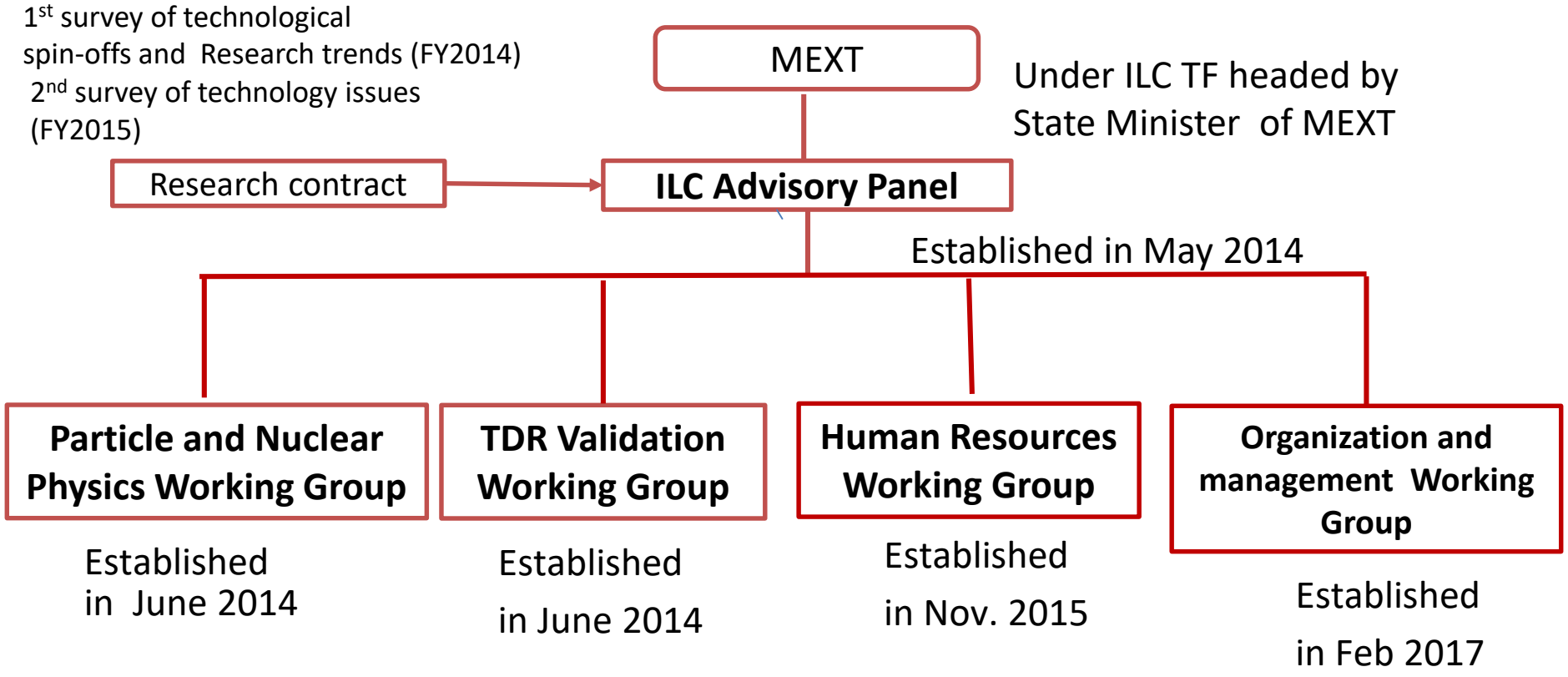
Report for TCMB on Dec.12,2017

Shin MICHIZONO

- ILC advisory panel on Dec.5 @MEXT (report by T. Nakada)
- TDR validation working group
  - Issues pointed out at previous TDR WG (on 2015)
  - Human resources WG
- MEXT survey

ILC Advisory Panel in MEXT



- Special Committee investigates critical issues required to judge hosting ILC.
- ILC Advisory Panel's Summary (Aug 2015)
- "Report on measures to secure and develop human resources for the ILC" (July 2016)
- A WG to investigate organizational and management issues was recently set up (Feb 2017).

資料４

Position of the LCB and ICFA toward the 250 GeV ILC

Presentation to the MEXT ILC Advisory Group

Tokyo, Japan, 5 December 2018

リニアコライダー国際推進委員会と国際将来加速器委員会の
250 GeV ILCに対する見解
2017年12月5日の文科省リニアコライダーに関する有識者会議での発表

Tatsuya NAKADA
Chair of Linear Collider Board
EPFL, Switzerland

中田達也
リニアコライダー国際推進委員会議長
スイス連邦工科大学ローザンヌ校

Japanese HEP community Statement

"To conclude, in light of the recent outcomes of LHC Run 2*, JAHEP proposes to promptly construct ILC as a Higgs factory with the center-of-mass energy of 250 GeV in Japan." 22 July 2017

以上のことから、LHC Run 2のこれまでの結果を踏まえて科学的な重要性を考慮すると、高エネルギー物理学研究者会議は、ILCを、重心系250GeVのヒッグスファクトリーとして、早期に建設することを提案する。
高エネルギー物理学研究者会議声明

LHCでの結果は、精密測定を標準理論と比べることによる間接的な新物理の検索がますます重要になっていることを、さらに裏付けている。

*Talk by E. Elsen in this meeting: Emerging LHC physics results confirms the increasing importance of search for New Physics through precision measurements.

