NA 62 – straw detector

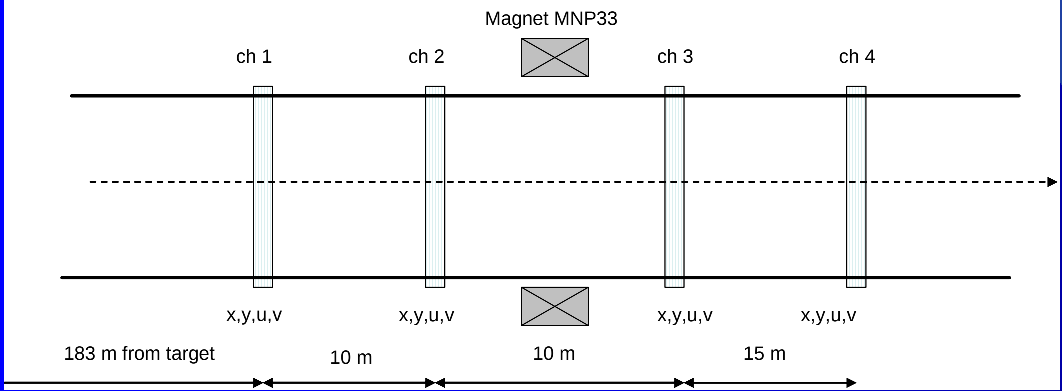
For the straw working group

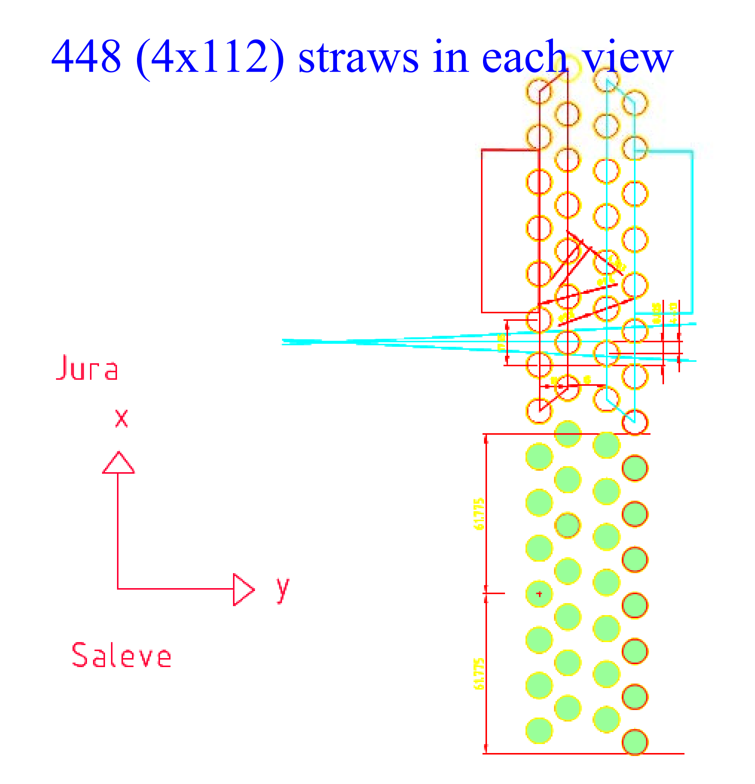
- Specifications
- Chamber design
- FEM calculations
- Prototyping
- Straw straightness
- Tooling
- Plans

Straw tracker layout

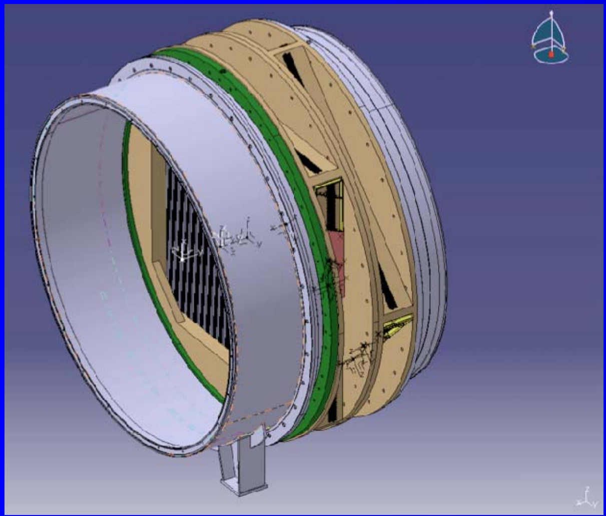
- 448x16 = 7168 straws
- Operate in vacuum 2.1m long D_i =9.8mm
- Precise tracking (<120 μm)
- Straw rate: up to 0.5 MHz
- Non-flammable gas mixture
  - CO_2 (80%)+ CF_4 (16%) + Isobutene (6%) (Test beam 2008)
- For more parameters see files in EDMS:
  - https://edms.cern.ch/document/837445/1
  - https://edms.cern.ch/document/908415/1

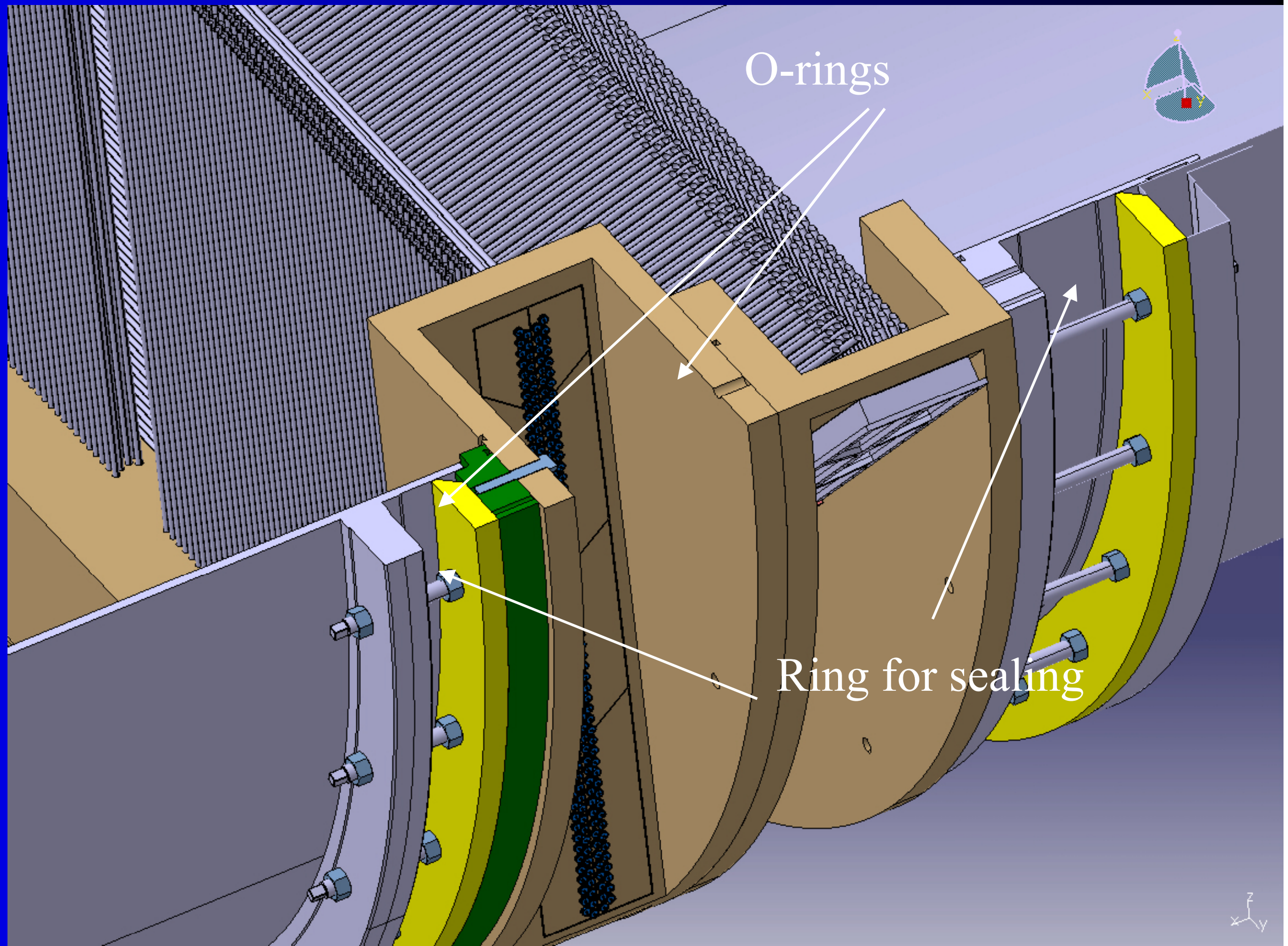
4 chambers
4 views in each chamber
448 (4x112) straws in each view



