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Next Generation Lidar for Automotive - *As the Pace of Innovation and Product Options Accelerate*

A Global Prior Art Study
powered by Cipher

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IP & Technology Analysis & Actionable Insights to Understand and Capture the Future

Scanning Mirrors

Wavelengths

Flash

Optics

MEMES Scanners

Hardware

Transformational Technology & IP Analysis Service

Global Prior Art & Cipher are partnering together to leverage their combined deep technological expertise and machine learning capabilities to breakdown, analyse and monitor current and future transformational technologies. Fact driven insights into complex IP spaces and interaction with the team will yield a competitive edge, facilitating proactive strategies to capture the future.

Each technology will support the R&D / IP/ Strategy Professional as well as the C-Suite and Financial Investors to understand who and what is driving each technology.

Be informed, make decisions

Global Prior Art Inc - *GPA is widely recognized for its deep technology expertise, a Diligent process referenced by the PTAB, analysts with access to proprietary databases such as P-9 and foreign language databases, as well as experience leveraging the power of the Cipher Tool. This paired with their scientific backgrounds enables clients to utilize the best resources for their specific search into transformational technology services. Knowledge transfer is promoted by two presentations for participants, and access to the team. Each technology & IP analysis will support the R&D / IP/ Strategy Professional as well as the C-Suite and Financial Investors to understand who and what is driving each technology.*

Cipher - *Our mission is to unleash the strategic value of patents for our customers. We do this by enabling patent owners to make rational decisions by providing strategic patent intelligence, powered by machine learning. By using your view of the key technologies, Cipher is able to design and build your custom taxonomy.*

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Contents

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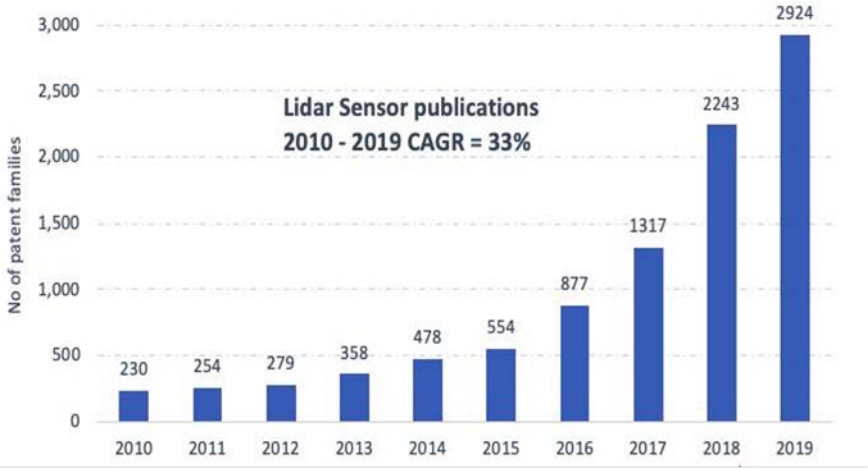
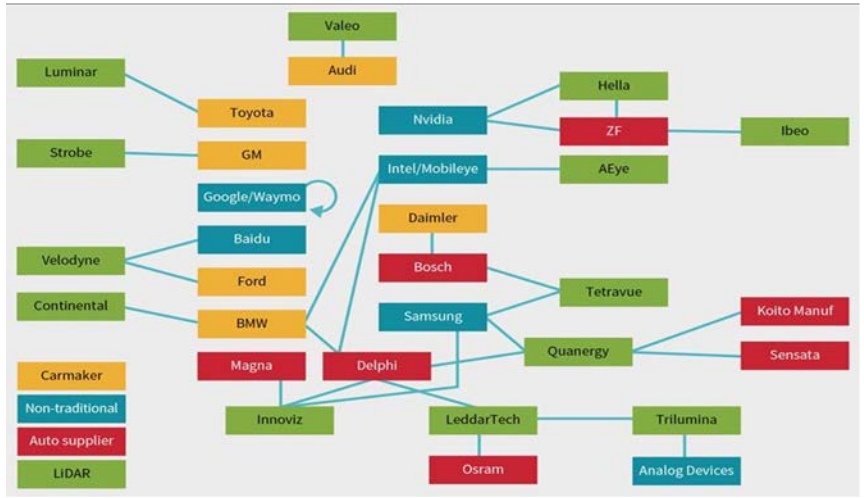
Next Generation Lidar for Automotive

