Thoughts on Technology Choice

Zoom, 19.1.2021

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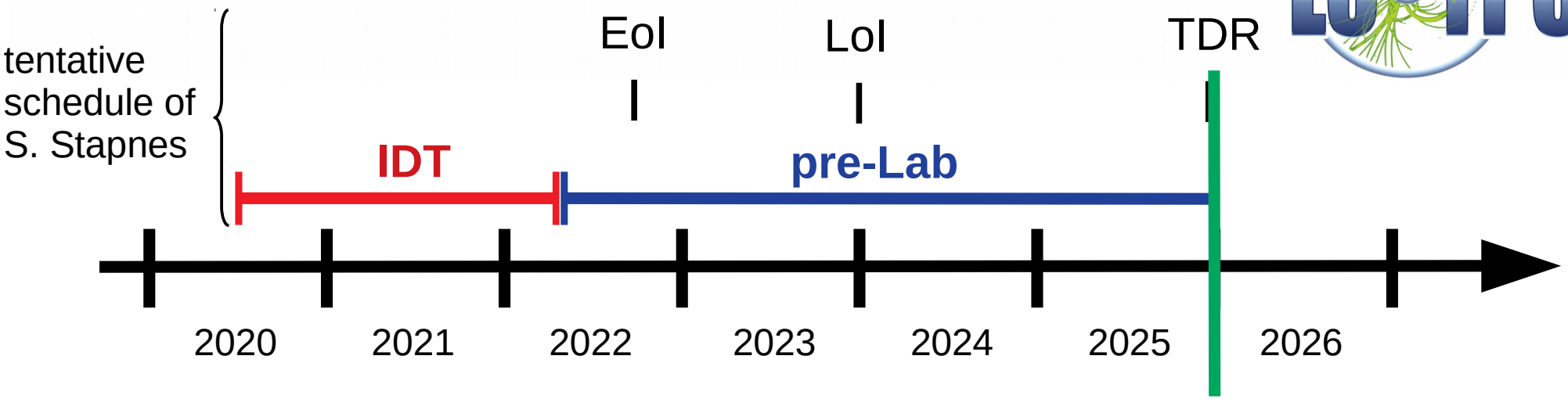
Timeline



Test in B = 4 T

Ion blocking

Development of new readout electronics

Efficient and precise construction of large number of GridPixes

Treatment of large amount of data from GridPixes

Calibration and alignment methods

Simulations

Current Situation

Only one hard requirement:

Transverse spatial resolution of < 100 µm for complete drift length

The rest is ‚the more the better'. Regarding

dE/dx,
Longitudinal spatial resolution
Double track resolution
Cost (obviously the less the better)

Detector tests have shown sofar, that

GEMs and MMs have roughly the same performance as far as transverse. longitudinal spatial resolution and dE/dx is concerned.
GridPix readout is difficult to compare for spatial resolutions, but gives a slightly better dE/dx.

Are we done?

I disagree: we haven't even started yet

My Opinion – put bluntly

<u>Our current data is not comparable:</u>

Pad sizes are different: GEM-HH: 1.26 x 5.85 mm² (4829/module)
GEM-J: 1.2 x 5.4 mm² (5152/module)
MM: ~3 x 7 mm² (1728/module)

Different electronics with different noise, gain, shaping etc.

<u>Our current knowledge about modules is incomplete:</u>

In all designs (not the Japanese) the gating module is missing.
I think this would change a lot – in particular the electric field distortions.

Important tests have not been done yet, all HEP experiments do:
Aging tests
Tests in high magnetic fields
We don‘t even know, how the gas behaves in a high radiation environment

<u>Our knowledge of what we need is too little:</u>

We don‘t know what is required, but we talk about relaxing 20 year old estimates of what we can reach:
Double track resolution 2mm → relaxing on the outer parts
dE/dx degrading the barely reached 5% by increasing pad size and decreasing bit number of ADC

We have very little time!

There are only ~4 years left.
The resources will not increase in the largest fraction of this period significantly.
If we don‘t want to build the detector on guestimates, we have to develop a plan and work on it.

We should therefore:

- simulate crucial parameters like pad size, electronics etc
- build a common module accordingly
- fix parameters in the mean time
- test new modules extensively in all necessary environments

Example pad size

We claim a pad size of 1x6 mm² in all documents,
starting from TESLA-TDR to the IDR
But we have never built a pad plane with this. Why?

Yes, we can reach the transverse spatial resolution with longer/shorter and wider pads. Fine,but

the pad length has also significant effect on
- transverse spatial resolution (improves for angles of 0° because of high n_e)
- the track angular effect (becomes worse with longer pads)
- dE/dx (becomes worse with longer pads, because of less sampling?)
- longitudinal resolution (???)

