

CLHCP 2017 at Nanjing (2017.12.22-24)

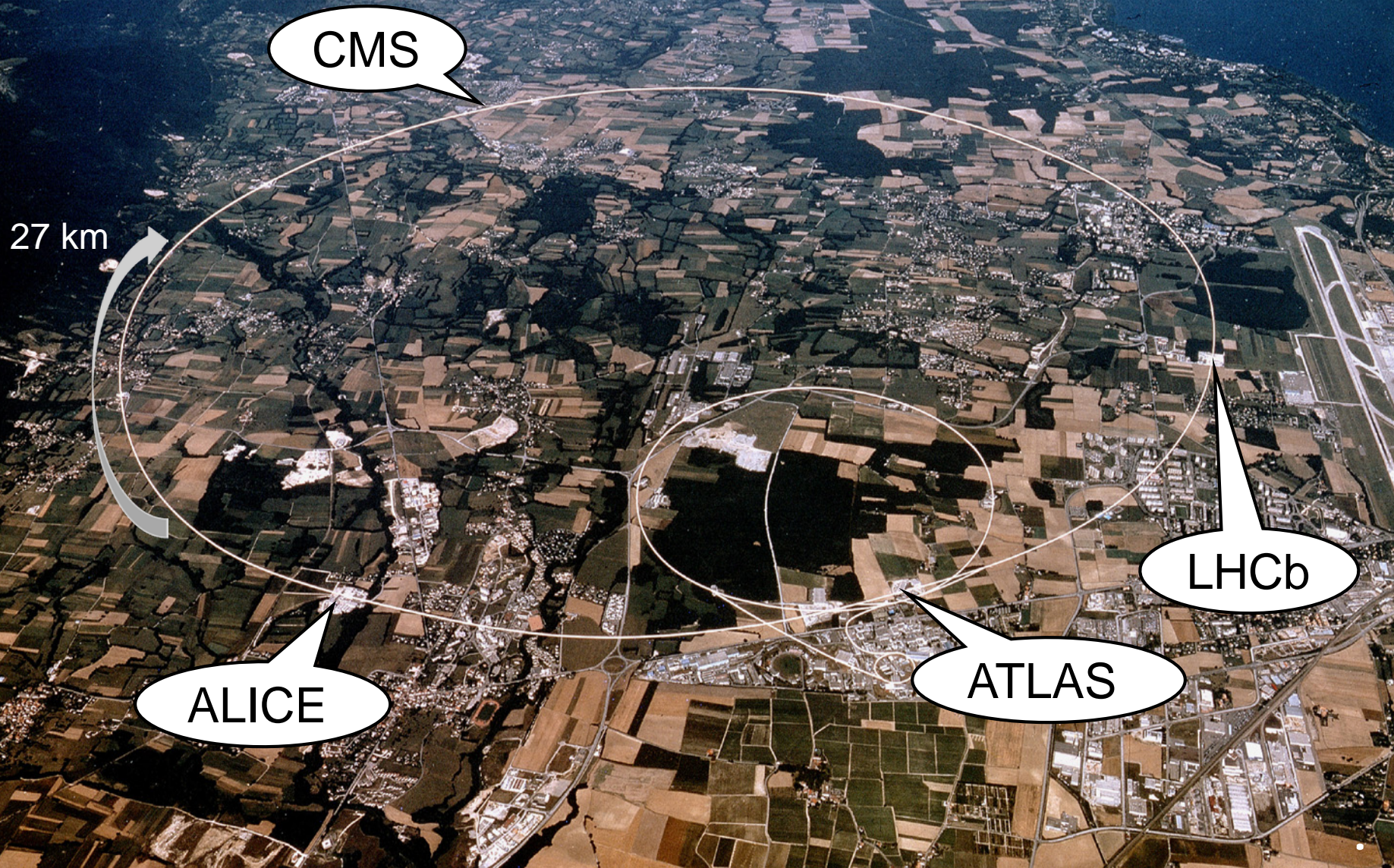
ATLAS Phase II Update

- Inner tracking: silicon strip detector ----Xin Shi et al
- Thin gap muon trigger RPC ----Yongjie Sun