Ever changing technology landscape

- *5,000+ organisations with lidar patents*
- *8,500+ patents pending , 28% CAGR in the number of patents over the last 5 years*
- *Complete set of players from OEMs - Large Tech - Pure Play - Service companies ‘*
- *New entrants still entering the market*
  - *Over 300 companies have entered the space for the first time in the last 4 year*
- *Critical technology to underpin the autonomous vehicles investment theme*
- *DTechEx Research forecasts the global market for lidar in autonomous vehicles growing to $5.4 billion by 2030*



Crowded, diverse & growing ecosystem of players



Key takeaway

Critical space, continually moving and changing, hard to monitor and track

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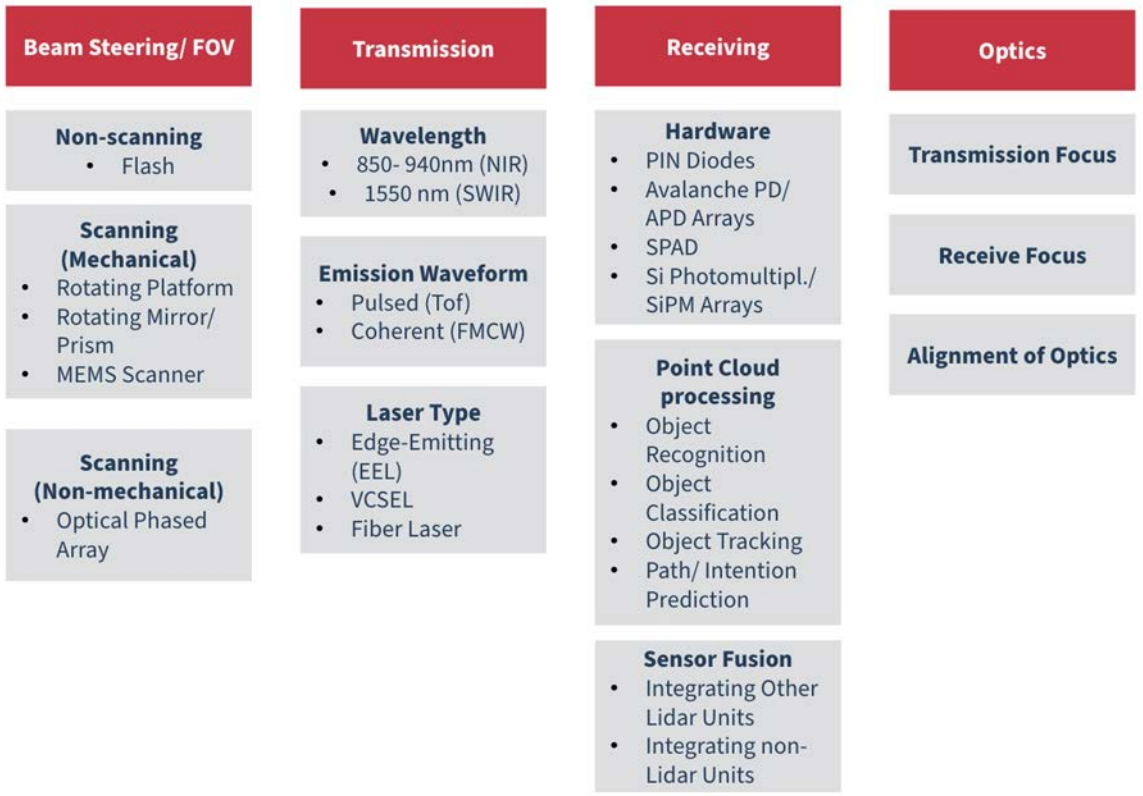
Technology Landscape - broken down & analysed



01 Who is doing what in the Lidar space?

02 What are the winning / waning technologies across the landscape?

03 What are the disruptive technologies to watch for?

04 What other red flags should we be monitoring?

05 Who should we be partnering with? Who is partnering with whom?

06 Are we partnering with vendors having the most competitive new technology plus strong patents?

07 What are the most recent developments in the technology?

08 What is China's approach to the technology? Implication for the global market?

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Strategic direction and product insight

