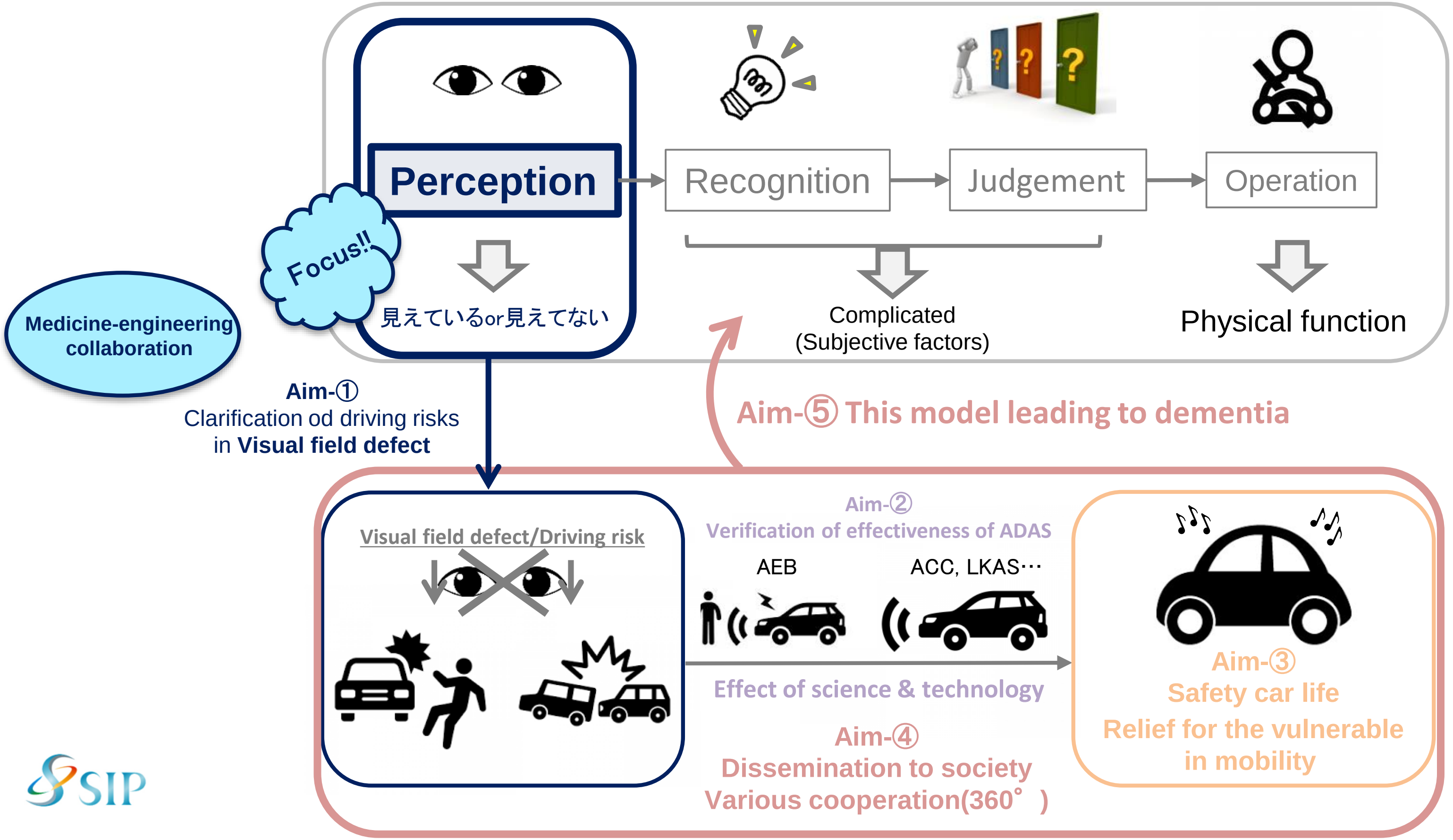
「Strategic Innovation Promotion Program (SIP) Phase Two / Automated Driving (Expansion of Systems and Services)
Research on ADAS for people with visual field defects

RIKEN
Nagoya university
University of Tsukuba

Introduction(An aim)

