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CERN & Fermilab

LHC & Neutrinos

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CERN Council

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P5 Report...still very impactful in Washington

- P5 report has had and is having a major impact on US planning for particle physics because:
 - Excellent report that made difficult choices and has focused field
 - Community support very high
- Secretary of Energy has expressed strong support for report because of community support
- P5 top priorities: LHC and Neutrinos

CERN/DOE Agreement: The Signers...Moniz, Heuer, Cordova



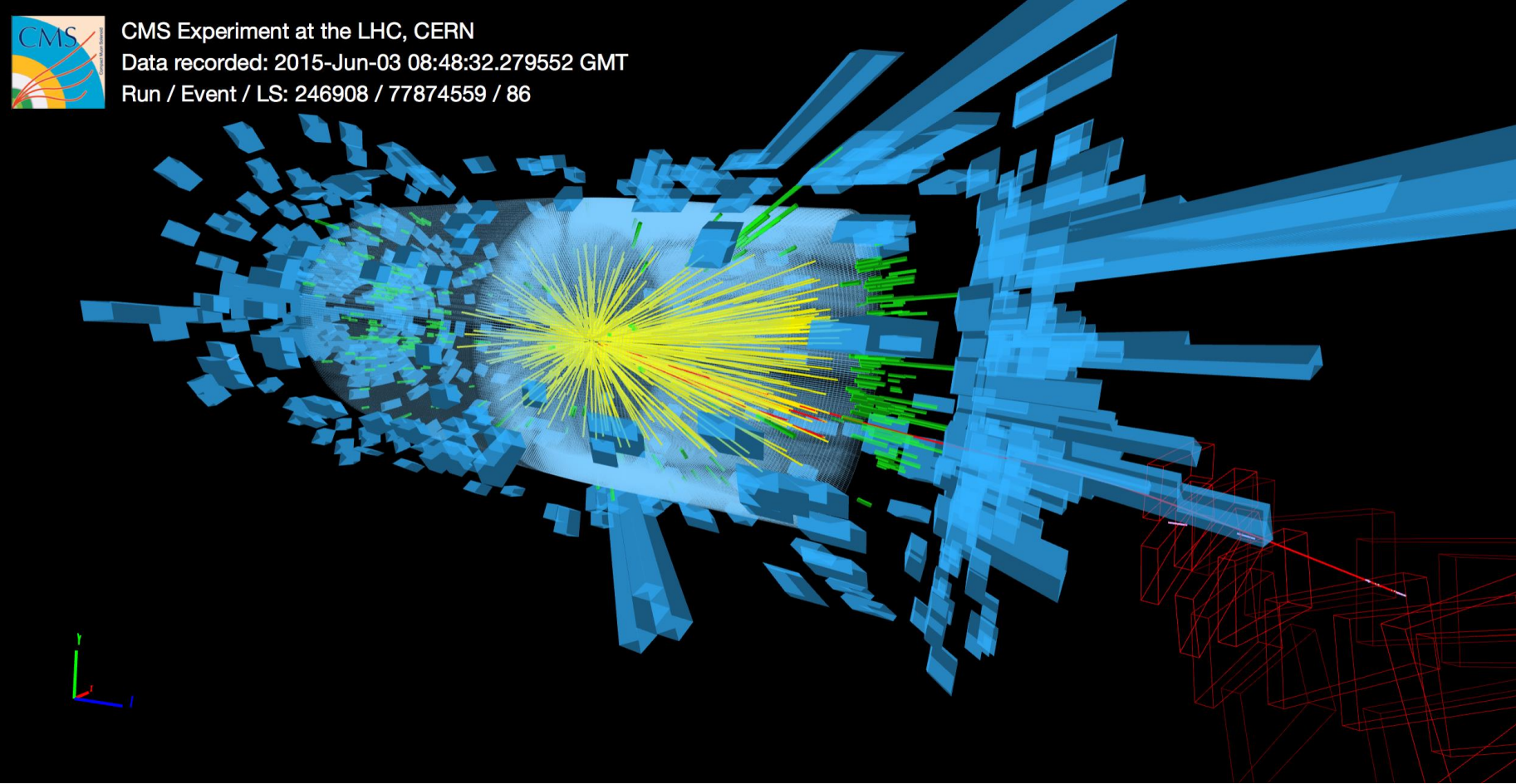
CERN & Fermilab....together we are stronger