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1. Beam Steering

2. Sensor Fusion

Beam Steering/ FOV

Non-scanning
- Flash

Scanning (Mechanical)
- Rotating Platform
- Rotating Mirror/ Prism
- MEMS Scanner

Scanning (Non-mechanical)
- Optical Phased Array

Sensor Fusion
- Integrating other lidar units
- Integrating non-lidar units

09 Who are the new emerging players and in which areas of the technology? And what makes them different?

10 Trend spotting: With technology changing rapidly and many new players are emerging and what trends or developments are we missing?

11 Which key emerging technologies can accelerate our product development efforts?

12 How will newer technologies impact vehicle design and elevate vehicle safety as a key differentiator

13 Which newer LiDAR technologies can enhance vehicle & pedestrian safety in fog, snow, or rain?

14 What is the technology and IP roadmap being pursued by competitors in Europe, Korea, Japan and China?

15 Analysis of Products being developed. Future outlook for Lidar offerings (lower cost, superior performance in rain and fog, merging of players, etc.)

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Everyone is asking questions

OEMs	Pure Players	Services	Big tech
R&D	R&D	R&D	R&D
IP	IP	IP	IP
New Business	New Business	New Business	New Business
Strategy / Board	Strategy / Board	Strategy / Board	Strategy / Board

Investors

Who is best positioned today to win the short term or longer term LiDar race?

What combination of technology, performance and cost will define the winners?

Which technologies might yield big time winners in a 5 year interval?

Red flags to watch for the technology? Disruptive technology to lidar?

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What's in the study

- *Automotive Lidar for autonomous driving and ADAS and application agnostic Lidar references that could include Autonomous applications*
- *Not including non automotive applications e.g. airborne or stationary lidar systems)*

Approach

Proposal 1: Top Down

- *Identification of higher level challenges and trending topics*
- *Review of patent space tackling these challenges*

Proposal 2: Bottom Up

- *Identification of key technologies in hierarchy*
- *Review of relevant patent space for ownership and trends in technology across taxonomy*

