The TERA TULIP project

(TUrning LInac for Protontherapy)

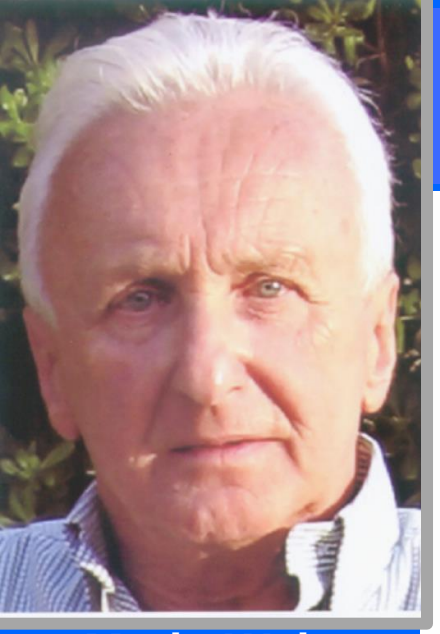
Ugo Amaldi

TERA Foundation

Technische Universität München

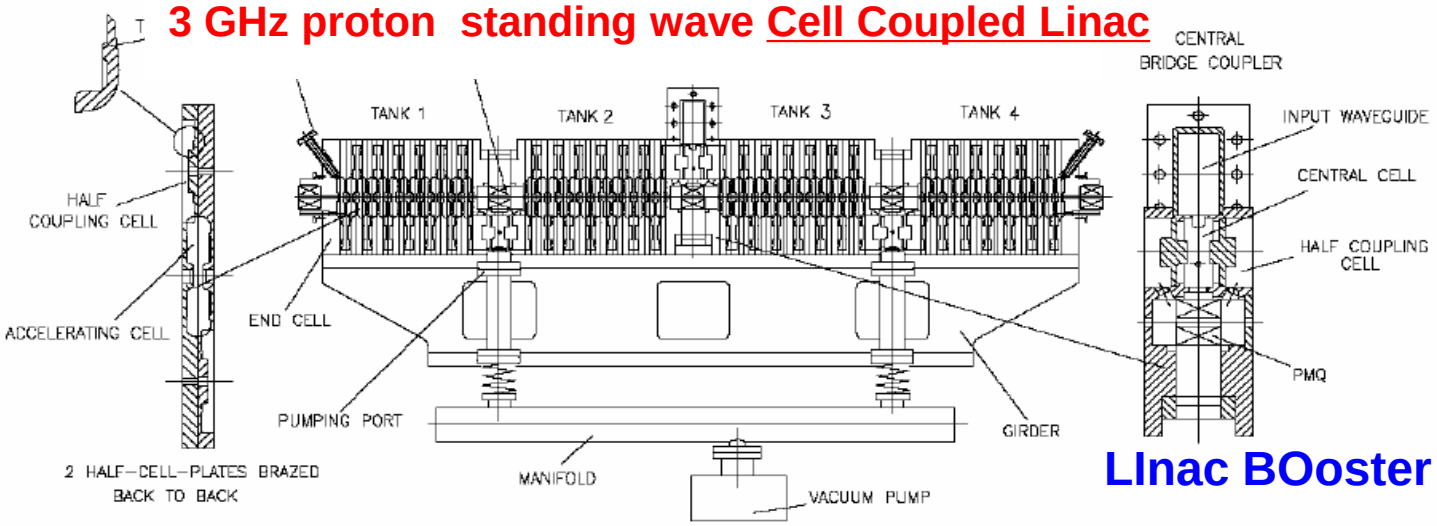
TERA Cell Coupled Linacs for proton therapy

Prototype of CCL built and beam tested by TERA-CERN-INFN: 2003



Mario Weiss

3 GHz proton standing wave Cell Coupled Linac

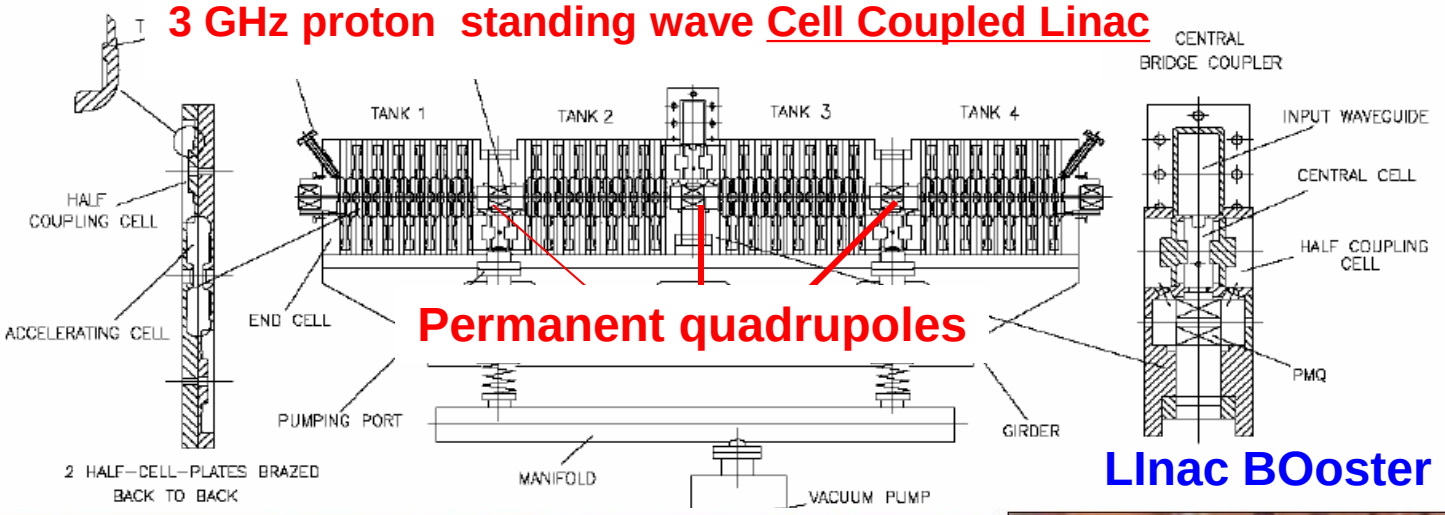


LInac BOoster

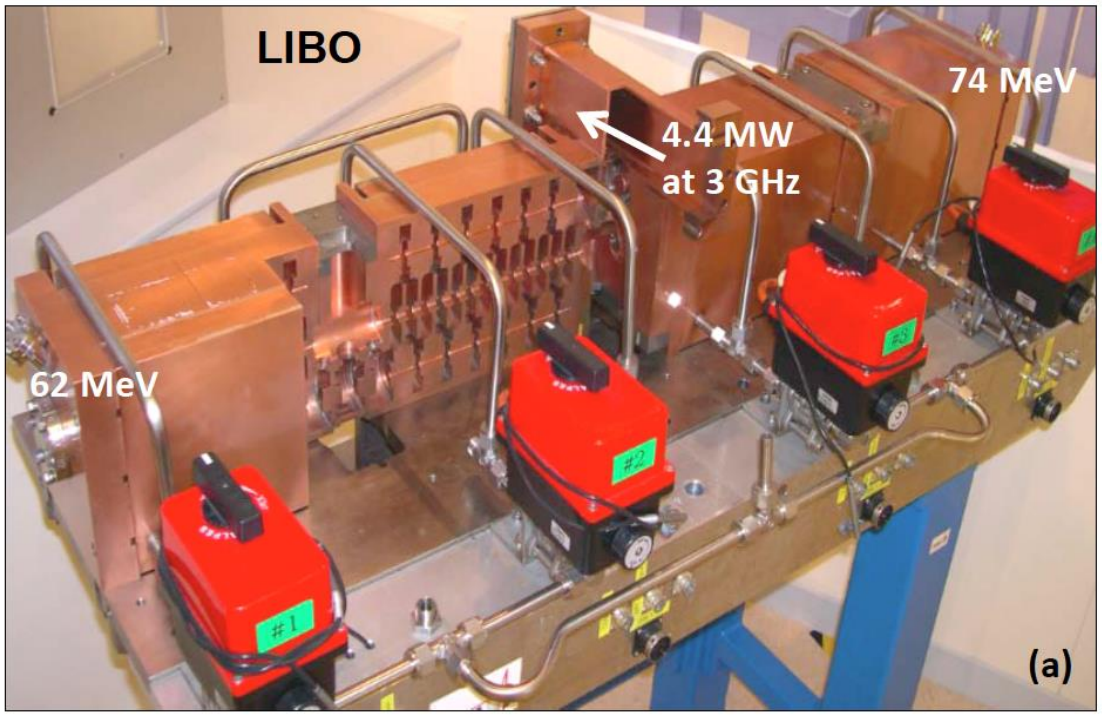
Prototype of CCL built and beam tested by TERA-CERN-INFN: 2003

