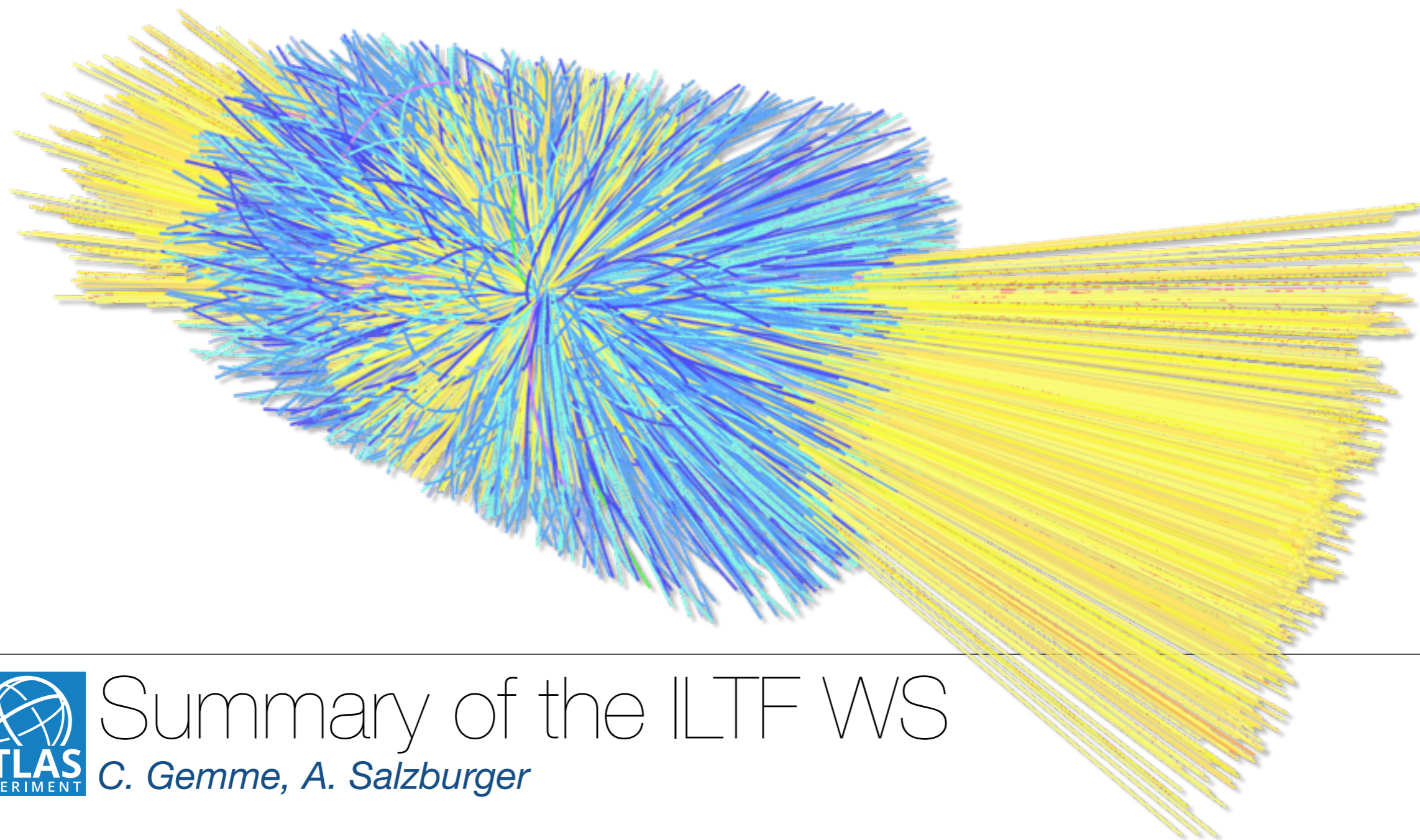https://twiki.cern.ch/twiki/bin/view/Atlas/ITK

21 countries, 93 institutions

Summary of the ILTF WS
C. Gemme, A. Salzburger

layout task force - strategy & timeline

‣ Kick-off & review of the high-level requirements

 - draft finished for ($|\eta| < 2.7$), VF requirements missing

‣ Formulation of high-level design choices

 - 1st ITk Layout TF workshop
   focus: pixel/strip boundary, eta coverage

 - **definition of the new baseline setup**

‣ ITK week (Sep 2015): validation of baseline setup

‣ Collection of technical solutions/design proposals

 - 2nd ITk Layout TF workshop, proposed for 23rd/24th November

 - *focus: detailed solutions/implementations of new baseline*

 - **definition of a few candidate layouts**

‣ Performance evaluation of few

 - **convergence to a final ITk layout**

Nov 2014

Q1 2015

Q2 2015

Q3 2015

Q4 2015

Q1 2016
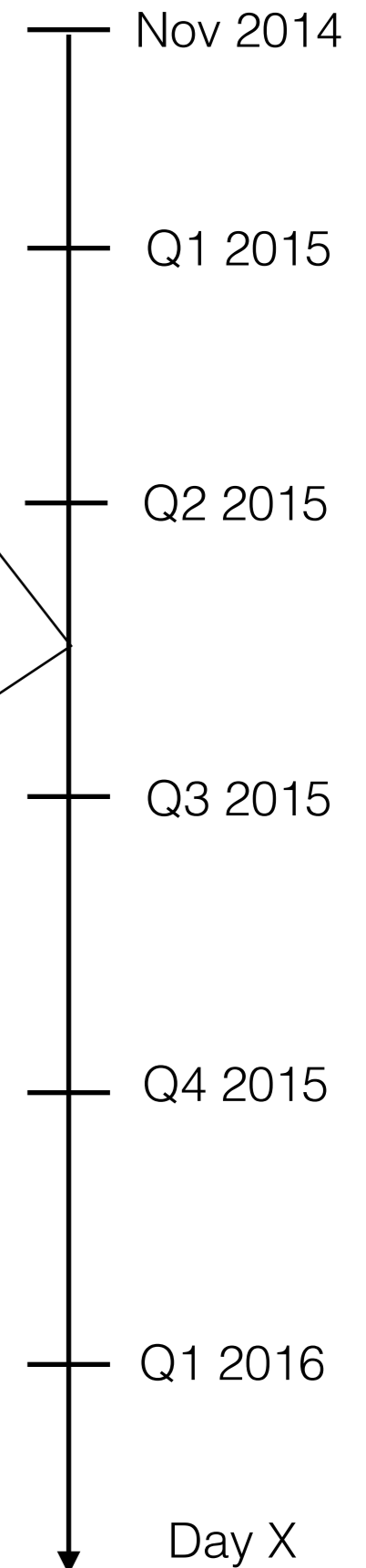
*we do **not** want to adapt this to an updated LHC schedule*

Day X

Program of the workshop

‣ Short introduction session

- main focus on requirements and layout rules

- requirement document is on CDS, please read, comment, question !

