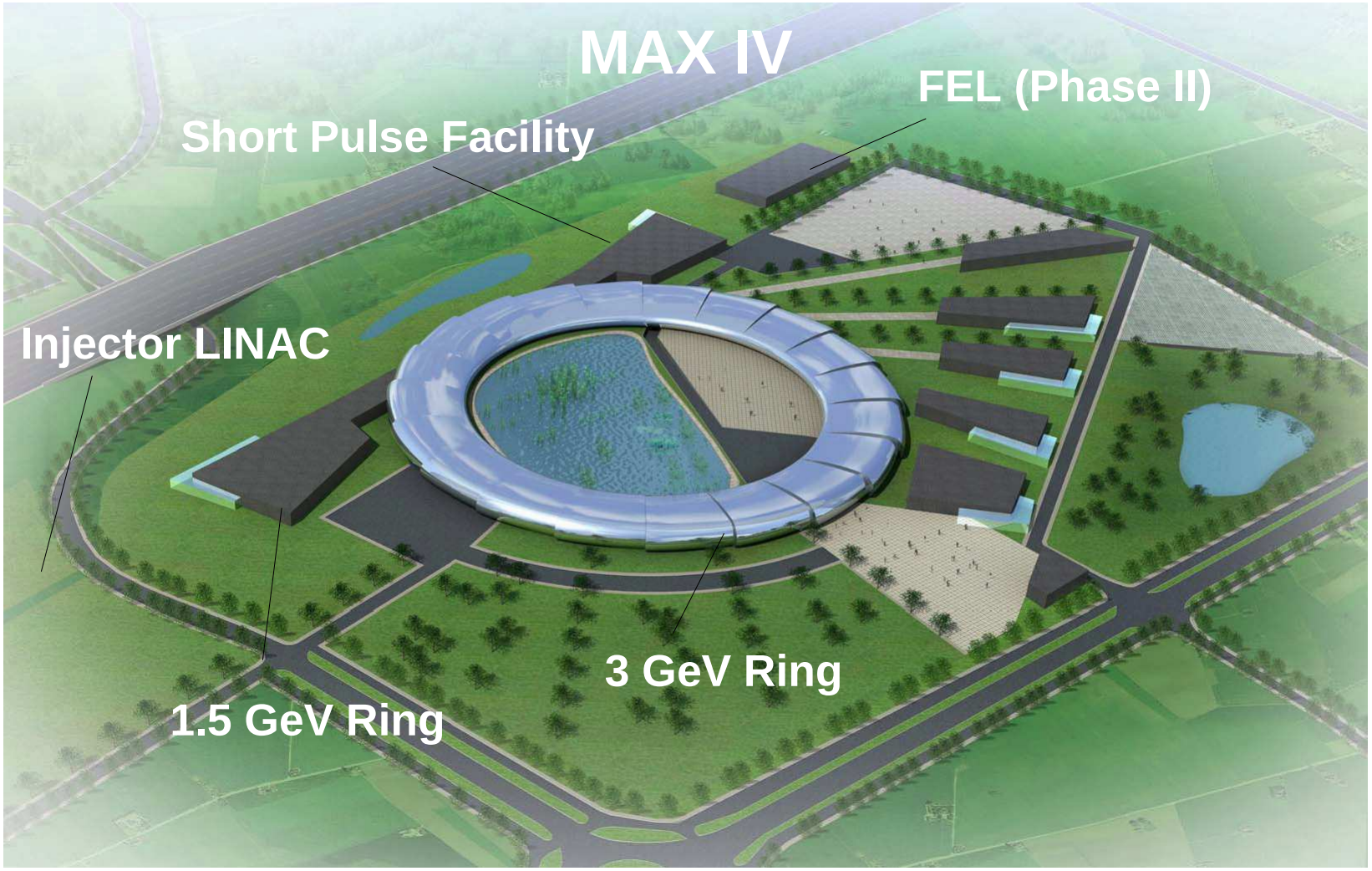
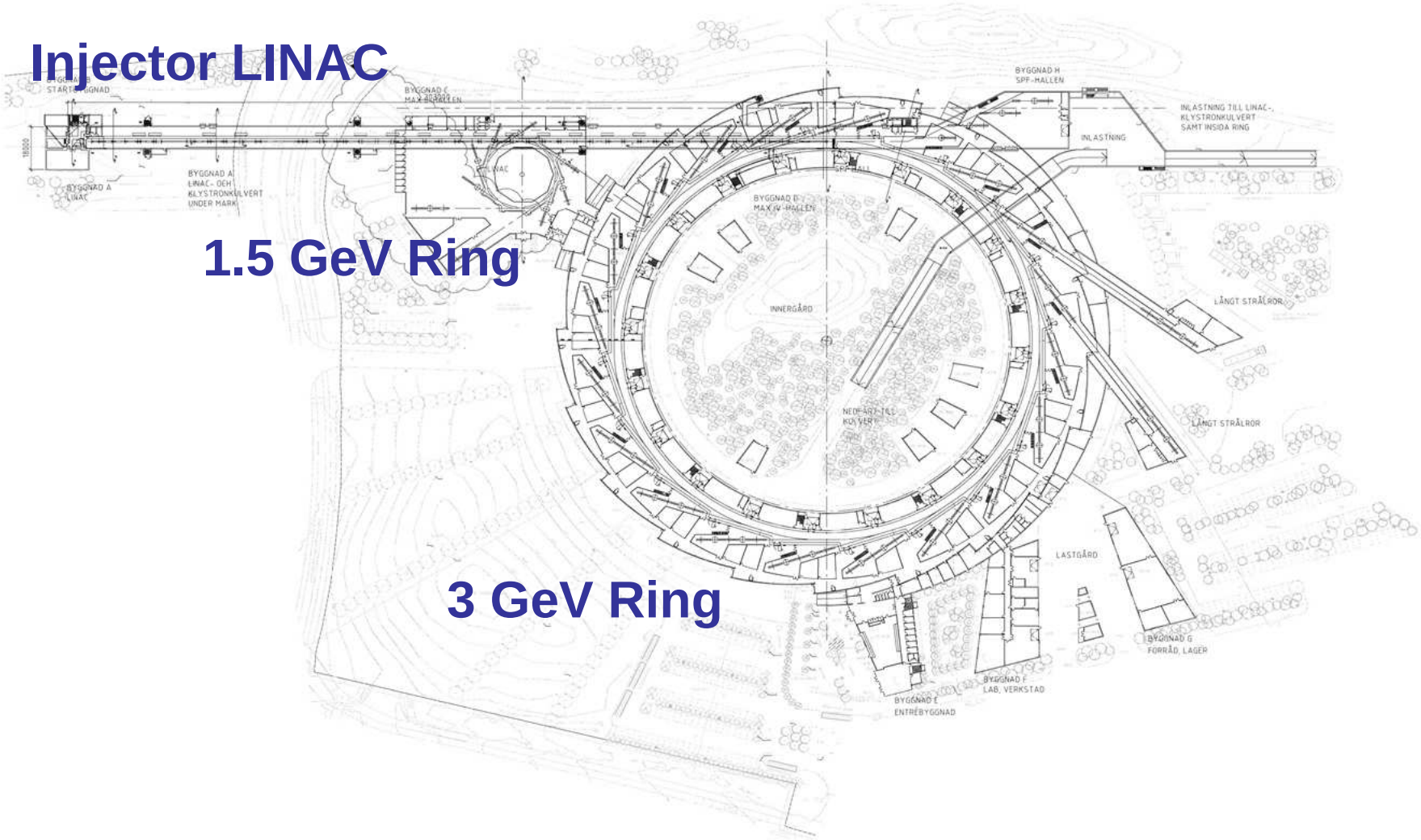
# Max IV Project Status Report


