Erk Jensen/CERN

O. Brüning, C. Bracco, R. Calaga, N. Catalan-Lasheras, B. Goddard, R. Torres-Sanchez, A. Valloni/CERN; M. Klein/CERN and U-Liverpool

Design Study of an LHeC ERL Test Facility at CERN

Many special thanks to

K. Aulenbacher (JG|U), A. Bogacz, A. Hutton (JLAB), O. Brunner, E. Ciapala, S. Calatroni, T. Junginger, E. Montesinos, K. Schirm, D. Schulte, A. Milanese, E. Shaposhnikova, J. Tückmantel †, W. Venturini, W. Weingarten, D. Wollmann (CERN)

5th International Particle Accelerator Conference

June 15 - 20, 2014 | Dresden, Germany

Outline

- Introduction: LHeC and FCC-he
- The ERL-TF: Goals and parameters
- Layout and Optics
- ERL Cavity/Cryomodule Development
- Summary

Introduction

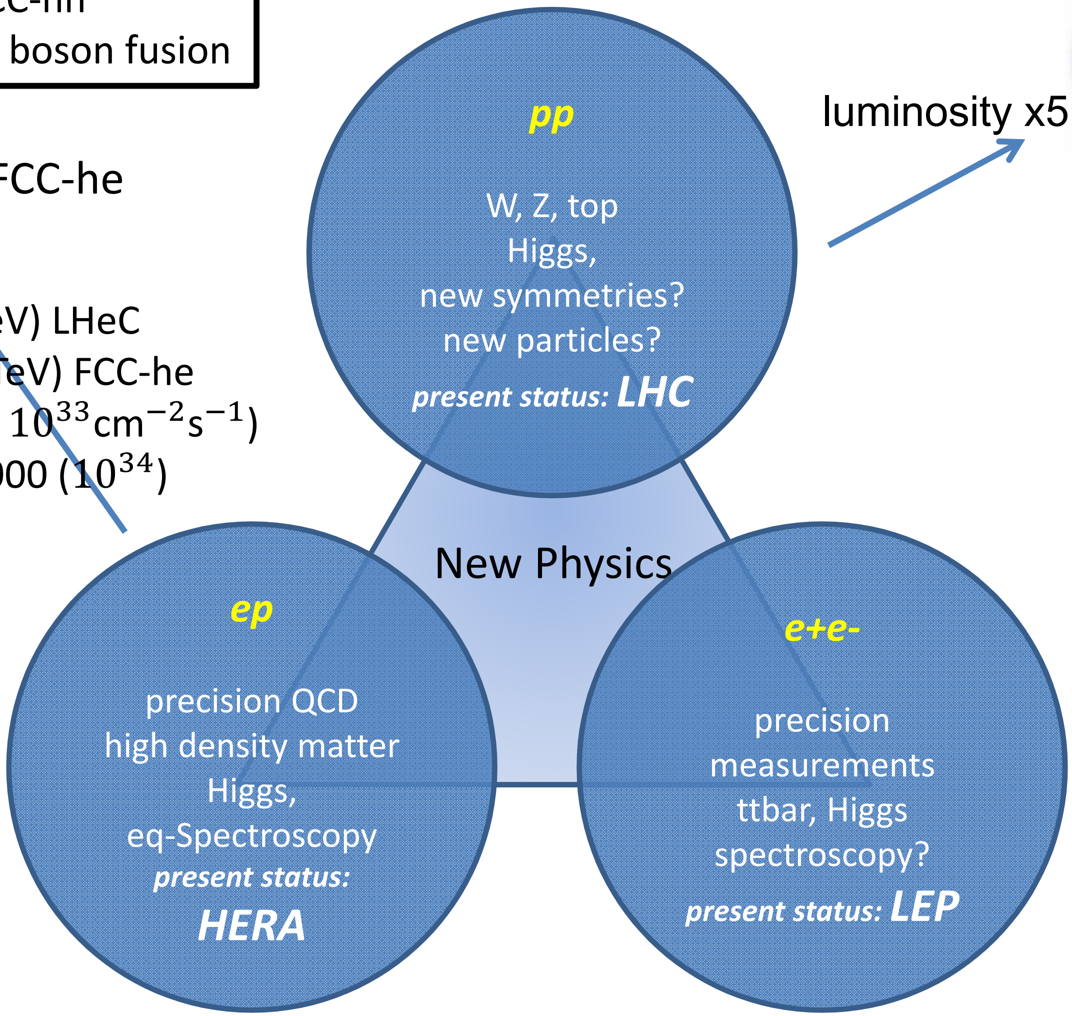
LHeC and FCC-eh

LHeC Physics – complementary to pp and e+e-

- BSM physics (leptoquarks, …)
- PDFs for LHC/FCC-hh
- Higgs via vector boson fusion

FCC-he

energy x4 (to 1.2 TeV) LHeC
energy x15 (to 4.5 TeV) FCC-he
luminosity x100 (to $10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$)
or pushed even x1000 (10^{34})



luminosity x5

energy x2.4 (HE-LHC)
energy x7 (FCC-hh)

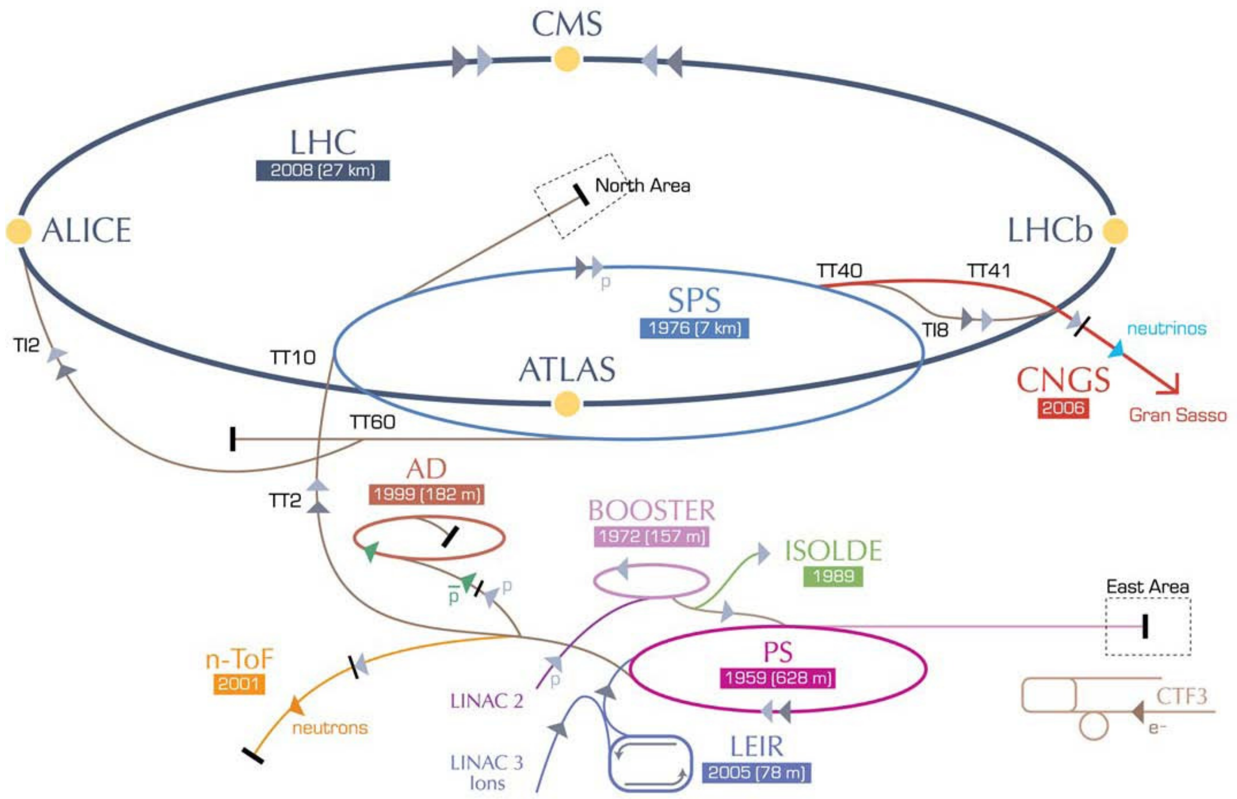
energy x2.4 (ILC)
energy x14 (CLIC)

FCC-ee?

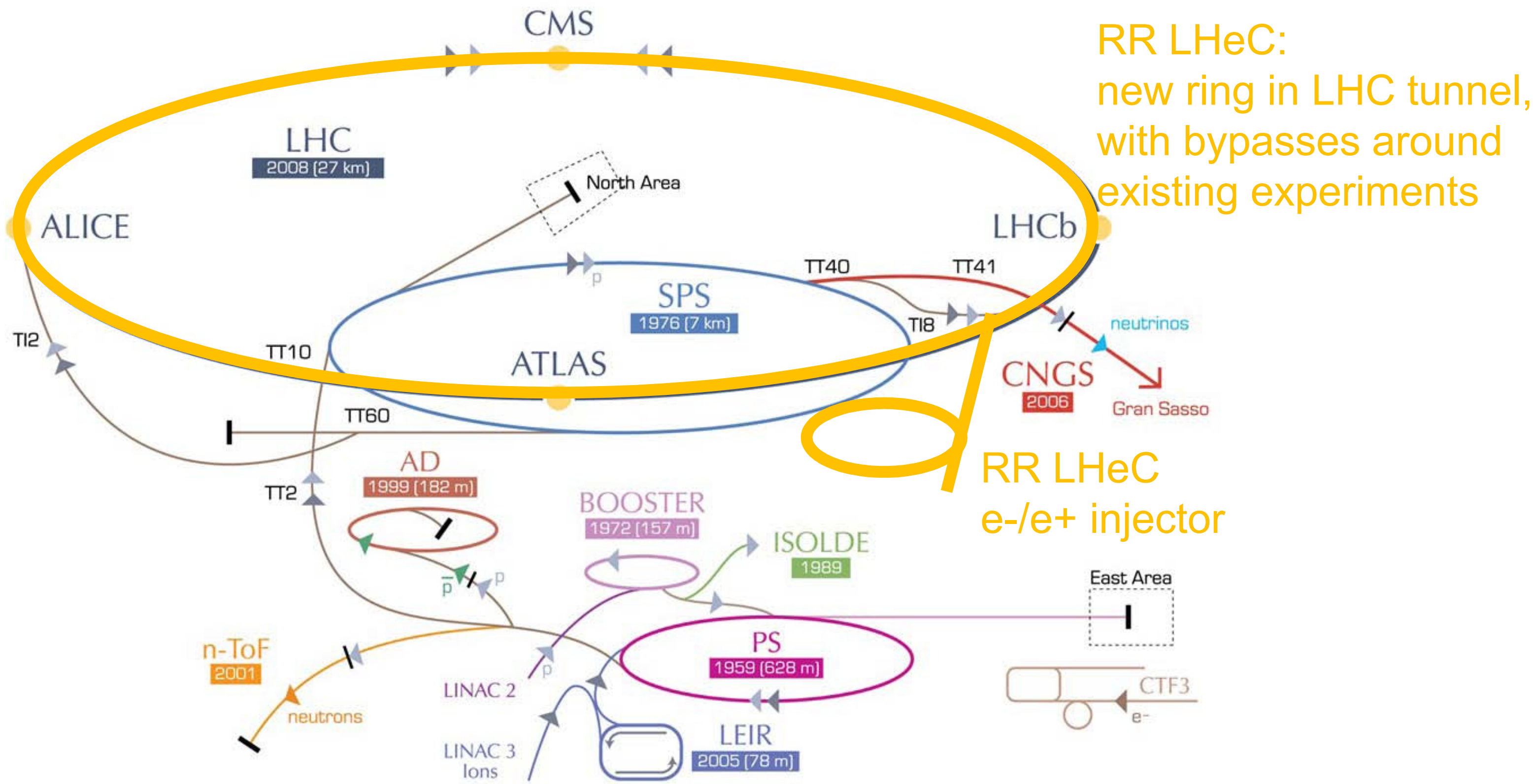
LHeC

- Phyics Goals: Colliding LHC proton beam with e^- or e^+ beam
  - Exploration of the energy frontier, complementing the LHC for BSM physics with high precision DIS measurements!
  - Investigation of a variety of fundamental questions in strong and electroweak interactions;
  - Electron-ion scattering in a (Q^2, *1/x*) range extended by 4 orders of magnitude as compared to previous lepton-nucleus DIS experiments;
  - Novel investigations of neutron's and nuclear structure, initial conditions of Quark-Gluon Plasma formation and further QCD phenomena;
  - With $\mathcal{L} = \mathcal{O}(10^{34})$: Higgs factory via vector boson fusion
- Constraints and challenges:
  - Power consumption ≤ 100 MW!
  - $\mathcal{O}(60\ \mathrm{GeV})$ ERL with two 10 GeV Linacs, 3 passes
  - Luminosity $\mathcal{O}(100\ \mathrm{fb}^{-1})$ with $10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ (100 x HERA) (and possibly more!)
  - No interference with pp physics!

LHeC options: RR and LR

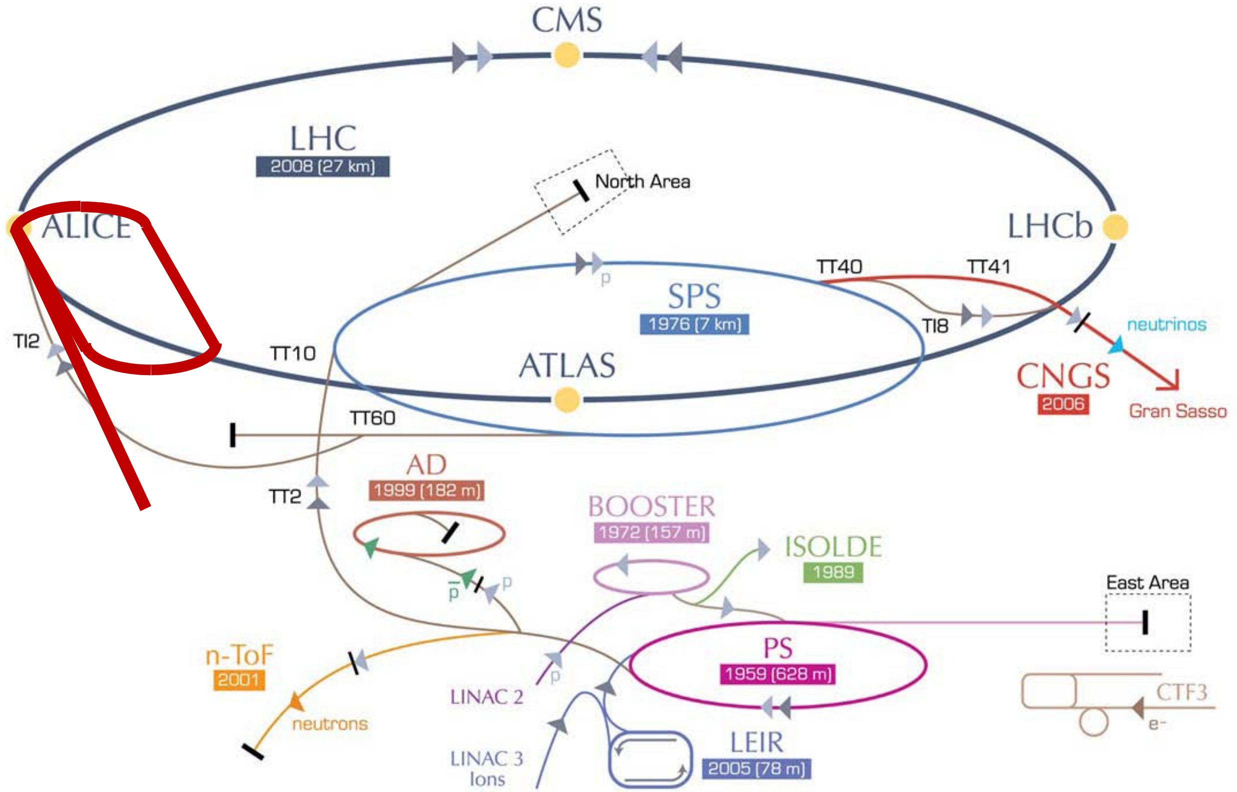


LHeC options: RR and LR



Study team provided CDR:
Ring-ring option, feasible but impact LHC operation during installation

LHeC options: RR and LR



LR LHeC (baseline): ERL

Study team provided CDR:

Ring-ring option, feasible but impact LHC operation during installation

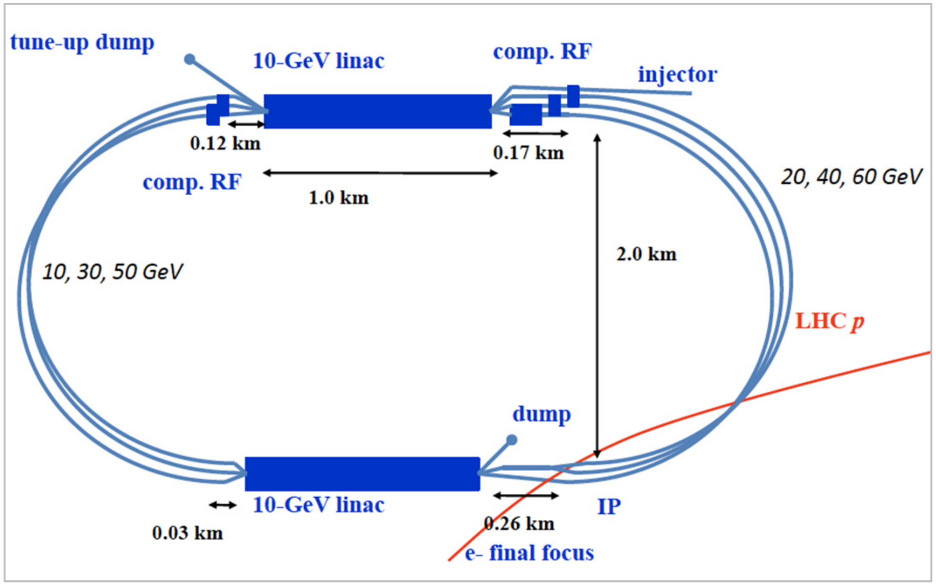
Linac-ring option, the baseline

A solution exists, will now have to find the best solution

Already have a baseline and alternatives for some components

LHeC LR option (baseline)

- Super Conducting Linac with Energy Recovery & high current (> 6 mA)



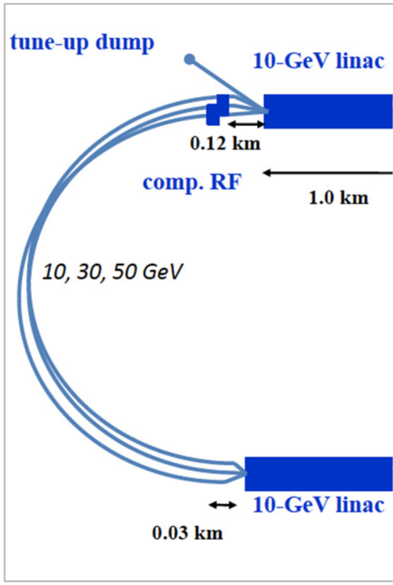
Two 1 km long SC linacs in CW operation ($Q_0 > 10^{10}$)

➔ requires cryogenic system comparable to LHC system!

