

The background is a solid blue color with a pattern of faint, light blue geometric shapes, including rectangles and triangles, some of which are overlapping. There are also several small, light blue arrows pointing in various directions, creating a sense of movement and progress.

LHC UPGRADE ROADMAP

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Business from technology

OUTLINE

- Upgrade timeline
- Present tracker and orders
- Estimates for the upgrade
- Partner profiles

Timeline

ATLAS

- Letter of intent: 2009
- Technical design report: 2010
- Phase 1: 2011-2012
- Shutdown: 2013
- Phase 2:
 - Evaluation: 2012-2013
 - Mass production: 2013-2015
- Shutdown: 2018

CMS

- Letter of intent: 2010
- Technical design report: 2012
- Phase 1: 2012-2013
- Shutdown: 2013
- Phase 2:
 - Evaluation: 2013-2014
 - Mass production: 2014-2016
- Shutdown: 2018

Present tracker and orders

ATLAS

- Fabrication on **100** mm wafers
- Pixel tracker:
 - ~1.75 m² of silicon
 - 830 wafers
 - 100% CiS production
- Semiconductor tracker (SCT):
 - ~63 m² of silicon
 - 15382 wafers Hamamatsu
 - 1196 wafers CiS

CMS

- Fabrication on **150** mm wafers
- Pixel tracker:
 - ~1 m² of silicon
 - 485 wafers
 - 100% CiS production
- Semiconductor tracker (SCT):
 - ~210 m² of silicon
 - 24244 wafers
 - 98% Hamamatsu
 - 2% ST Microelectronics

Phase 1

ATLAS (IBL)

- 0,3 m² of silicon
- ~100 wafers
- 3D or thin planar pixels?
- Thickness <200 um
- Readout: FE-I3?
- 50x400 um² pixel size
- Electrons collected: n-on-n or n-on-p
- 100 mm fabrication

CMS

- ~2 m² of silicon
- ~200 wafers
- Thin planar pixels?
- Thickness <200 um
- 150x100 um² pixel size
- Electrons collected: n-on-n (p-on-n)
- 100/150 mm fabrication

Phase 2: Pixels

ATLAS

- 5 m² of silicon
- ~500 wafers
- 3D (layers 1&2) pixels
- Thin planar pixels (R>10 cm)
- Thickness <200 um
- Readout: FE-I4?
- 50x250 um² pixel size
- Electrons collected: n-on-n or n-on-p
- 100/150 mm fabrication

CMS

- 2-4 m² of silicon
- ~400 wafers
- 3D (layers 1) pixels
- Thin planar pixels (R>7 cm)
- Thickness <200 um
- 50x100 um² pixel size
- Electrons collected: n-on-p
- 100/150 mm fabrication

Phase 2: Short strips

ATLAS

- 60 m² of silicon
- ~6000 wafers
- Strip length 2.4 cm, pitch 70 μ m
- Thickness ~250 μ m
- Electrons collected: n-on-p
- 150 mm fabrication

CMS

- 40-60 m² of silicon
- ~4000-6000 wafers
- Strip length 2-4 cm, pitch 100 μ m
- Thickness <200 μ m
- Electrons or holes collected: n-on-p or p-on-n
- 150 mm fabrication