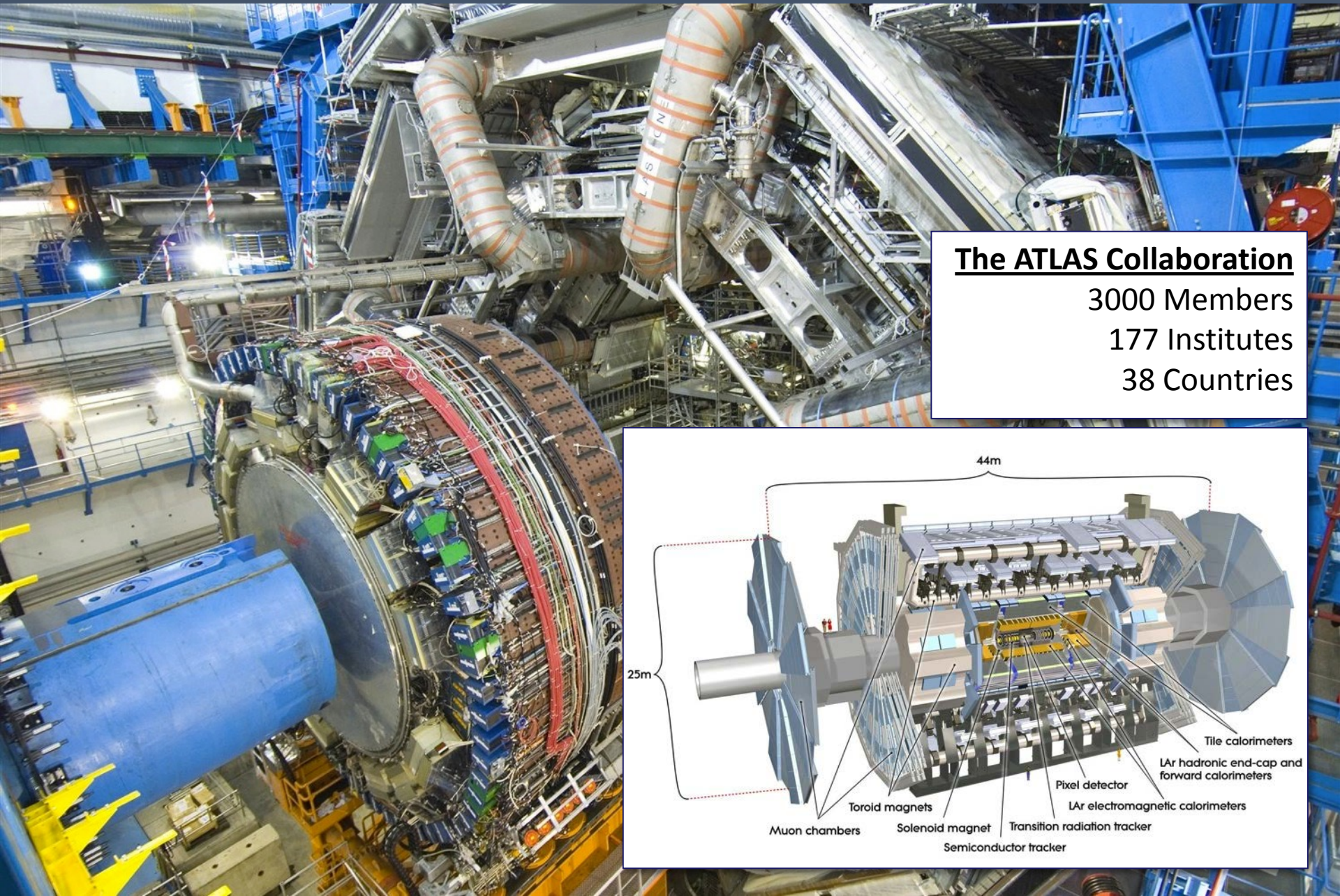
Yuzhen Yang
2017.12.29

Special Topic

The Large Hadron Collider at CERN



LHC Point 1: The ATLAS Experiment

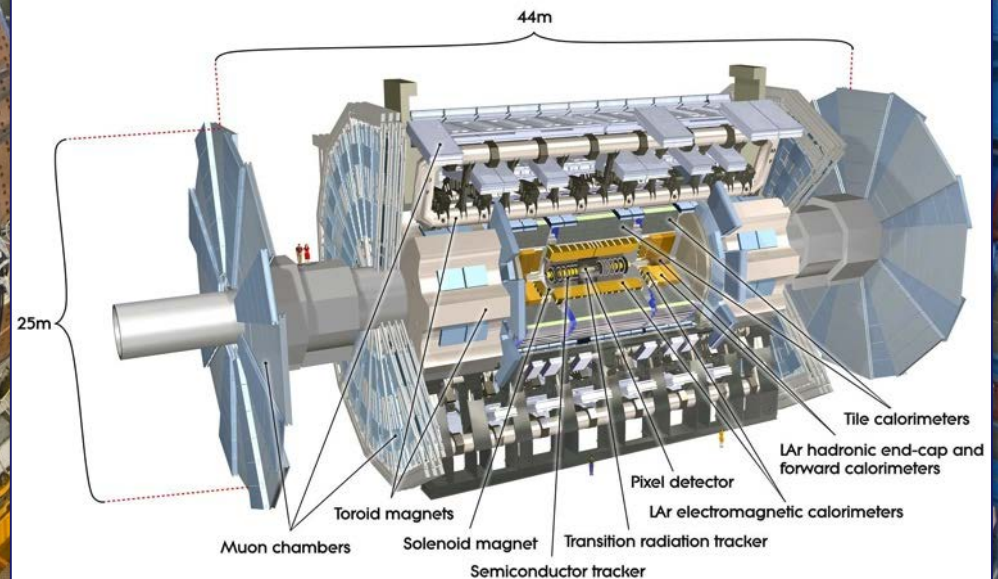


The ATLAS Collaboration

