# Linac4 Drift Tube Linac Overview

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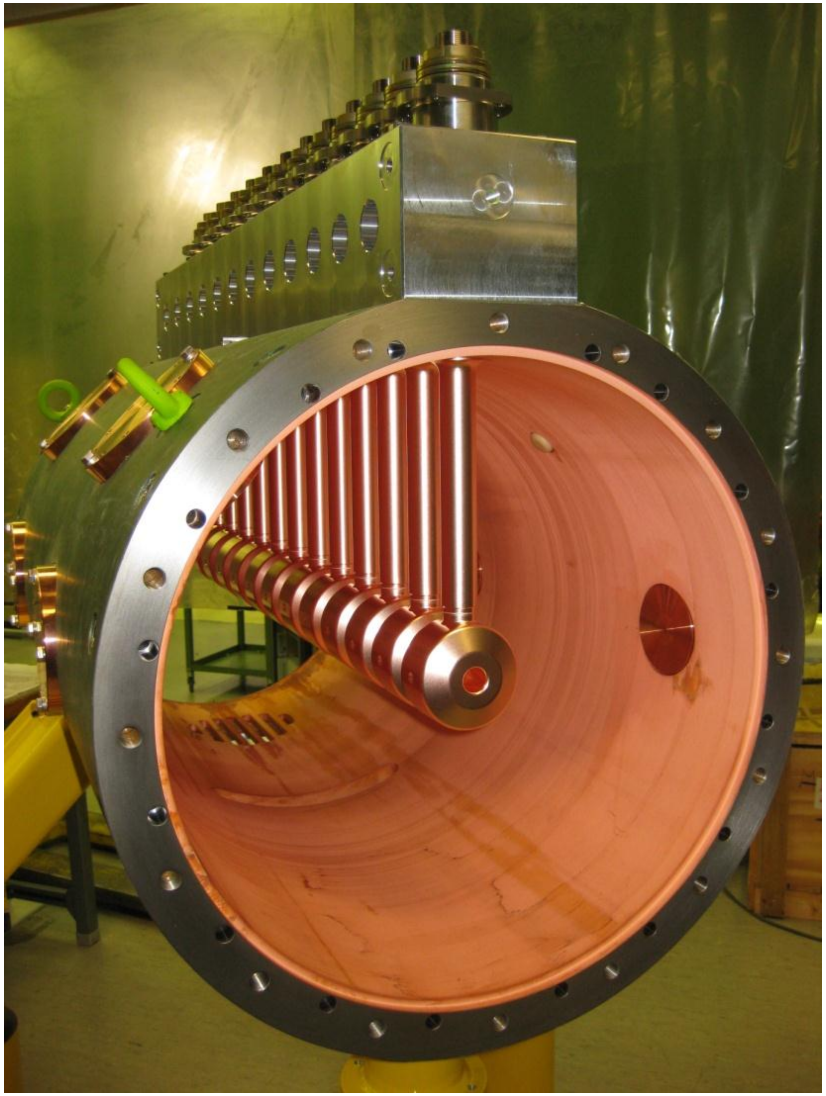
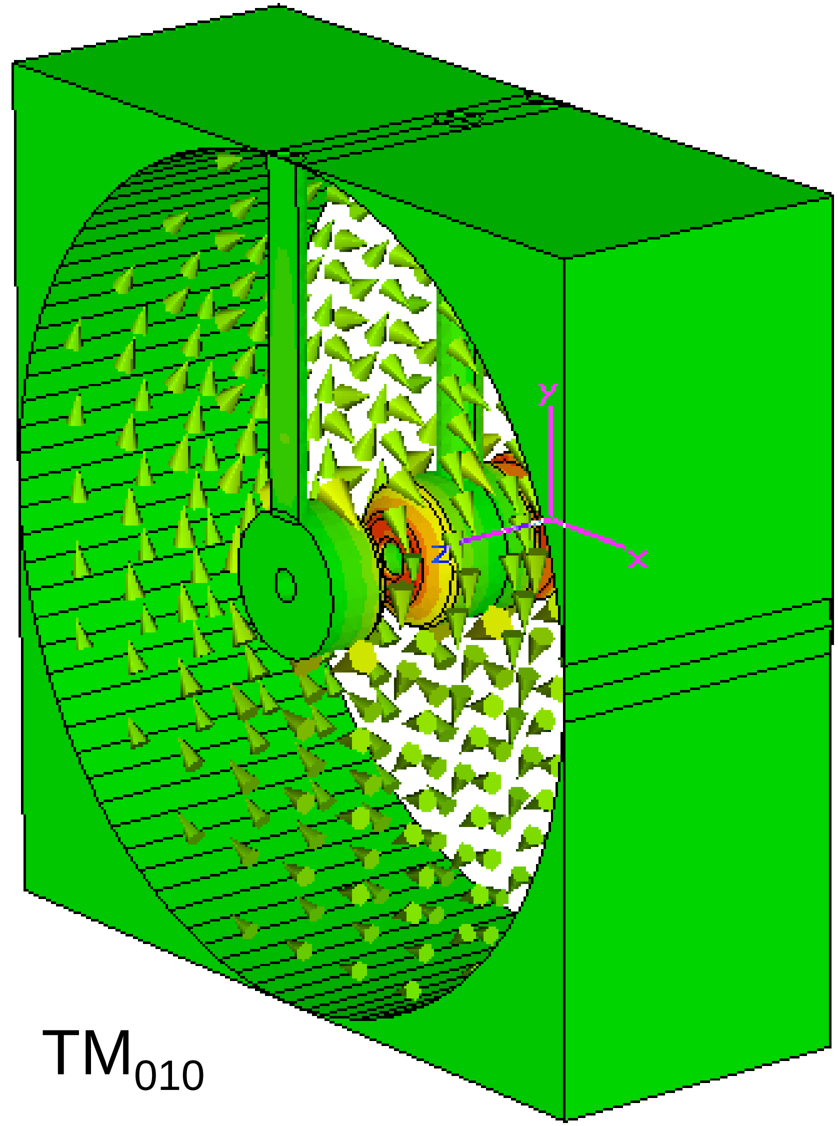
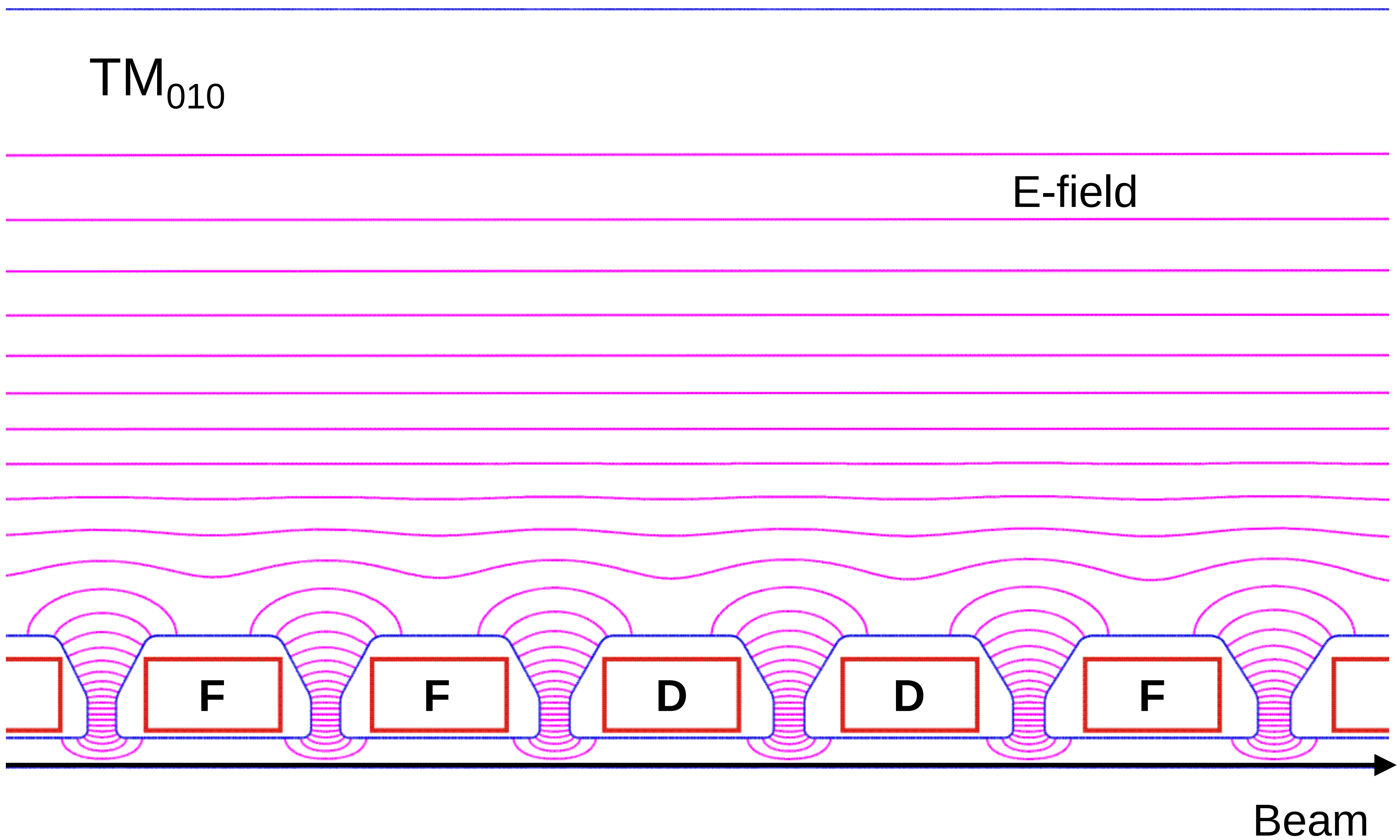
- Physics
  - RF Resonator in Vacuum
  - Acceleration by Electric Fields
- Design
  - Interdependencies
  - Intricacies
  - Iterations
- Linac4 DTL
  - General Parameters
  - Parameters by Tank

