Implications of „One vs Two Detectors“ for Infrastructures

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HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

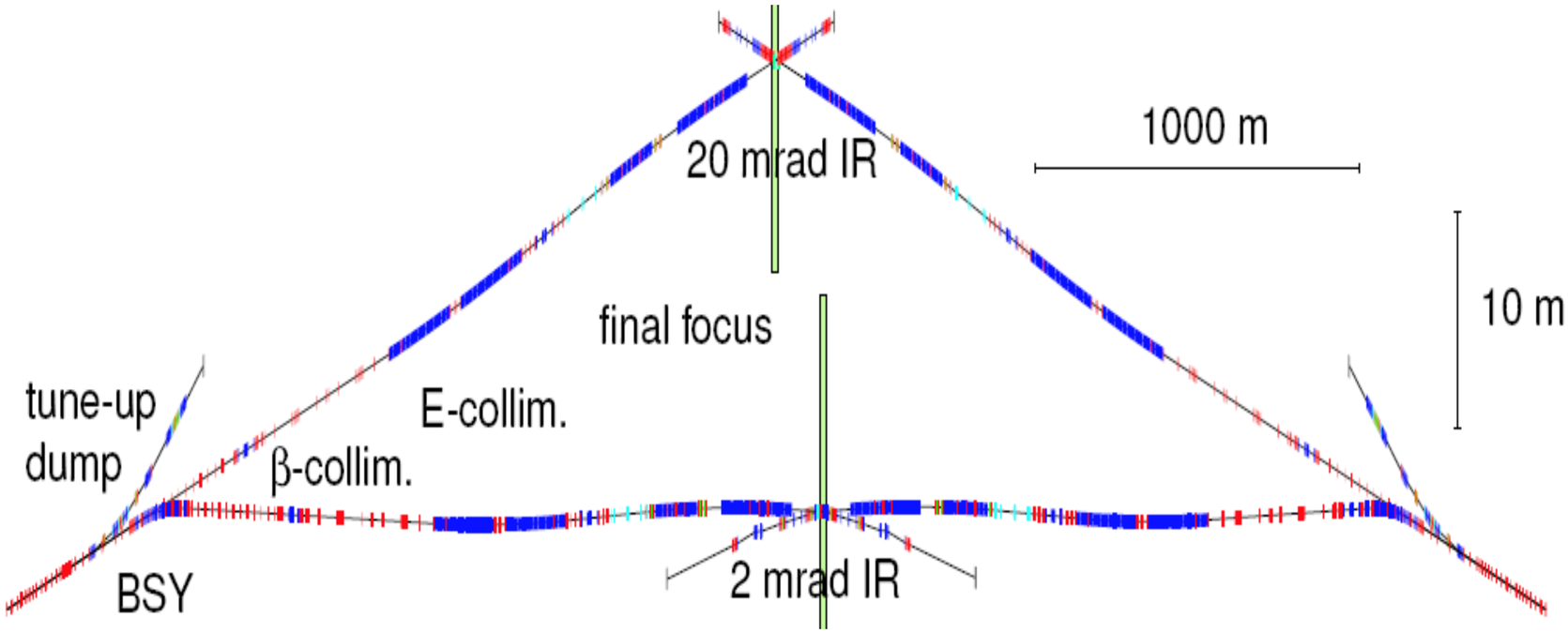
DESY.

All I am going to present are my personal thoughts and have not been discussed in IDT-WGs!

Some history

ILC started with two BDS systems, serving two interaction regions

- Integrated luminosity does not scale with number of interaction regions
- Different crossing angles (2mrad, 20mrad)
- Was eventually changed before ILC Reference Design Report to one interaction region with push-pull system



M. Woodley, BDIR WS 2005

Rationale for two detectors

From the ILC TDR:

- The scientific productivity of collider facilities, such as the Tevatron, LEP, HERA, and the LHC, has benefited from independent operation of multiple experiments. This leads to operation of detectors with **complementary strengths, cross-checking and confirmation of results, reliability, insurance against mishaps, competition between collaborations, as well as increased number of involved scientific personnel, all contributing to enhanced scientific success**.

This position has not changed!

Nevertheless, it might be useful to re-visit these arguments in view of the current stage of the ILC

- Preparing for realisation… „now or never“
- Starting discussions on new experimental possibilities at the ILC: beam-dump experiments, etc.
- Better view on the ILC scientific core programme at 250 GeV cms energy
- Energy staging scenarios

This discussion will happen elsewhere

- But it is worth to look into possible implications for the technical design of the interaction region

Possible scenarios

Start as planned with two detectors sharing the luminosity equally

- Frequent detector exchanges to avoid a possible publication advantage
- Stay with the current design, review and adapt to technology progress

One detector only

- Step back from two-detector rationale

Staging scenarios

- Start with one detector, optimised for the 250 GeV Higgs Factory
- Replace or complement later with second detector
  - optimised for higher energies, new technologies, …

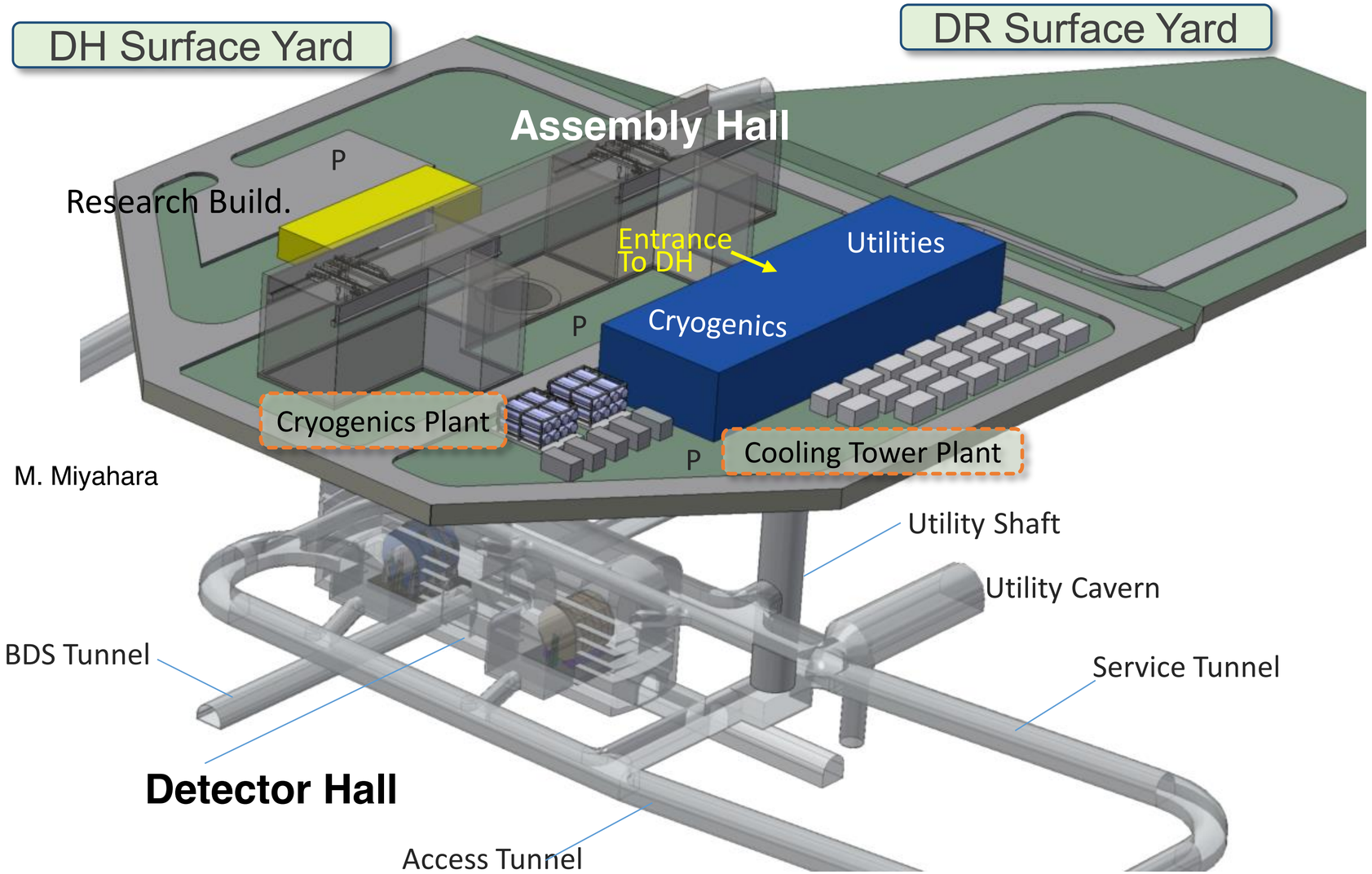
Non-collider options, extending the landscape