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Key Findings to date

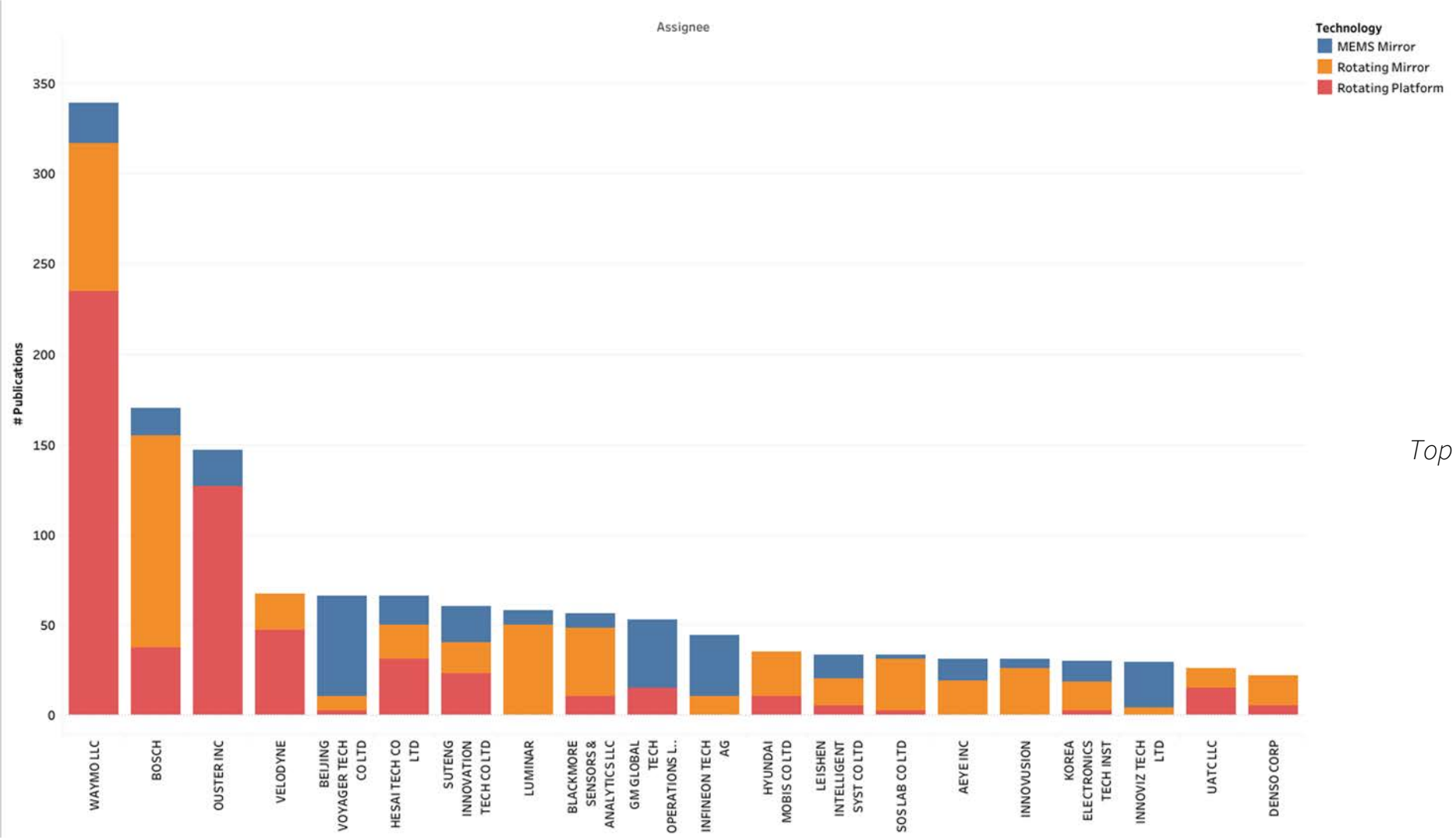
We have analysed the following technology areas:

- **Rotating Platform**
- **Rotating Mirror**
- **MEMS Mirror**

We are still analysing the following:

- **Flash Lidar**
- **Optical Phased Array**

Who owns innovation across these technology areas?



Top 20 owners patents

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But are the top 5 innovators slowing down?

