RF structures for Linac4

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PAC'07, Albuquerque, USA

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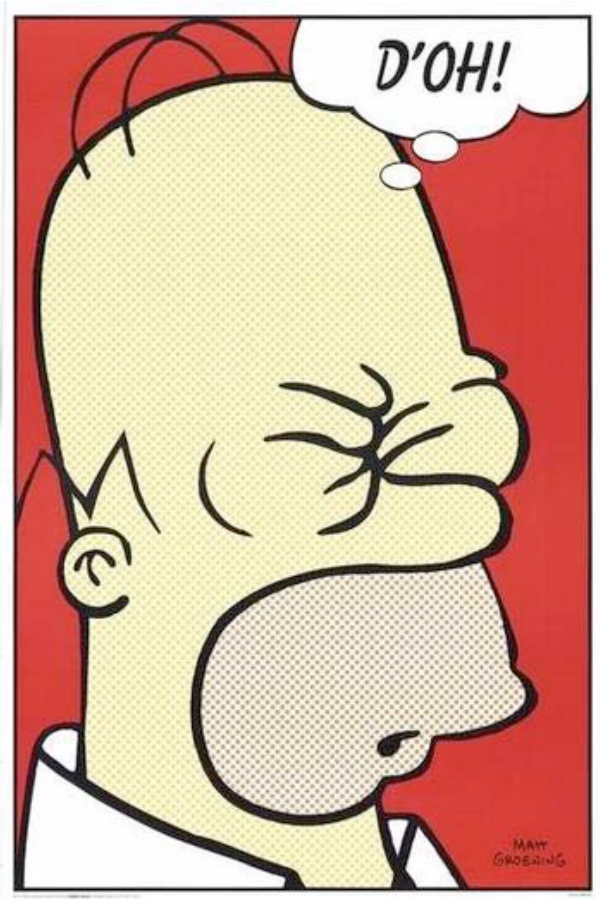
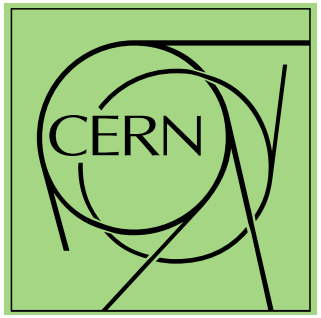


Now it is time to deliver!

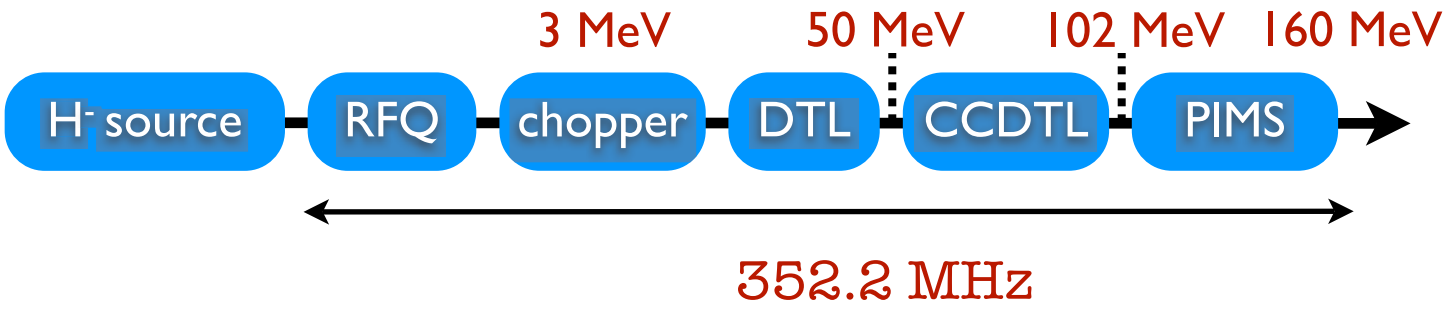
Motivation

- Linac4 will enable the CERN proton injector chain to reach the "ultimate" LHC luminosity,
- Linac4 will inject at 160 MeV into the PS Booster (PSB) → increase $\beta\gamma^2$ by a factor of 2 → double the number of particles per cycle (TUPAN109, TUPAN093)
- as PSB injector Linac4 will operate at low duty cycle (<0.1%),
- Linac4 is also designed to become the front end of the SPL, a multi-GeV, multi-MW H^- linac, which will operate at a duty cycle of ≈5%,
- while the accelerating structures and klystrons are designed for 5% duty cycle the Linac4 infrastructure (klystron modulators, cooling water, electrical station, etc) is only designed for 0.1% and will then be upgraded.

Linac4 machine layout



Linac4 as PSB injector (0.1% duty cycle)



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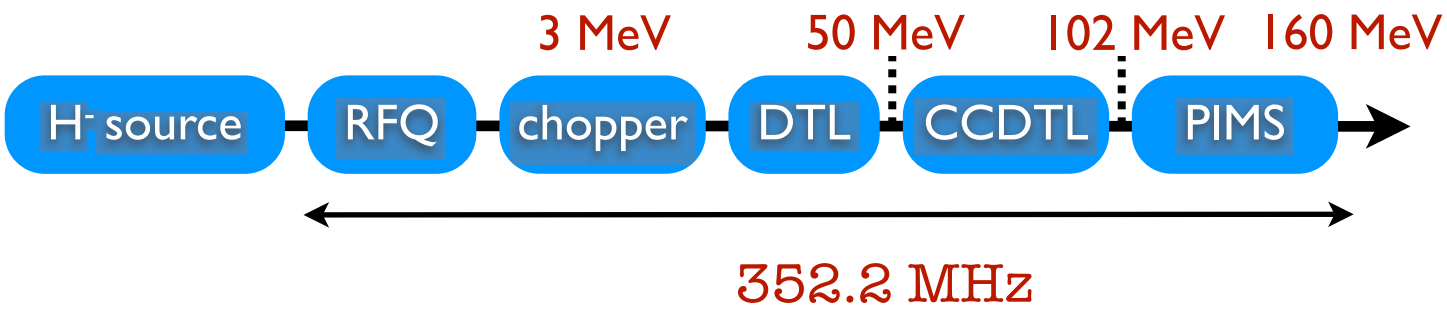
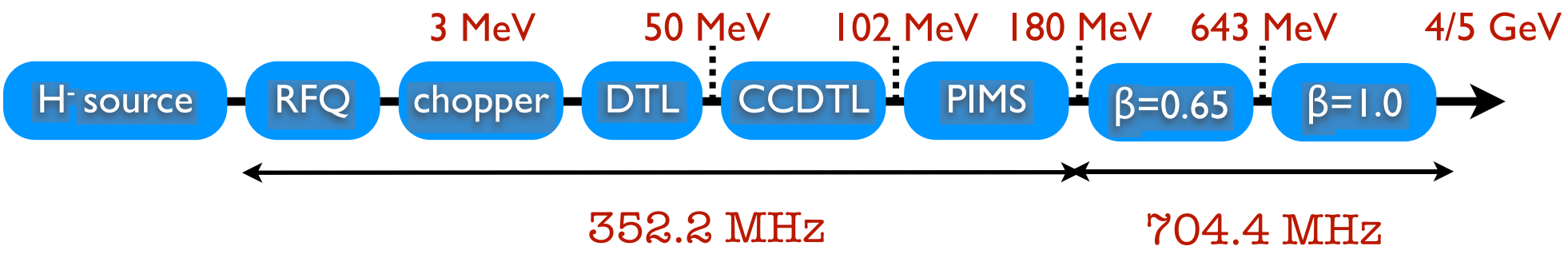
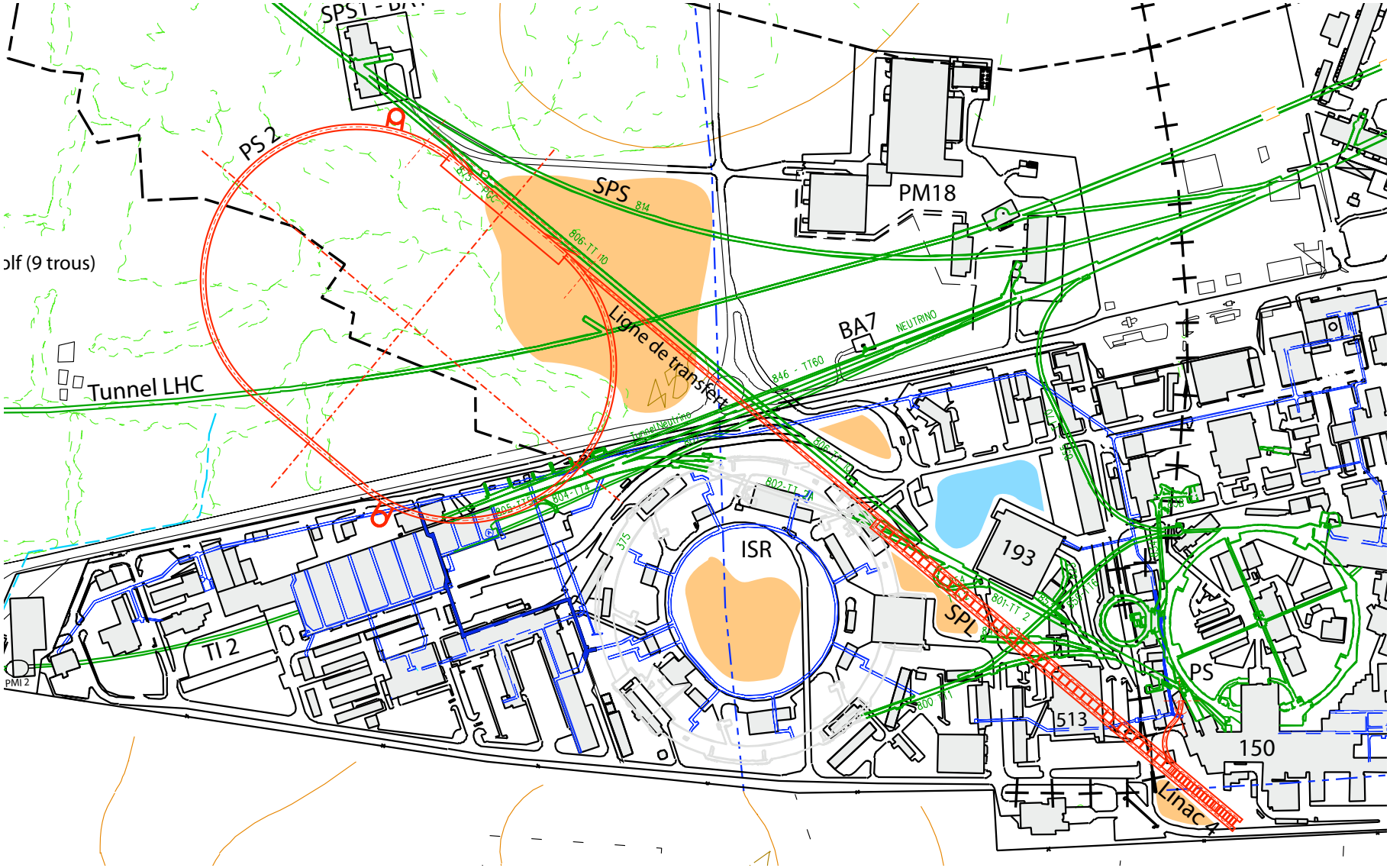