Pedro F. Tavares, on behalf of the Max IV Project Team


MAX IV
FEL (Phase II)
Short Pulse Facility
Injector LINAC
3 GeV Ring
1.5 GeV Ring

# Facility Lay-Out



# Conceptual Basis of the Max IV Design

- Scientific Case calls for high brightness radiation over a wide spectral and time range: IR to Hard R-rays, Short X-Ray Pulses.
- Need for high brightness: low emittance and optimized insertion devices.
- This is hard to achieve in a single machine:
- higher electron beam energy → harder photons
- lower electron beam energy → softer photons

⇩

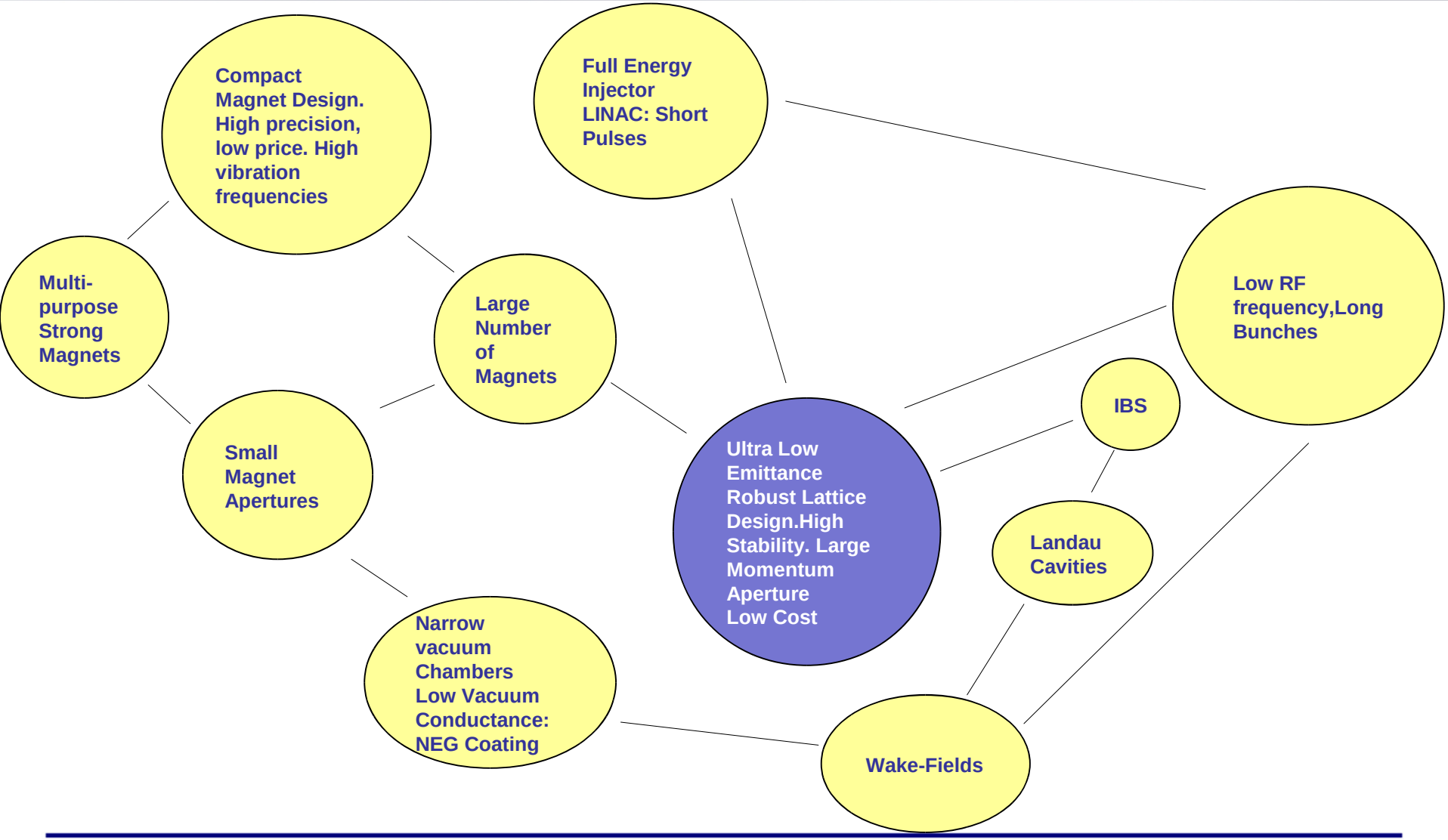
Need to Compromise

# The MAX-Lab Approach

**Different machines for different uses:**

- **A high energy ring with ultra-low emittance for hard X-ray users.**
- **A low emittance low energy ring for soft radiation users**
- **A LINAC based source for generating short pulses and allowing for future development of FEL source.**