- Relatively large return arcs
  ➔ ca. 9 km underground tunnel installation
  ➔ total of 19 km bending arcs
  ➔ same magnet design as for RR option: > 4500 magnets

LHeC LR option (baseline)

- Super Conducting Linac with Energy Recovery & high current (> 6 mA)

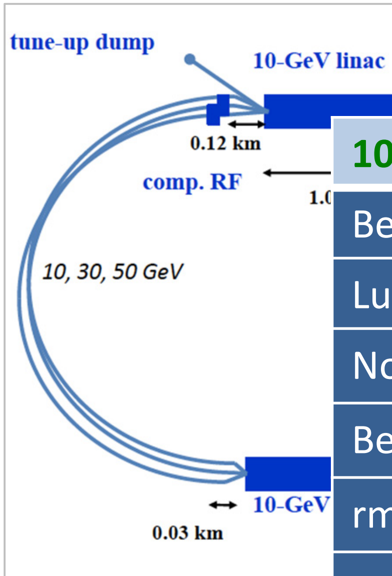


10^{33} cm^{-2} s^{-1} Luminosity reach	PROTONS	ELECTRONS
Beam Energy [GeV]	7000	60
Luminosity $[10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}]$	1	1
Normalized emittance $\gamma\epsilon_{x,y}$ [μm]	3.75	50
Beta Funtion $\beta^*_{x,y}$[m]	0.1	0.12
rms Beam size $\sigma^*_{x,y}$ [μm]	7	7
rms Beam divergence $\sigma'^*_{x,y}$ [μrad]	70	58
Beam Current [mA]	430 (860)	6.6
Bunch Spacing [ns]	25 (50)	25 (50)
Bunch Population	$1.7*10^{11}$	$(1*10^9)$ $2*10^9$
Bunch charge [nC]	27	(0.16) 0.32

- Relatively large r
  - → ca. 9 km under
  - → total of 19 km bending arcs
  - → same magnet design as for RR option: > 4500 magnets

LHeC LR option (baseline)

- Super Conducting Linac with Energy Recovery & high current (> 6 mA)

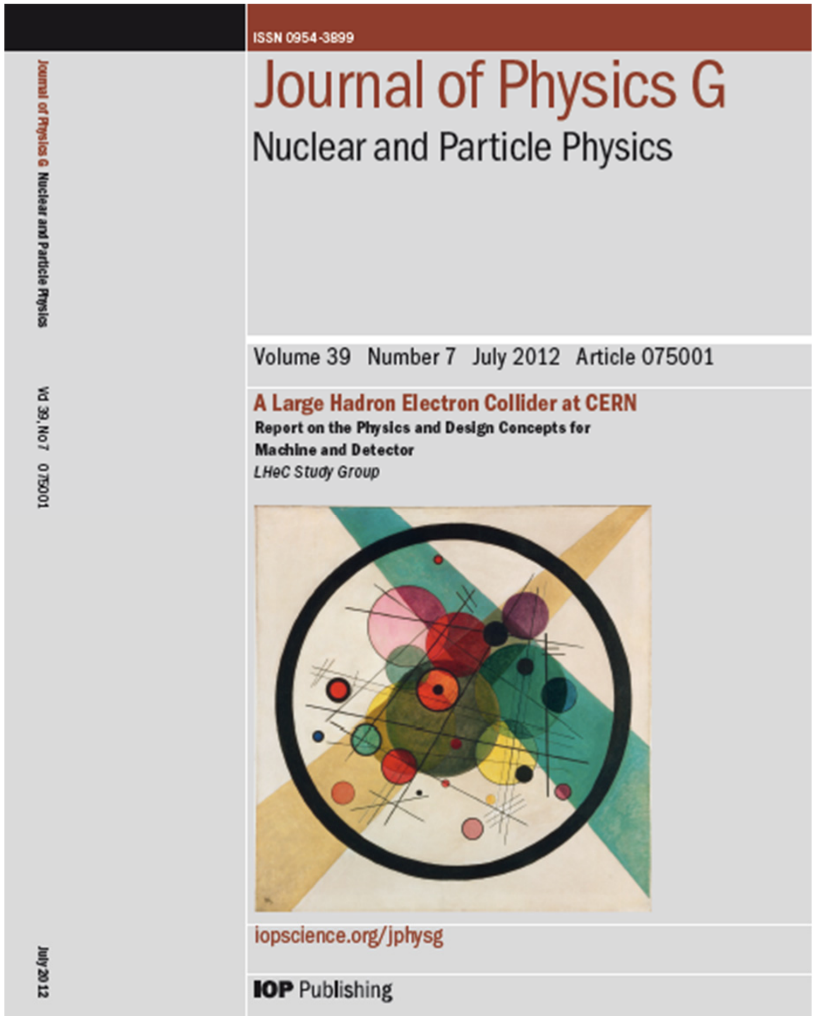


10^{33} cm^{-2} s^{-1} Luminosity reach	PROTONS	ELECTRONS
		60
		1
		50
		12
		7
		58
		.6
		0)
		0^{9}
		32

10^{34} cm^{-2} s^{-1} Luminosity reach	PROTONS	ELECTRONS
Beam Energy [GeV]	7000	60
Luminosity $[10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}]$	16	16
Normalized emittance $\gamma\epsilon_{x,y}$ [μm]	2.5	20
Beta Funtion $\beta^*_{x,y}$[m]	0.05	0.10
rms Beam size $\sigma^*_{x,y}$ [μm]	4	4
rms Beam divergence $\sigma'^*_{x,y}$ [μrad]	80	40
Beam Current [mA]	1112	25
Bunch Spacing [ns]	25	25
Bunch Population	$2.2*10^{11}$	$4*10^{9}$
Bunch charge [nC]	35	0.64

- Relatively large
  - ➔ ca. 9 km und
  - ➔ total of 19 k
  - ➔ same magnet design as for RR option: > 4500 magnets

LHC Conceptual Design Report

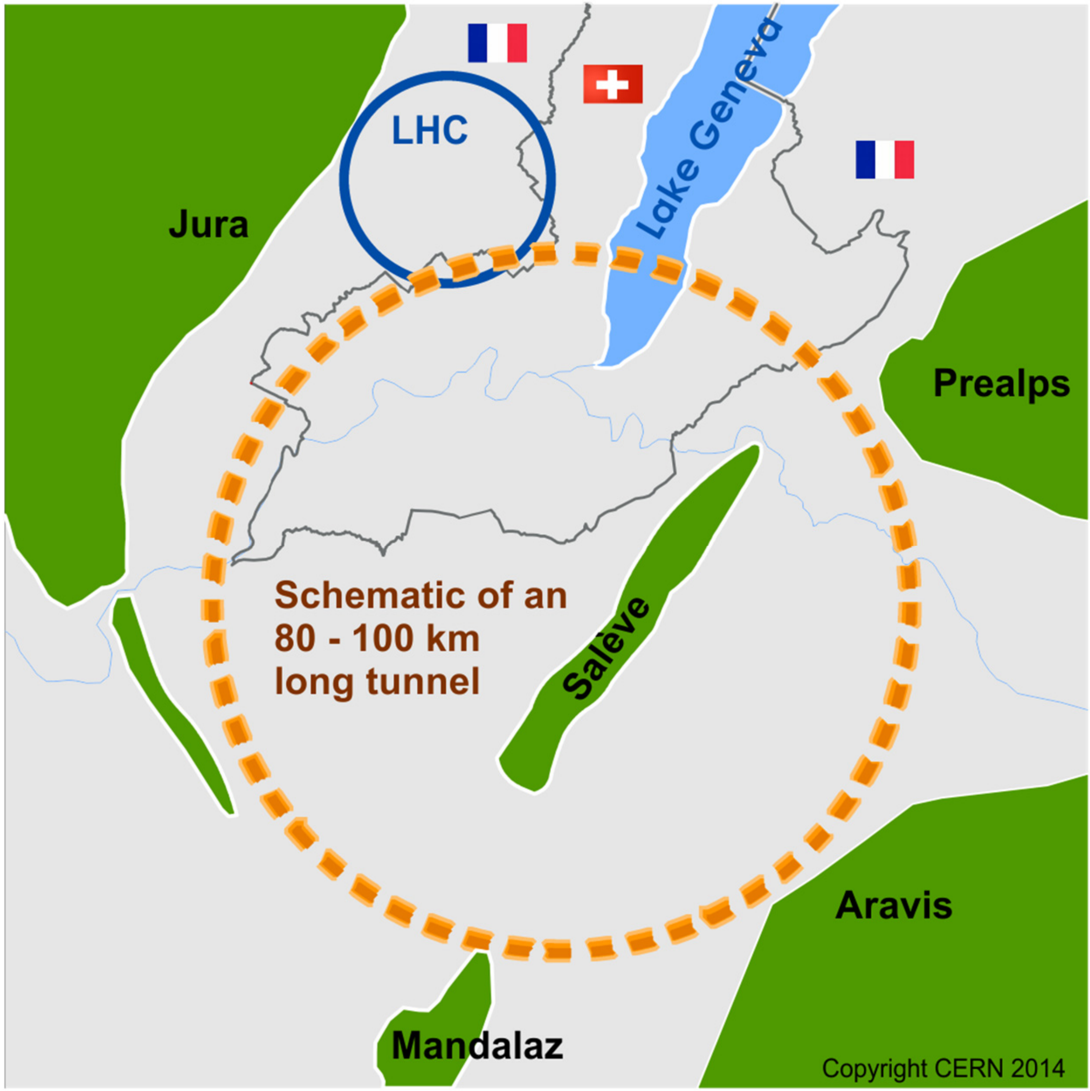


- Published in 2012 In Journal of Physics G: http://iopscience.iop.org/0954-3899/39/7/075001
  - Introduction
  - Physics
    - Precision QCD and Electroweak Physics
    - Physics at High Parton Densities
    - New Physics at High Energy
  - Accelerator
    - Ring-Ring Collider
    - Linac-Ring Collider
    - System Design
    - Civil Engineering and Services
  - Detector
    - Detector Requirements
    - Central Detector
    - Forward and Backward Detectors
  - Conclusions

FCC-he

- 80-100 km tunnel infrastructure in Geneva area
- *pp*-collider (*FCC-hh*) defining the infrastructure requirements
- e^+e^- collider (*FCC-ee*) as potential intermed. step
- ***p-e (FCC-he)*** option
- international collaboration hosted by CERN

~16 T ⇒ 100 TeV *pp* in 100 km
~20 T ⇒ 100 TeV *pp* in 80 km



FCC-he

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- ***p-e (F***
- interna hosted

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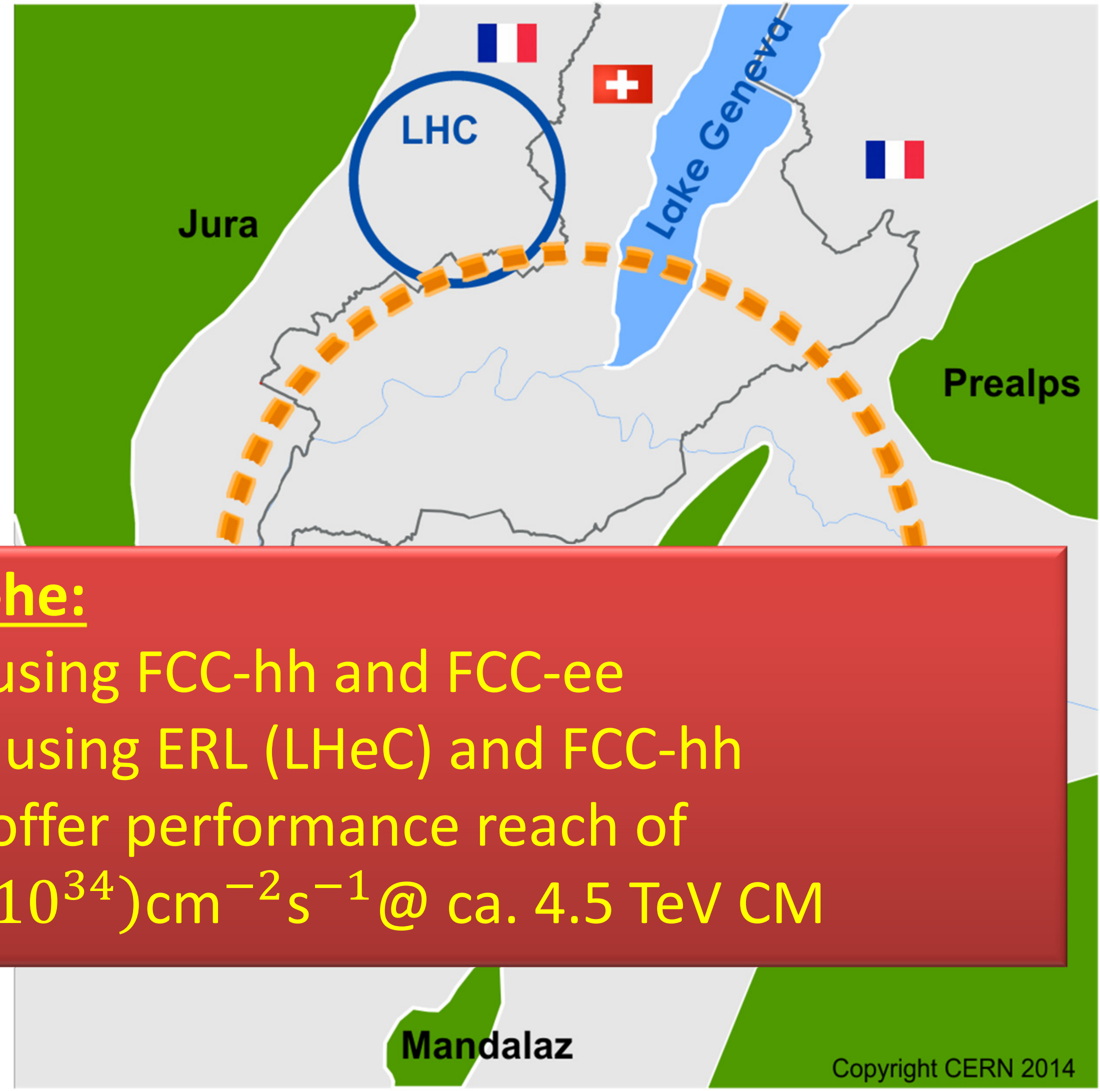


Two Options for FCC-he:

- Ring-Ring collider using FCC-hh and FCC-ee
- Linac-Ring collider using ERL (LHeC) and FCC-hh

Both options offer performance reach of
$\mathcal{L} = (10^{33} \div 10^{34})\mathrm{cm}^{-2}\mathrm{s}^{-1}$@ ca. 4.5 TeV CM

Goals and parameters

The ERL-TF

The Context

- In this decade, CERN is exploiting and upgrading the LHC – but not constructing “the next big machine”.
- CERN needs to study and develop the technologies to prepare for a possible next energy-frontier machine.
- This R&D focuses on ***high field magnets*** and ***high gradient acceleration***. (European Strategy for Particle Physics)
- Superconducting RF is a key area – this is where this planned facility comes in.

CERN management has asked us to conduct a **Conceptual Design Study** for an Energy Recovery Linac Test Facility (ERL-TF).

We have started this study and have started to establish collaborations.