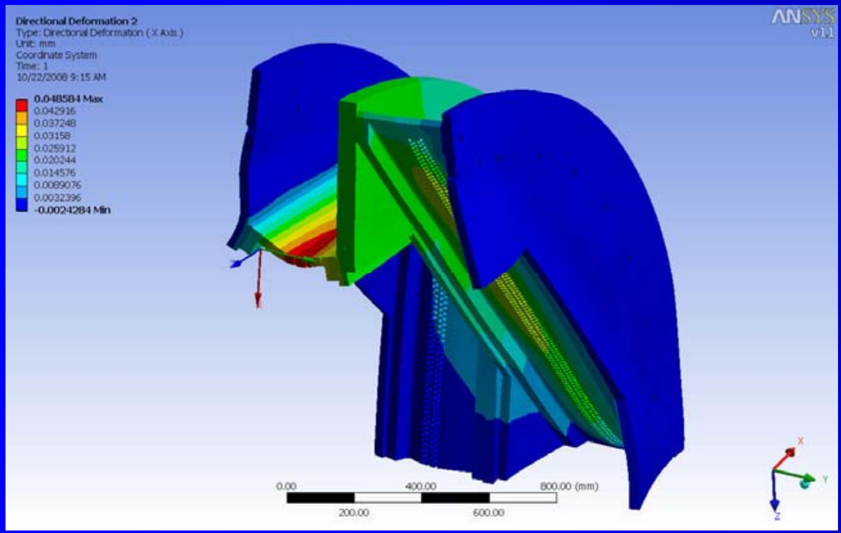


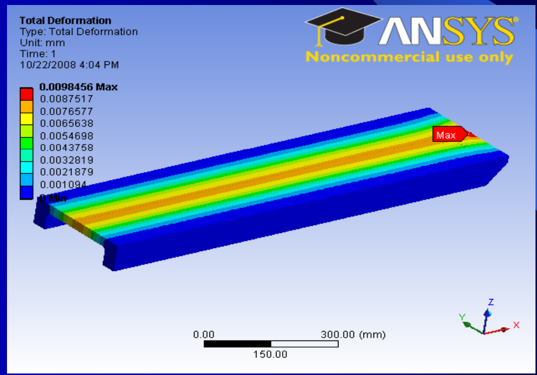
Chamber design

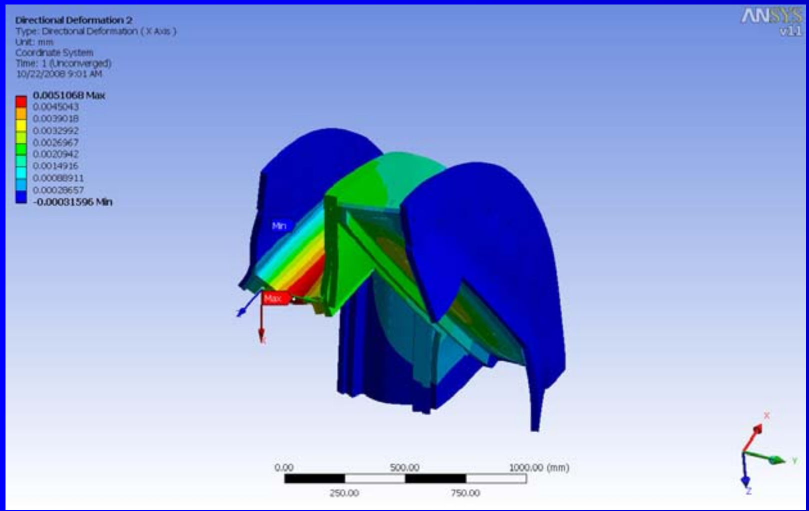


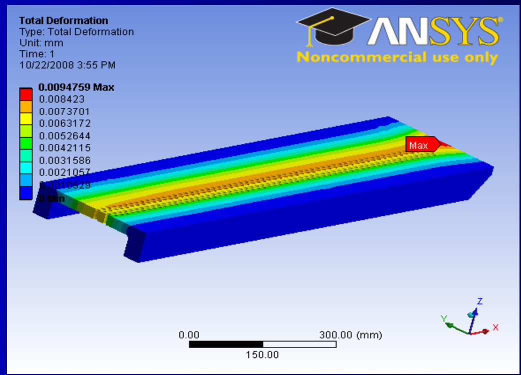


FEM calculations of the chamber





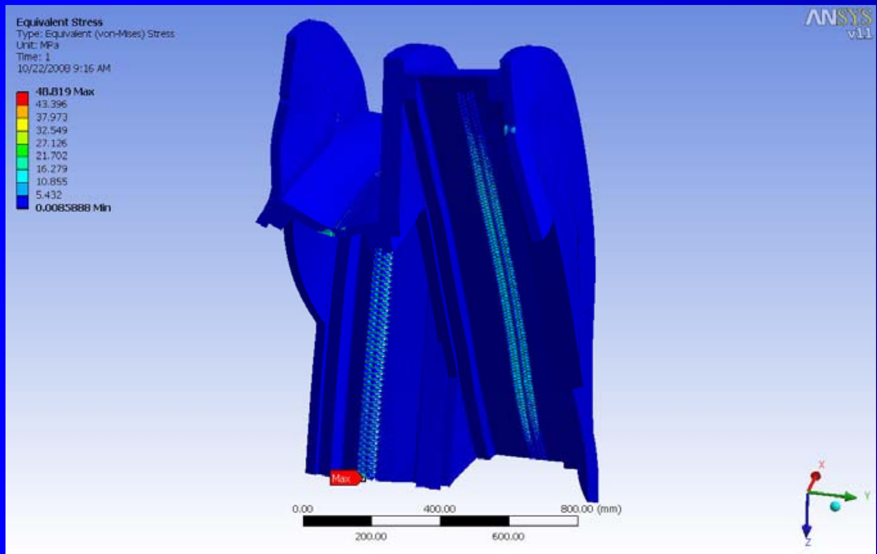




Hans Danielsson ,SPSC

FEM calculations of the chamber

Stress levels

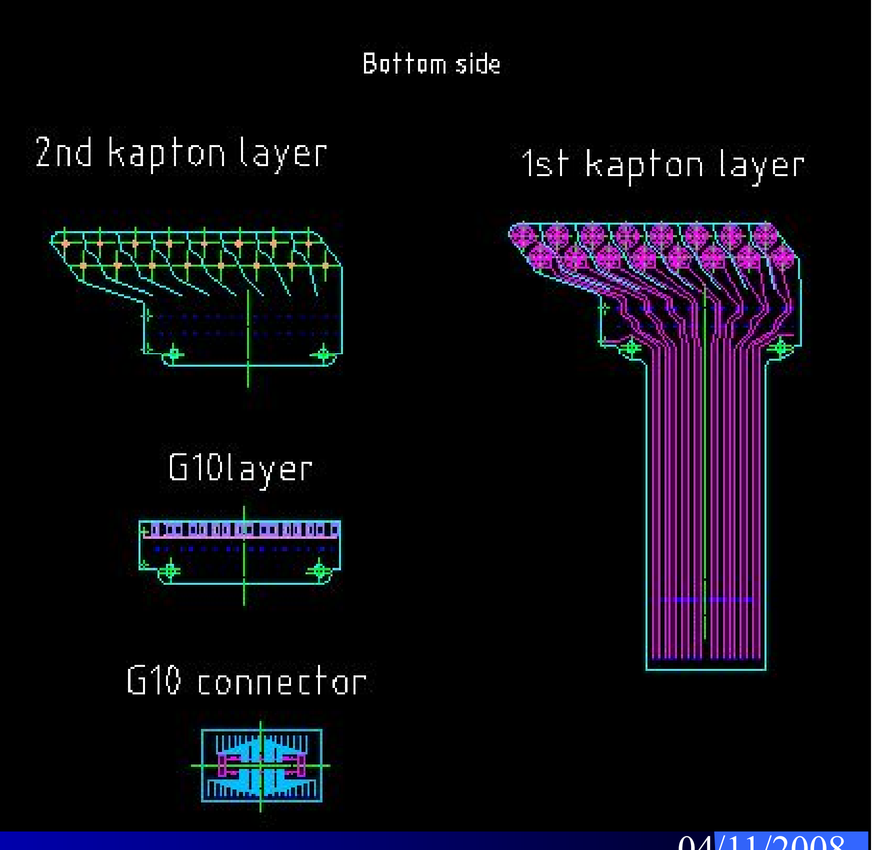


- The model contains all the loading details: Pressure difference, pretension, fixation points to the vacuum tube etc.
- We have a model to study global deformations and details e.g. stress concentration around the holes.
- We are working on a model to study the deformation of individual straws.
- 25 mm thickness looks ok
- Basis for price enquiry

Prototypes of the gas manifold, straw connectivity and web

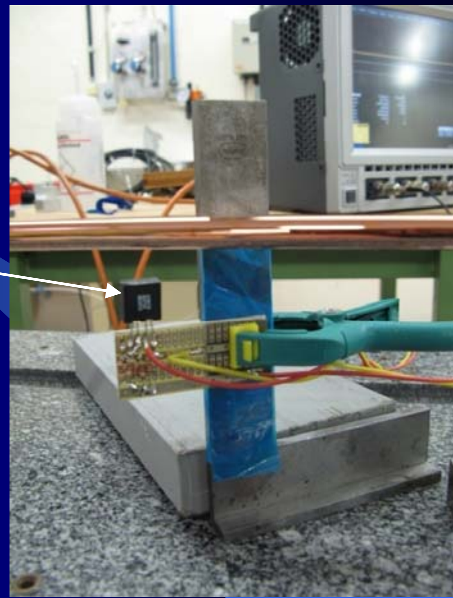
- Questions that will be addressed are:
- Type of glue
- Gluing procedure
- Tooling and access
- Leak tightness
- Electrical connection to the straws (web)

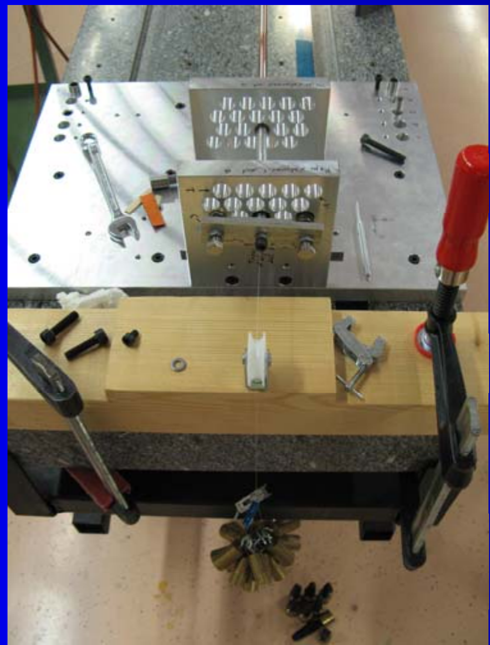
- The design of the web(16 channels) is finished and a prototype is launched in the. 4– 6 weeks for production



A set-up to measure the straw tension

This method was developed to study the straw straightness under tension and pressure
An IR light sensitive sensor gives a voltage proportional to the reflected IR light from the LED

