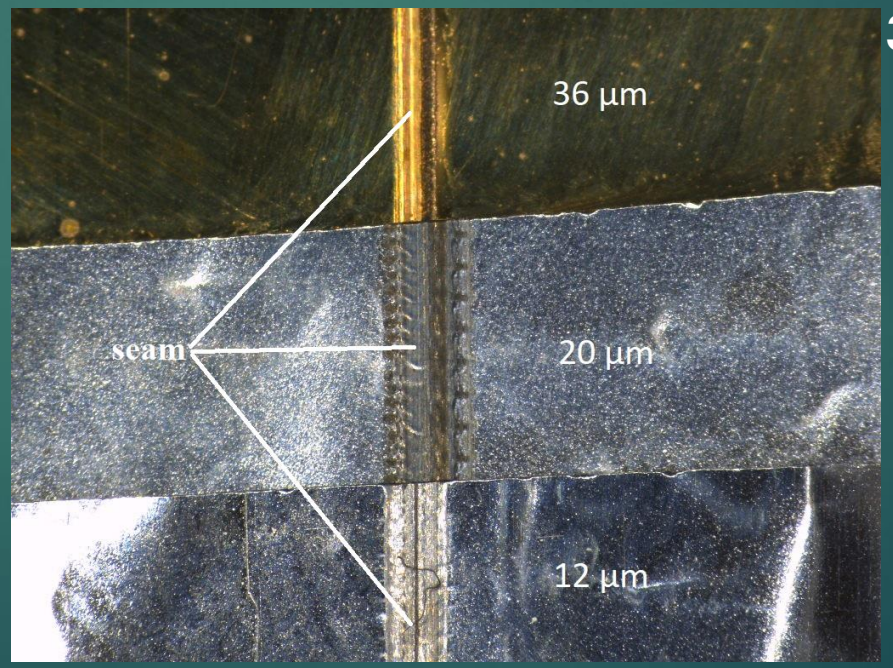
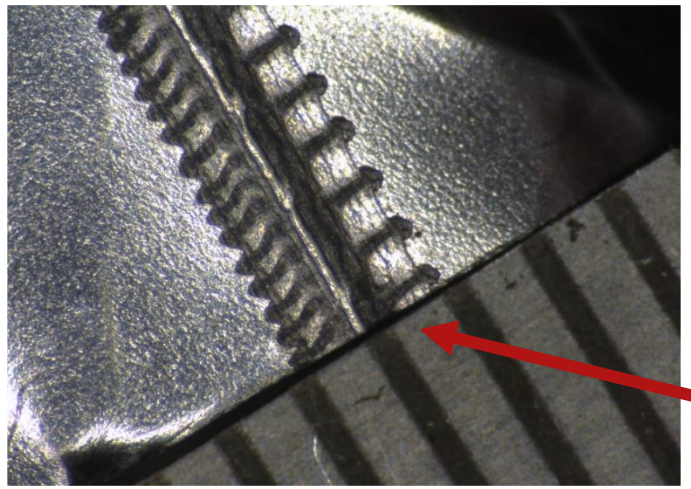


3.

1) 5 mm diameter 12 µm straw tube sample
2) Picture of seam
3) Comparison of Seam quality of NA62 COMET Phase-1&2 straw tubes used optical microscope
4) All samples were study by SEM-EDS methods