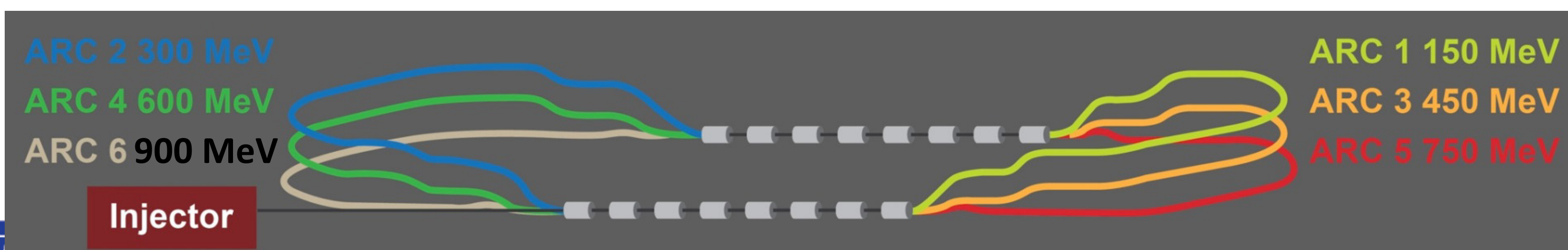
Goals of a CERN ERL-Test Facility

- Main goal: **Study real SRF Cavities with beam** – not interfering with HEP!
  - citing W. Funk ("Jefferson Lab: Lessons Learned from SNS Production", ILC Workshop 2004 http://ilc.kek.jp/ILCWS/):
    - **All problems will not be experienced until the complete subsystem is tested under realistic conditions. Be prepared to test, with full rf power systems and beam, all of the pre-production prototypes.**
- In addition, it would allow to study **beam dynamics** & **operational aspects** of the advanced concept ERL (recovery of otherwise wasted beam energy)!
- Exploration of the ERL concept with multiple re-circulations and high beam current operation
- Additional goals:
  - Gun and injector studies
  - Test beams for detector R&D,
  - Beam induced quench test of SC magnets
  - … later possibly user facility: e^- test beams, CW FEL, Compton γ-ray source …
- At the same time, it will be fostering international collaboration (JG|U Mainz and TJNAF collaborations being formalized)

Parameters of the ERL-TF

Parameter	Value	
injection energy	5 MeV	
RF f	801.59 MHz	
acc. voltage per cavity	18.7 MV	
# cells per cavity	5	
cavity length	$\approx$ 1.2 m	
# cavities per cryomodule	4	
RF power per cryomodule	$\leq$ 50 kW	
# cryomodules	4 *)	
acceleration per pass	299.4 MeV *)	
bunch repetition f	40.079 MHz	
Normalized emittance $\gamma\epsilon_{x,y}$	50 µm	
injected beam current	$<$ 13 mA	
nominal bunch charge	320 pC $= 2 \cdot 10^9\ e$	
number of passes *)	2	3
top energy *)	604 MeV	903 MeV
total circulating current *)	52 mA	78 mA
duty factor	CW	

*) in stages



Layout and optics

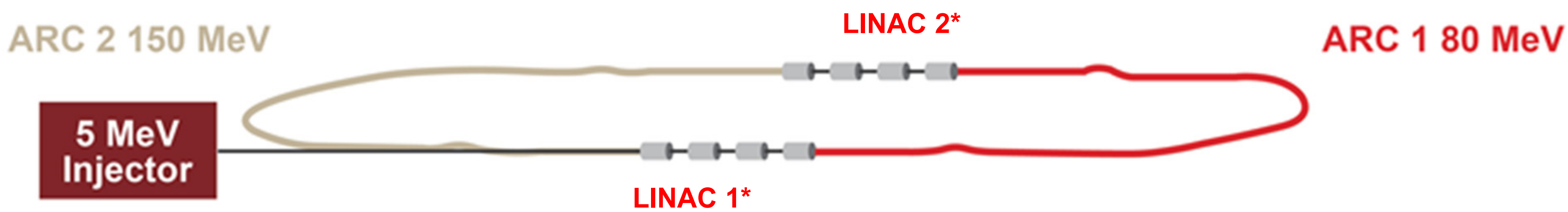
Layout stage by stage

STEP 1

SC RF cavities, modules and e⁻ source tests, single pass

- Injection at 5 MeV
- 1 pass
- 75 MeV/linac
- Final energy 150 MeV

ARC	ENERGY
ARC 1	80 MeV
ARC 2	155 MeV



A. Valloni, A. Bogacz

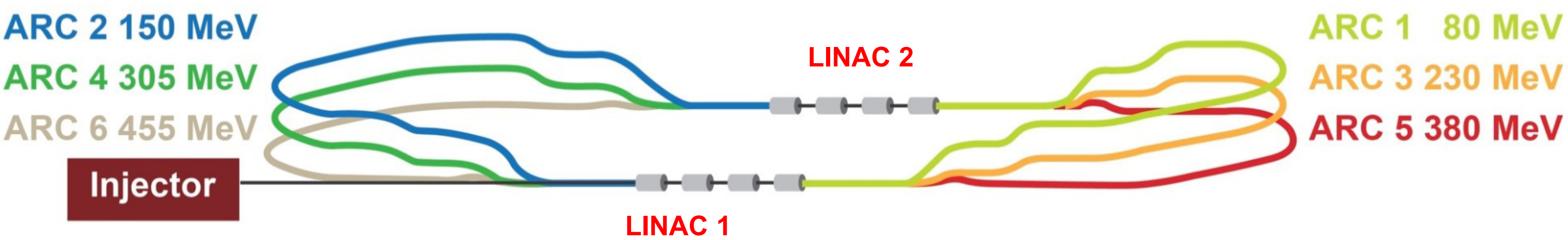
Layout stage by stage

STEP 2

Test the machine in Energy Recovery Mode

- Injection at 5 MeV
- 3 passes
- 75 MeV/linac
- Final energy 450 MeV

ARC	ENERGY
ARC 1	80 MeV
ARC 2	155 MeV
ARC 3	230 MeV
ARC 4	305 MeV
ARC 5	380 MeV
ARC 6	455 MeV



Recirculation realized with vertically stacked recirculation passes

A. Valloni, A. Bogacz

Layout stage by stage

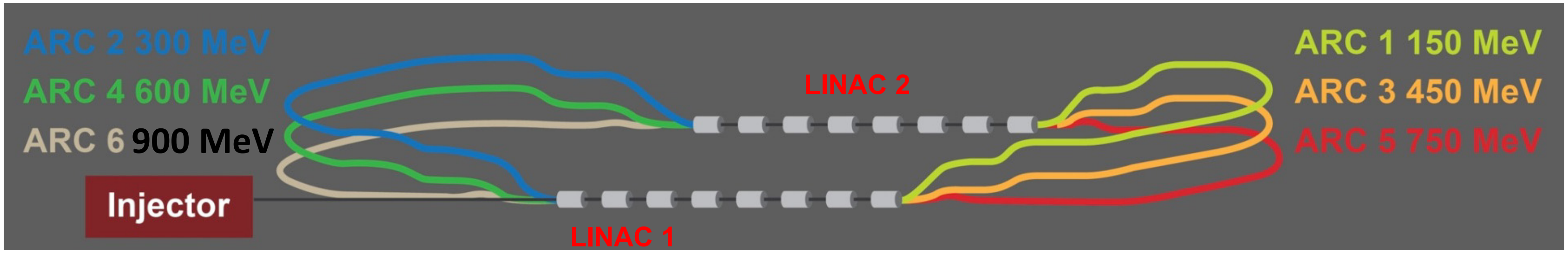
STEP 3

Additional SC RF modules test

Full energy test in Energy Recovery Mode

- Injection at 5 MeV
- 3 passes
- 150 MeV/(double length linac)
- Final energy 900 MeV

ARC	ENERGY
ARC 1	150 MeV
ARC 2	300 MeV
ARC 3	450 MeV
ARC 4	600 MeV
ARC 5	750 MeV
ARC 6	900 MeV



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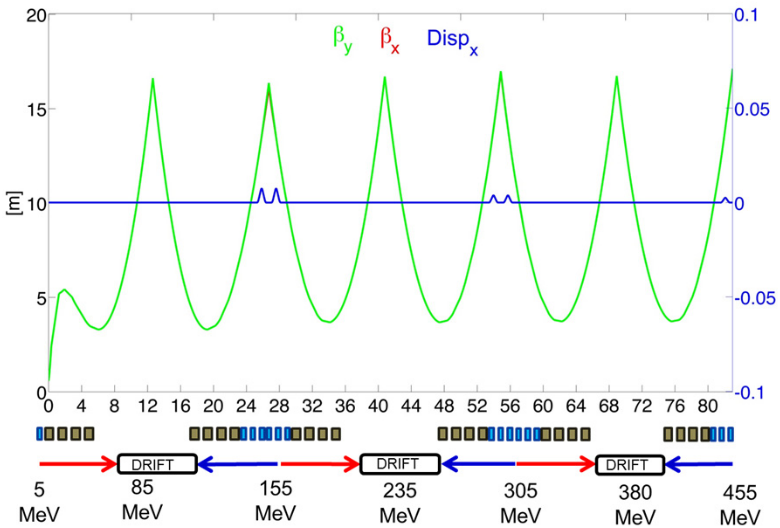
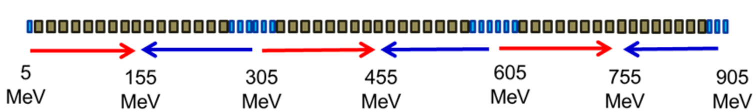
Linacs multi-pass optics

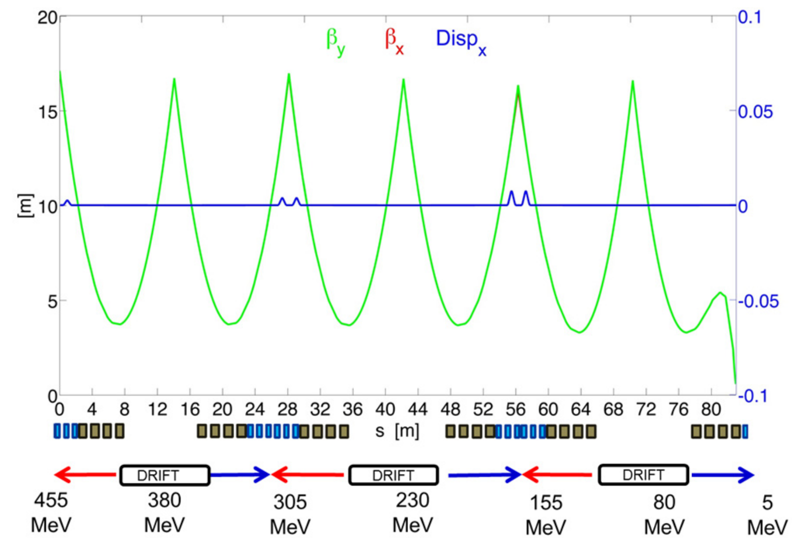
- Linac 1
  - step 2:



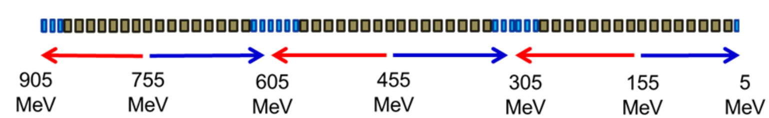
  - step 3:



- Linac 2
  - step 2



  - step 3:



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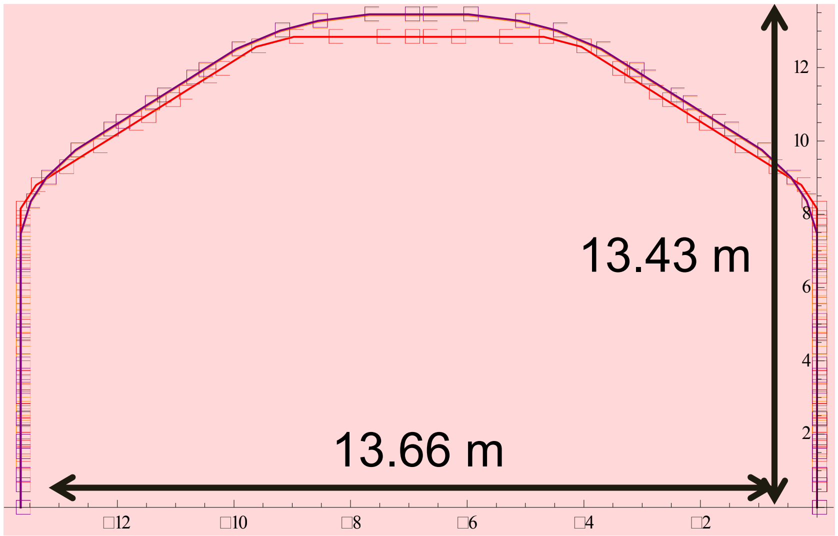
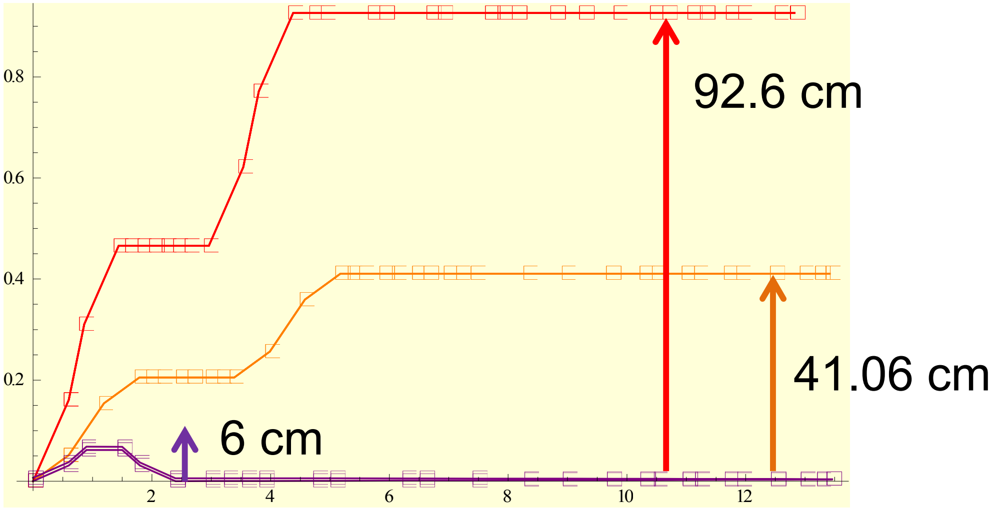
Arcs layout



- Isochronous
- Achromatic
- FMC optics
- symmetric

FMC: Flexible Momentum Compaction

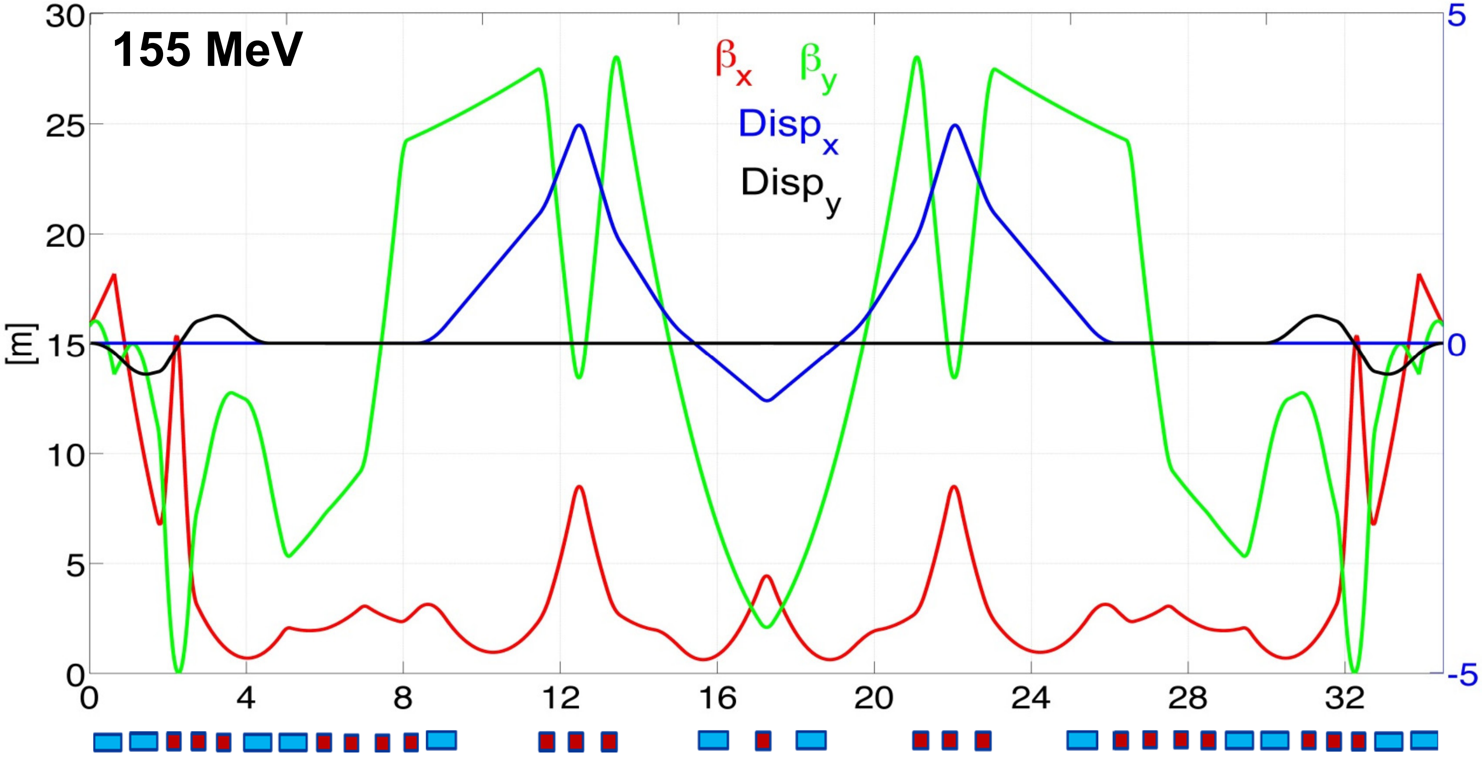


Total Arc length for Arc 1,3,5
$34.5112\ \mathrm{m} = 94 \times \lambda_{RF}$

For all 6 arcs:
84 dipoles + 114 quadrupoles

A. Valloni, A. Bogacz

Arc 1 optics



2-step vert. Spreader

30° bends

(1 rec. + 3 sec.)

4×45° sector bends

Arc dipoles :

Ldip = 71.8 cm

B = 5.67 kGauss

ρ = 91.45 cm

2-step vert. Combiner

30° bends

(1 rec. + 3 sec.)

