



THE FAIR PROTON LINAC

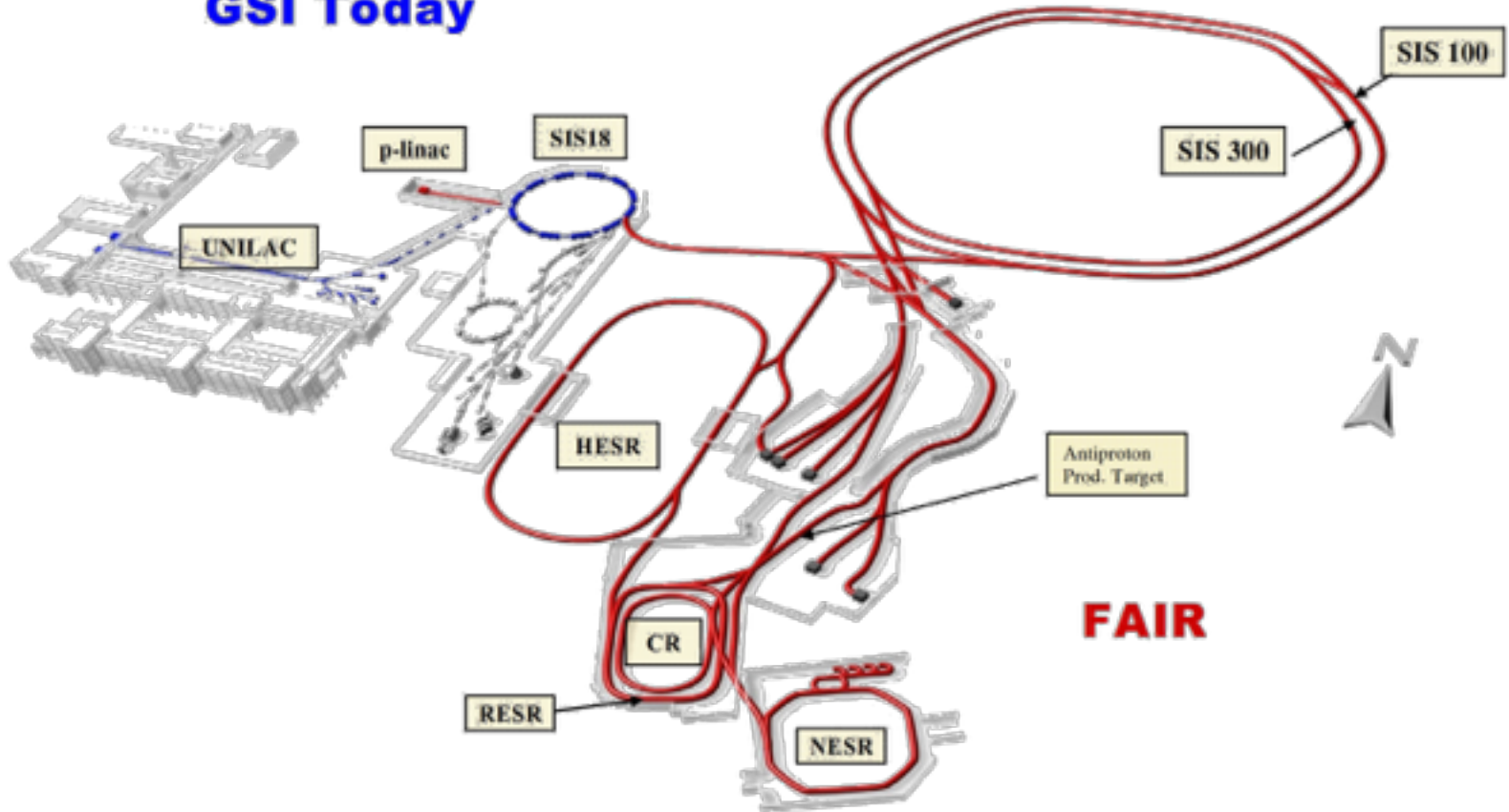
**INTERNATIONAL WORKSHOP ON
ANTIPROTON PHYSICS AND TECHNOLOGY
16.11.2015 @ BINP NOVOSIBIRSK**

INTRODUCTION

FAIR OVERVIEW



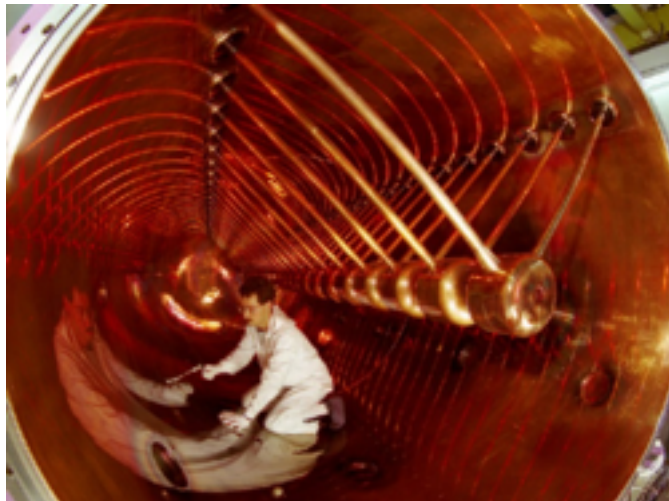
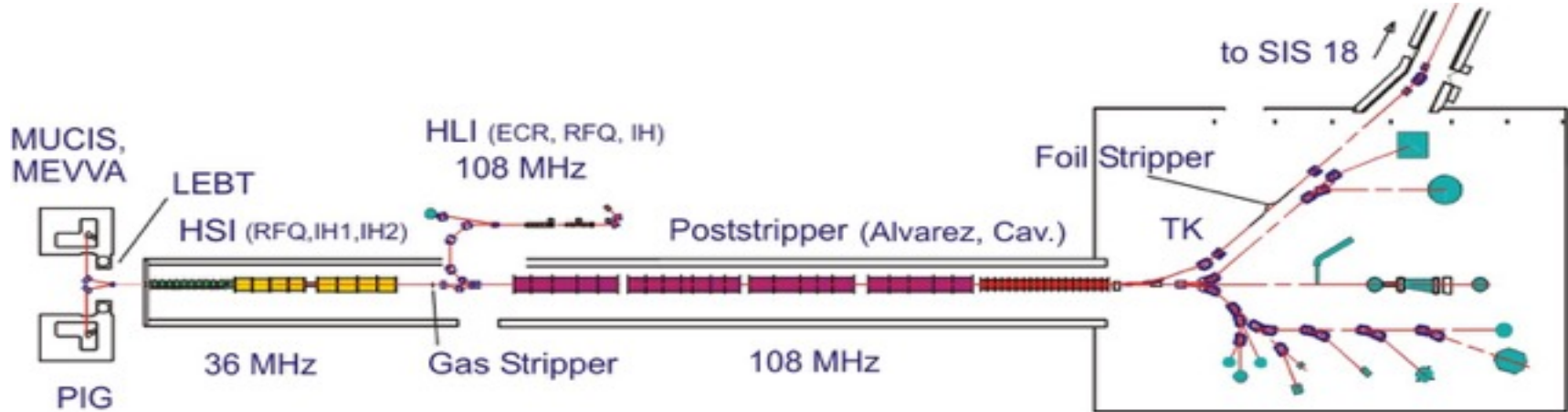
GSI Today