# An integrated Solution

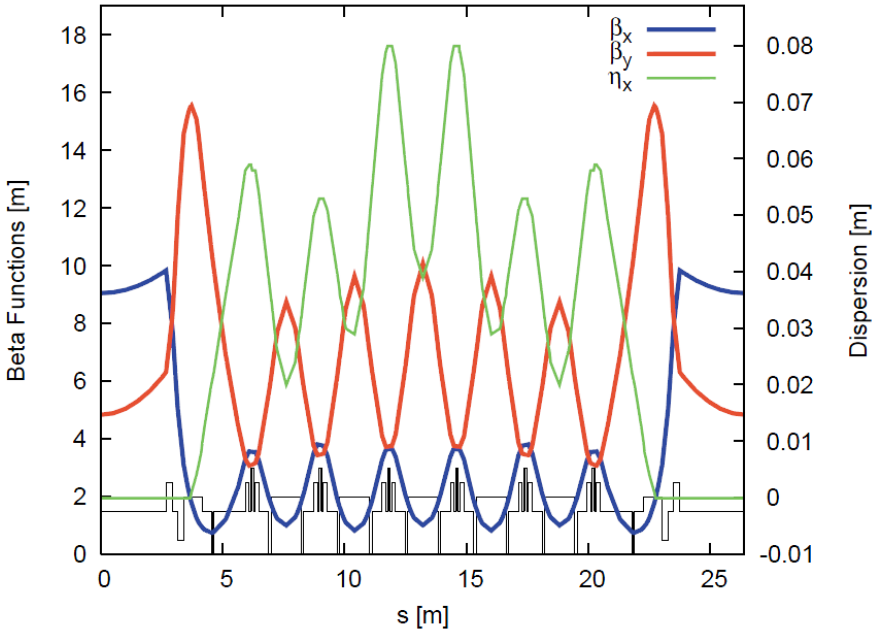


# Storage Rings Parameters

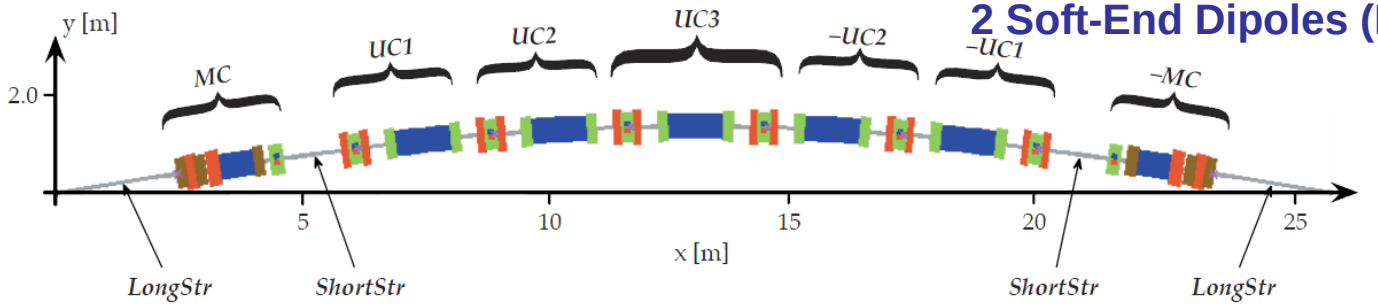
| | High Energy | Low Energy | |
|---|---|---|---|
| Energy | 3 | 1.5 | GeV |
| Average Current | 500 | 500 | mA |
| Circumference | 528 | 96 | m |
| Horizontal Emittance | 0.23 - 0.37 | 6 | nm rad |
| # Straight Sections | 20 | 12 | |
| Length of Straight Section | 4.8 | 3.5 | m |
| Hor Beam Size | 45 | 184 | µm |
| Vert Beam Size | 2 | 13 | µm |
| Beam Lifetime | 10 | 10 | hours |

# 3 GeV Ring Achromat

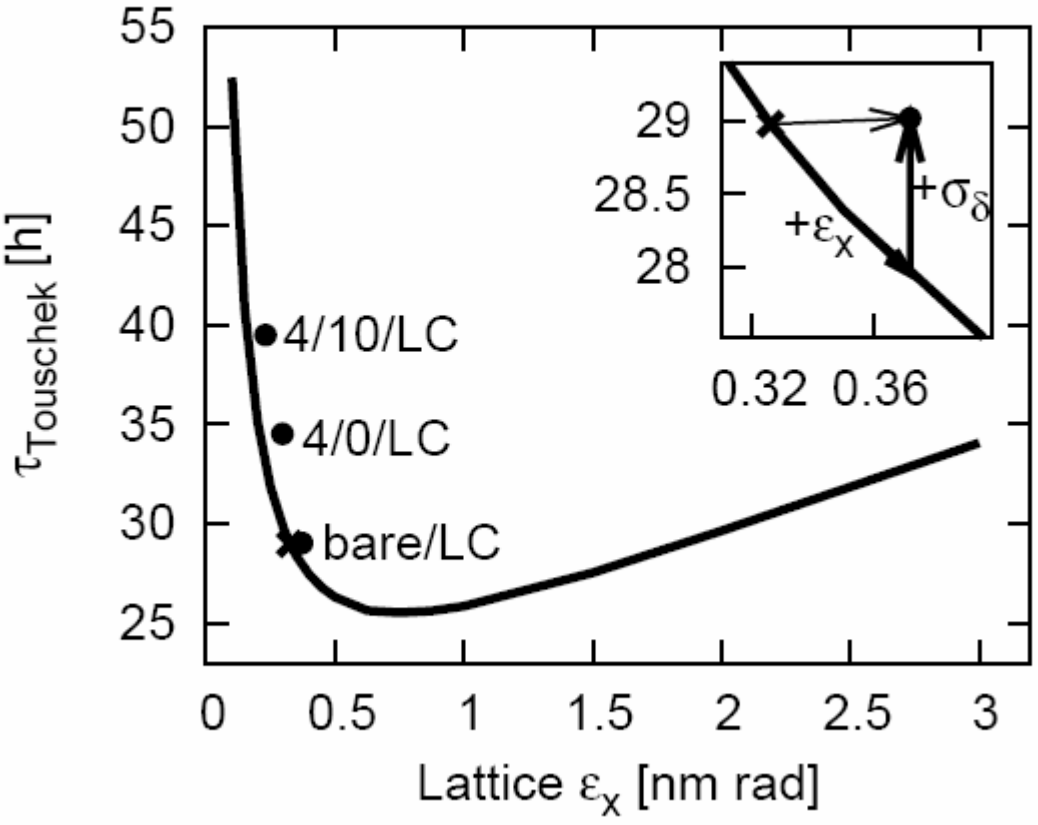
**16 Quadrupoles.**
**18 Sextupoles.**
**6 Octupoles.**