- Fixed-target or beam-dump experiments
- Non HEP-research (?)

Detector infrastructure

The expensive parts of the detector related infrastructure are part of the project cost:

- CFS for underground and surface areas
- Service supplies: power, cooling, etc.



Only one detector?

Infrastructure savings for only one detector:

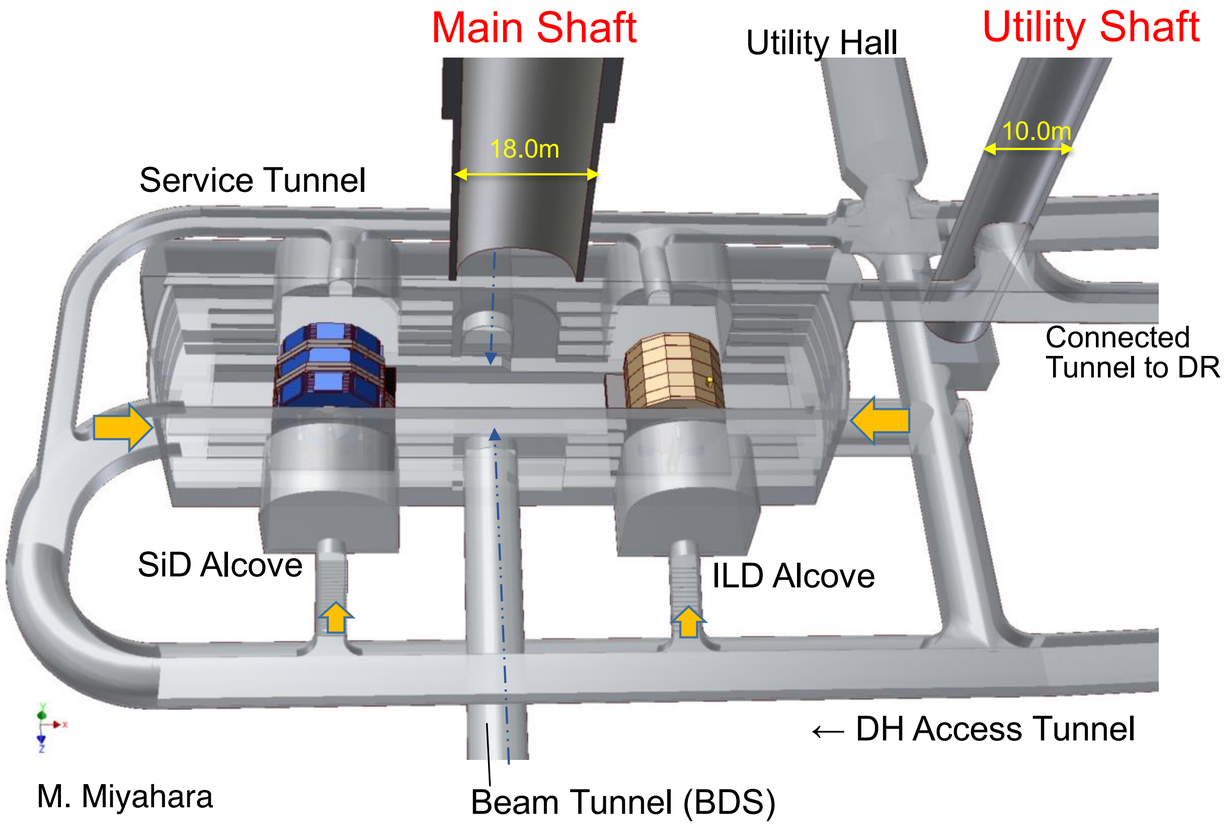
- Reduced underground volume
- Reduced surface areas
- Reduced services

Possible savings on the detector

- No need to take care of other detector
- Hall could be closed for access during beam running
- Lesser requirements on radiation or magnetic field shielding

Push-pull?

- Can we abandon the push-pull system?