▶☐Aim of our research & overall scheme



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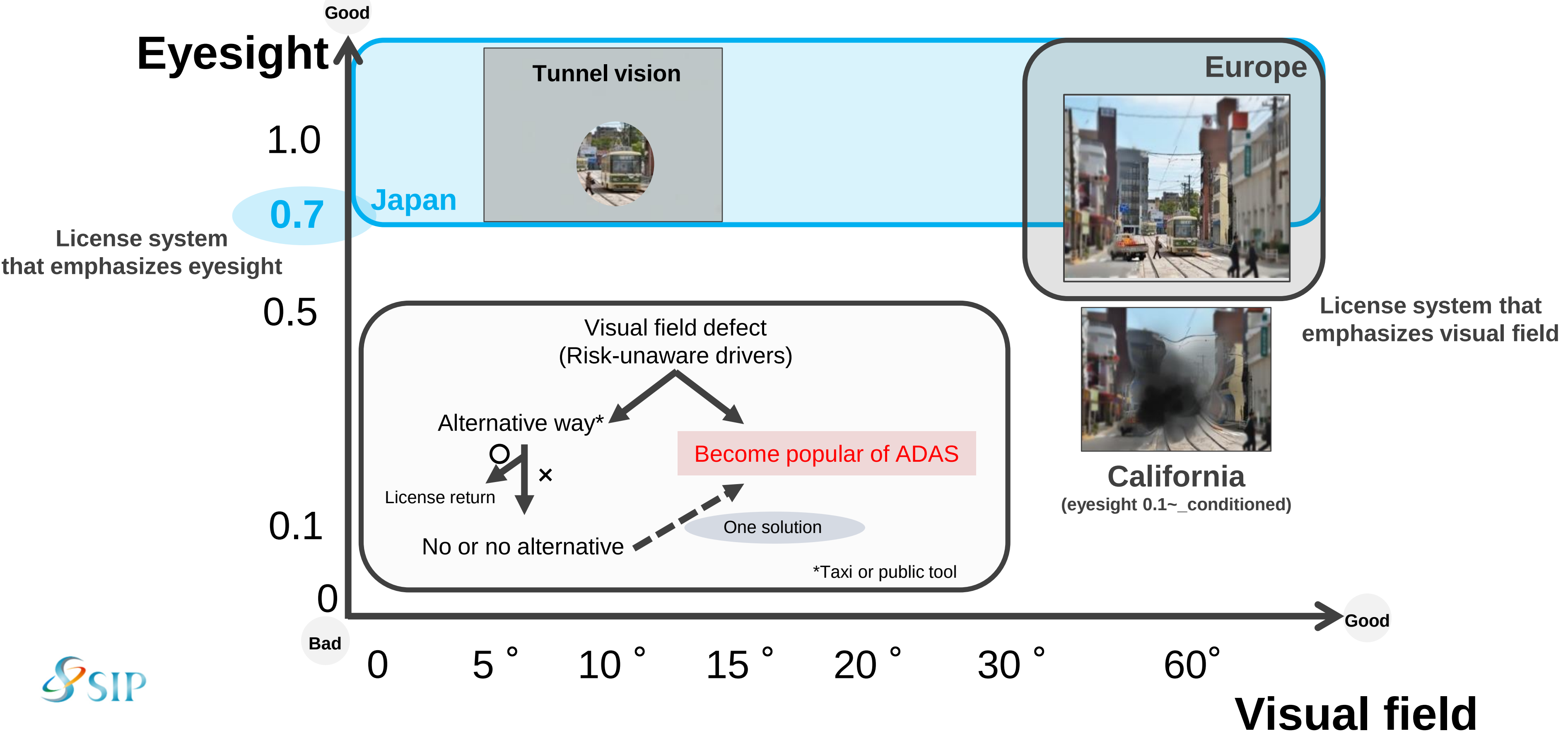
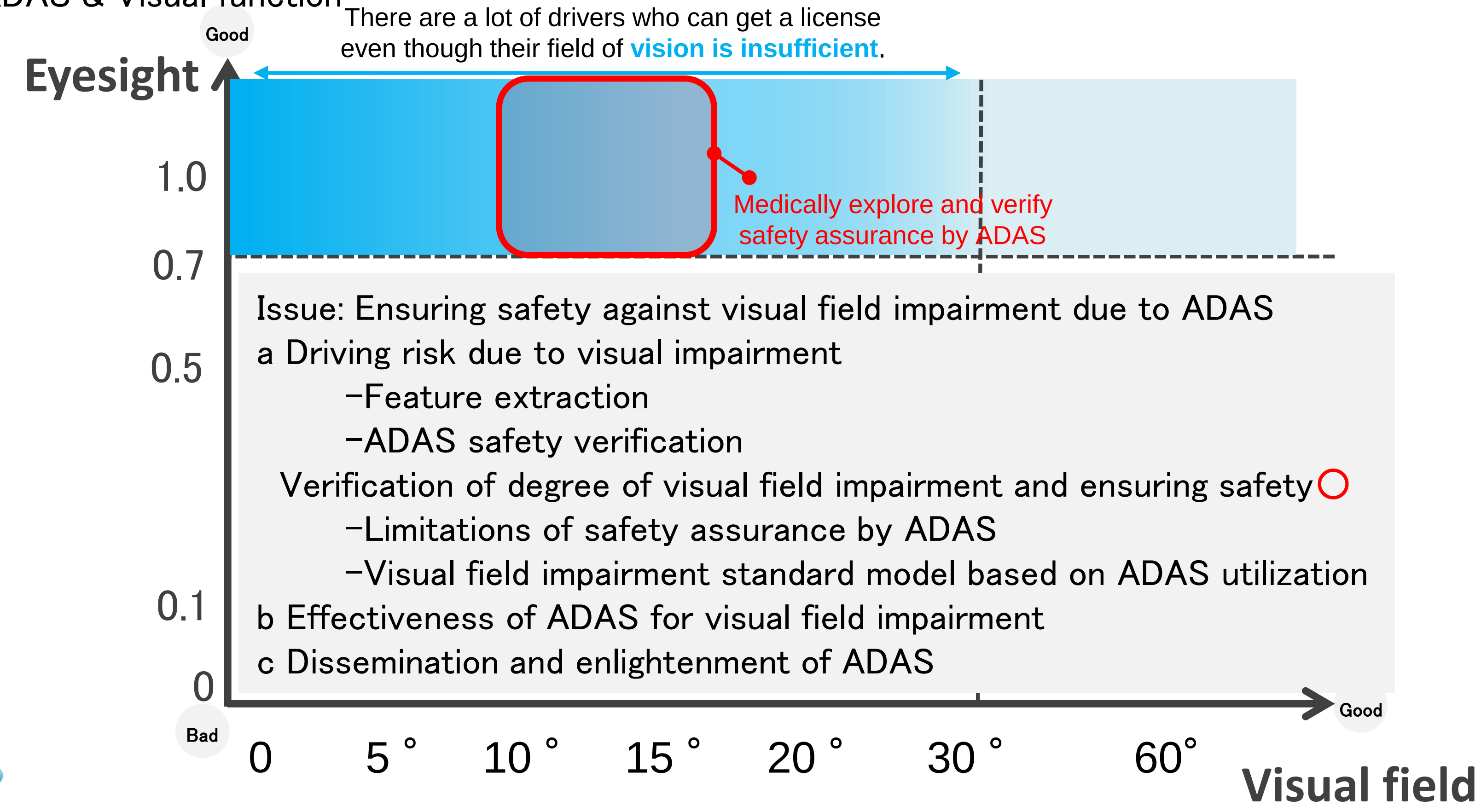
Introduction (Driver's License)

▸☐Difference of driver's license between Europe & Japan (eyesight/visual field)



Introduction(課題)

