Specific Instrumentation for Test-Stands: The X-ray scanner

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Outline

- Quality Control for chamber production
- Experience from ATLAS/TRT project
- First tests with MM chambers in summer 2013

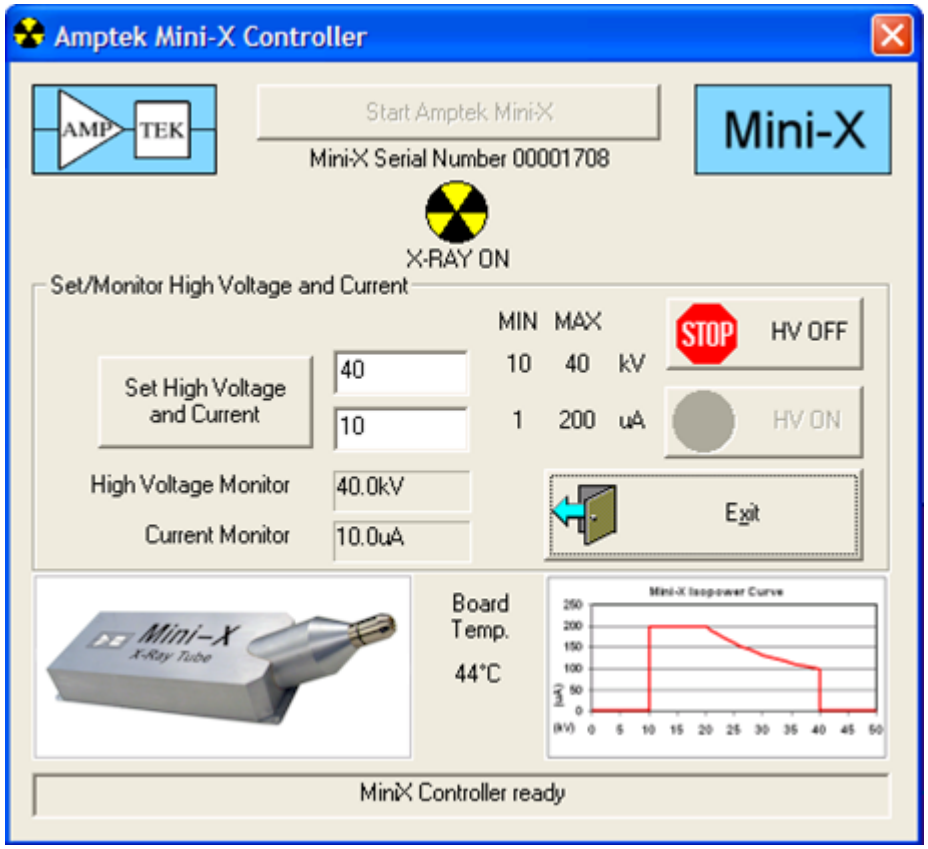
  (talk by Anatoli R. at NSW Upgrade Meeting on September 19, 2013
  https://indico.cern.ch/conferenceDisplay.py?confId=272889)
- Preliminary ideas
- Summary and future plans

Quality Control for MicroMegas and sTGC production with X-ray source - why it is important?

Possible tasks:

- Gas gain uniformity
- Hot spots detection
- HV instability regions
- Leakage current
- Position accuracy and quadruplet alignment verification
- Other…

Experience with TRT X-ray test facility



USB Software Interface. Allows the user to set the voltage and current as well as monitor both parameters

http://www.amptek.com/minix.html

Target material	Ag or Au
Tube voltage	10 to 50 kV
Tube current	5 µA min / 200 µA max
Tube power	9 W @ 50 kV and 80 µA
Approx. Flux	10^6 counts/sec/mm^2 on the axis @ 30 cm
X-ray window	Be, 127 µm; window at ground
Cooling	Air Cooled
Weight	360 grams
Focal spot size	approx. 2 mm
Output cone angle	120°