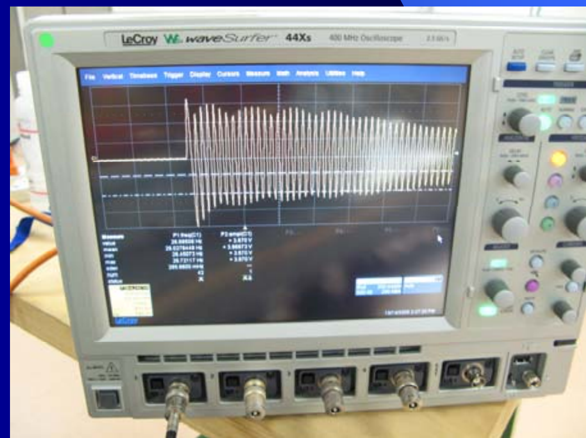




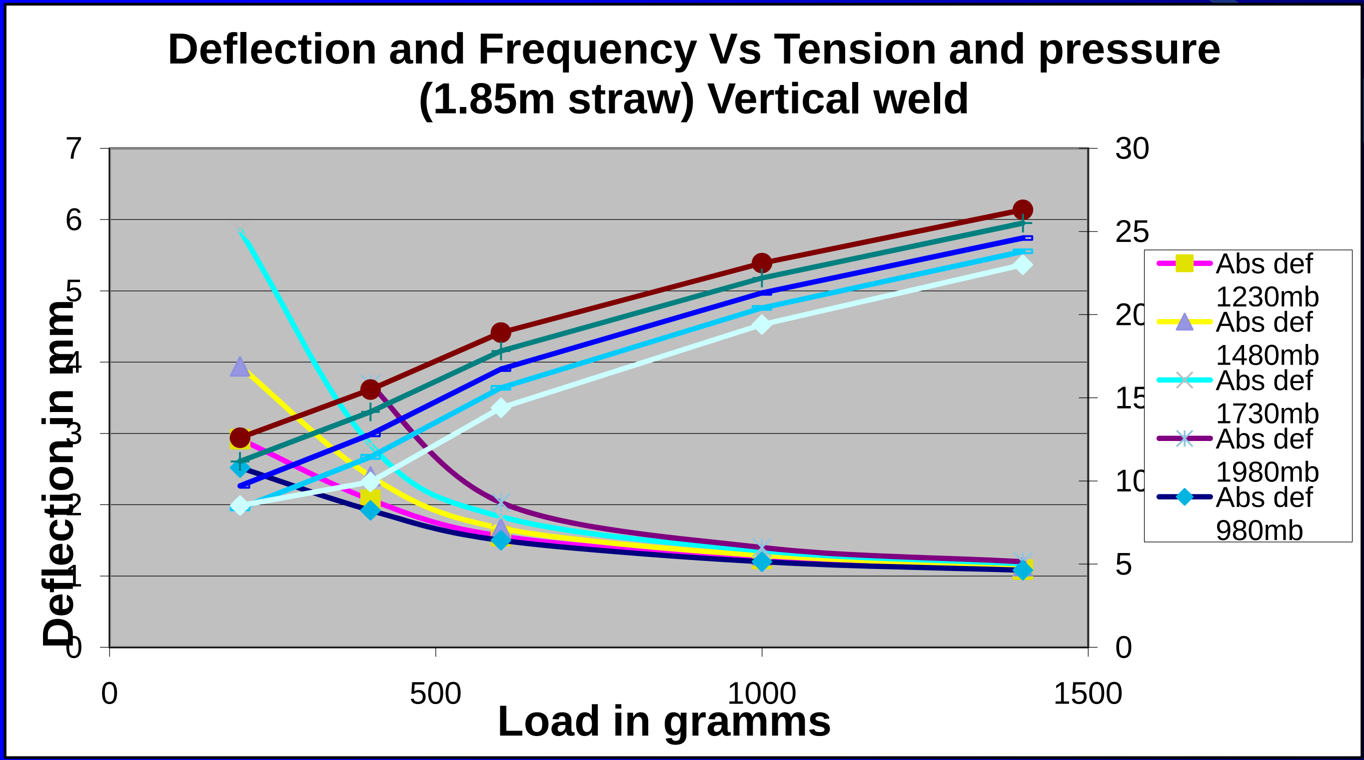
Tension $\propto w \times f^2$

where w is the weight per unit length and f the frequency

To be used in the QC of the chamber production



Deformation of the straw as a function of pressure for different pre-tension

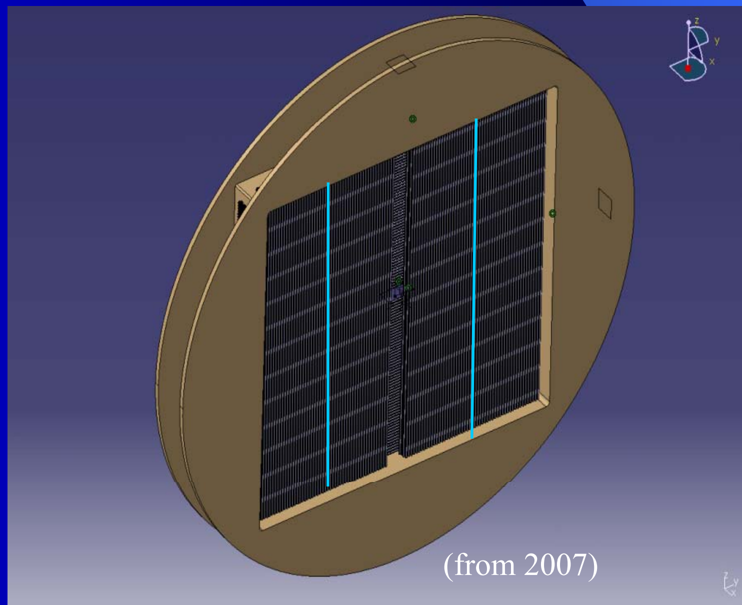


Negative Poisson's ratio! which results in a loss of tension when pressurized

$\varepsilon x = -\upsilon \times \varepsilon y$

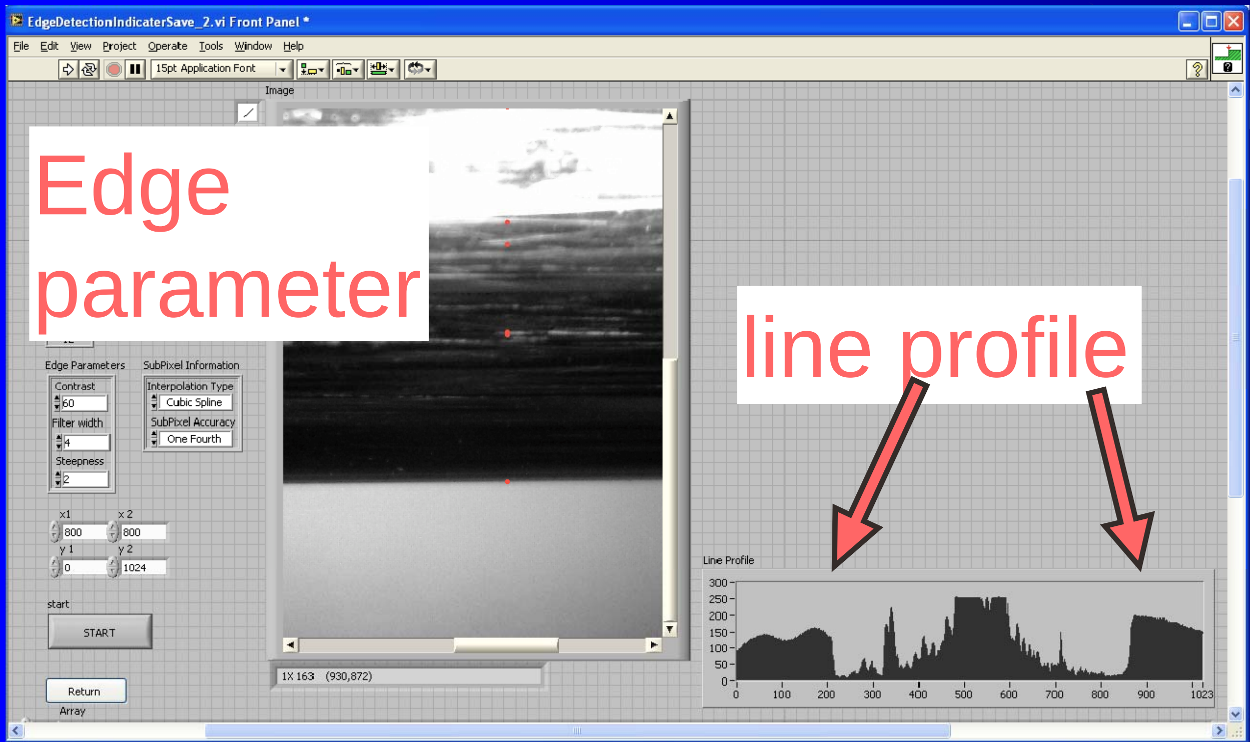
Results of the mechanical test

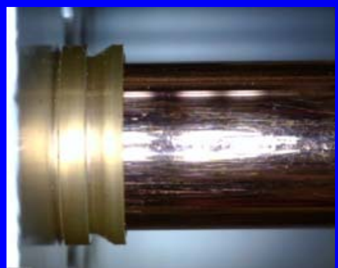
- Negative Poisson's ratio!
- The loss of tension with 1 bar is between 300g-400g
- 800 g of final straw pre-tension should be enough (with some safety)
- 1 kg is 1.2 mm deflection for a 1.85 m straw (≈ 1.75 mm for a 2.1m straw).
- We need 2 supports for the straws and possibly wire guides
- It is important to measure the tension after insertion
- We need experimental results of the long time mechanical behavior of the straws under realistic conditions


(from 2007)

Straw straightness with 50 µm precision

LabVIEW program panel of edge detection





To be used in the QC of the chamber production

Beam test 2008

- The goal was to compare two candidates for the FE chips and operate the chamber with the new non-flammable gas mixture
- Same straw prototype as in 2007 was equipped with two types of FE: CARIAOCA and ASDQ. Test boards were prepared in August at CERN, for these two chips
- The straw prototype was ready to take data as planned on the 2:nd of October. However, the beam was stopped on the 6:th of October.
- Nevertheless, we managed to take six points with muons (different HV and threshold):