- CERN is the world's leading high energy lab now that Fermilab has relinquished the energy frontier with closing of Tevatron
- CERN is mandated to “steward” all European particle physics
- Fermilab is only “single program” HEP laboratory in US
- CERN needs the US to execute the HL-LHC successfully and we need CERN to help with LBNF
- By supporting a world class long baseline neutrino program in US, CERN is supporting the European neutrino community
- CERN and Fermilab both have tremendous technical depth
- Interests & technology overlap on FCC
- **Success of both CERN & Fermilab are highly intertwined**

NY Times:U.S. & European Scientists Sign Cooperation Pact

- “a model for the kinds of international scientific collaboration that can enable breakthrough insights and innovations.” ...John Holdren, President’s Science Advisor
- “This agreement is also historic since it formalizes CERN’s participation in U.S.-based programs such as prospective future neutrino facilities for the first time.”
Rolf Heuer DG CERN
- “Our research programs in the U.S. and Europe are now deeply intertwined by the signing of this agreement.” ...Jim Siegrist... Office of High Energy Physics

CMS and the LHC are back at 13 TeV...congratulations!



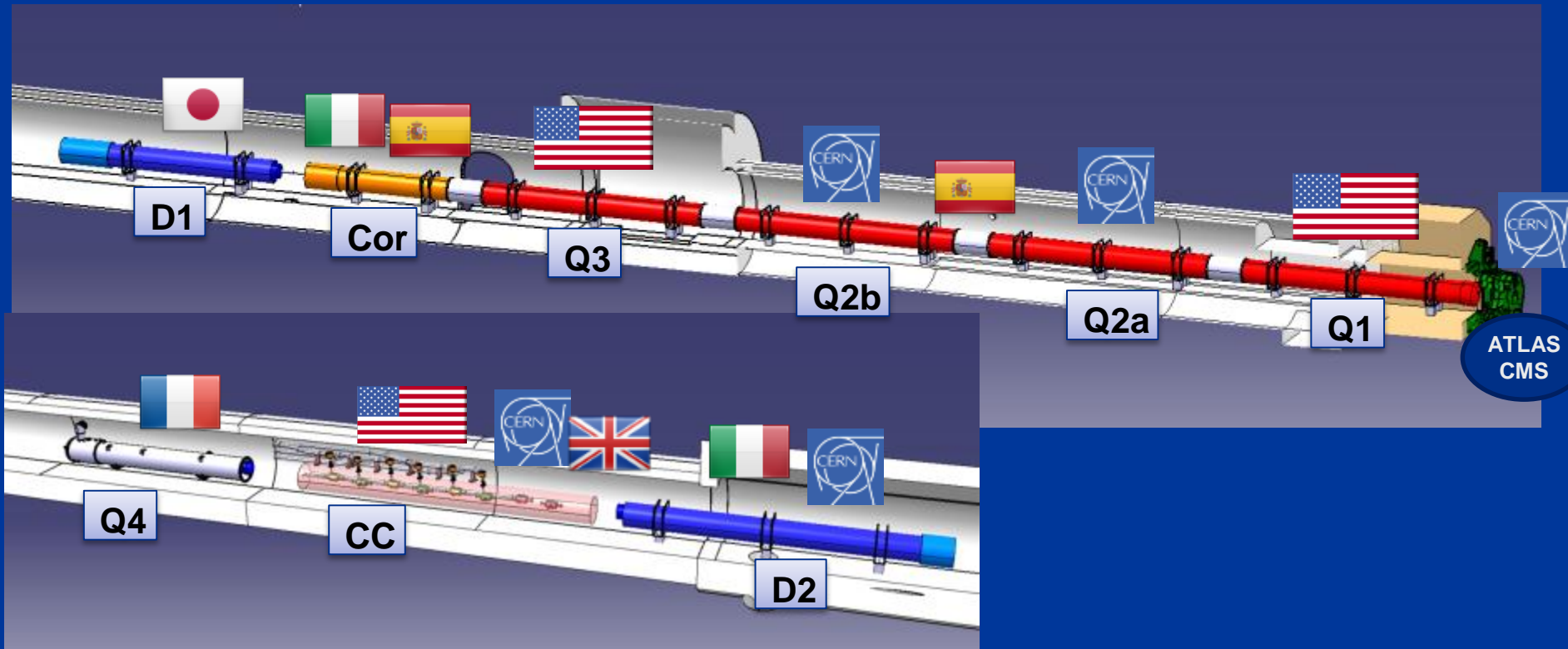
CMS in Wilson Hall...art collides with science