2

Japanese HEP community Statement

"To conclude, in light of the recent outcomes of LHC Run 2*, JAHEP proposes to promptly construct ILC as a Higgs factory with the center-of-mass energy of 250 GeV in Japan." 22 July 2017

高エネルギー物理学研究者会議提案に対するLCBの評価の為、インプットをリニアコライダー・コラボレーションに要請。

LCB has requested the Linear Collider Collaboration (LCC) to make machine studies (based on the ILC TDR) and physics studies for 250 GeV ILC to assess the JAHEP proposal.

*Talk by E. Elsen in this meeting: Emerging LHC physics results confirms the increasing importance of search for New Physics through precision measurements.

3

LCB findings for the 250 GeV ILC

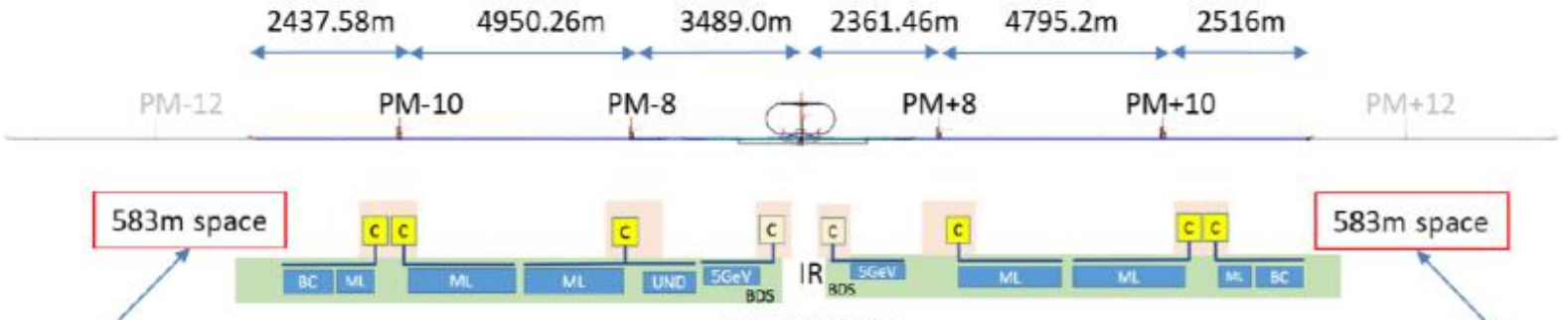
評価の為のインプット

- Compelling physics case as a Higgs factory.
- Substantial cost reduction compared to the original 500 GeV ILC.

500GeV ILC に比べて建設費が大幅に減少。

TDRに基づいたデザインで、内部の加速施設を含めてトンネルを20kmまで縮小。

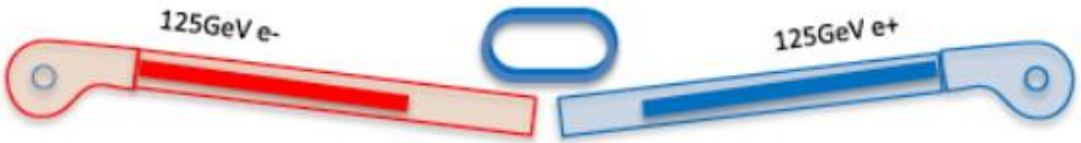
TDR based 250 GeV main linac configuration



Ecm=250GeV

	BC				e+inj		e-inj				BC	
module space margin for option C, 31.5MV/m	51	90	189	189	24	module space	24	180	189	90	51	module space margin for option C, 31.5MV/m
	51	45	189	189	24	cryomodules	24	180	189	45	51	
	17	10	42	42	8	RF unit	8	40	42	10	17	
e^- 134.8GeV =	10.0	12.8	53.5	53.5	5.0	E gain (GeV)	5.0	51.0	53.5	12.8	10.0	= e^+ 132.3GeV +5.8%margin