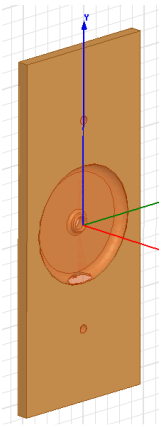
Mario Weiss

3 GHz proton standing wave Cell Coupled Linac



LInac BOoster

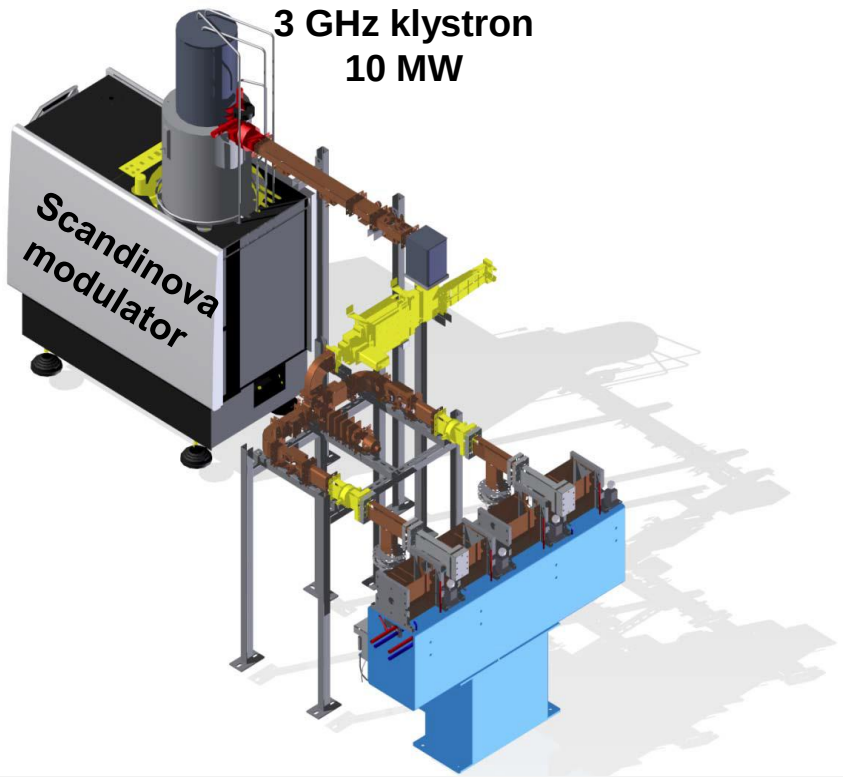




Basic unit:

half-cell

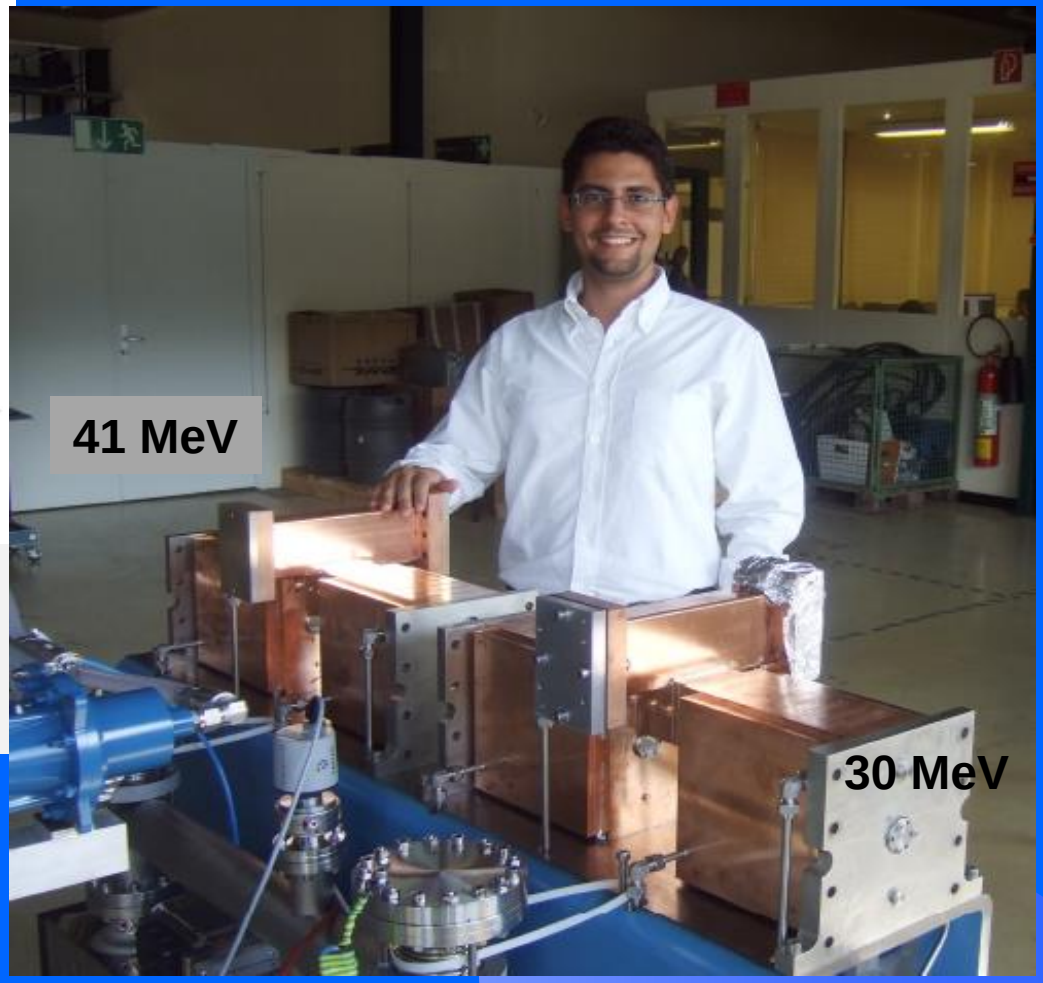
Commercial prototype built and power tested by A.D.A.M.: 2011



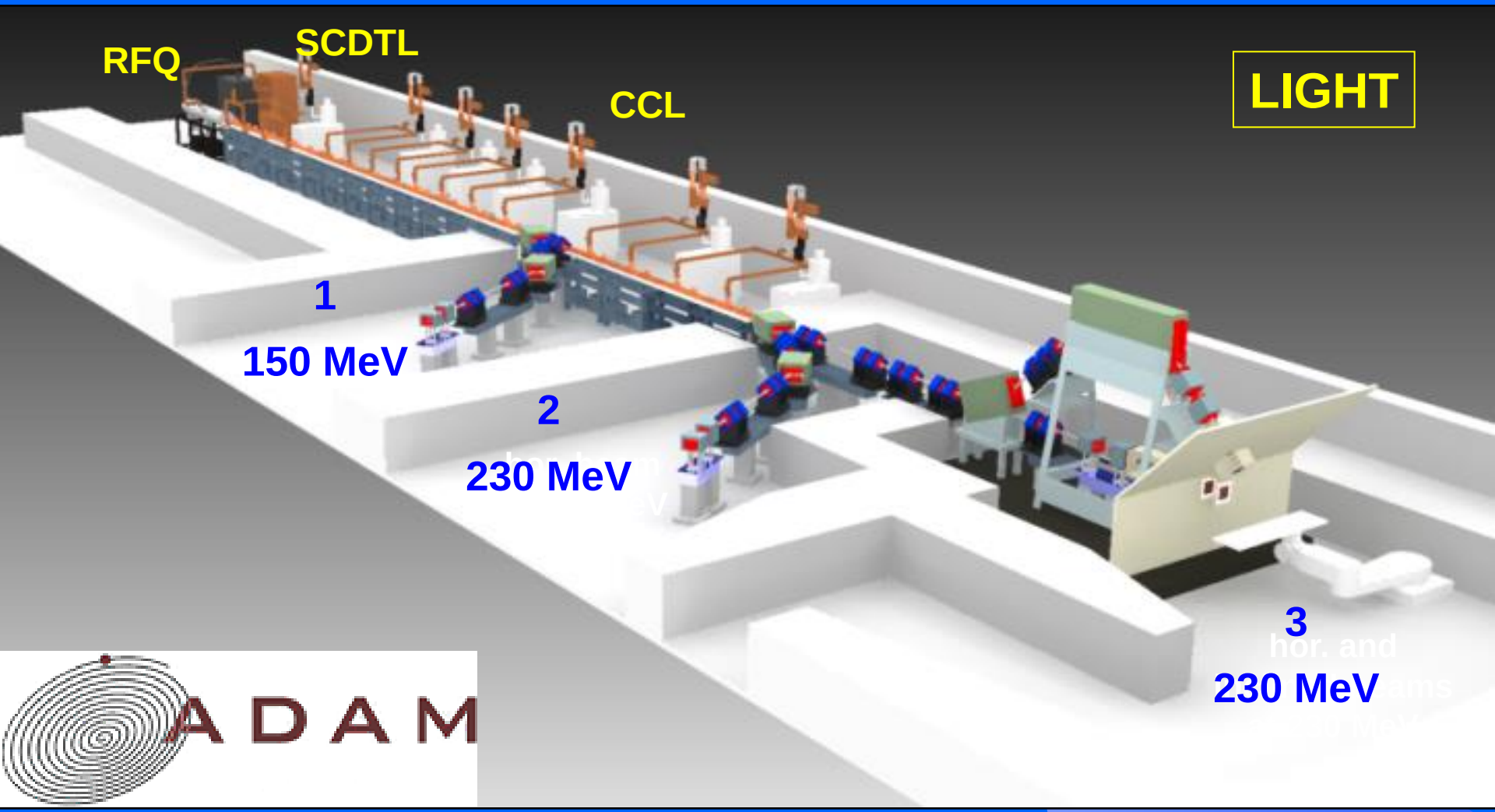
First Unit of LIGHT

Linac for Image Guided Hadron Therapy

A.D.A.M. = Applications of Detectors and Accelerators to Medicine



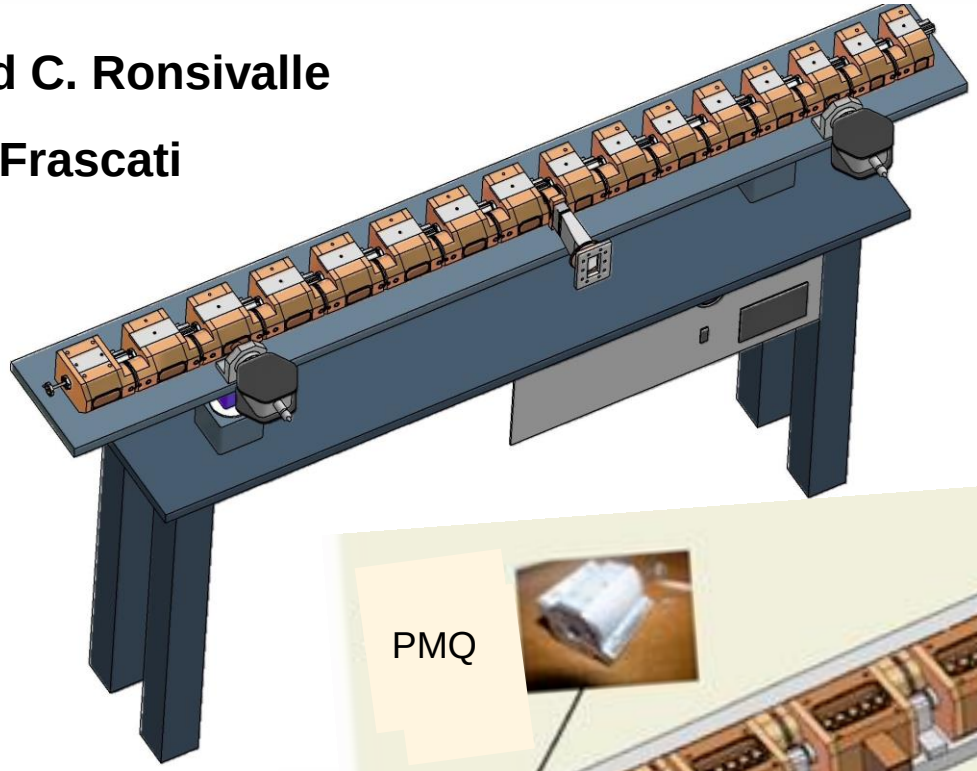
Centre offered by A.D.A.M. - CERN spin-off Company acquired by Advanced Oncotherapy in 2013