Tests and measurements

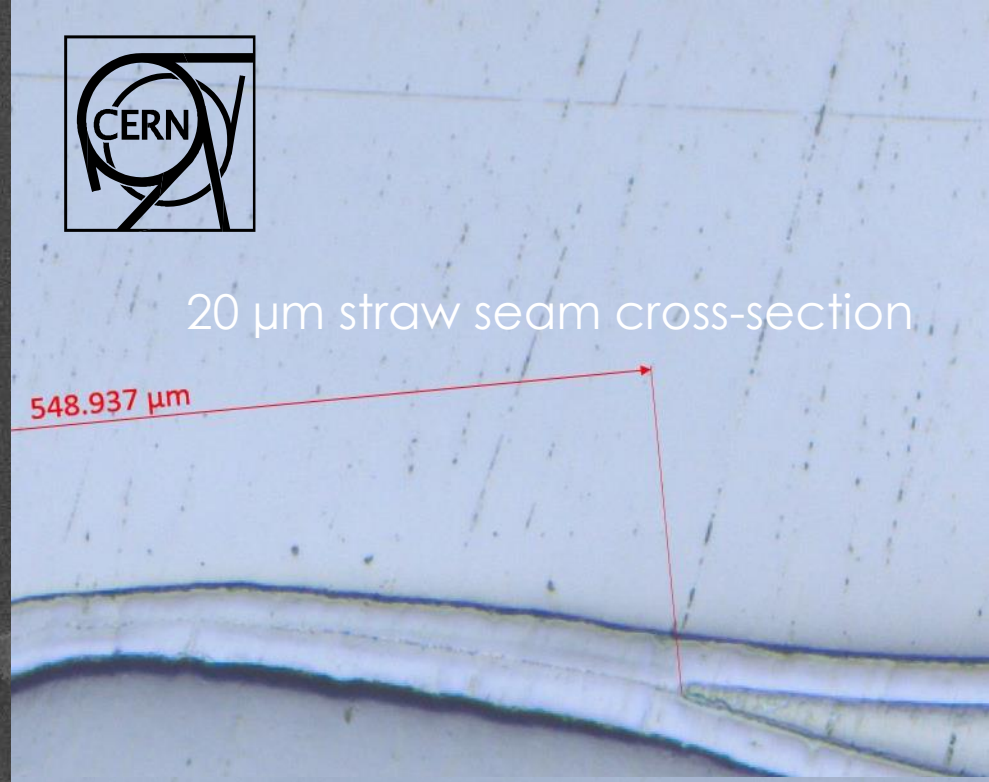


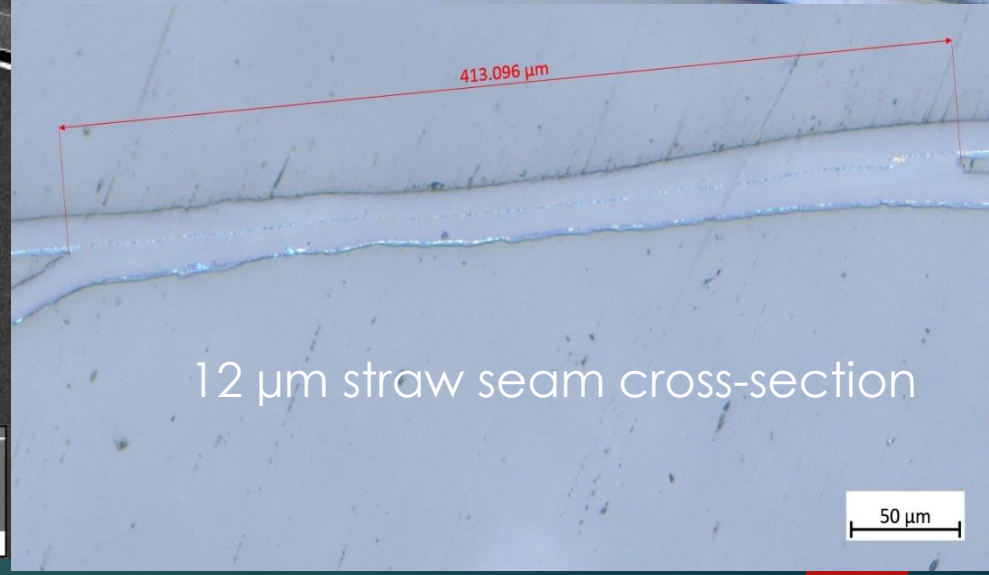
View of straw tube cross-section in digital microscope seam area are zoomed