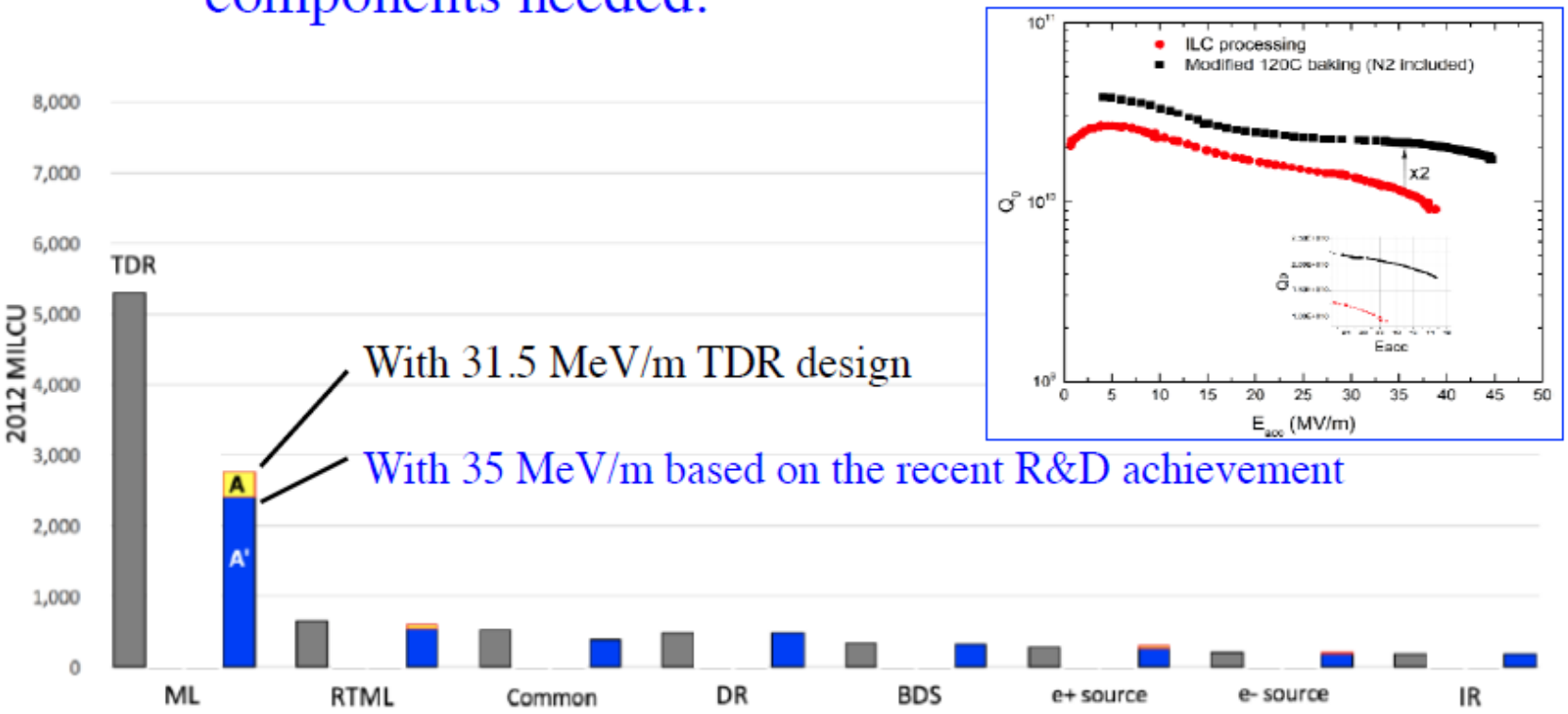
Total tunnel length = 20549.5m
(20.5km)



主に加速施設の縮小で、建設経費は500GeVに比較して最大40%の削減可能。

Compared to the ILC TDR 500 GeV machine

- Up to 40% reduction for the construction cost, predominantly due to the number of the main linac components needed.