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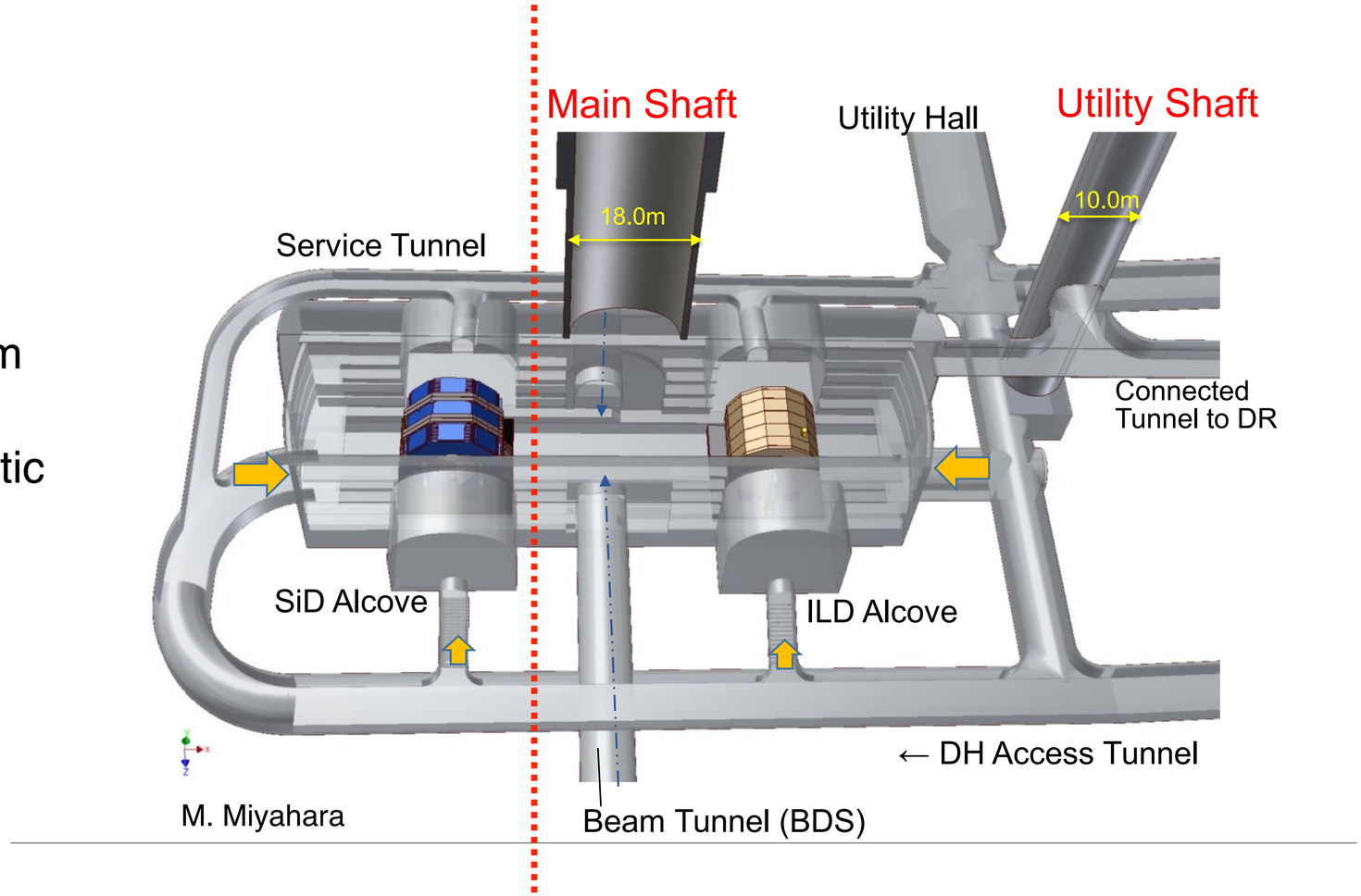
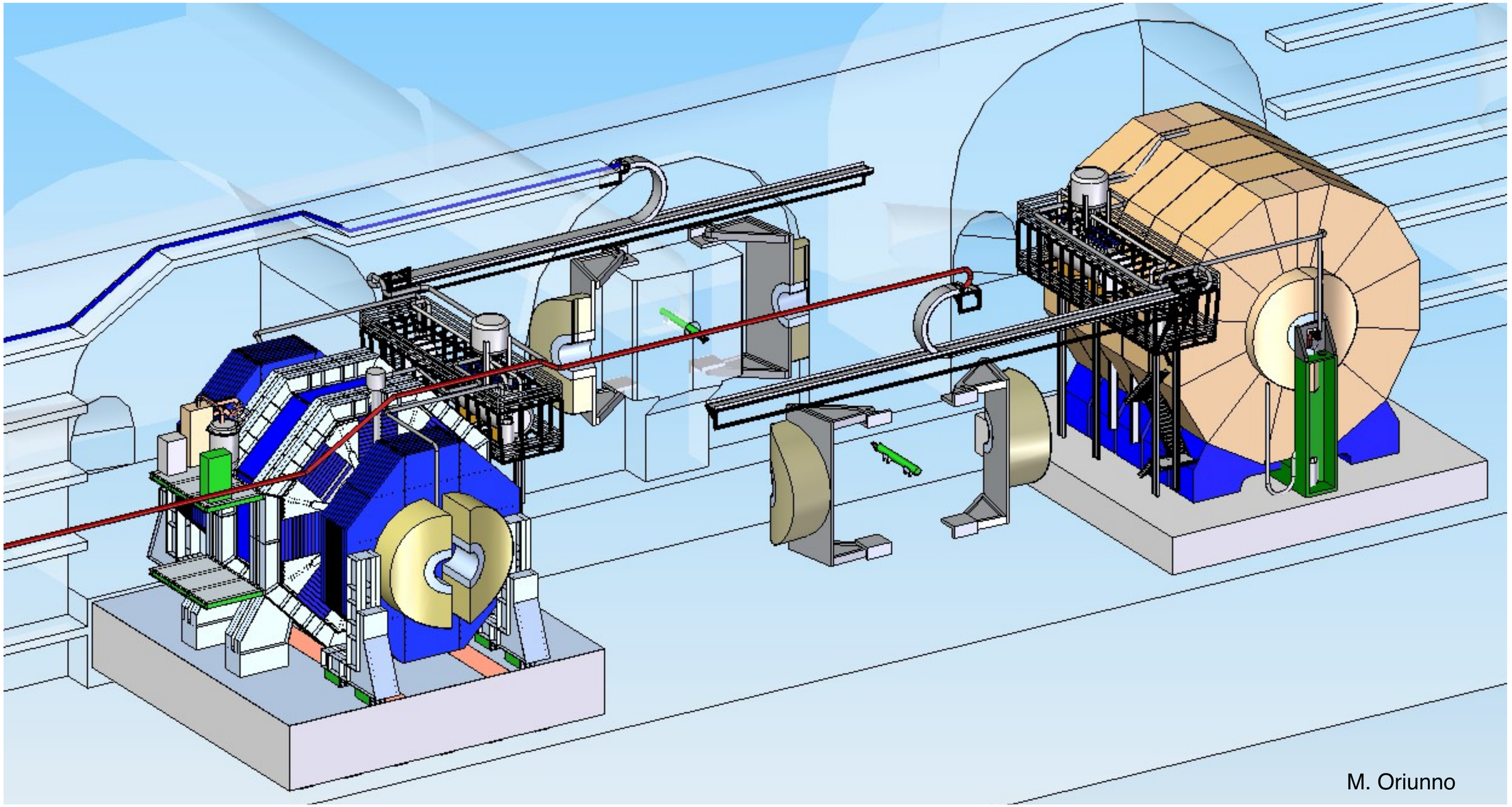


Push-pull system



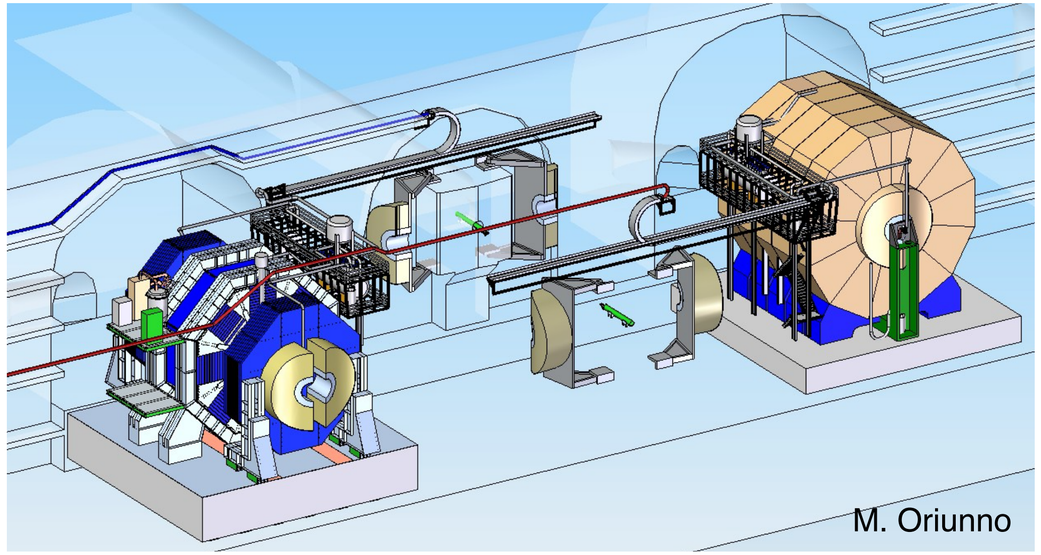
Push-pull - what if?

