



# *2009 Linear Collider Workshop of the Americas*

## *Tunnel Life Safety and Egress Accelerator Design and Integration*

### *Conventional Facilities and Siting Group*

*V. Kuchler, J. Osborne, A. Enomoto*



## **Overview**

- ***Current Status of Codes and Regulations***
- ***General Regional Laboratory Approaches***
- ***Current Regional Designs***
- ***Global/Project Issues***
- ***Summary***



## **Current Status of Codes and Regulations**

- ***There are No Codes that Directly Address Underground Accelerator Complexes***
- ***Most Initial Approaches Review Experience with Traffic Tunnels and Their Associated Guidelines and Regulations for Designs***
- ***Most Recognized Codes Evolve Over Time and are Revised, Based in Part, in Response to Fire and/or Catastrophic Failures***
- ***But Traffic Tunnel Requirements are Based on Fuel Loads that Far Exceed Those Found in Actual Accelerator Installations (i.e. Gasoline, Diesel Fuel, Oil, etc.)***



## Current Regional Laboratory Approaches

- *Most Laboratories Rely on Examples from Previous Projects to Develop Initial Criteria for Life Safety and Egress Design for a New Project*
- *This Initial Criteria is Then Supplemented by Consultant Review, Local Underground Codes where Available and Applicable as well as Regulations/Guidelines from Funding and Project Oversight Organizations*
- *While Most Regions do have Regulations that Directly Control Traffic Tunnel Design, in the Americas Region Two Distinct Codes have been Developed*
  - *NFPA 130-2007, Standard for Fixed Guideway Transit Systems*
  - *NFPA 520-2005, Standard for Subterranean Spaces*
- *It Should be Noted that All Codes are Subject to Interpretation*



## Current Regional Designs

- *Life Safety and Egress Issues and RF System Selection are Two of the Major Drivers of Main Linac Tunnel Diameter*
- *All Three Sample Sites have Developed a Life Safety and Egress Design for the Main Linac Single Tunnel Alternative Based on Their Local Experience and Applicable Regional Regulations*
- *All Three Regions have Reviewed both RF Alternatives and Selected the More Appropriate Alternative to Develop Their Regional Main Linac Tunnel Diameter*
- *A Global Safety Document is Currently Being Developed that will Gather Information from All Current Accelerator Projects, Including ILC, XFEL, CLIC, LHC and Project X, for Use as a Supporting Reference to any Current or Future Accelerator Design Project*



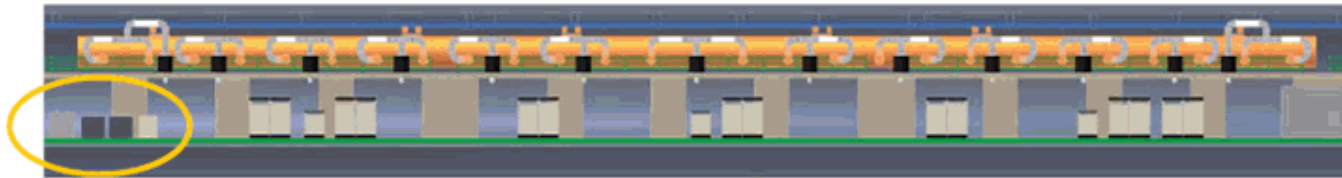
## Asian and European Design Approaches

- *Main Linac Single Tunnel is Divided into 500 m Long Segments (i.e. Compartmentalization)*
- *Firewall and Fire Doors Separate Adjacent Segments*
- *Ducted Transverse Ventilation is Used for Fresh Air Supply and Return and Smoke Control and Exhaust*
- *The European Region Uses the Klystron Cluster RF System*
- *The Asian Region Uses the Distributed RF System*
- *Both Regions Currently Utilize a 5.2 m Main Linac Tunnel Diameter*