FAIR

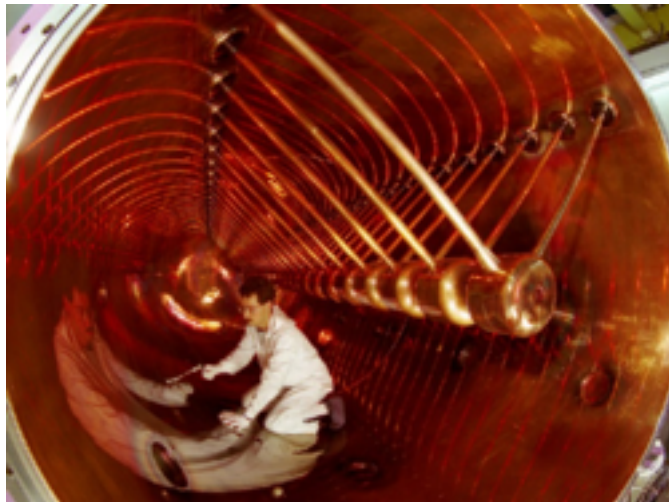
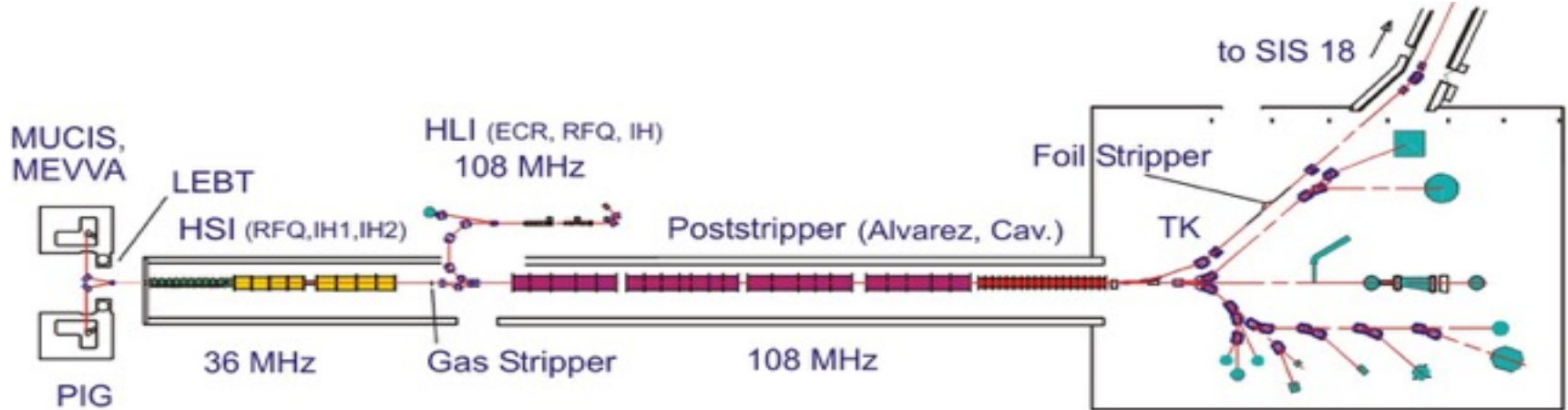
INTRODUCTION

MOTIVATION FOR P-LINAC



INTRODUCTION

MOTIVATION FOR P-LINAC



Alvarez built in 1975

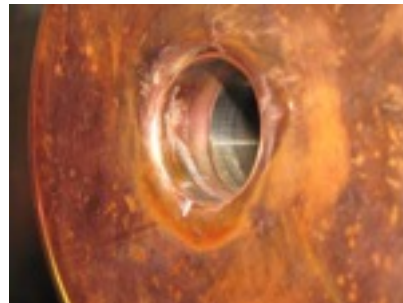
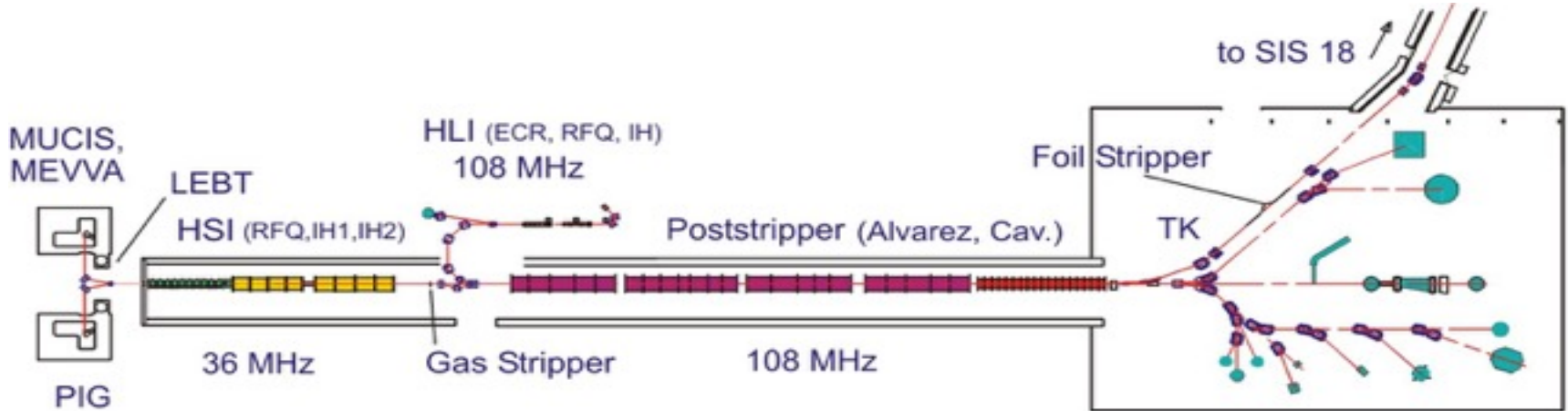
Acc. up to 11.4 MeV/u

178 DC Quadrupoles

$A/q < 8.5$ (U28+)

INTRODUCTION

MOTIVATION FOR P-LINAC



40 years of high duty cycle operation:

- Massive Spark Overs
- Beam Induced Surface Defects
- Vacuum Leaks



DC Quadrupoles:

- Limited Flexibility
- Ground Faults of the Coils
- Heat Dissipation Problems

FAIR Requirements:

- High Intensity
- Low Duty Factor

INTRODUCTION

MOTIVATION FOR P-LINAC



40 years of high duty cycle operation:

- Massive Spark Overs
- Beam Induced Surface Defects
- Vacuum Locks

DEDICATED PROTON LINAC NEEDED FOR FAIR

DC Quadrupoles:

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FAIR Requirements:

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INTRODUCTION

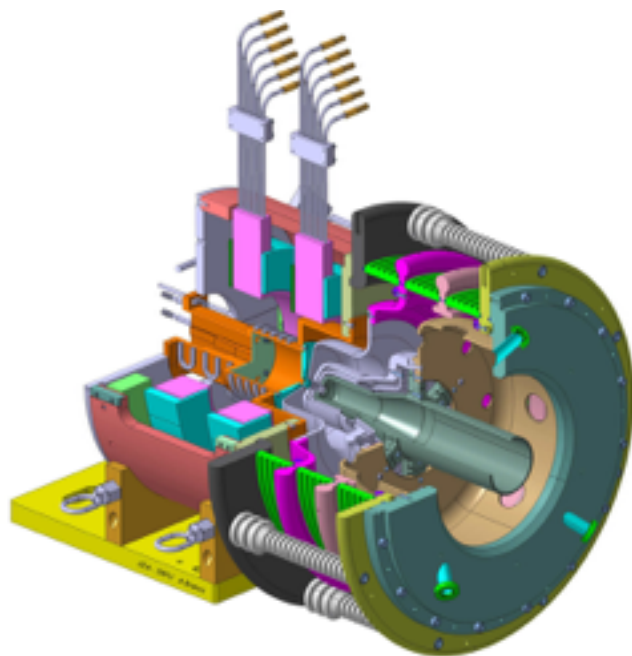
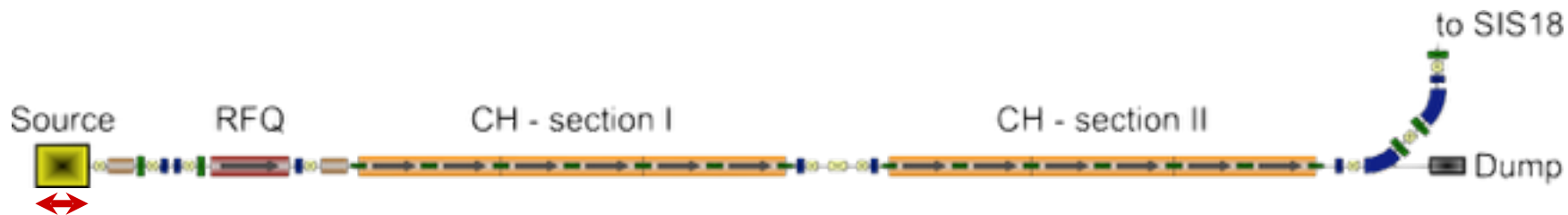
OVERVIEW OF P-LINAC



BEAM ENERGY (MEV)	70
BEAM CURRENT (MA)	35 - 70
BEAM PULSE (μ S)	36
REPETITION RATE (HZ)	4
FREQUENCY (MHZ)	325.224
NORM. EMITTANCE AT OUTPUT (μ M)	2.1 / 4.2
BEAM LOADING (PEAK) (MW)	4.9
RF POWER (PEAK) (MW)	2.2
KLYSTRON (3 MW PEAK POWER)	7
SOLID STATE AMPLIFIER (50 kW)	3
TOTAL LENGTH (RFQ + CH)	\approx 27 M

P-LINAC STATUS

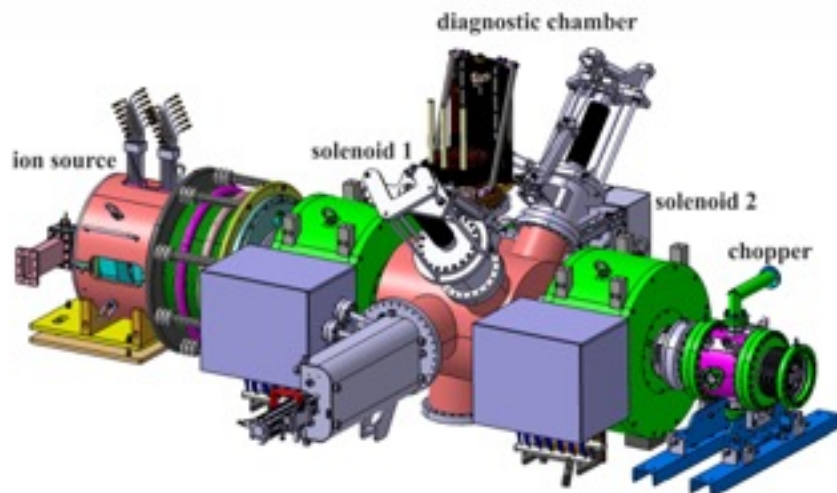
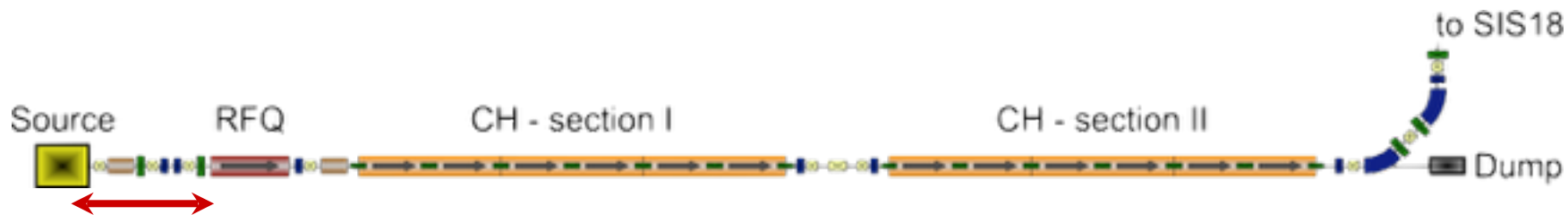
ION SOURCE



BEAM INTENSITY (MA)	100
BEAM ENERGY (KEV)	95
PROTON FRACTION (%)	> 85
EMMITANCE (MM MRAD)	< 0.3

P-LINAC STATUS

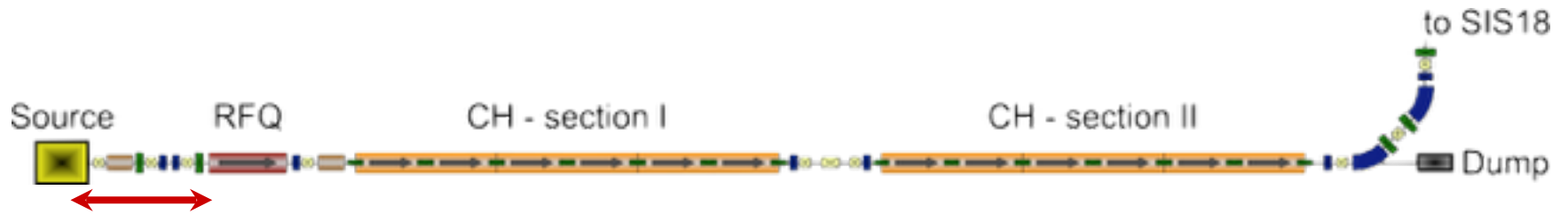
ION SOURCE AND LEBT



- Ion Source is ready
- Solenoids and diagnostics chamber are ready
- Chopper is under preparation
- Power supplies are ordered
- Commissioning of LEBT with beam behind the chopper is planned for early 2016
- Installation of control system was done in 2015