Timeline of Filings for Top 5 patent filers

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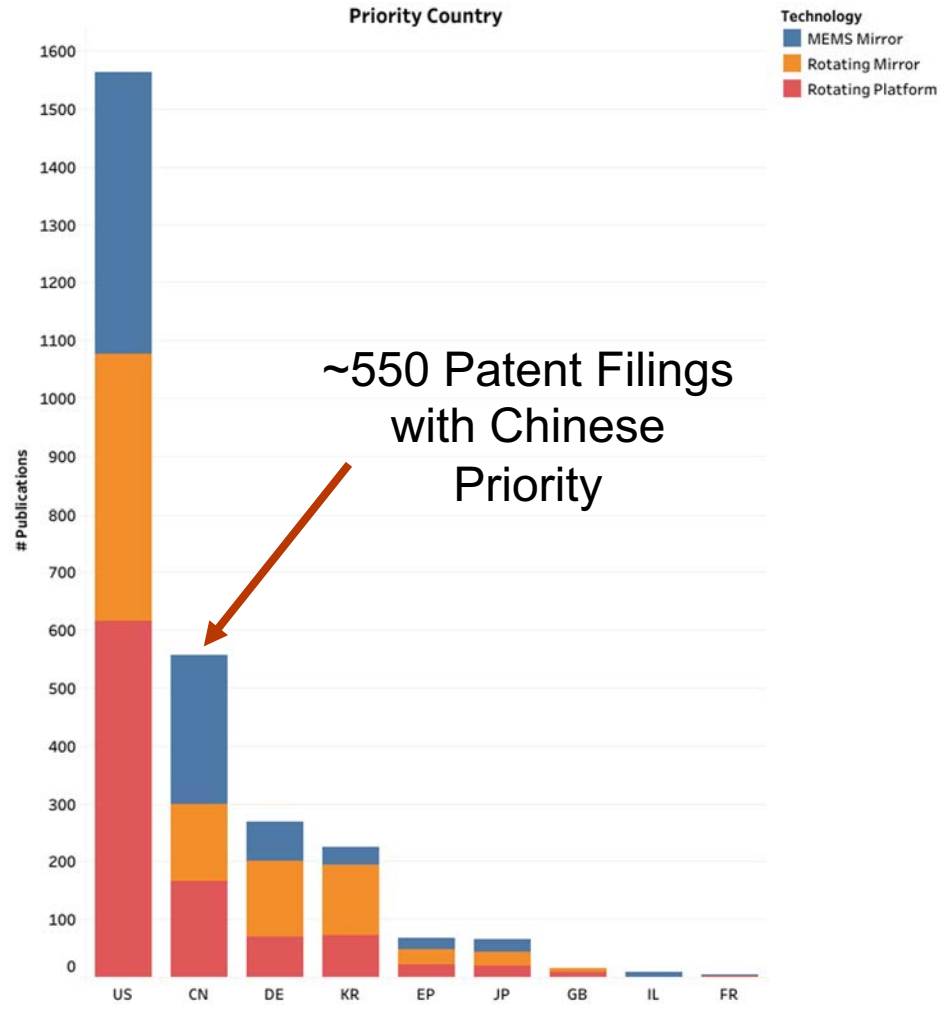
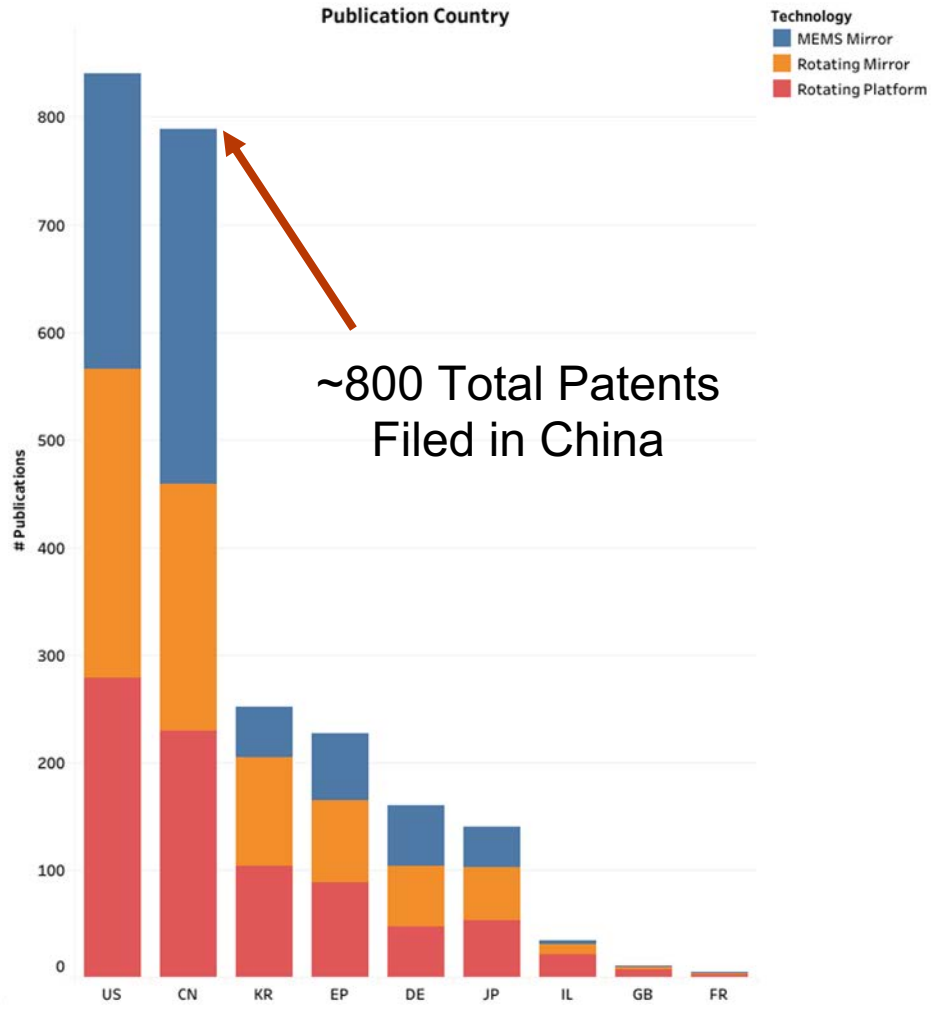
Geographically where are the innovations being filed?