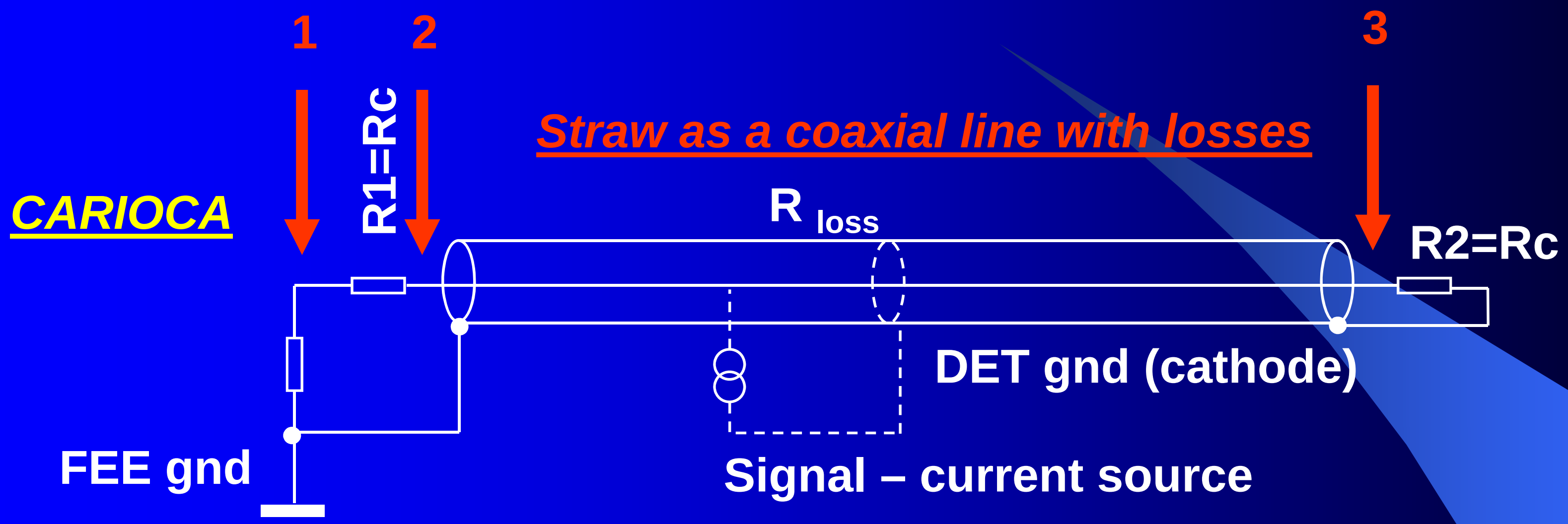
  HV (kV): 2.4 , 2.5 , 2.6 (at two different thresholds), 2.7
- The off-line analysis is going on.
- Since then, we have learned that:
  - Only a ***maximum*** of 900 chips (7200 channels) are available of the ASDQ chip (no spare!)

  ➔ CARIOCA is the baseline for our FE

Example of study on the FE

FEE sensitivity measurements in June

by injection known charge Q_{in} [fC] into various points



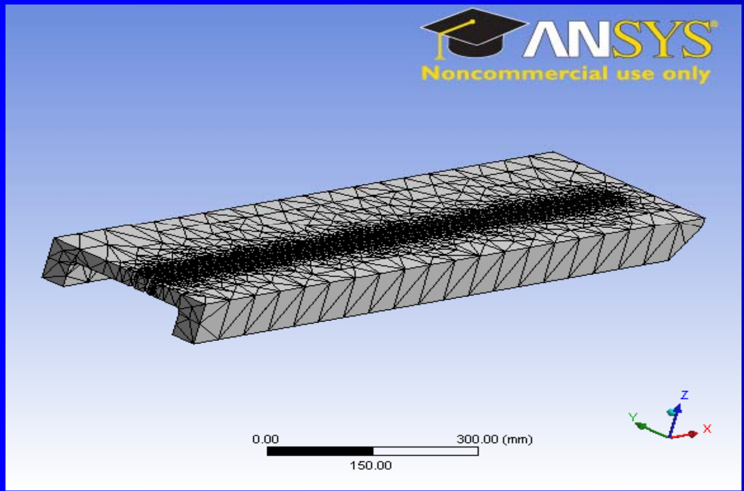
1 Sensitivity =16mV/fC (100%) - CARIOCA
2 Sensitivity = 8.3mV/fC (50%) – reduction due to current division
3 Sensitivity = 4.5mV/fC (~30%) – with termination on far-end (max R_{loss})
3 Sensitivity = 11.2mV/fC (70%) at open far-end

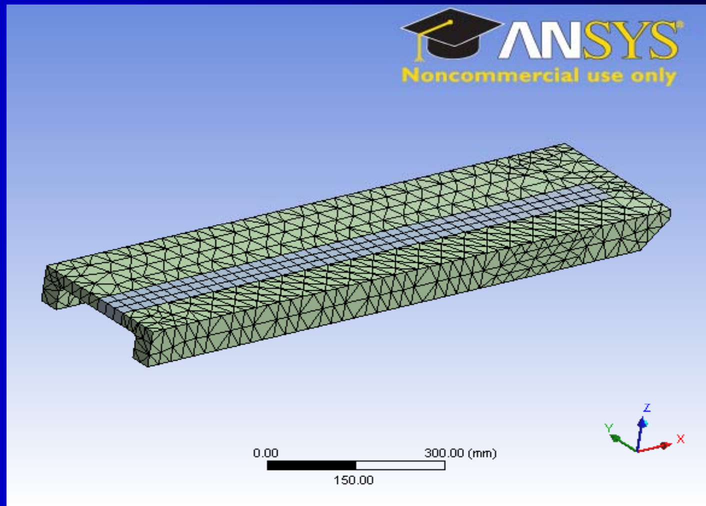
Future Plans

- Terminate the detailed study on the straw material and its mechanics
- Detailed FEM analysis of the structure and the straw
- Finalize layout of the mechanical structure
- Plan and build a new sector prototype:
  - Verify **mechanical support of the straws (and wire)** . Measure final straw deformation and wire off-set
  - New straw layout
  - New connectivity
  - Final electronics CARIOCA
- Build a full-scale engineering prototype
- Aging component validation