P-LINAC STATUS

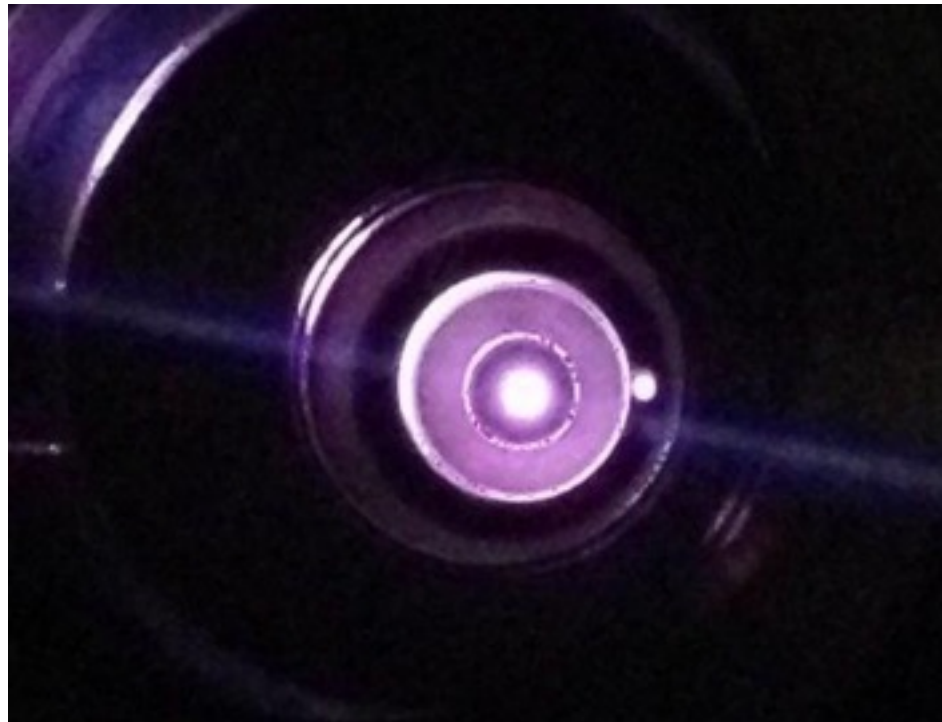
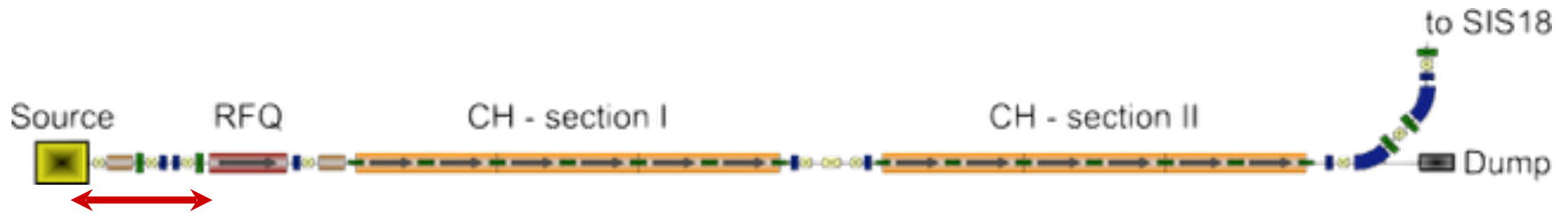
ION SOURCE AND LEBT



Ion Source and LEBT are ready.

P-LINAC STATUS

ION SOURCE

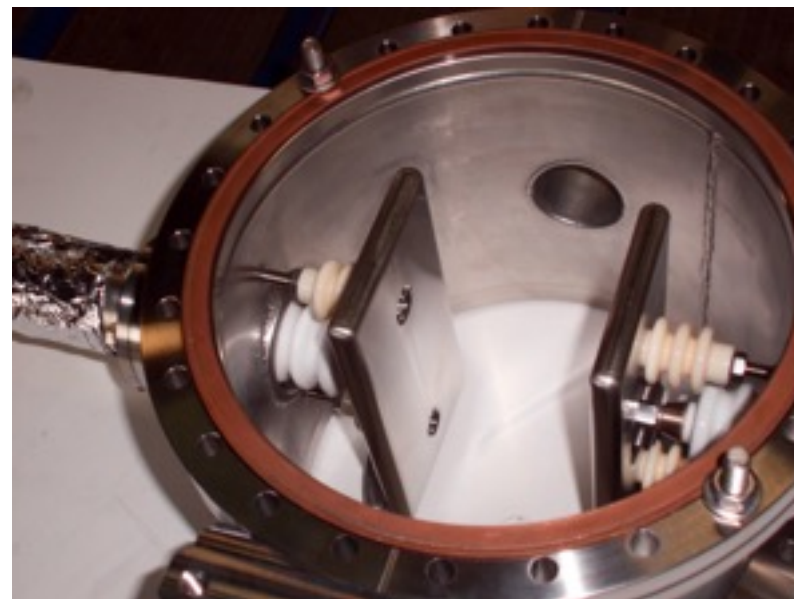
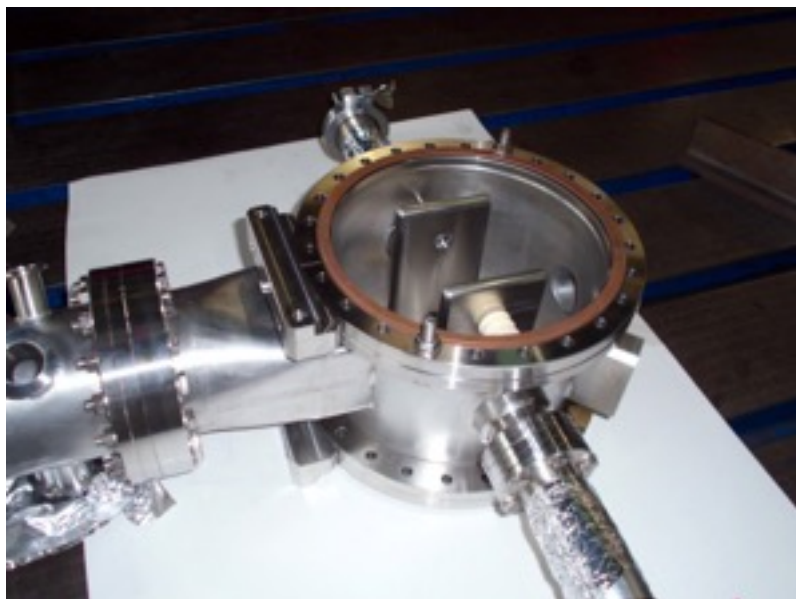
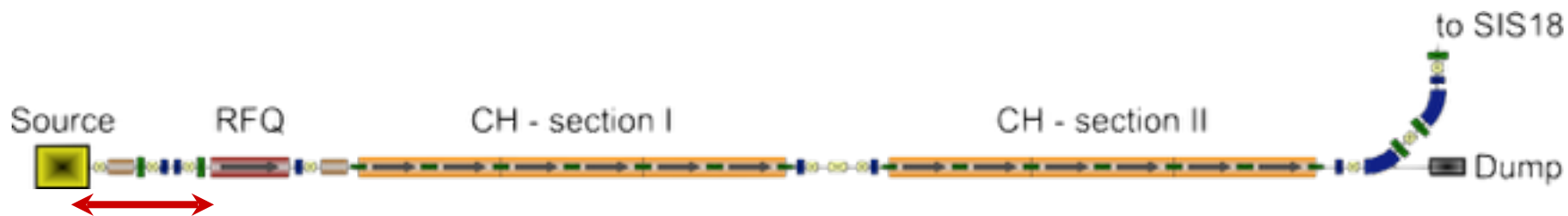


First Plasma in
ECR Source:

04.11.2015

P-LINAC STATUS

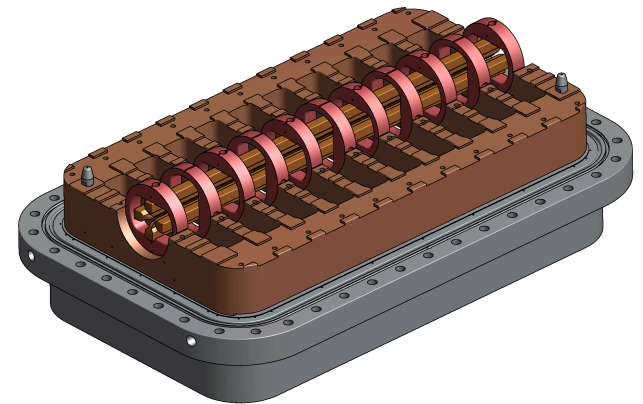
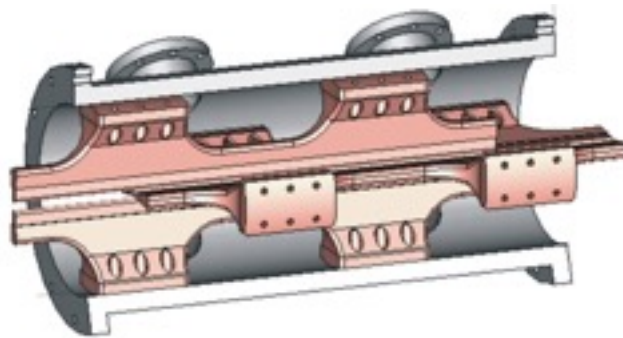
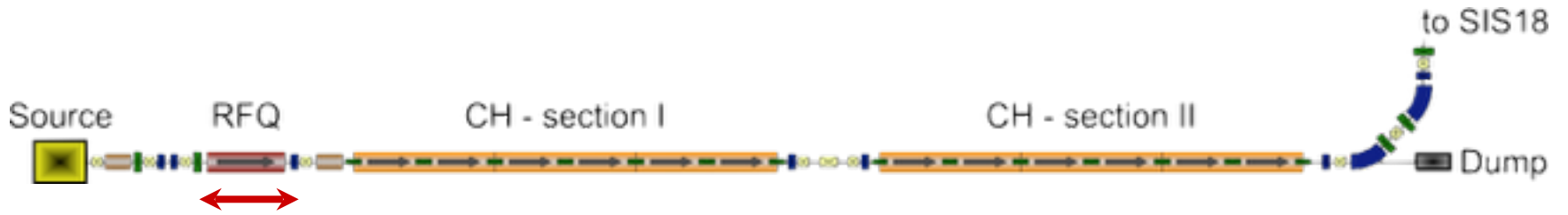
CHOPPER



Chopper ist nearly ready.

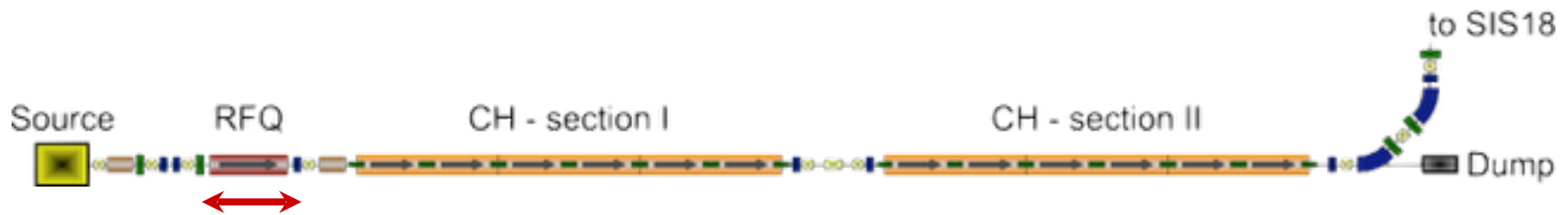
P-LINAC STATUS

RFQ POSSIBILITIES



P-LINAC STATUS

4-VANE RFQ

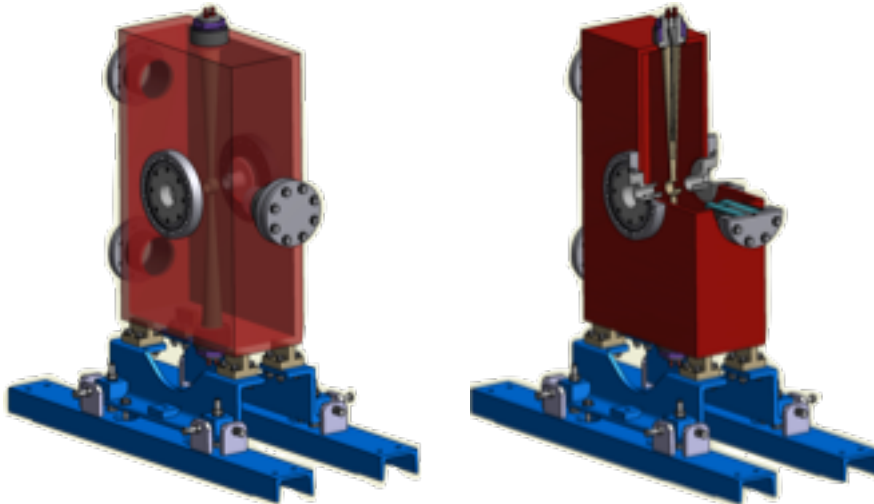
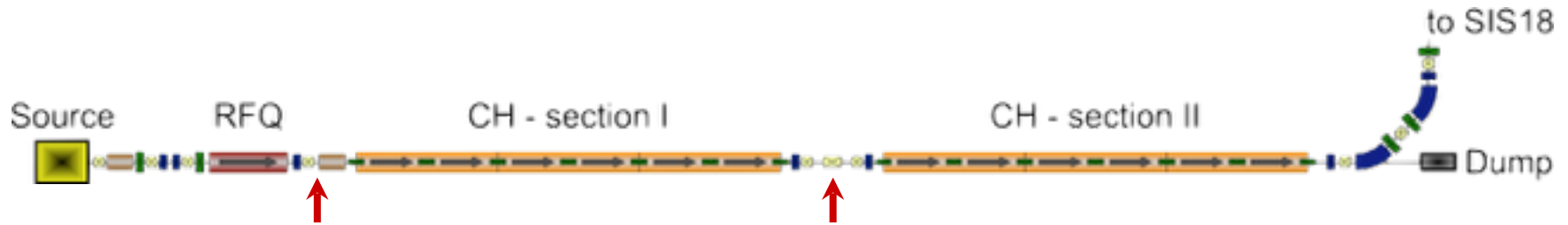


- Decision for a 4-Vane RFQ was made in summer 2014
As accordance to the expert meeting from nov. 2013
- CERN collaboration unfortunately failed, due to ... ???
- New collaboration with INFN Legnaro started end of 2014, but stopped due to political reasons on the GSI campus

But: University of Frankfurt is building an operational 325MHz RFQ for the p-Linac