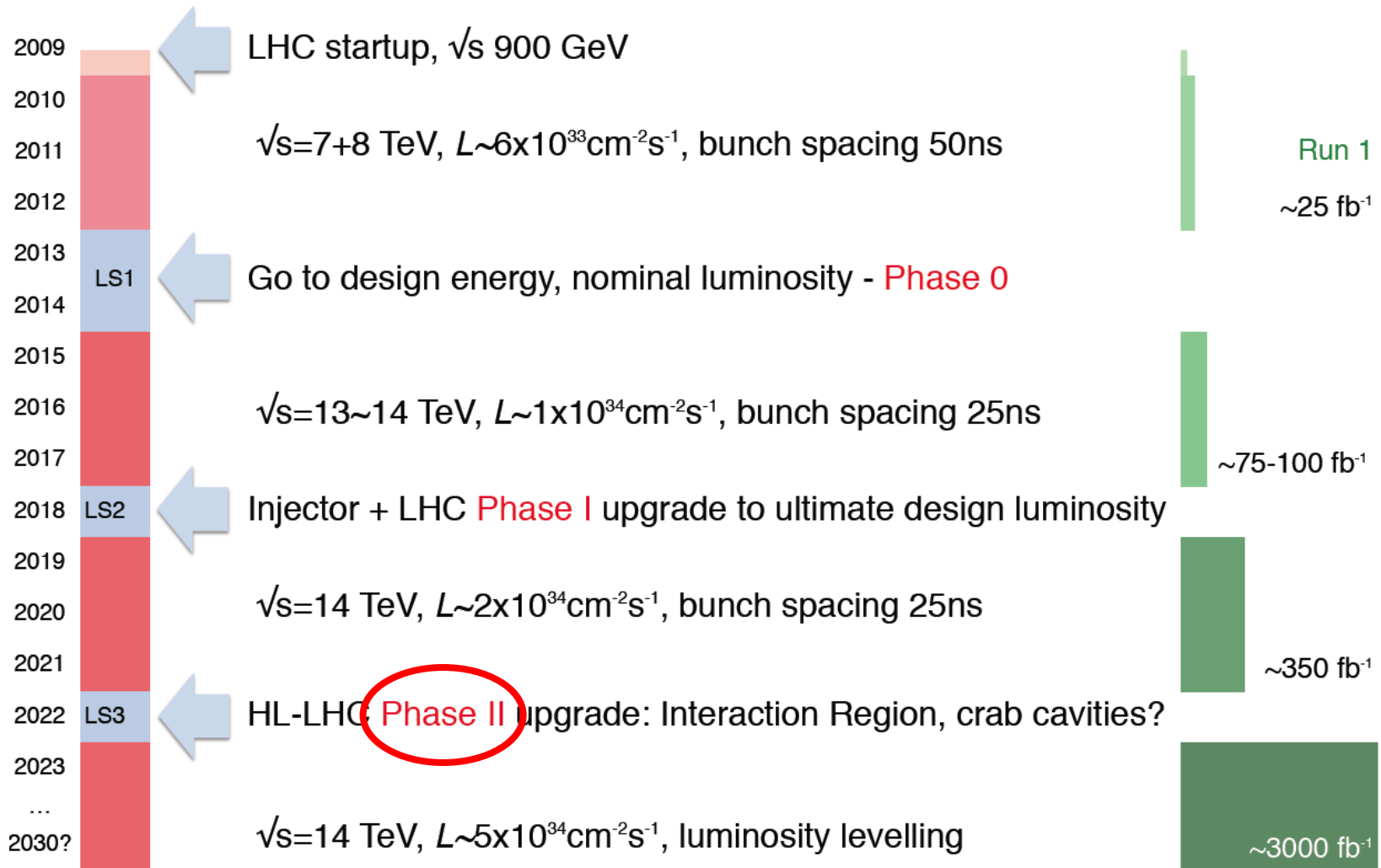
3000 Members

177 Institutes

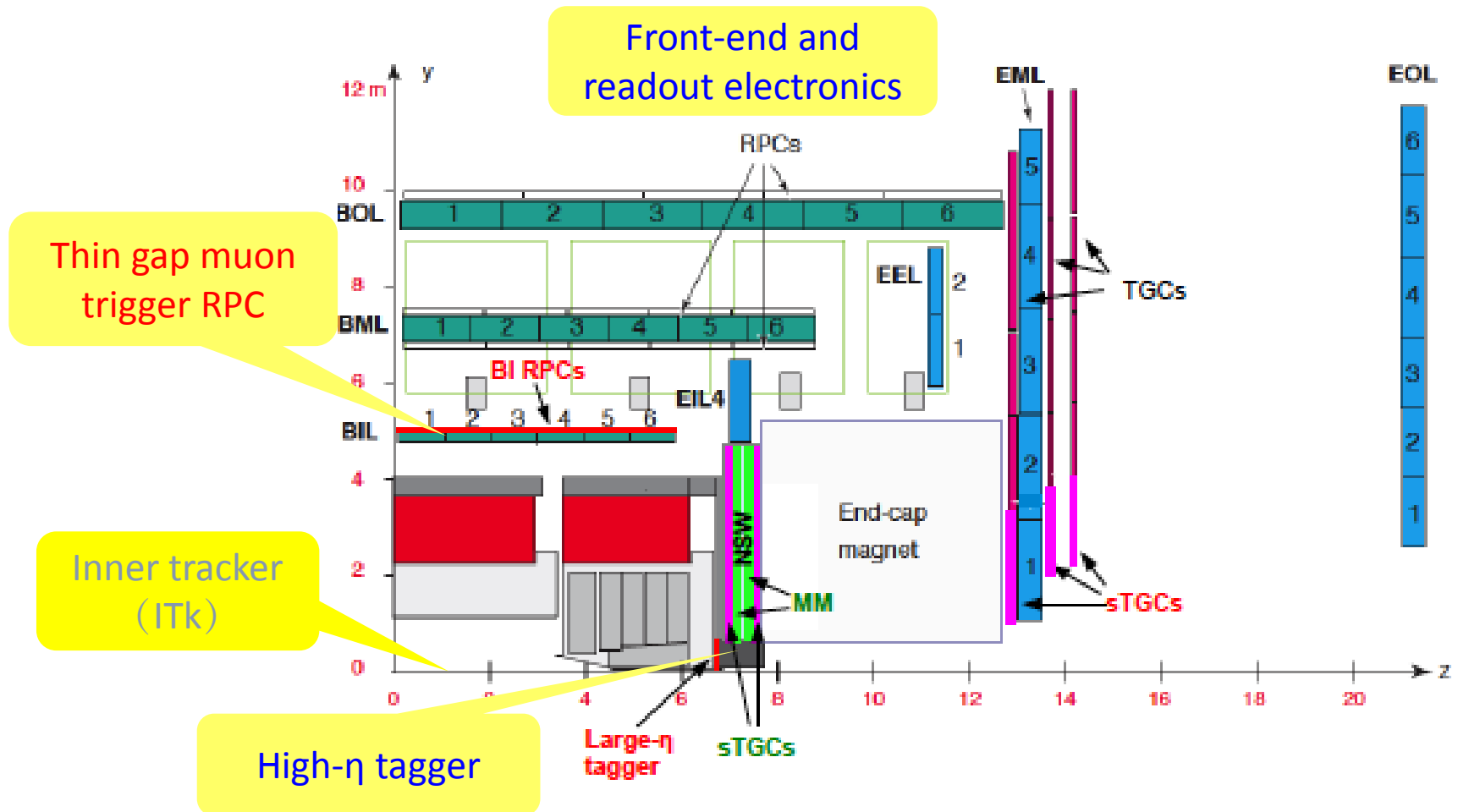
38 Countries



LHC to HL-LHC



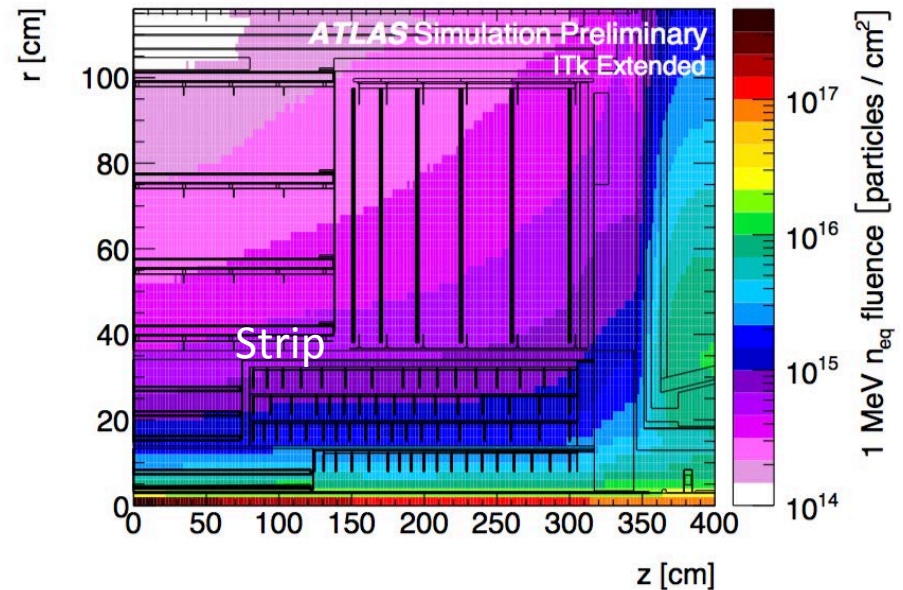
ATLAS Phase-II upgrade



ATLAS ITk Upgrade