TRT conditions and extrapolation to MM and sTGC

- Used to operate TRT barrel module
- Operation parameters 30 kV, at ~20% of maximum current
- Situated ~0.5 m from the module
- Current in the straw filled with Ar/CO_2 mixture (70/30)
  ~60 nA/cm at the gas gain ~ $3*10^4$
- Gas thickness ~3 mm area 0.4 cm^2.
- Power can be significantly increased if needed

MicroMegas:

Easy to obtain current density
~100 nA/cm^2

sTGC

Atomic absorption equivalent corresponds to 3C and 1O (TRT mixture 0.7Ar+0.3C+0.6O)

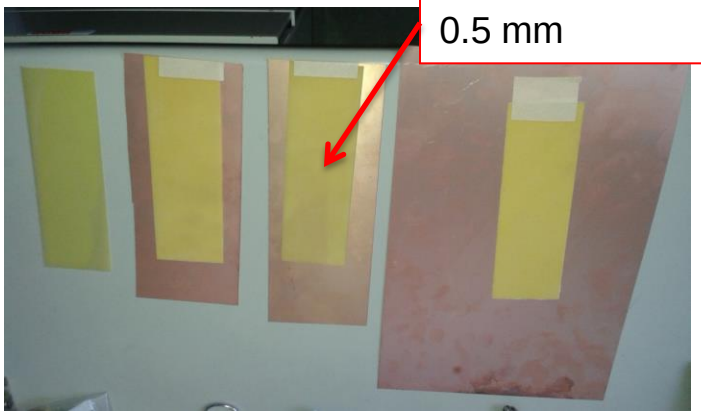
Absorption coefficient using Z^{-3} low is a factor of ~3.2 less than for the TRT

At gas gain ~10^5 gas
Current ~100 nA/cm^2 is easy to obtain at similar operation conditions

Tests with MicroMegas chambers

Test were carried out together with MMgas experts

- T1 Chamber (single coordinate)
- Strip pitch 0.4 mm
- Resistivity 20 MOhm/cm
  HV1=510-520 V
  HV2=-300 V
- Gas mixture 93% Ar + 7% CO_2
- Active work area 10x10 cm^2
- Gas gain $<10^4$

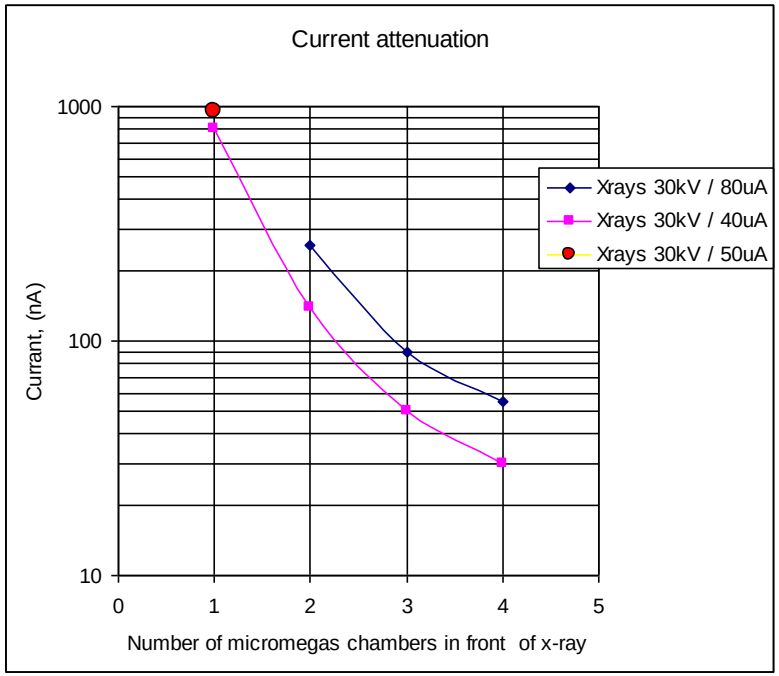


Material effect was checked MMgas components

Tests with MicroMegas chambers

With collimator of 1 mm
HV_Xray= 30 kV
I_Xray=113 μA
Chamber current = 65 nA at HV=500 V