P-LINAC STATUS

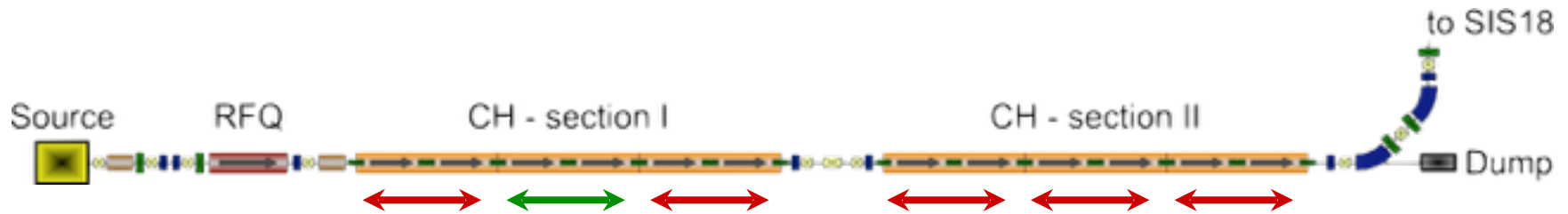
BUNCHER I & II



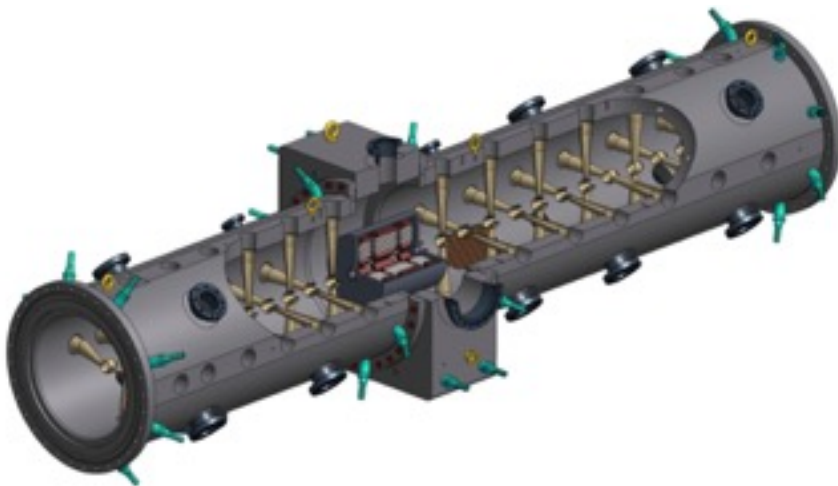
- Investigations of buncher cavities started a long time ago
- General layout is clear
- Final simulations and technical layout can be done quickly
- No major effect on the overall costs or time schedule

P-LINAC STATUS

CH CAVITIES

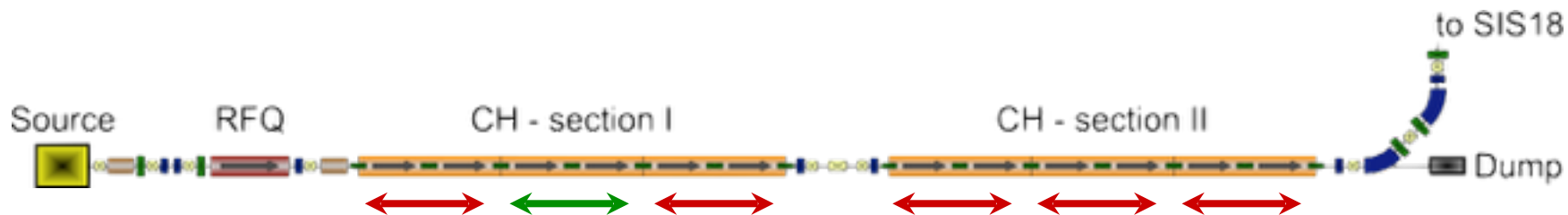


- CH prototype cavity arrived at GSI end of 2013
- Lots of small technical issues concerning plating could be investigated and solved
- New production techniques have been evaluated
- Cavity is now ready for final low level RF measurements
- High power tests may be performed, when infrastructure is ready in early 2016