CMS at Fermilab

- CMS is the single largest science program at Fermilab
- ~100 people involved
- Continued strong support from DOE and Fermilab management
- Leading the USCMS phase 1 upgrade project
- Leading the USCMS preparations for HL-LHC upgrades
- Fermilab is committed to leading roles in CMS operations and computing

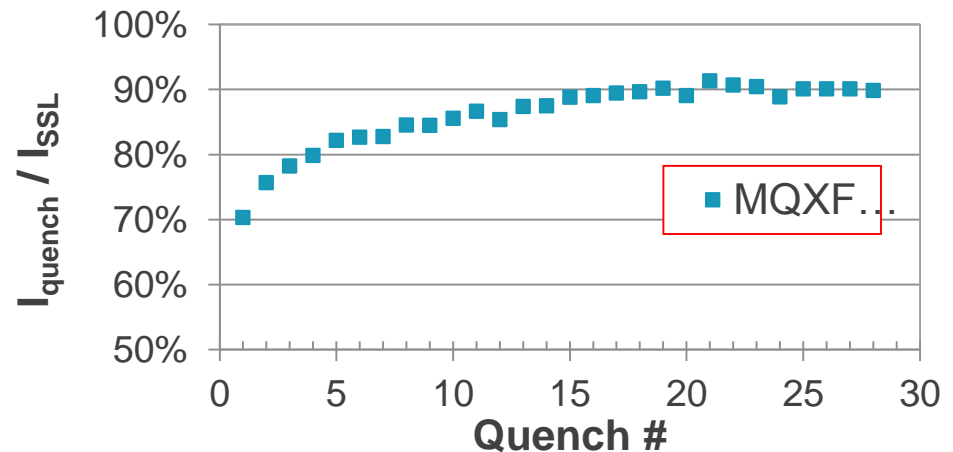
Good Example of International Collaboration



Baseline design of HL-LHC Interaction Region (Bordry)

Successful test of first HL-LHC coil

- First model coil for HL-LHC magnets assembled and tested in mirror configuration at Fermilab. The Mirror Magnet was tested in the IB1 Vertical Magnet Test Facility using for the first time an upgraded 30kA setup.
 - Higher current needed for higher-performing Nb₃Sn magnets
- Coil achieved HL-LHC “operating current” (16.5kA) in 3 quenches during the first day of testing.
- Next goal: Test of first 4-coil complete quadrupole later in CY15.



Long Awaited HEPAP Accelerator subpanel report

- Strong support for:
 - High field magnet research for very high energy pp collider
 - this could evolve to be a “LARP-II” type framework

CERN Chiefs Visit Washington...encourage support for LHC



Cannot take Congressional support for granted...must work hard



P5 Mandate: a new international collaboration

P5 recommendation 13: “Form a new international collaboration to design and execute a highly capable Long-Baseline Neutrino Facility (LBNF) hosted by the U.S. To proceed, a project plan and identified resources must exist to meet the minimum requirements in the text [of the report]. LBNF is the highest-priority large project in its timeframe”

- Basically asks Fermilab to do for neutrinos what CERN did for the Higgs, involving the worldwide community



Building for Discovery

Strategic Plan for U.S. Particle Physics in the Global Context

Secretary of Energy Ernest Moniz

....its a policy question



- The Secretary viewed “how to send a positive signal” to international partners that the US was considering hosting an international mega-science project a “policy issue” and therefore of importance to the White House (OSTP)

From the European Strategy Document

f) Rapid progress in neutrino oscillation physics, with significant European involvement, has established a strong scientific case for a long-baseline neutrino programme exploring CP violation and the mass hierarchy in the neutrino sector.

CERN should develop a neutrino programme to pave the way for a substantial European role in future long-baseline experiments.