The pad width has impact on
- transverse spatial resolution
- two track separation

=> impact on many measurements,
we can not compare measurements different technologies,
we have to know the impact if we want to increase the pad sizes

Common module (take 6)

So, I am proposing again the common module with
- a common pad design (1*6 mm² – left/middle/right)
  and something wider (>1.85 x 6 mm² or larger)
- a gating device
- common HV connections
- ready for SALTRO

We can use this to make
Comparable results honestly
Study effect of GatingGEM + degrader (?) on field distortion
Study different cooling technologies (TGC, Microchannel cooling, 3D printed cooling block, etc.)

Advantages:
Safe resources (manpower / money) by developing only once for all groups
order larger numbers (cheaper), reuse for example gating device for all technologies (only 1 or 2 gating GEMs are needed)

Parameters

We have to start defining the parameters which are relevant for the technology choice, e.g.

transverse/longitudinal spatial resolution, momentum resolution, dE/dx, two track resolution,

but also material budget, gas gain required, power consumption, cooling, costs, HV stability, data volume (thanks Uli)

And we have to define the conditions of measurements, e.g. same pad sizes (common module), same gatingGEM voltage differences, etc.

We had a list of necessary requirements for all test beam:

Who still has it?

We have to revisit it and update it.

We need some simulations.

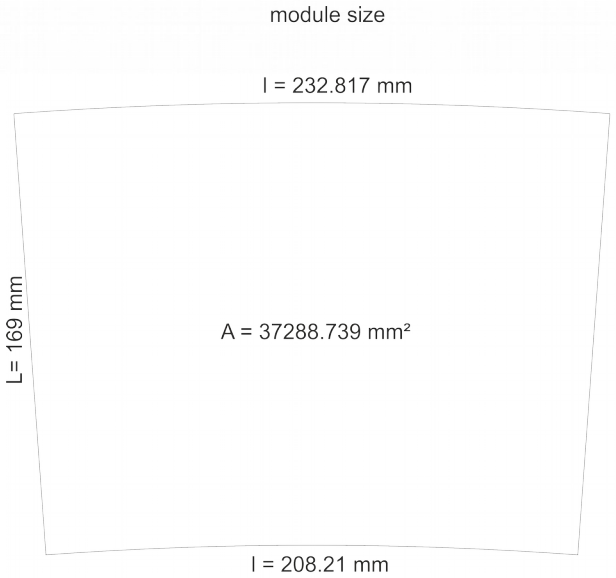
Simulations

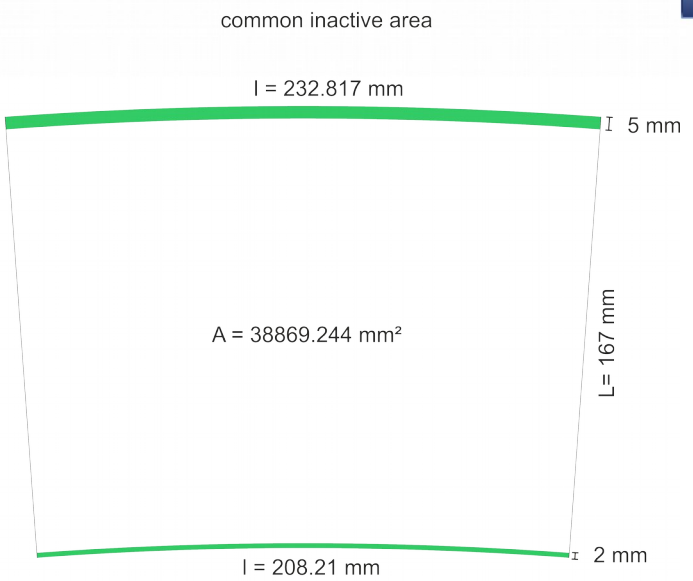
While obviously the impact on physics analysis would be the best thing to know for all parameters,
this is unlikely to happen (making a physics analysis for every parameter).

Many parameters can be studied in a much easier way: e.g.
- Two track separation: choose physics process with highest energetic decay products (→ closes together on outside), simulate only this process study how far the tracks are separated.

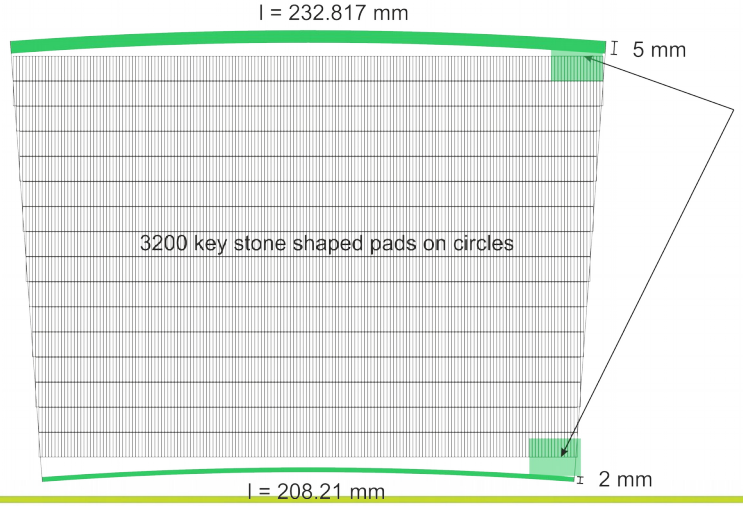
BACK UP
old files regarding common module