P-LINAC STATUS

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COUPLED CH PROTOTYPE

BRIEF HISTORY - PRODUCTION

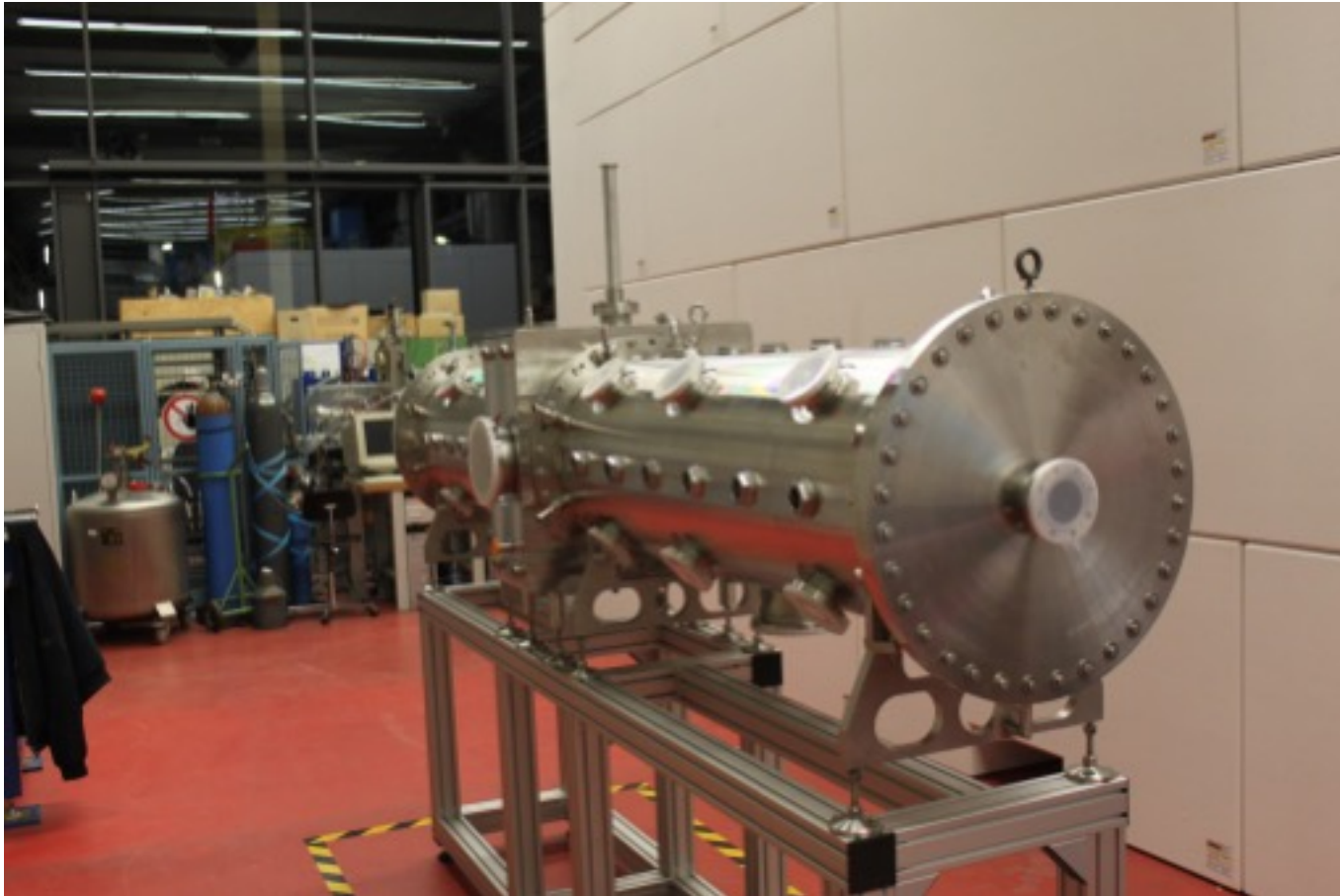
2009



COUPLED CH PROTOTYPE

BRIEF HISTORY - TUNING

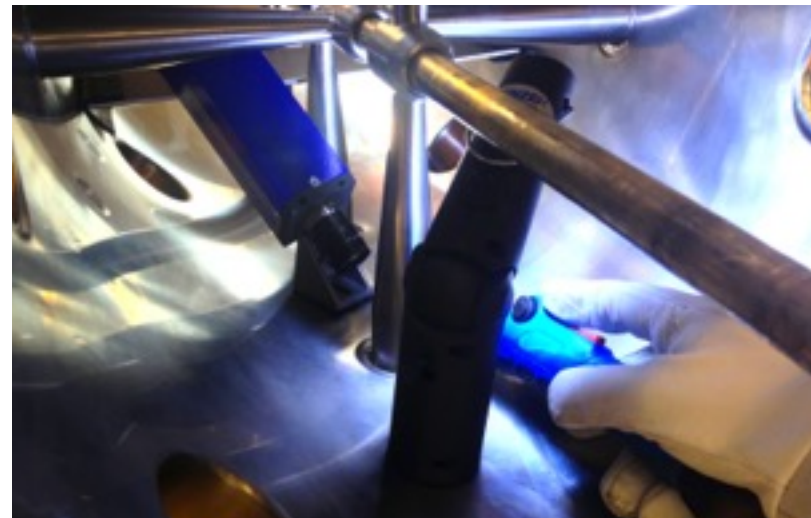
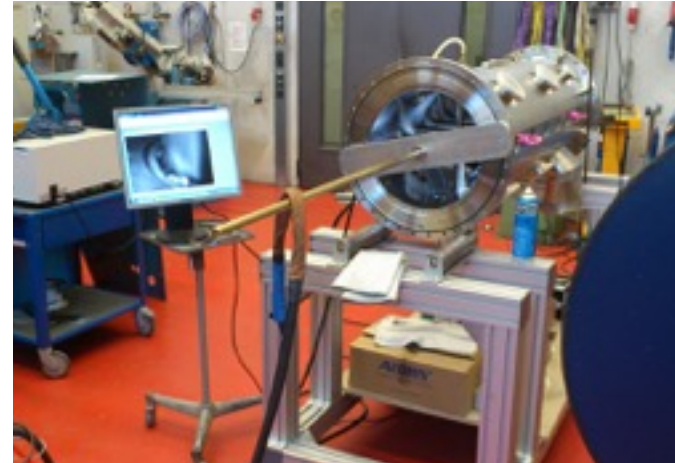
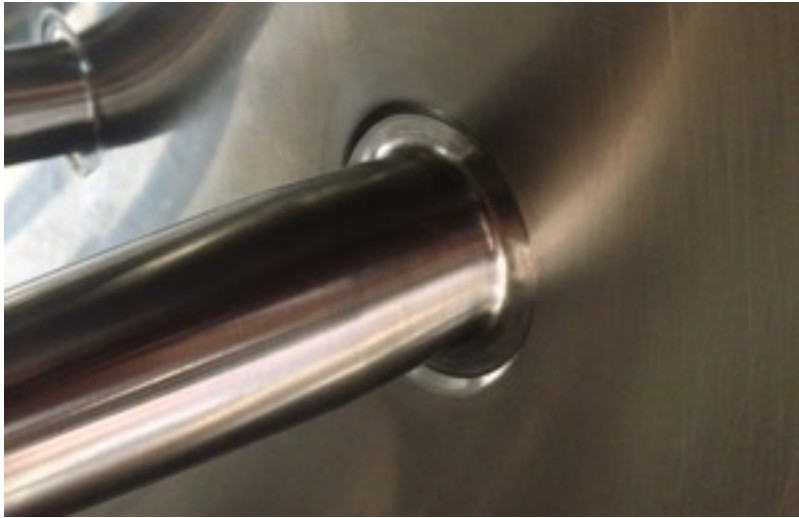
2011



COUPLED CH PROTOTYPE

BRIEF HISTORY - WELDING

2013



COUPLED CH PROTOTYPE

BRIEF HISTORY - ASSEMBLING

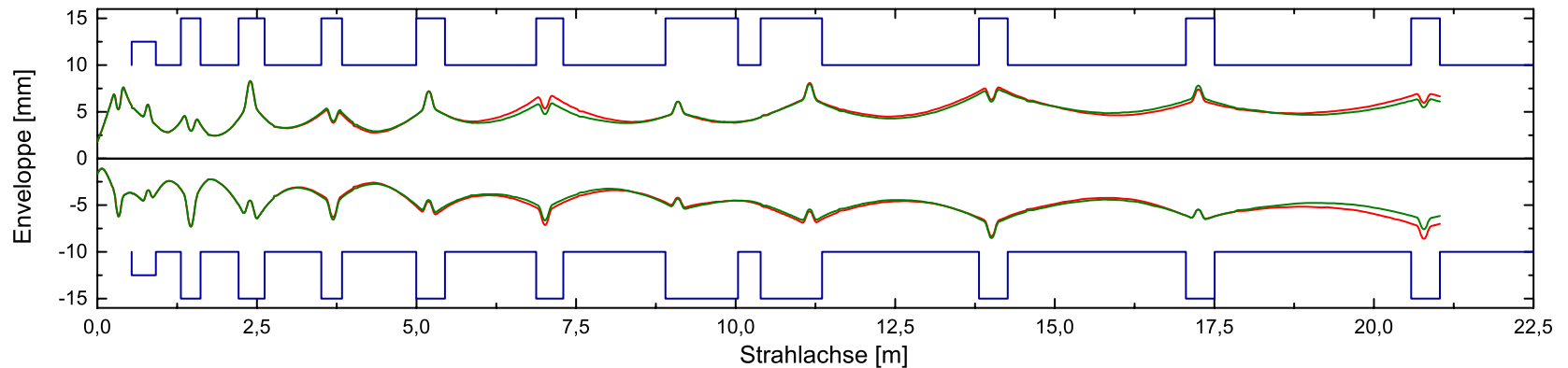
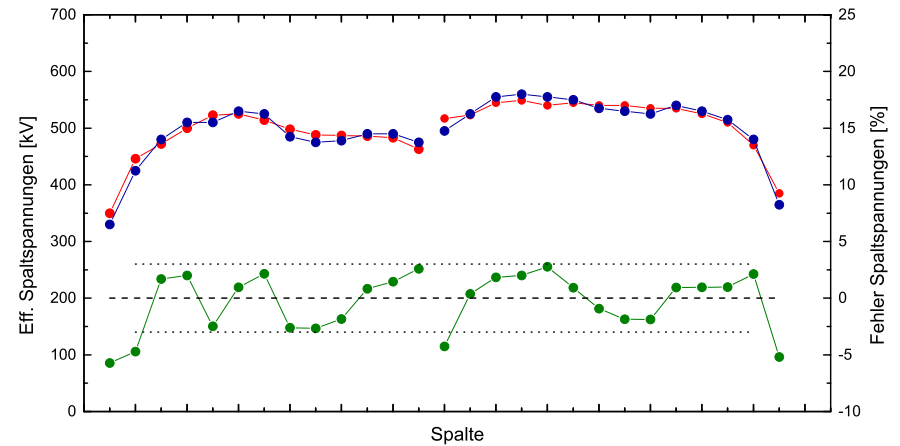
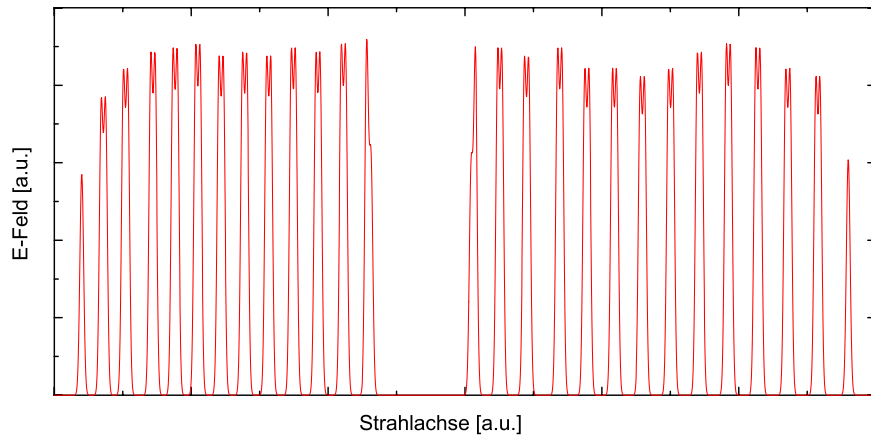
2014