Phase 2: Long strips

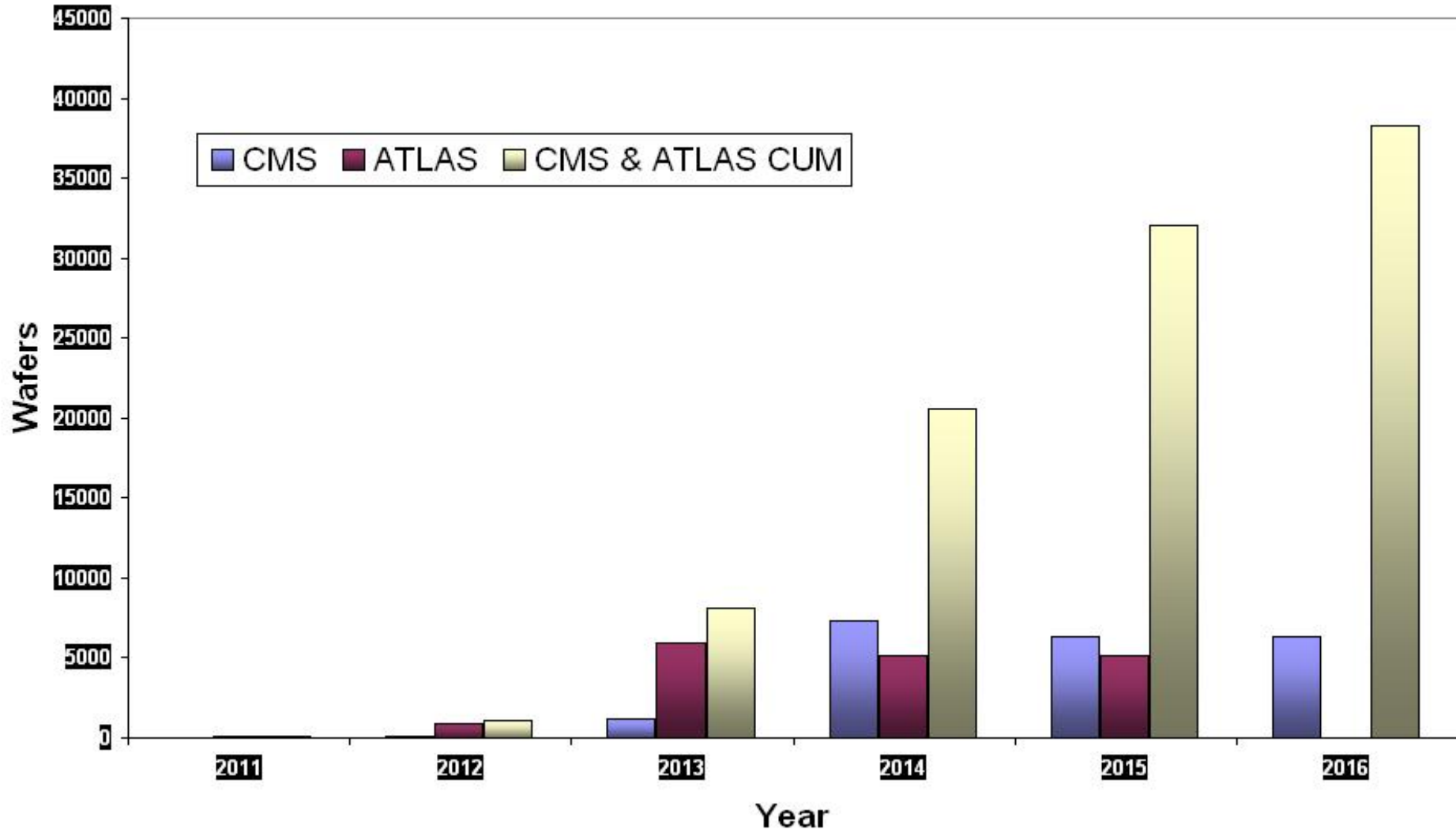
ATLAS

- ~100 m² of silicon
- ~10000 wafers
- Strip length 9.6 cm, pitch 80 μ m
- Thickness ~250 μ m
- Electrons collected: n-on-p
- AC-coupled
- 150 mm fabrication

CMS

- 110-190 m² of silicon
- 11000-19000 wafers
- Strip length 10 cm, pitch 100 μ m
- Thickness <300 μ m
- holes collected: p-on-n
- AC-coupled
- 150 mm fabrication

LHC upgrade in wafers



Challenges

- Thin wafer fabrication (~200 um) on 150 mm wafer (~10000 wafers required) and high voltage reliability.
- Short strip technology to be verified – hybridization.
- 3D and edgeless pixel detectors on 100 mm or 150 mm wafers (~200-500 wafers)
- Radiation hard silicon wafers to be used for the upgrade (PMCZ, PFZ or NMCZ) – quantities?
- Possible long strip fabrication on 200 mm wafers (material availability, production yield)
- Economical challenges in detector fabrication, hybridization and packaging – adequate technology vs. price.

Partner profiles

Country	Company	Production capability
Sweden	Acreo	+ (small scale), 100&150 mm
Italy	FBK	+ (medium scale), 100 mm
Finland	VTT	+ (medium scale), 100&150 mm
Norway	Sintef	+ (medium scale), 100&150 mm
Spain	CNM	+ (medium scale), 100&150 mm
Sweden	Sitek	+ (small scale), 100 mm
Denmark	CiS	+ (small scale), 100&150 mm
??	On semiconductor	?
UK	Micron	+ (?), 100&150 mm
Belgium	Canberra	+ (medium scale), 100&150 mm
Finland	Deetee	+ (large scale), 150 mm
Switzerland	4-labs	+ (large scale), 100&150 mm
Spain	Arquimea	-
Spain	Alter	-
Finland	Okmetic	-

	Wafers/year
Small scale	<2000
Medium scale	2000 - 7000
Large scale	>7000



VTT creates business from technology