- https://cds.cern.ch/record/2025549

09:00 - 10:40	General Session	
	09:00	**Workshop introduction** *10'* Speakers: Andreas Salzburger (CERN), Claudia Gemme (Universita e INFN Genova (IT))
	09:10	**Layout requirements wrap-up** *35'* Speaker: Stephen Mcmahon (STFC - Rutherford Appleton Lab. (GB))
	09:50	**Positioning requirements document** *15'* Speaker: Georg Viehhauser (University of Oxford (GB))
	10:05	**Track Trigger requirements** *15'* Speakers: Richard Brenner (Uppsala University (SE)), Nikos Konstantinidis (University College London (UK)), Jahred Adelman (Northern Illinois University)
	10:20	**Layout design rules from LoI experience** *15'* Speaker: Markus Elsing (CERN)
10:40 - 11:10	Coffee break	

Program of the workshop - Part 1

‣ Pixel/strip boundary definition

| 11:10 - 13:00	Pixel Volume extension	
11:10	**Pixel volume extension introduction** *10'* Speakers: Andreas Salzburger (CERN), Claudia Gemme (Universita e INFN Genova (IT))	
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- tendency within the project to move from a **4** + **5.1** setup towards a **5** + **4** setup

considerations:
- additional pixel layer certainly beneficial for dense environments
- enlargement of the pixel volume together with potential enlargement of strip barrel can limit impact of stub removal
- needs re-design of pixel and strip endcap setup (strip endcap would simplify)
- has to be proven **beneficial by performance studies, has to be cost neutral**

Program of the workshop - Part 1

https://indico.cern.ch/event/394897/

‣ Pixel/strip boundary definition

- tendency within the project to move from a **4** + **5.1** setup towards a **5** + **4** setup
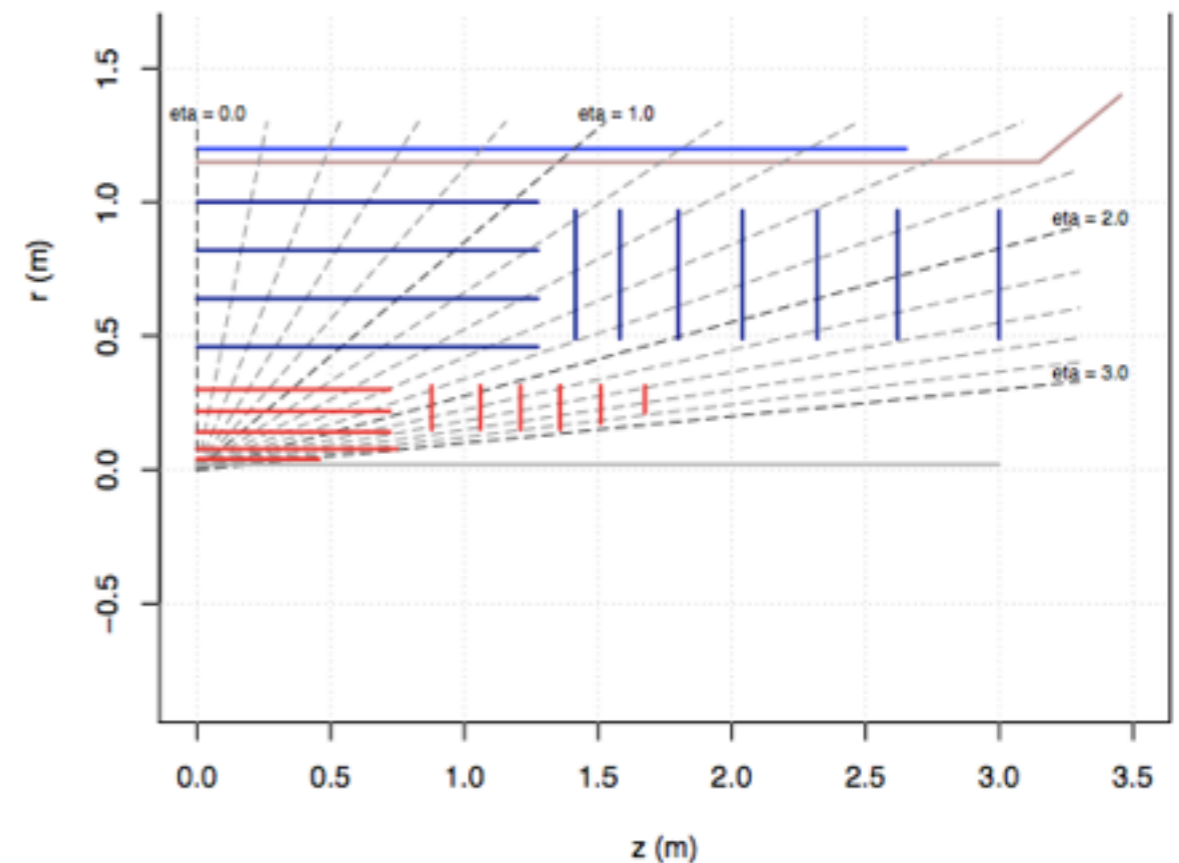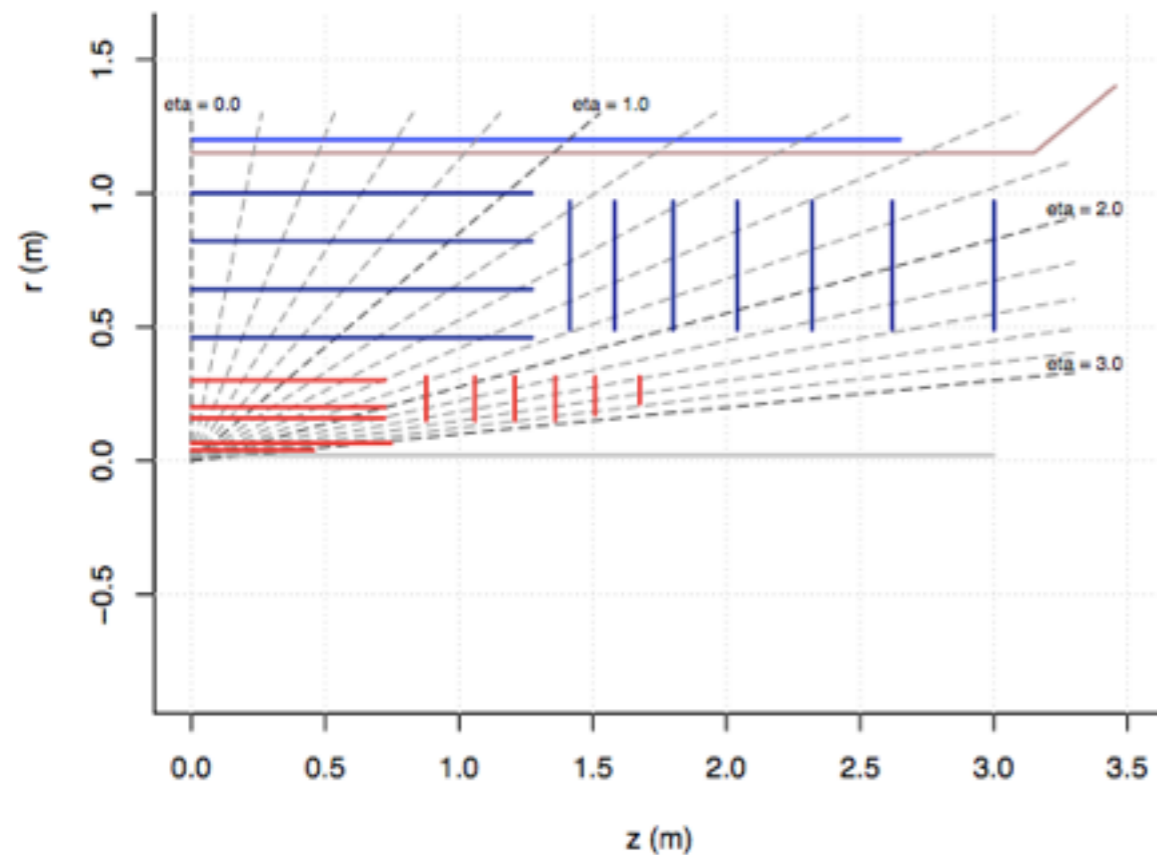
- needs redefinition of the end cap region (not done yet)