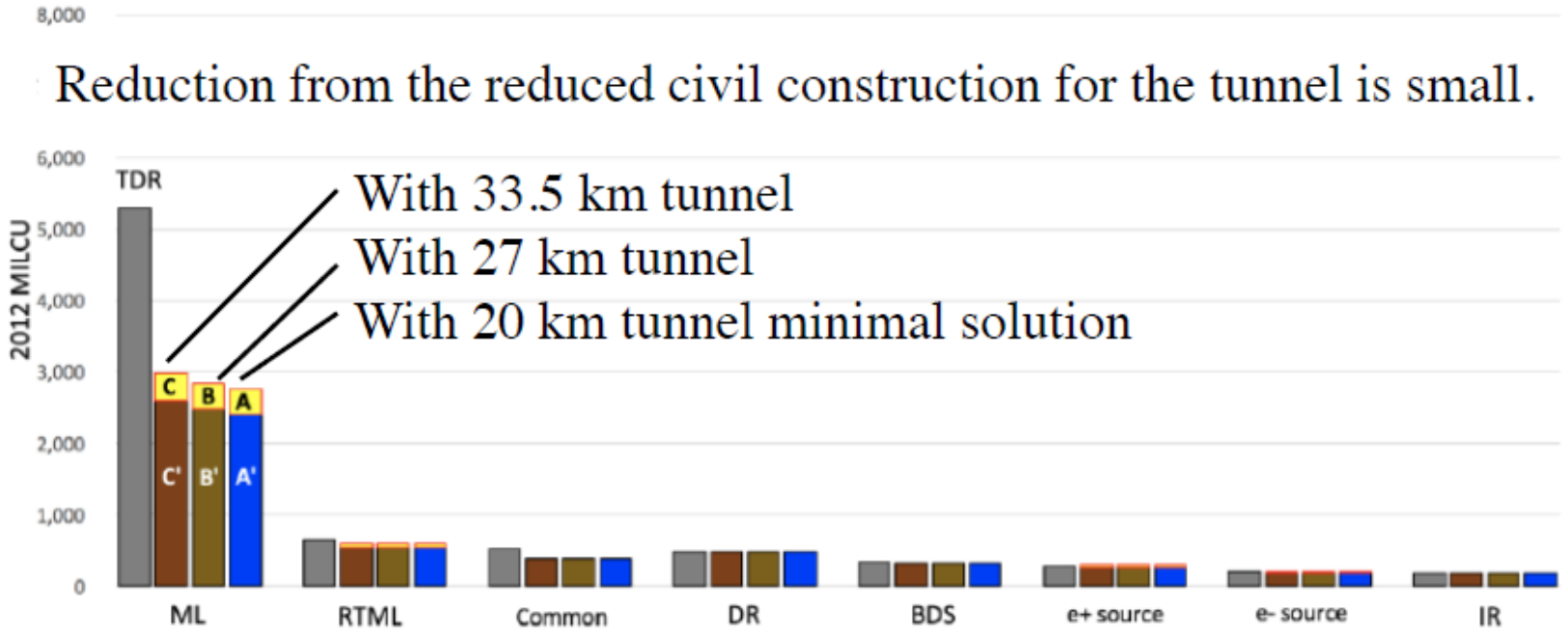


9

トンネル縮小だけによる効果は少ない。

Compared to the ILC TDR 500 GeV machine

- Up to 40% reduction for the construction cost, predominantly due to the number of the main linac components needed.



10

Compared to the ILC TDR 500 GeV machine

- Up to 40% reduction for the construction cost, predominantly due to the number of the main linac components needed.
- Up to 25% reduction for the human resources due to less assembly, installation and testing work.
- Up to 25% reduction for the operation due to less electricity consumption.

組立、設置、試験作業が減り、人件費を最大25%削減。
消費電力の低減による、運転費の最大25%の削減。

11

LCB findings for the 250 GeV ILC

評価のためのインプット

- Compelling physics case as a Higgs factory.
- Substantial cost reduction compared to the original 500 GeV ILC.
- Technology is mature, thanks to the European XFEL.

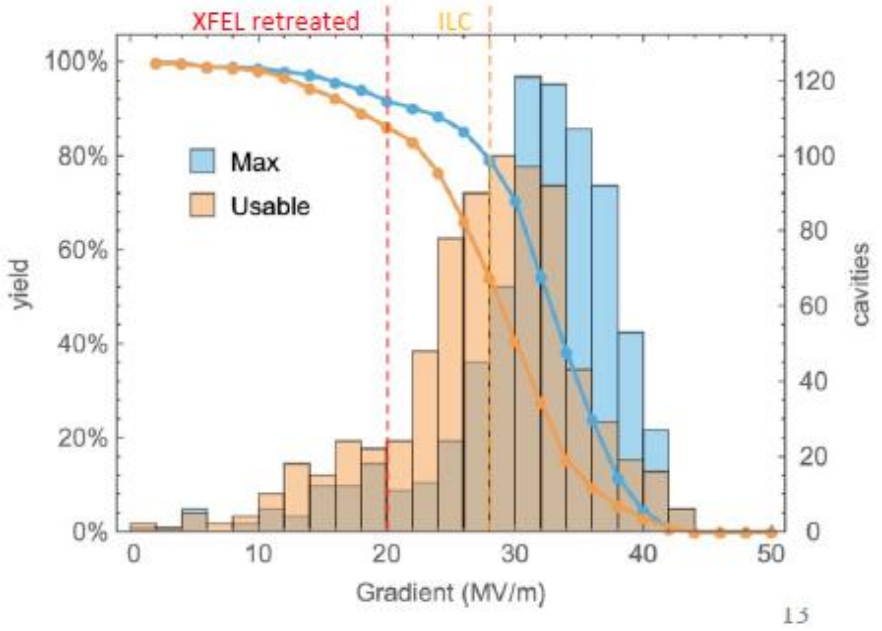
ヨーロッパ X 線自由電子レーザーのおかげでテクノロジーは確立。

12

ヨーロッパX線自由電子レーザーは、既にILC250GeVの規模の10%。

European XFEL is a 10% prototype for the ILC 250 GeV

	XFEL	ILC250
Nr of cryomodules	100	~900
Nr of cavities	800	~8500
Nr of Klystrons/ Modulators/LLRF	26	~300