▸□ADAS & Visual function



Issue: Ensuring safety against visual field impairment due to ADAS

a Driving risk due to visual impairment

- −Feature extraction
- −ADAS safety verification

Verification of degree of visual field impairment and ensuring safety ○

- −Limitations of safety assurance by ADAS
- −Visual field impairment standard model based on ADAS utilization

b Effectiveness of ADAS for visual field impairment

c Dissemination and enlightenment of ADAS

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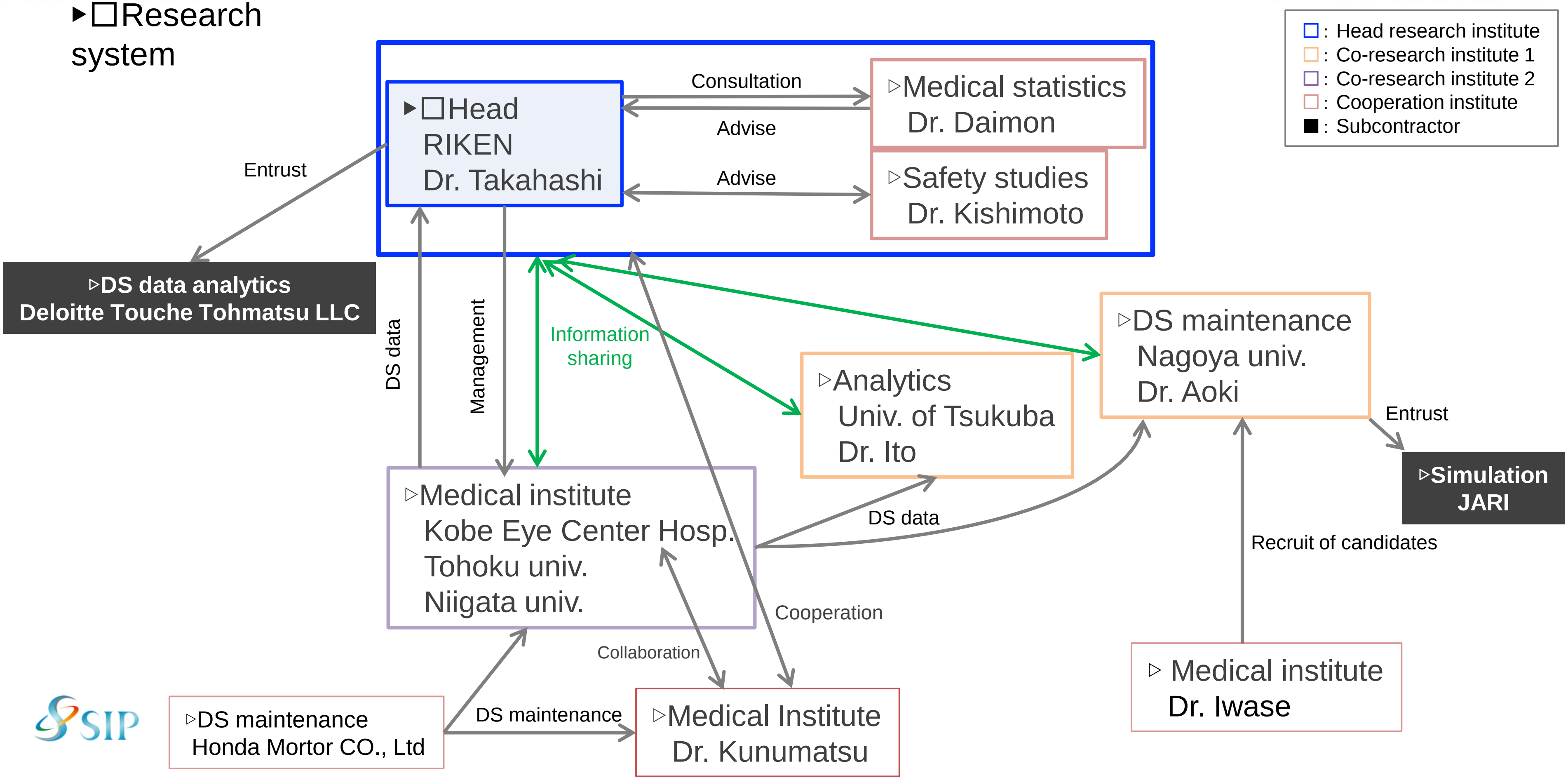
Introduction(全体計画)

▹Research agenda

			FY2018	FY2019	FY2020
a.	Construction of driving database for visually impaired and normal persons, clarification of accident factors specific to visually impaired persons				
	i. Construction of driving database for visually impaired and normal persons	ALL	Data acquisition using DS		
	ii. clarification of accident factors specific to visually impaired persons	RIKEN/Tsukuba		Data analysis	
b.	Verification of accident reduction effect specific to people with visual impairment for driving support system using DS				
	i. DS repair for presentation of driving support function specialized for visual field disorder	Nagoya	DS repair	Reviewing the scenario	
	ii. Clarification of support conditions for obstacle recognition function and avoidance function to avoid accidents as well as healthy people	Nagoya/Tsukuba	Preliminary Exam.	Clarification of support conditions	
	iii. Verification of accident reduction effect by using driving support system	Nagoya/Tsukuba		Eye Center Hosp./Tsukuba	Verification of accident reduction effect
c.	Development of driving support design guidelines using automated driving technology for visually impaired persons				
	i. Establishment of methodology to prove safety by using driving support system	RIKEN		Organize requirement items; Methodology of safety assurance	
	ii. Development of design guidelines utilizing automated driving technology	ALL			Design guidelines