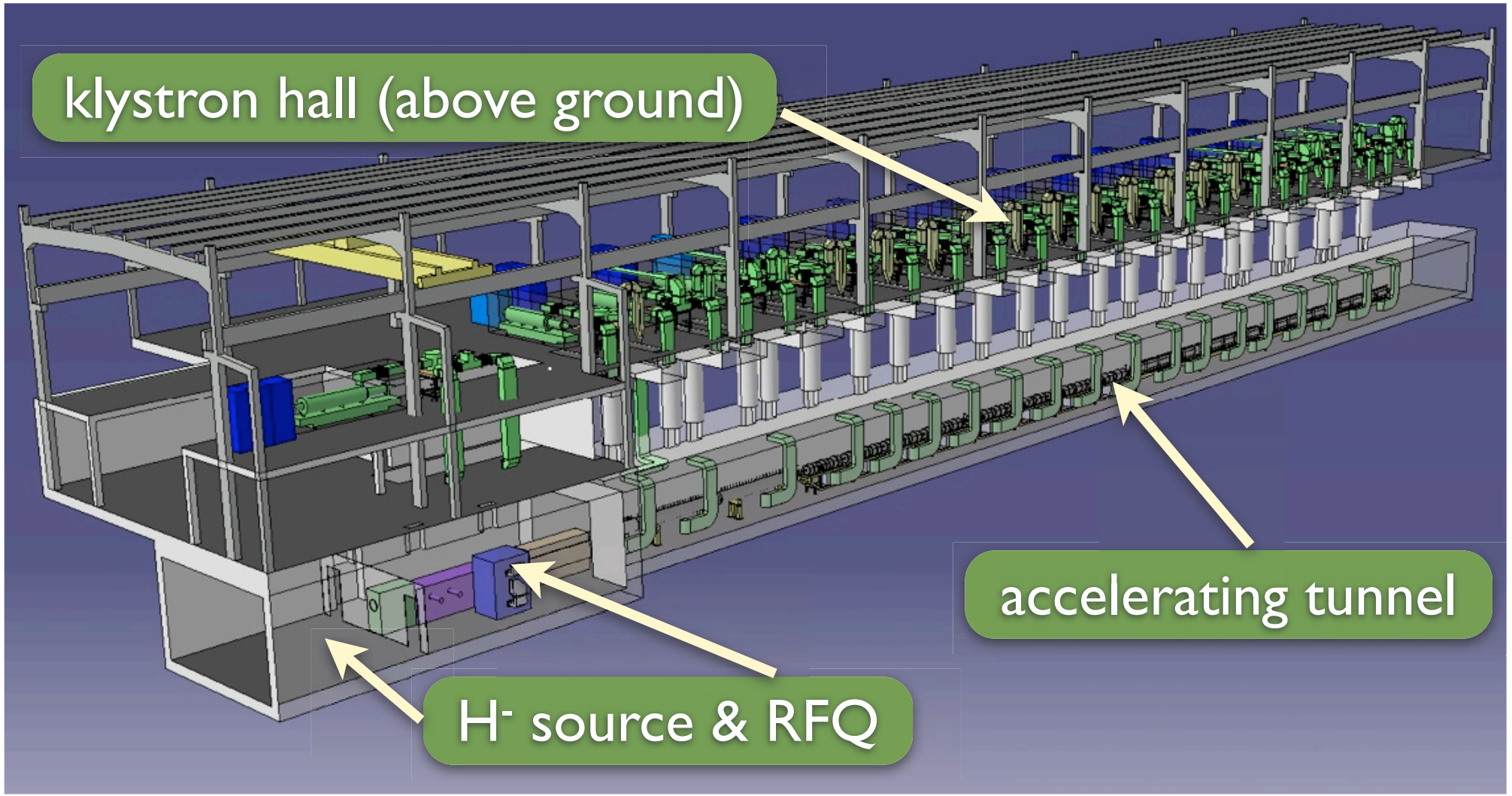
Linac4 as SPL injector (5% duty cycle)



Site layout SPL



Linac4 layout



Accelerating structures

Final round of optimisations is now finished ➔ design frozen!

All structures have been re-assessed and the overall approach was revised.

Latest optimisation:

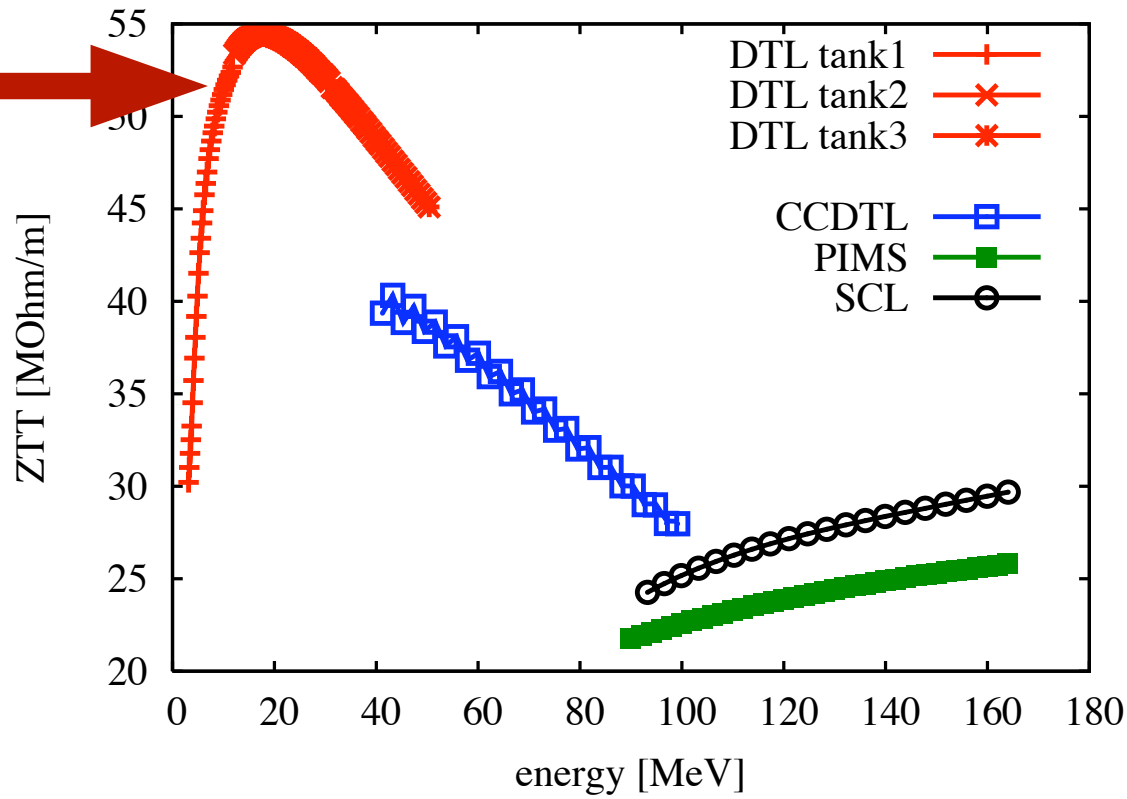
- decrease safety margin on LEP klystron operation (0.8 MW ➔ 1.0 MW, max. power: 1.3 MW, CW), maintaining 80% of Superfish ZT^2 ,
- shift in transition energies:
  - ➡ DTL/CCDTL: 40 to 50 MeV,
  - ➡ CCDTL: 90 to 102 MeV,
- exchanged the SCL (90-160 MeV) with a π-mode structure (102 - 160 MeV)