- bench mark studies defined (and some started)

- significant number of Pixel modules to be produced (~ 10k including VF extension)
  raises questions about feasibility/cost

Part 1 - Pixel input (1)

5 Layers, $\eta = 3.2$

	Radius	# staves/rings	# mods per struct	# modules	Cost
			$\eta = 3.2$		
Layer 1	3.9	16	60	960	7092.87
Layer 2	6.5	16	60	960	
Layer 3	16	32	35	1120	10025.03
Layer 4	20	40	35	1400	
Layer 5	30	60	35	2100	7612.60
Layer 6	34	68	35	2380	
Ring Set 1	15-19	8	36	288	
Ring Set 2	21-25	20	48	960	9718.90
Ring Set 3	27.5-31.5	22	60	1320	
Ring Set 4	33.5-37.5	24	72	1728	5841.20
					4325.78
Total				10836	44616.38

- 10836 modules, 15.7 m², ~44.6 MCHF
- Back of the envelope extrapolation from $\eta=4$

5 Layers, $\eta = 4$

	Radius	# staves/rings	# mods per struct	# modules	Cost
			$\eta = 4$		
Layer 1	3.9	16	60	960	7092.87
Layer 2	6.5	16	60	960	
Layer 3	16	32	35	1120	10025.03
Layer 4	20	40	35	1400	
Layer 5	30	60	35	2100	7612.60
Layer 6	34	68	35	2380	
Ring Set 1	15-19	18	36	648	12293.66
Ring Set 2	21-25	24	48	1152	
Ring Set 3	27.5-31.5	24	60	1440	
Ring Set 4	33.5-37.5	24	72	1728	5841.20
Other					4497.81
Total				11508	47363.17

- 11508 modules, 16.8 m², ~47.5 MCHF
- Still large uncertainties in the number of rings (need simulations and optimized tracking).
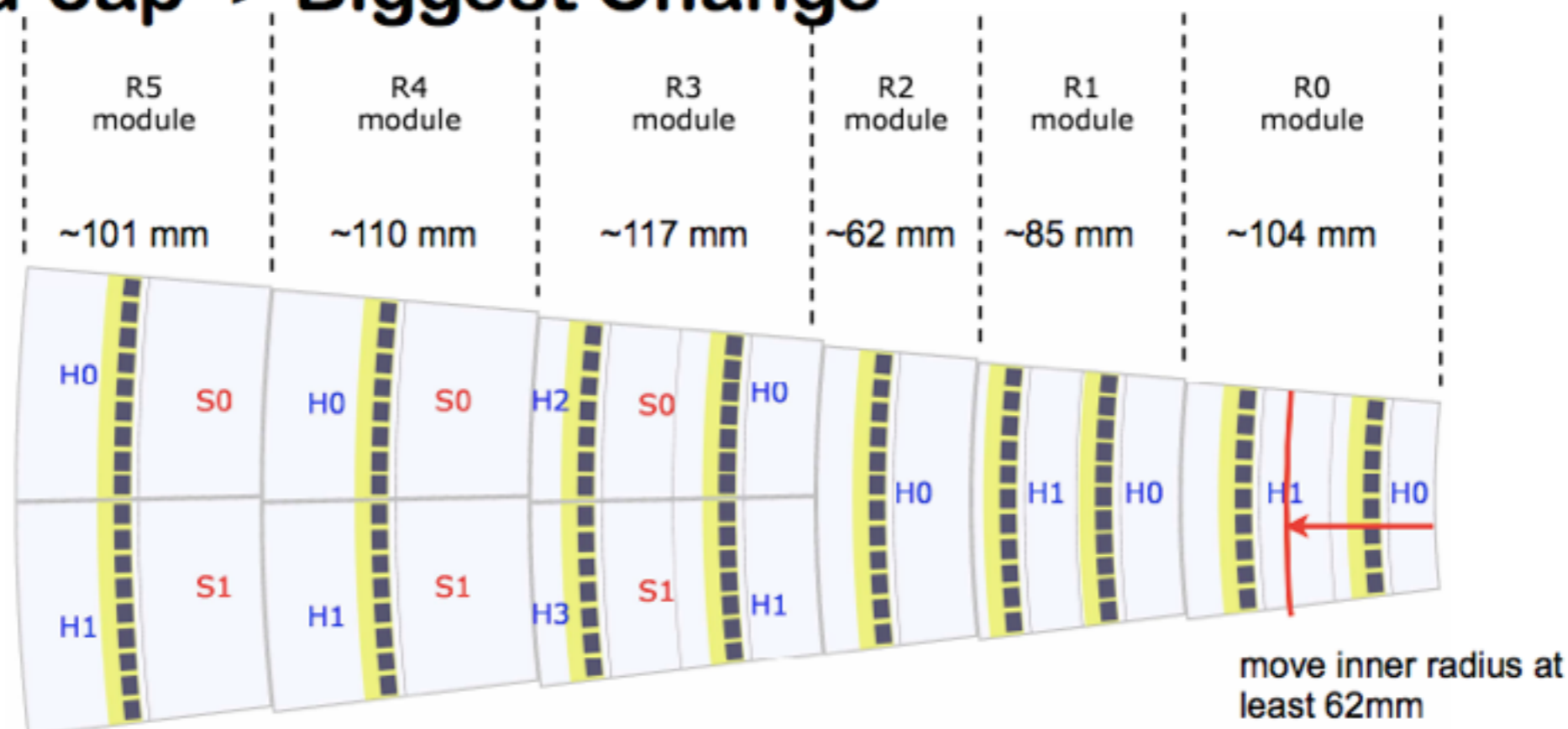
7