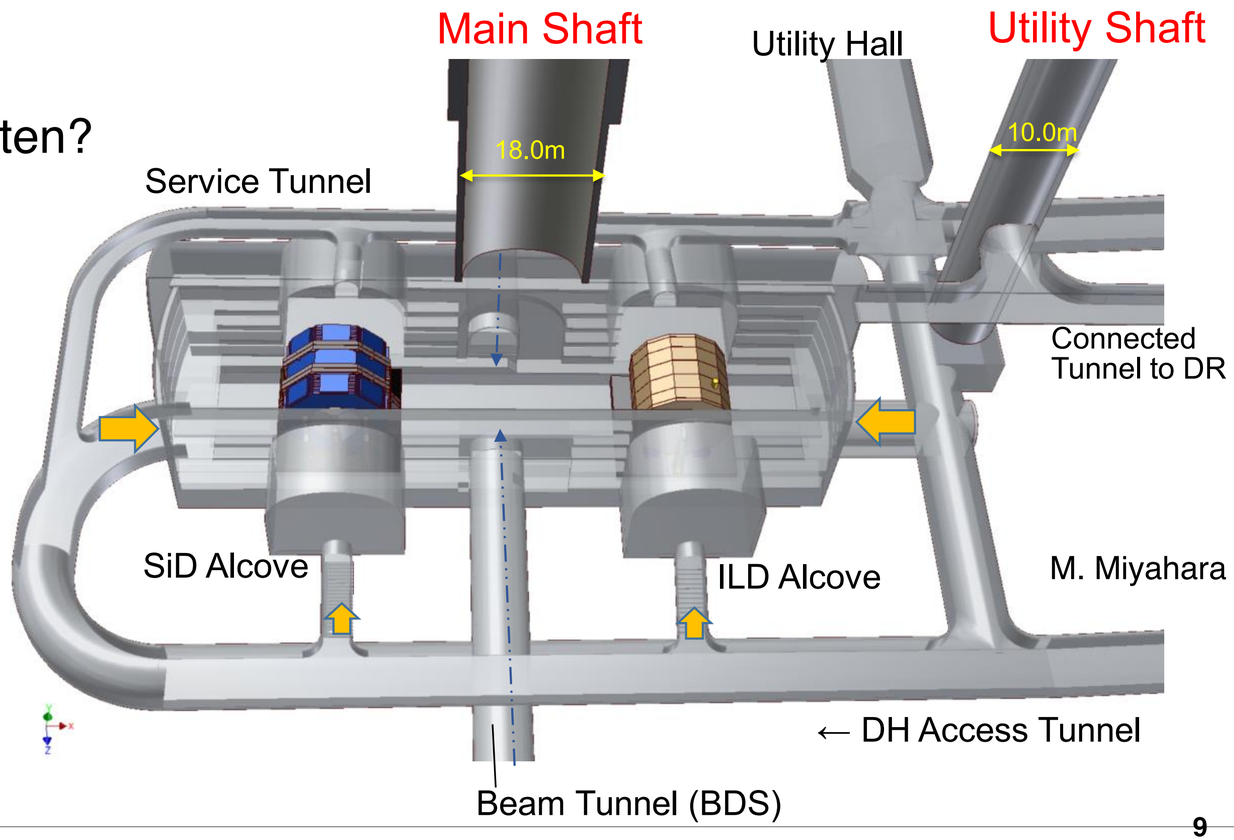
Push-pull system design

- optimised for fast lumi-lumi transition times
  - < 24h for detector exchange and lumi-lumi transition
  - allows for frequent detector exchanges (1/month)

Questions

- Is the design still optimal?
- Do we really need the envisaged speed?
  - Maybe detector exchange does not take place so often?
- Do we need such a system if
  - there is only one detector?
  - the second detector comes much later?





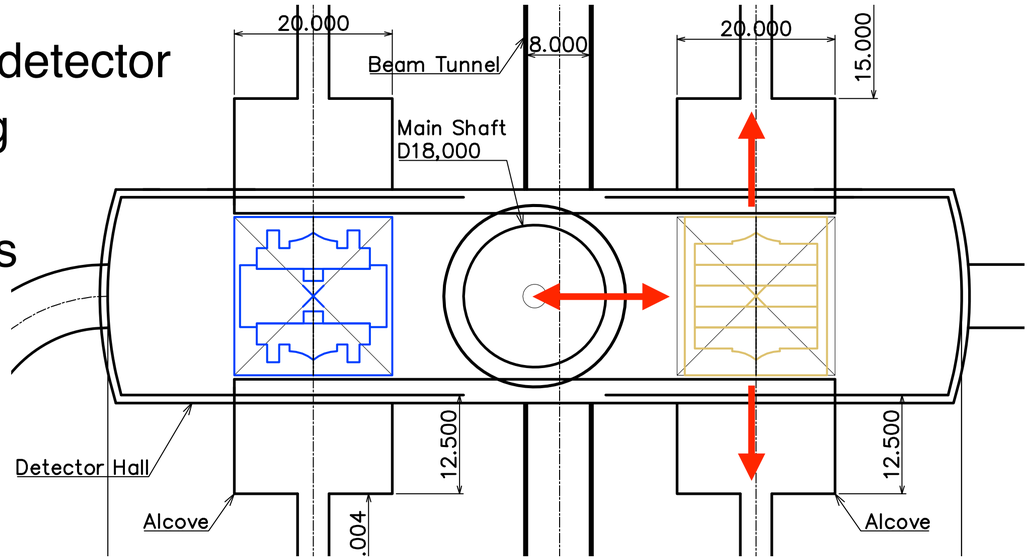
Detector installation and maintenance

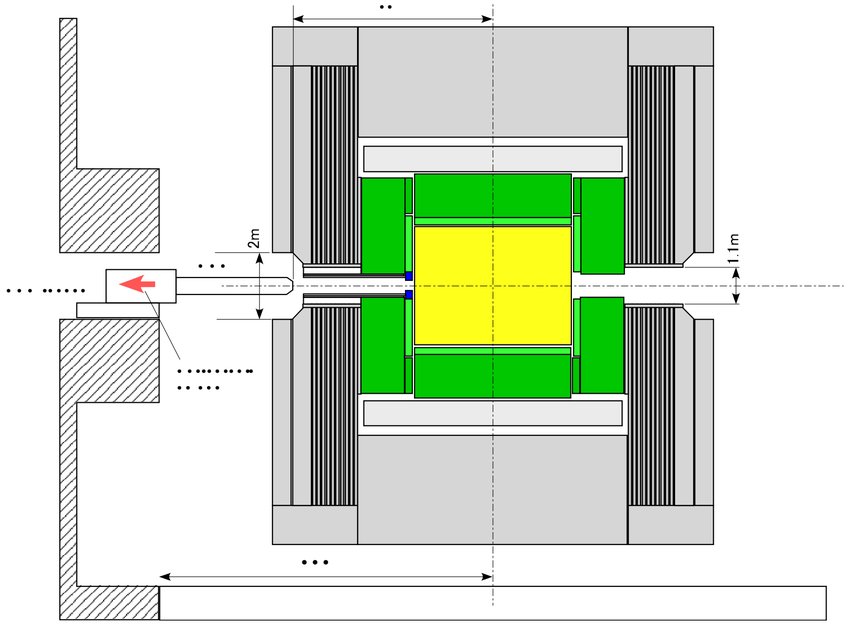
There is not enough space to assemble or maintain a detector in the beamline position in the current design