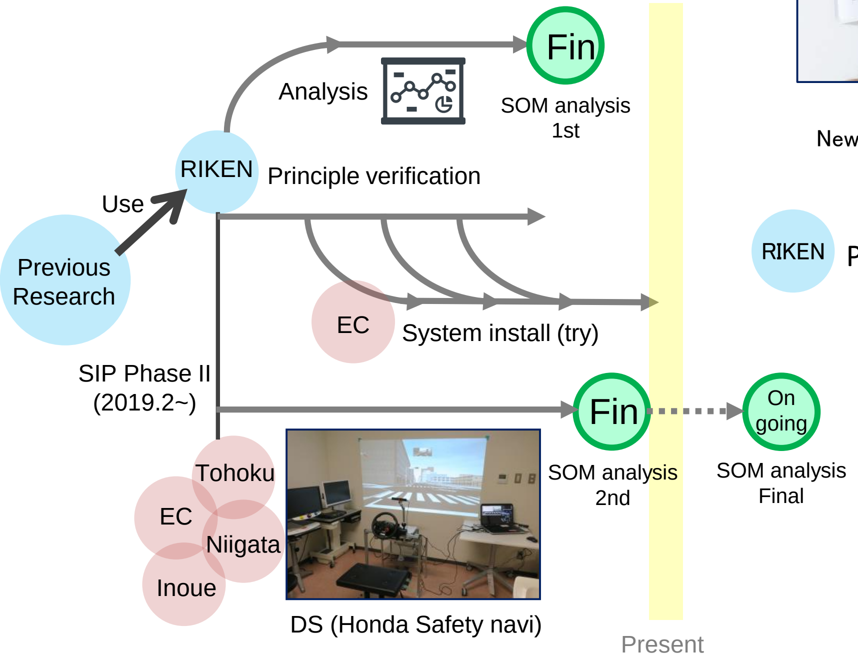
Introduction(Research system)

▶☐Research system



Issue a. (Collection of DS data)

a.	Construction of driving database for visually impaired and normal persons, clarification of accident factors specific to visually impaired persons	FY2018	FY2019	FY2020
	i. Construction of driving database for visually impaired and normal persons	Collection of DS data	Collection of DS data	Present
	ii. clarification of accident factors specific to visually impaired persons		DS-data analysis	DS-data analysis



↑
New devise (VR)

New test→

RIKEN Principle verification (device & method)

EC Tohoku Niigata Inoue

Medical institution	Case (RP)
Kobe Eye Center Hospital	89(61)
Tohoku university	41(19)
Niigata university	89
Nishikasai Inoue ganka clinic	40(1)

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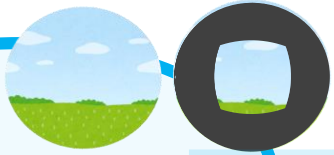
Issue a. (DS data analysis-1)

【DS data analytics】
Deloitte Tohmatsu LLC

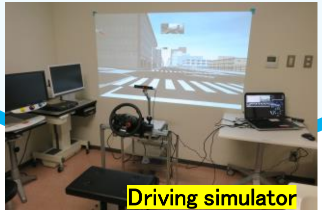
▷ Clarification of accident factors peculiar to visual field impairment

Data Collection ⇨ Analysis Clustering ⇨ Database

Eyesight

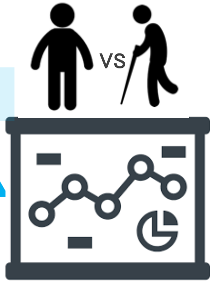


Visual field



DS

見える化



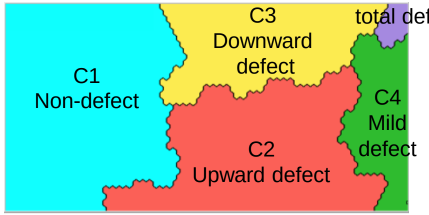
Analysis
~increase number in future~

Qualitative and quantified how to move the eyes (just research level)

Line of sight

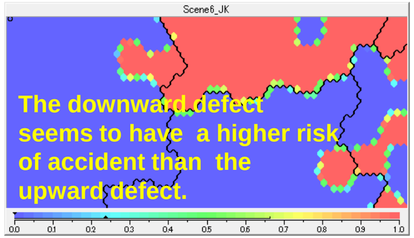
-Basis data collection: Fin.
-Conditioning: Fin.
-Pre-running: Fin.
-Start: 2019.1~: **on going**
-Data collection: **on going**

▸☐ Clustering patients by clinical characteristics



▸☐ Risk scene

▸☐ Overlay with risk aversion



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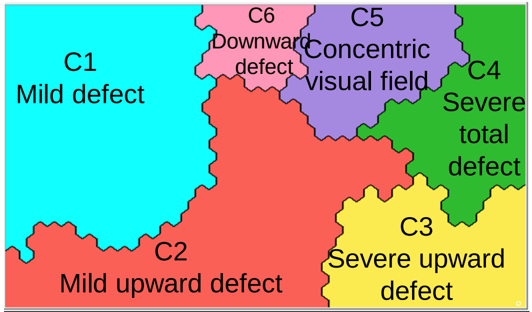
Issue a. (DS data analysis-2)

【DS data analytics】
Deloitte Tohmatsu LLC

【Data】
Previous Research
SIP data

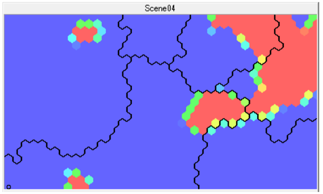
▸☐Number (104/108)
Niigata(27), Tohoku(37), Kobe(13), Nishi-kasai(27)
▸☐Objects
Age, Sex, Visual field, Accident history, eyesight, MD, DS data



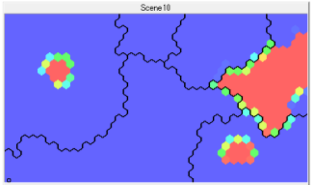
Analysis

In the risk scene from the right, many accidents occurred in the C4 (■ severe total defect) cluster.