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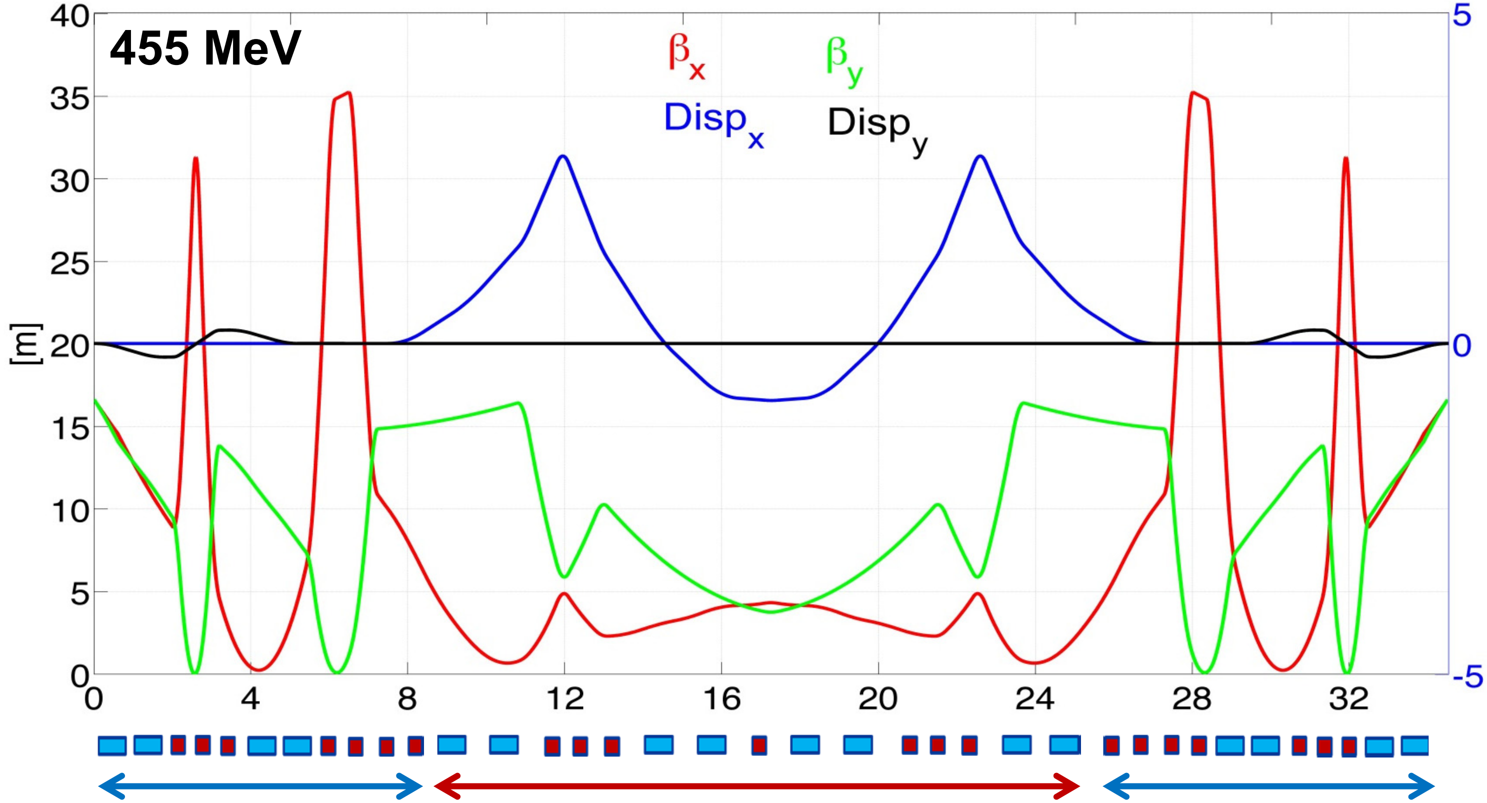
Arc 3 optics



2-step vert. Spreader

8×22.5° sector bends

2-step vert. Combiner

9.8° bends

(1 rec. + 3 sec.)

Arc dipoles :

Ldip = 90.58 cm

B = 6.58 kGauss

ρ = 230.66 cm

9.8° bends

(1 rec. + 3 sec.)

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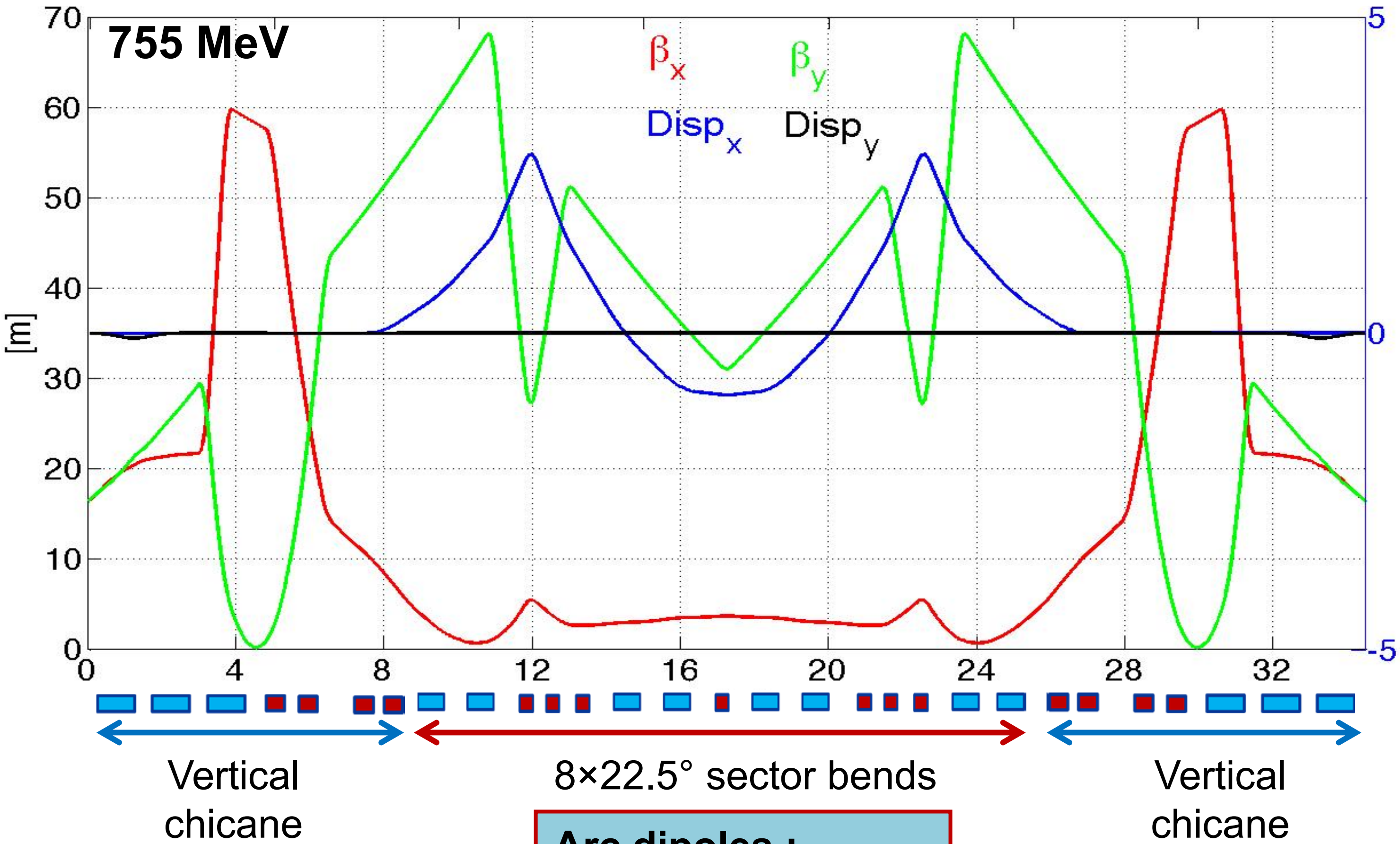
Arc 5 optics



Arc dipoles :

Ldip = 90.58 cm

B = 10.92 kGauss

ρ = 230.66 cm

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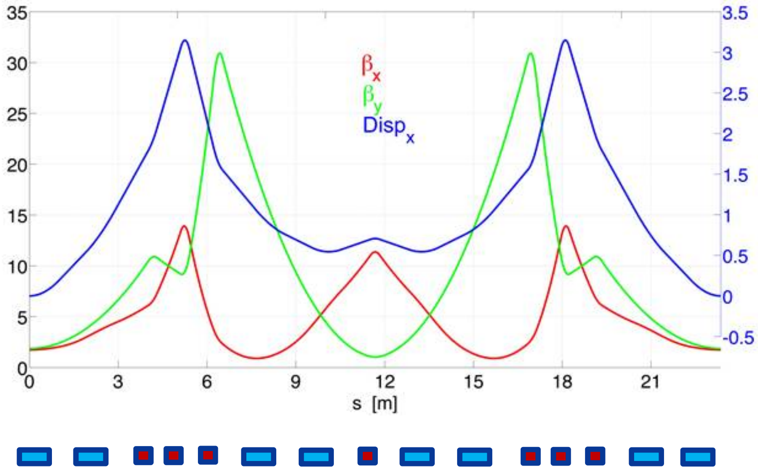
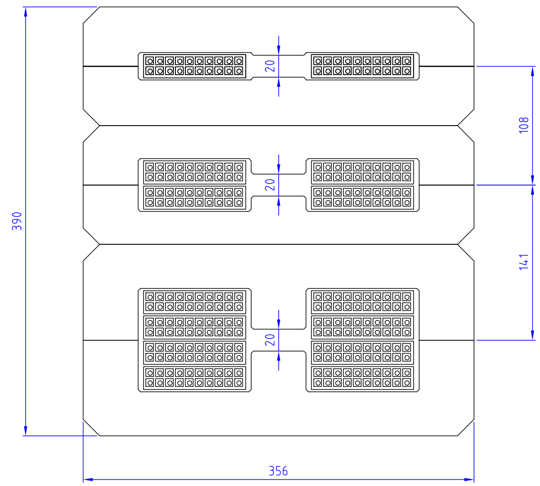
Arc optics option 2

Identical optics layout for all arcs (150 … 900) MeV





3 dipoles stacked with common yoke

Arc dipoles :

8×22.5° bends

L_{dip} = 1.006 m

ρ = 2.563 mm

Arc quadrupoles

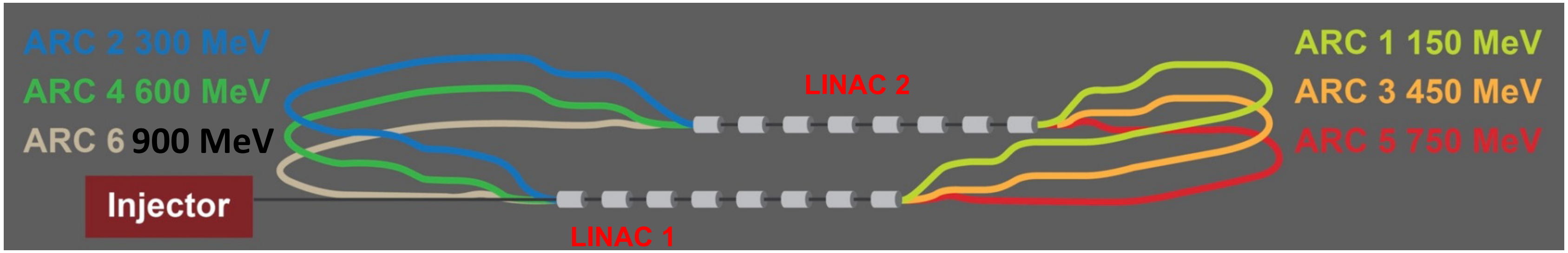
L_{quads} = 0.3 m

Attilio Milanese

	1GeV	750MeV	600MeV	450MeV	300MeV	150MeV
B	1.30 T	0.97 T	0.78 T	0.58 T	0.39 T	0.19 T

	Q1	Q2	Q3	Q4
Kq[m^{-2}]	-1.01	2.91	2.09	1.19

Footprint



Arcs

Total length for Arc 1, 3, 5:

$$34.5112\ \mathrm{m} = 94 \times \lambda_{RF}$$

(last cavity linac1 to first cavity linac 2)

Total length for Arc 2, 4:

$$34.2704\ \mathrm{m} = 101 \times \lambda_{RF}$$

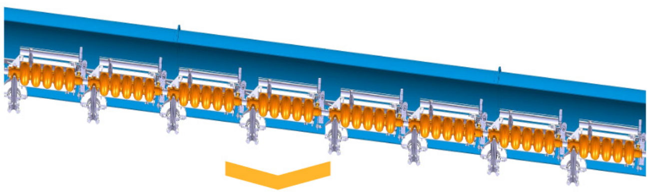
(last cavity linac2 to first cavity linac 1)

Total length for Arc 6:

$$\mathbf{34.4574\ m = 101.5 \times \lambda_{RF}}$$

(last cavity linac 2 to first cavity linac 1)

Linacs



ONE CRYOMODULE: 8 RF CAVITIES

PARAMETER	VALUE
Frequency	801.58 MHz
Wavelength	37.4 cm
Lcavity= 5λ/2	93.5 cm
Grad	20.02 MeV/m
ΔE	18.71 MV per cavity

Total length ~ 13 m

Injection/extraction chicane:

Length ~ 1.75 m

Total dimensions

42 m x 13.7 m

ERL-TF possible sites

We have started to look into possible existing buildings on site possibly suited to host the ERL test facility.

Example shown here:
Building 2275, near LHC P2

- Current use under investigation
- Power converters already in place
- Geographically perfect as injector for LHeC ERL

Other options investigated:

- SM18, extension to building 2173? Ideal for existing infrastructures!
- Building 973 (Prévessin), former QRL testing, partially existing cryo infrastructure.

N. Catalan Lasheras

ERL-TF possible sites

We have started to look into possible existing buildings on site possibly suited to host the ERL test facility.

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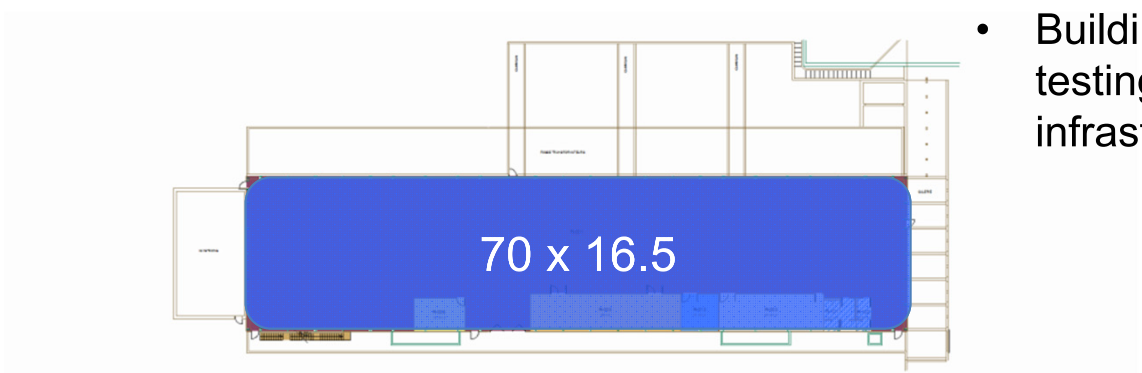


N. Catalan Lasheras

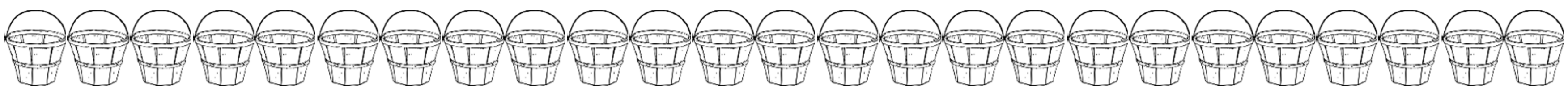
ERL Cavity/Cryomodule Development

… only just starting

Post CDR frequency choice

LHeC Meeting at Daresbury Laboratory, January 2013

802 MHz buckets (harmonic 20 of 25 ns^{-1})



Synergetic with CERN SPS, LHC, LHC upgrades, …

JLAB-CERN-Mainz 801.58 MHz Cavity/cryomodule now under design

Post CDR frequency choice

LHeC Meeting at Daresbury Laboratory, January 2013

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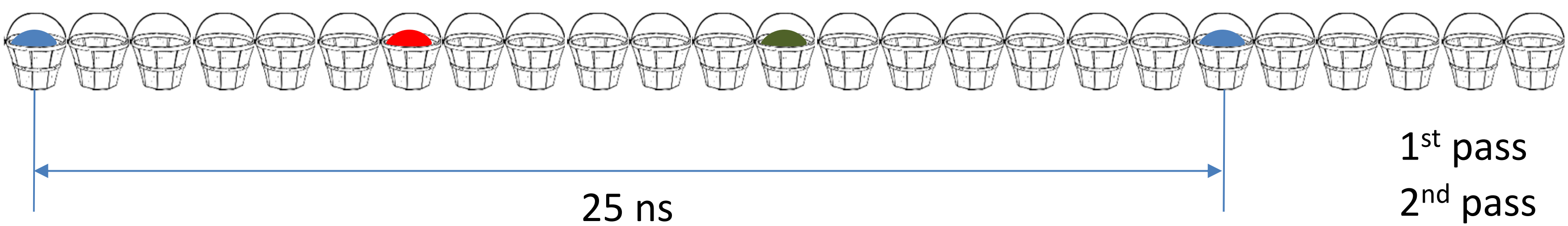
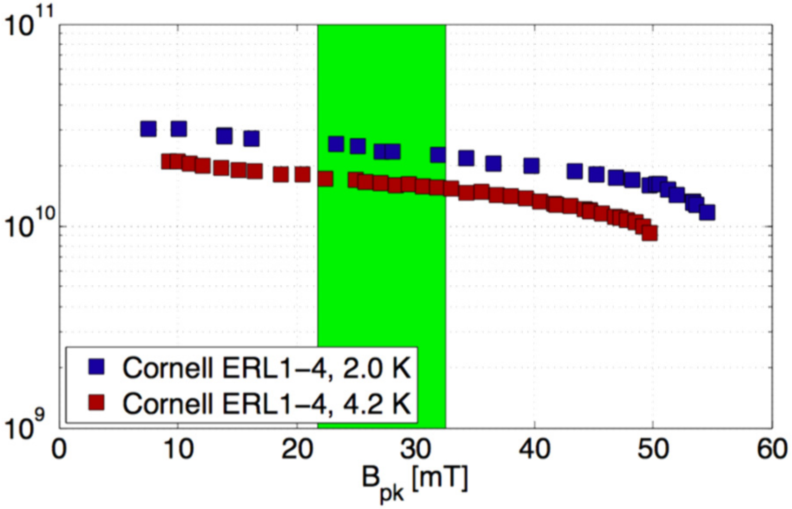