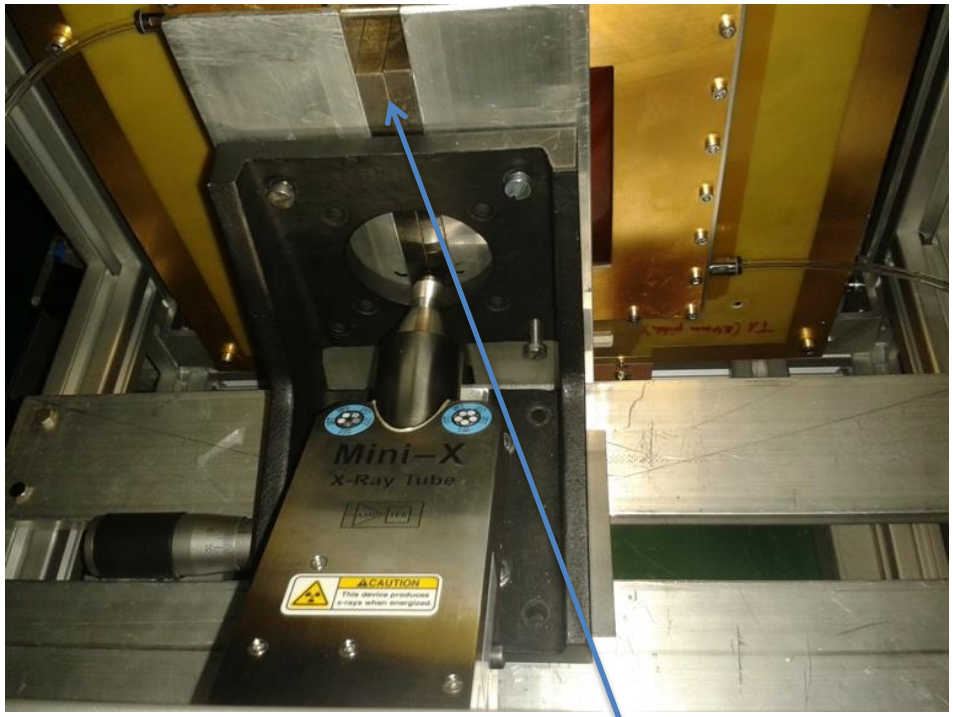
Material effect was checked MMgas components simulating a stack of few chambers. Larger size of the collimator was used for this.



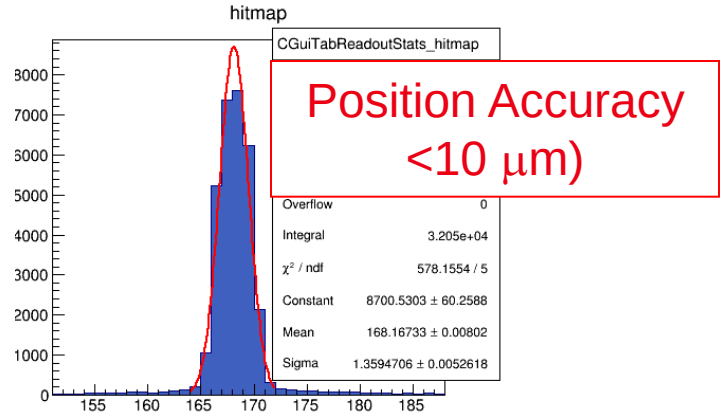
Even last chamber will have enough current at safe operation conditions of the X-ray tube.

Current measurement with 0.1 nA accuracy is not a problem.