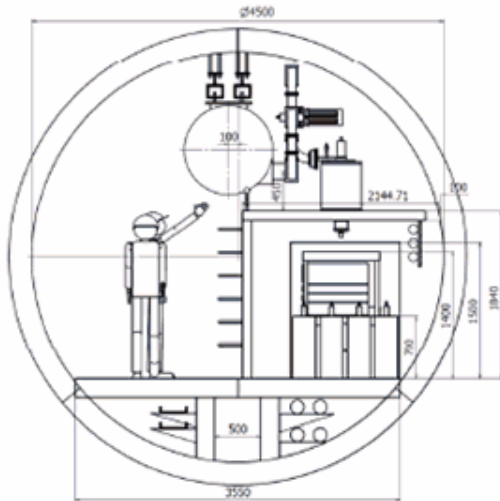


# Asian Region Tunnel Design

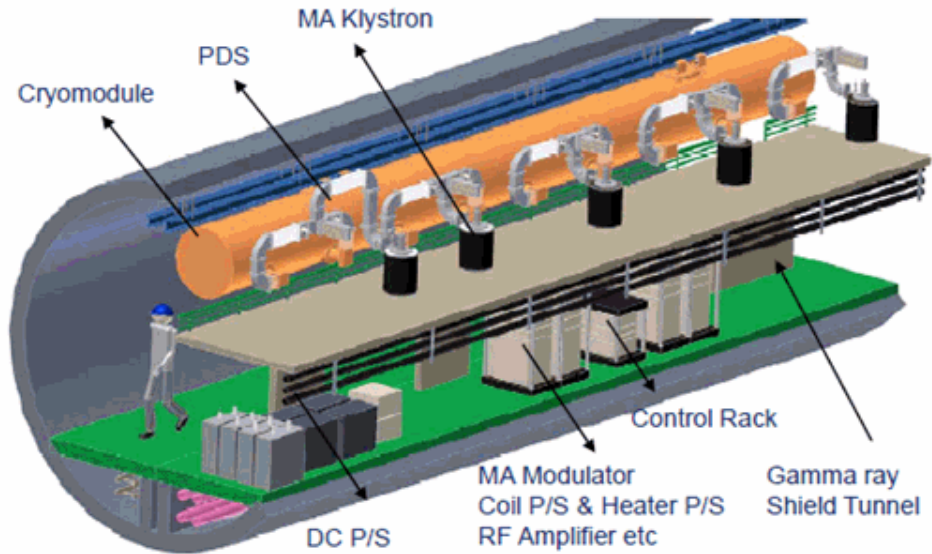
Sketch of 3-Cryo-odule unit



6.6kV In & Rectifier Transformer  
Capacitor Bank, Bouncer

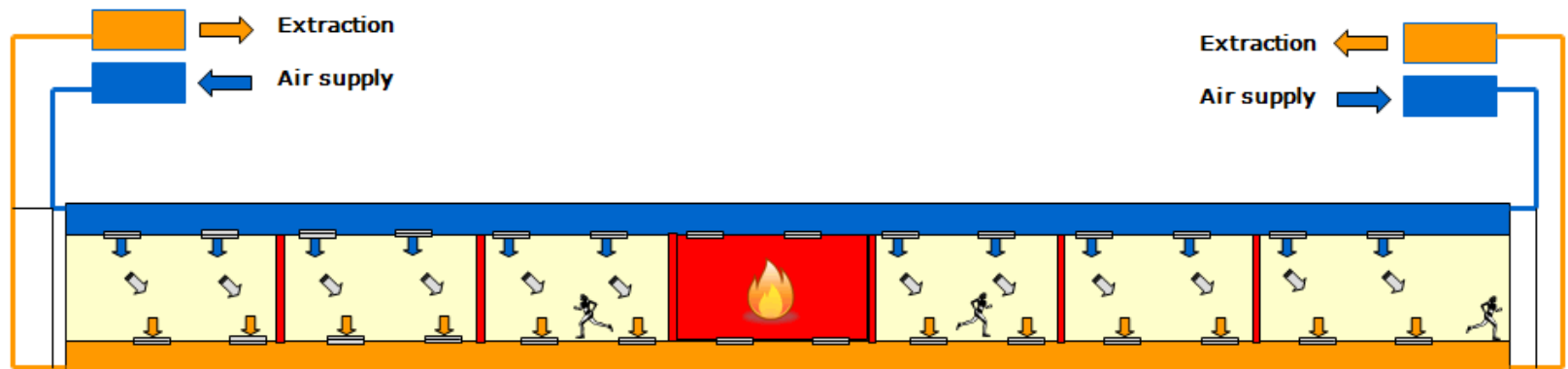


Cross Section