- Distance between FF magnets is limited
- Hard to extract detector systems from the solenoid
- Beamline elements would need to be taken away
- No machine studies in IR region possible

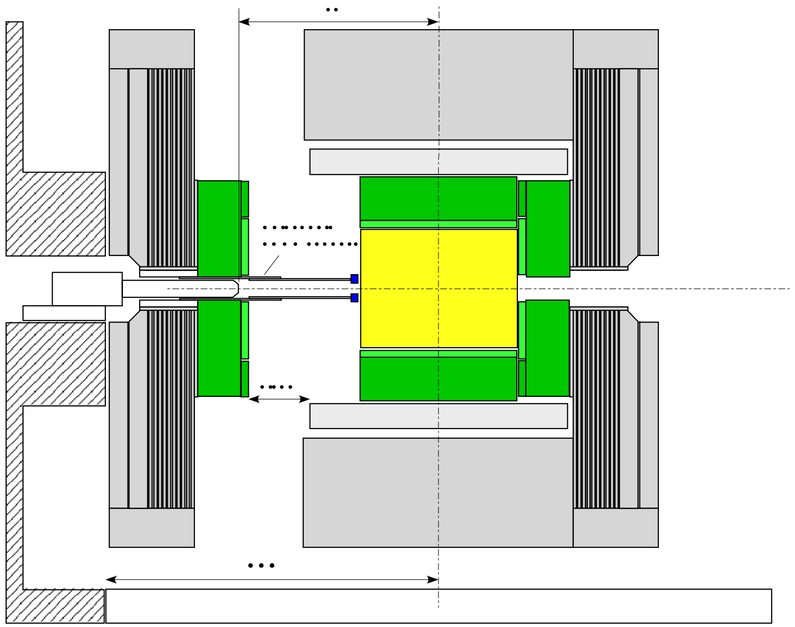
It is good to have a system for moving the detector out of the beamline into a parking position with more longitudinal space (alcoves)

- Even if there is only one detector
- Machine could run during maintenance
- System would still be less complicated
  - only one platform
  - services for one detector



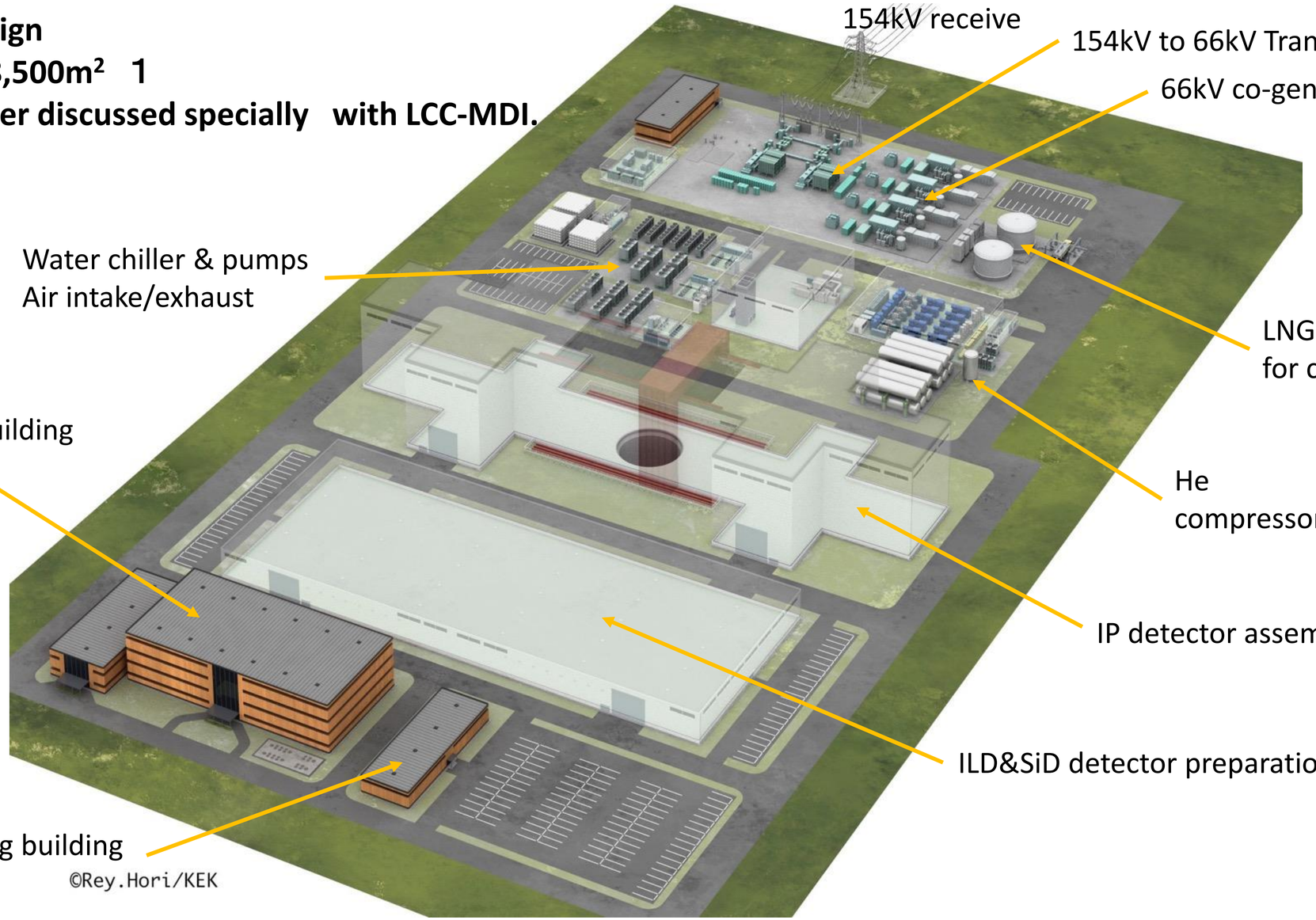


Y. Sugimoto



Surface infrastructure for one detector

surface design
IP area 78,500m² 1
to be further discussed specially with LCC-MDI.