LCB findings for the 250 GeV ILC

評価のためのインプット

- Compelling physics case as a Higgs factory.
- Substantial cost reduction compared to the original 500 GeV ILC.
- Technology is mature, thanks to the European XFEL.
- Operation energy of a linear collider is intrinsically upgradable
  - by extending the tunnel and acceleration structure (technically straightforward),

  or/and

  - Adopting improved acceleration technology with higher acceleration gradient (for a longer term).

長期的には加速技術の進化で、さらなるエネルギー拡張が期待できる。

18

Final Remarks by the LCB

- In recent examples of similar international projects, the host country made the majority contribution. A natural expectation would be that the cost for the civil construction and other infrastructure is the responsibility of the host country, while the accelerator construction should be shared appropriately.

最近の同様の国際プロジェクトの例では、ホスト国が主要な費用負担を行なっています。自ずと、土木建設やその他インフラの建設コストはホスト国が責任を持ち、加速器建設については適切な費用分担がなされることが期待されます。
KEK訳

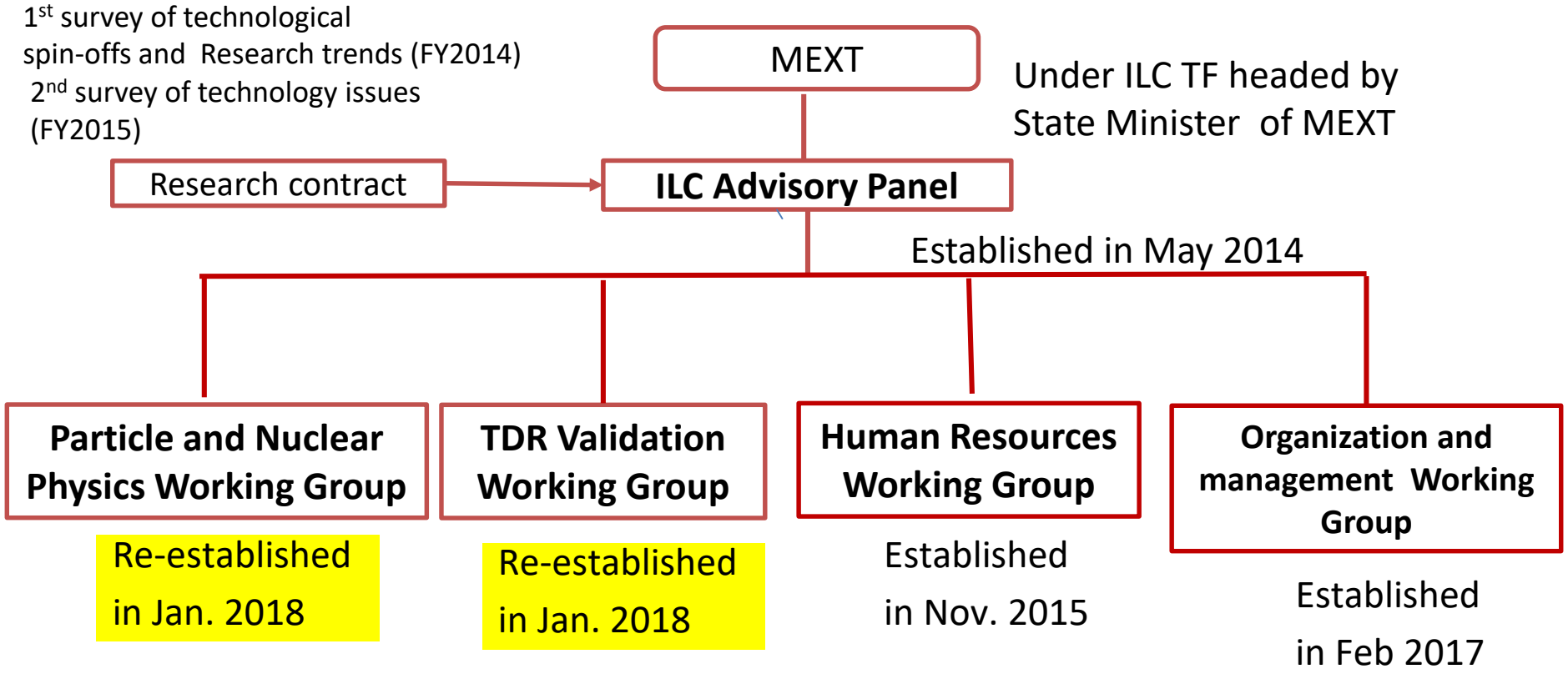
注釈
European XFEL: 総額12.2億ユーロ（2005コスト）、58%ドイツ（連邦+州+市）
(発足時の総額10.82億ユーロ（2005コスト）、54%ドイツ)
FAIR: 総額13.57億ユーロ（2005コスト）, ~75%ドイツ（連邦+州）
(発足時の総額が10.27億ユーロ(2005コスト)、69%ドイツ)
両プロジェクト共、ドイツが発想、自国での建設を提案して国際参加を求めた。20

