# Study of strip geometries with two “Pt layers”

using a standalone software tool

- some results
- planned developments
- GUI almost ready for release

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# The tool generates the positions in 3d of all active surfaces

- **following a basic set of requirements (hermeticity, coverage, etc…)**

- **basic engineering parameters (outer dimensions, clearances, etc…) taken (or "inspired") from present tracker**

- **calculates (or estimates) automatically many basic parameters (surface, channels, occupancy, power, cost, bandwidth…. more to come)**

- **intended to allow quick comparison of different options under a consistent set of (reasonble) assumptions (… to narrow down phase space)**

- **with further developments, generate layouts to be used as input for the full simulation**

# Example: study of strips layouts with 2 pt layers

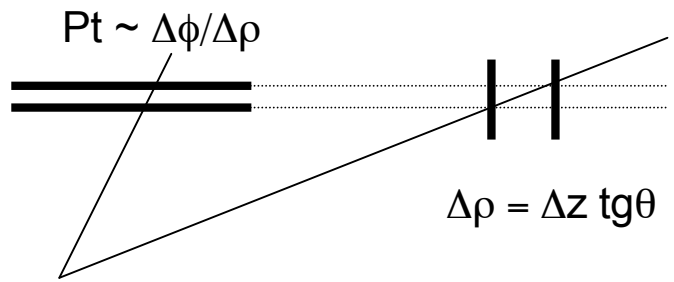
**Assumptions:**

(1) 2 Pt layers at 20-30 cm is what we need (prejudice)
(2) Occupancy in Pt layers must be well below 1% (M. Pesaresi - is it really the last word?)
(3) 6 barrel layers in total (prejudice)
(4) 2 stereo layers after the Pt layers (prejudice - hopefully not needed?)
(5) Occupancy in strip layers around 2-3% (probably OK, need to check also expected leakage current)
(6) Pt "rings" are feasible (I think so, but extra difficulty needs to be evaluated)

**Only an exercise**

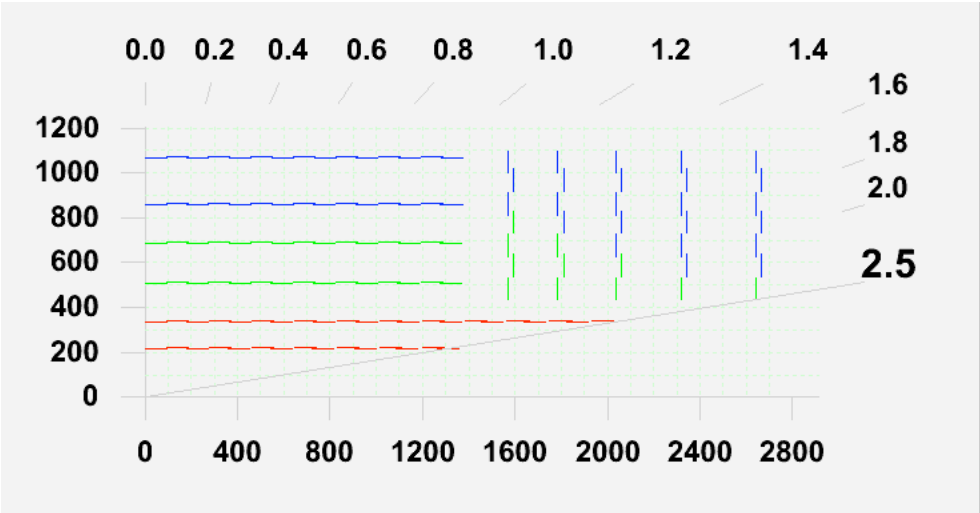
**Large implications if any of the above assumptions is not valid - especially n (1) -**