Part 1 - Pixel input (3)

Problems to address

- **Cost**: removing one strip layer saves at most ~10 MCHF.

- **Local supports**: new studies needed to optimize material and increase loading efficiency.

- **Production**: more workload, need to exploit the available resources and find help from new groups.

- **Bump-bonding**: a possible bottleneck, the process is intrinsically slow and prone problems that may reduce the rate.
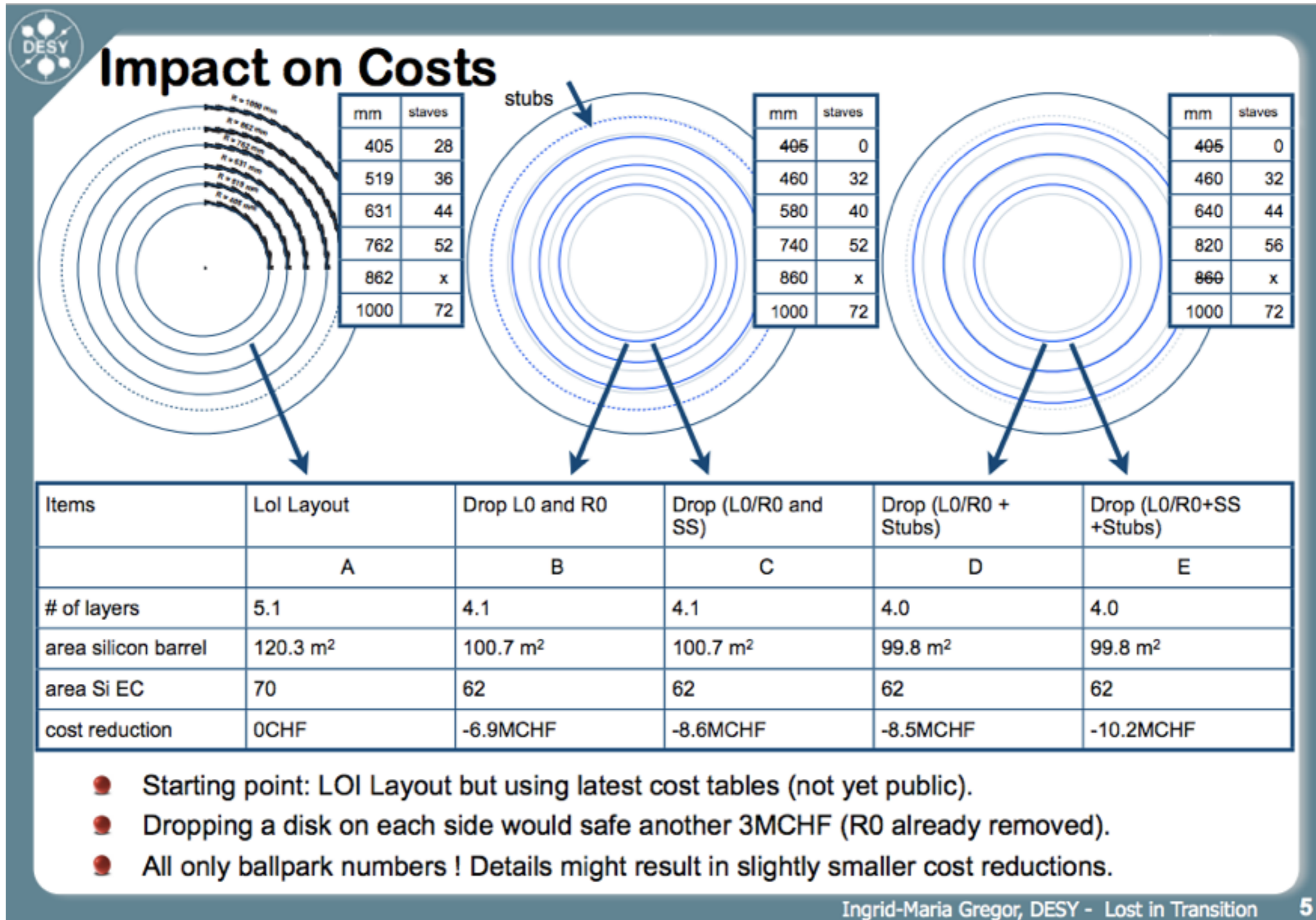
End-cap -> Biggest Change