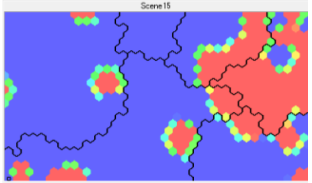
Scene4 : Car coming out of the right



Scene10 : Mobility scooter coming out of the right

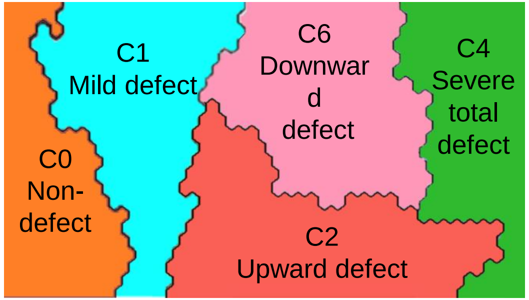


Scene15 : Truck coming out of the right



Increase number then re-analysis

▸☐Number (104/108)
Niigata(27), Tohoku(37), Kobe(13), Nishi-kasai(27)
▸☐Objects
Age, Sex, Visual field, Accident history, eyesight, MD, DS data, Visual impairment



Analysis

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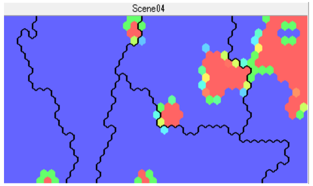
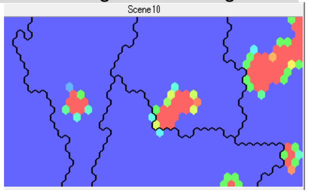
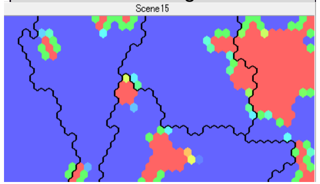


Scene10 : Mobility scooter coming out of the right



Scene15 : Truck coming out of the right



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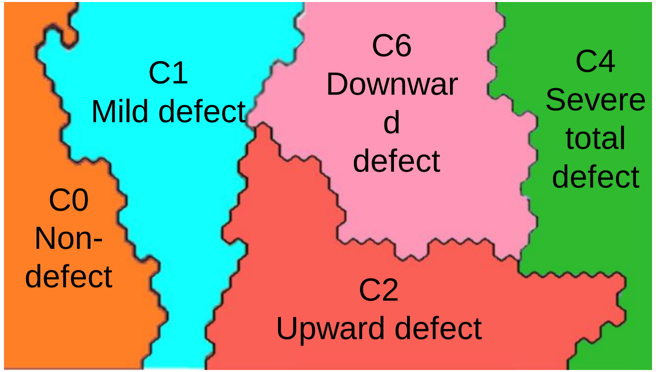
Issue a. (DS data analysis-3)

【DS data analytics】
Deloitte Tohmatsu LLC

▸☐Reversible analysis (Scene to/from Cluster)

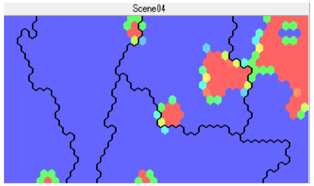
▸☐Number (104/108)
Niigata(27), Tohoku(37), Kobe(13), Nishi-kasai(27)

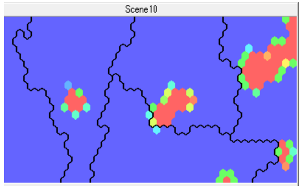
▸☐Objects
Age, Sex, Visual field, Accident history, eyesight, MD, DS data, Visual impairment

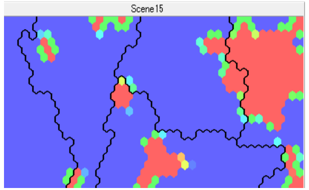


In the risk scene from the right, many accidents occurred in the C4 (■ severe total defect) cluster. **Scene→Cluster**

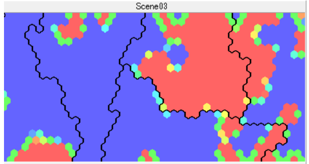
Scene oriented

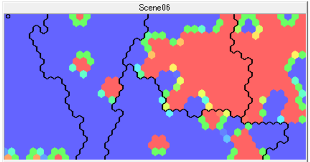

Scene4 : Car coming out of the right


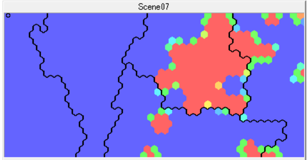

Scene10 : Mobility scooter coming out of the right



Scene15 : Truck coming out of the right


Cluster oriented


Scene3 : Right turn of oncoming car



Scene6 : Car coming out of the left



Scene7 : Right turn of oncoming car


In the downward defect (C6) cluster, many accidents occurred in scenes 3, 6 and 7. **Cluster→Scene**

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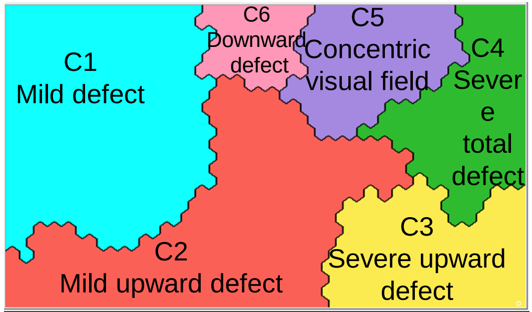
Issue a. (DS data analysis-4)

【DS data analytics】
Deloitte Tohmatsu LLC

▸☐ Detailed medical verification is possible by accumulating detailed clinical information (eg, disease type).

▸☐Number (104/108)
Niigata(27), Tohoku(37), Kobe(13), Nishi-kasai(27)
▸☐Objects
Age, Sex, Visual field, Accident history, eyesight, MD, DS data

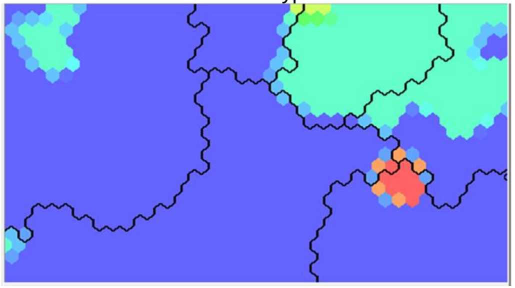


Scene oriented

In the risk scene from the right, many accidents occurred in the C4 (■ severe total defect) cluster.

Detailed analysis of disease type

Disease type



Blue : Glaucoma
Light blue : Retinal Pigmentosa
Red : Cataract

▸☐Database

Data collection(DS, visual field etc.)