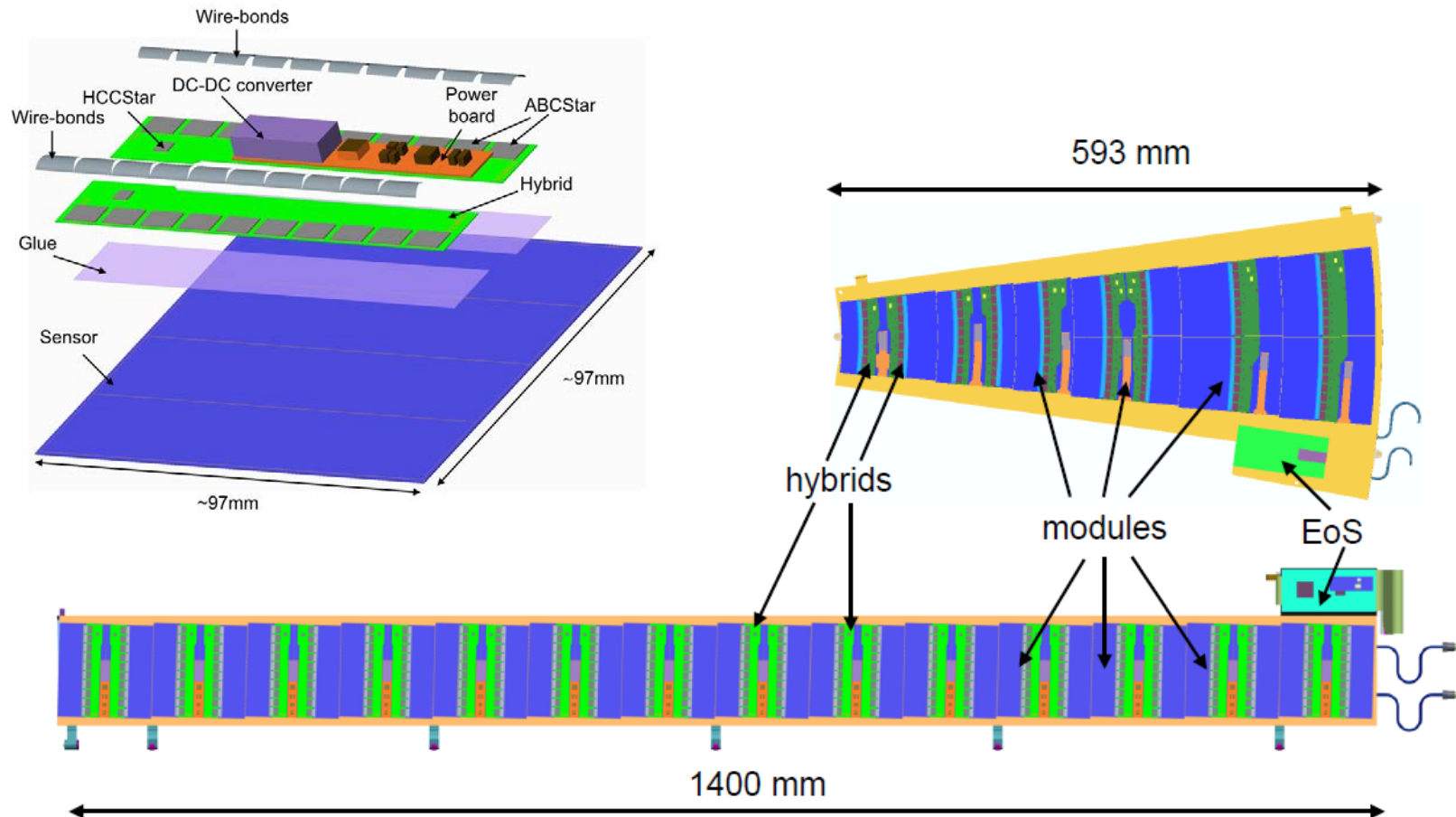
- ATLAS Detector upgrade for the LHC high luminosity upgrade, all silicon tracking device

Layer	Radius [mm]	Maximal Fluence [n_{eq}/cm^2]	Maximal Dose [MRad]
Strips			
Long Strips	762	4.2×10^{14}	10.7
Short Strips	405	8.1×10^{14}	35.7
End-cap	385	1.2×10^{15}	50.4
Pixels			
Layer 0	39	2.25×10^{16}	1710
Layer 1	75	0.82×10^{16}	715
Layer 2	155	0.25×10^{16}	148
Layer 3	213	0.12×10^{16}	96
Layer 4	271	0.12×10^{16}	61
End-cap	80	0.67×10^{16}	687