R5 module	R4 module	R3 module	R2 module	R1 module	R0 module
~101 mm	~110 mm	~117 mm	~62 mm	~85 mm	~104 mm

move inner radius at least 62mm

- Change of at least 62 mm: remove R2 or R0 from petal and thus reduce number of sensors for the end-cap
- Very preliminary study: need to study details
  - if R2 removed: redesign -> turns out that still 9 modules per petals side are needed
  - if R0 removed: "cut" petal short and drop R0 (assumed in further discussion)
- End-cap local/global support and services (barrel and EC) to be redesigned !!
- All studies so far: **removed R0** and thus increased gap between pixel end-cap and strip end-cap

Impact on Costs

mm	staves
405	28
519	36
631	44
762	52
862	x
1000	72

stubs

mm	staves
405	0
460	32
580	40
740	52
860	x
1000	72

mm	staves
405	0
460	32
640	44
820	56
860	x
1000	72

Items	Lol Layout	Drop L0 and R0	Drop (L0/R0 and SS)	Drop (L0/R0 + Stubs)	Drop (L0/R0+SS +Stubs)
	A	B	C	D	E
# of layers	5.1	4.1	4.1	4.0	4.0
area silicon barrel	120.3 m²	100.7 m²	100.7 m²	99.8 m²	99.8 m²
area Si EC	70	62	62	62	62
cost reduction	0CHF	-6.9MCHF	-8.6MCHF	-8.5MCHF	-10.2MCHF

- Starting point: LOI Layout but using latest cost tables (not yet public).
- Dropping a disk on each side would safe another 3MCHF (R0 already removed).
- All only ballpark numbers ! Details might result in slightly smaller cost reductions.

Part 1 - Strip input (3)

Preliminary Conclusion

- Impact on strip R&D acceptable
  - Need to define radius soon to avoid delays towards TDR
- Cost reduction in CORE around up to ~10MCHF
  - number to be treated with care as large error bars are possible

- EC production easer with one ring less
  - One sensor and two hybrid designs removed from long list
  - Less modules to be produced (8064 -> 7168)

- Barrel module production also reduced

- Larger radius for pixel system acceptable for strip system if decision is taken before summer.
- Exact layout of strips requires fresh look at occupancies and barrel-endcap transition region.

Program of the workshop - Part 1

‣ Pixel/strip boundary definition

- tendency within the project to move from a **4** + **5.1** setup towards a **5** + **4** setup

investigation of slightly enlarged strip barrel
to minimise stub gap effect

radial reduction of strip disk system,
simplification of sensor design
(drop one type of sensor)

larger area to cover for pixel system (production constraints?)
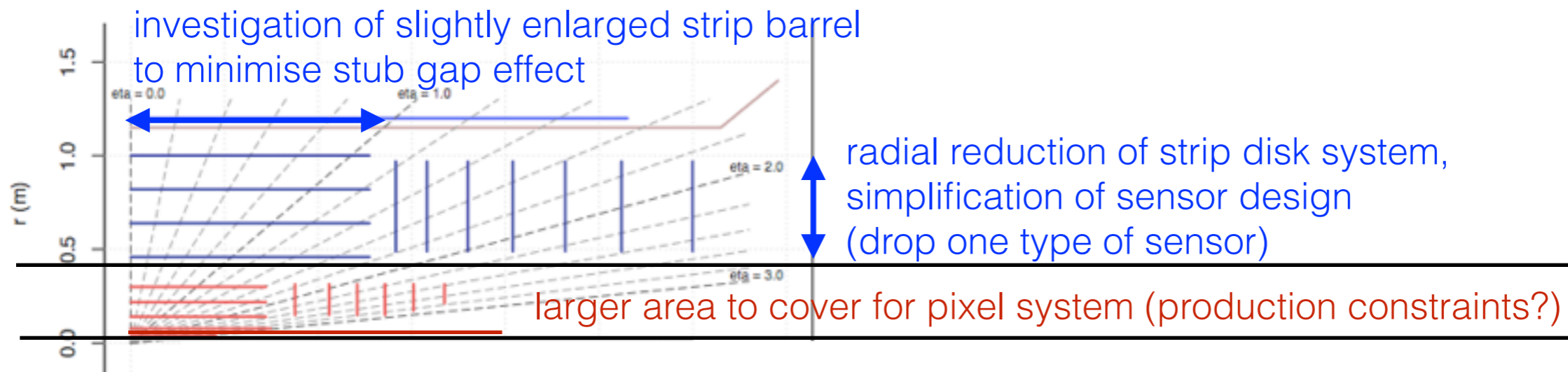
‣ Performance studies started

- effects on track seeding in pattern recognition

- potential gain in TIDE (e.g. boosted b-jets) , conversion reconstruction

‣ Extended barrel design in consideration

- exploit cluster properties to classify tracks (e.g. fake probability)