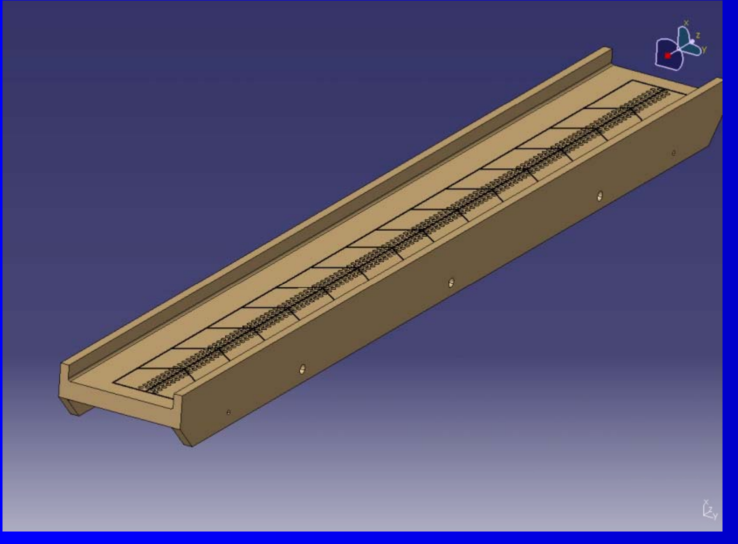
Spares

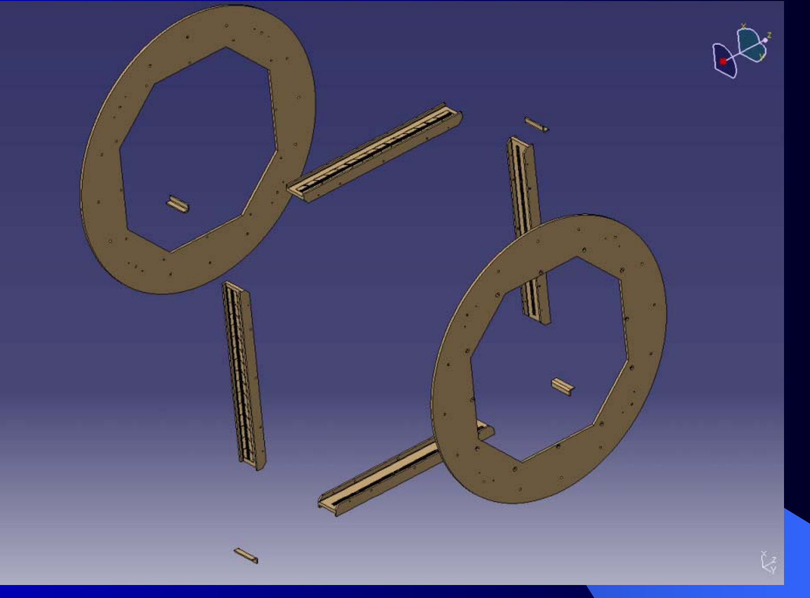
FEM calculations of the chamber

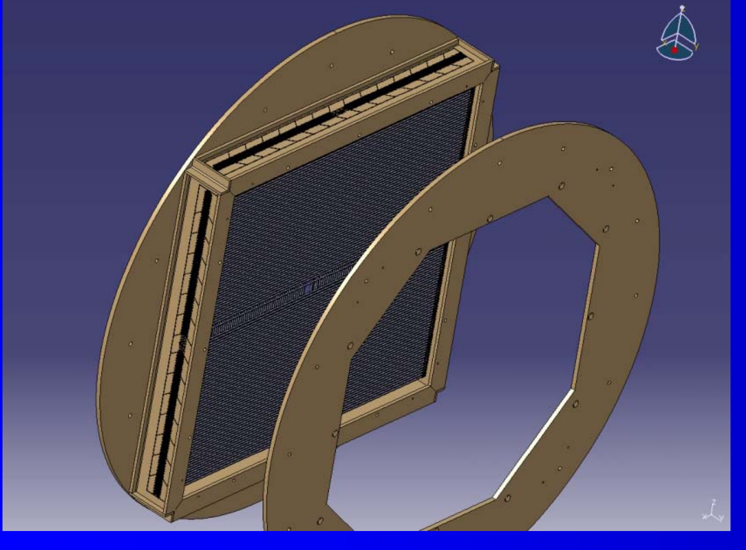


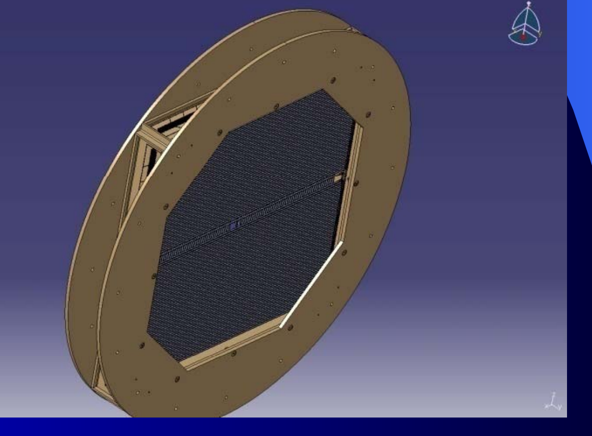


Chamber design (detail)



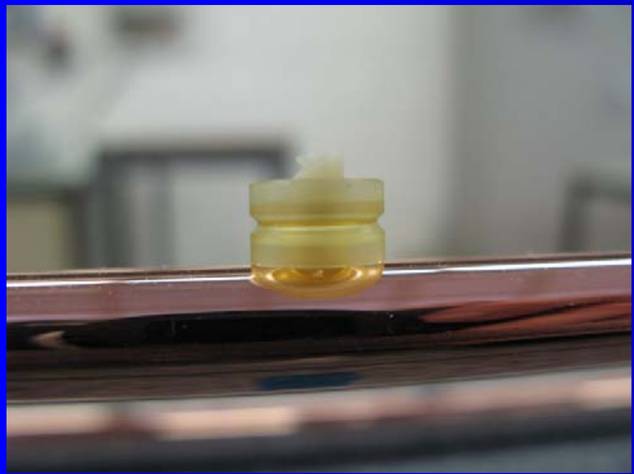


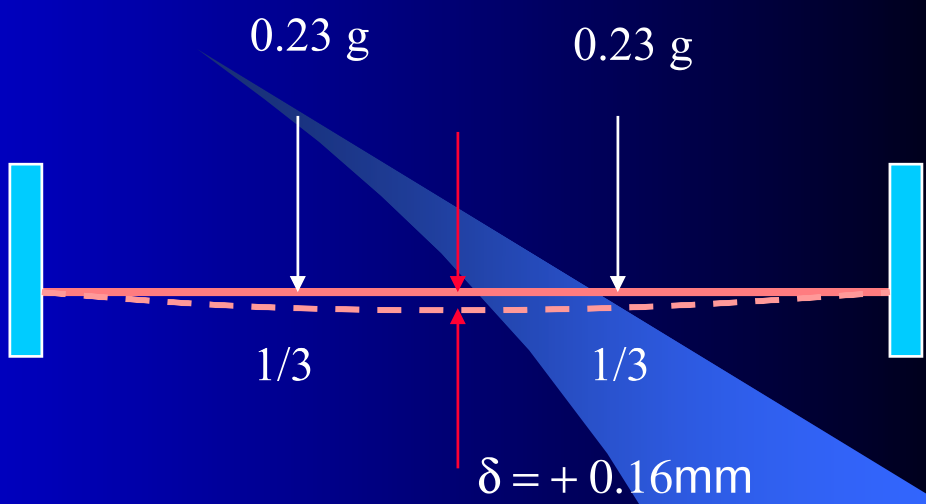


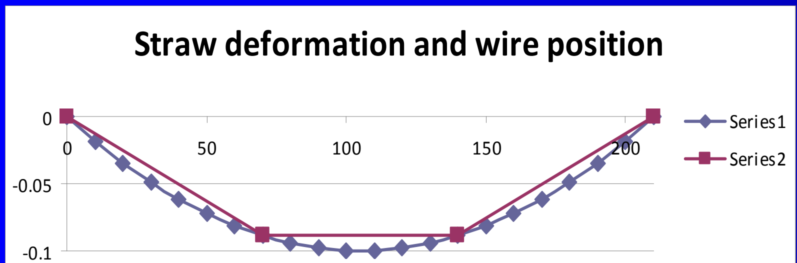


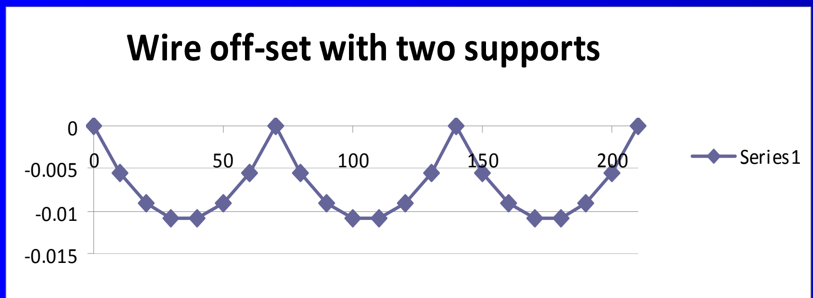
Two wire guides in the straw do limit wire off-set