Report for TCMB on Dec.12,2017

Shin MICHIZONO

- ILC advisory panel on Dec.5 @MEXT (report by T. Nakada)
- TDR validation working group
  - Issues pointed out at previous TDR WG (on 2015)
  - Human resources WG
- MEXT survey

ILC Advisory Panel in MEXT



- Special Committee investigates critical issues required to judge hosting ILC.
- ILC Advisory Panel's Summary (Aug 2015)
- "Report on measures to secure and develop human resources for the ILC" (July 2016)
- A WG to investigate organizational and management issues was recently set up (Feb 2017).
- Particle and Nuclear Physics Working Group and TDR Validation Working group are re-established to evaluate ILC250GeV.
- First working group will be held on middle of January, 2018.

Next TDR WG

1. Reply to the issues (pointed out at the previous TDR validation working group on 2015)
   -> should be reported at next TDR WG at MEXT
   -> includes some re-estimate of staging cost at 2017 base

2. Revise the human resources during construction (ILC500 -> ILC250) (discussed at Human Resources Working Group)
   -> should be reported at next TDR WG at MEXT

TDR validation WG (1)

(2) Validation of TDR

Total construction cost has been estimated to be 990.7 Billion JPY for the accelerator construction and 100.5 Billion JPY for the detector. Yearly budget necessary for the machine operation has been estimated to be 49.1 Billion JPY[2] .

In the TDR, contingency costs of about 25% are included but this figure stems only from the ambiguity of the cost estimate. Other kinds of possible cost increases related to technology risk, construction period extension risk, and market risk etc. should also be considered.

It should be noted that the contingency cost is minimized in TDR because the most plausible cost estimate has been taken. This could cause cost increases in case of unexpected failures in construction and/or human resource arrangement.

From a technical point of view, the design is based on actual results of previous studies, leaving only a fractional margin of deviation from them. Attention must be paid to the conducting of performance tests in a large system. The project should also be able to ensure the quality of components produced in different regions of the world.

Based on previous experience with the construction of large-scale facilities, the ILC project should consider possible cost increases due to a limited number of materials suppliers, further cost reduction in mass production, risk management of unexpected accidents in the infrastructure

---

[2] International tender is considered here supposing 1 Euro=115 JPY and 1 US dollar = 100 JPY.

http://www.mext.go.jp/component/b_menu/shingi/toushin/__icsFiles/afieldfile/2015/08/05/1360596_3.pdf

TDR validation WG (2)

fabrication such as water inflow to the tunnel from the environment, and preparation of countermeasures not listed in the TDR.

It is necessary to do risk management and prepare countermeasures against possible earthquakes near the site because the project is a long-term one both for construction and operation.

The ILC project utilizes large amounts of acceleration RF cavities. Their components are produced in different regions in the world and are assembled before installation. It is important to ensure the reliability of the assembled equipment. For this purpose, the project should have clear prospects for the quality control of components and reliable assembly within the system.

http://www.mext.go.jp/component/b_menu/shingi/toushin/__icsFiles/afieldfile/2015/08/05/1360596_3.pdf

Human resources for ILC500

[Appendix]

Overview of Human Resources during the ILC Construction

Preparation stage (4 years) ~ Construction stage (9 years)