↓ SOM analysis(Clustering)(left upper)

①: DS data analysis(right upper)

②: Detailed analysis of disease type(left bottom)

③: Construction of database

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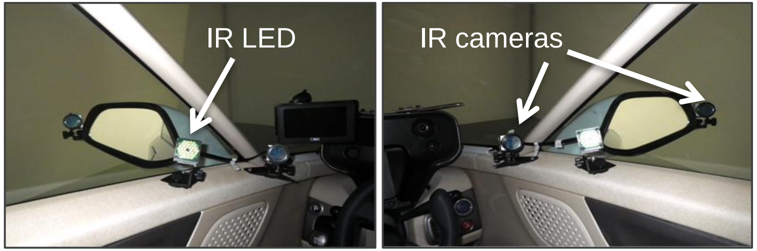
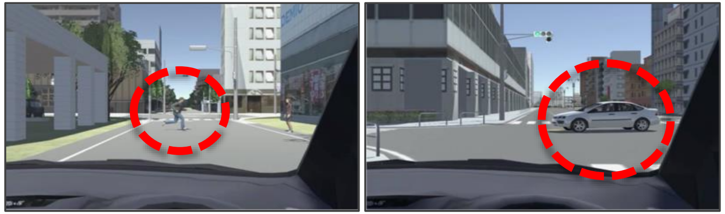
Issue b (Driving data collection by a high-performance DS)

- ☐Eye-tracker (4 IR-cameras + 2 IR-LEDs) are installed in the Driving Simulator cockpit
- 5 types of scenarios（5 different events in each scenario）
  - Scenario 2 - 5：Runs autonomously（Surveillance as if it is manual driving）
  - Scenario 1　：Operates gas and brake pedals（Warning to the pedestrian crossing and hit the brake）
- Participants: 10 non-patients, 15 glaucoma patients*

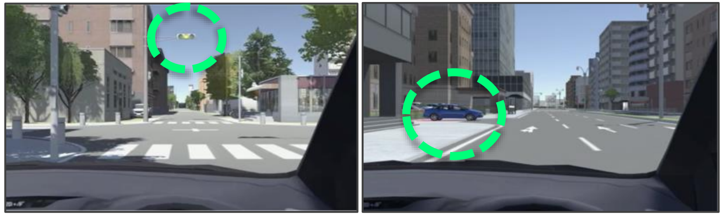
High performance DS



Eye tracker (SmartEye)



Imminent event examples

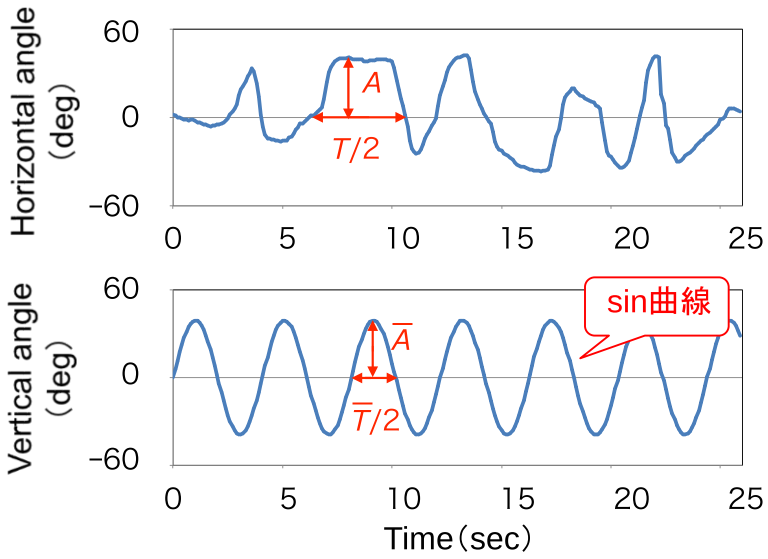


Careful events examples

*Supported by Tajimi Iwase Eye Clinic

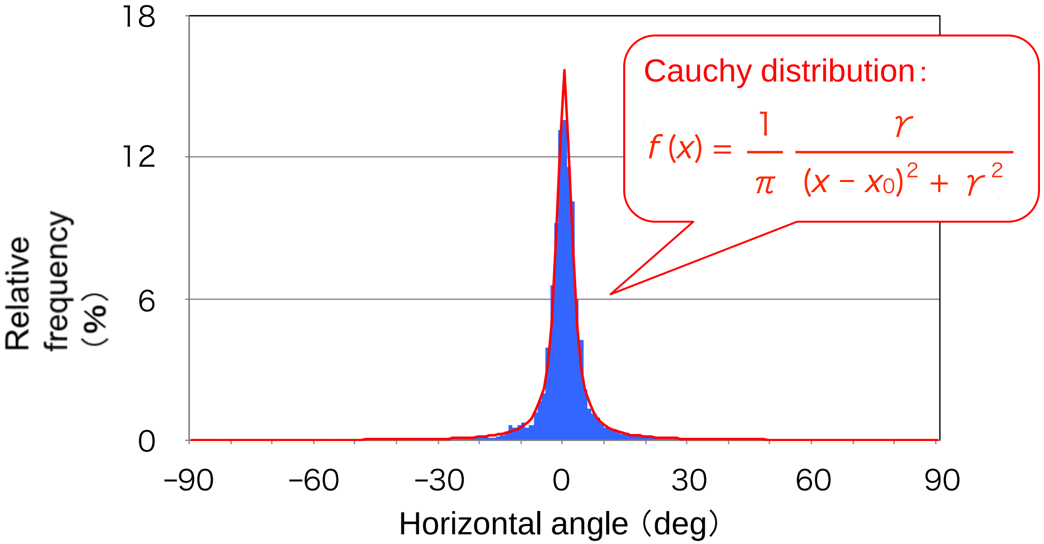
Issue b (Driving data analysis-1)

- ☐Among the data of the patients, there are some noise due to the glasses
  → Based on the head tracking data, numerical simulation is conducted for the accident reduction estimation
- Modeling of head movements showed that there was little difference between non-patients and glaucoma patients



Non-patients: $\underline{A}$ = 37.63 Patients: $\underline{A}$ = 39.13
$\underline{T}$ = 4.22 $\underline{T}$ = 4.06