➡ one single frequency (352 MHz).

Shunt impedance

DTL with PMQs:

➔ high ZT^2 but not flexible,



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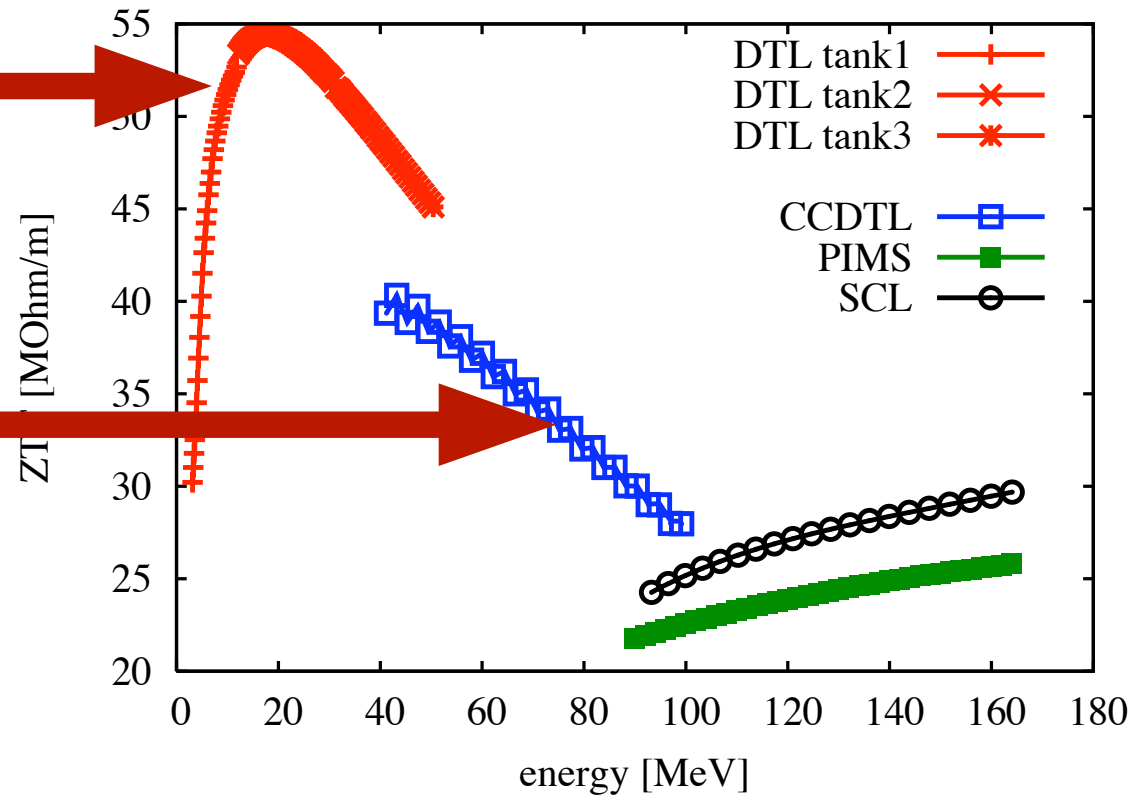
CCDTL with ext. EMQs:
- high ZT^2 and flexible,
- cannot be used < 40 MeV,



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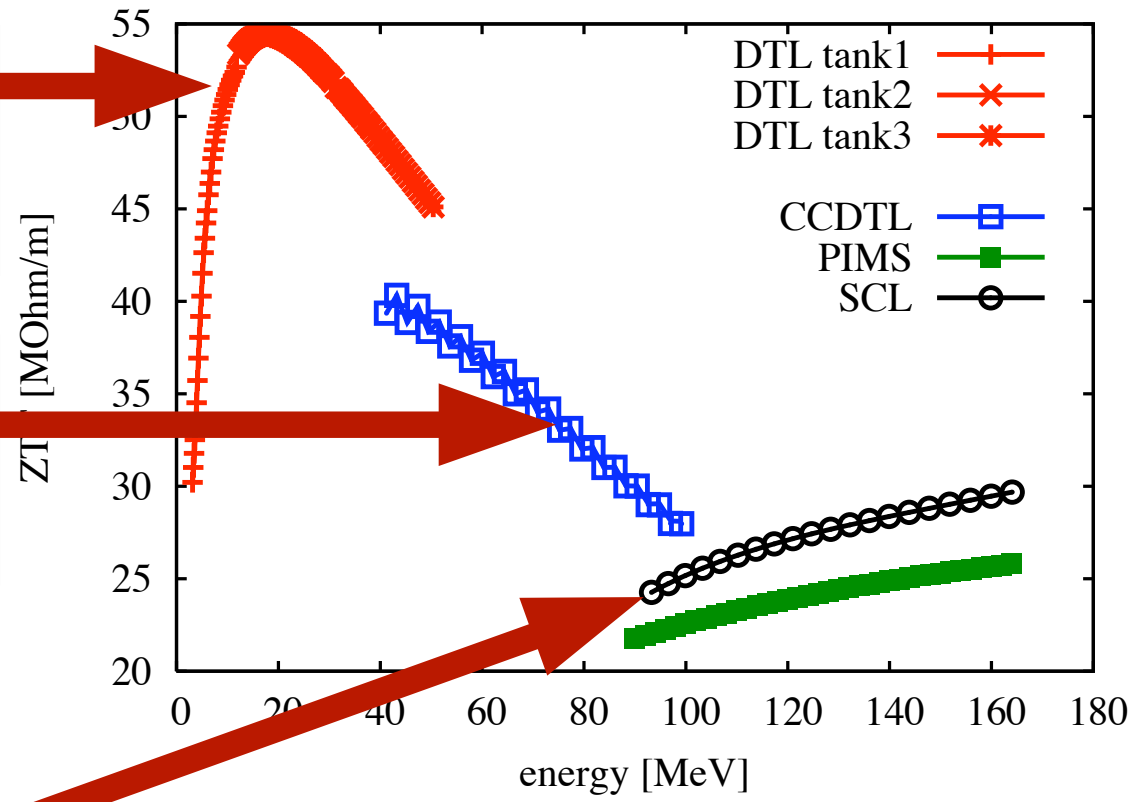

SCL: π/2 mode structure at 704 MHz: 4 modules with 5 coupled cavities (21 cells each!): 468 cells!