# European Tunnel Compartmentalization

## Safety considerations



SHAFT  
POINT

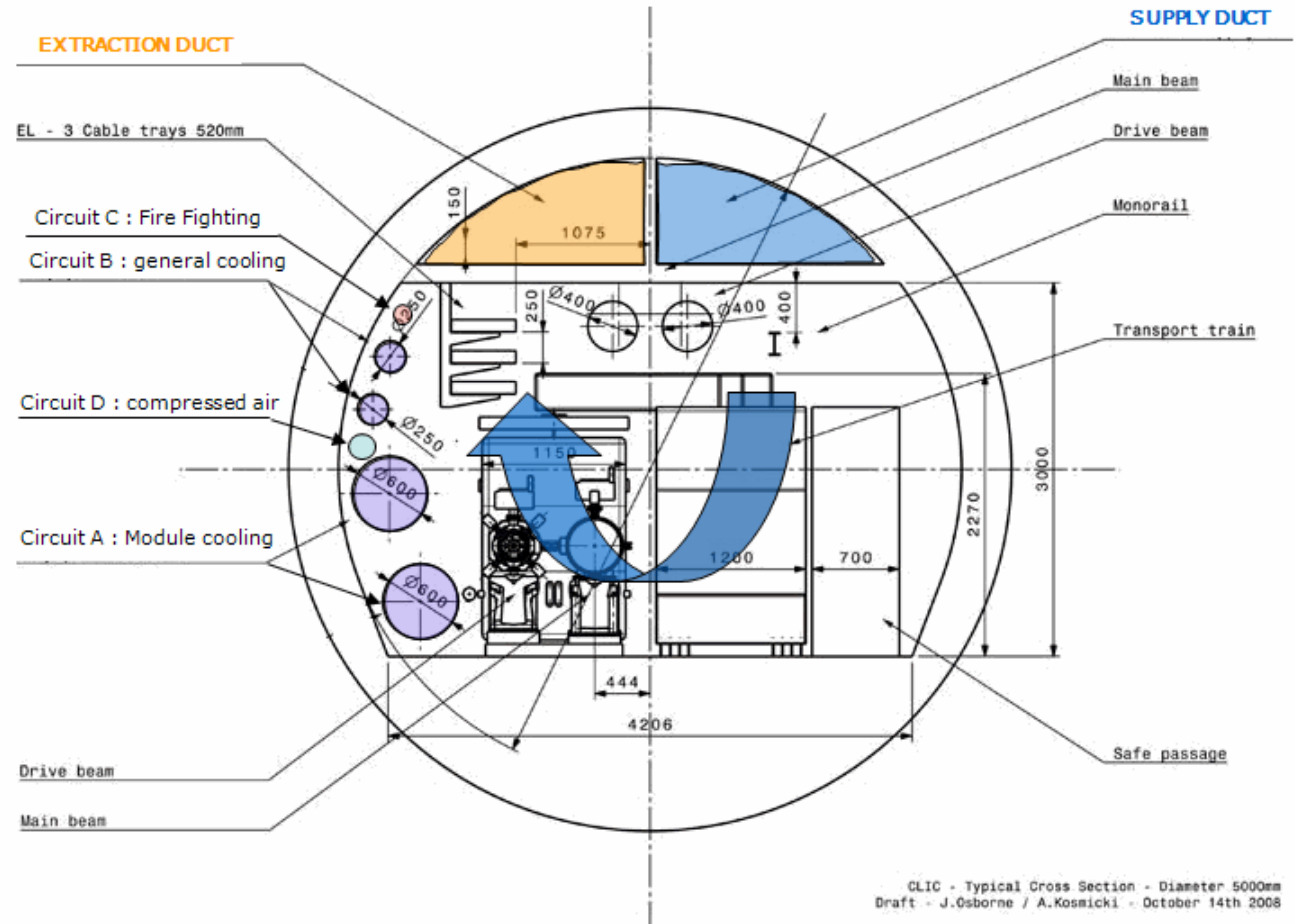
- Control of the pressure from both ends of a sector.
- Control of the pressure (overpressure or underpressure in each area).
- Fire detection per sector compatible to fire fighting via water mist.