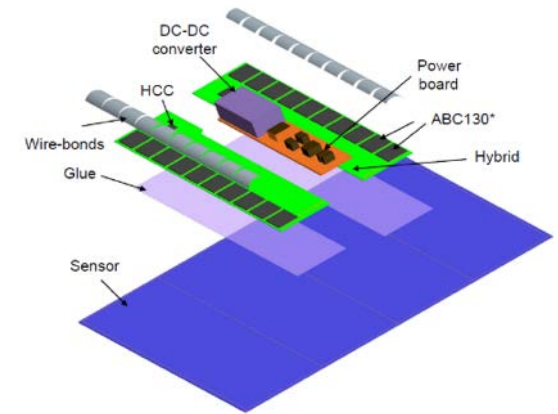
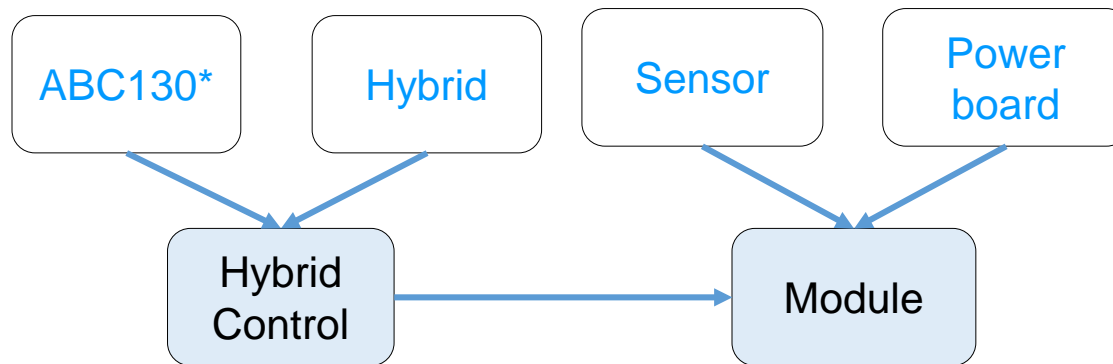
ITk Silicon Strip Detector Concept

- Stave/Petal + Mechanics Supported Silicon Modules



Assembly and tests of barrel modules

- Produce 50 working modules during pre-production



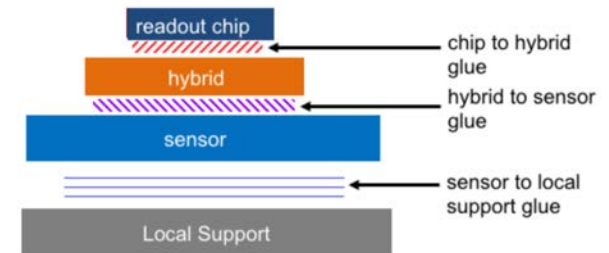
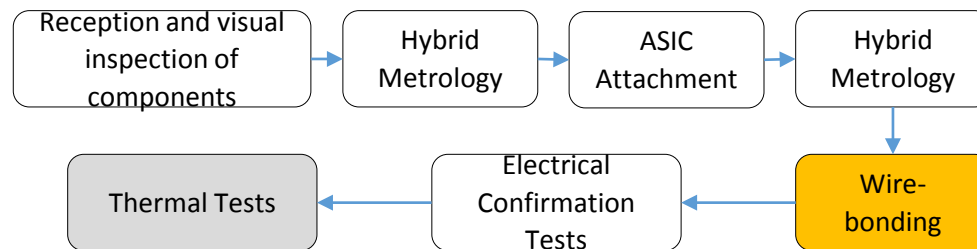
Silicon Strip Detector Module

- Silicon Sensor + Hybrid PCB (with Readout ASICs and control chips) + Power board + Glue and Wire-bonds

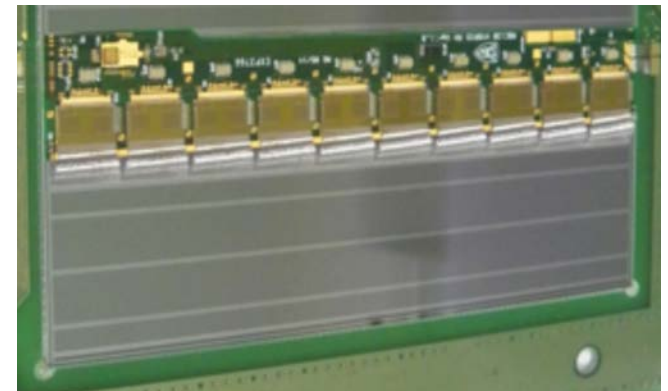
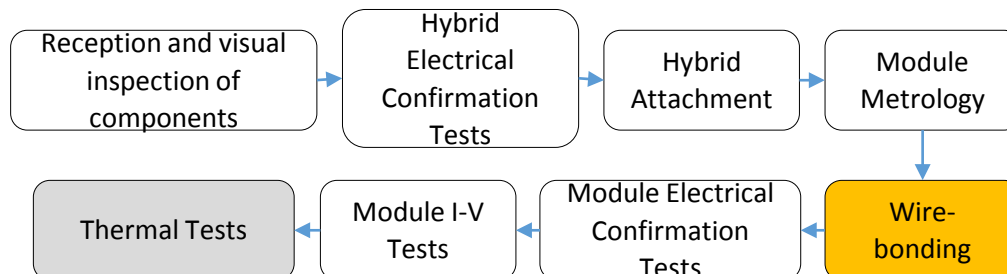
Quality Control

- Based on the prototype study, along with the current ATLAS SCT detector experience, improve the quality control (QC) of module production process