- Yes, it is possible in terms of added wire sag



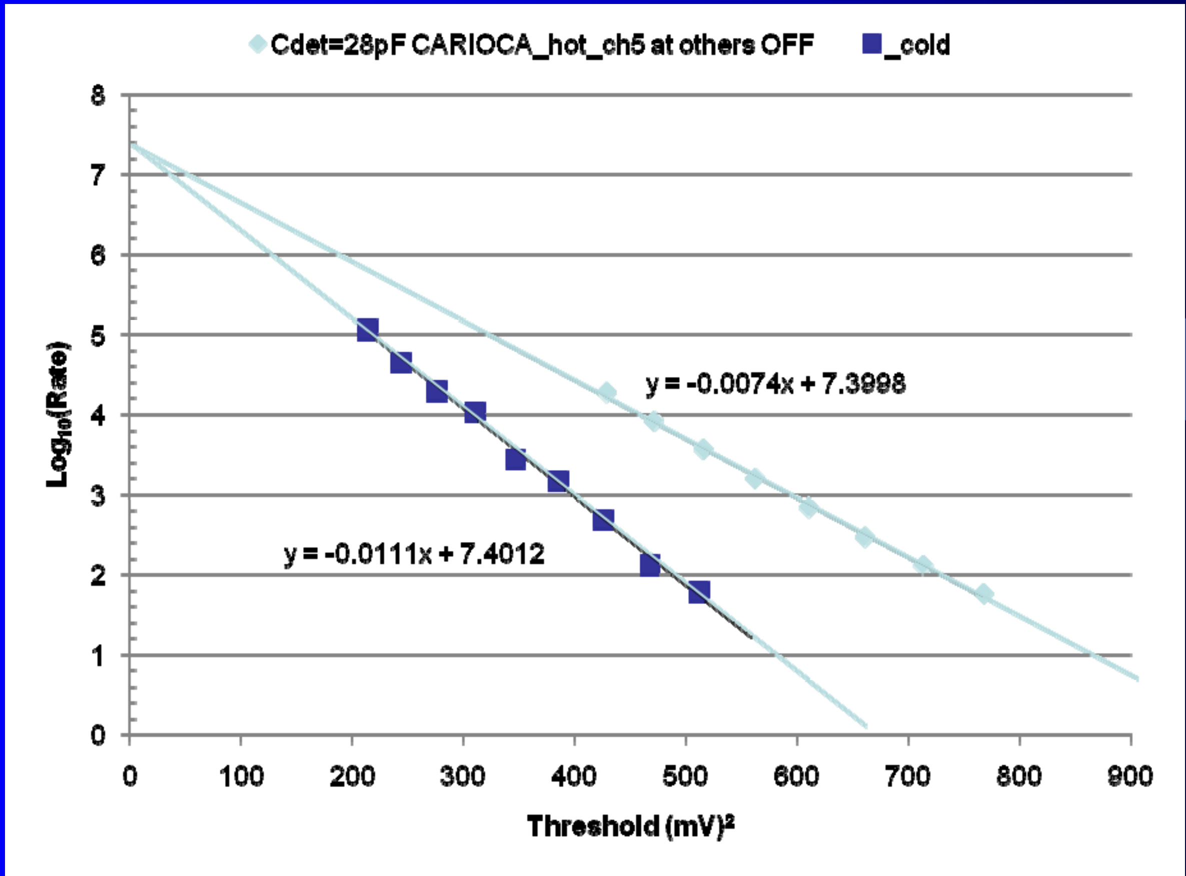






We have to see if this is necessary. It complicates the wire stringing , but reduces significantly the risk of wire-off -set in case of bent straws