Significant Domestic and Foreign Patent Filings in China





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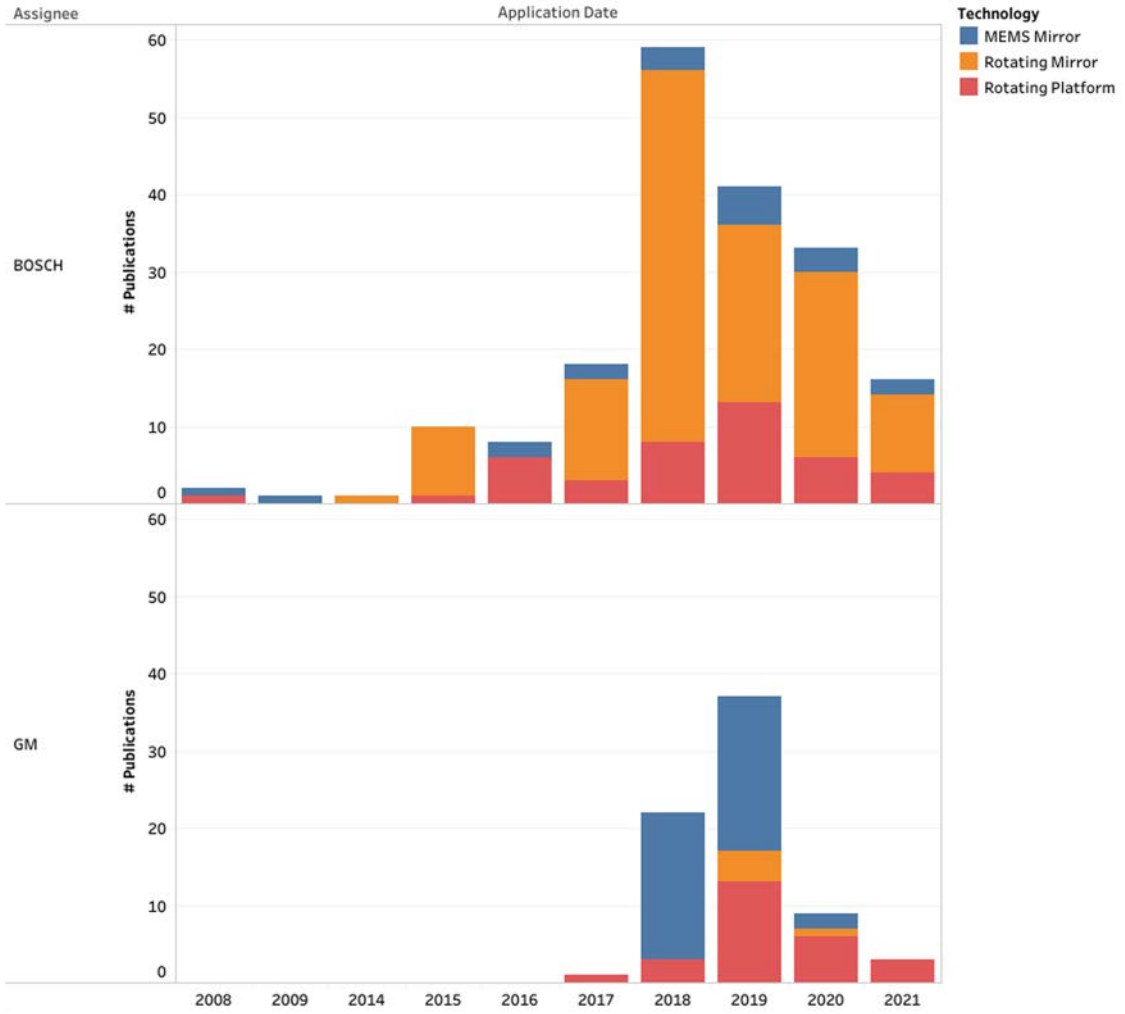
How are Bosch and GM innovating?