Head movements AT the stop intersection

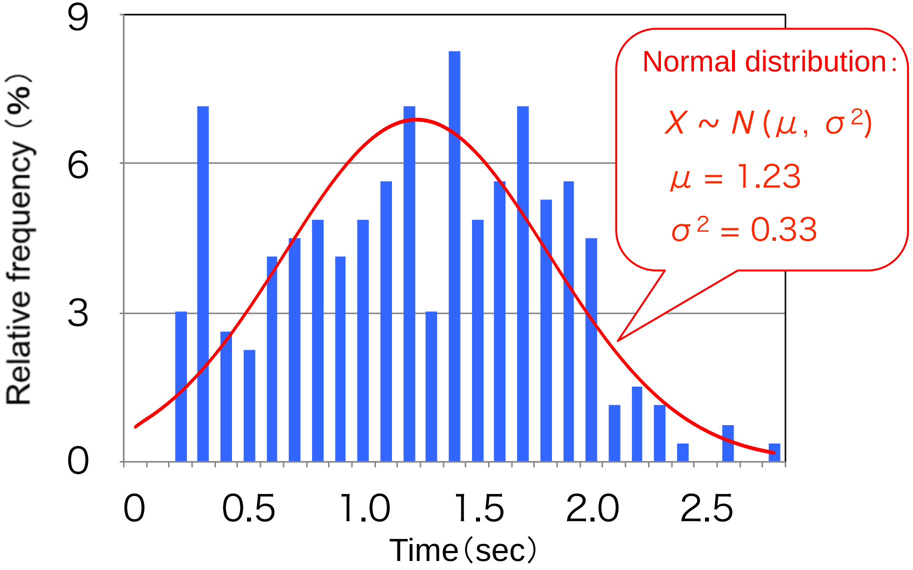


Non-patients: x_0 = 0.14 Patients: x_0 = -0.04
γ = 1.97 γ = 1.99

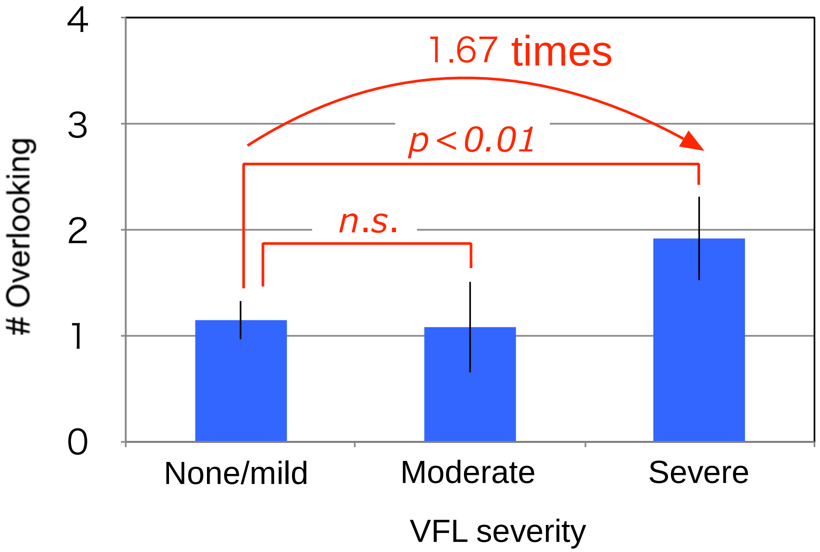
Head movements EXCEPT the stop intersection

Issue b (Driving data analysis-2)

- ☐Gaze movement was analyzed by the head-mounted display with the eye tracker
- Modeling the gaze duration for the pedestrian
- Modeling the overlooking probability for the traffic signals
  - Overlooking probability is statistically higher by the serious visual field loss (VFL)



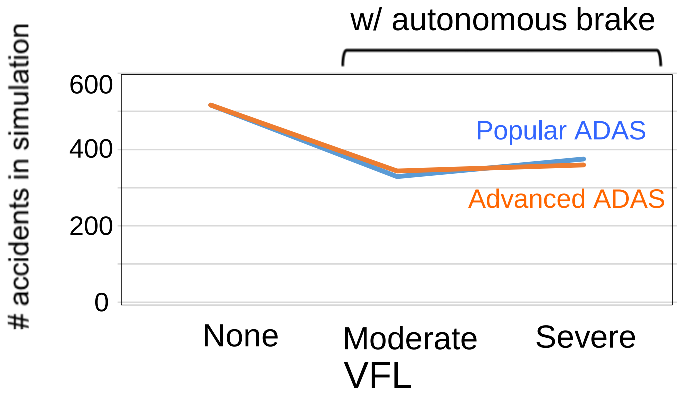
Gaze duration for the pedestrian

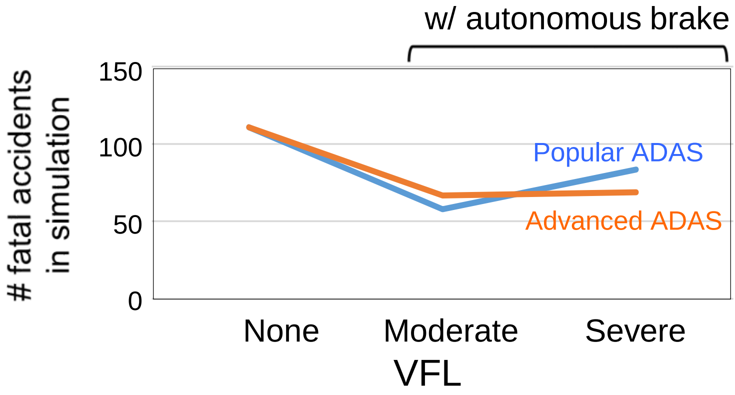


Overlooking times for the traffic signals

Issue b (Numerical simulation for accident reduction estimation)

- ☐Preliminary results of the simulation shows the effectiveness of autonomous brake
- Head/gaze data by DS is used for further simulation
  - Higher accuracy, more ADAS system validation including（e.g., Front-side collision avoidance brake, FCW）