**Need to measure $\Delta\phi/\Delta\rho$**



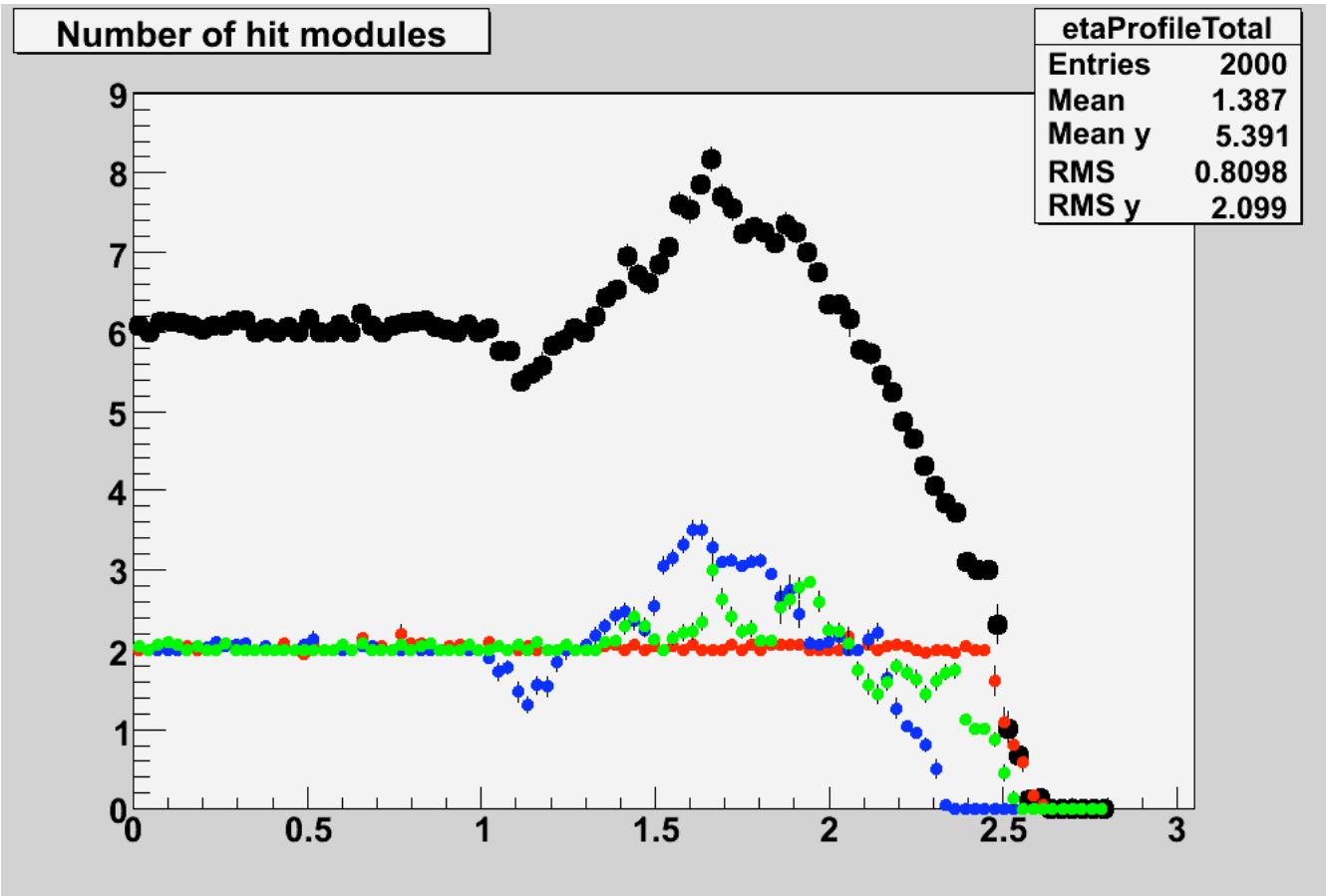

**A spacing of 2 mm in the barrel translates to ~1 cm in the forward**

**Detectors in the forward *must* be wedge shaped**




# Example of layout - Features:

+ Keep EC "above" barrel (with some clearance)
- Non optimal coverage close to $\eta = 2.5$
+ Possibly an option to route service of the Pt layers out of the $\eta$ acceptance
+ One type of Pt module only
- Inefficient use of Pt modules (→more channels, power, money…)
- Likely one structural cylinder between Pt and strips