# European Tunnel Design

## Tunnel section



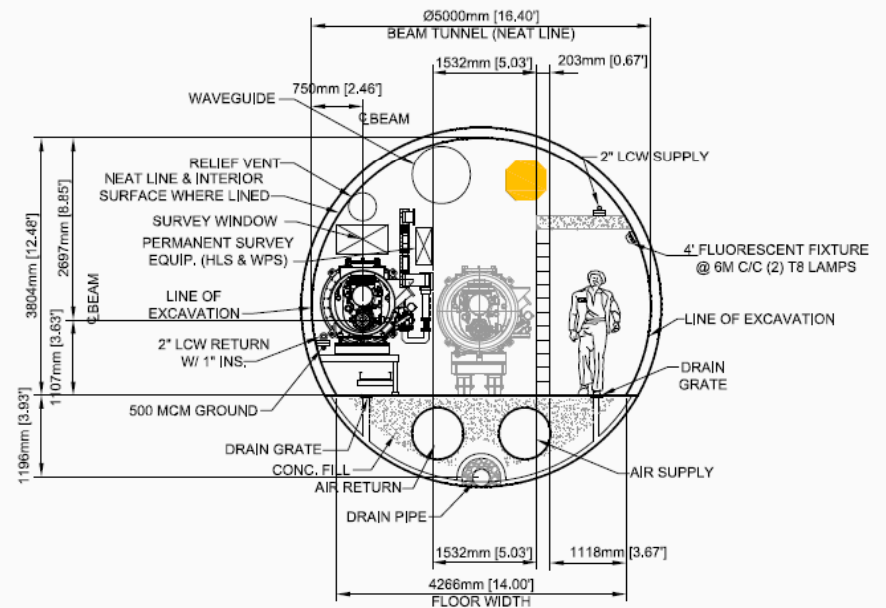
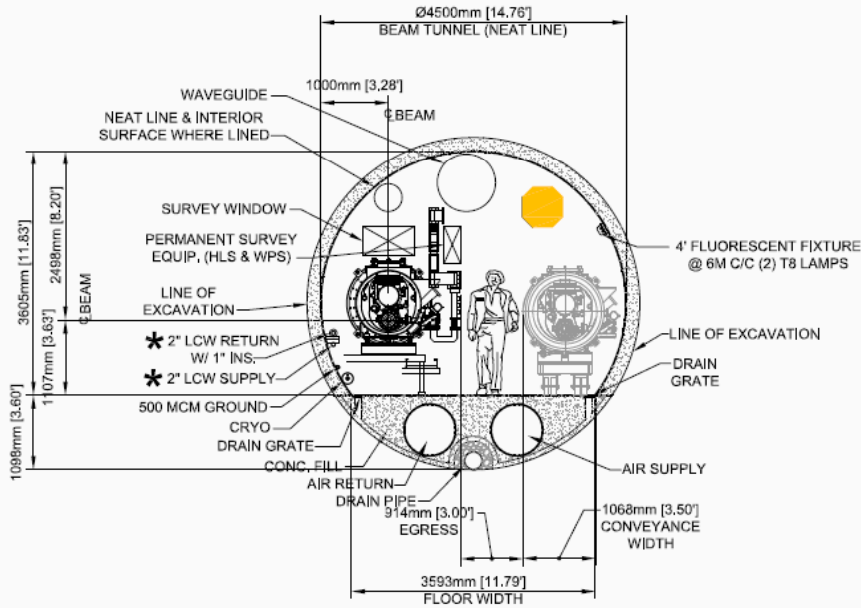