Strip position accuracy: movable table and Gap collimator 0.2mm

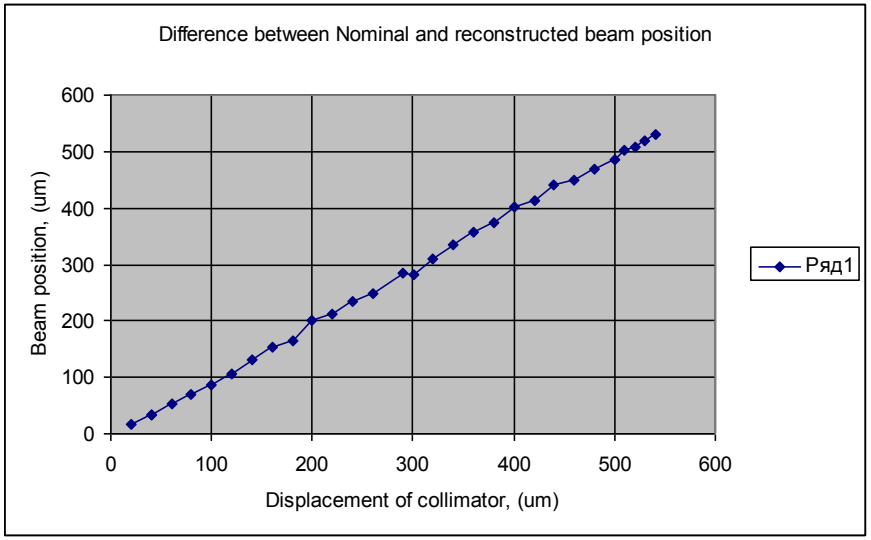


- 1mm Xray Collimator + 0.2 mm collimator in front of the chamber
- AVP25 DAQ used
- HV=520->470 to reduce saturation
- Xray at U=10 kV I=100 uA



Position Accuracy <10 μm)