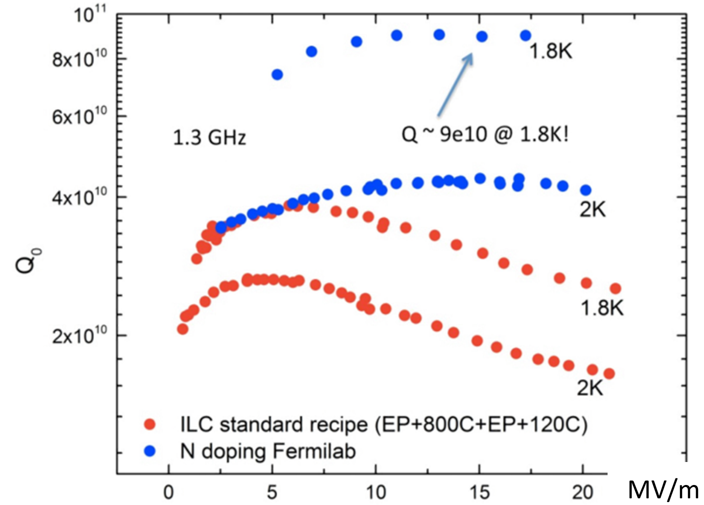
1st pass
2nd pass
3rd pass

Synergetic with CERN SPS, LHC, LHC upgrades, …
JLAB-CERN-Mainz 801.58 MHz Cavity/cryomodule now under design

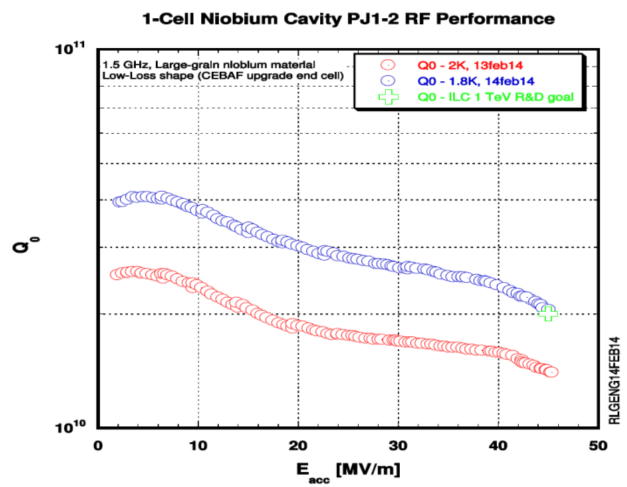
R&D goal: large Q_0 – recent progress



Sam Posen et al. (Cornell): "Theoretical Field Limits for Multi-Layer Superconductors", SRF 2013



Anna Grasselino et al. (FNAL): "New Insights on the Physics of RF Surface Resistance and a Cure for the Medium Field Q-Slope", SRF 2013

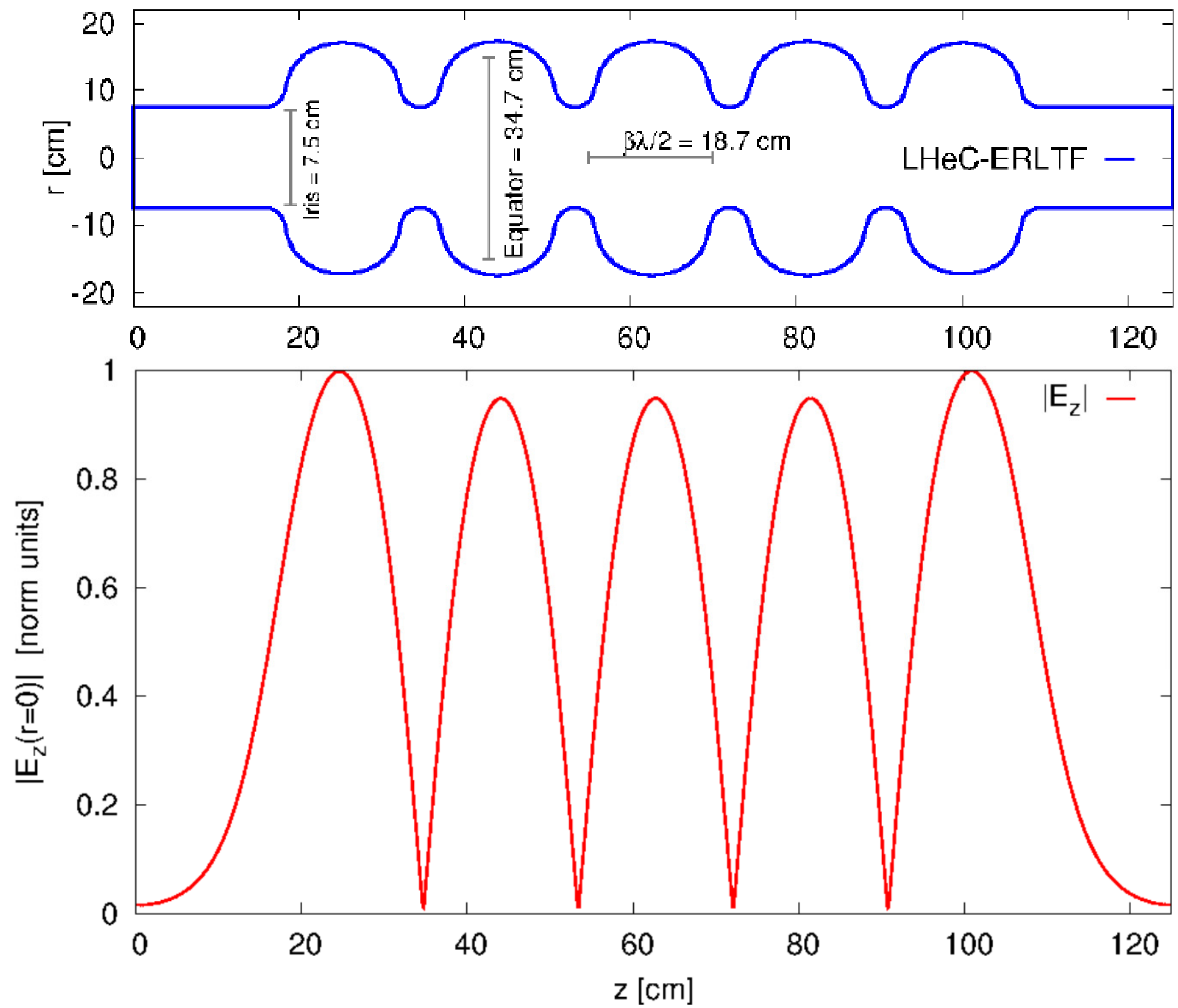


Andrew Hutton (JLAB), private communication 2014: recent results with large-grain Nb in low-loss shape (CEBAF upgrade end cell)

802 MHz cavity: Some first choices

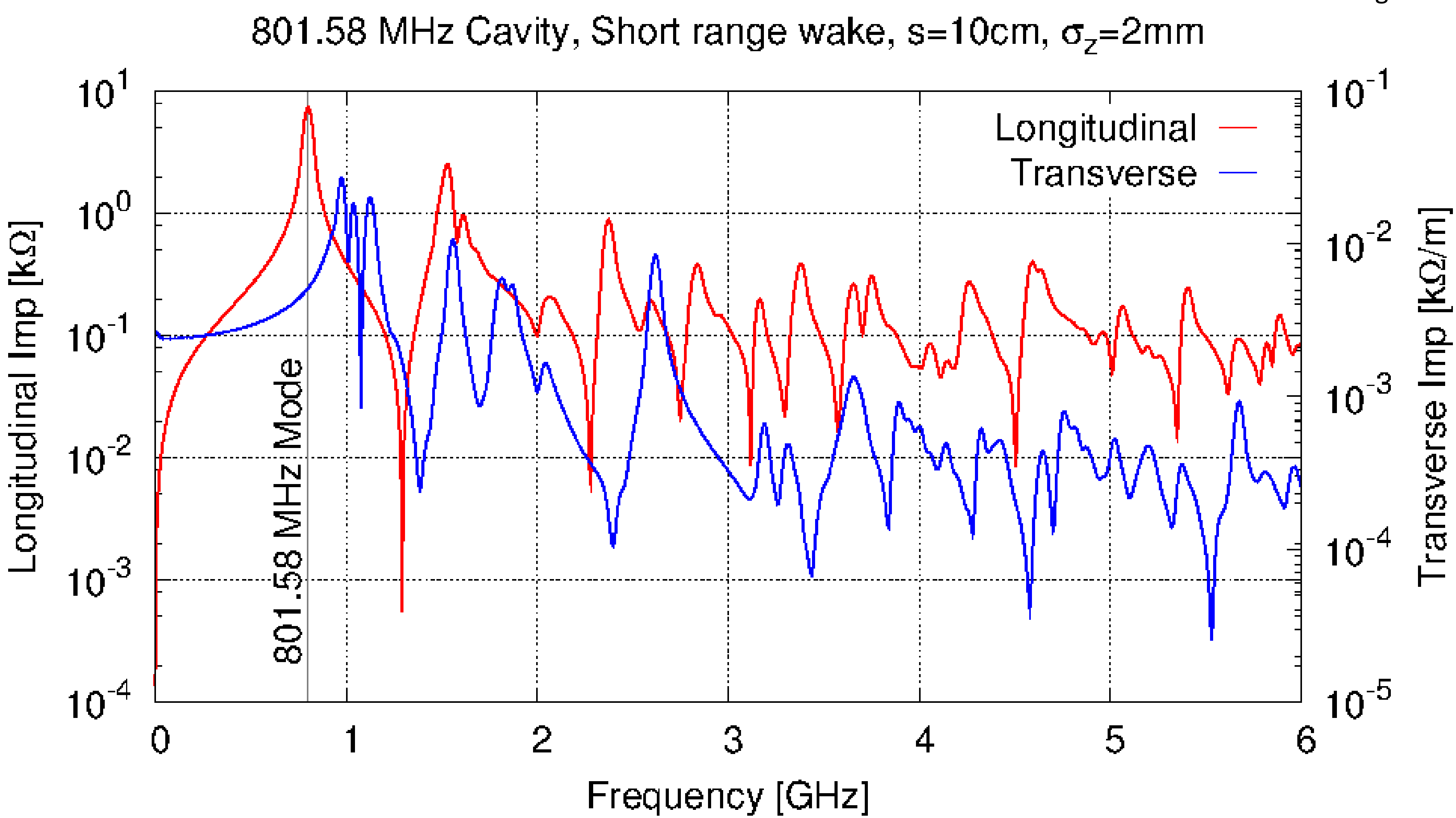
R. Calaga

Parameter	Value
n_{cell}	5
V_{acc}	18 MV
f_0	801.58 MHz
W	131 J
aperture Ø	75 mm
equator Ø	347 mm
R/Q	462 Ω
G	276 Ω
E_{peak}	41 MV/m
B_{peak}	86 mT
$P_{diss}\big\|_{2K}$	< 28 W



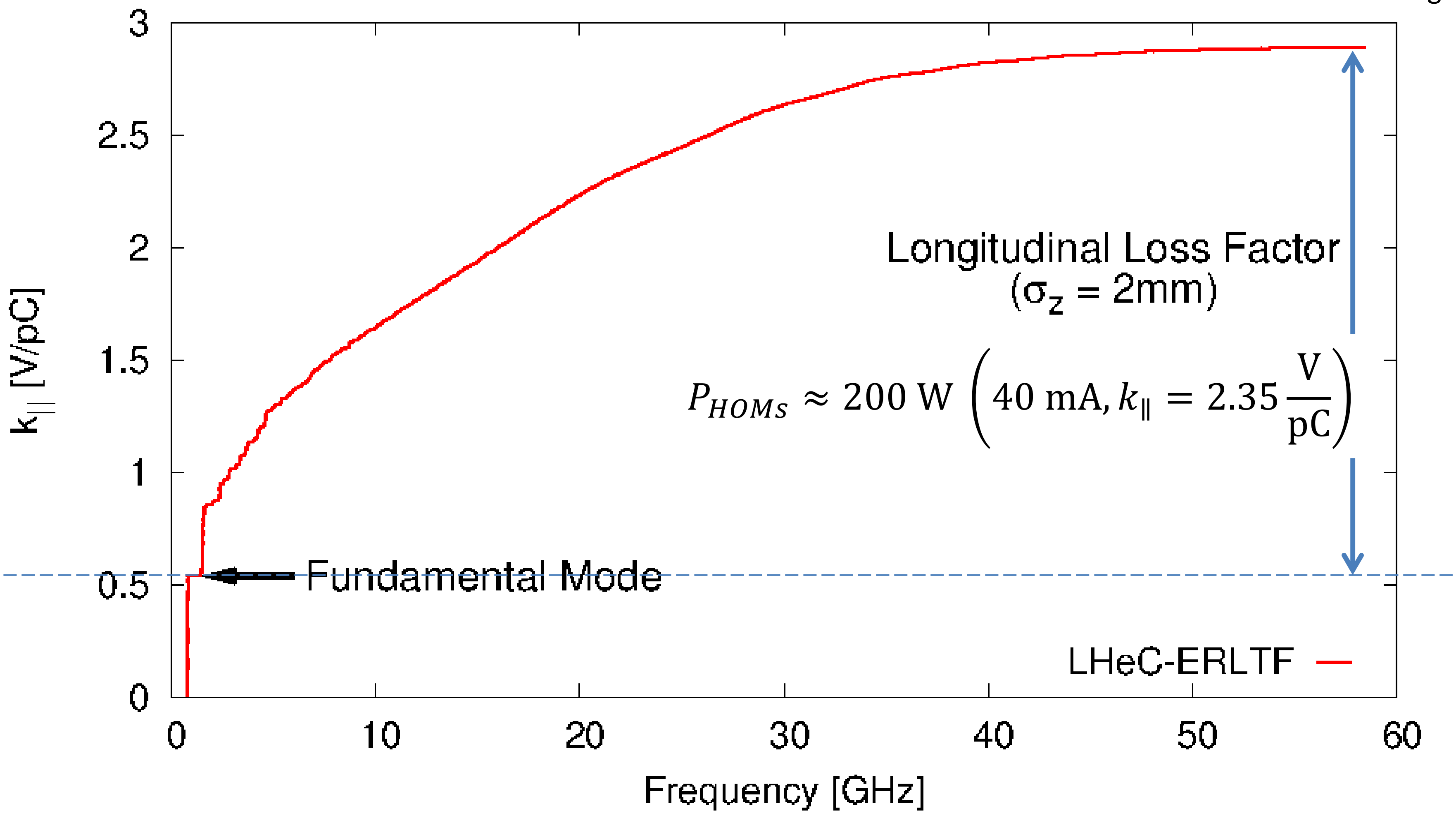
Impedance spectra

R. Calaga



HOM power estimate (short bunches)

R. Calaga



Note: with 13 mA injected, the total current for HOM excitation can be 80 mA!

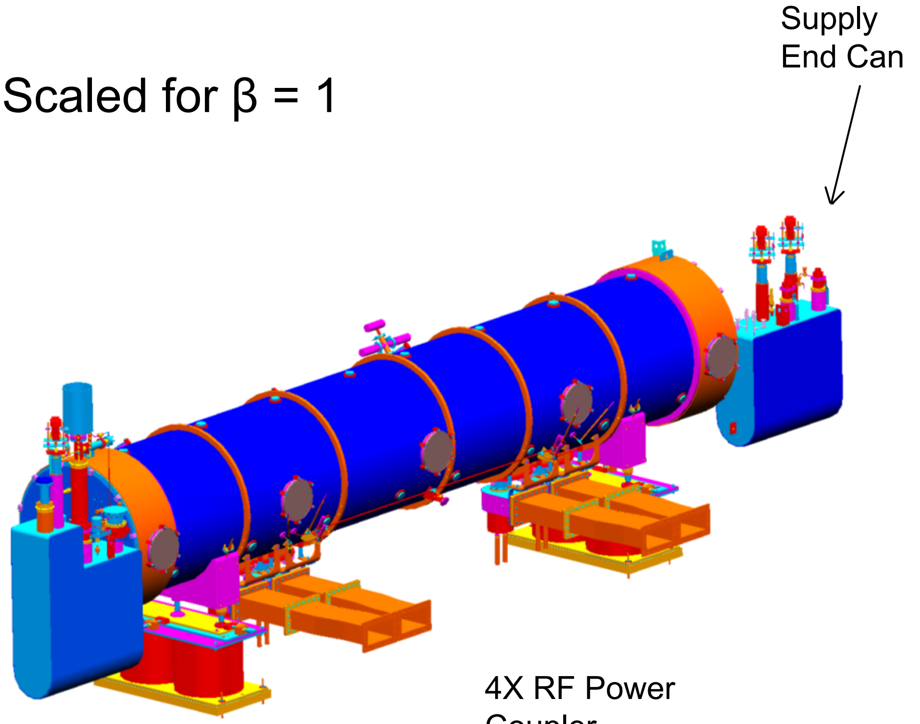
JLAB proposal: SNS style Cryomodule

- Based on SNS CM
  - 5-cell low-loss shape
  - coaxial FPC
  - Single RF Window
  - DESY Style HOM coupler
  - Cold tuner drive