# Alvarez Drift Tube Linac

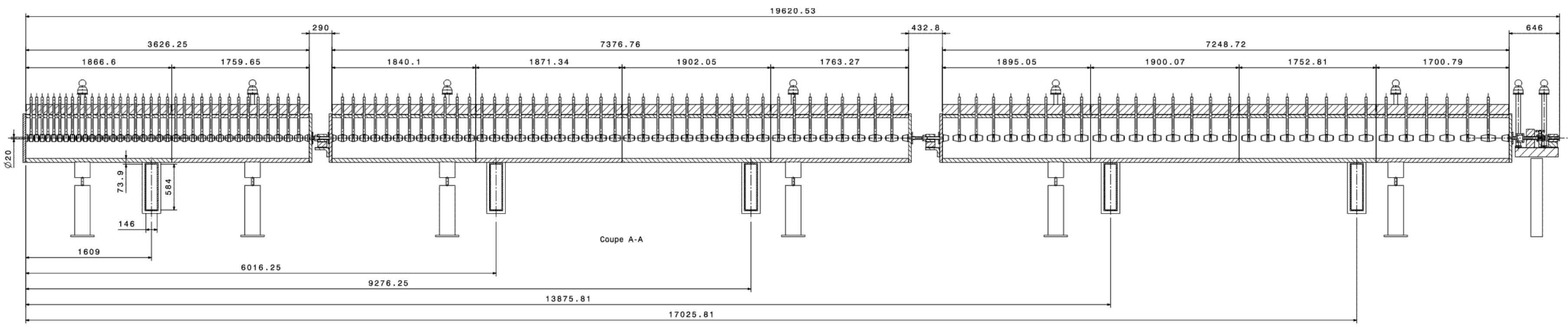





$TM_{010}$

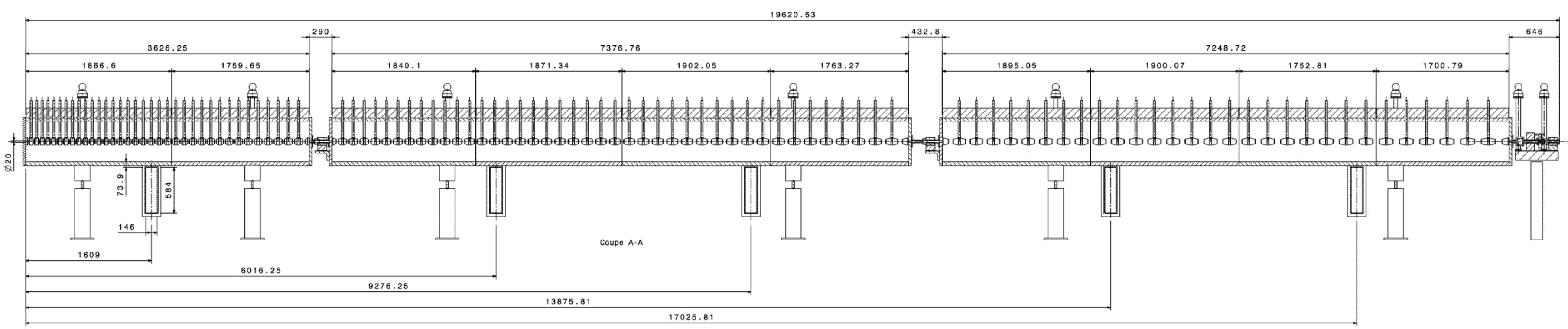

TM010
E-field
F
F
D
D
F
Beam

- Every drift tube adjusted to the velocity of the particles
  - Every drift tube is different in dimensions and shape
  - Every cavity is different in number of drift tubes per unit length
- Electro-magnetic design needs to fit with beam dynamics design
  - Longitudinal: synchronous phase & accelerating gradient
  - Transverse: focusing scheme & magnetic gradients
  - Phase matching at end of tank
- Cavity length needs to fit with available power