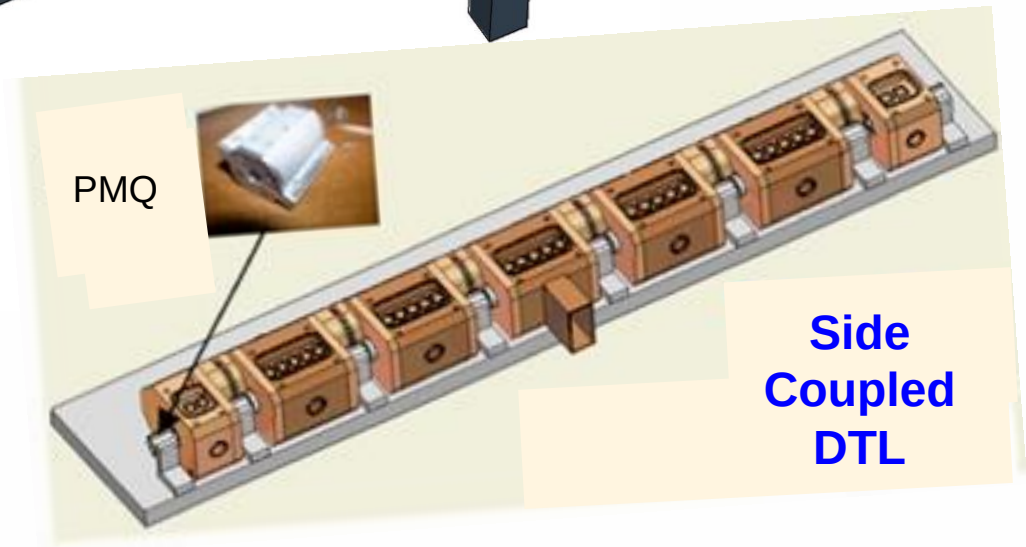


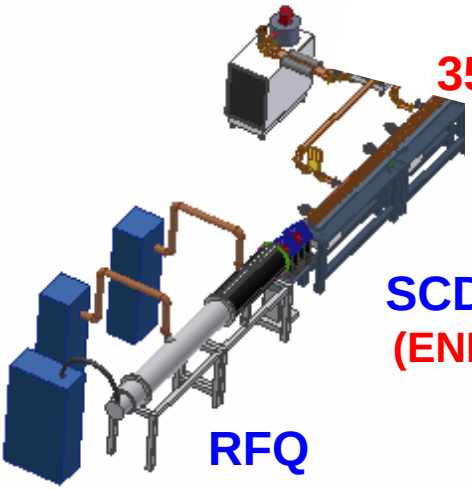
Side Coupled Drift Tube Linac

L. Picardi and C. Ronsivalle

ENEA-Frascati



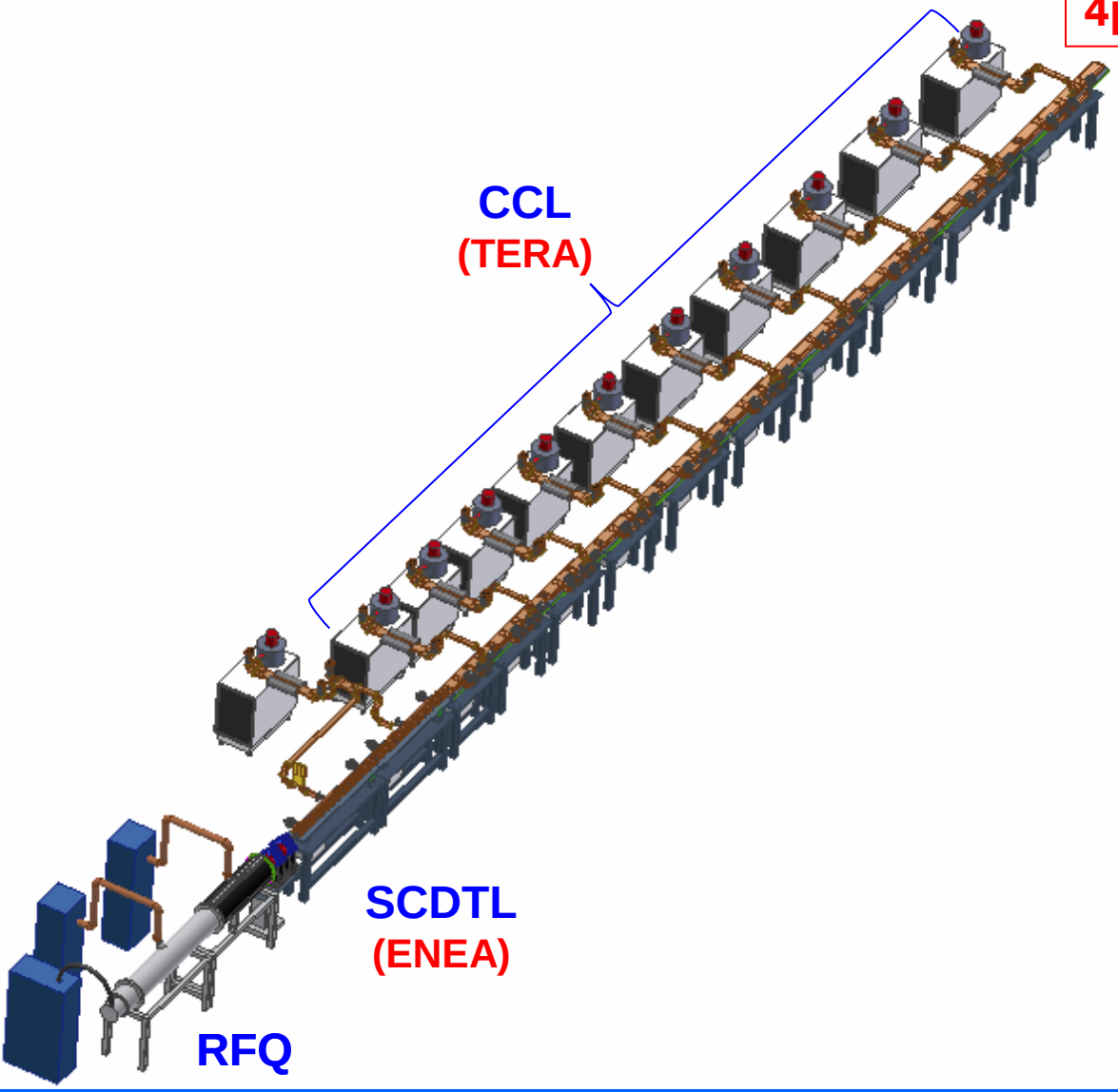




Linac for Image Guided Hadron Therapy

≤ 230 MeV

4μs pulses @ 200 Hz



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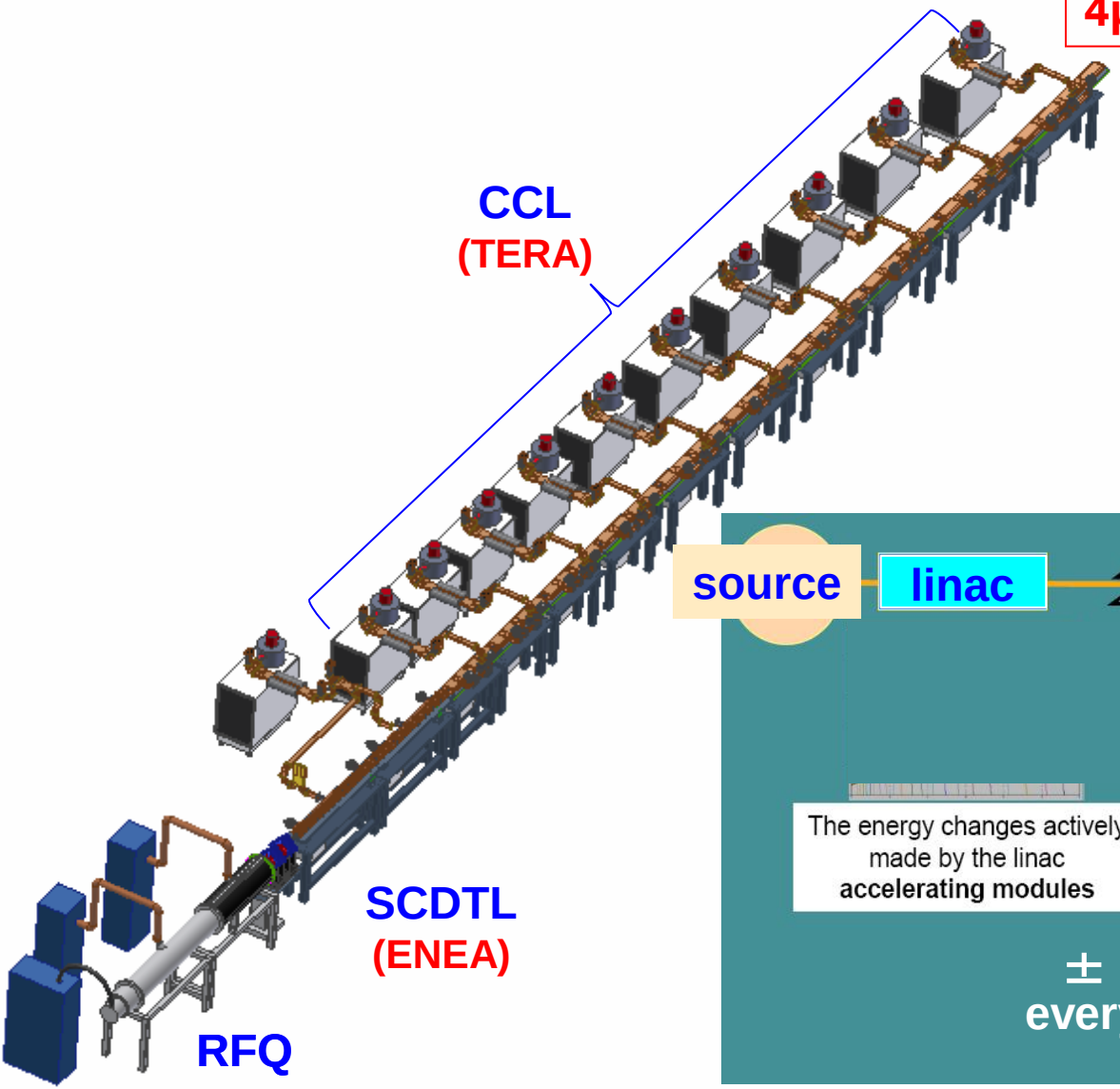
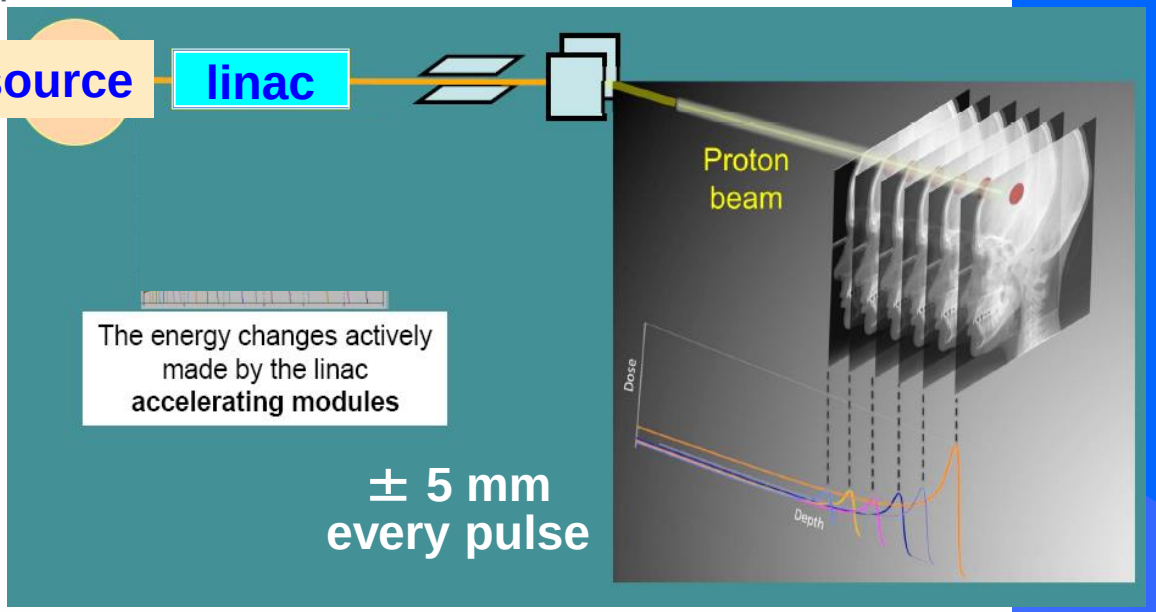
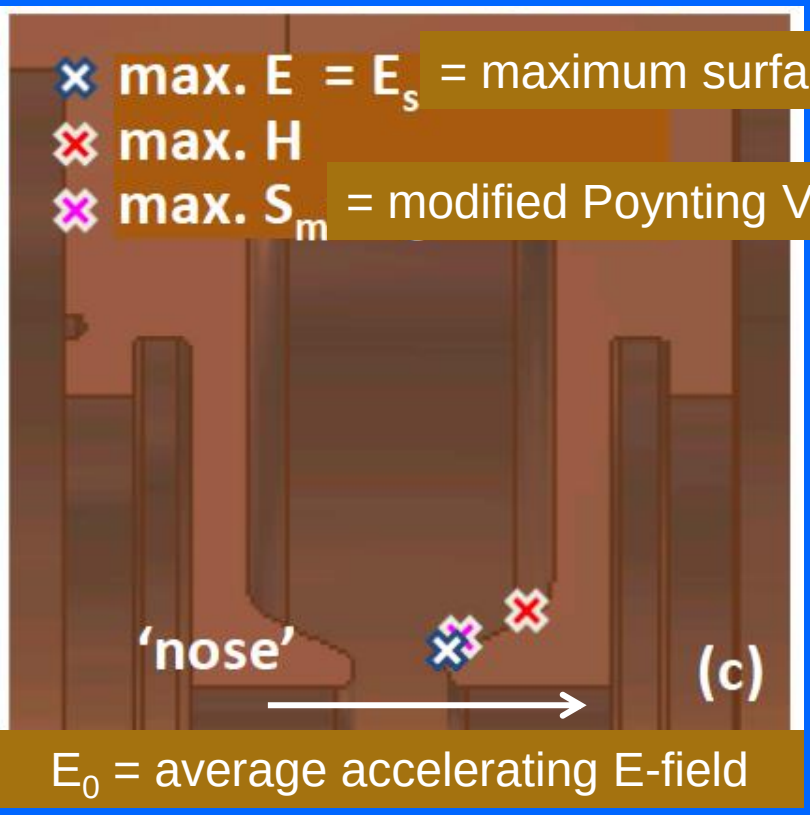




Towards shorter proton linacs

Breakdowns and the 'nose' in a CCL structure



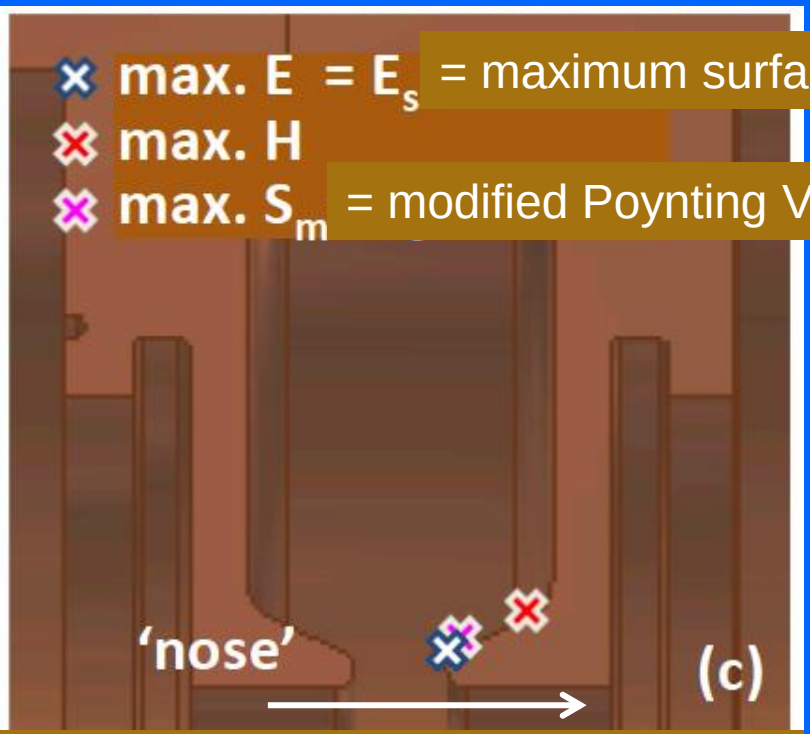
= maximum surface E-field

= modified Poynting Vector (*)

E_0 = average accelerating E-field

(*) A. Grudiev, S. Calatroni and W. Wuensch, *New Local Field Quantity Describing the High Gradient Limit of Accelerating Structures*, Phys. Rev. ST Accel. Beams 12, (2009) 102001.

Breakdowns and the 'nose' in a CCL structure



E_0 = average accelerating E-field

Ratio E_s /E_0 =

4.5 in a CCL structure

2 in a CLIC structure

(*) A. Grudiev, S. Calatroni and W. Wuensch, *New Local Field Quantity Describing the High Gradient Limit of Accelerating Structures*, Phys. Rev. ST Accel. Beams 12, (2009) 102001.