Part 1 - Studies - TIDE

Seems to work

- Only plotting track inside jets, Z'
- Goes into the right direction for track in jets efficiencies etc (a bit low stats..)
- Does not mess up inclusive efficiency
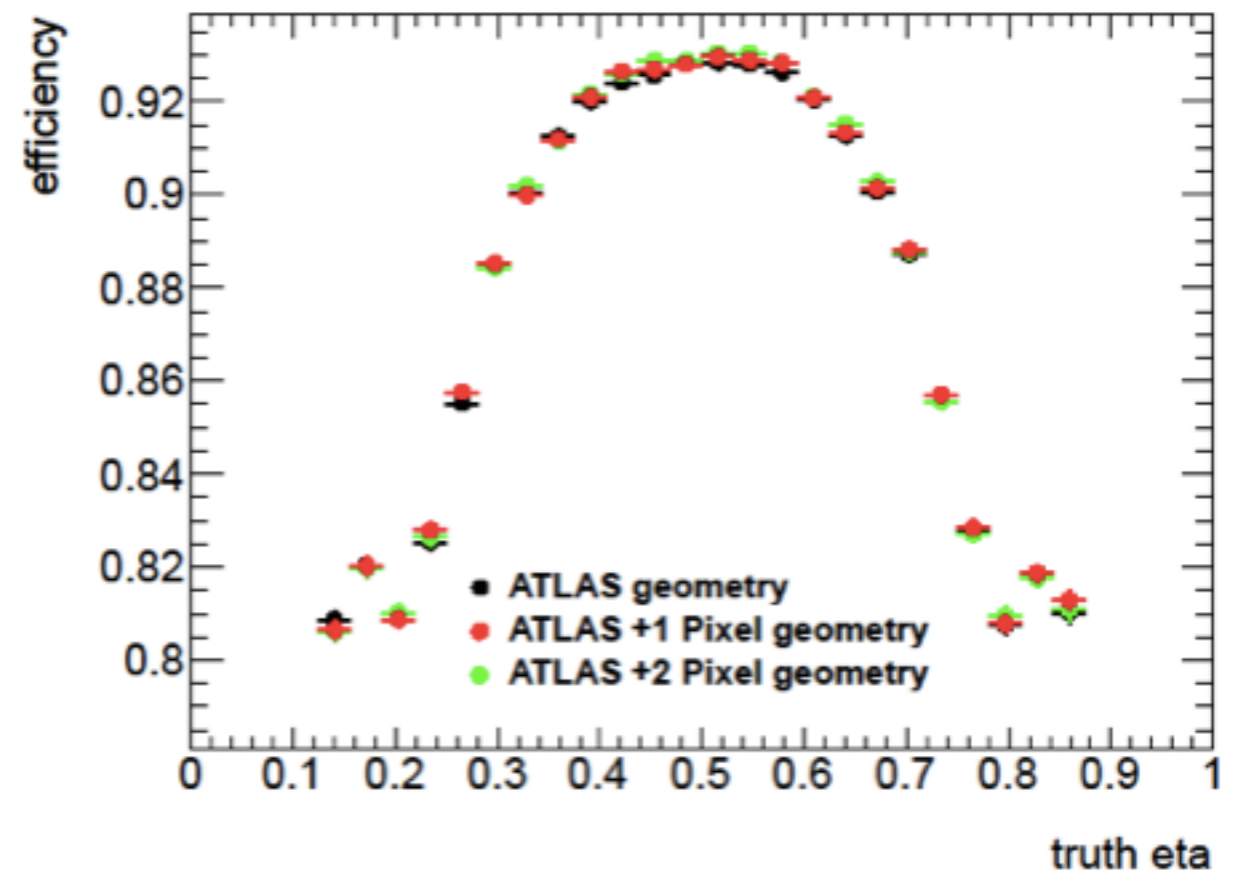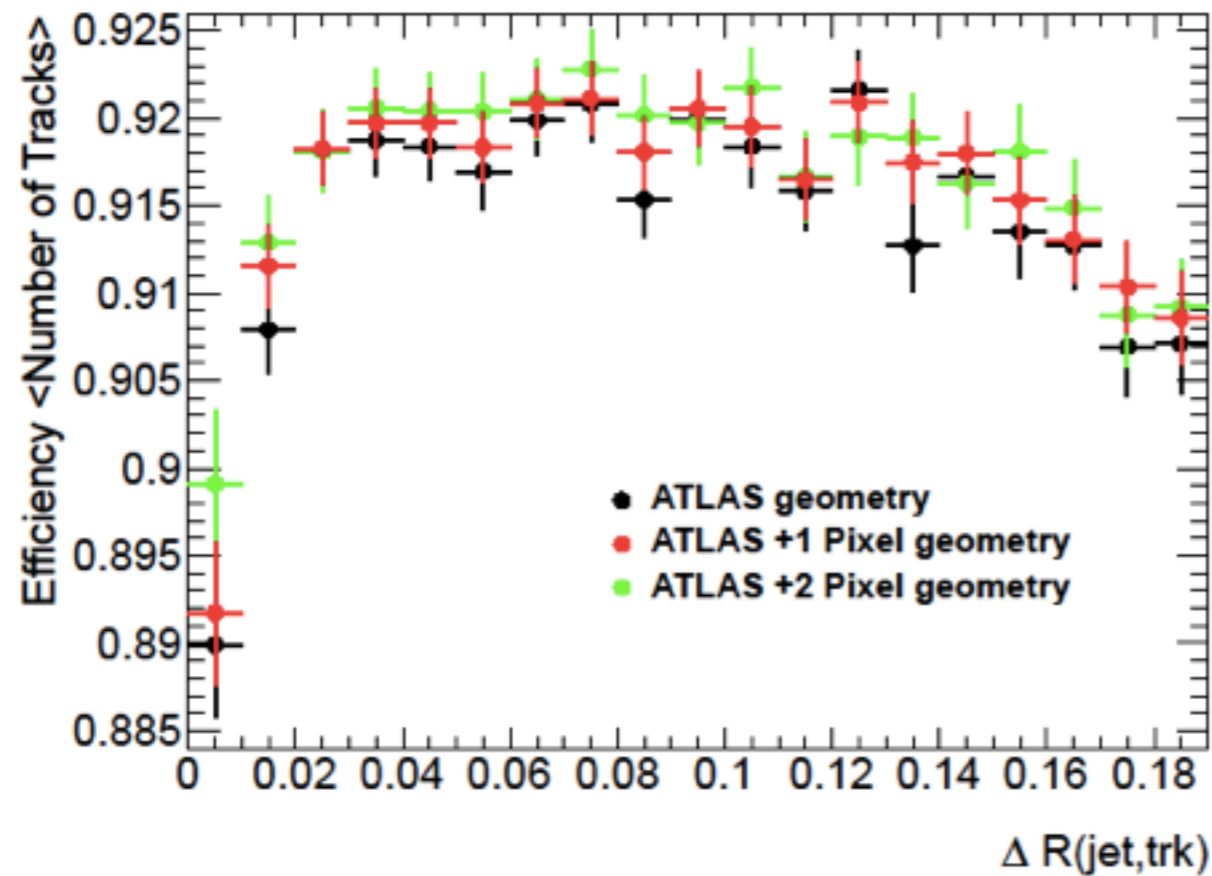
Part 1 - Studies - Fakes

Fake with various layout

In general, loose Si Hit requirement has large efficiency.

- Efficiency strongly depends on the n Si Hit requirement.

- While, the fake doesn't.