**5 Gradient Dipoles**
**2 Soft-End Dipoles (Matching Cells)**

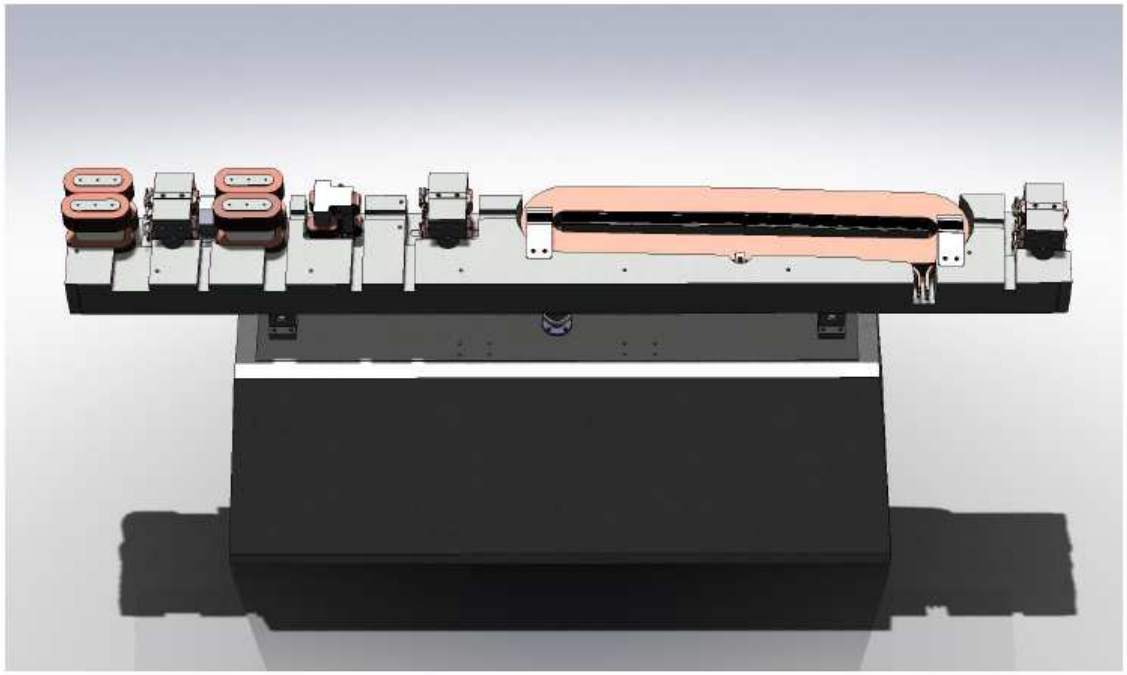


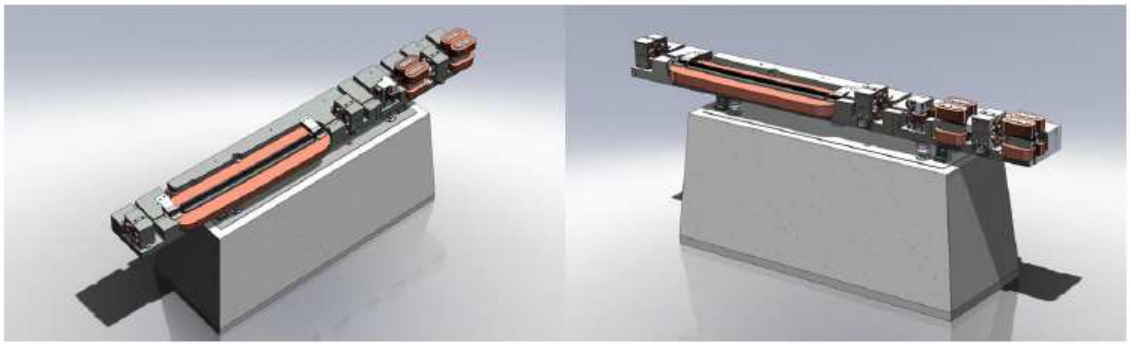
# Touschek Lifetime in the 3 GeV Ring



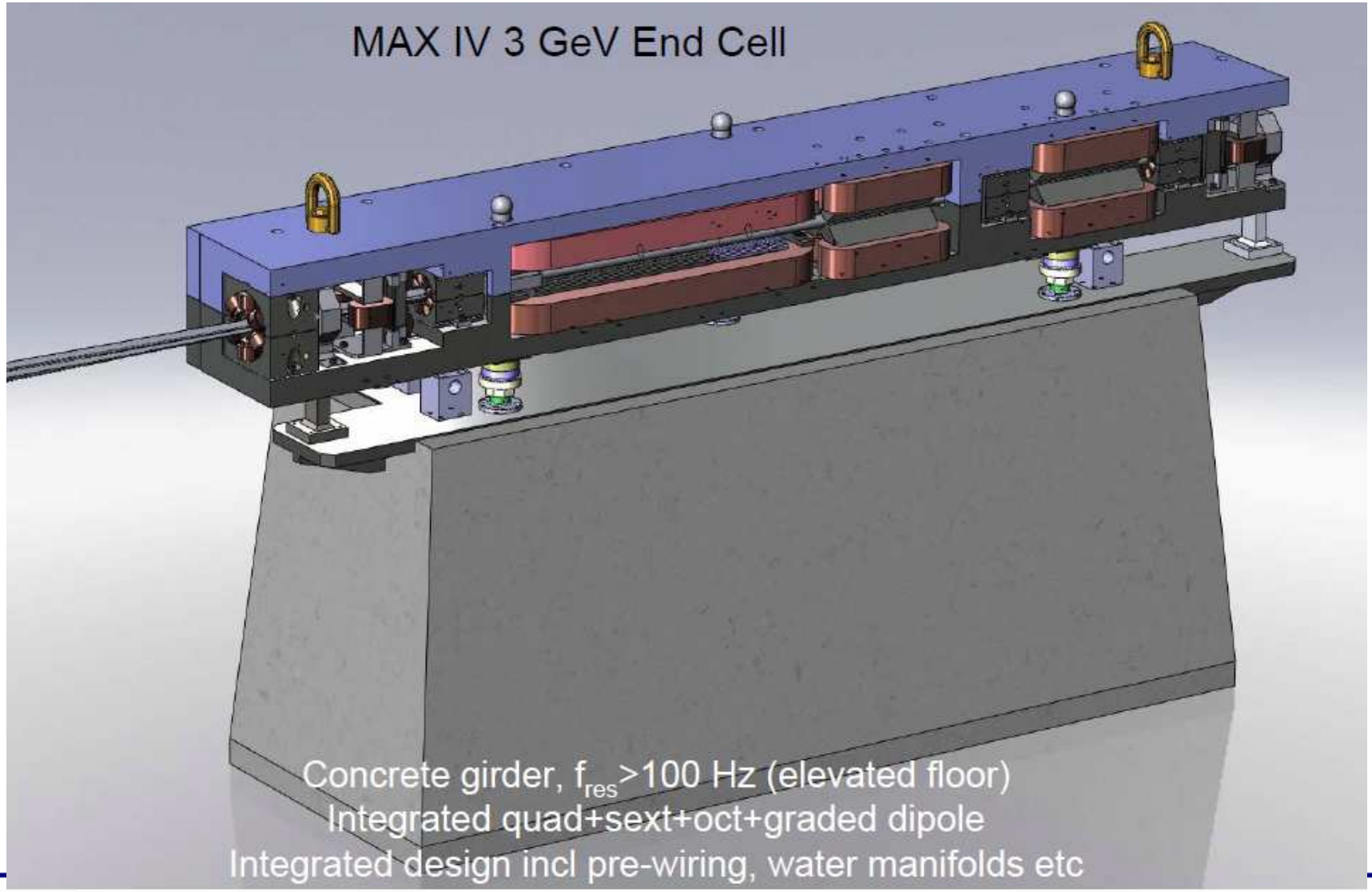
# Magnets for the Max IV Rings

- Magnet Design for 3 GeV ring is completed.
- Supplier for 304 tons of ARMCO steel for all magnets in MAX IV selected.
- Call for tender for Magnet manufacturing .
- Prototype Magnet Block built and undergoing tests since June 2010.