High cost of manufacturing[2] likely driving the recent increase of filings by automakers on *MEMS Mirror* designs

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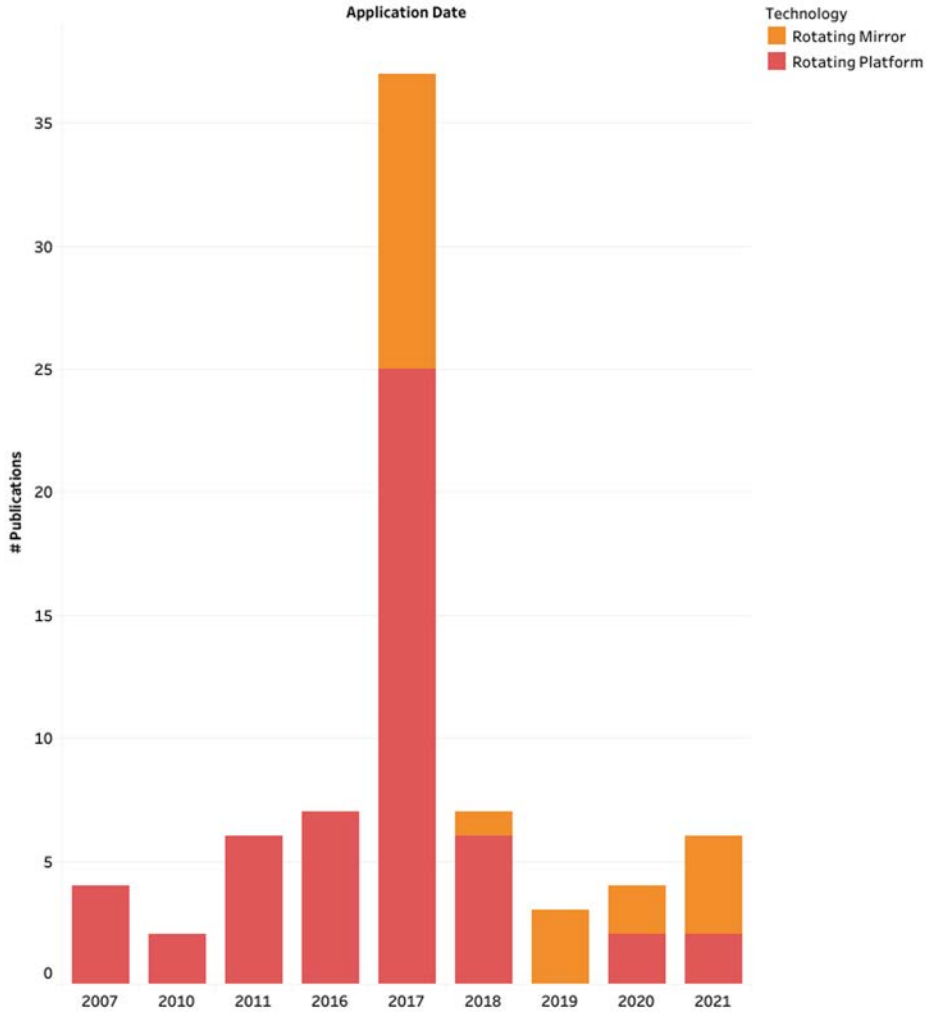
Where is Velodyne innovating?



- Began with *Rotating Platform* in 2007
- Shift towards *Rotating Mirror* in 2017