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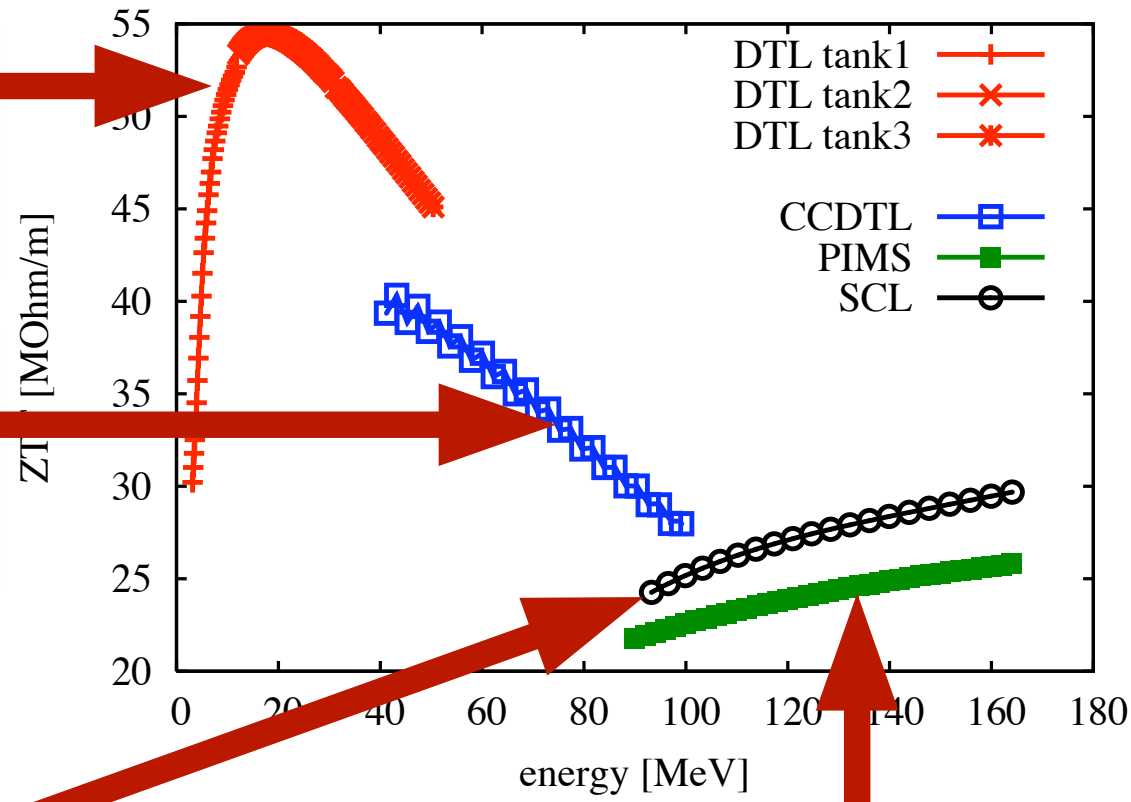
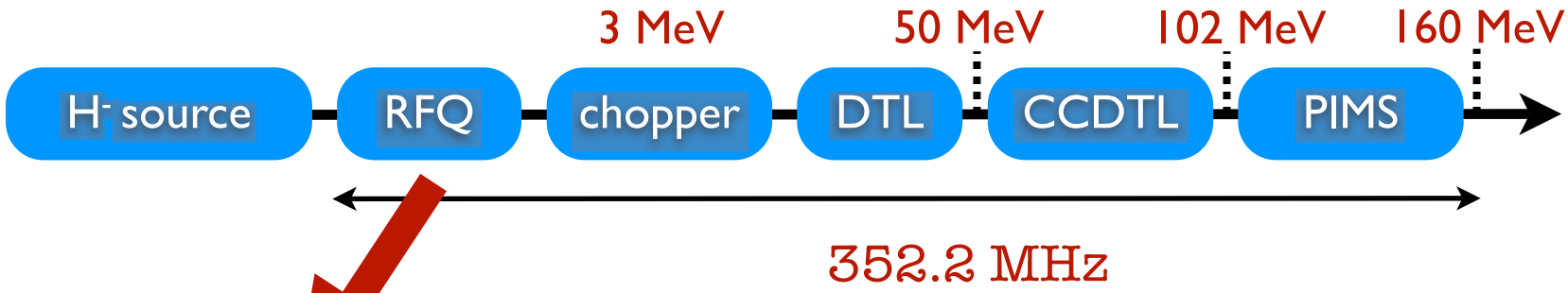
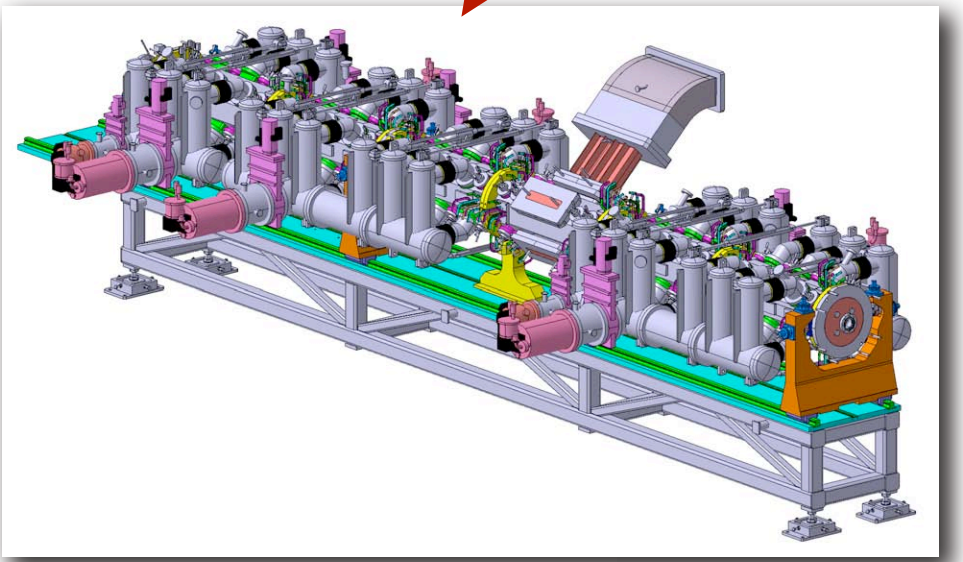


SCL: π/2 mode structure at 704 MHz: 4 modules with 5 coupled cavities (21 cells each!): 468 cells!

PIMS: π mode structure at 352 MHz: 12 cavities with 7 cells each: 84 cells (+3 CCDTL tanks)

Accelerating structures: RFQ



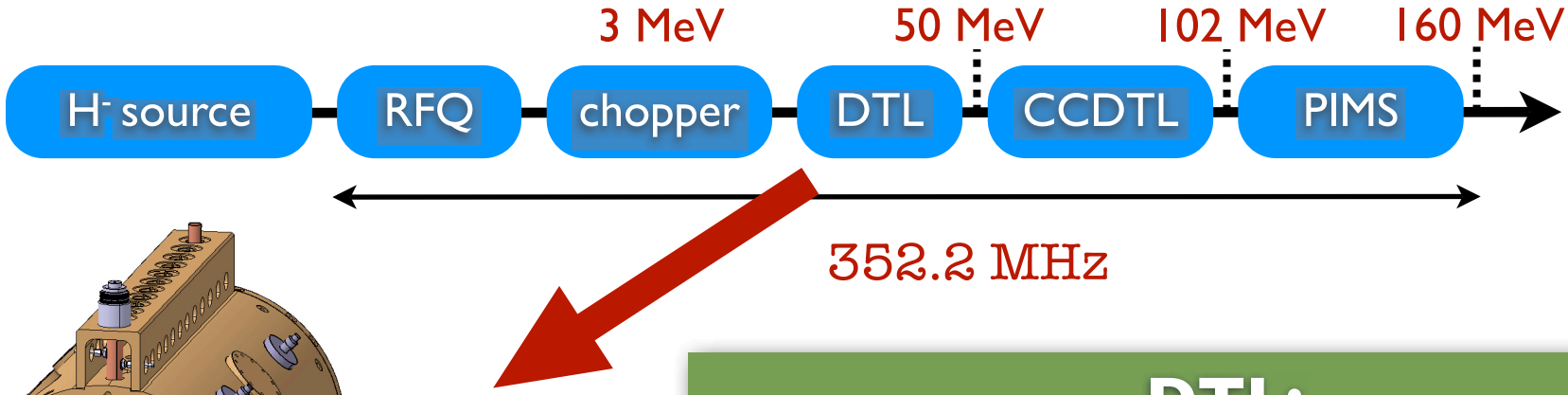


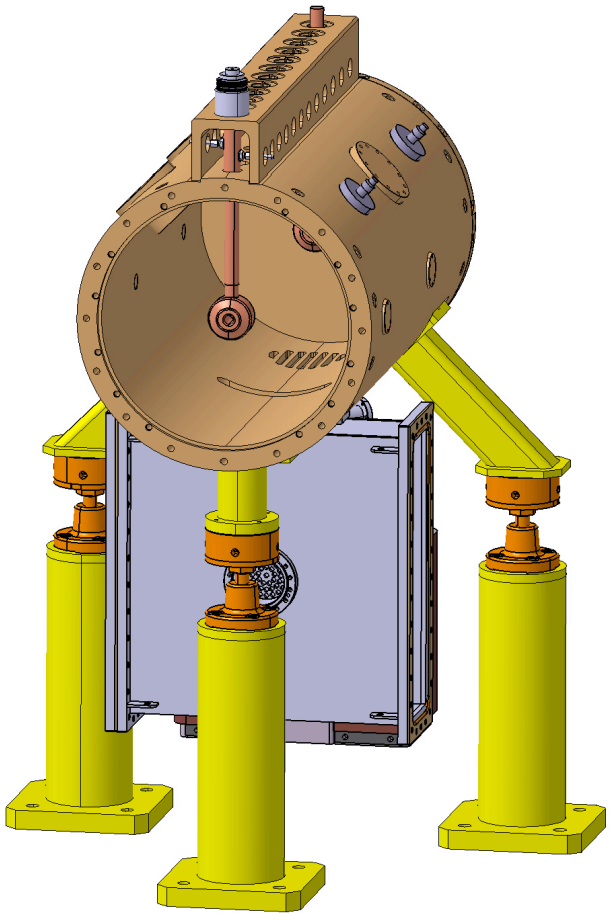
RFQ:

- nominal solution: IPHI RFQ (CW, 100 mA, P_{av}=300 kW), under development at CEA,
- a scaled down version (P_{av}=10 kW) is under study at CERN,

➡ 3 m instead of 6 m, simplified cooling, simplified construction,

Accelerating structures: DTL

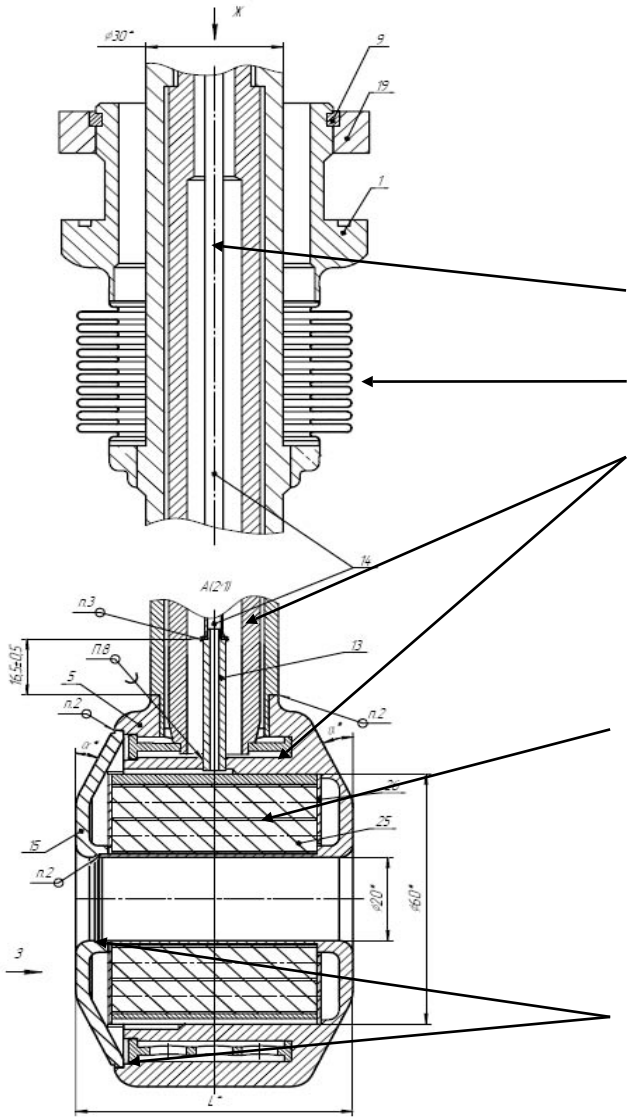




DTL:

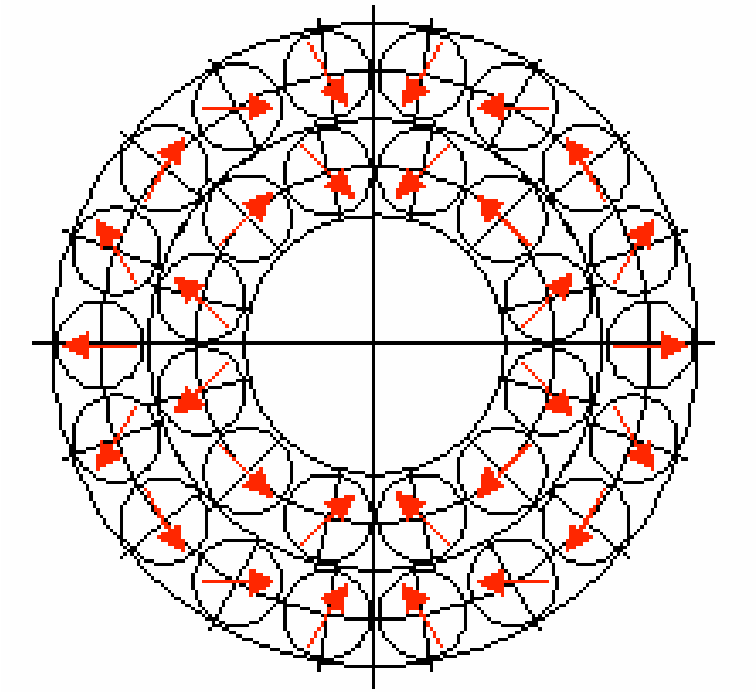
- 3 tanks, 3 - 50 MeV,
- ITEP, VNIIEF, Russia: PMQs, drift tubes,
- revised hot prototype under development at CERN,
- cold model under construction (KASCT, Saudi Arabia),

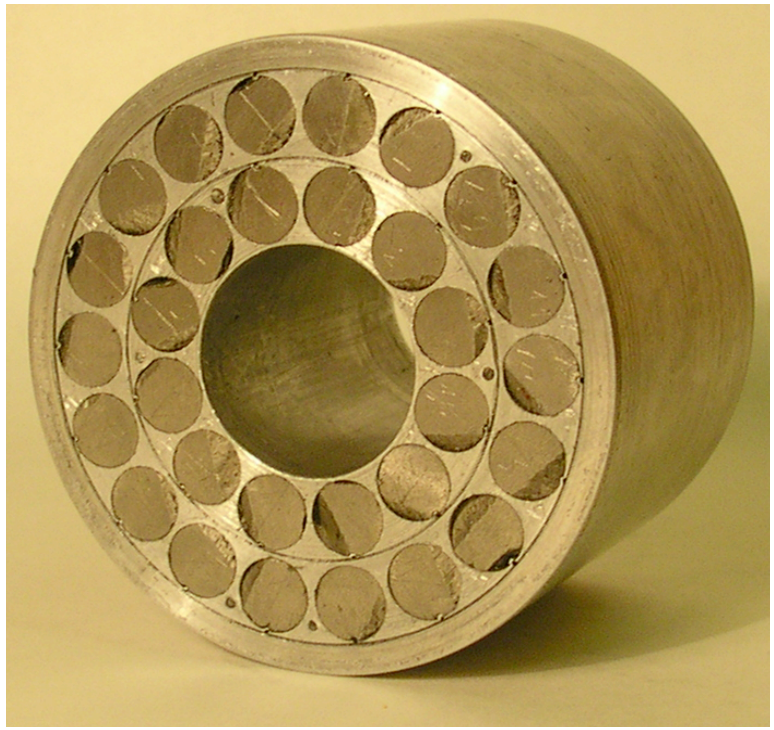
Drift tube prototype (VNIIEF)