Straw cylinder shape and attached with ultrasonic welding Mylar to each other

20 µm straw seam cross-section

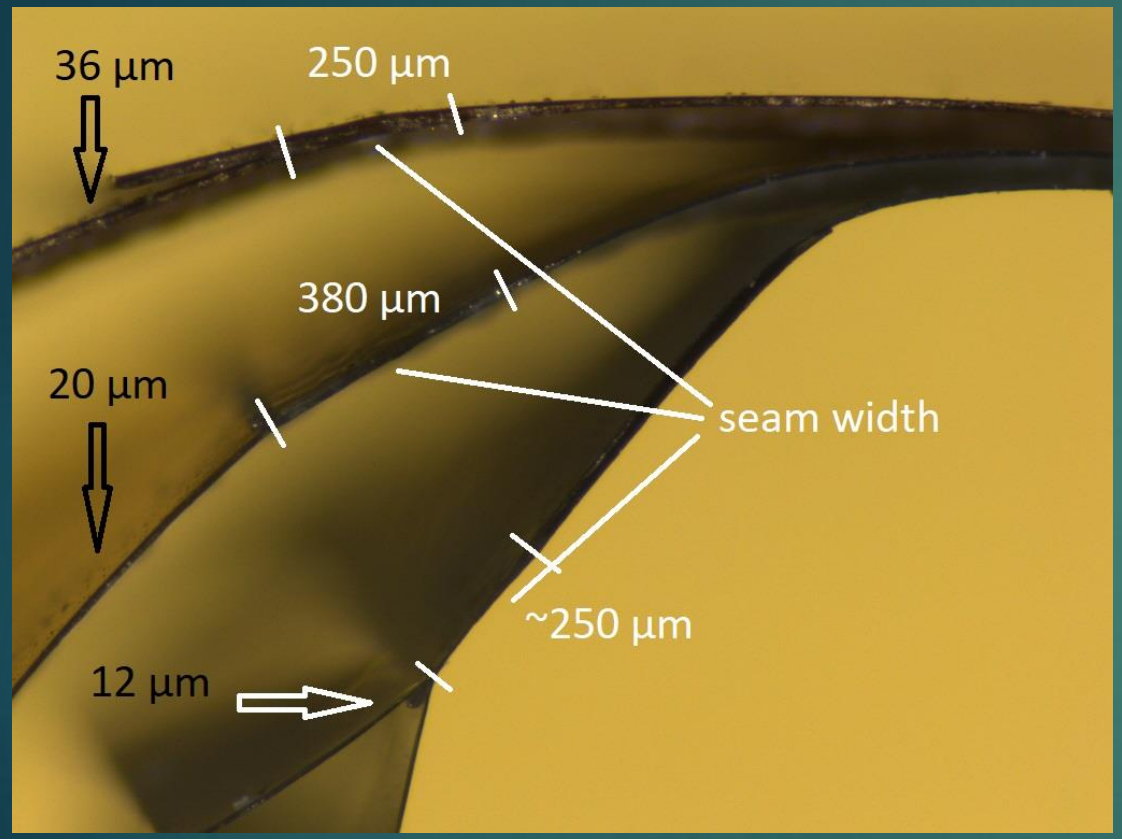
20 µm straw seam cross-section





12 µm straw seam cross-section

R&D of new 12 mic straw tubes and quality test results



Straw wall thickness	Weld bead width	Weld bead thickness	PET film thickness
12 micrometres	375.8 ± 26.5	24.3 ± 3.4	12.8 ± 0.2
20 micrometres	532.9 ± 23.8	42.3 ± 7.1	23.2 ± 0.8

Conclusion and discussion of the CERN study

Both optical and electronic microscopic examination showed that welds are free from imperfection. The welding process seems homogeneous since no major deviation has be detected among the samples.

Future plans

- More R&D for new straw tubes (trying new tapes for improving parameters)
- Development quality control tests and methods
- Produce 5 mm diameter, ~4 m length straw tubes
- Prepare new facility for mass production

Thank you for attention