# Some numbers

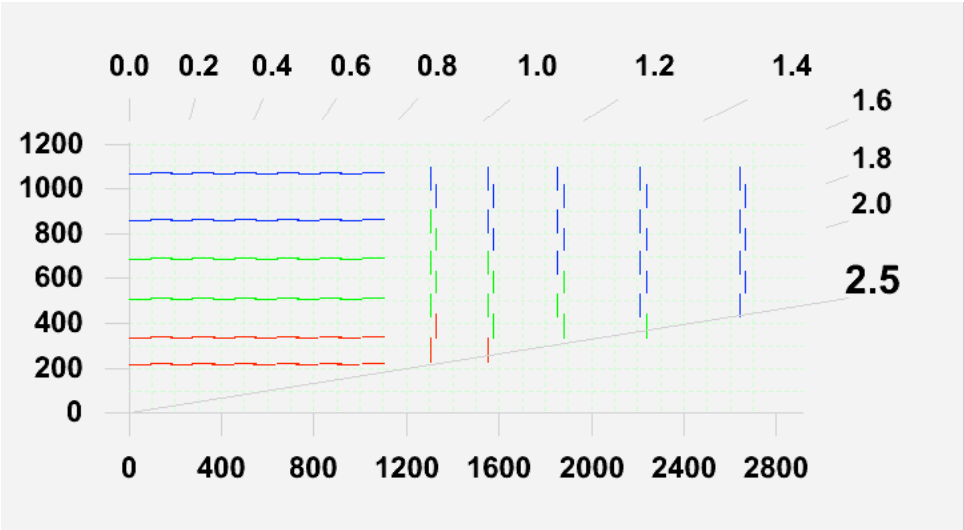
| | B1 | B2 | B3 | B4 | B5 | B6 | E1 | Total |
|---|---|---|---|---|---|---|---|---|
| Tag | PTBARRELL1 | PTBARRELL2 | TOBL1 | TOBL2 | TOBL3 | TOBL4 | ENDCAPR1 | |
| Type | pt | pt | stereo | stereo | rphi | rphi | stereo | -- |
| Area (mm2) | 8580.5 | 8580.5 | -- | -- | -- | -- | -- | 26.9(m2) |
| Area (mm2) | -- | -- | 8580.5 | 8580.5 | 8580.5 | 8580.5 | 8439.9 | 122.1(m2) |
| Occup (max/av) | 0.7/0.3 | 0.3/0.2 | 4.3/3.3 | 2.4/2.0 | 3.0/2.7 | 2.0/1.8 | 3.4/3.4 | -- |
| Pitch (min/max) | 90 | 90 | 120 | 120 | 120 | 120 | 100/123 | -- |
| Segments x Chips | 48x8 | 48x8 | 2x6 | 2x6 | 1x6 | 1x6 | 4x6 | -- |
| Strip length | 1.9 | 1.9 | 46.3 | 46.3 | 92.6 | 92.6 | 24.5 | -- |
| Chan/Sensor | 49152 | 49152 | 1536 | 1536 | 768 | 768 | 3072 | -- |
| N. mod | 512 | 1056 | 1200 | 1440 | 1800 | 2280 | 360 | 12288 |
| N. sens | 1024 | 2112 | 2400 | 2880 | 1800 | 2280 | 720 | 17440 |
| Channels (M) | -- | -- | 3.69 | 4.42 | 1.38 | 1.75 | 2.21 | 19.89 |
| Channels (M) | 50.33 | 103.81 | -- | -- | -- | -- | -- | 154.14 |
| Power (kW) | 15.1 | 31.1 | 2.6 | 3.1 | 1.0 | 1.2 | 1.5 | 60.2 |
| Cost (MCHF) | 17.6 | 36.2 | 8.2 | 9.9 | 6.2 | 7.8 | 2.4 | 102.7 |

Occupancy well below 1% in Pt modules (90 μm x 2.2 mm)
Typical occupancy in strips 2-3%, below 3.5% everywhere
Smallest pitch 100 μm, largest 120 μm
Shortest strips EC ring 1 (24 mm, x4 segmentation)
Longest strips in Barrel layers 5/6 (93 mm, no segmentation)