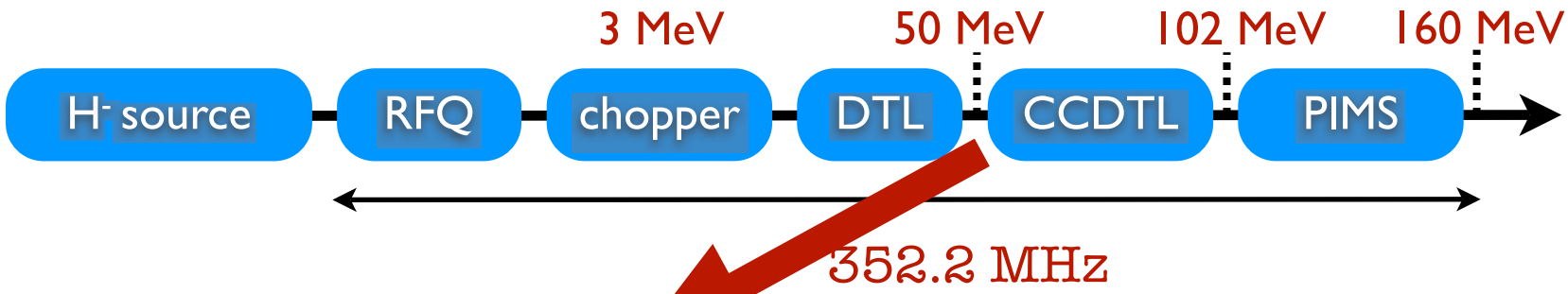
PMQ ITEP prototype

PMQ made of SmCo5, constructed to specifications, measured at CERN





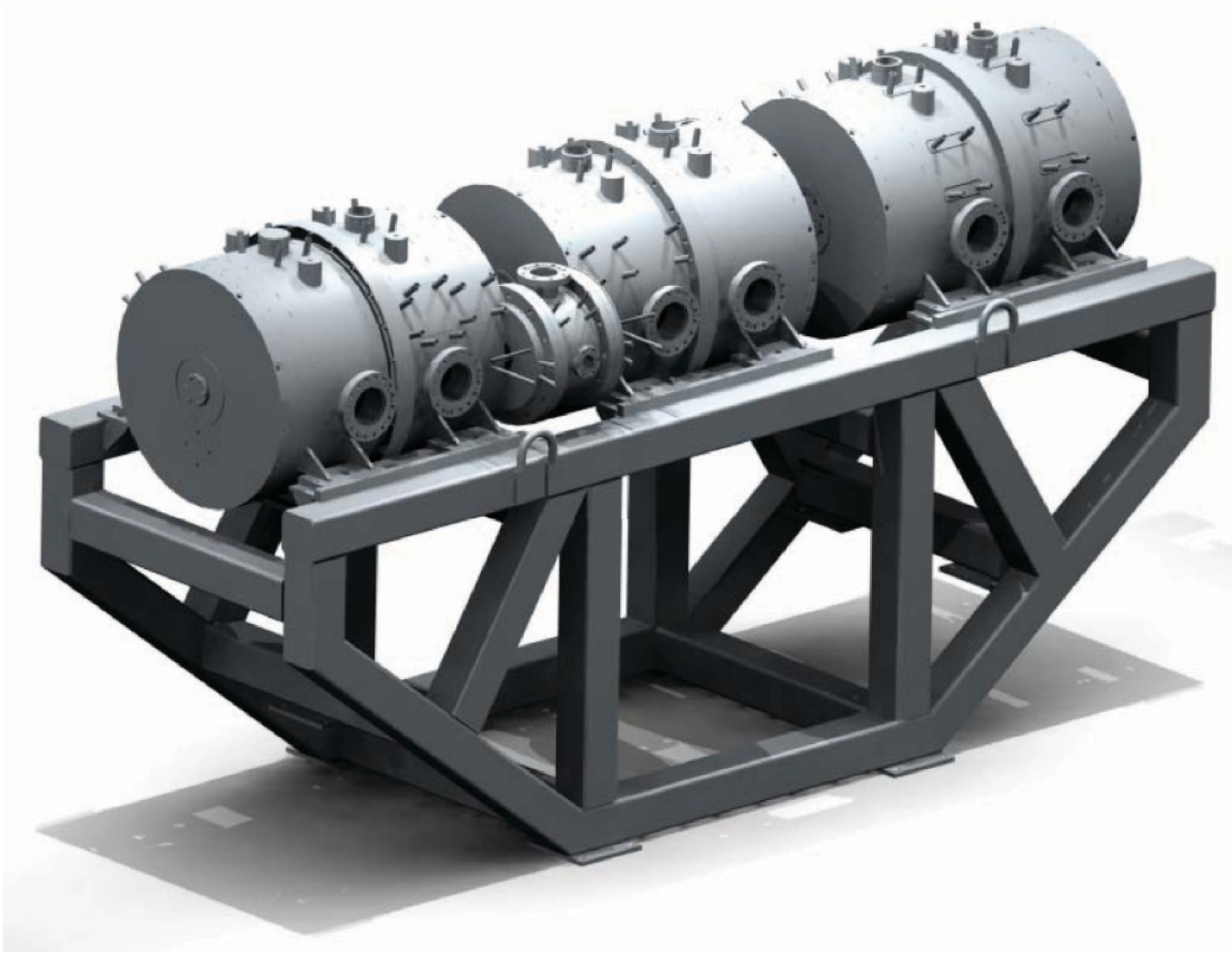
Accelerating structures: CCDTL



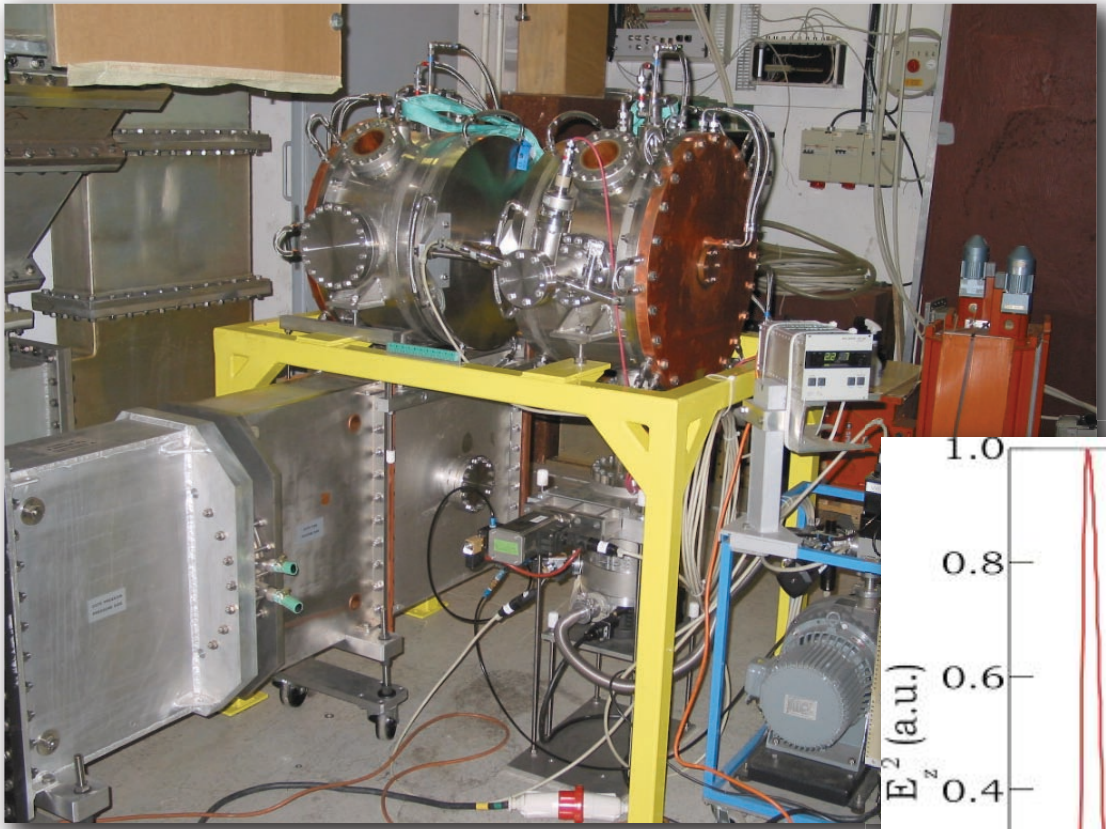
CCDTL prototyping:

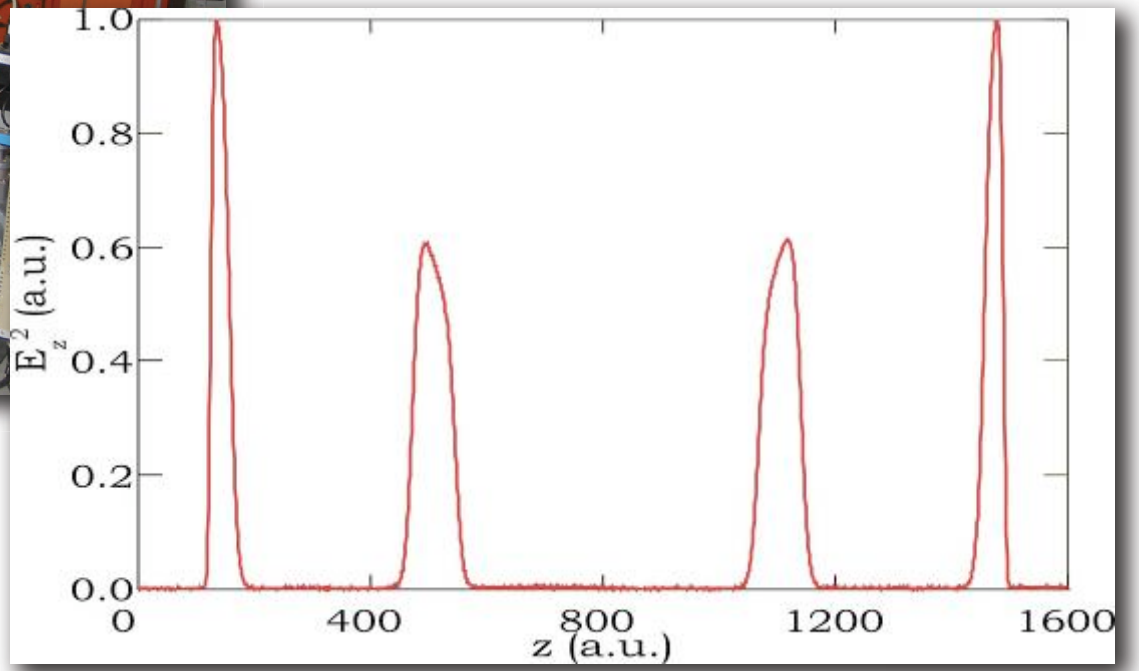
- under development at CERN since ~5 years,
- CERN hot model with 2 half cavities and one coupling cell was high-power tested,
- BINP/VNIITF hot model with 2 full cavities and 1 coupling cell is high-power tested this week,