- The layout with fewer layer has larger fake rate. (~ +0.5%)

- Pix5B seems have better rejection at mu=200. (~25% better than LoI)

electron pT=15GeV

ε_{fake}

○/□/△ LoI (Si Hits ≥ 9,10,11)   Barrel |eta|<1.0
○/□/△ Pixel 5A + strip D
○/□/△ Pixel 5B + strip D
○/□/△ Pixel 4(LoI) + strip D

$\langle\mu\rangle$ = 200

Si Hits ≥ 11   10   9

$\langle\mu\rangle$ = 0

ε_{reco}
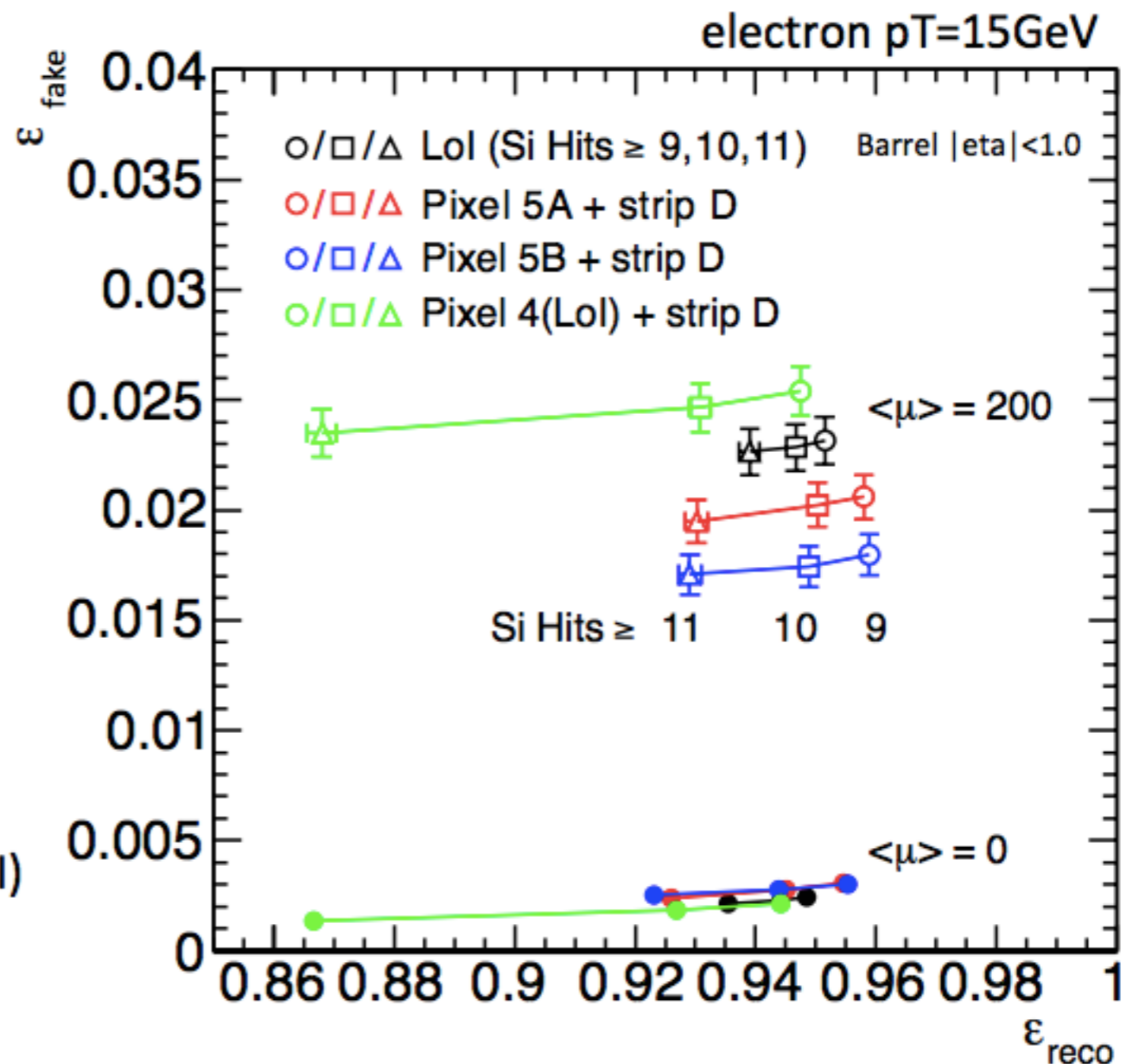
Outcome of the workshop - Part 1

‣ Pixel/strip boundary definition

11:10 - 13:00	Pixel Volume extension	
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ITk : 4p5.1s ⟶ ILTF baseline : 5p4s

13s barrel modules ⟶ 14s barrel modules

Todo's after part 1

‣ Increase of PST is not yet clear

  - proposal to have two baselines with **345mm** and **390mm**

  - both layouts need an optimisation of the layers (see talk of Markus at WS)

  - both layouts need a coherent forward extension

‣ Pattern recognition study for n pixel layers and m strip layers

  - full simulation setup for a basic layout can be done in O(1 week)

  - can test with 6p setup if the trent shown by Soshi continues

‣ Hopefully achieve one/two new baseline layout(s) within O(weeks)

  - optimisation started (-> talk in tomorrow's TF meeting)