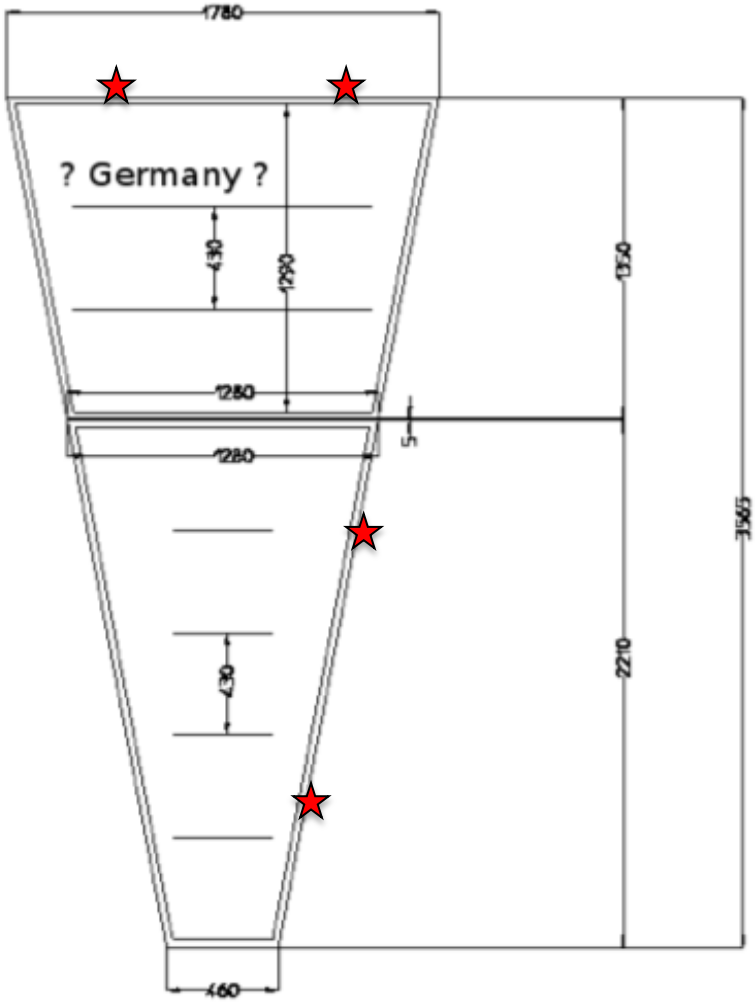
Strip counting rate



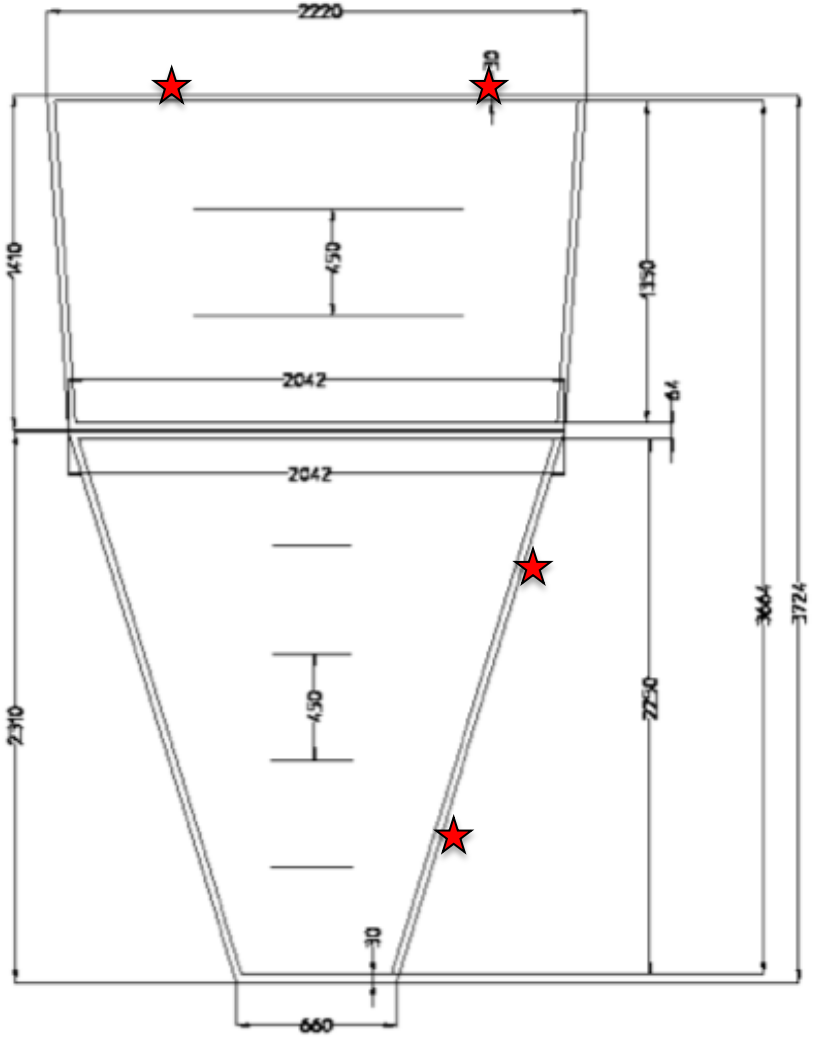
Calculated beam position VS collimator position.