Control board QC



Detector Module QC





R&D on high performance RPC for the ATLAS Phase-II upgrade

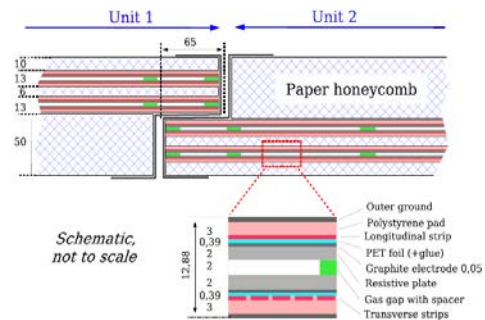
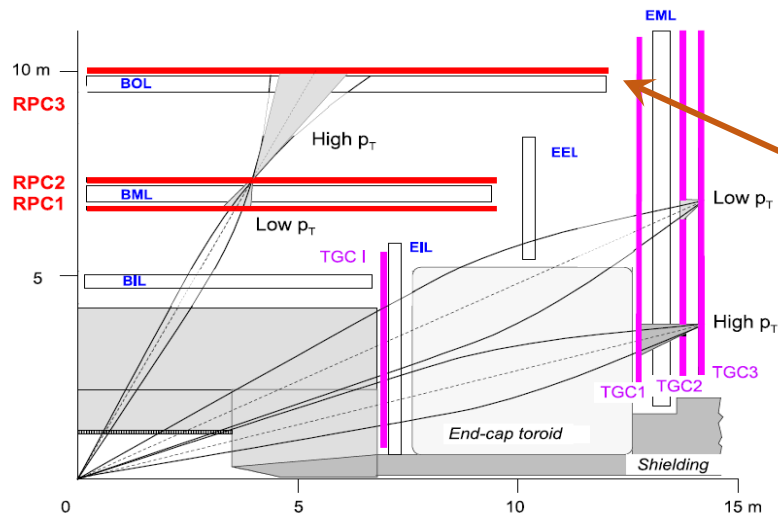
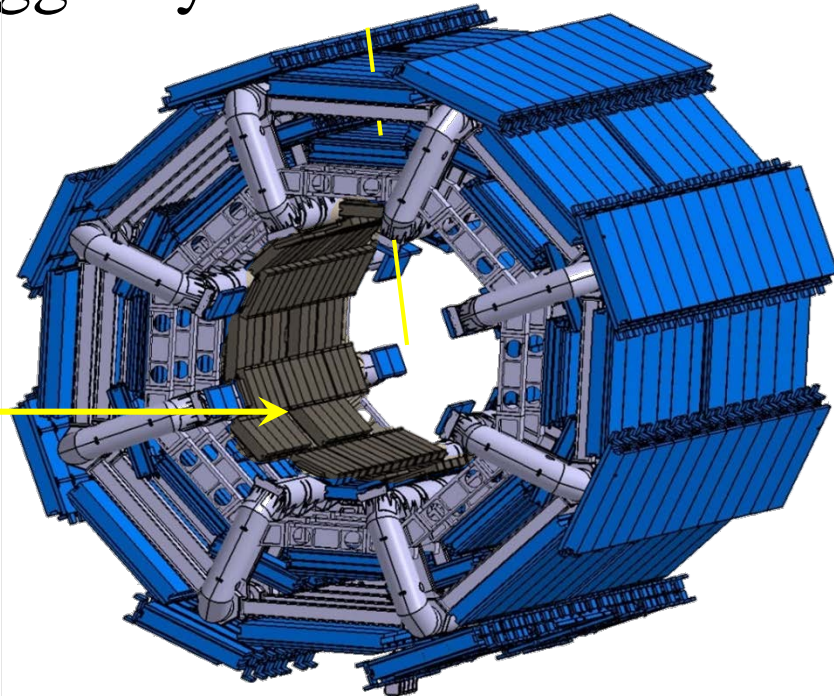
Yongjie Sun

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Department of Modern Physics, USTC

Current ATLAS RPC muon trigger system

- ▶ 6 layers RPC (BM and BO), measure η & ϕ position on each layer.
- ▶ OUTER LAYER (BO) for High p_T trigger
- ▶ MIDDLE LAYER (BM) for Low p_T trigger
- ▶ NO RPC on INNER LAYER (BI))



The main problems of current RPC

➤ Longevity:

- Designed for work under $1 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$ @14TeV for 10 years, corresponding to integrate charge of 0.3 C/cm^2
- Reach the life time at HL-LHC
- Can only work under lower voltage with detection efficiency lost of 15%-35%

$$L = 7 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1} @ 14 \text{ TeV}$$