COUPLED CH PROTOTYPE

BRIEF HISTORY - MEASUREMENTS

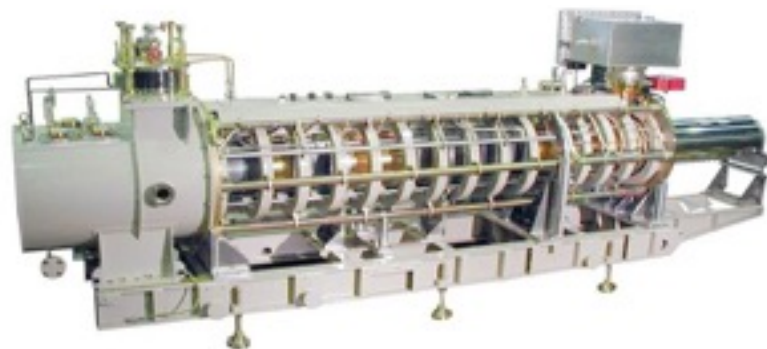
2015



Measurements proofed the capability of KONUS beam dynamics and coupled CH Cavities

P-LINAC STATUS

RF TEST STAND AND KLYSTRON

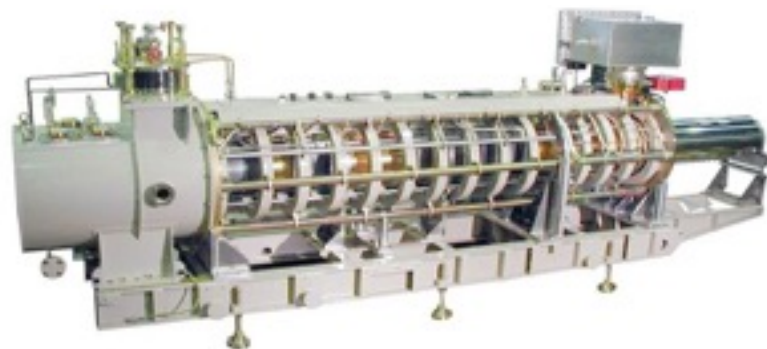


Toshiba Klystron 3740A

- Peak power of 3.0MW
- No R&D related costs
- Delivery in 2008

P-LINAC STATUS

RF TEST STAND AND KLYSTRON



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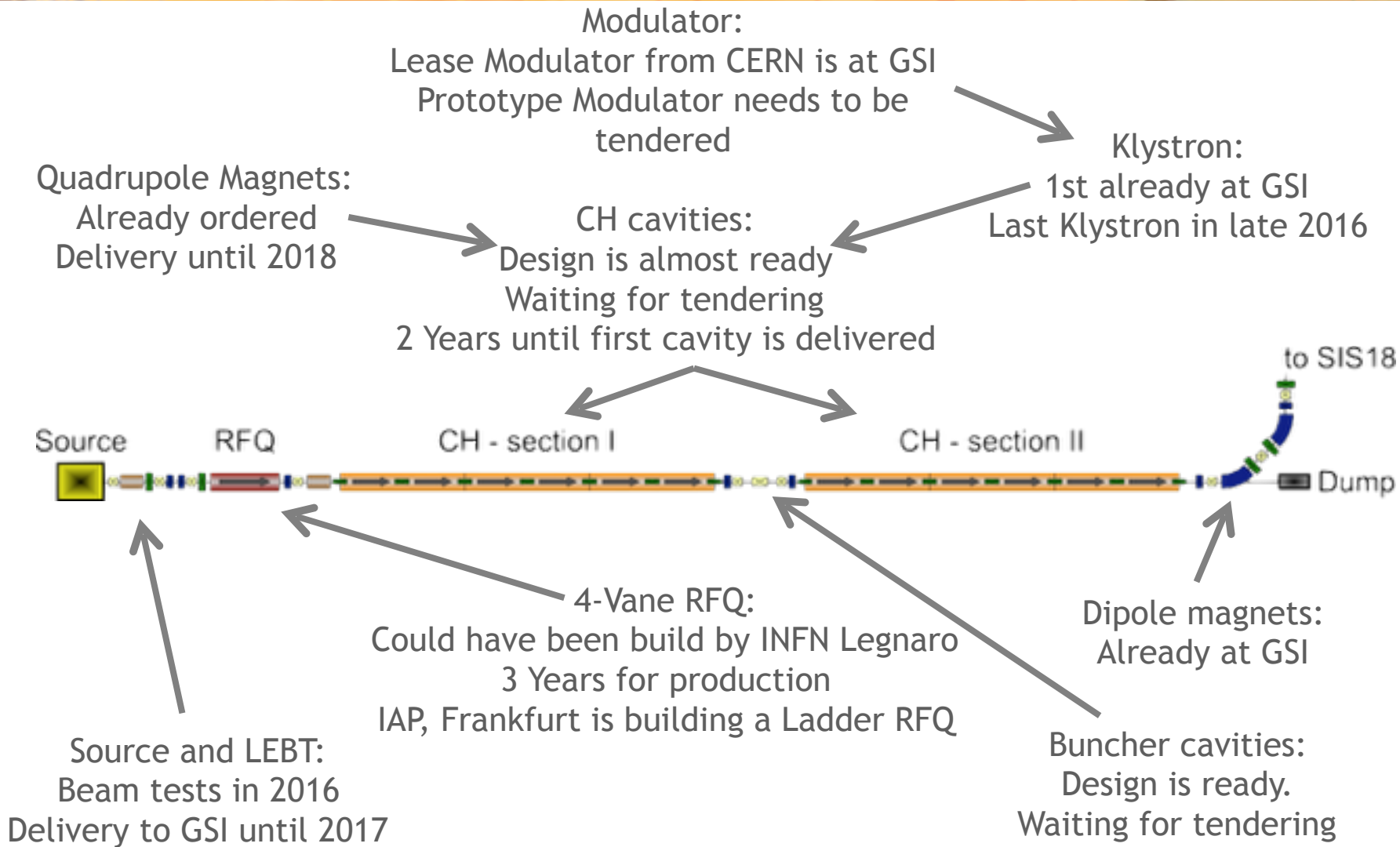
RF TEST STAND AND KLYSTRON



- 1st Thales Klystron arrived at GSI
- Six more Klystrons will be ready until end of 2016
- CERN modulator arrived and is under operation
- GSI modulator design is under preparation based on the CERN Layout
- 45kW amplifier for the buncher successfully tested on resonant load

P-LINAC STATUS

OVERVIEW OF MAJOR COMPONENTS





THANK YOU FOR YOUR ATTENTION