CCDTL module: 3 cavities



CERN prototype: 2 half-cavities

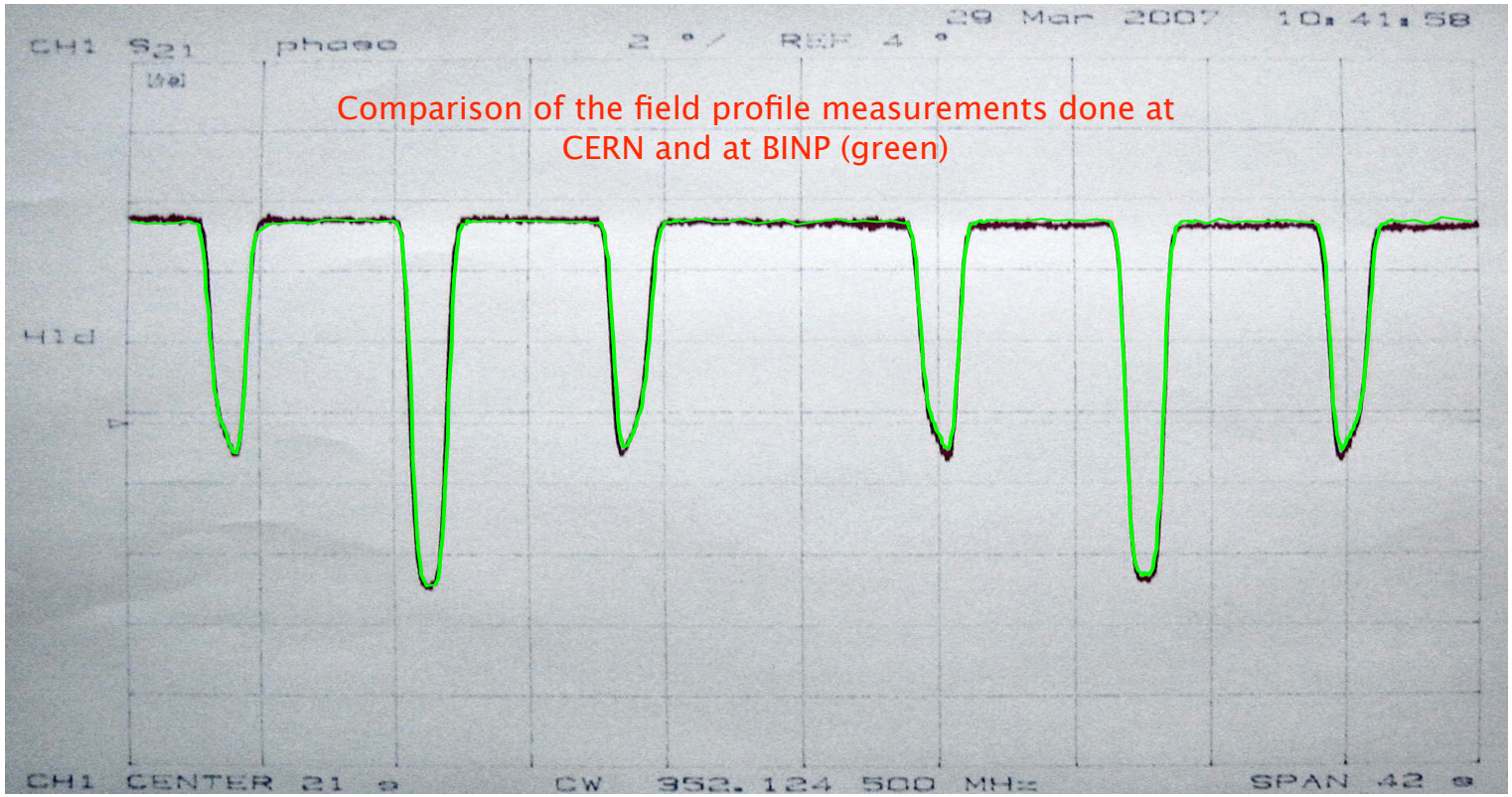




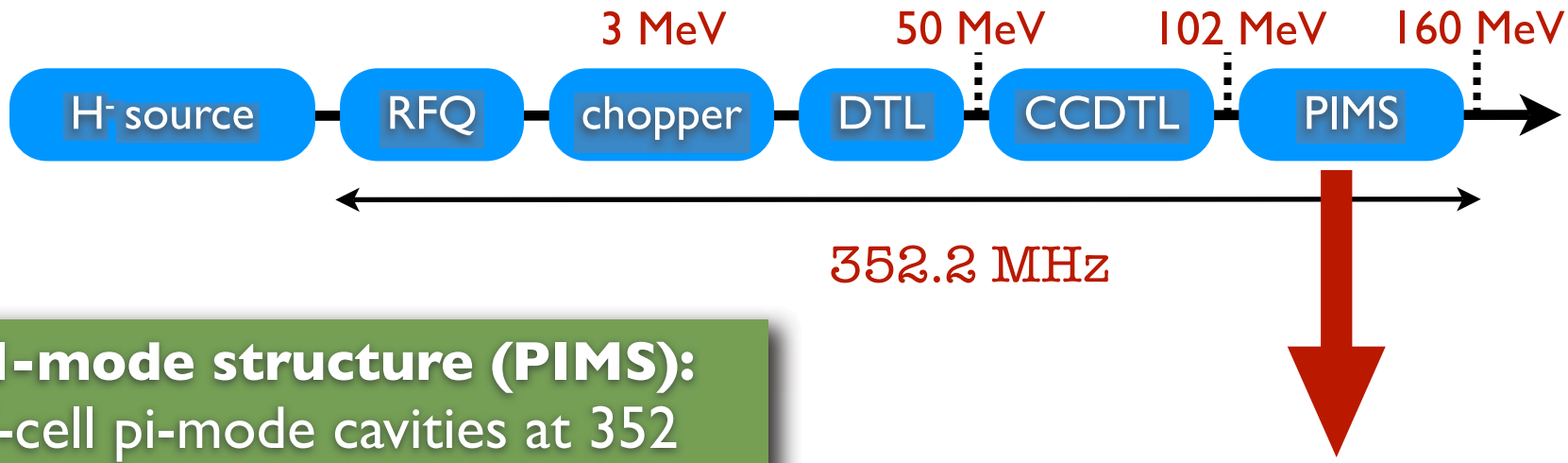
BINP/VNIITF prototype: 2 full cavities

- field flatness error < 1%,
- surface roughness: 1.3 um,
- 90% of theoretical Q value (36200),
- vacuum quality depends on Helicoflex joints,