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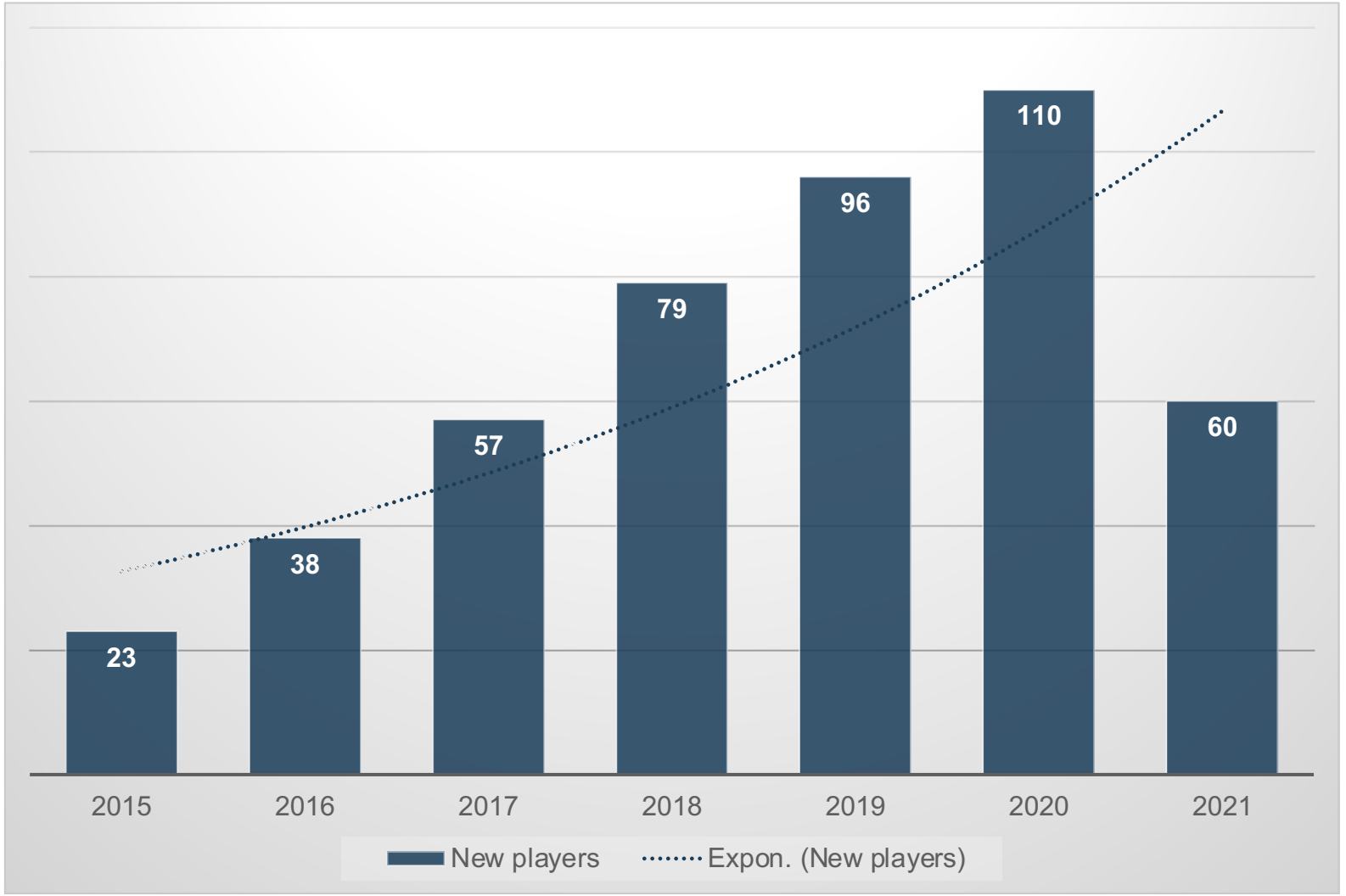
New players – over 300 new entrants in 4 years



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Study deliverables

- *Key findings for trends, players and products*
- *Access to underlying data to answer further questions via Cipher*
- *Interim results presentation and full study completion presentation*
- *Access to analysts to ask further questions*
- *Deliverable completed in 4 months from commencement*
- *Updated on a quarterly basis for 12 months*

What GPA/Cipher can bring

Independence

An independent view with no investment bias

Expertise

World class expertise in the technology area

Classification

Unique classification of patent data

Previous Experience

Building on previous studies on Lidar

Functionality

Quality reporting & tools to include analytics & visualisations

Automation

Enable efficiency, accuracy & scalability

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What the study aims to cover

Key trends in Lidar - technologies, players, regions, Lidar radar

Key players and emerging players

Analysis of products being developed

Future outlook for Lidar offerings (bringing costs down, merging of players etc)