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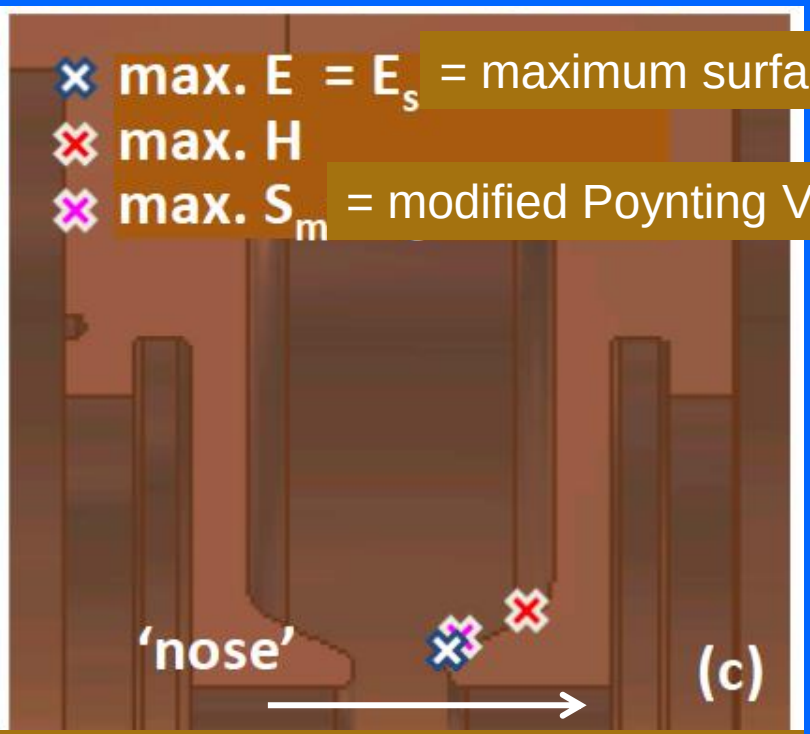


E_0 = average accelerating E-field

Ratio E_s /E_0 =

4.5 in a CCL structure

2 in a CLIC structure

100 MV/m in CLIC

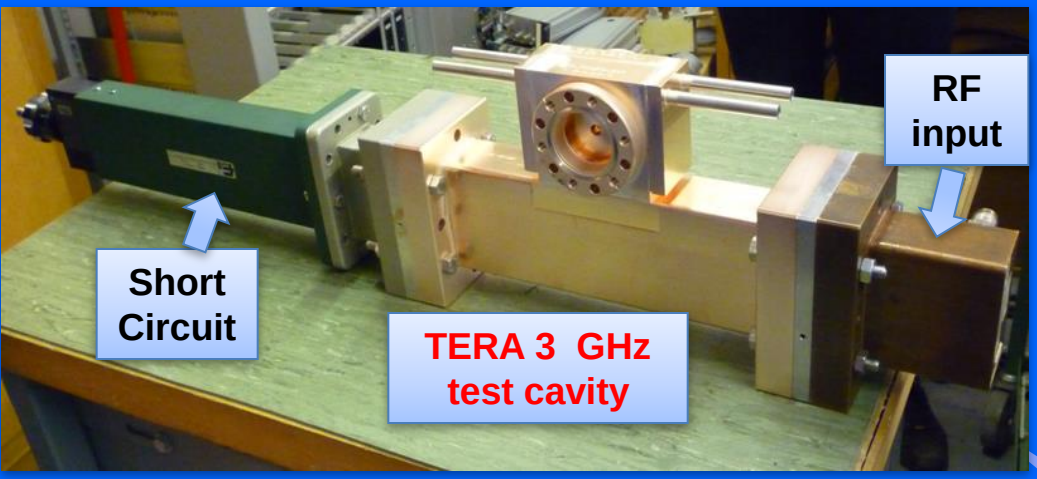
correspond to

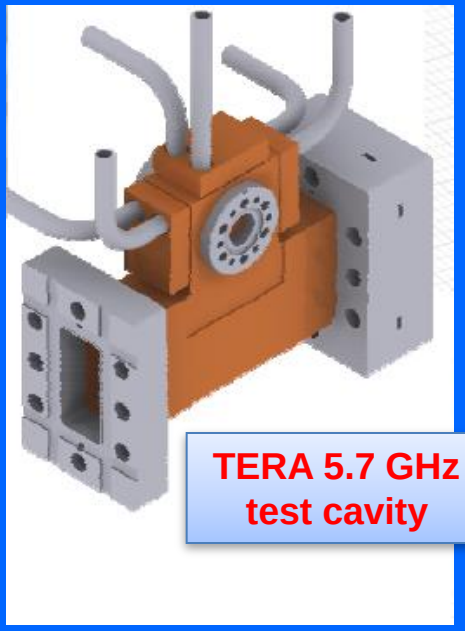
45 MV/m in CCL

(with 0.2 μs pulses)

(*) A. Grudiev, S. Calatroni and W. Wuensch, *New Local Field Quantity Describing the High Gradient Limit of Accelerating Structures*, Phys. Rev. ST Accel. Beams 12, (2009) 102001.

3 GHz high-gradient tests: comparison with CLIC results





High-power test results of a 3 GHz single-cell cavity

U. Amaldi[1], D. Bergesio[1], R. Bonomi[1,4], A. Degiovanni[1,2], M. Garlasché[1,4], P. Magagnin[1], S. Verdú-Andrés[1,3] and R. Wegner[4]
[1] TERA Foundation, Via Puccini 11, 28100 Novara, Italia

arXiv:1206.1930v2 [physics.acc-ph] 15 Jun 2012

HIGH GRADIENT RF LINACS
for APPLICATIONS IN HADRONTHERAPY

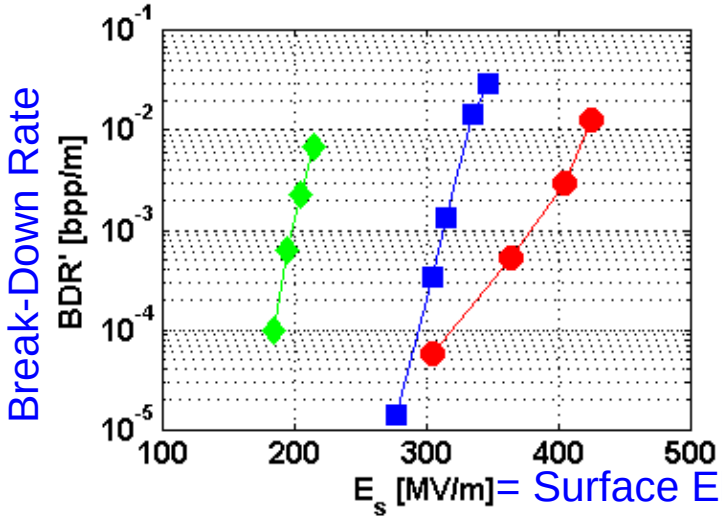
December 2013

Alberto Degiovanni

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

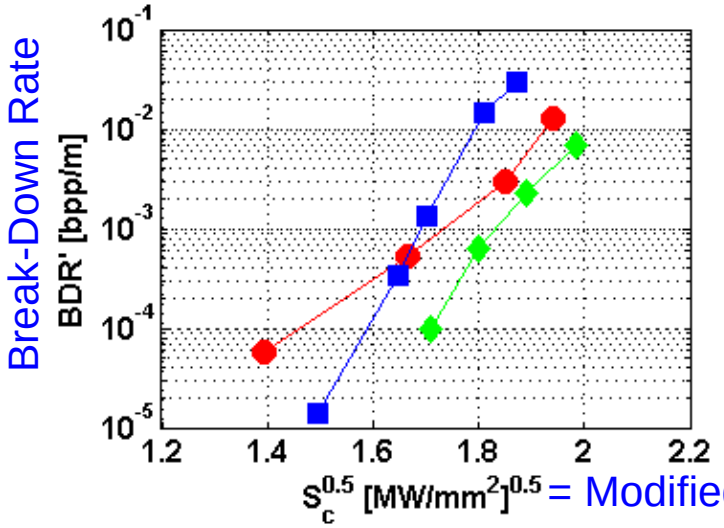
acceptée sur proposition du jury:

3 GHz high-gradient tests: comparison with CLIC results



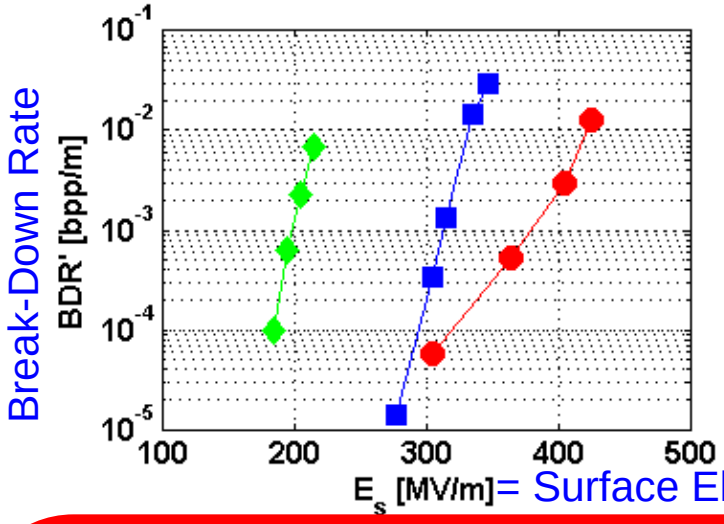
= Surface Electric Field

- **S band** SW (TERA)
- **C band** SW (TERA)
- **X band** TW (CLIC)