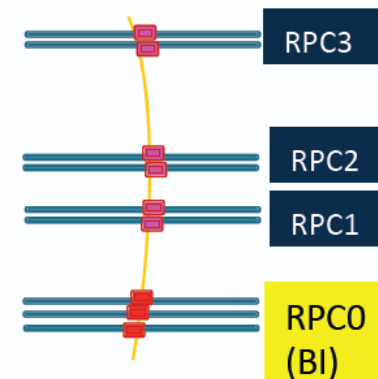
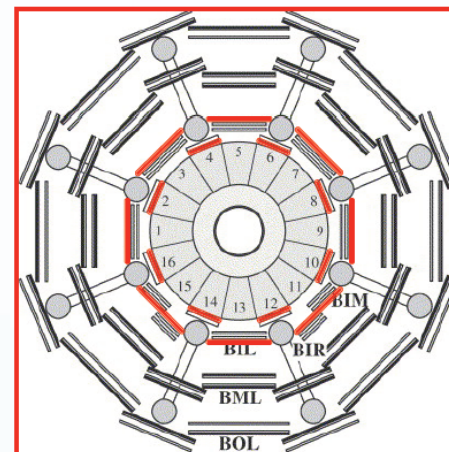
Sector	RPC unit Id. along Z direction																								Average
Φ deg.	-6.2	-6.1	-5.0	-4.0	-3.2	-3.1	-2.2	-2.1	-1.2	-1.1	1.1	1.2	2.1	2.2	3.1	3.2	4.0	5.0	6.1	6.2					
01.01	192	203	201	225	145	134	124	101	84	61	71	113	122	127	136	234	276	269	285						180
01.02	201	211	201	228	150	133	129	113	76	71	75	127	143	140	148	235	295	278	297						188
2	168	204	188	138	120	90	77	63	55	56	45	48	61	79	94	104	140	207	196	152					135
01.03	207	206	211	216	148	128	129	119	68	67	65	71	111	126	114	125	207	220	268	290					177
03.02	300	343	277	240	151	129	155	112	85	75	70	122	127	152	132	307	312	345	369						175
4	132	160	158	151	131	83	65	77	81	58	46	41	73	68	52	108	160	196	175	112					101
05.01	171	178	263	138	105	102	140	127	68	60	69	124	177	102	137	185	290	173	171						149
05.02	227	198	237	158	120	105	126	143	77	61	63	71	111	136	108	141	200	267	255	282					159
6	175	180	208	165	126	95	90	95	71	59	52	98	81	106	124	189	200	227	167						131
07.01	820	263	288	191	154	129	111	114	76	78			122	180	124	148	185	263	268	305					181
07.02	127	258	216	203	141	112	129	108	74	77			109	134	112	152	184	278	276	278					175
8	146	180	195	141	103	80	80	100	57	54			107	124	85	108	168	196	194	158					138
09.01	110	146	202	206	155	117	149	113	66	64			106	134	134	135	197	283	262	297					181
09.02	141	258	287	205	143	95	207	103	58	67			99	122	95	137	188	285	265	292					176
10	124	201	207	147	99	86	68	71	46	41	50		94	69	80	103	148	193	201	170					125
11.01	168	248	287	157	97	81	81	87	60	43			83	94	92	91	146	227	225	228					152
11.02	108	193	157	105	78	66	53	57	33	31			50	62	58	71	98	151	160	185					98
12									80	81	66	53	36	36	51	75	87	80							64
13.01	203	278	253		140	102	99	84	43	41	47	50		87	95	89	123	249	263	131					149
13.02	109	204	262		101	67	255	88	48	50	56	89	122	97	100			252	227	294					146
14									142	68	64	52	41	40	49	53	68	135							76
15.01	106	221	148	111	76	71	67	49	38	36			30	59	86	87	104	156	173	196					106
15.02	183	159	246	164	116	98	103	75	84	43			75	126	112	107	158	218	159	181					141
16	175	216	216	178	128	89	54	75	56	59	50	50	77	54	87	103	177	239	208	154					126
Average	220	223	234	167	118	101	96	88	56	52	51	56	86	97	103	118	171	240	221	221					137

➤ The rate capability:

- Under HL-LHC, the extrapolated rate on RPC will be an order of magnitude higher, $\sim 300 \text{ Hz/cm}^2$

➤ Basic solution:

- Add 3 BI RPC layers
- Rate: $\sim \text{kHz/cm}^2$, work 10 years for HL-LHC
- With higher spatial and time resolution for muon tracking and bunch crossing ID
- Close most of the acceptance holes





The basic requirements

- Higher rate capability: $\sim \text{kHz/cm}^2$
- Longer longevity: 10 years of HL-LHC
- Higher spatial resolution: $\sim \text{mm}$
- Higher time resolution: $\sim 0.5 \text{ ns}$

Current RPC detector:

- 2 mm gas gap, with avalanche mode $\rightarrow 1 \text{ mm}$
- Work voltage: 4.8 kV/mm $\rightarrow \sim 2.7 \text{ kV}$
- Charge: 30 pC/count
- Rate: 100 Hz/cm²
- Time resolution: 1.1 ns $\rightarrow 0.5 \text{ ns}$
- Strip pitch: 26-35 mm
- FEE: GaAs technology $\rightarrow \text{Si BJT} \rightarrow \text{SiGe}$
- Gas component: Freon, Iso-butane, SF6

Main challenges

- More sensitive, high signal-to-noise ratio, fast, low power consumption **Front End Electronics**
- **New materials** for a thinner and more rigid chamber structure
- Increasing the signal-to-noise ratio by optimizing **the gas gap and readout panel structure**
- Optimizing the detector parameters for **maximizing spatial and time resolution**, thus momentum resolution, and track-to-track separation.
- Looking for new **environment friendly** gas mixture.