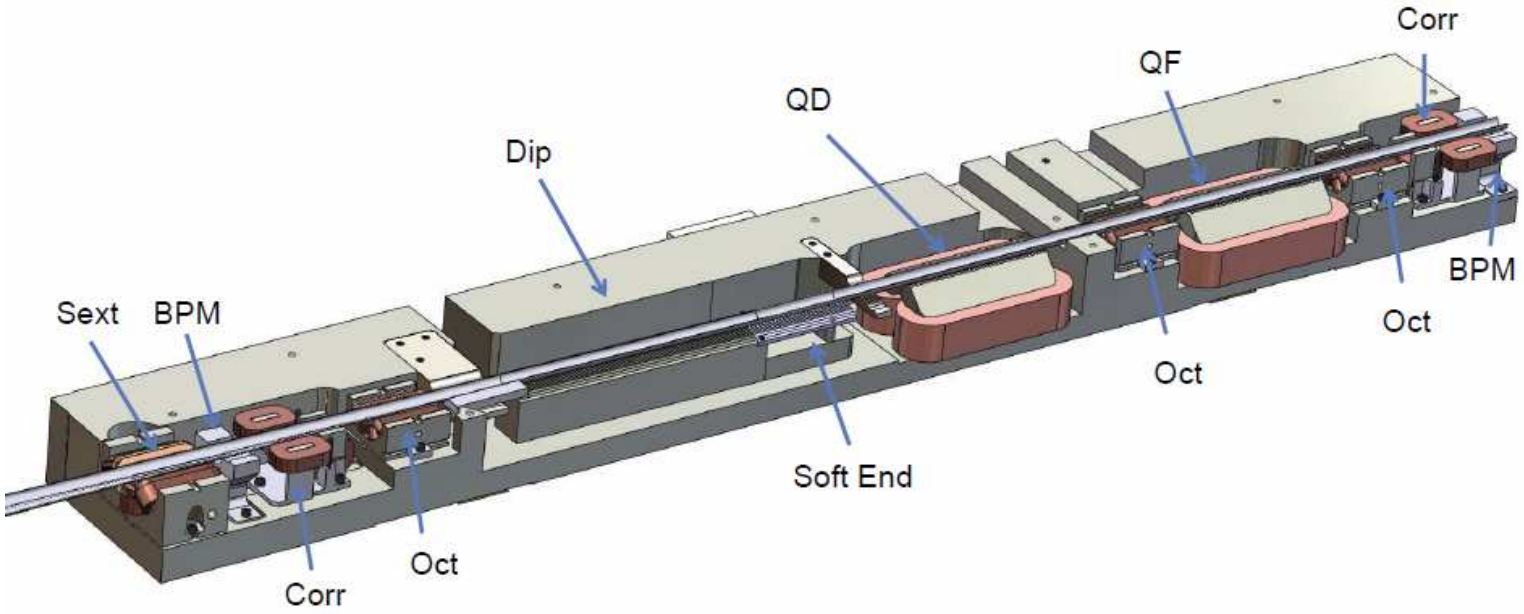




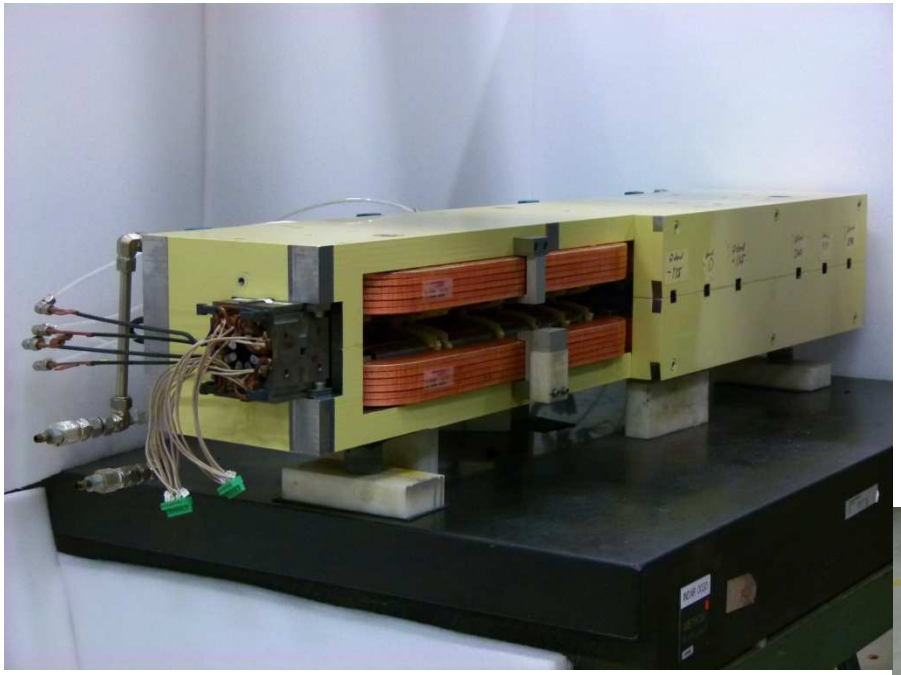
# Engineering Design and Prototype Work

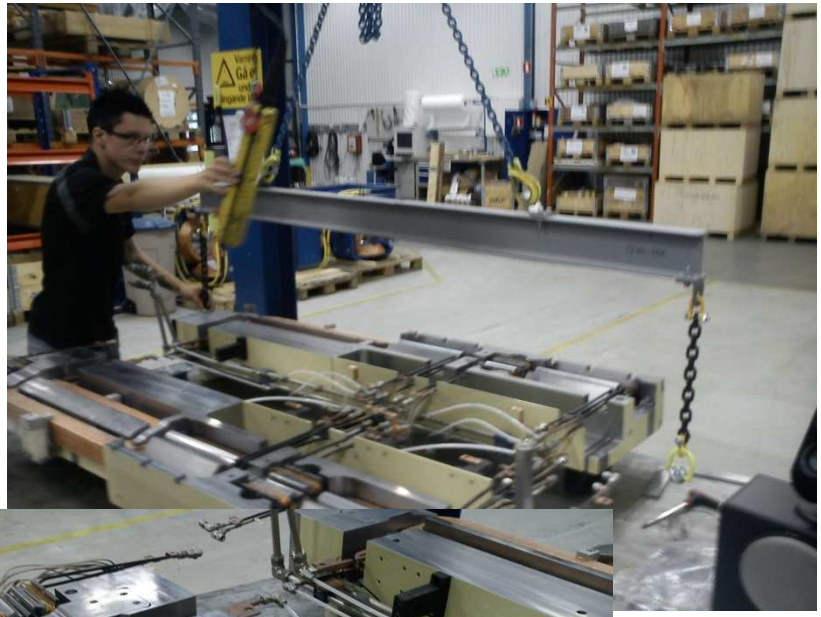


# MAX IV 3 GeV End Cell



# Prototype 3 GeV Ring Magnet Block



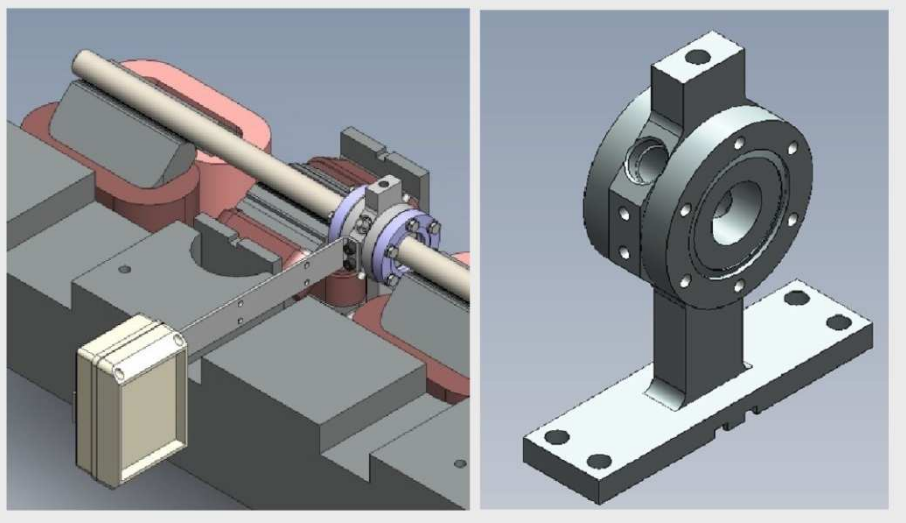


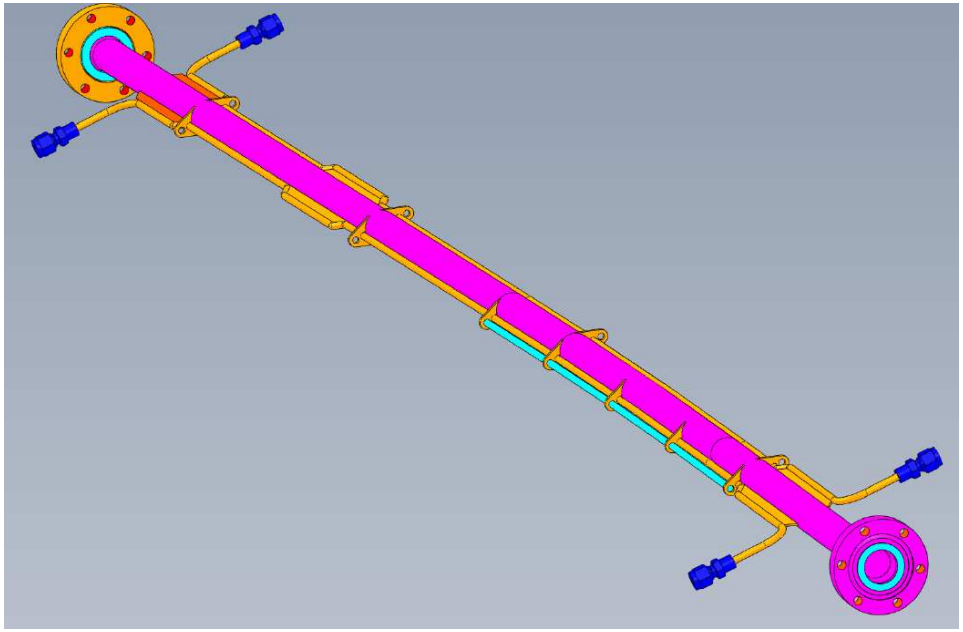
| | | |
|---|---|---|
| Field | 0.52 | T |
| Gradient | 8.6 | T/m |
| Gap (pole center) | 28 | mm |
| Good Field Region (2x10E-4) | -12.5 to + 15 | mm |
| Number | 100 + 40 | |