= Modified Pointing Vector

3 GHz high-gradient tests: comparison with CLIC results



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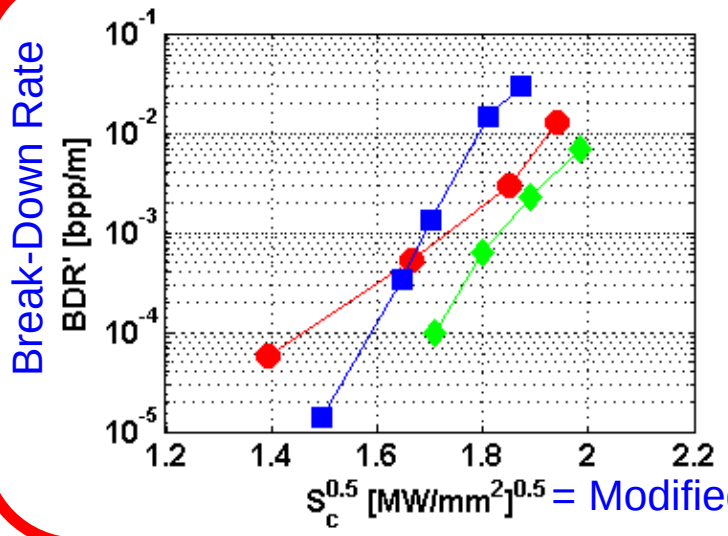
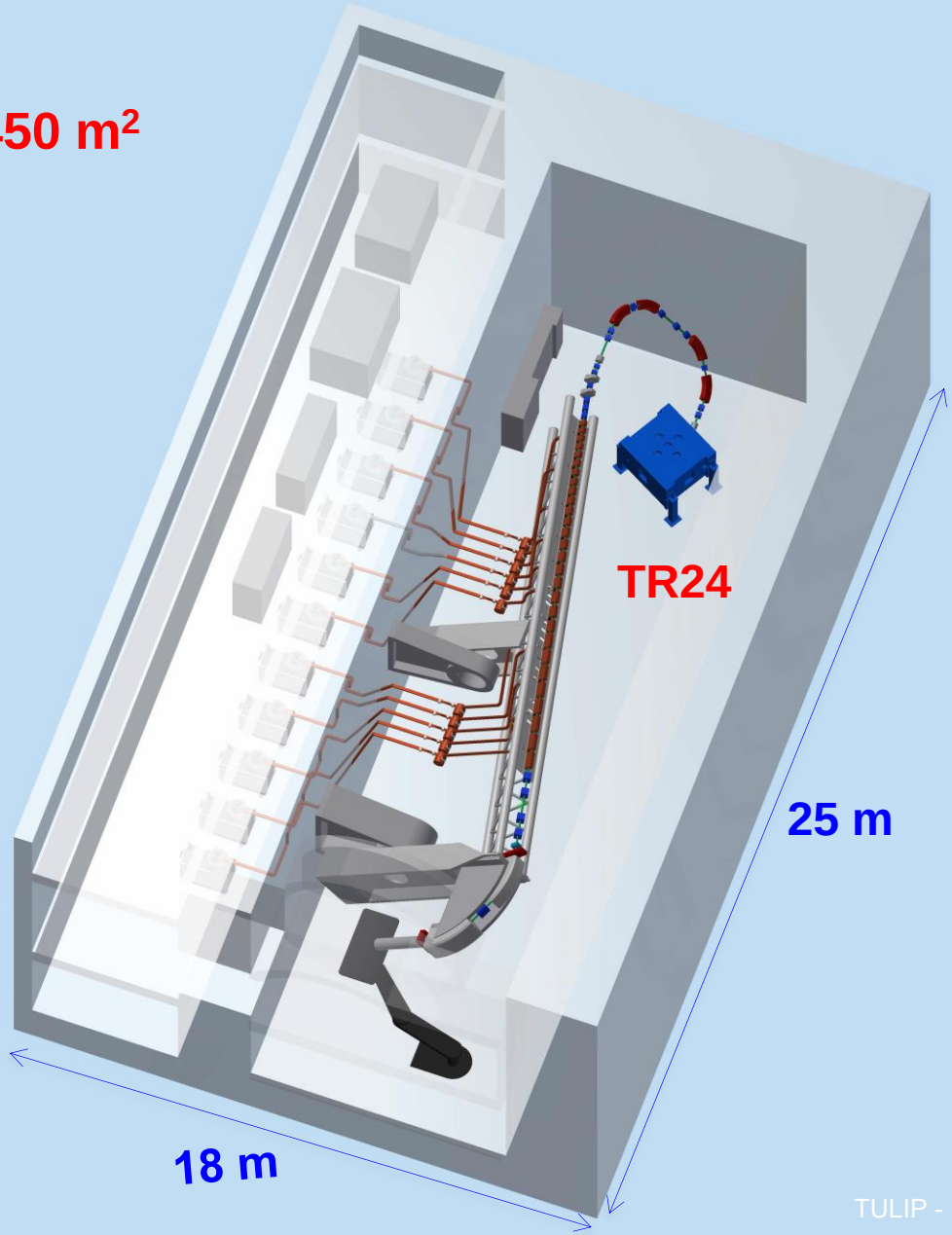
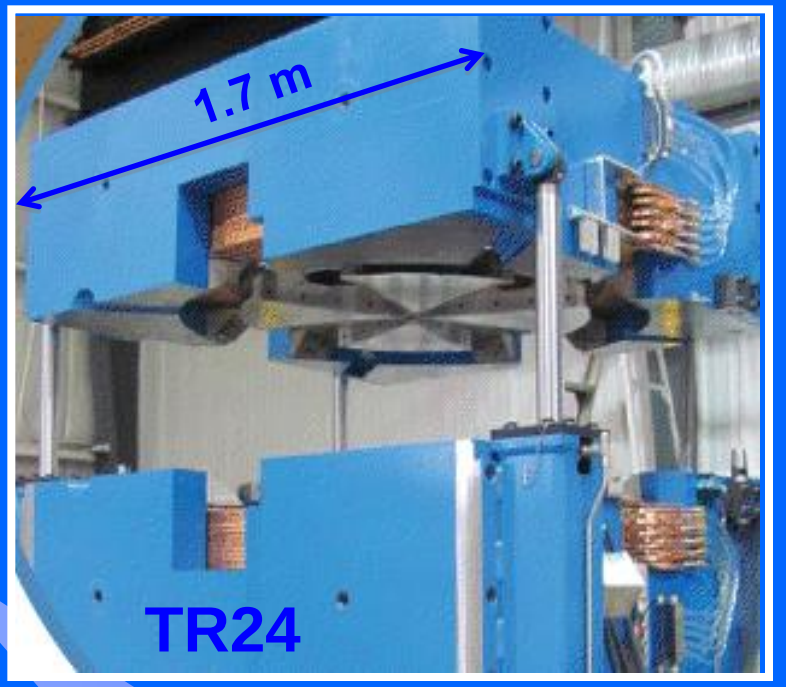


= Modified Pointing Vector

TULIP is based on high-gradient structures

TULIP at 3 GHz and high gradients (E_0 = 30 MV/m)





24 MeV cyclotron

by

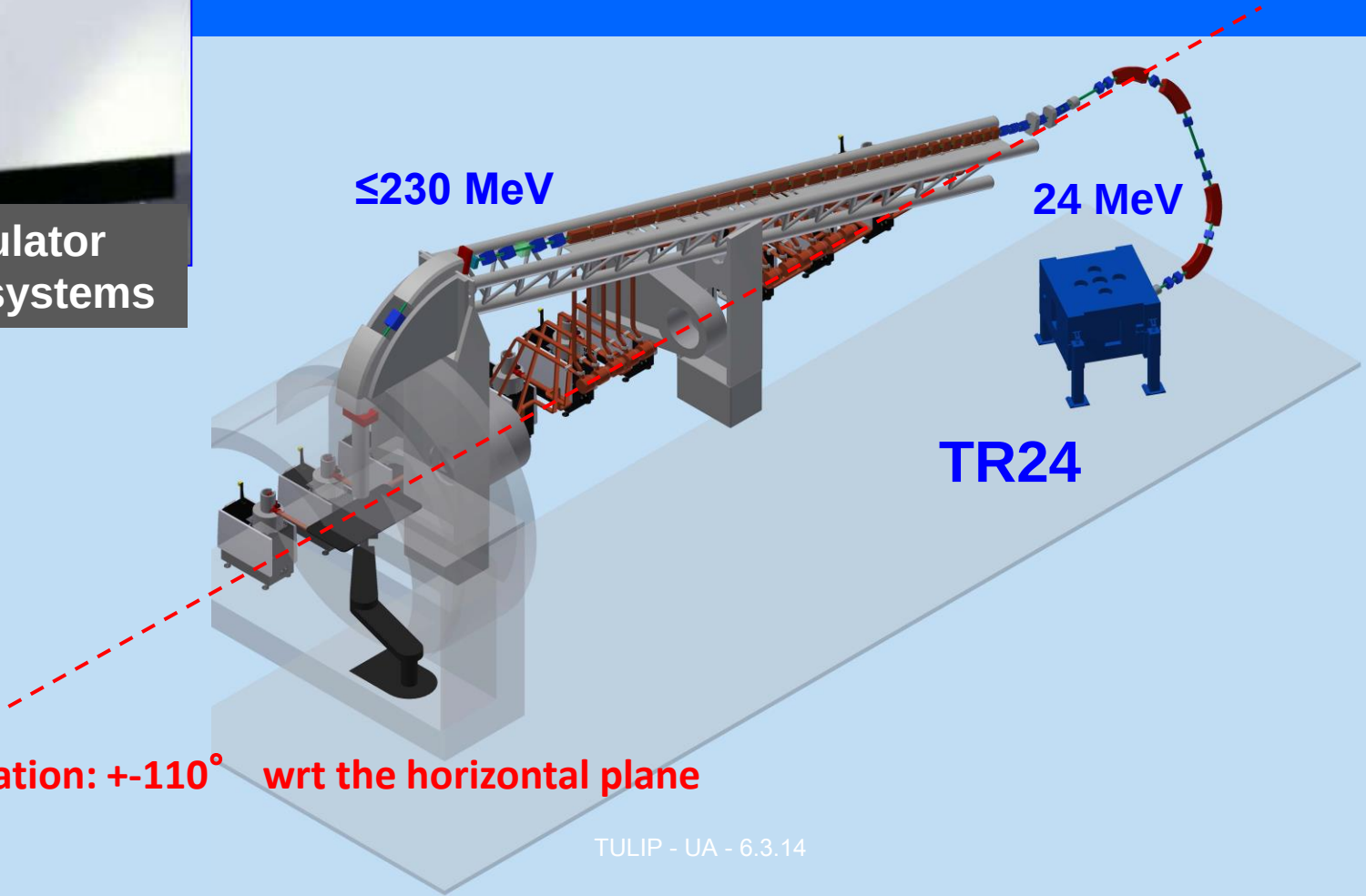
Advanced Cyclotron Systems

(Canada)