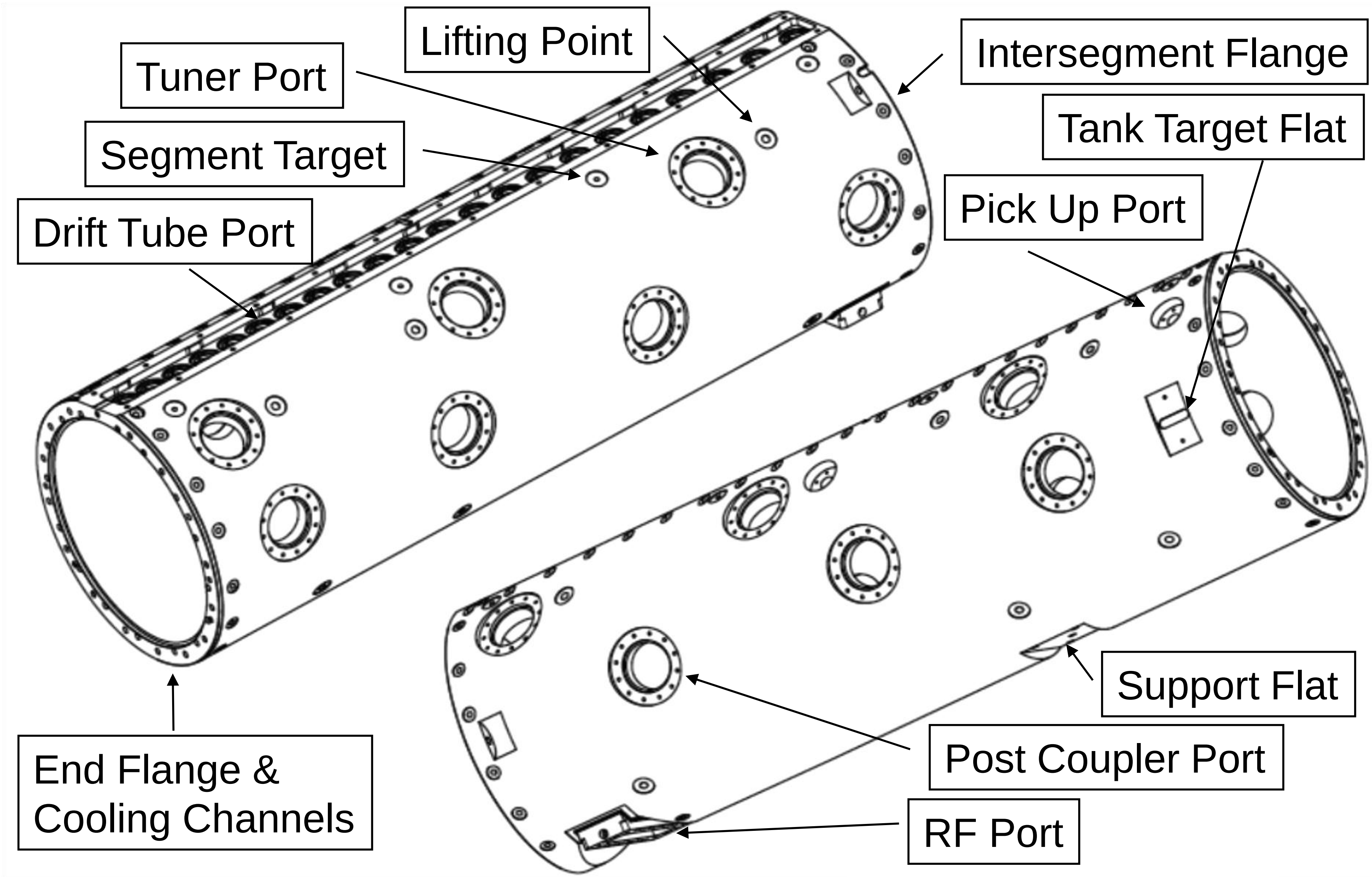


# DTL Design Interdependencies

- Design must be manufacturable
  - Magnets fit drift tubes
  - Tanks split into segments of suitable length
  - Splitting requires space
  - Post-couplers and other ancillaries need to fit with splitting



# DTL Segment T1S1



# DTL Design Example

You will be presented with a <u>final</u> design today **but**

It is a tedious process to arrive at <u>your</u> optimum!