Cost estimates
Pt modules: 200.0 CHF/cm2 - Strip modules: 40.0 CHF/cm2

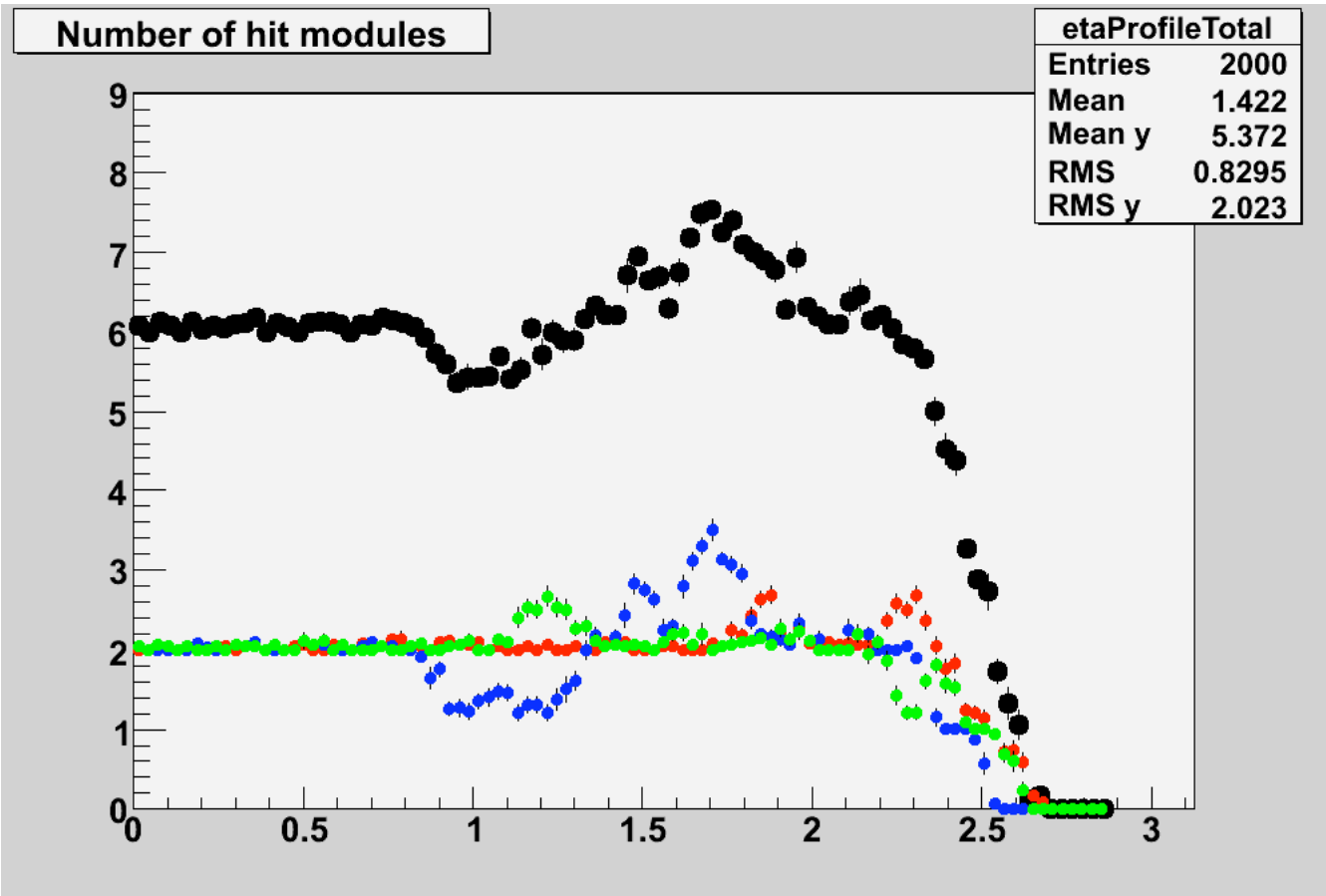
Power estimates:
Pt modules: 0.30 mW/chan - Strip modules: 0.70 mW/chan

| TOTALS | Pt | Strips | Total |
|---|---|---|---|
| Surface (m2) | 26.9 | 122.1 | 149.0 |
| Channels (M) | 154.1 | 19.9 | |
| Power (kW) | 46.2 | 14.0 | 60.2 |
| Cost (Mchf) | 53.8 | 48.9 | 102.7 |




# Another option - Features:

+ Simple geometry
+ Improved coverage close to $\eta = 2.5$
- Pt modules in the forward (two types)
- More efficient use of Pt modules (less channels, power, money…)
- High local heat dissipation in 2 disks
- All barrel services go backward in rapidity