Example of test of the CARIOCA chip in the lab

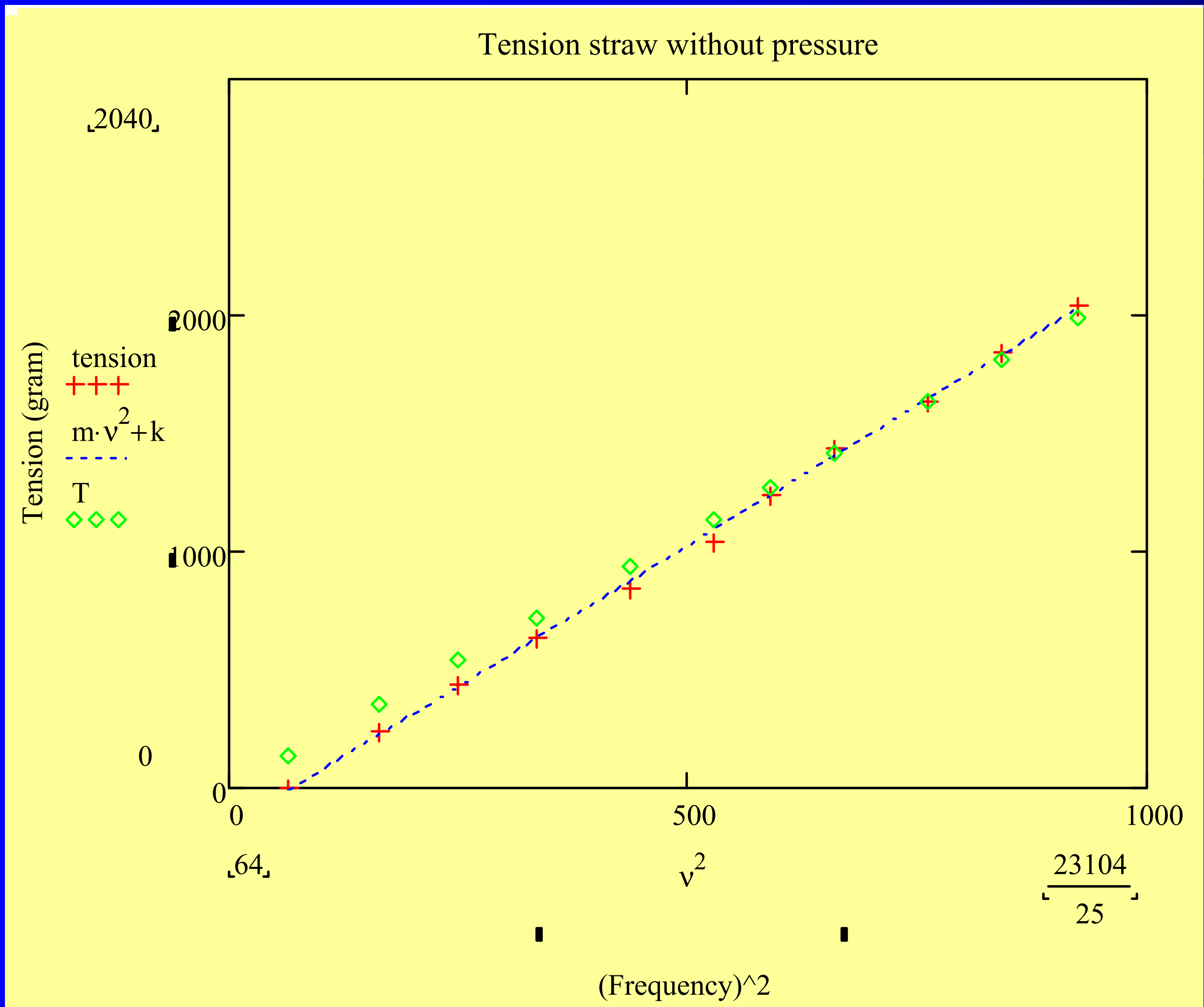


	slope	ENC (mV)
CARIOCA_cold	0.0111	4.42
CARIOCA_hot	0.0074	5.42

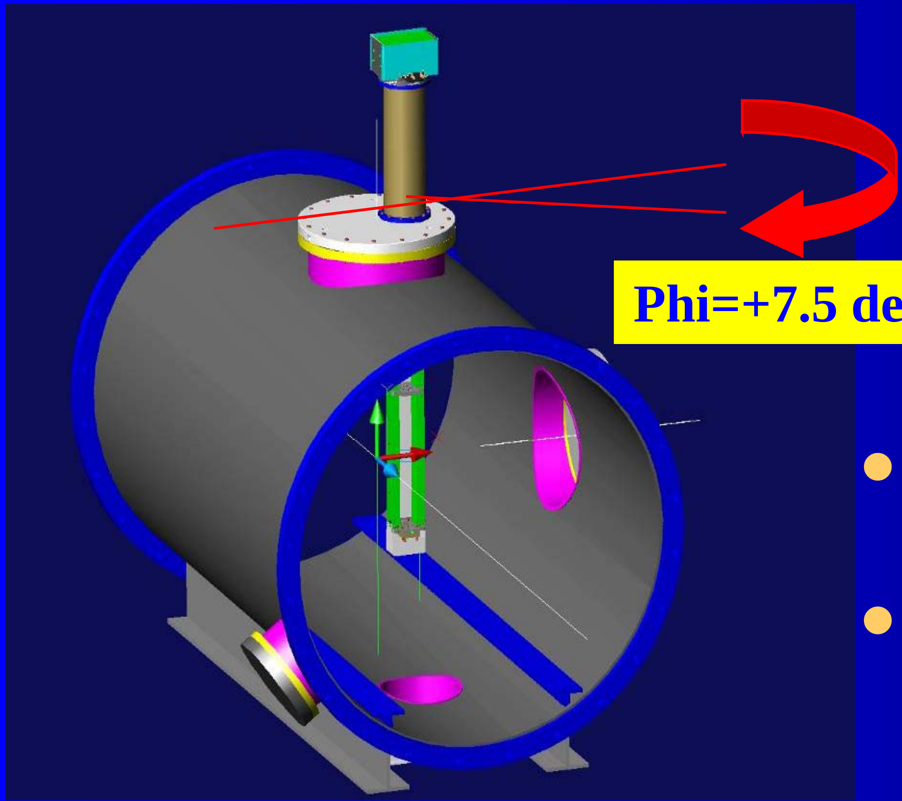
Better

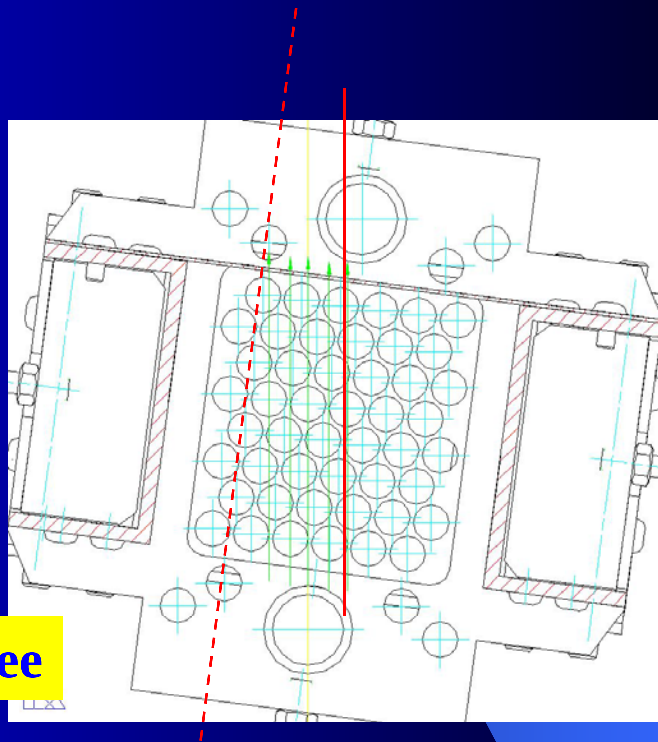
Theoretical

$$T := 4\cdot(w + w_{.Mylar})\cdot Ls^2\cdot\nu^2$$



Test beam 2008

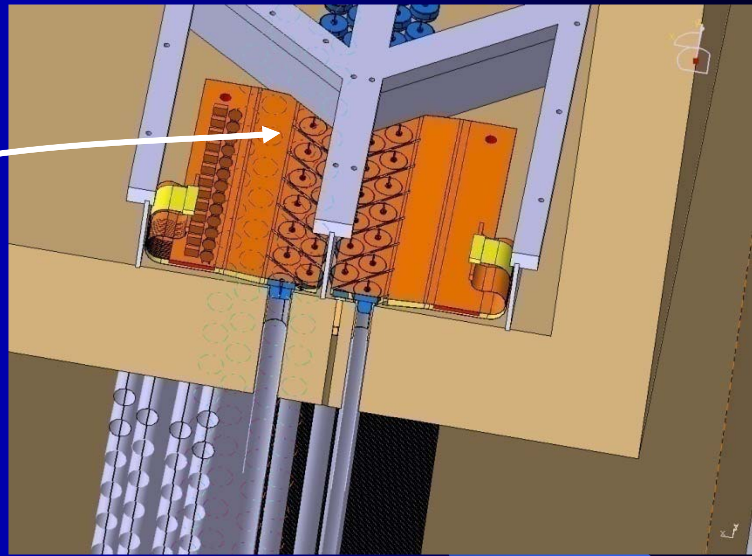


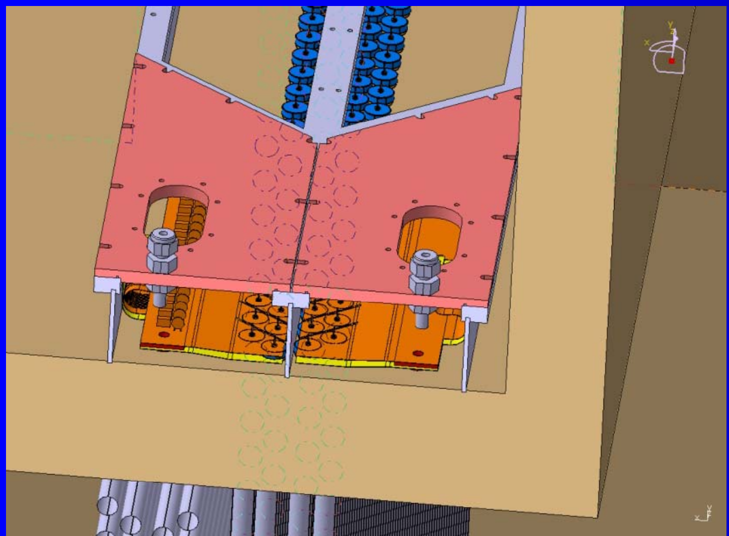


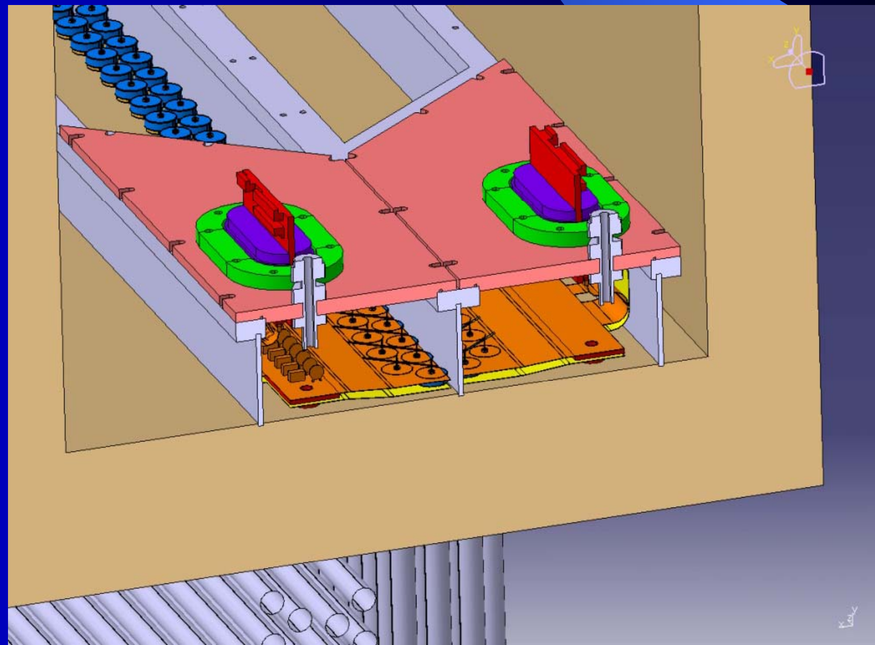
Phi=+7.5 degree

- Modification of the geometry compared to 2007:
- Rotating of the prototype to avoid that the wires line up with the beam axis

Assembly of web connection and gas manifolds







Plan

ID	Task Name
1	**Prototype testing (2007-2008)**
2	Full length 48 straws
3	Tested in the actual vacuum tank (under test October 2007) under realist
4	Gas studies
5	Performance studies with new electronics and 2008 test beam
6	
7	**Engineering design**
8	Chamber design
9	Validation of the (FEM calculations, prototypes)
10	Detailed design of the parts
11	Engineering review
12	Freeze detector design
13	
14	**Electronics**
15	Study FE electronics used in other experiments
16	Test of new electronics in the 2008 test beam
17	Electronics review
18	Freeze design
19	
20	**Assembly and testing of a module 0 (one full view) (2008 – 2009)**
21	Procurement
22	Construction
23	Testing
24	Freeze detector parameters
25	
26	**Chamber production**
27	Call for tender, mass production of parts
28	Chamber assembly
29	Installation
30	Integration and commissioning