**Several Magnets Machined out of a Single Solid Iron Block**

# Vacuum Systems

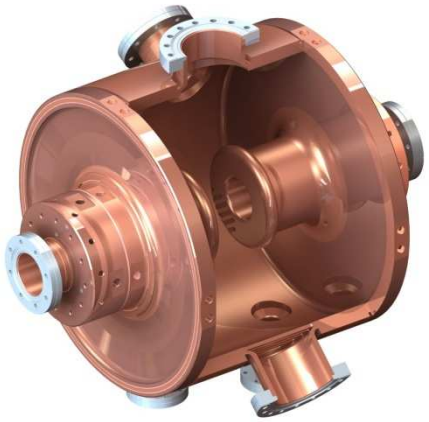
- Copper chambers, extensive use of NEG coating
- Detailed Design in Progress at ALBA.
- Procurement for chambers: early 2011

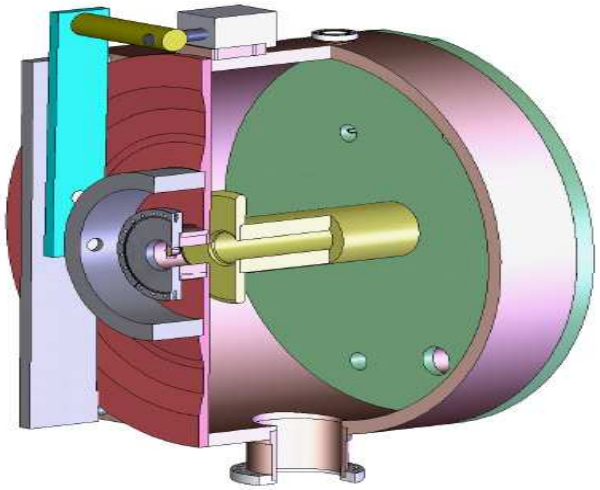


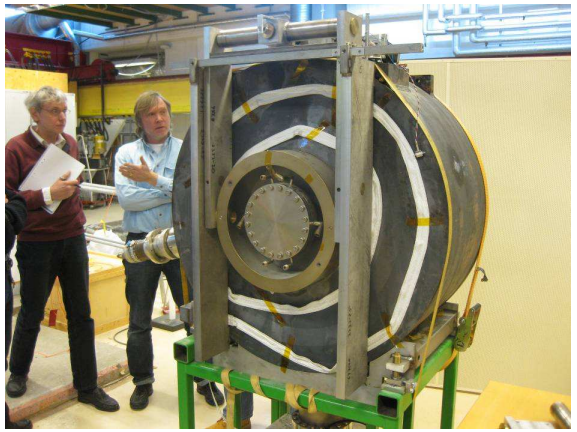


# 3 GeV Ring RF System

- **Cavity specs finalized. Procurement started.**
- **Low Level RF System Design done at ALBA**
- **Prototype Work on Landau Cavity started**