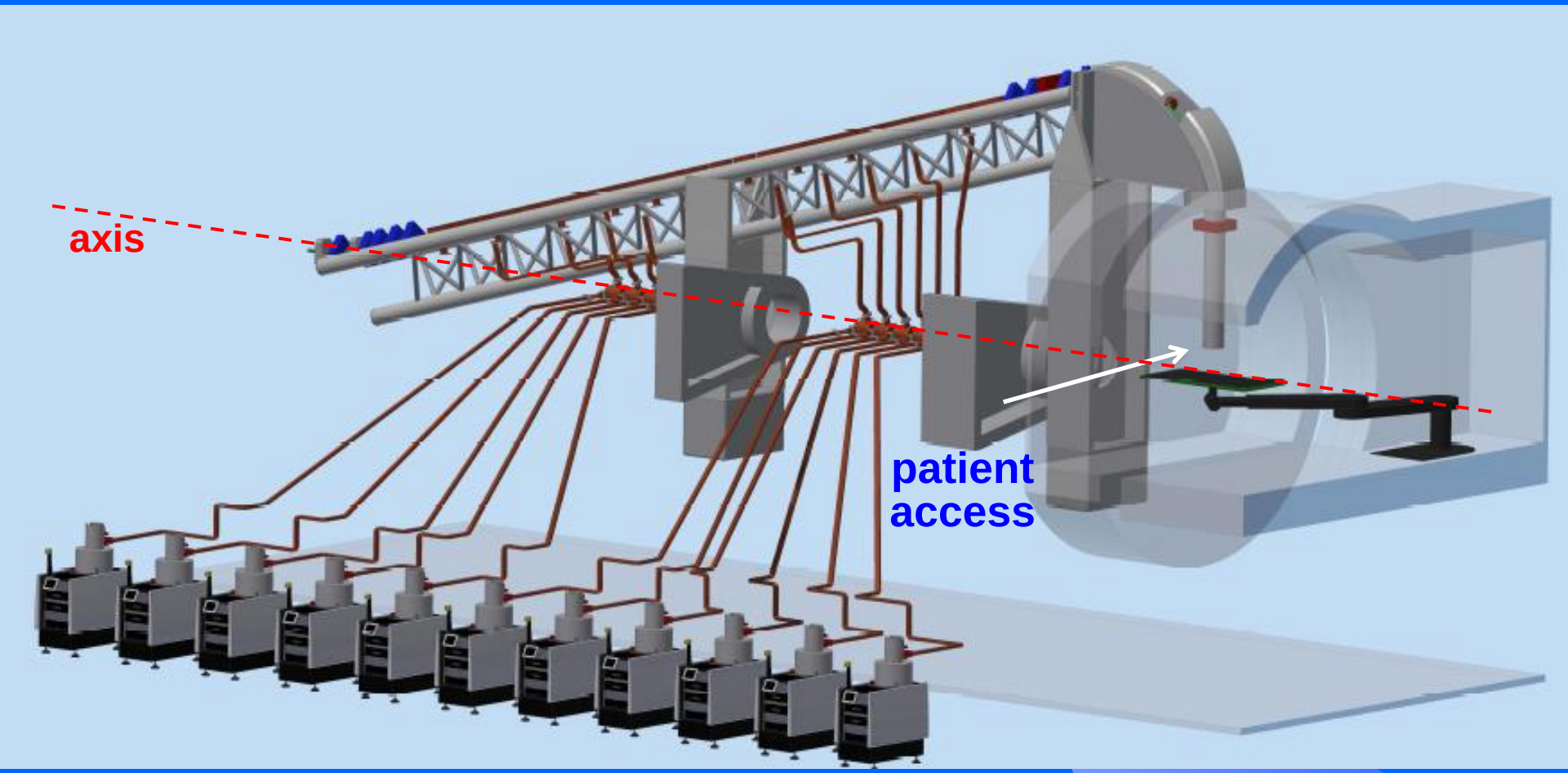
TULIP at 3 GHz with E_0 = 30 MV/m

11 modulator
-klystron systems

10 MW
klystron

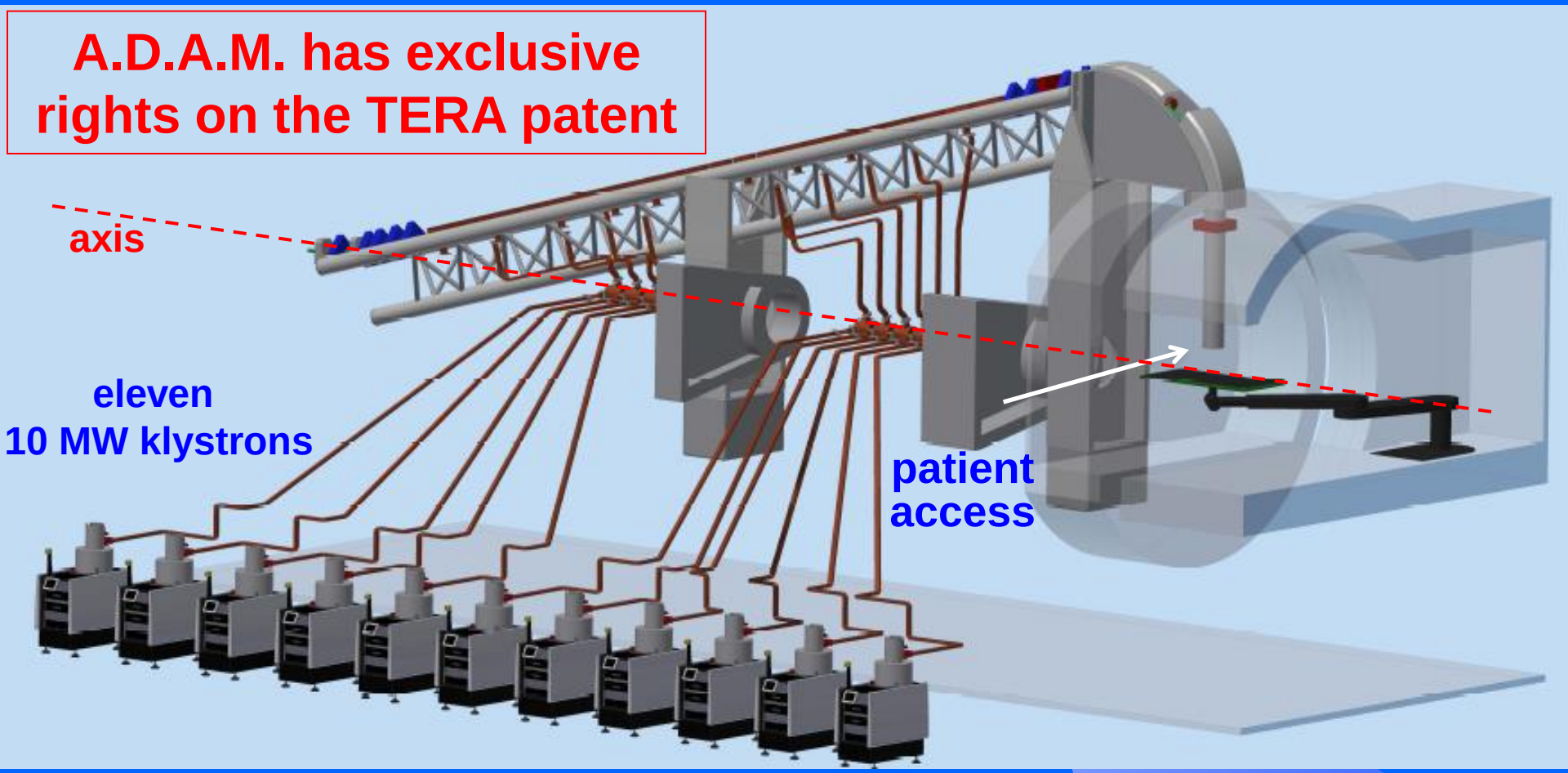


TULIP at 3 GHz with E_0 = 30 MV/m

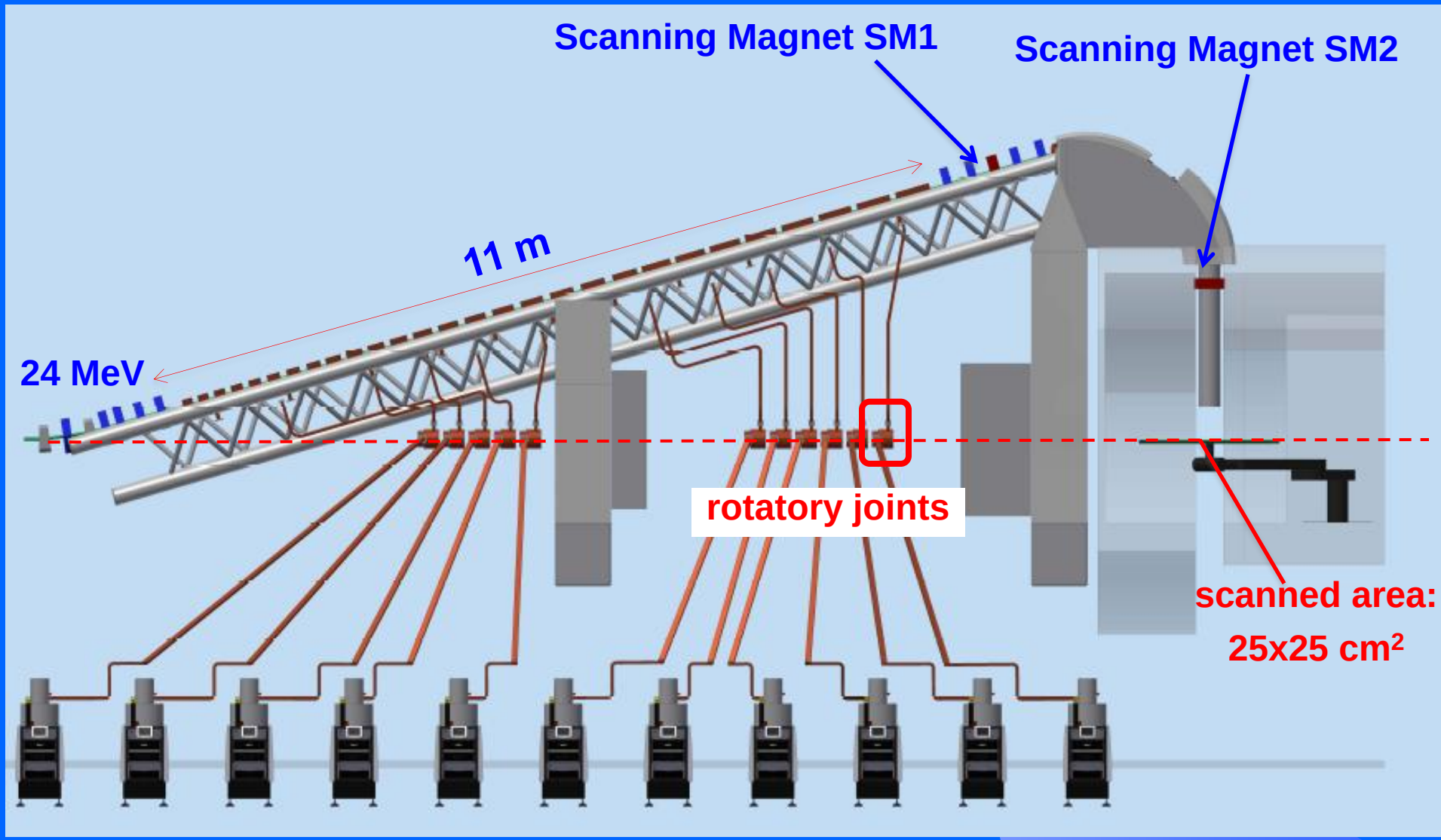


TULIP at 3 GHz with E_0 = 30 MV/m

A.D.A.M. has exclusive rights on the TERA patent

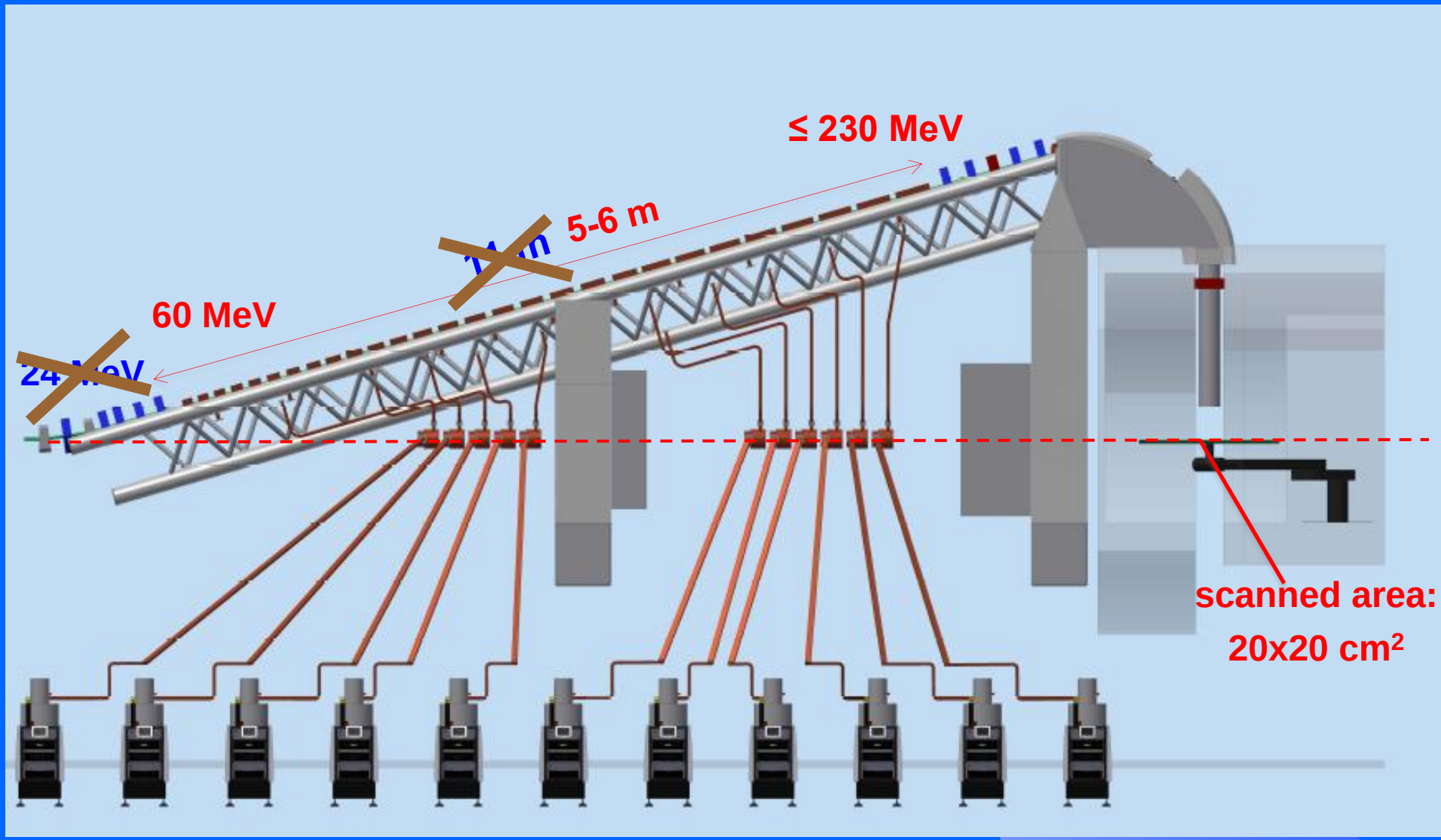


TULIP at 3 GHz with E_0 = 30 MV/m

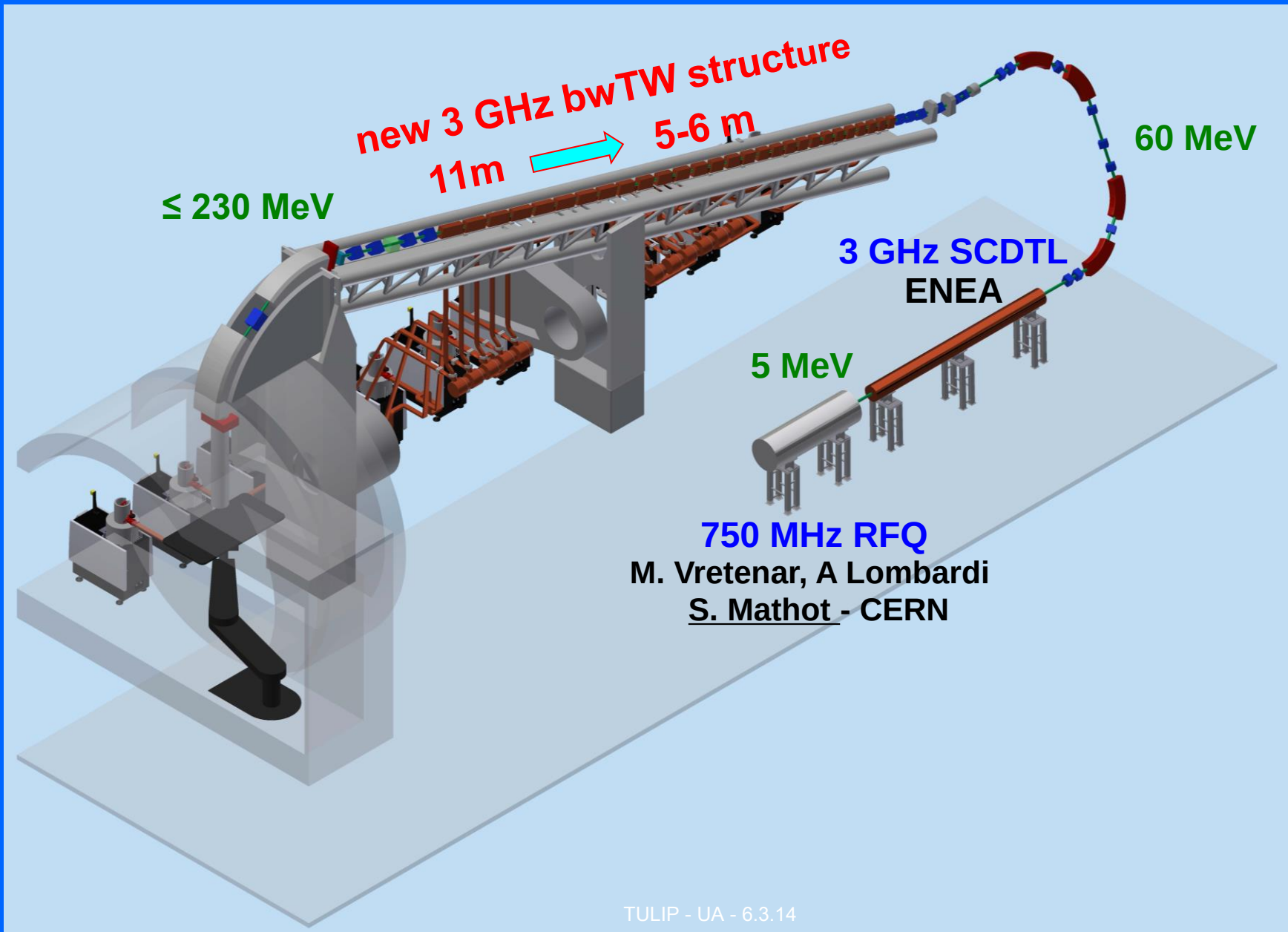


TULIP-2.0 is based on a novel high-gradient structure

TULIP-2.0 at 3 GHz with $E_0 \cong 50$ MV/m



TULIP-2.0 at 3 GHz with $E_0 \cong 50$ MV/m



High-gradients for proton therapy KT Fund project

CLIC: **W. Wuensch**

A. Grudiev

I. Syratchev

M. Garlasché

TERA: **U.A.**

A. Degiovanni (now at CERN)

P. Magagnin (now at CERN)

S. Benedetti

G. Porcellana

High-gradients for proton therapy KT Fund project

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P. Magagnin (now at CERN)

S. Benedetti

G. Porcellana

S.B. presented yesterday the bwTW strucure

A.G. - next talk