Europe should explore the possibility of major participation in leading long-baseline neutrino projects in the US and Japan.

LBNF/DUNE status....they are off and running

- Strong support from DOE Office of Science
- Proposing and planning for site preparation in South Dakota starting in fiscal year 2017
- Tremendous progress by collaboration: 144 institutions and 775 scientists already



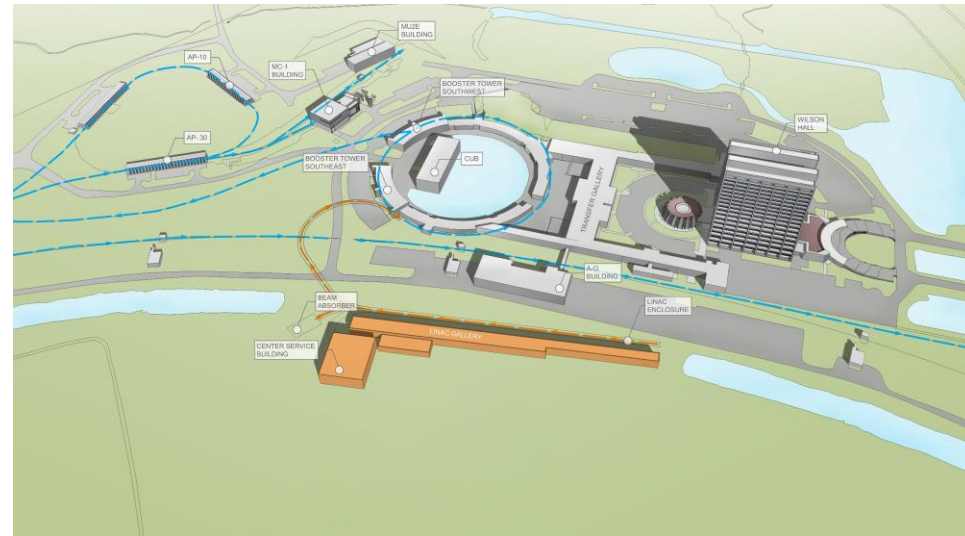
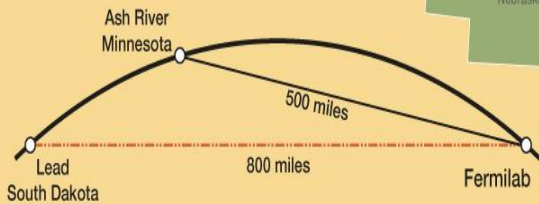
**Dune spokespeople:
André Rubbia (ETH) and
Mark Thomson (Cambridge)**



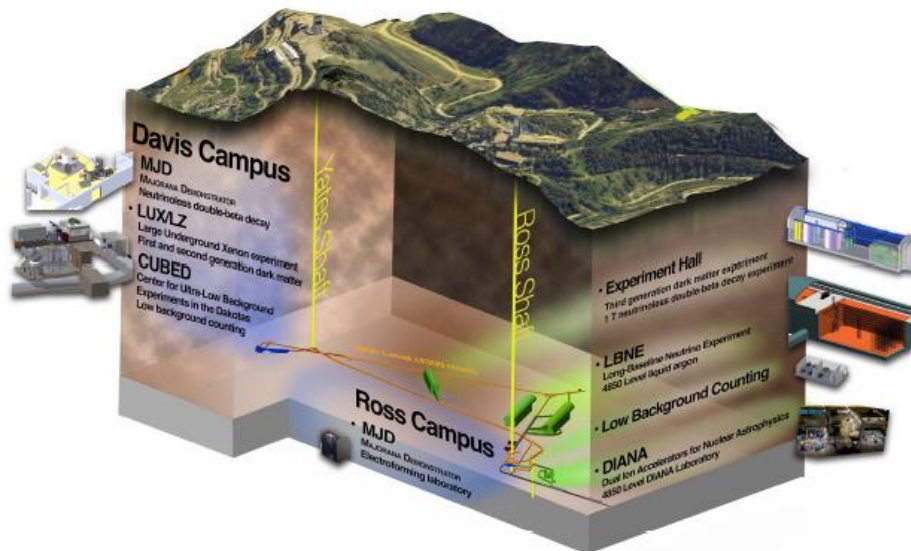
Detectors deep underground at the Sanford facility S.D.