Program of the workshop - Part 2

‣ Forward coverage/extension

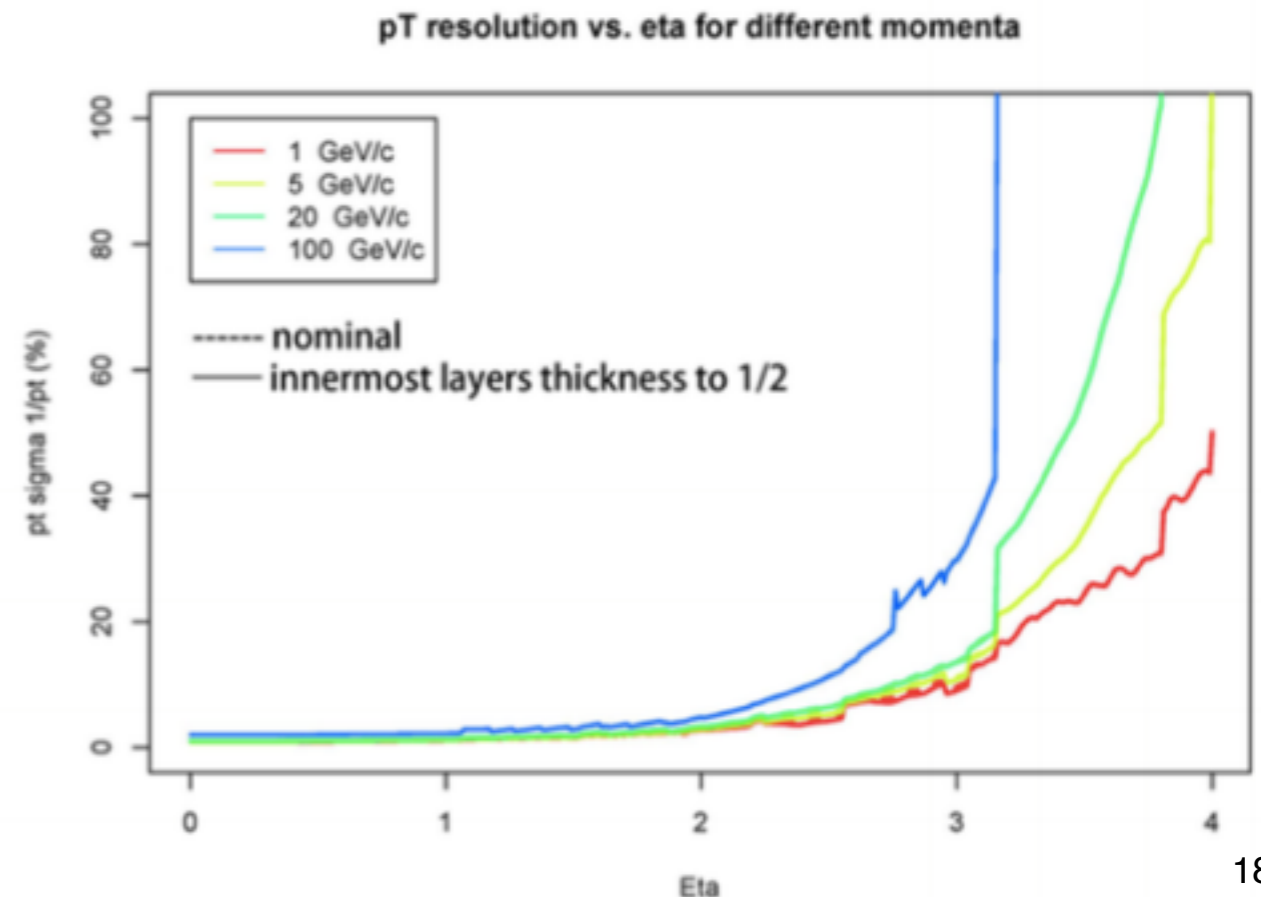|		
14:00 - 18:00	**Forward and Very Forward regions** Location: 3162-1-K01	
14:00	**(F) Inclined sensors for the barrel-endcap transition** *15'* Speakers: Jessica Leveque (LAPP (Annecy-Le-Vieux)), Sergio Gonzalez Sevilla (Universite de Geneve (CH))	
14:15	**(F) Detector input: strips** *15'* Speaker: Ingrid-Maria Gregor (DESY)	
14:30	**(F/VF) Calorimeters requirements on ITK** *15'* Speaker: Sven Menke (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D)	
14:50	**(VF) Physics performance (and tracking requirements)** *30'* Speakers: Pippa Wells (CERN), Anadi Canepa (TRIUMF (CA))	
15:25	**(VF) Detector Feedback: mechanics (TBC)** *15'* Speaker: Danilo Giugni (Università degli Studi e INFN Milano (IT))	
15:40	**Coffee** *20'*	
16:00	**Sim: Fluences and doses** *15'* Speakers: Ian Dawson (University of Sheffield (GB)), Paul Miyagawa (University of Sheffield (GB))	
16:15	**Sim: Descoping and LoI-VF** *30'* Speakers: Andreas Korn (University College London (GB)), Helen Hayward (University of Liverpool (GB))	
16:50	**Sim: track clustering** *20'* Speakers: Aliaksandr Pranko (Lawrence Berkeley National Lab. (US)), Simon Viel (Lawrence Berkeley National Lab. (US))	
17:10	**Workshop wrap-up** *30'* Speakers: Andreas Salzburger (CERN), Claudia Gemme (Universita e INFN Genova (IT))	

Program of the workshop - Part 2

‣ Forward coverage/extension

- tracker extension to |η| < 4 under consideration, incl. extended barrel concepts

- physics driven arguments:
  forward pile-up jet rejection, acceptance enhancement, additional PDF constraints

- consequences on calorimetry/L1Track needs to be understood

‣ Requirements for very forward tracking not yet fully established

- workshop should help to draft
  the first very forward requirements

- pT resolution breaks down at |η| > 3

- what sort of tracker do we design for ?
  - high efficiency/low fake rate detector
  - tagging detector

pT resolution vs. eta for different momenta

1 GeV/c
5 GeV/c
20 GeV/c
100 GeV/c

nominal
innermost layers thickness to 1/2

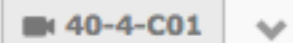pt sigma 1/pt (%)

Eta

Wrap-up WS meeting, tomorrow !

ITK Layout task force

chaired by Andreas Salzburger (CERN), Claudia Gemme (Universita e INFN Genova (IT))

📅 Friday, 3 July 2015 from **16:00** to **18:25** (Europe/Zurich)

📍 **CERN (40-4-C01)**

Manage ▾

Videoconference Rooms

First_Meeting_of_the_ITK_Layout_task_force   **Join** ▾   🎥 40-4-C01 ▾

Friday, 3 July 2015

16:00 - 16:25	**Workshop Wrap-up and next steps** *25'* Speakers: Claudia Gemme (Universita e INFN Genova (IT)), Andreas Salzburger (CERN)
16:25 - 16:45	**Pixel and PST** *20'*
16:45 - 17:00	**Strip and PST** *15'*
17:00 - 17:20	**Forward region layouts for PST study** *20'* Speakers: Markus Elsing (CERN), Andreas Salzburger (CERN), Paolo Morettini (INFN Genova), Claudia Gemme (Universita e INFN Genova (IT))
17:20 - 17:40	**Full simulation updates** *20'* Speaker: Soshi Tsuno (High Energy Accelerator Research Organization (JP))
17:40 - 18:00	**Tracking with extended barrel** *20'* Speakers: Simon Viel (Lawrence Berkeley National Lab. (US)), Aliaksandr Pranko (Lawrence Berkeley National Lab. (US))