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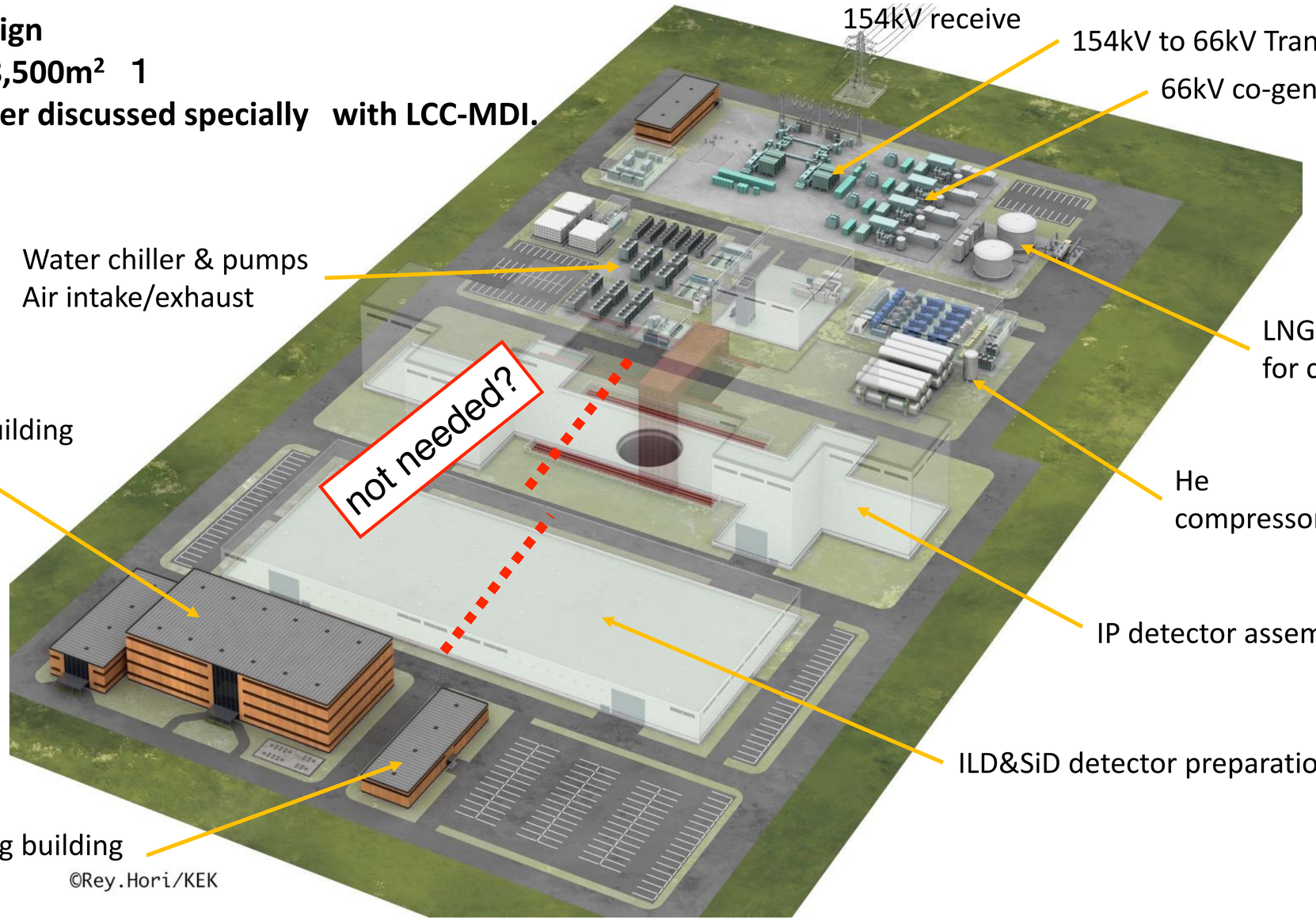


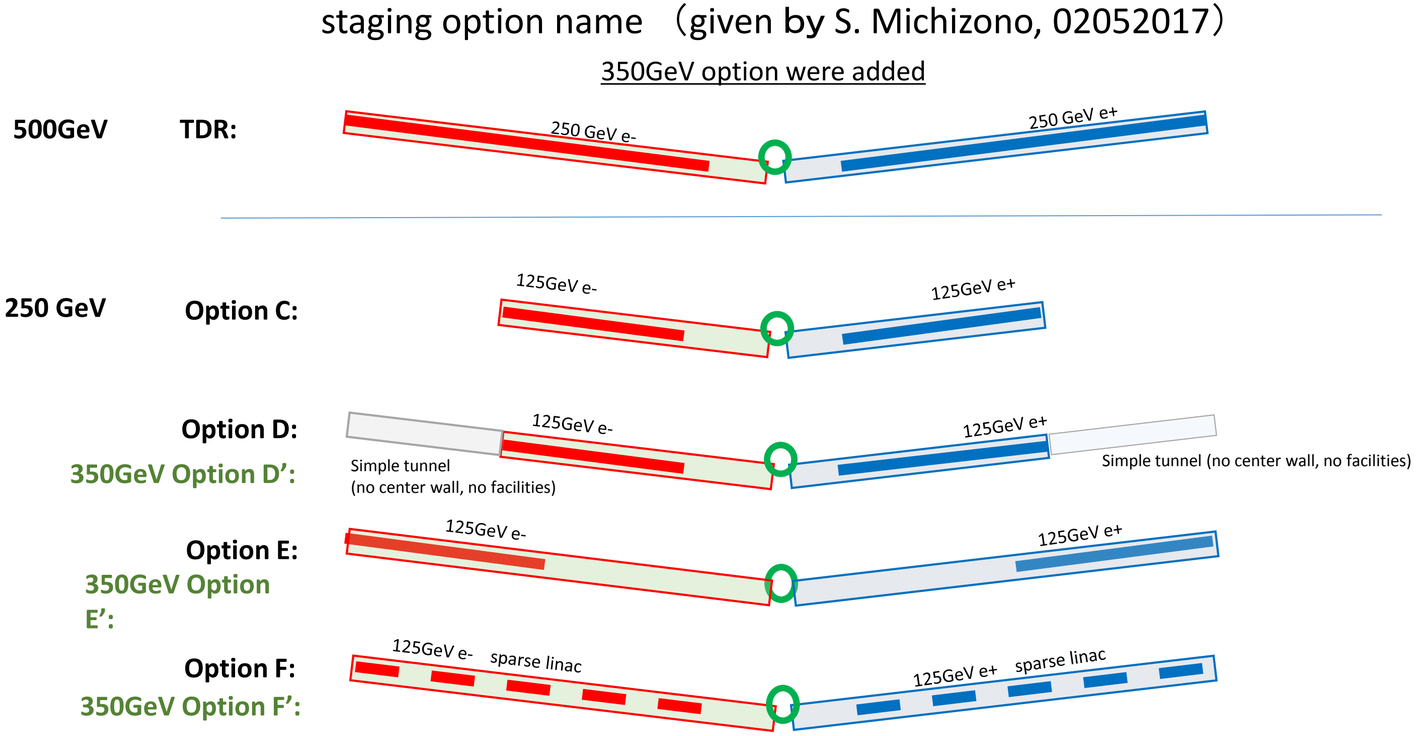
Staging of detectors?