Straight Through the Earth

MINOS	Soudan Mine, MN	2340 ft deep
NOvA	Ash River, MN	Surface level
LBNE	Homestake Mine, SD	4850 ft deep

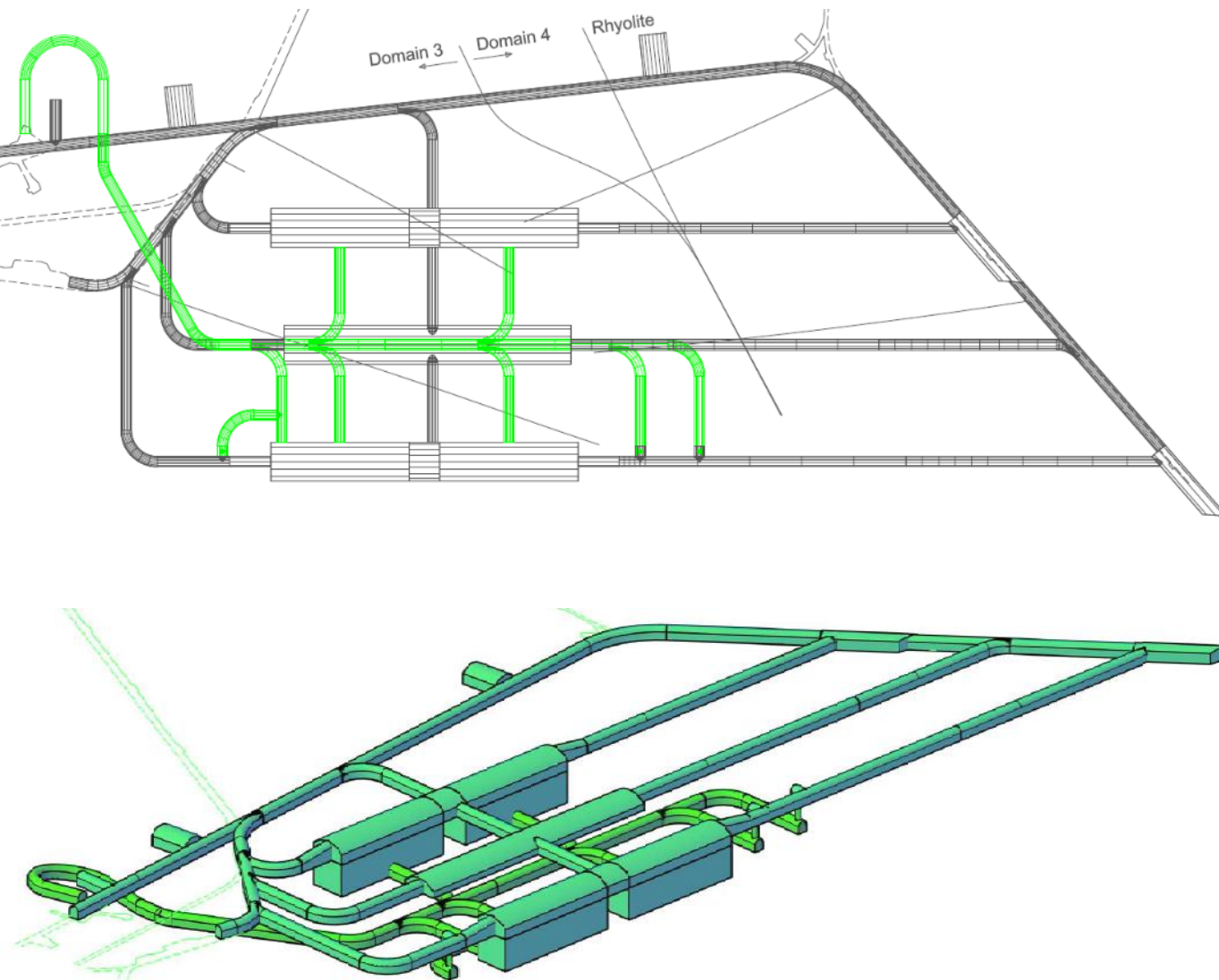


Planned PIP-II linear accelerator
power upgrade to > 1 MW



40ktons liquid argon
deep underground at
Sanford facility