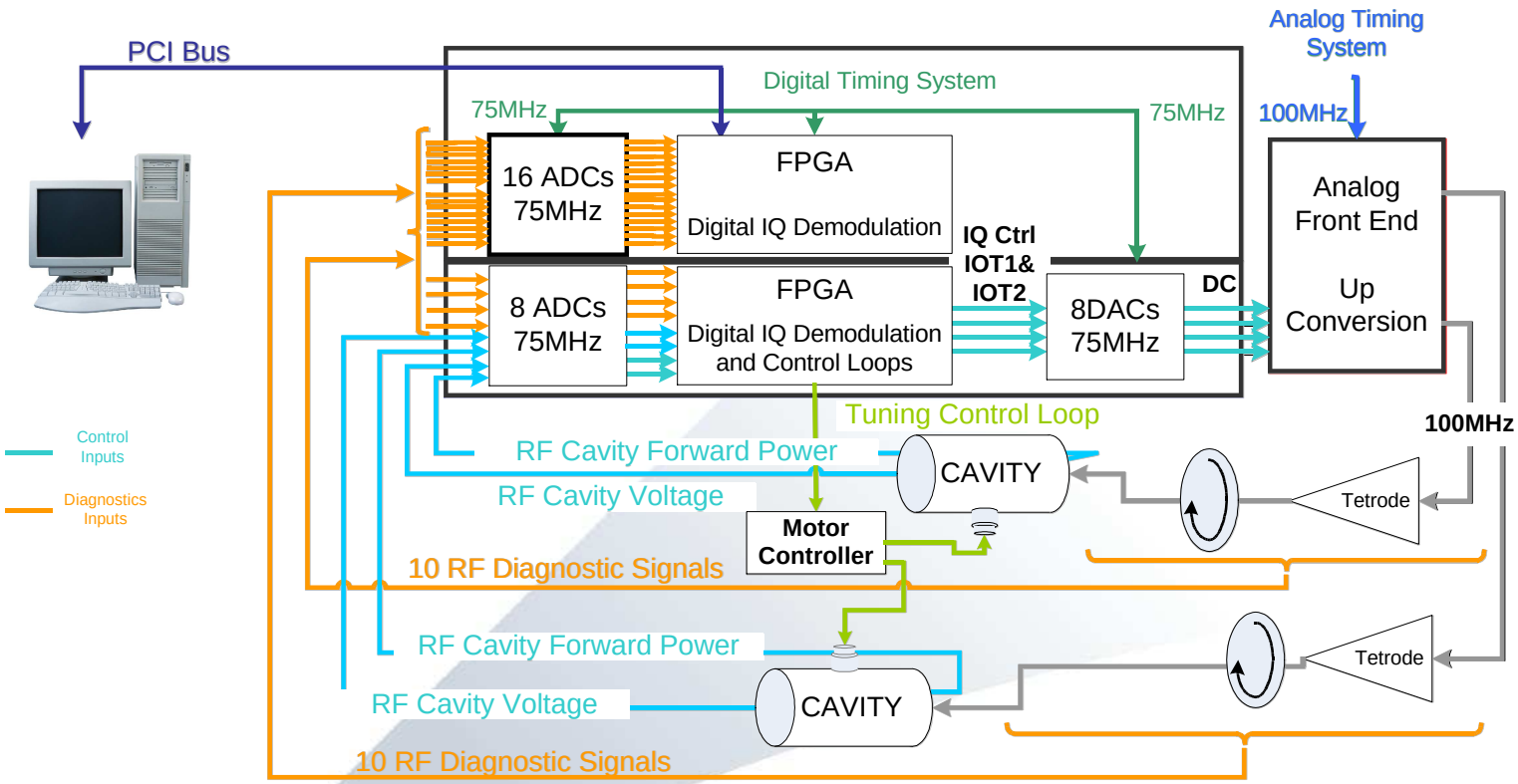






# LLRF Conceptual Design

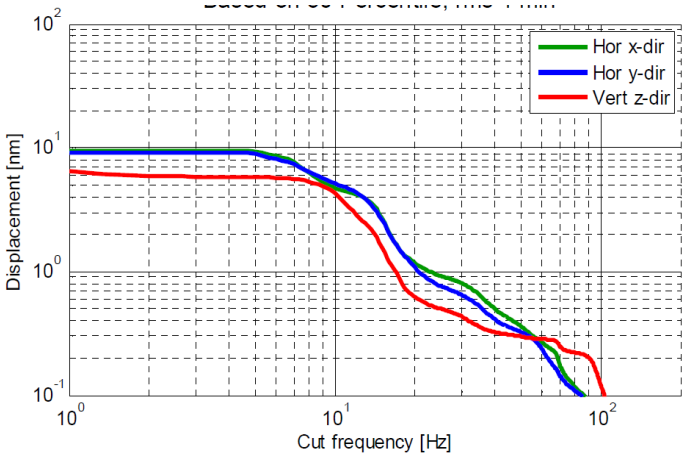
Angela Salom

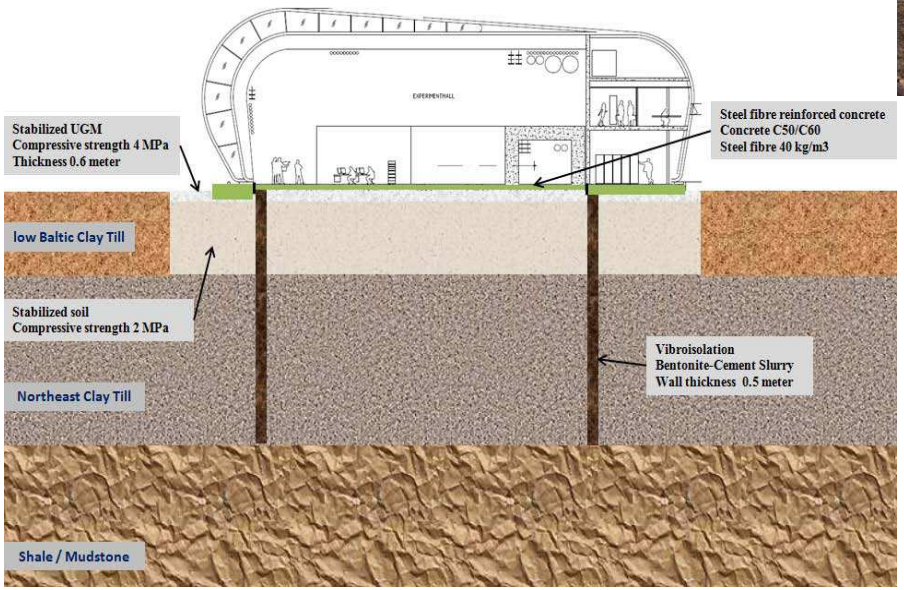



## Hardware Subsystems

- ✓ **Digital Commercial Board: cPCI with 8ADCs, 8DACs and FPGA for Loops and 16 ADCs and FPGA for Diagnostics.**
- ✓ **Analog Front End for Upconversion (DC to RF)**
- ✓ **Local Timing System: 75MHz digital clock synchronized with General Timing System (10MHz)**

# Vibration Studies on Max IV site



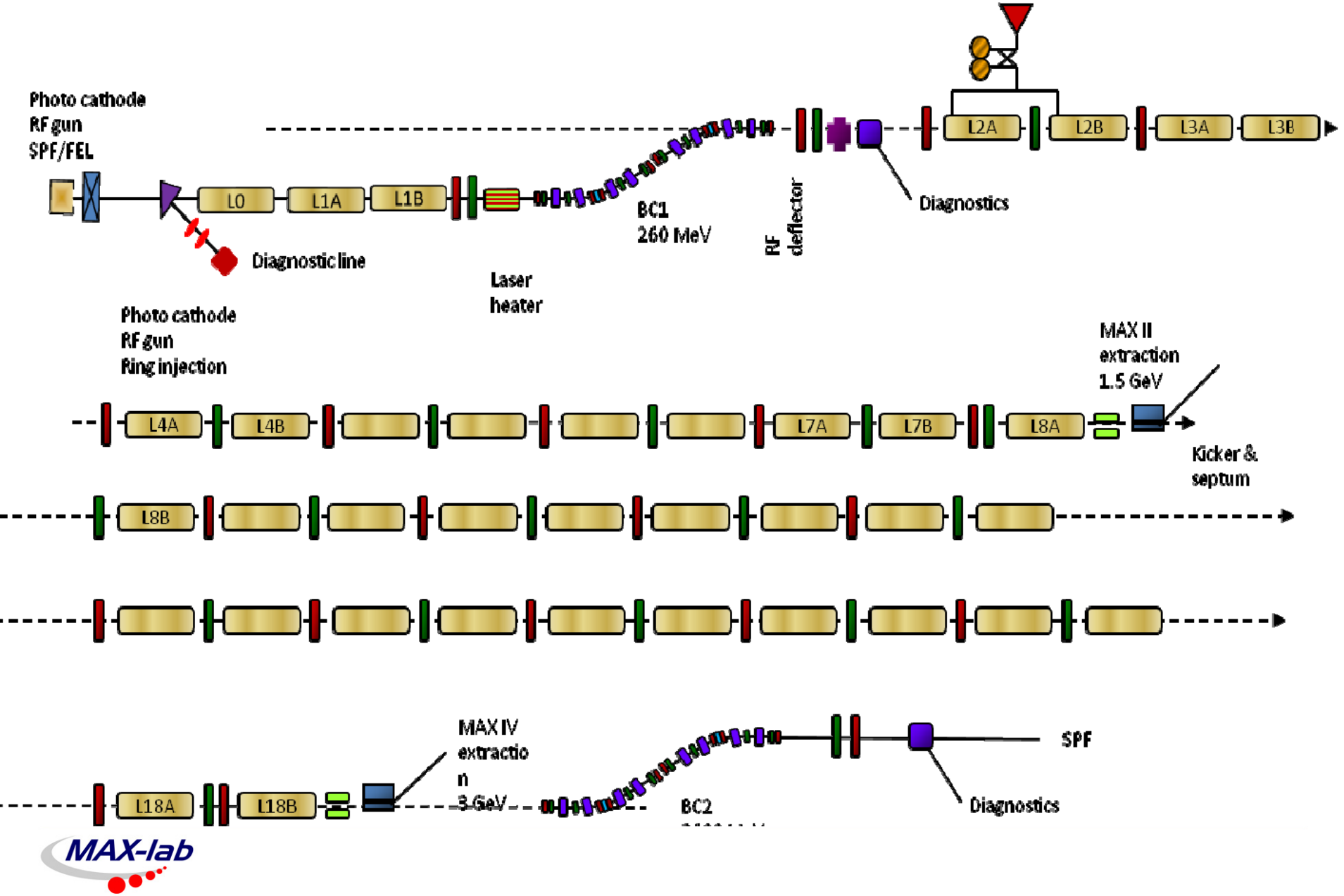



# MAX IV Injector LINAC Parameters

| | Injection into HE Ring | Injection Low Energy Ring | Short Pulse Facility | |
|---|---|---|---|---|
| Energy | 3 | 1.5 | 3 | GeV |
| Charge per Pulse | 300 | 300 | 100 | pC |
| Time Structure | 3 S Band Bunches @ 10 Hz | 3 S Band Bunches @ 10 Hz | 1 S Band Bunch @ 100 Hz | |
| Normalized Emittance | < 1 | < 1 | < 1 | nm rad |
| Pulse Length | 660 | 660 | 0.1 | ps |
| Structures | Sband , Travelling Wave, Warm | | | |
| Electron Source | Photo Cathode RF Gun | | | |