The ILC machine comes with upgrade scenarios to higher cms energies

- start with 250 GeV
- later 500 GeV, (1 TeV)

Staging detectors?

- start with optimised detector for Higgs factory running
- exchange or complement later with a second detector
  - new technologies
  - optimised for other energies or focused on other physics scenarios



S. Michizono

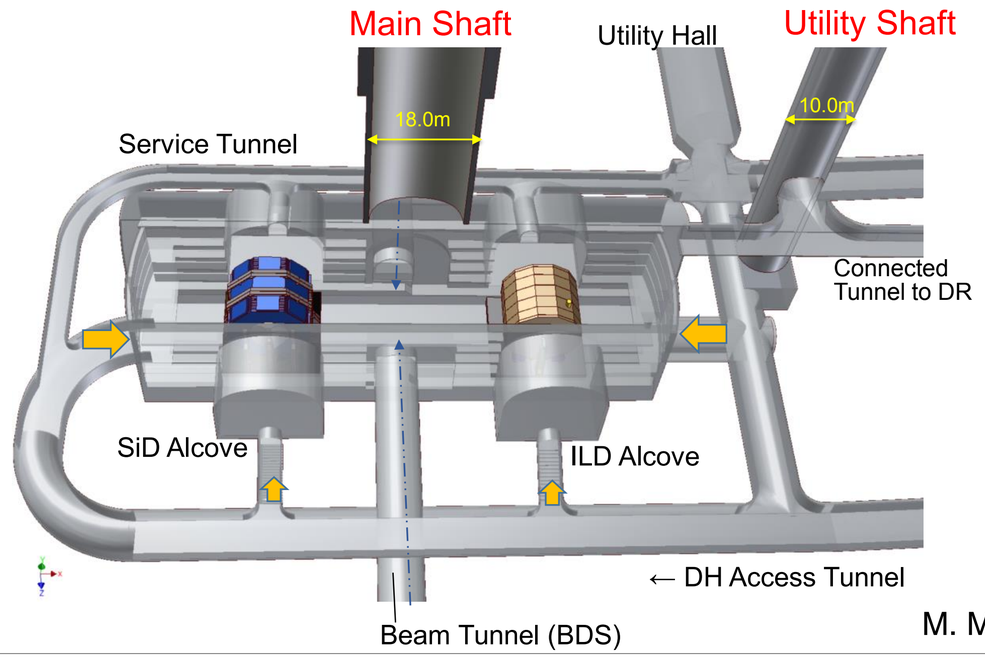
All scenarios require surface and underground space beyond the minimum one-detector scenario

Adding a second detector…

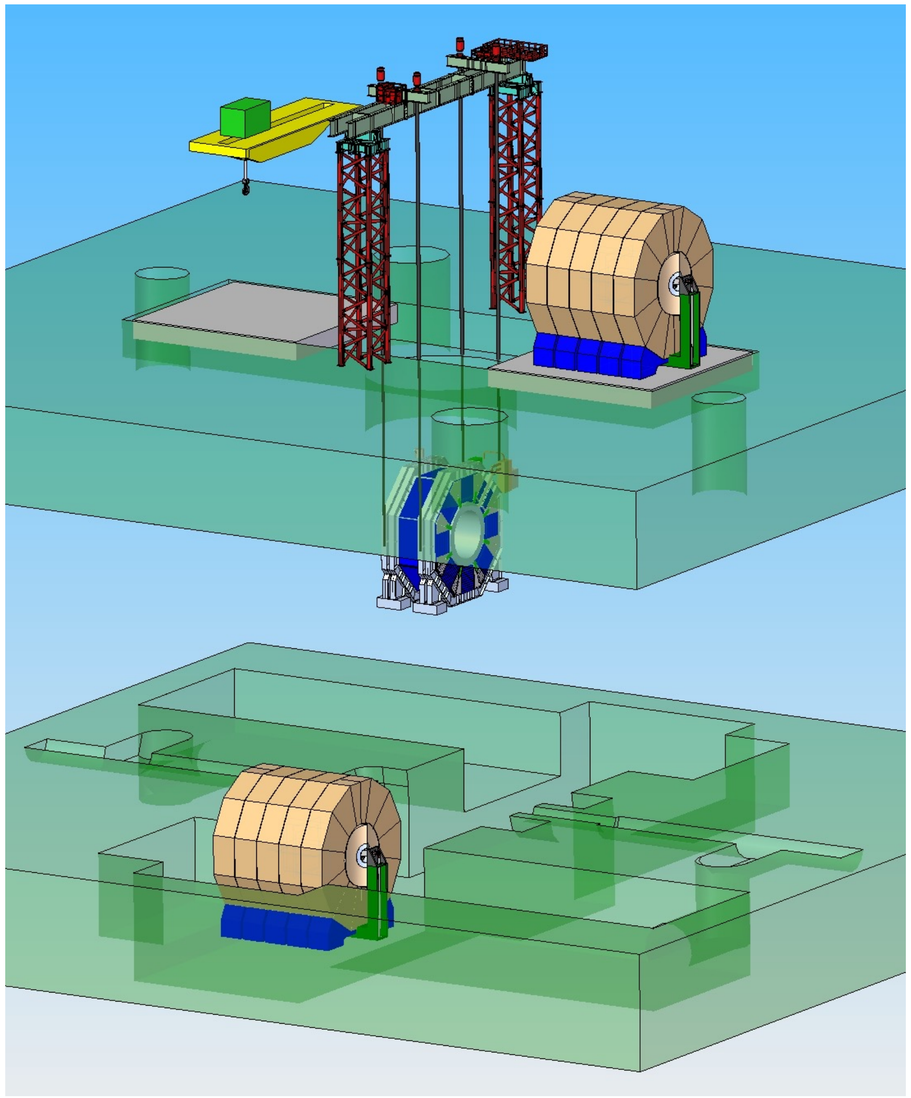
Underground and surface areas are currently laid out to build and maintain two detectors

- Adding a second detector later can be done with minimal interruption of the data taking using surface assembly and existing underground space (2nd parking position)

This would not work if the areas would have been de-scoped at the beginning of the project to fit only one detector!



M. Miyahara



M. Oriunno

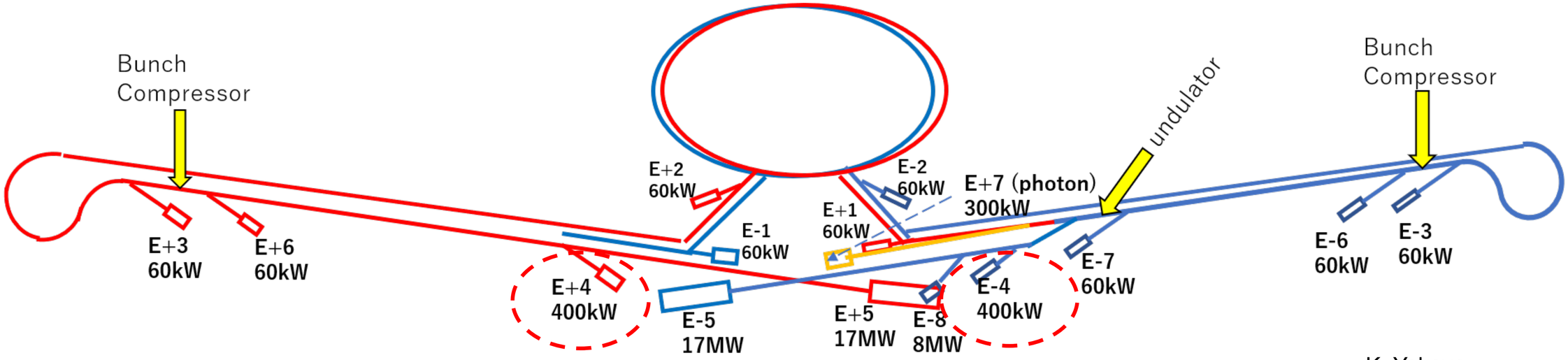
Non-collider options

Fixed-target or beam-dump experiments are now being discussed to complement the ILC collider programme