Scaled for $\beta = 1$

- Overall length: 7.524 m
- Beamline length 6.705 m

- End Cans include integral heat exch
operations



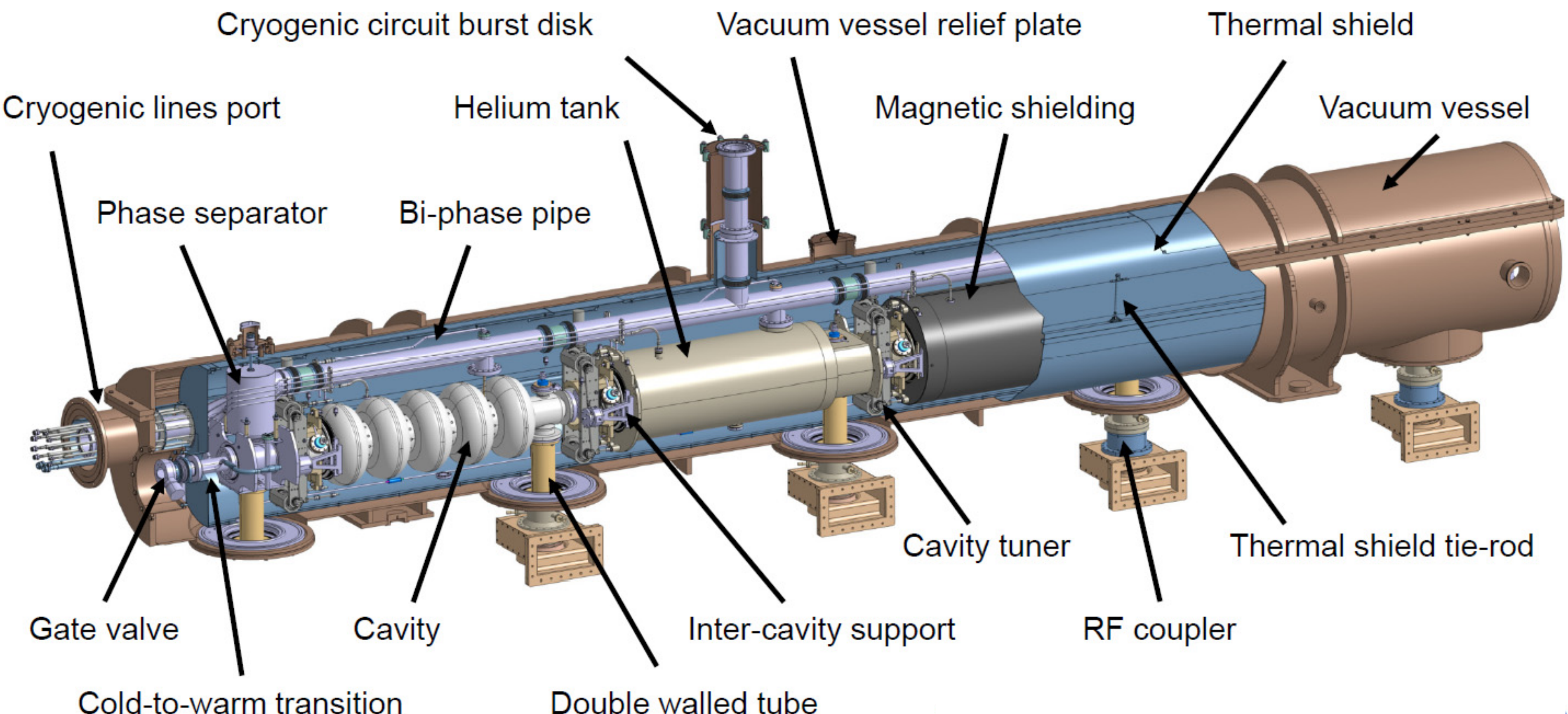
A. Hutton

JLAB CM Design Maturity

- Design maturity
  - Cryostat design is complete, SNS cryostat and cryogenic connection is a “drop in” design
  - Jefferson Lab has existing 750 MHz and 800 MHz cavity designs
    - Needs HOM coupling design, detail SNS style coupler for this application
    - Can use SNS coupler with minimal changes for CW operations (lower average power in this case, makes the design simpler)
- Production
  - Cryostat and power coupler costs from SNS production (2002) available
    - Costs need to be corrected for small quantity production and escalation
  - Jefferson Lab in-house cavity assembly to control schedule

A. Hutton

CERN experience: SPL Short Cryomodule



O. Capatina, V. Parma, R. Bonomi, S. Rousselot

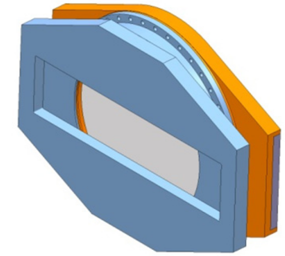
Recent SPL progress in pictures

RF Power Couplers (FPCs)

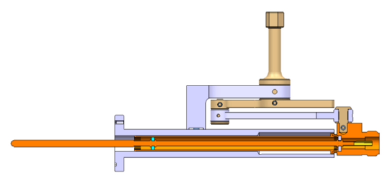
E. Montesinos

Machine	Design	Construction	Operation
SPS 200	✓	✓	2001
LHC 400	✓	✓	2006
SPL cylindrical	✓	✓	**1 MW TW** **550 kW SW**
SPL disk	✓	✓	**1 MW TW** **1 MW SW**
ESRF	✓	✓	**300 kW CW**
ANL-APS	✓	✓	**100 kW CW**
Linac 4	✓	✓	**750 kW SW**
HIE-Isolde	To be improved		
LIU- SPS 200	To come		
SPS 800	To come		
SOLEIL	To come		
Crab Cav x 3	To come		

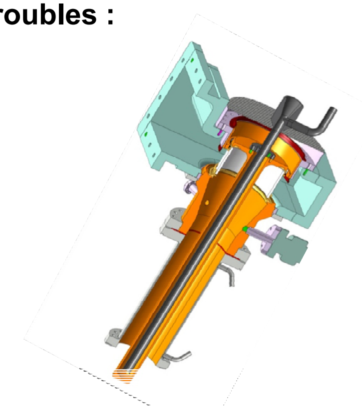
- **Some good results this year :**
  - **ESRF**
  - **APS (tests still on-going)**
  - **SPL coaxial disk**
- **Some still to be improved :**
  - **SPL cylindrical**
  - **HIE-Isolde**
- **Some still operating without troubles :**
  - **SPS 200**
  - **LHC 400**
- **Some additional to come**



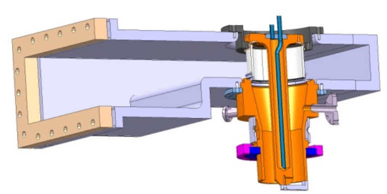
Linac 4



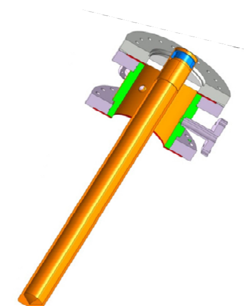
HIE-Isolde



SPL cylindrical



ESRF & APS



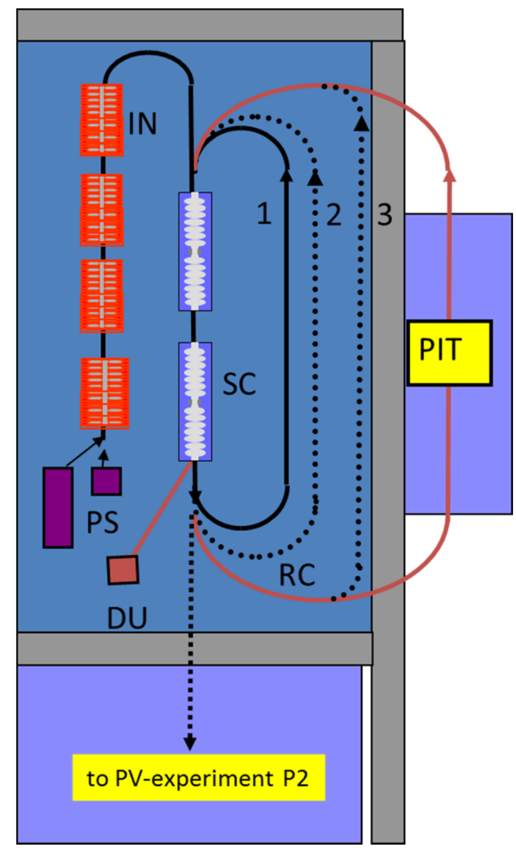
SPL disk

The planned collaboration:

- We are now finalizing collaboration agreements with JG|U Mainz and JLAB to build prototype 802 MHz cavities/CMs together!
  - JG|U to provide infrastructure (MESA and HIM) manpower and resources
  - CERN to design/engineer cavities, HOM dampers, FPCs, tuners, He vessel, ancillaries…
  - JLAB to design/engineer the CM (based on SNS 805 MHz concept)
- 1st prototype cavities can serve in MESA.

K. Aulenbacher

MESA Concept:



MESA: Mainz **E**nergy recovering **S**uperconducting **A**ccelerator
HIM: Helmholtz-Institut Mainz

Summary

- The concept of the ERL-TF is designed to allow for a staged construction with verifiable and useful stages for an ultimate beam energy in the order of 1 GeV.
- A key part of the design study is the development of superconducting RF cavities and CM's.
- This study has started in collaboration with JLAB and JG|U Mainz.
- There is strong synergy with the JG|U Mainz project "MESA" – the cavities/cryomodules could be identical.
- CERN is in the process of re-establishing know-how and upgrading its facilities for SRF R&D.
- Ongoing work in SRF at CERN also includes LHC, SPL, HIE-ISOLDE, crab cavities HL-LHC; planned future work will include the study of a large circular collider (FCC).

Thank you for your attention!

www.cern.ch

Spare slides

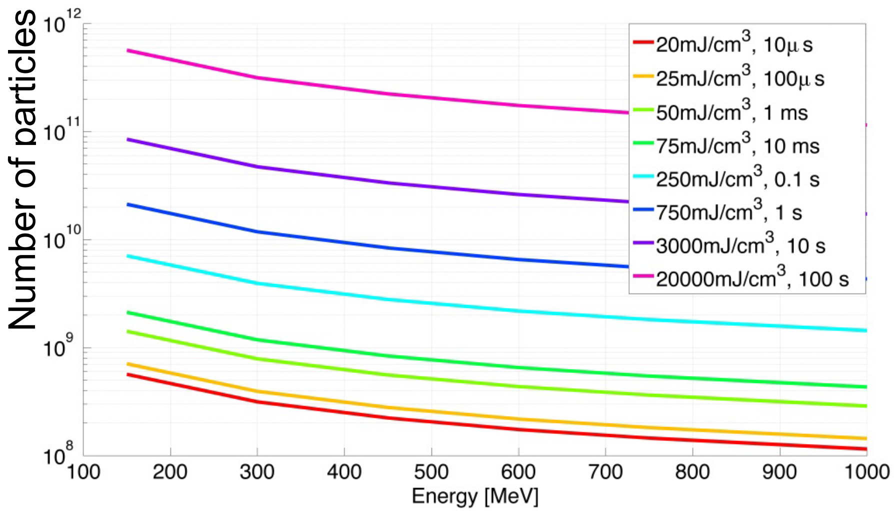
LHC schedule

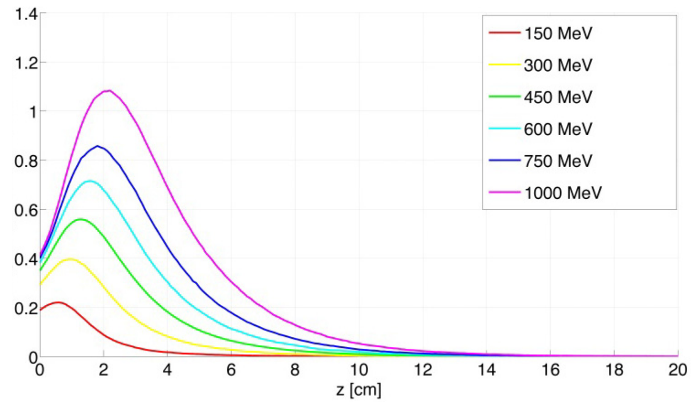
Controlled quench tests of SC magnets

Study beam induced quenches (quench thresholds, quenchino thresholds) at different time scales for:

- SC cables and cable stacks in an adjustable external magnetic field
- Short sample magnets
- Full length LHC type SC magnets
- Vital program for the development of high field magnets for FCC-hh and HE-LHC

MB quench limit @ 3.5 TeV





1 GeV = 1.602 x 10^{-7} mJ

MB quench limit 450 GeV is 140mJ/cm^3 in 10ms:

$\approx 2.2 \cdot 10^9\ e^-$ **@ 1GeV necessary**

MB quench limit 7 TeV is 16 mJ/cm^3 in 10ms:

$\approx 0.3 \cdot 10^9\ e^-$ **@ 1GeV necessary**

These numbers are well in reach (bunch charge $2 \cdot 10^9\ e^-$).

possible later applications

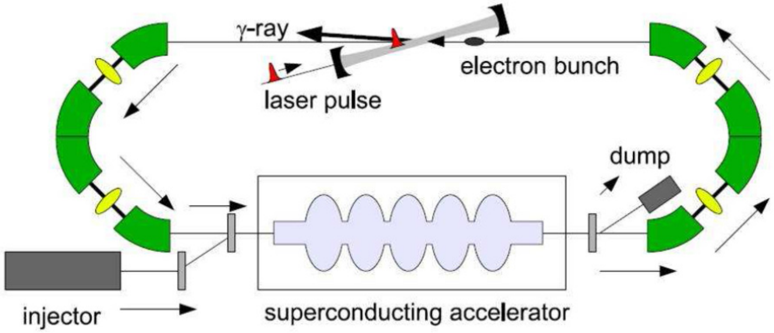
ELI-NP is the M€ 293 pillar for nuclear physics of the European Extreme Light Infrastructure presently under construction at Magurele, near Bucharest, Romania.

It is a major laser facility, including a 700 MeV electron linac for production of intense, energy-tuneable, quasi-monochromatic, polarized gamma-ray beams.

http://www.eli-np.ro/

Interest formulated by Norbert Pietralla, IKP Darmstadt

With a ERL TF @ CERN, one could produce significantly (2 orders of magnitude) larger gamma-flux in very narrow bandwidth (CW operation)



Overview SRF Activities at CERN

- At the times of LEP II (1990s), CERN was at the forefront of SRF Technology
  - Key technology: Nb sputtered on Cu!
- Then came TESLA/ILC and technology progressed tremendously – CERN lagging behind … (see previous page)

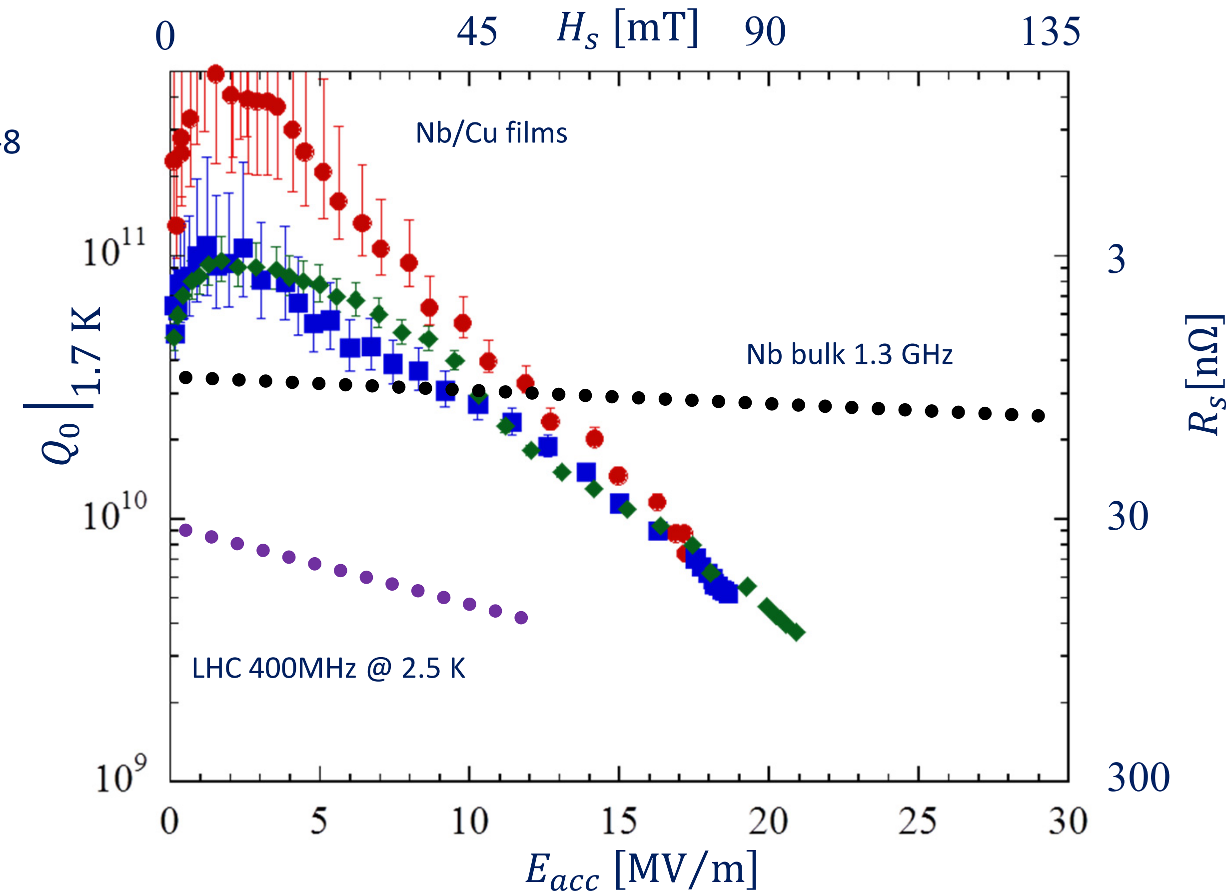
- Recently, CERN is involved in the following SRF projects/studies:
  - LHC — operational, 16 cavities in 4 CMs, 2 MV/cavity, Nb/Cu
  - HIE-ISOLDE — construction (20 + 12) QWR cavities, Nb/Cu
  - HL-LHC Crab Cavities — CERN coordinating; 3 different designs, bulk Nb
  - SPL — study, with CEA, IPNO and ESS, 4 cavity CM, bulk Nb
  - LHeC — design study, ERL, ERL-TF
  - FCC — design study – about starting now.
- Today CERN is trying to ***re-establish know-how*** and ***upgrade its facilities*** to be able to perform relevant R&D and help prepare SRF technology for the future.
- In the centre of attention (but not exclusively) are again the thin-film techniques