## Americas Design Approach

- *Based on NFPA 520, the Main Linac Single Tunnel Must be Divided into “Building” Space (i.e. Functional or Operation Space) and “Common” Space (i.e. Space Used Only for Exit Travel to the Surface)*
- *A 2 hr Firewall and 1-1/2 hr Fire Doors Must be Used to Separate the Two Spaces*
- *Alcoves are Also Required in the Common Space to Limit the Distance to an Exit or Area of Refuge to 610 m*
- *The Americas Region Currently Utilizes the Klystron Cluster RF System and a 5.0 m Main Linac Tunnel Diameter*



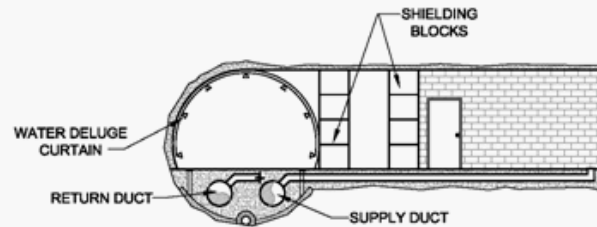
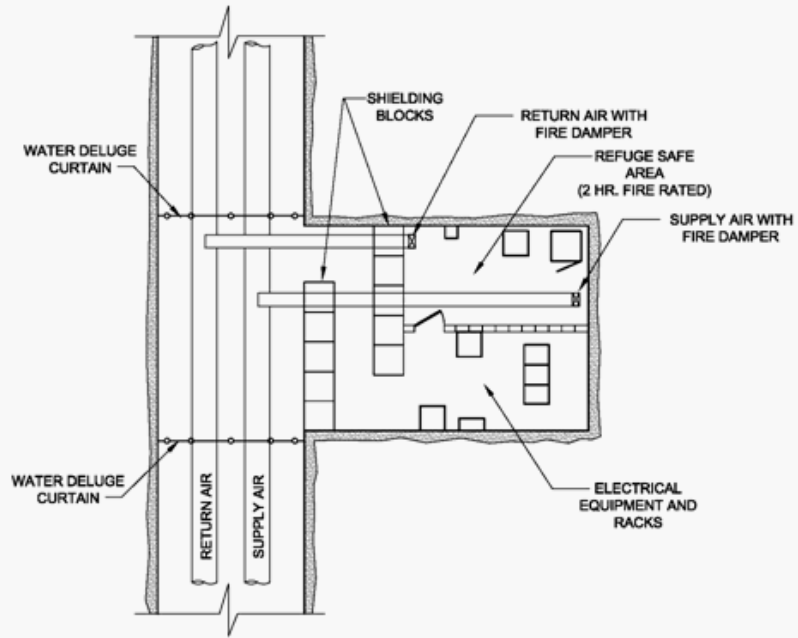
# Americas Region RDR and AD&I





# Americas Areas of Refuge

## Area of Refuge





## Global/Project Issues

- *Applicable Regional Codes and Local Governing Bodies will have an Effect on the Eventual ILC Design*
- *There are Two Scenarios that Could be Considered for the Governance of the Proposed ILC Project*
  - *A New International Laboratory, which Follows the CERN Model, Could be Developed with an Internal Responsibility for Self-Regulation*
  - *A New Internationally Operated and Funded Laboratory Could Be Developed but Constructed in Accordance with Local Applicable Codes and Regulations*
- *The CFS Group is not in a Position to Speculate on the Eventual Governance Model*
- *Therefore All Current Sample Site Solutions are Based on the Responsible Implementation of Available Local Experience and Regulatory Codes and Guidelines*



## Summary

- ***Each Region has Developed a Sample Site Solution that Satisfies Local Life Safety and Egress Requirements Using Both Identified RF System Alternatives***
- ***The Development of a Single, Cost Optimized, Uniform Design for All Three Regions is Simple not Possible***
  - ***Different Geology***
  - ***Different Tunnel, Shaft and Cavern Construction Means and Methods***
  - ***Different Approaches to Life Safety and Egress***
  - ***Preference of RF System***
- ***Using the Regional Sample Site Approach for the ILC CFS Design Appears to be a Sensible Model for the Development of the TDR***
- ***The Final Life Safety and Egress Design for the ILC Cannot be Completed Until a Specific Site is Chosen and an Approving Authority has been Established***