BINP/VNIITF prototype: 2 full cavities

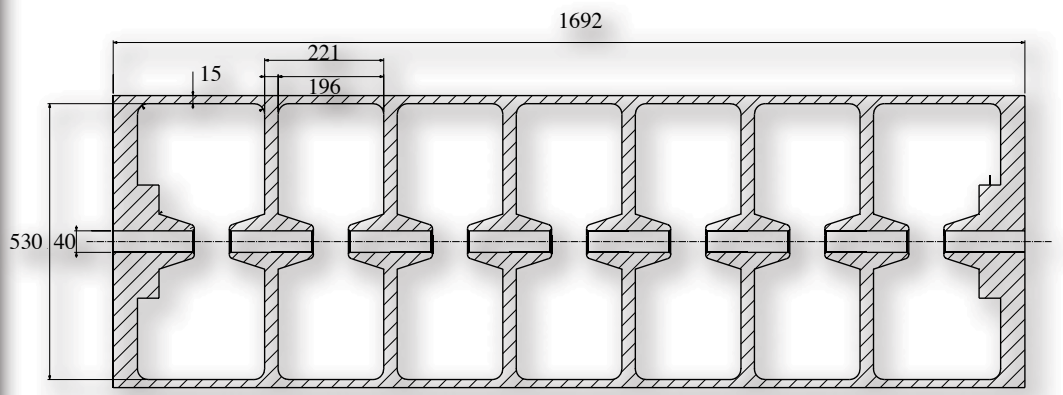


Accelerating structures: PIMS

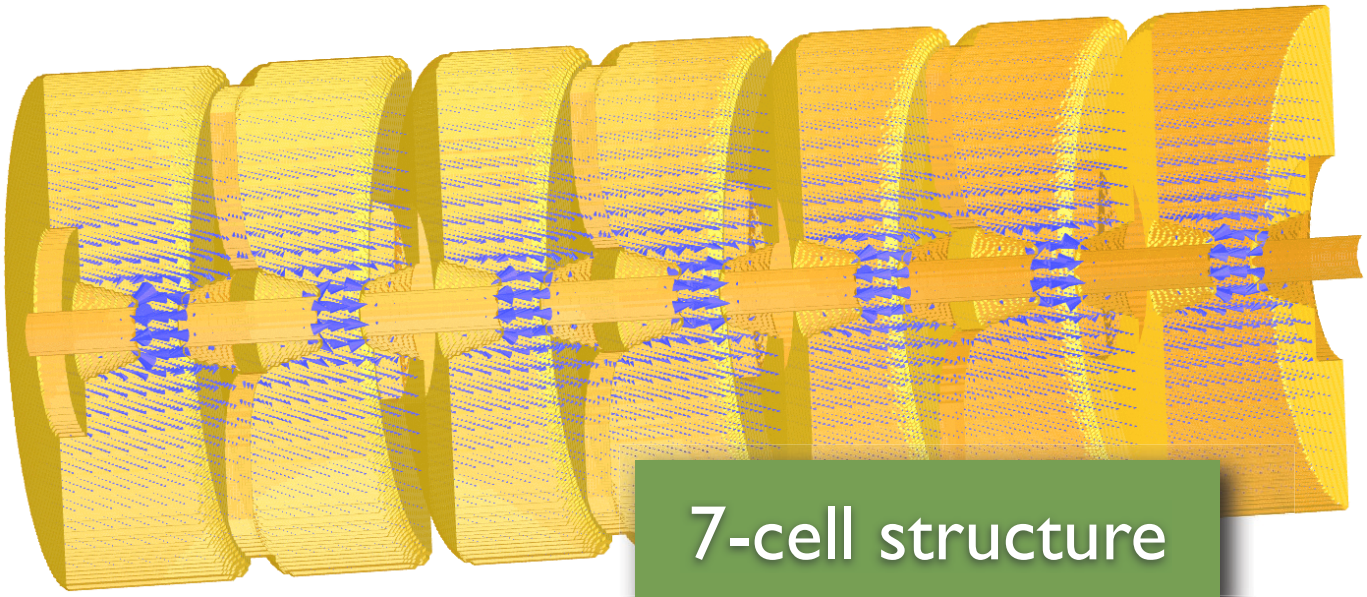


PI-mode structure (PIMS):

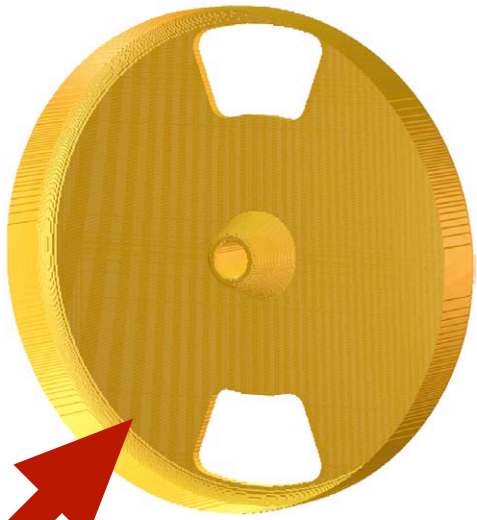
- 7-cell pi-mode cavities at 352 MHz,
- scaled (β) version of the LEP NC accelerating structure,
- in operation at CERN until 2000,
- cold and hot prototype under development.

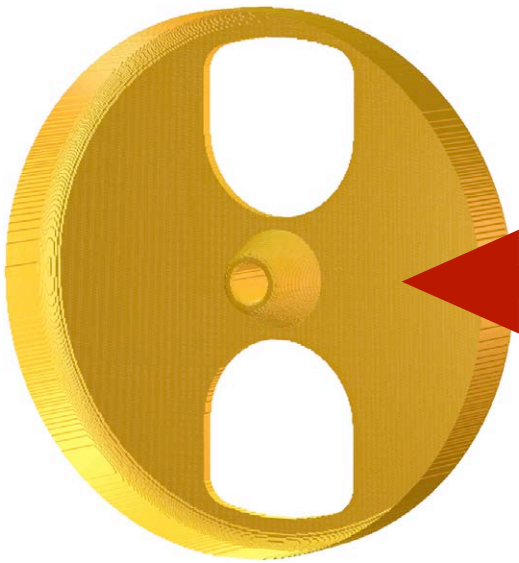


Accelerating structures: PIMS

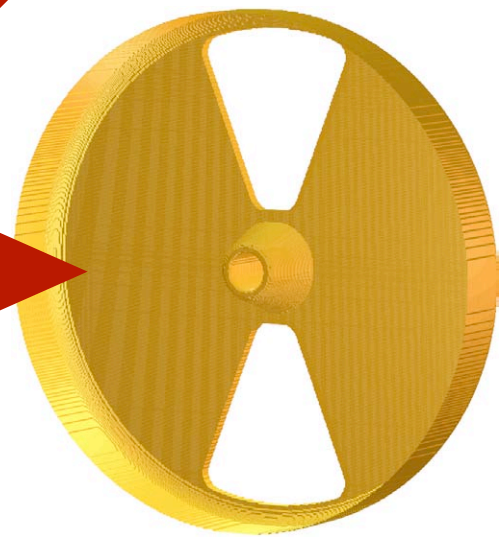


7-cell structure



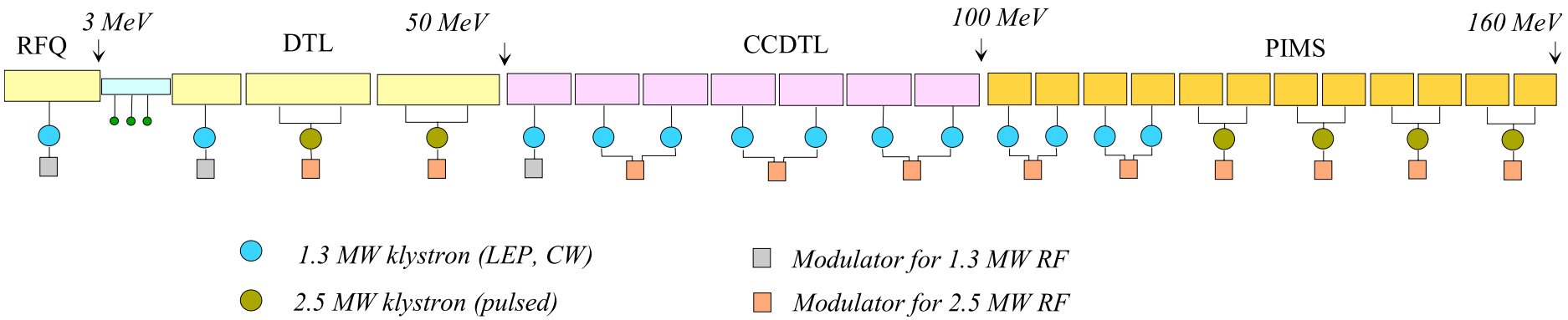


different coupling slot geometries

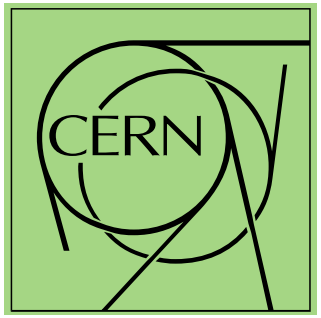


Structure parameters

	DTL	CCDTL	PIMS
output energy [MeV]	50	102	160
cavities	3	7 x 3	12
peak power [MW]	4.7	7	11.3
movable tuners	8	9	24
length [m]	18.7	25	22



summary



- Linac4 is approved!
- The final round of structure optimisations is completed.
- Prototyping for all structures is in progress.
- Civil engineering plans ready by August.
- Next year we will start to dig!!