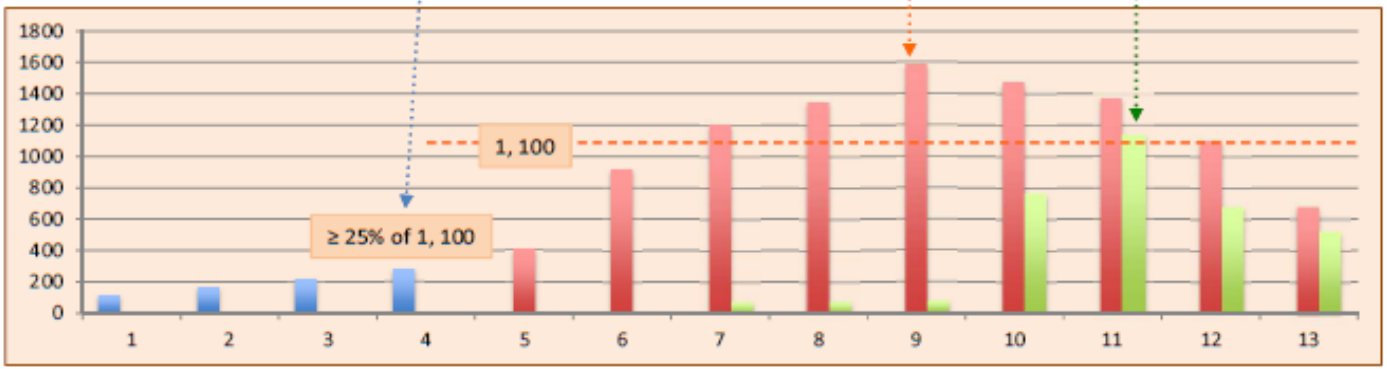
unit: person

Stage	Preparation				Construction									Total
Year	1	2	3	4	1	2	3	4	5	6	7	8	9	
Prep.	118	161	222	282										
Constr.					410	922	1,208	1,350	1,589	1,480	1,374	1,106	679	10,118
Install.							80	80	80	768	1,140	683	522	3,353
Total					410	922	1,288	1,430	1,669	2,248	2,514	1,789	1,201	13,471

KEK Study after TDR was issued

TDR Study by ILC Global Design Effort (GDE)

Ann. average: ~ 1,100 persons



- This data is taken from "Human resources securement and development in the Technical Design Report of the International Linear Collider " presented by Prof. A. Yamamoto (KEK) at the 1st Human Resource Securing and Developing Working Group, on November 18, 2015.
- The number of persons described above is based on and updated from the work estimate in the Reference Design Report (RDR) with an assumption of 1,700 yearly working hours.
- Work categories of project human resources are: research, engineering, administration, and sub-contractors. Installation work in the accelerator tunnel is mainly to be outsourced.

http://www.mext.go.jp/component/b_menu/shingi/toushin/__icsFiles/afieldfile/2016/08/29/1374377_2.pdf

Other topic

1. MEXT survey of the cost reduction R&D by new technology
   In this fiscal year, KEK get a contract about "survey of cost reduction R&D" from MEXT.
   We will survey and make some study about cost reduction (like N-infusion) by this budget.
   The cost reduction session during LCWS2017 is helpful to this survey.
   The external advisory committee will check the survey and the advisory committee was held on Nov.20. We reported R&Ds of Nb material, N-infusion, input coupler, and normal conducting linear collider (CLIC). Next committee will be held on Jan. 12.

Detail of the comments at TDR WG

Comments at TDR validation WG (on 2015)

1）risk in terms of cost コスト面でのリスクに関する課題

(1) 豊富な実績を有する海外企業の見積りが多く採用されるなど、現時点での最適な状況を選択した見積りとなっており、国内企業での調達を考慮した場合、実際にかかる費用がTDR の見積りを超過する恐れがあるなど、結果として見積に余裕が少ないことに留意が必要。

Estimates are based on selection of the optimum situation at the present time, such as the adoption of estimates of overseas companies with various experiences. Considering the procurement at domestic companies, the cost actually exceeds TDR estimates. It is necessary to keep in mind that the estimate has little margin.

(2) 本計画では大量の加速空洞が必要である。加速空洞の製作には、高純度・高品位のニオブが必要となるが、その供給元が限られること、及び、目標加速勾配が達成できない場合には大きなコストアップにつながるおそれがあり、留意が必要。超伝導加速空洞・クライオモジュールの一式のコスト予想では、欧州X 線自由電子レーザー（EXFEL）の実績製作コストと比較して72%と低く見積もられているが、今後、各地域での状況を踏まえつつ、量産化に伴うさらなる製作コストの低減、システム技術の検証が必要。

A large number of cavities are necessary in this project. Although high purity and high-grade Nb is required for the production of the cavity, the number of suppliers are limited. When the target acceleration gradient can not be achieved, it leads to a large cost increase. A set of cost estimates for the superconducting acceleration cavities and cryomodules are estimated to be as low as 72% compared with the actual production cost of the European X-ray free electron laser (EXFEL). It is necessary to reduce the mass production cost and verify the system.

Comments at TDR validation WG (on 2015)

1）risk in terms of cost コスト面でのリスクに関する課題

(3) TDR の見積りの前提とは異なって、参加国がそれぞれ自国で構成品等の製作を分担する場合のコスト増（複数メーカーに製作が分散される）を考慮すべきである。また、海外メーカーから調達した機器に関するメンテナンス保守を我が国で実施できない場合、保守費用が増大するおそれがあり、留意が必要。

Unlike the assumption of TDR estimate, consideration should be given to the cost increase (in case the production is dispersed to several manufacturers) when each participating country shares the production of components etc. in their respective countries (in-kind contribution). In addition, If the maintenance for equipment procured from overseas manufacturers can not be done in Japan, maintenance costs may increase, so it is necessary to pay attention.