- Dedicated sessions at LCWS2021
- Possible locations for those experiments are already foreseen beam-dump extraction lines

These proposals add complexity to the simple „1 or 2 detector“ question

- Assuming most of these experiments run parasitically
- Not a lot known at this time about requirements for space, services, etc.



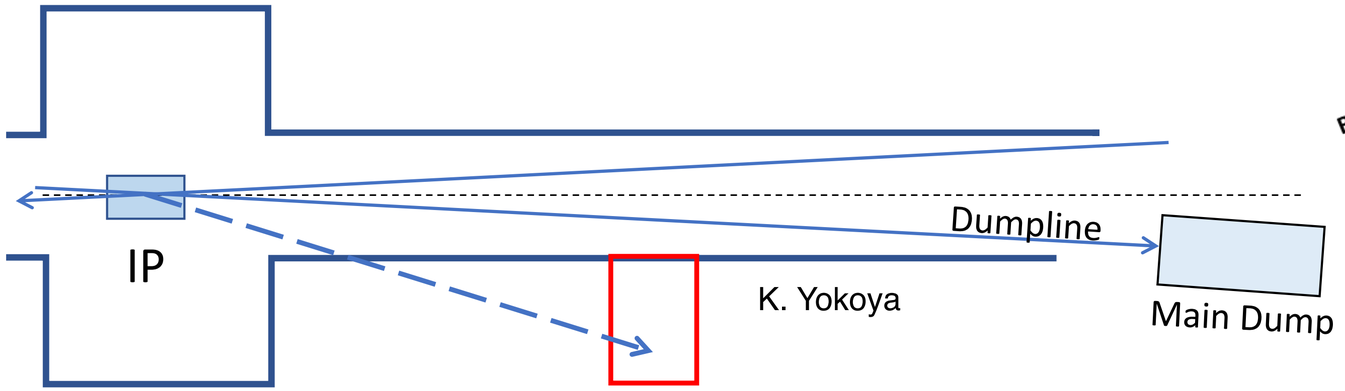
K. Yokoya

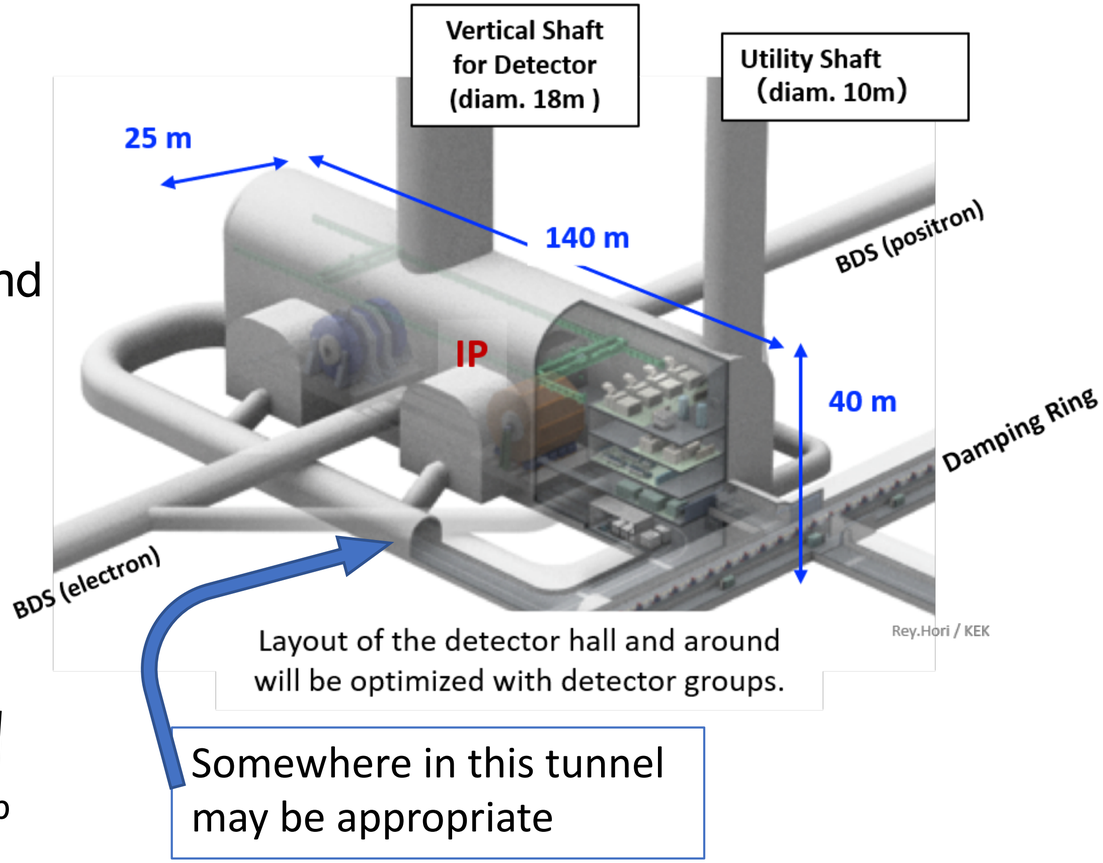
Example: far detector

K. Yokoya

Install a dedicated detector for the search of long-lived particles 50-200m from the IP

- This is far in terms of physics, but close enough to make it part of the central interaction region infrastructures
- Need to study how this interacts with the planned underground





In the end we might have not „one or two“ detectors, but many….

Summary

The current baseline of the ILC foresees an interaction region with two detectors sharing one beamline in push-pull mode

- The interaction region infrastructure has been tailored for this scenario
- A review of the boundary conditions and primary assumptions might nevertheless be useful

If the project would start with only one detector, possible savings could be realised

- Less underground and surface space required
- Moderate savings on the detector from lesser shielding (magnetic and radiation)
- We still would want to move the detector to a dedicated parking position for maintenance
- Extending the underground areas at a later stage will be very difficult, probably expensive, and will require long interruptions in data taking

Upgrading the ILC with a second detector, optimised for higher energies or using advanced technologies, can be realised with the currently planned infrastructure with minimum interruptions in data taking

The discussed fixed-target experiments bring more degrees of complication to the system

- If the discussions proceed, we need to study the technical implications in detail

Keep in mind that the ILC infrastructure should exist for many decades and might undergo different upgrade scenarios (CLIC or PWA technologies, fixed-target, gamma collider, lightsource, ???)