**Pt modules**

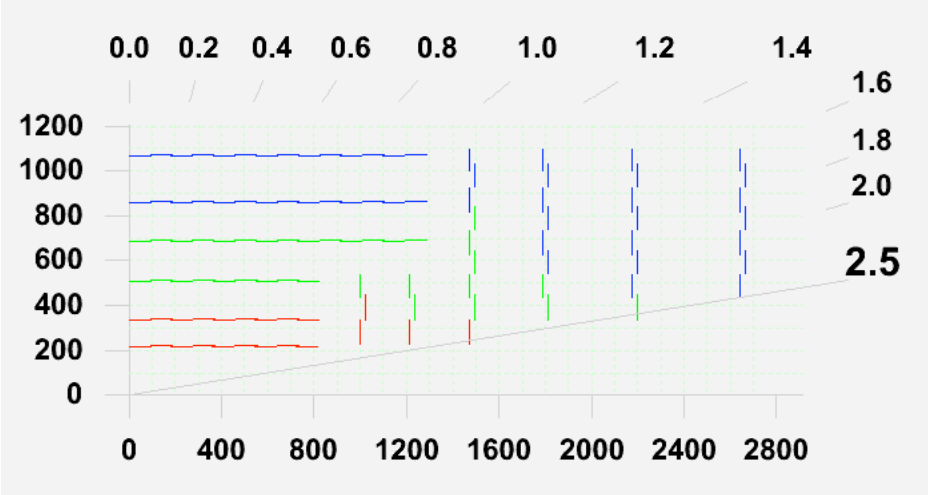
| | | | |
|---|---|---|---|
| Surface | 26.9 | → | 19.0 |
| Channels | 154.1 | → | 108.0 |
| Power | 46.2 | → | 32.4 |
| Cost | 53.8 | → | 38.2 |

**Strips**

| | | | |
|---|---|---|---|
| Surface | 122.1 | → | 108.1 |
| Channels | 19.9 | → | 18.8 |
| Power | 14.0 | → | 13.2 |
| Cost | 48.9 | → | 43.1 |