Cavern configuration for LBNF....decided



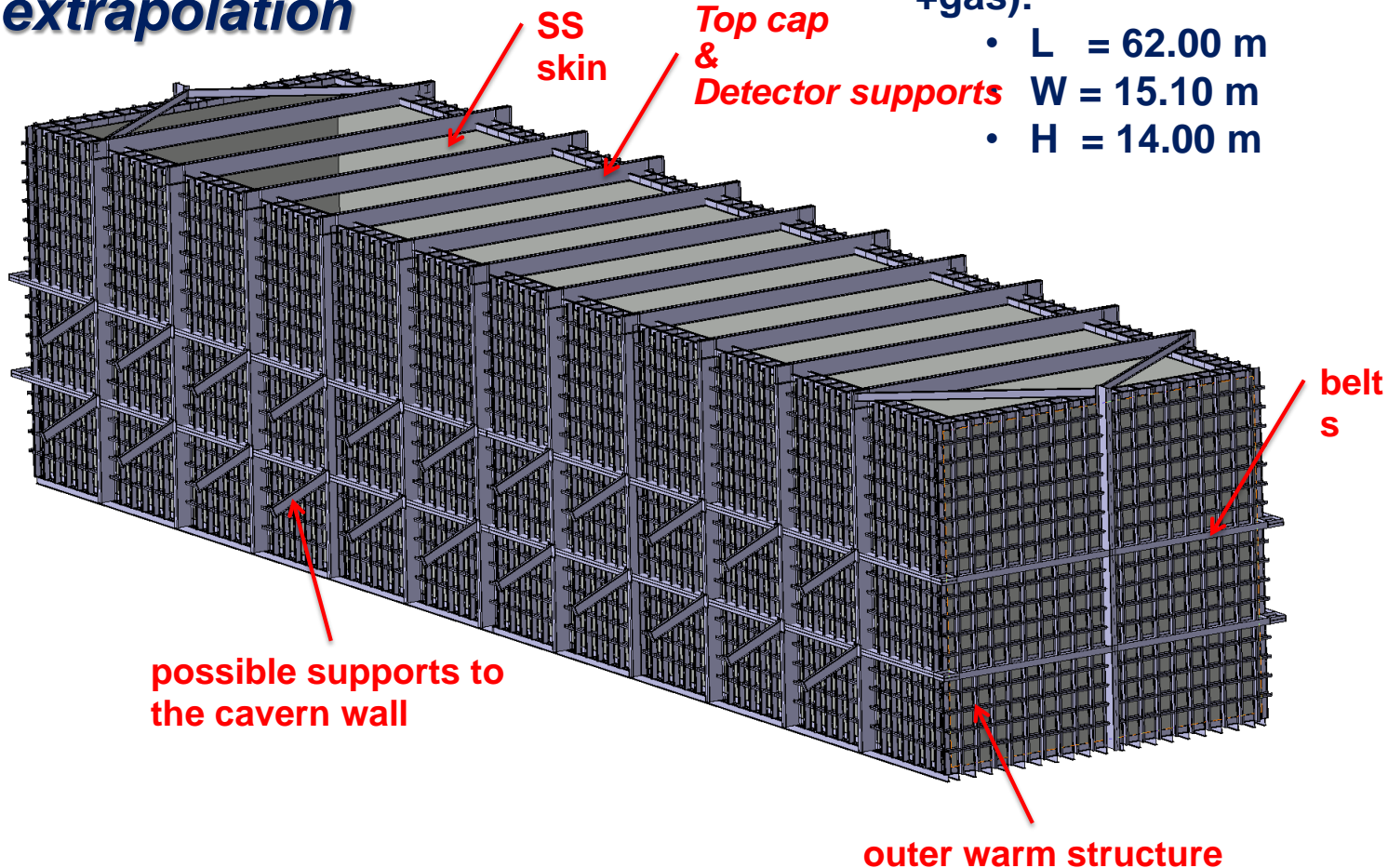
- Two parallel caverns each have two 10 kt detector pits with a laydown space in between
- The CF utilities and cryogenics are in a separate parallel chamber, thus no conflict with cryostat & detector laydown