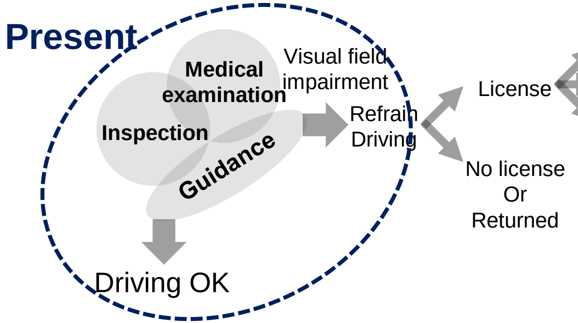
Preliminary results of the numerical simulation

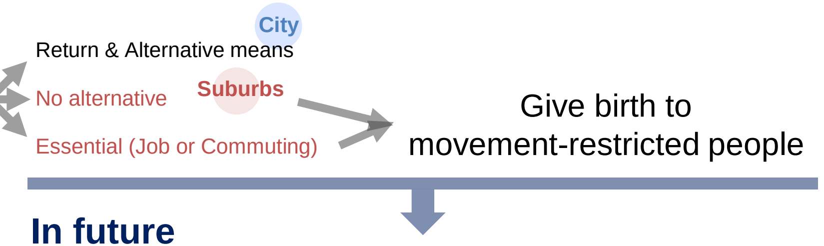
Simulation setting

Issue c. (Medical approach & External cooperation)

c.	Development of driving support design guidelines using automated driving technology for visually impaired persons	FY2018	FY2019	FY2020 (Present)
	i. Establishment of methodology to prove safety by using driving support system		Verification of ADAS efficacy	Prove safety by ADAS
	ii. Development of design guidelines utilizing automated driving technology			External cooperation

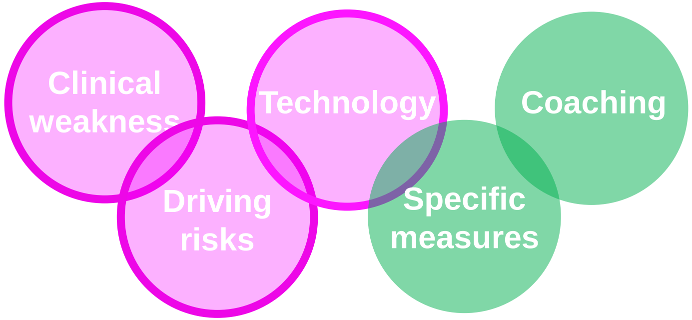
▷Issue c-i：Driving outpatient





In future

Take the opportunity to know and receive a prescription for specific measures in a driving outpatient



Current status

- ✔☐Clinical weakness
- ✔☐Driving risks
- ✔☐Technology
- —Specific measures
- —Coaching

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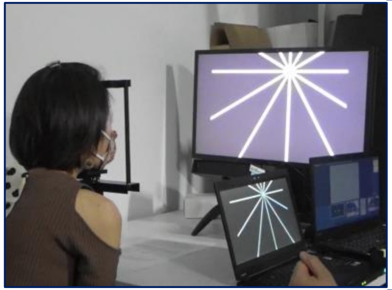
Issue c. (Medical approach: Driving outpatient @Kobe)

①Medical examination

Dr

Dr: Medical Doctor
Rs: Researcher
In: Inspector



↑② IC & DS test
In

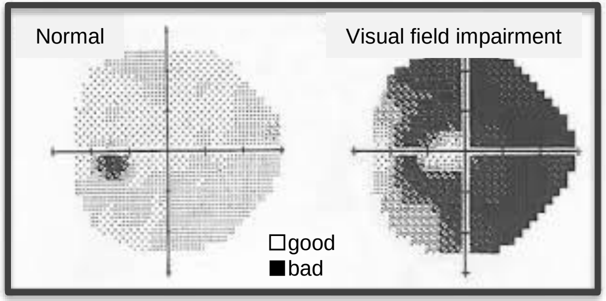
←③ IC & Line-of-sight test
In

Dr Rs
↓④ Counseling

DS score sheet

Scene	Risk type	Score (Bad=0, 1, 5=Fine)	Speed Condition
1	A signal		50km/h Two lanes on each side
2	Jumping out from the left		
3	Oncoming vehicle turn right		
4	Jumping out from the right		
5	A signal		
6	Jumping out from the left		
7	Oncoming vehicle turn right		
8	Jumping out from the left		40km/h One lane on each side
9	A signal		
10	Jumping out from the right		30km/h One lane
11	Stop sign		
12	Jumping out from the left		
13	Jumping out from the left		
14	Stop sign		
15	Jumping out from the right		
Sum Score			

Visual field test results



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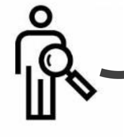
Issue c. (External cooperation)

① Before driving outpatient → ② Driving outpatient → ③ After driving outpatient

【For personal】
・Medical checkup
・Self medication
・Find the unaware group



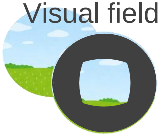
【For group/company】
・Safety promotion
・Medical checkup
・Preparation of safety net

Transportation, Bus, and Taxi etc.

Driving outpatient (Ophthalmologist)

Eyesight

Visual field



DS/Line of sight

Cooperation with medical association

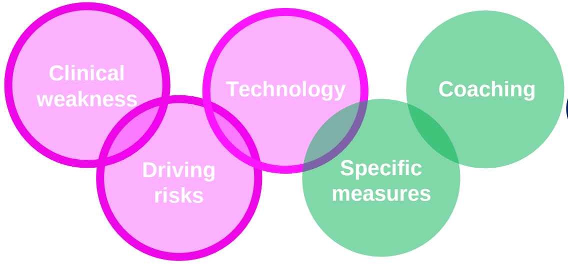
【Dissemination and enlightment】
・Retrofit device
・ADAS

【Learning and training】
・Driving school
・Improvement and training (Line of sight)

【Institutional design】
・Administration
・Insurance industry

【Medical cooperation】
・Dementia
・Taking medicine and chronic condition

FY2020



Improvement of driving outpatient
▷Clinical weakness、Driving risks: Finished
▷Specific measures and Coaching: Planning

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Thank you