State of the art in magnetron sputtered Nb/Cu films

1.5 GHz Nb/Cu cavities, sputtered with Kr @ 1.7 K ($Q_0 = 295\,\Omega/R_s$)

S. Calatroni

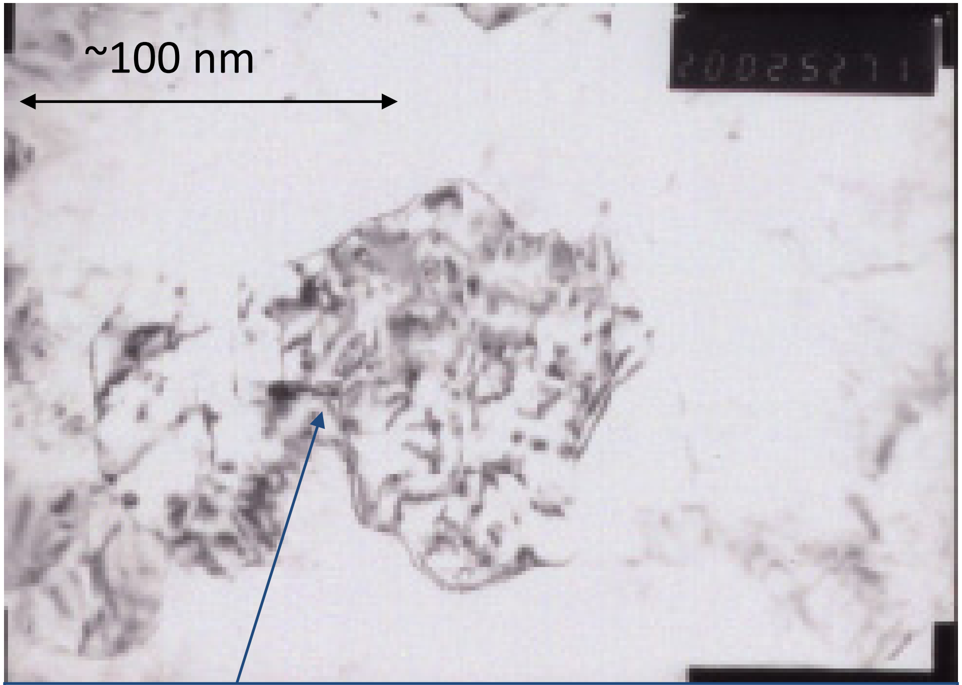
NIM A463 (2001) 1-8



$\boldsymbol{Q_0 = 1 \cdot 10^{10}}$ **@ 15 MV/m** is a value that would make film cavities a competitive option in several future projects.
Current R&D is focussed on improving the "slope", applying films to new geometries, new materials

Possible origin of Q-slope: film defects

S. Calatroni



Crystallographic defects can be at the origin of reduced H_{c1} compared to bulk Nb

$$\frac{1}{l_{total}} = \frac{1}{l_{intra-grain}} + \frac{1}{D}$$

RRR of films: $10 \div 30$

$\Rightarrow$

mfp of films $(30 \div 100)$ nm

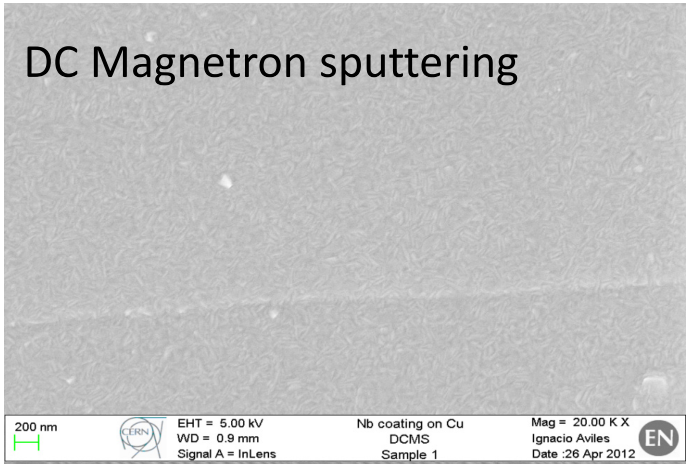
Grain size of films $> \ 100$ nm

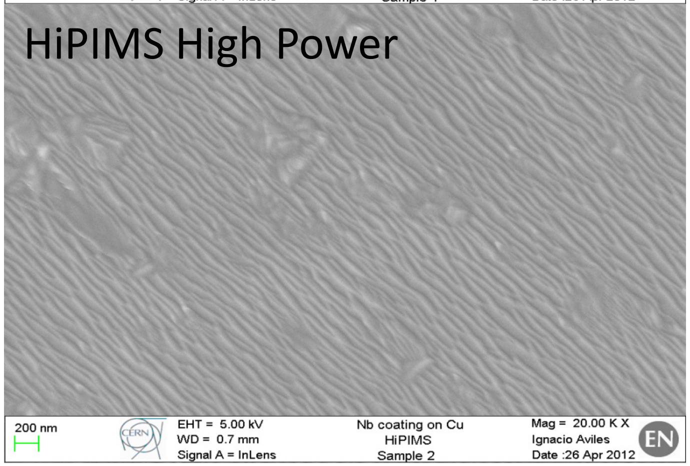
$\Rightarrow$

RRR limited by intra-grain defects in most cases

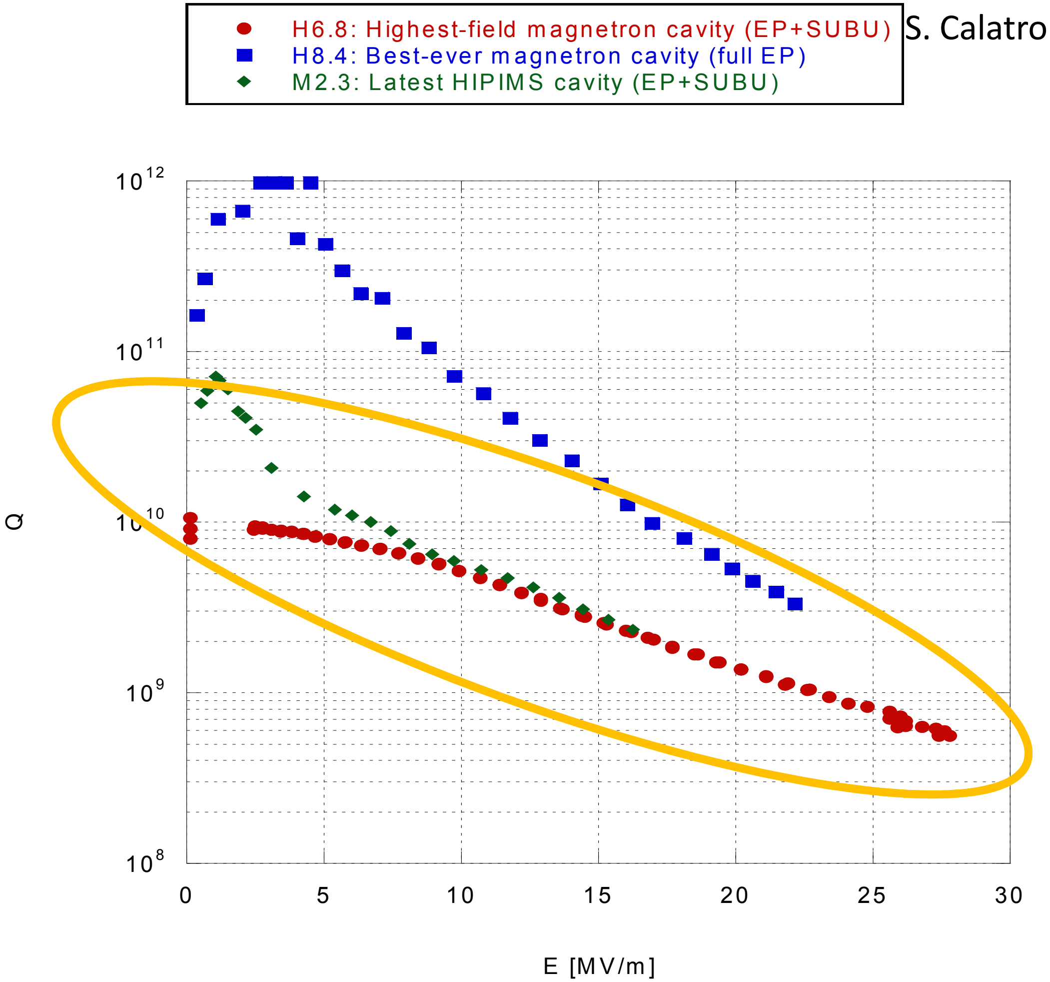
The goal is to make films as bulk-like as possible in terms of microstructure. The grain size does not seem to be a major issue

HiPIMS: a way to produce Nb ions for coating





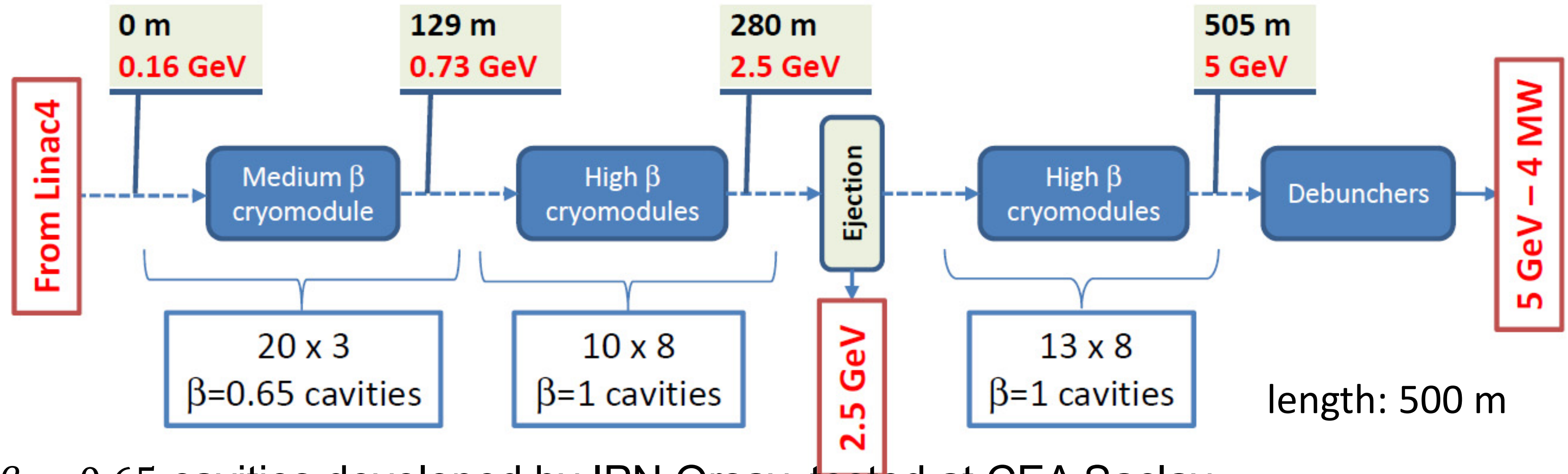
S. Calatroni



With HIPIMS at this early stage we are currently **at the level of the best performing magnetron sputtering coatings**, for an equivalent surface preparation (SUBU vs EP)

Superconducting Proton Linac - SPL

O. Capatina



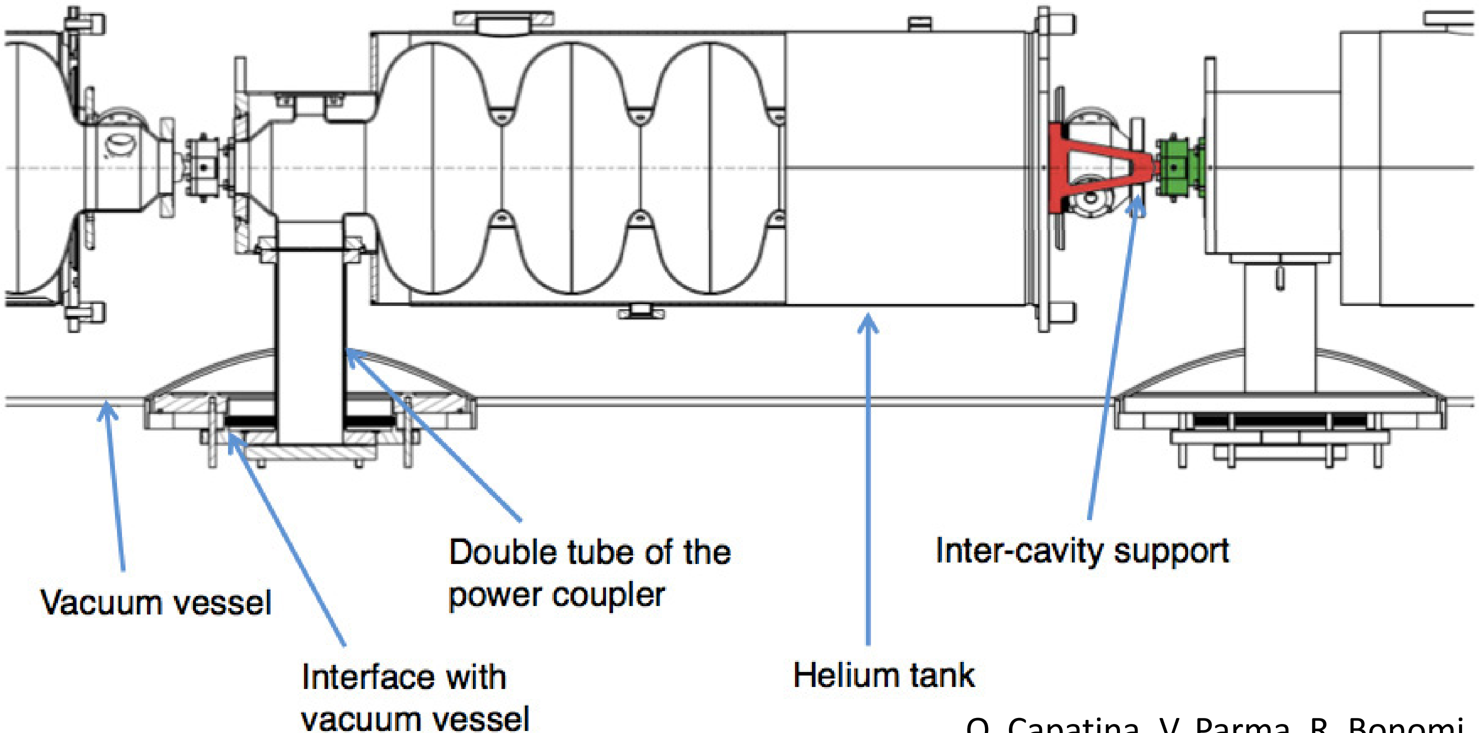
- $\beta = 0.65$ cavities developed by IPN Orsay, tested at CEA Saclay
- $\beta = 1$ cavities developed and tested by CEA Saclay and (short CM) by CERN.
- Strong Synergy and collaboration established with the European Spallation Source

EUROPEAN SPALLATION SOURCE

For more details: http://ipnweb.in2p3.fr/srf2013/papers/friob04.pdf

SPL Short Cryomodule

New supporting system (by double-walled tube) could minimize heat load to 2 K bath



O. Capatina, V. Parma, R. Bonomi, S. Rousselot

Cryolab Activities

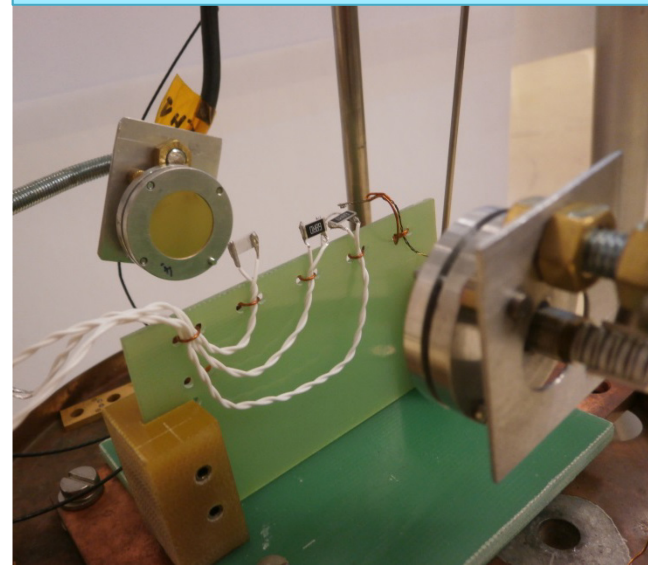
New Coating Technologies: HIPIMS on 1.3 GHz cavities