Steel-supported cryostat design....decided

4 LBNF Cryostats extrapolation

Inner dimension (liquid
+gas):

- L = 62.00 m
- W = 15.10 m
- H = 14.00 m



LAr = 17'432 tons (95% liquid)

DUNE Collaboration

- **775 collaborators from 144 institutes in 26 countries**
 - a large international collaboration with strong European participation
 - Current CERN member state representation:

Country	People	Institutes
Belgium	1	1
Bulgaria	1	1
Czech Republic	5	3
France	18	4
Germany	2	1
Italy	40	10
Netherlands	2	1
Poland	7	4
Spain	19	3
Switzerland	26	3
UK	92	13
Total	213	44

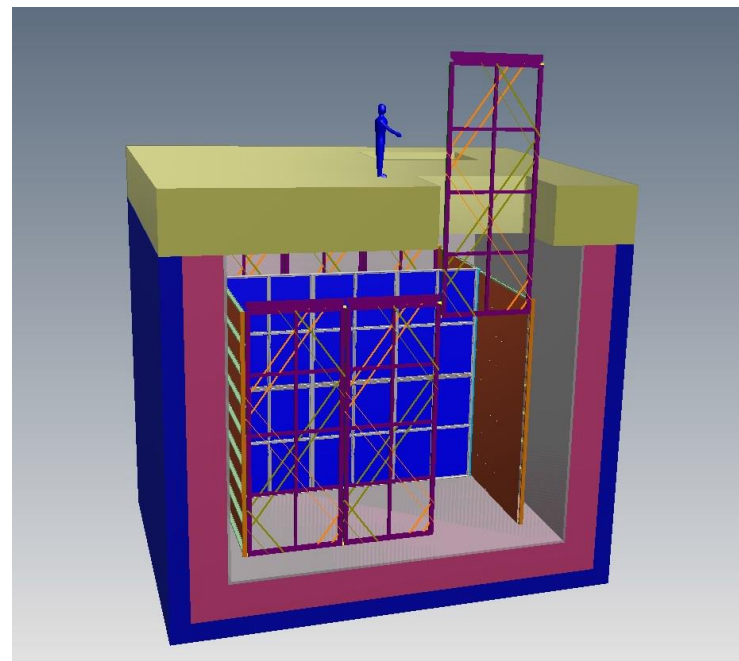
Other nations:

- Armenia, Brazil, Canada, Columbia, India, Iran, Japan, Madagascar, Mexico, Peru, Romania, Russia, Turkey, Ukraine, USA

Future growth:

- Collaboration is ~3 months old
- CD-3a (November) will be a strong signal
 - Expect rapid expansion of collaboration