An example:

- Phase matching requires additional RF power
- If power is not available, tank needs to be made shorter
  - Changing number of cells interferes
    - with post-coupler scheme
    - with focusing scheme – in two tanks!
- Or the gradient needs to be lowered:
  - Lower gradient – more cells, smaller cell lengths
    - Maximum segment size fulfilled?
    - Sufficient space for splitting available?

# DTL Design Iterations

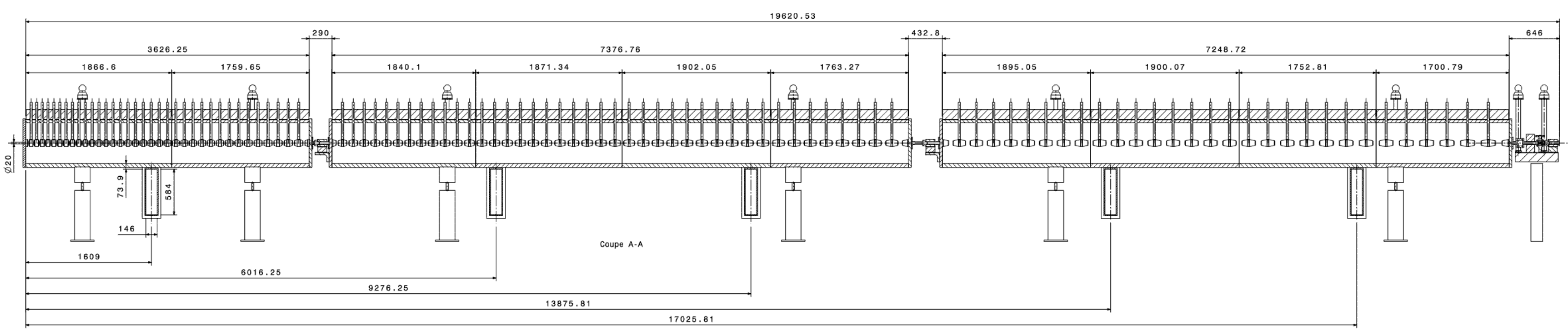
DTL design is an iterative process:

- Definition of principal cell dimensions
  - For optimum gradient
  - Sufficient magnet volume
  - Correct post-coupler length
- Find optimum output energy
  - Define average gradient & number of tanks
  - Keep power margin for additional losses and matching
- Discretize in tanks
  - Check for post-coupler scheme
  - Adjust gradient between tanks
- Implement mechanical design
  - Check compatibility & try options with proper matching

# Linac4 DTL Design

**DTL design parameters**:

- DTL from **3 – 50 MeV** with 3 cavities and 1 LEP and 2 new klystrons
- Klystron output power at cavity port **1 MW** (Tank1) and **2 MW** (Tank2&3)
- Accelerating field at ~**3.2 MV/m**
- Peak electric field of **1.6 Kilpatrick** lowered to 1.2 Kilp. over the first cells
- **PMQ**s in **vacuum**
- Self supporting steel cylinders of **50 mm** thickness
- Maximum segment length of **2 m**

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Production design:

- Parameters compatible with mechanical realization
- Production drawings are ready and manufacturing started

| Parameter \ Cavity | 1 | 2 | 3 |
|---|---|---|---|
| Cells per cavity | 39 | 42 | 30 |
| Accelerating field | 3.1 MV/m | 3.3 MV/m | 3.3 MV/m |
| Maximum surface field | 1.5 Kilp. | 1.4 Kilp. | 1.45 Kilp. |
| Synchronous phase | -35 to -24 deg | -24 deg | -24 deg |
| RF peak power per cavity | 1.00 MW | 2.03 MW | 1.98 MW |
| Quadrupole length | 45 mm | 80 mm | 80 mm |
| Flat Size | 11 mm | 7 mm | 5 mm |
| Number of sections | 2 | 4 | 4 |
| Length per cavity | 3.8958 m | 7.3406 m | 7.2508 m |
| Beam output power | 11.88 MeV | 31.45 MeV | 50.14 MeV |

Today:

- Beam dynamics and RF design
  - Coffee break
- Mechanical design and ancillaries
  - Lunch break
- PMQs, prototype testing, vacuum
  - Coffee break
- ESS Bilbao and INFN LNL

Tomorrow:

- Visit to workshops:
  - Welding, Assembly, Linac4 Bd.