Design ideas – current modules





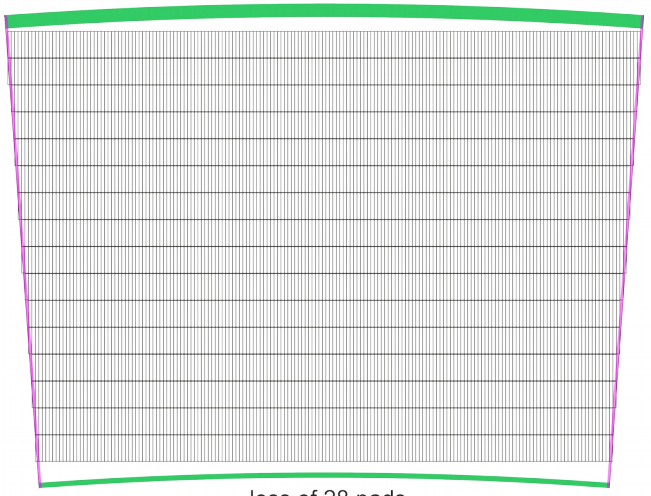
38869.244 mm² / 3200 pads = 12.15 mm²/pad
-> 1.26 mm * 9.6 mm pads



Define common areas for HV feet-through of gating device and field degrader?

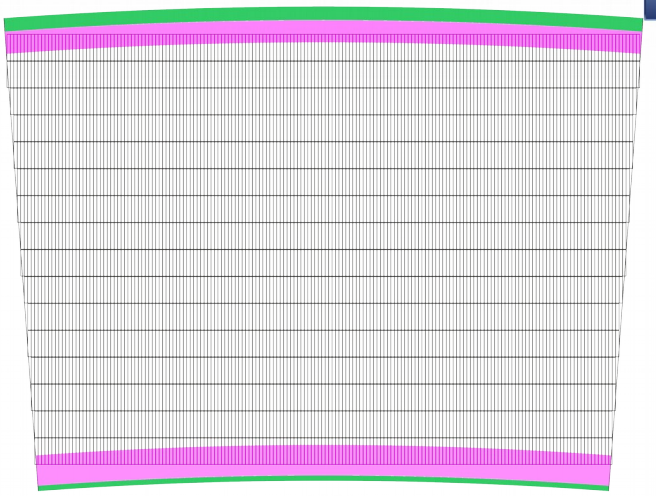
Design idea common module

DESY - GEM (border 1mm at sides)



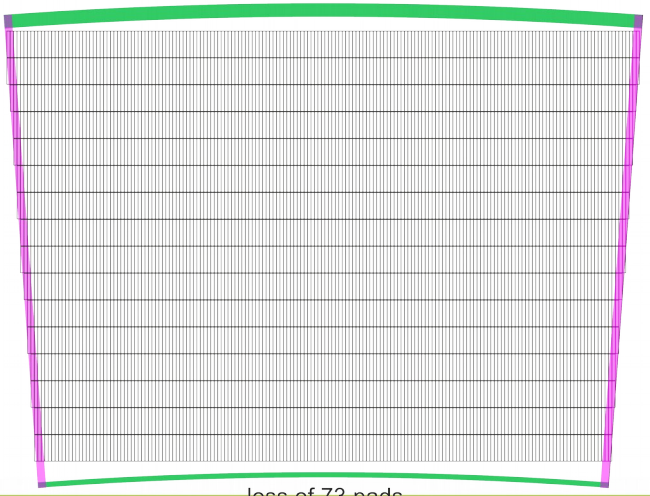
loss of 28 pads

Asian- GEM (border 13 mm top and bottom)



loss of 250 pads

Micromegas (border of 3mm everywhere)



loss of 73 pads

1.) Should try to minimize loss of pads for everyone (Asian in particular)
2.) Base design (Connectors, pads and routing should be the same for everyone
3.) Special design of HV feed through, add frames etc. can be adapted for every design.
4.) Pad rows possibly could be moved by 4mm up and down to adjust for specific requirements.
5.) Same could be done with ‚half-full' modules of 1*6mm² pads on left and right side (mirror is easy).
6.) supply HV for field degrader and gatingGEM on backside of pad plane
7.) include some switching of gating GEM?

Field degrader

side view

frond view