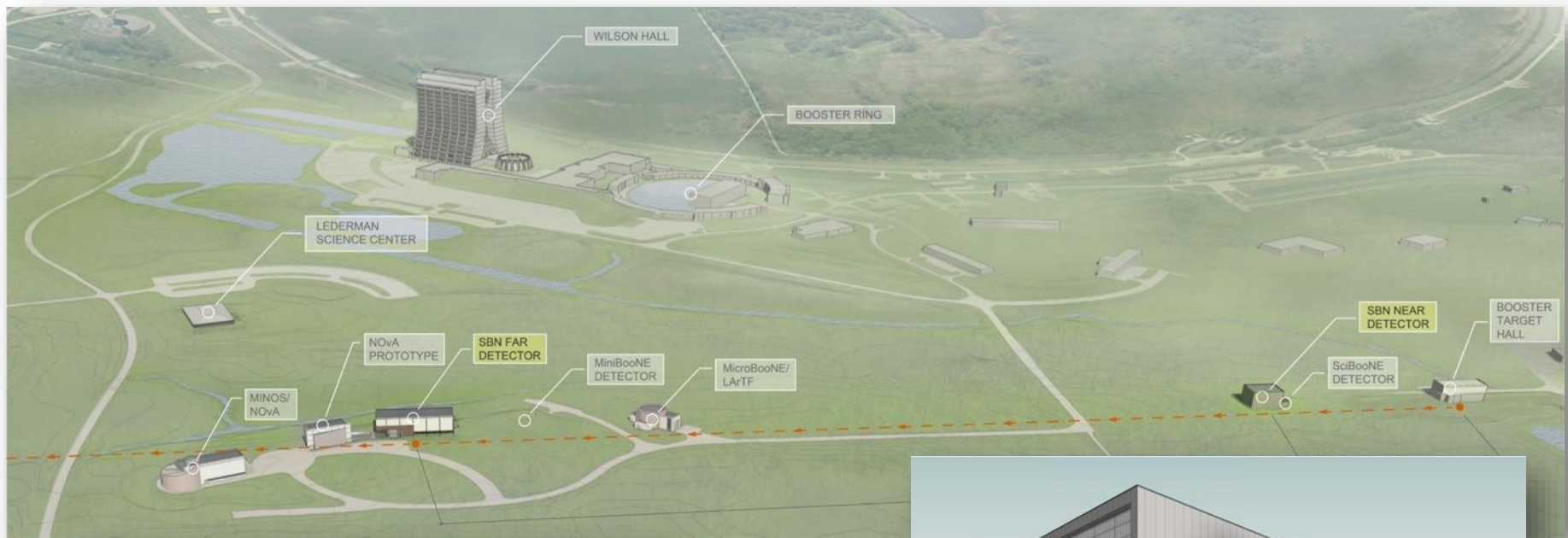
- **DUNE Far Detector installation planned for 2020/2021**
 - DUNE Single-Phase Prototype at CERN (2018) is an important step
 - Major undertaking in own right
 - **Proposal at CERN SPSC on June 23rd**
 - 214 signatories from 43 institutes
 - **High priority for DUNE collaboration**
 - Infrastructure requested from CERN
 - **Prototype funded from U.S. DOE**
 - also seeking other resources
 - **DUNE collaboration responsible for operation and analysis (2018 -)**
 - Represents “Start-up” of the production line(s) for the far detector...
 - Aiming for (at least) one U.S. & one European production site



DUNE/LBNF...rapid progress, major hurdles

- This is a special and critical year: support from DOE is strong
- **Must pass DOE “critical decision” gates**
- **The immediate hurdle is July 14-16 CD1-refresh review**
 - Full scope cost and schedule to be presented
 - Must fit within funding profile provided by DOE
 - Director’s review June 2-4 was successful
- **CD3a review this November**...if successful, this is baseline and construction start for far site caverns and infrastructure
- Near site construction at Fermilab comes later in schedule
- PIP-II upgrade of accelerator complex runs in parallel
- **For the CD3a review to succeed, we must be able to show that we have Europe, and CERN in particular, as a strong international partner**

Fermilab short baseline neutrino program...roaring ahead



Near Detector Building
Construction Start – Fall 2015



Far Detector Building
Construction Start – Summer 2015

US HEP is at a turning point

- Good news:
 - Strong support from DOE for both LHC and LBNF/DUNE
 - DUNE collaboration has assembled quickly and working hard
 - LBNF/DUNE “funding profile” provided by DOE Office of Science
 - Interest from international partners spurs US investment
 - First time US is hosting a truly international science facility...new & exciting approach has the attention of Washington
- Cautions:
 - Major US investment in HL-LHC is not a “slam dunk” to US Congress
 - Cannot maintain a healthy level of support for US HEP without a flagship program at Fermilab
 - Without LBNF, no major thrust in US for at least two decades

Conclusion: CERN & Fermilab Futures Intertwined

- Anticipation for LHC palpable...next few years will be exciting!
- US community is focused on:
 - Contributing to detector upgrades, both phase I and HL-LHC
 - Contributing to HL-LHC with high-field quads and crab cavities
 - Preparing to lobby for congressional support for HL-LHC era
- Critical moment in US HEP history: need flagship to be healthy
- Unique opportunity to host a global program that leads to the discovery of CP violation in the leptonic sector
- DUNE is a highly motivated, experienced and well organized international team that has assembled quickly
- Support by DOE is strong, chance to move through major gates
- CERN partnership is critical to success of LBNF/DUNE

Overarching Science Strategy.....diverse with flagship

“A world class laboratory with the resources on the scale of Fermilab or CERN should have a diverse particle physics program and a flagship project”

- F. Gianotti, at White House visit during FCC meeting in Washington

The herd expands

- First 2015 baby bison born on April 25
- 13 babies so far, maybe a few more to come