MM module sizes & support points

Small wedge

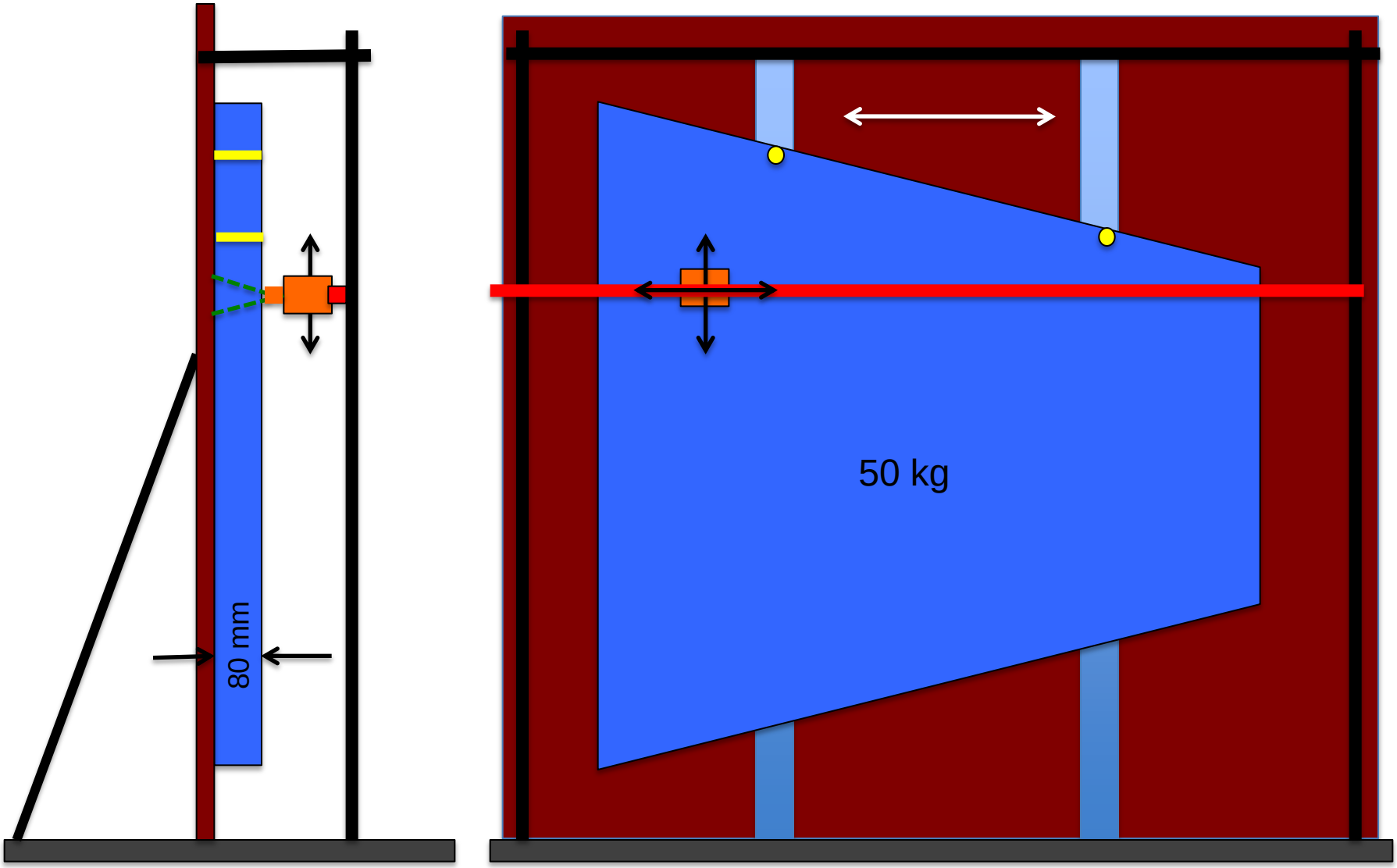


Large wedge



Largest: 2220 x 2310

X-ray scanner sketch

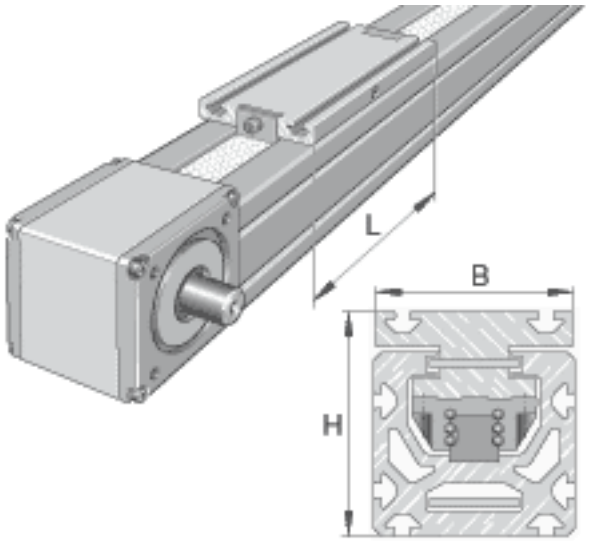


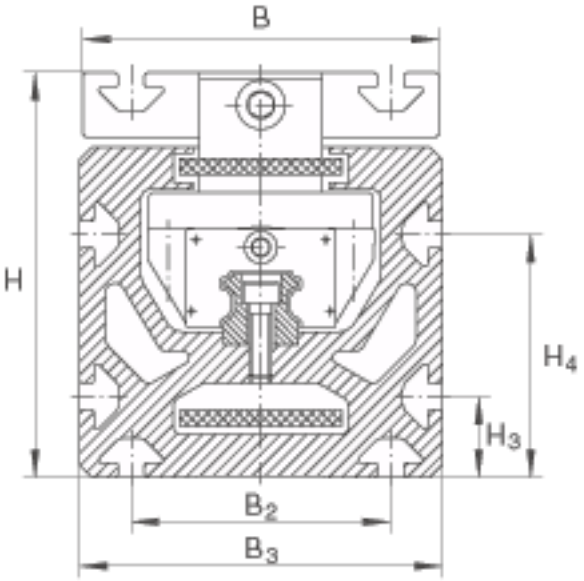
Technical requirements
(we need input from collaboration)

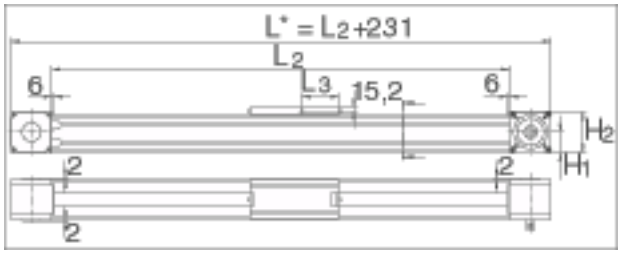
Scan requirements for MM:

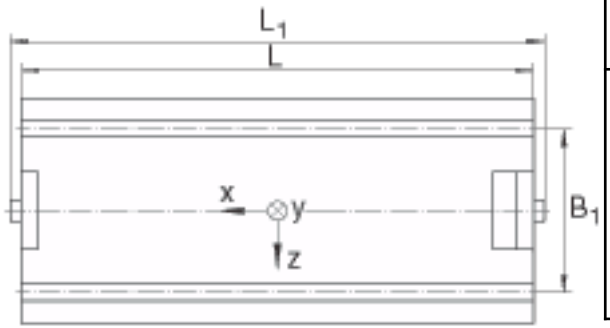
1. Tasks (still to be specified)
   - Gas gain uniformity measurements
   - Other?
2. Scanning window 2220 x 2310 m
3. Beam spot ~1-5 cm in diameter (variable collimator) +set of collimators with attenuators?
4. Beam position accuracy requirements ~0.5 mm
5. Number of scanners ~5
6. Scanning time - whole area: 20 min and more
7. Scanning directions: variable X-Y, Y-X any other (needed? Cost?, programmable by whom?)
8. Movements
   - Continuous with given speed (<3mm/sec-corresponds to 100 passes 250 cm)
   - With step of >=1mm
9. Area for scan programmable (including trapezoid shape)
10. Position of X-ray variable within 10 cm?
11. Shield to be foreseen as a part of set-up?
12. X-ray tube: cheap tube which fits requirements
13. Movements of whole scanner then fixation to the floor
14. Height with respect to the floor
15. Supports for MM chambers
16. Measurements algorithms and technique for fully automated procedure
17. Data analysis algorithms
18. Final data storage (Oracle DB ?)

Preliminary proposal on linear guidance system by Schaeffler Technologies (INA) AG









H	125 mm
B	110 mm
L	500 mm
Mass of carriage	6.6 kg
Max single-piece support rail length L2	8000 mm

Summary and future plans

- The Moscow group has sufficient experience with QC tools for large scale detectors
- We need to define main requirements
- Prepare technical specification (at least preliminary)
- Discuss with producers and get quotation
- Start the production of X-ray scanner prototype in Moscow
- Define what X-ray tube is the most appropriate (cost issue)
- Make a funding request

Preliminary cost estimate ~250 kCHF for both (MM & sTGC) projects (depends also on the number of scanners)