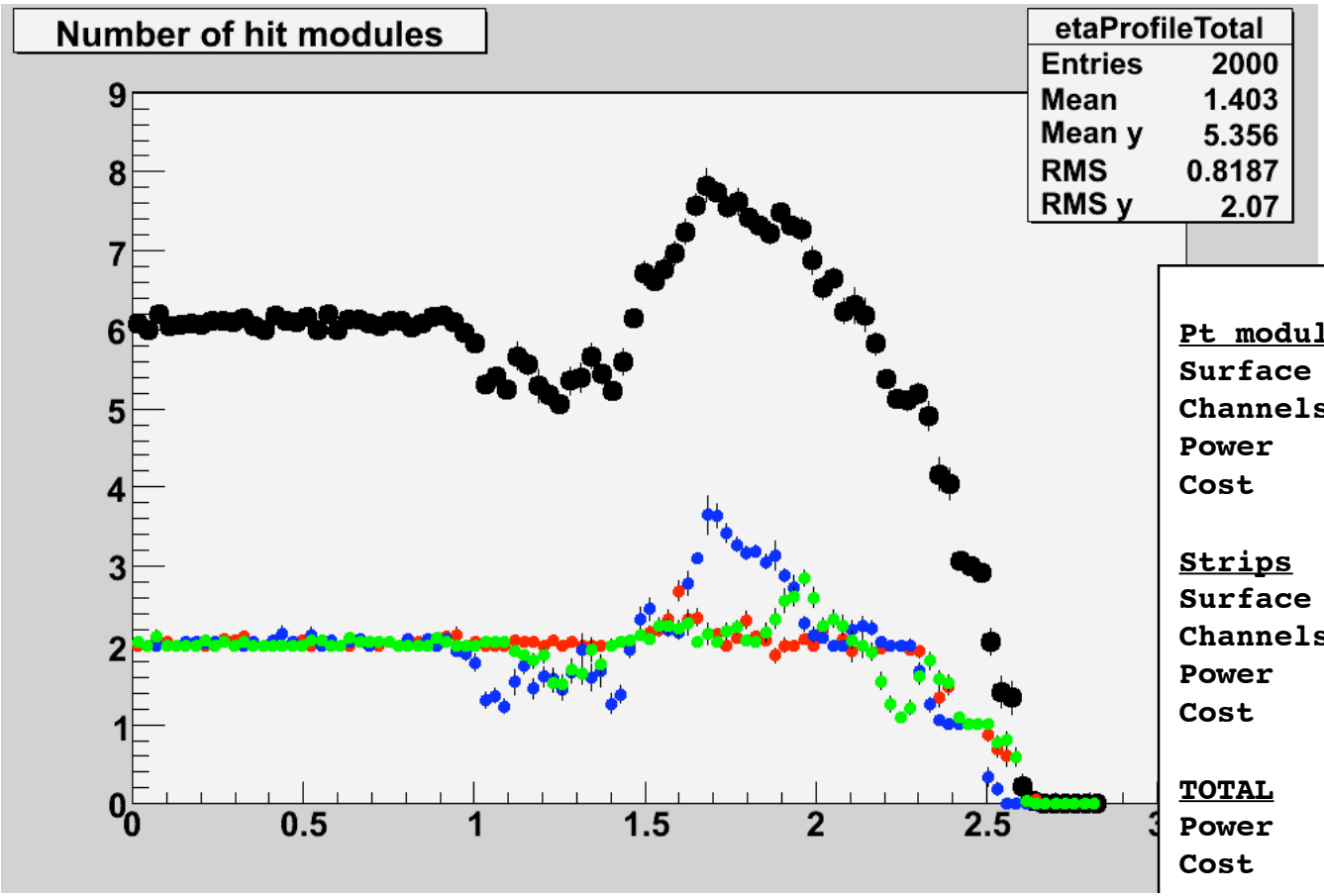
**TOTAL**

| | | | |
|---|---|---|---|
| Power | 60.2 | → | 45.6 |
| Cost | 102.7 | → | 81.3 |