(4)トンネル工事等、建設前の地盤等を含めた立地条件に関する調査やトンネルへの環境水の流入などインフラ工事における不測の事態発生のリスク検討、対応策、現在の見積りから漏れている項目、および想定外項目のリストアップとコスト増への対応策の検討が必要。

(CFS) Investigation on location conditions before construction, investigation on location conditions including infrastructure such as inflow of environmental water into the tunnel, investigation of risks of unforeseen circumstances in infrastructure construction are necessary. Items (that are missing from the current estimate) should be listed and the countermeasures against cost increase should be considered.

Comments at TDR validation WG (on 2015)

1）risk in terms of cost コスト面でのリスクに関する課題

(5)国際的な枠組みを構築する上では、その枠組みに応じた事務管理コストが必要となってくる。特に新たな国際研究機関を設置する場合、研究機関で技術者等の人材の雇用を行う（海外の研究機関の多くは建設に関する人材の多くを機関が雇用）等により、追加の費用が必要となるため、実際に必要な人件費がTDR で試算された人件費（全体建設コストの1/5）を超過するおそれがあり、留意が必要。

In establishing an international framework, the administrative management cost becomes necessary. Especially when setting up a new international research institution, we will hire human resources such as engineers at research institutes (many overseas research institutes hire a lot of human resources for the construction), etc. and additional expenses are necessary. As a result, actual personnel expenses may exceed the personnel expenses (1/5 of the total construction cost) estimated by TDR.

Comments at TDR validation WG (on 2015)

２）Issues on technological feasibility 技術面での実現可能性に関する課題

(1)TDR で示された、過去の実績値における性能が実機量産品でも達成されるという前提での設計となっており、設計に尤度が少ない。また、輸送時においては衝撃や温度変化による性能劣化及び輸送手段の事故等による不測の損害の発生が問題となるので、製作個数に余裕が欲しい。建設開始までの準備期間で、目標性能を安定に実現させること（歩留りの改善を含めて）、製造技術の確立、メーカーへの製造技術移転及び量産体制の確保の他、日本における技術蓄積等が重要。

The TDR design is based on the premise that the performance at the past achievement value can be achieved even with the mass-production of the actual machine, and the design has small margin. Also, at the time of transportation, performance degradation due to shock and temperature change, occurrence of unexpected damage. more margin for the number of production is desired.

In preparation period, stable production of target performance (including improvement of yield), establishment of manufacturing technology, transfer of manufacturing technology to manufacturers and securing of mass production structure, technology accumulation in Japan are important.

Comments at TDR validation WG (on 2015)

２）Issues on technological feasibility 技術面での実現可能性に関する課題

(2)小規模なシステムでの技術蓄積実績があったとしても、スケールの異なる大規模システムを検討する際は技術面、コスト面での不確実性が大きくなることから、ILCにつながる技術を駆使して実施されるEXFEL の進捗状況及び蓄積された実績を踏まえた技術的成立性に関する見通しが重要。

Even if there is a technology accumulation in a small-scale system, uncertainty in terms of technology and cost will be significant when considering a large-scale system with a different scale. It is important to see the technical feasibility based on the progress and experience of EXFEL (where the technology leading to ILC is adopted).

(3)建設を分担する複数の拠点間の品質保証等の協調方策の検討。特に国際的に統一した品質管理など、複数の拠点で分散して同じ品質のコンポーネントを製作するための性能再現化技術の確立について見通しを得ることが必要。一般に、異なる機関で製作された部品を組み上げて一つの構成品に組み上げる際には取り合いでの課題が増加するため、各国が部品製作を分担する場合は、システムとして組み上げる際の整合性などに関する技術的検証が必要。

(Quality control) Cooperative quality-assurance among multiple bases should be considered. Especially, it is necessary to obtain prospects about the establishment of performance reproducing technology (same quality at multiple bases) by such as internationally unified quality control. Generally, when assembling parts manufactured by different organizations into one component, connection troubles increase. In the case where each country shares parts production, consistency check for assembling as a system is necessary.

Comments at TDR validation WG (on 2015)

２）Issues on technological feasibility 技術面での実現可能性に関する課題

(4)運転の信頼性確保や要求性能の定常的維持の観点から、性能実証が不十分な構成機器、例えば、ビームダンプや電子源、陽電子源などが見受けられる。これらの構成機器に関し、所期の目標性能を明確化すると共に、目標達成に向けた現実的な研究開発・性能実証の工程表を策定することが必要。

(4) From the viewpoint of securing the reliability of operation and maintaining the required performance steadily, some equipments show insufficient performance demonstration, such as beam dump, electron source, positron source etc. It is necessary to clarify the desired target performance and to formulate a practical R & D schedule to achieve the target.