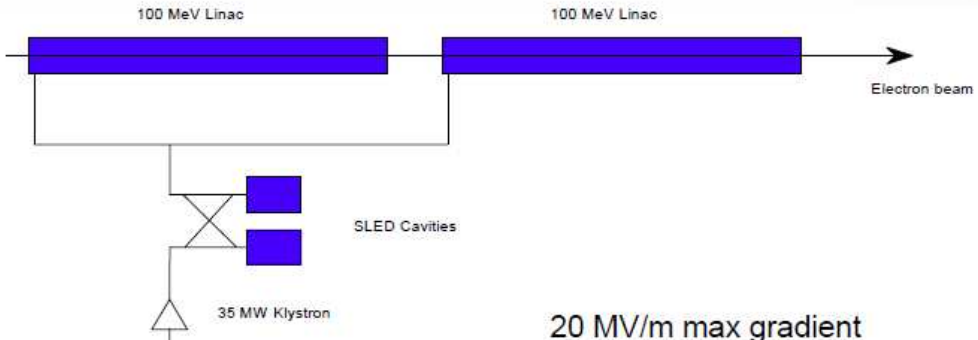
- **Top-up shots into both rings every few minutes, for a few seconds @ 10 Hz.**
- **In between top-ups, deliver beam to Short Pulse Facility at 100 Hz.**
- **Low Level RF must provide the flexibility for fast mode changes**
- **Significant RF power redundancy (max on crest Energy is 3.7 GeV)– high reliability.**

# The Max IV Injector



# Modular RF System

## Linac Module (18 of them)




1 35 MW klystron

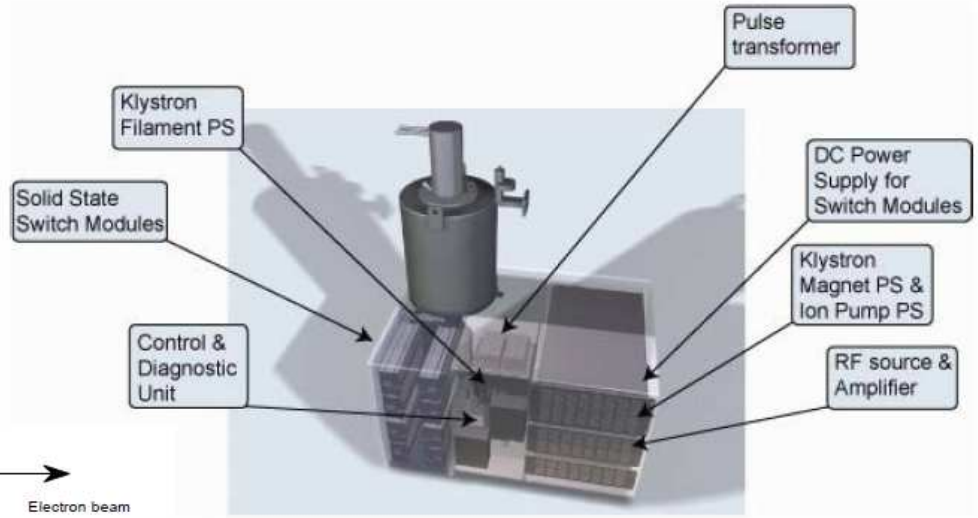
1 Pair of SLED cavities

2 pcs 5 m linac structures

20 MV/m max gradient

Max dutyfactor 0.001

Solid state modulators
=>variable pulse length



# Recent LINAC events

- Detailed Optics design review in collaboration with Daresbury Lab.
- Accelerating Structures Contract Signed Oct. 2010
- Supplier for RF Units (Modulator + Klystrons) defined. Contract to be signed soon.
- Gun Test Stand under construction
- Gun Sled Cavity and Solenoid Delivered.
- Gun Laser Contracted signed – delivery in 2011.

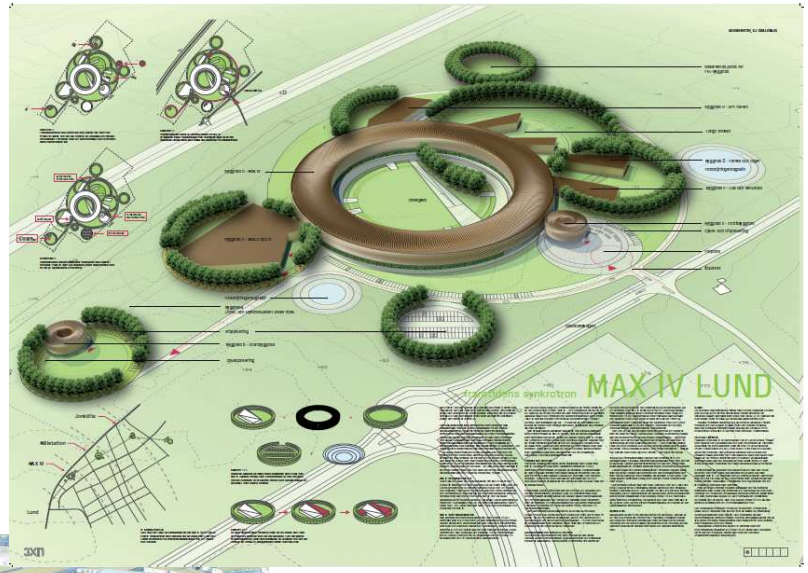
# Recent Events

- **Detailed Design Report Completed and Presented at the First Machine Advisory Committee Meeting (September 2010)**
- **Committee Members: (L.Rivkin (PSI), P.Kuske (BESSY), K.Balewsky (DESY), S. P. Møller (ISA), M.Cornacchia(SLAC)**
- **Committee considered MAX IV an *innovative and daring* project an concluded that**

  *..DDR has addressed all the issues relevant to achieving the performance goals…tolerance requirements…are demanding but not beyond what is reachable...*

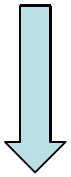
# Recent Events (cont.)

- **March 2010:** Building Contract Signed
- **September 2010:** Swedish Research Council approves release of 1 BSEK for the machine construction + 25 years operational budget.
- **September 2010:** Four proposals for the building design have been presented by competing companies.
- **October 2010:** Wallenberg foundation announced 450 MSEK for funding of beamlines.
- **November 22, 2010**: Groundbreaking ceremony.


MAX IV LUND

# MAC Recommendations:Machine Design

- Further studies on collective effects.
- Further studies on effects of insertion devices.
- Further investigations on diagnostic needs.
- Implications of Max III experience for the Max IV design concerning the quality of the magnets.



- Detailed Design Report continues to be updated.
- Detailed Engineering Design of Components is under way
- Prototype Work is on-going