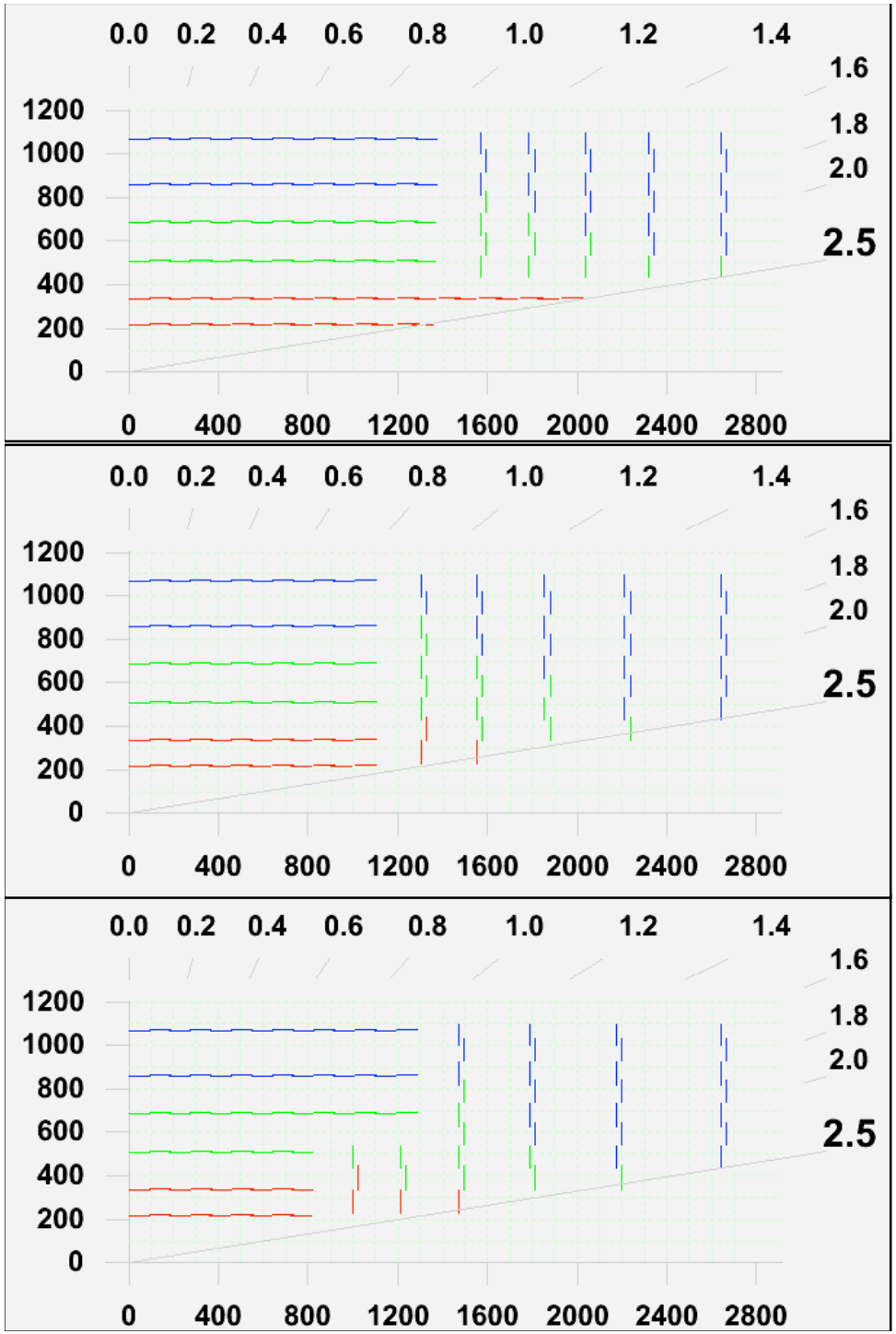



# Back to TIB and TID - Features:

- More complex geometry
- Pt modules in the forward (two types)
- High local heat dissipation in 2 disks
- Optimal use of modules (less channels, power, money…)
- TIB services go back and forth twice in rapidity




| | | | | | |
|---|---|---|---|---|---|
| **Pt modules** | | | | | |
| Surface | 26.9 | → | 19.0 | → | 15.8 |
| Channels | 154.1 | → | 108.0 | → | 89.7 |
| Power | 46.2 | → | 32.4 | → | 26.8 |
| Cost | 53.8 | → | 38.2 | → | 31.5 |
| **Strips** | | | | | |
| Surface | 122.1 | → | 108.1 | → | 106.3 |
| Channels | 19.9 | → | 18.8 | → | 19.0 |
| Power | 14.0 | → | 13.2 | → | 13.4 |
| Cost | 48.9 | → | 43.1 | → | 42.6 |
| **TOTAL** | | | | | |
| Power | 60.2 | → | 45.6 | → | 40.2 |
| Cost | 102.7 | → | 81.3 | → | 74.1 |




# Summarizing:

More advantageous routing of services

| Pt | Strip |
|---|---|
| 26.9 m² | 122.1 m² |
| 154.1 M ch | 19.9 M ch |
| 46.2 kW | 14.0 kW |
| Overall pwr | 60.2 kW |
| Overall cost | 102.7 Mchf |

| Pt | Strip |
|---|---|
| 19.0 m² | 108.1 m² |
| 108.0 M ch | 18.8 M ch |
| 32.4 kW | 13.2 kW |
| Overall pwr | 45.6 kW |
| Overall cost | 81.3 Mchf |

| Pt | Strip |
|---|---|
| 15.8 m² | 106.3 m² |
| 89.7 M ch | 19.0 M ch |
| 26.8 kW | 13.4 kW |
| Overall pwr | 40.2 kW |
| Overall cost | 74.1 Mchf |

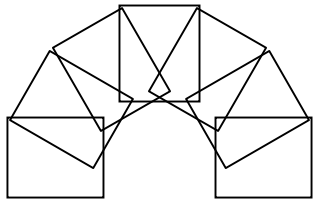
Better efficiency (less channels, power, Si surface and cost)

**Possible further studies (not necessarily in this order)**

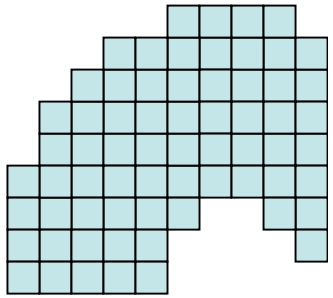
• Add calculation of bandwidth from Pt layers, assuming an effective Pt cut from signal correlations.

• Add estimate of leakage current per channel after a given integrated luminosity (to validate derivation of strip length)

• Generate forward with rectangular detectors, to quantify increase of silicon surface, channels and power, compared to the optimal wedge geometry.



• Study a layout for an "all-pixel" Tracker, with square pixels (relevant for the monolithic pixel R&D). With square sensing elements, the whole Tracker (including the endcaps) can be populated with a single detector flavour, since the orientation does not matter.



• Add pixel detector to the model, if useful (discussion later)

# Further developments

**Completed:**

• Graphical User Interface to select detector types on a given geometry (N. De Maio). Instructions for installation and use at
http://code.google.com/p/tkgeometry/wiki/GUIQuickStart

**Ongoing:**

• Generate a (small) set of inactive volumes matching any of the geometries studied Through configurable functions, attribute to active and inactive volumes a mass that accounts for electronics, cooling, mechanics etc... starting from the present Tracker to derive appropriate parameterizations.

**To start asap:**

• Translate the generated geometries (active and inactive volumes) in a format that can be used (easily, or even automatically?) as input for the detector simulation

**More infos and details about the material presented at**
http://abbaneo.web.cern.ch/abbaneo/tkgeometry/summaries/