Collaboration with S. Calatroni and G. Terenziani

Fundamental SRF studies using the Quadrupole Resonator

PhD Thesis S. Aull (Univ. Siegen)
Supervisor: S. Doebert

Cavity Diagnostic Developments with OSTs



Master Thesis B. Peters (Univ. Karlsruhe)
Co-Supervisor T. Koettig

New Electron-Beam Welding Machine

O. Capatina

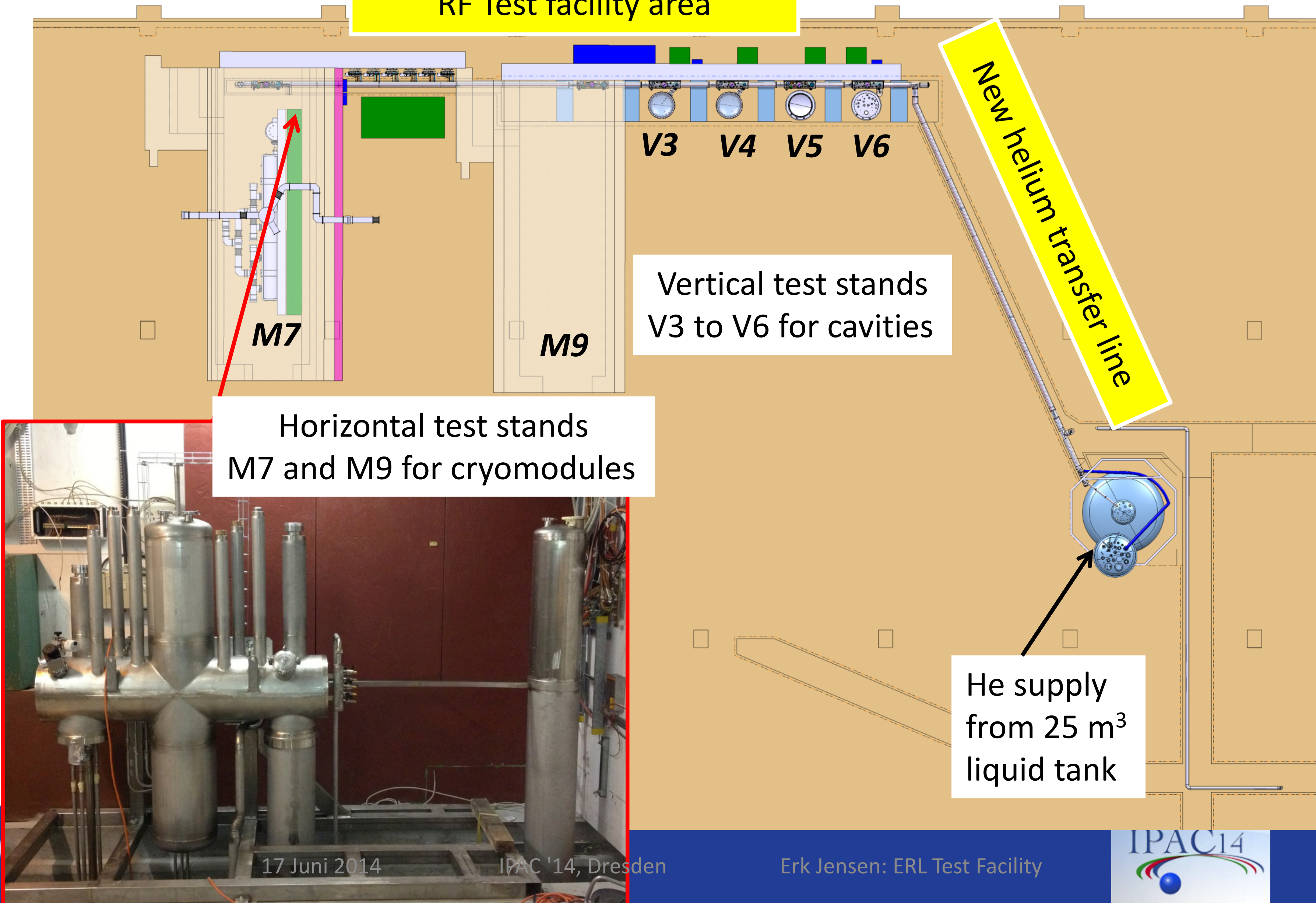
Electro-polishing

High pressure rinsing

O. Capatina, L. Marques, K. Schirm

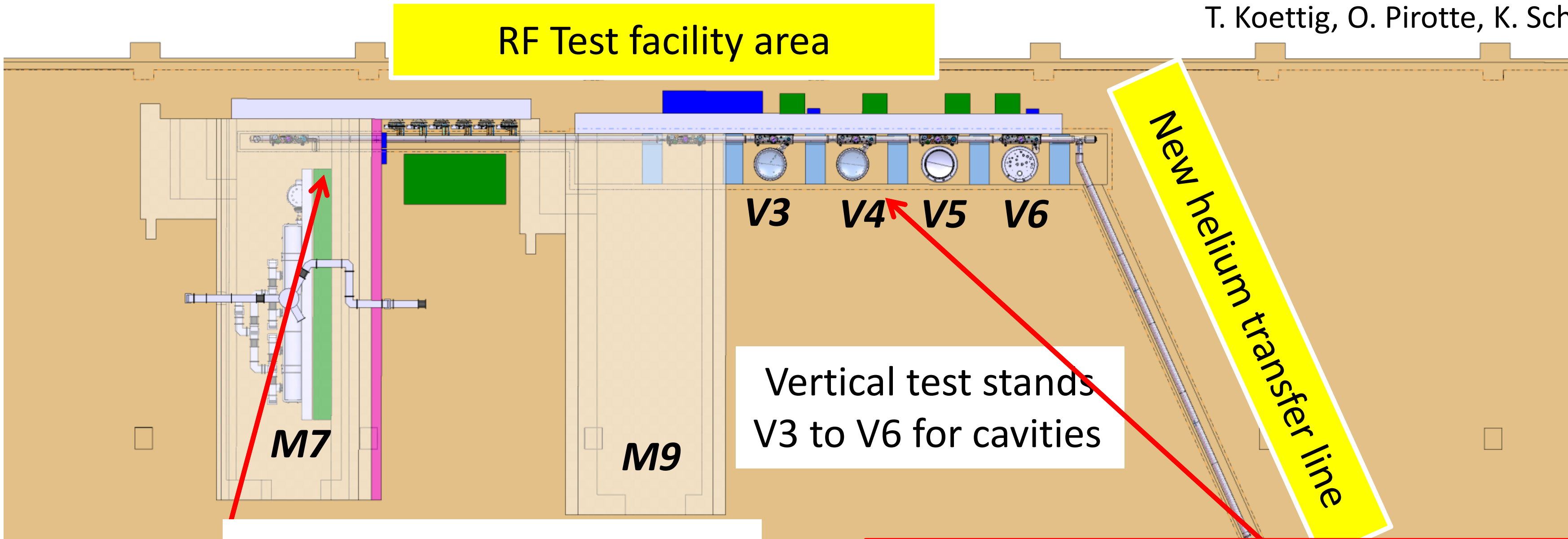
2 K Cryo-upgrade in SM18

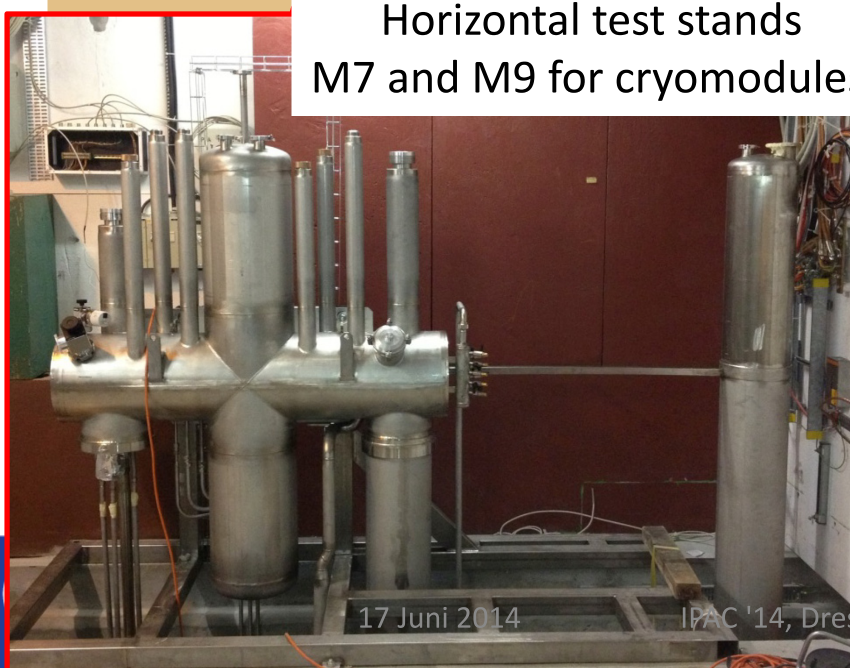
T. Koettig, O. Pirotte, K. Schirm



2 K Cryo-upgrade in SM18

T. Koettig, O. Pirotte, K. Schirm





Cavity and module test area SM18

Service module in horizontal bunker

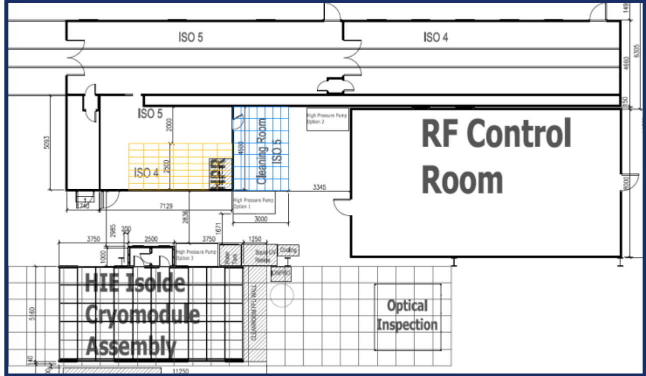
Helium tank

Cavity RF Test Area

SM18: Clean room & Preparation Zone Upgrade

Existing clean room upgrade and extension

New clean room facility – HIE-ISOLDE

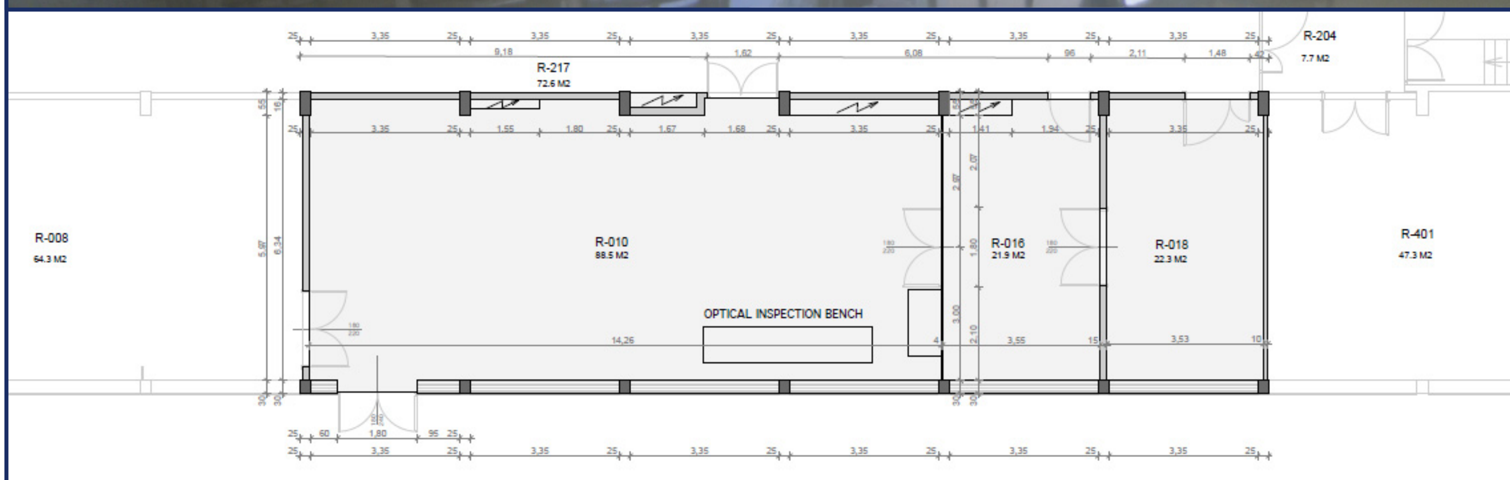


Clean room layout

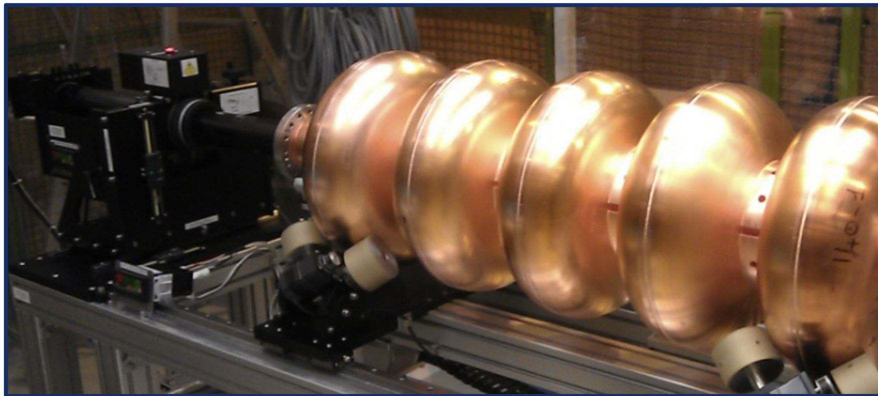
High-pressure rinsing

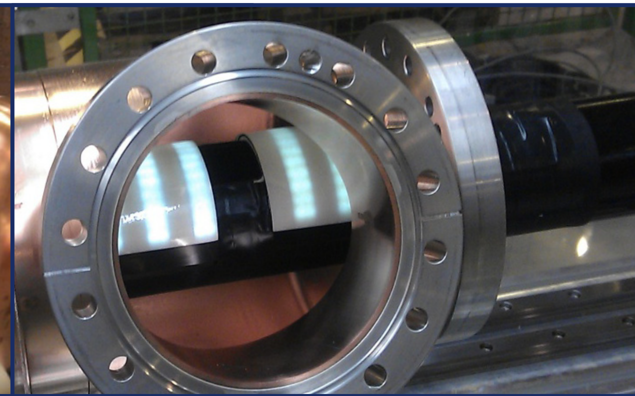
Ultra-pure water station

New cavity reception area

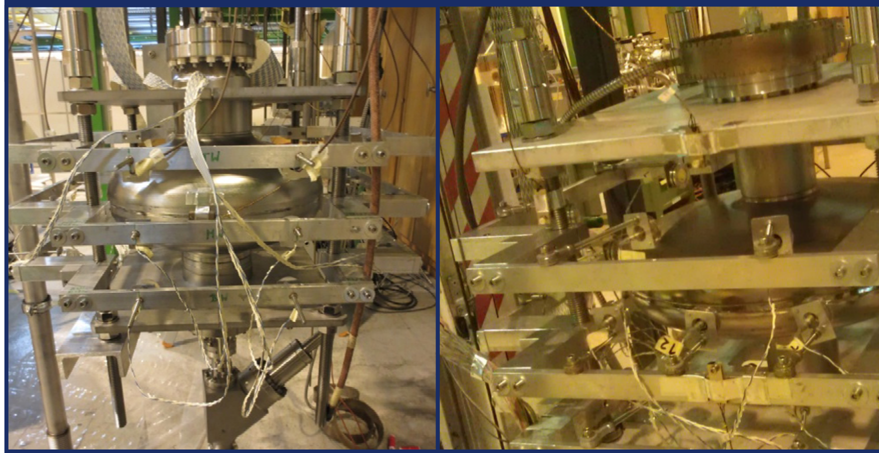


Cavity diagnostics

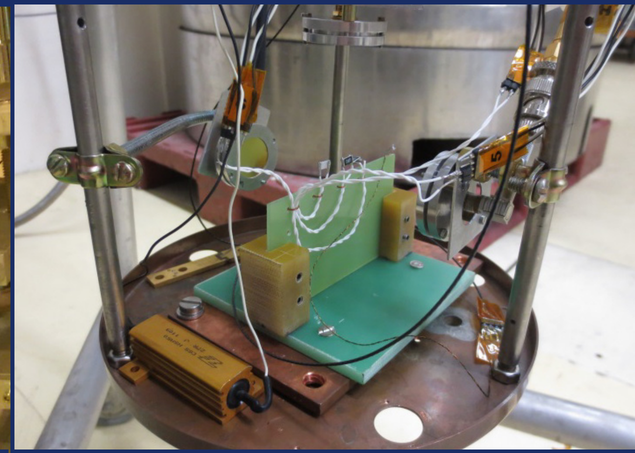




Optical Inspection Bench



Quench localization via second sound on SPL cavities

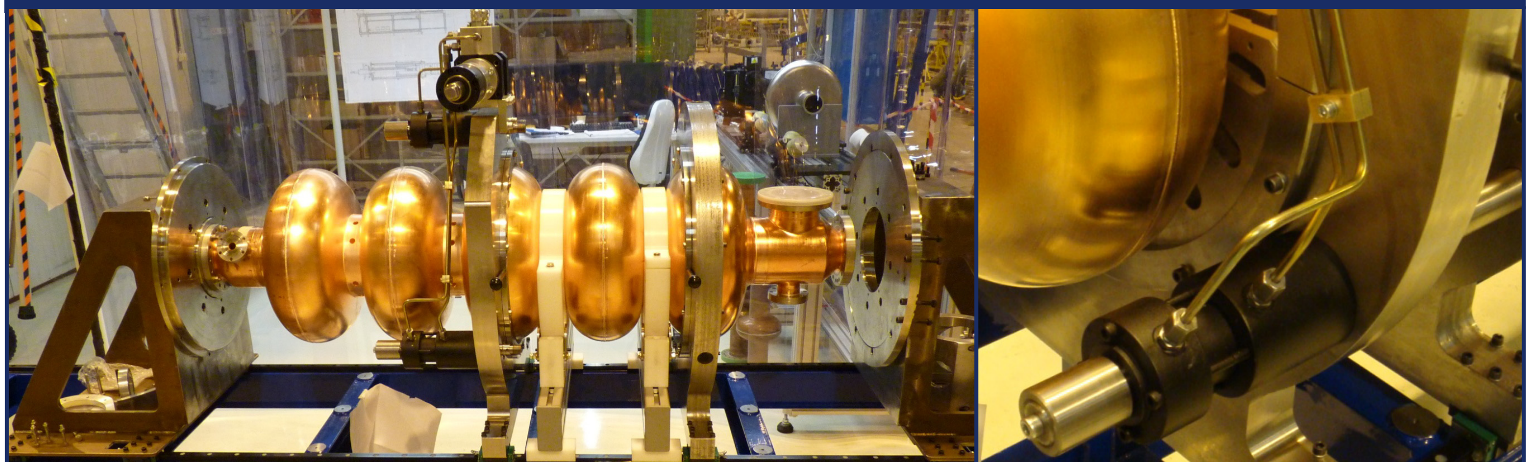


Fundamental research

J. Chambrillon, K. Liao, B. Peters, K. Schirm

Cavity ancillaries

Bead-pull measurement setup for field mapping



Cell-by-cell tuning system

F. Pillon, S. Mikulas, K. Schirm