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DIPARTIMENTO  
di MATEMATICA  
e INFORMATICA

# HSMDIS performance on the ESS ion source

(High Stability Microwave Discharge Ion Source,  
European Spallation Source)

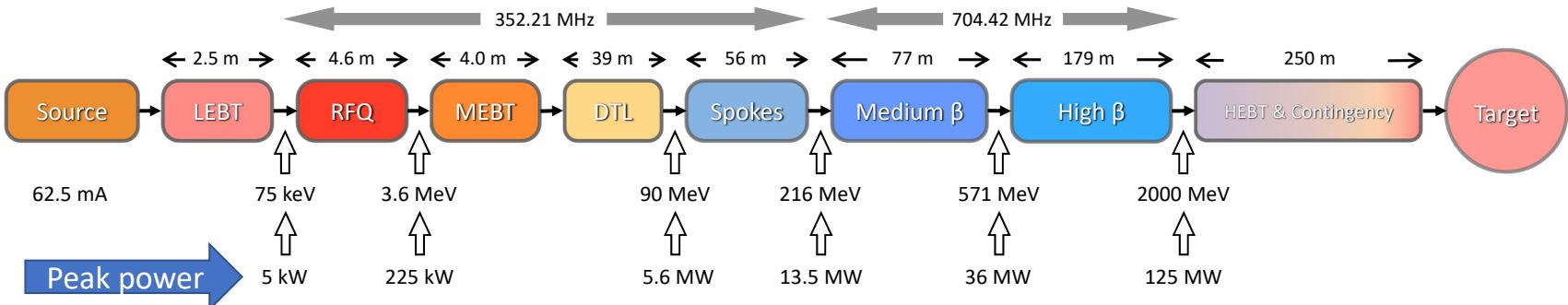
L. Neri, L. Celona, S. Gammino, O. Leonardi, G. Castro, A. Miraglia, *INFN-LNS Catania Italy*  
F. Grespan, M. Comunian, L. Bellan, C. Baltador, *INFN-LNL Legnaro Italy*  
B. Jones, E. Laface, A. Gacia Sosa, R. Miyamoto, *ESS Lund Sweden*

# Beam current control



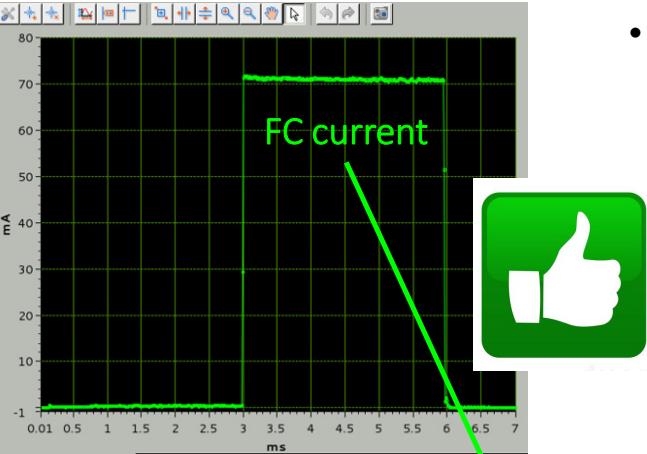
European Spallation Source  
in Lund (Sweden)

Proton Source and LEBT  
provided by  
INFN-LNS in Catania (Italy)

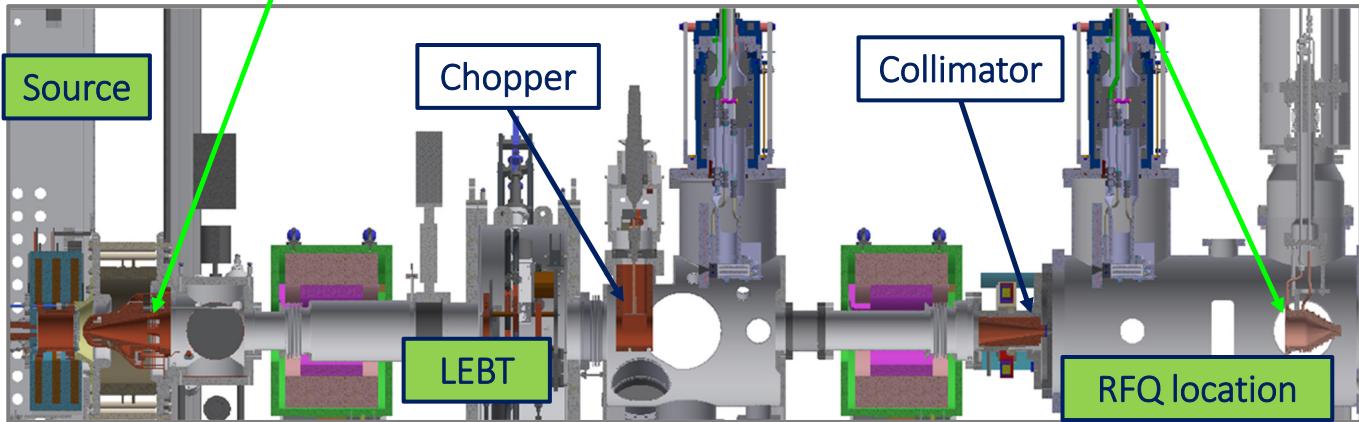


- Beam transport verification
  - Beam acceleration verification
  - Target verification
  - Neutron instrumentation
- Beam pulse duration modulation
  - Beam intensity modulation

# Chopper beam pulse duration modulation



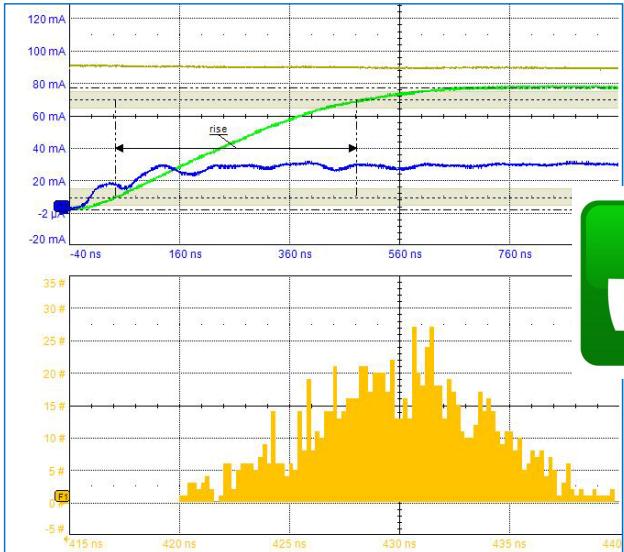
- Beam transition form 100% when it is off to 0% when it is on



# Chopper beam pulse duration modulation

- Beam transition from 100% when it is off to 0% when it is on
- Transition speed of about 500 ns

Beam pulse rise time: 430ns

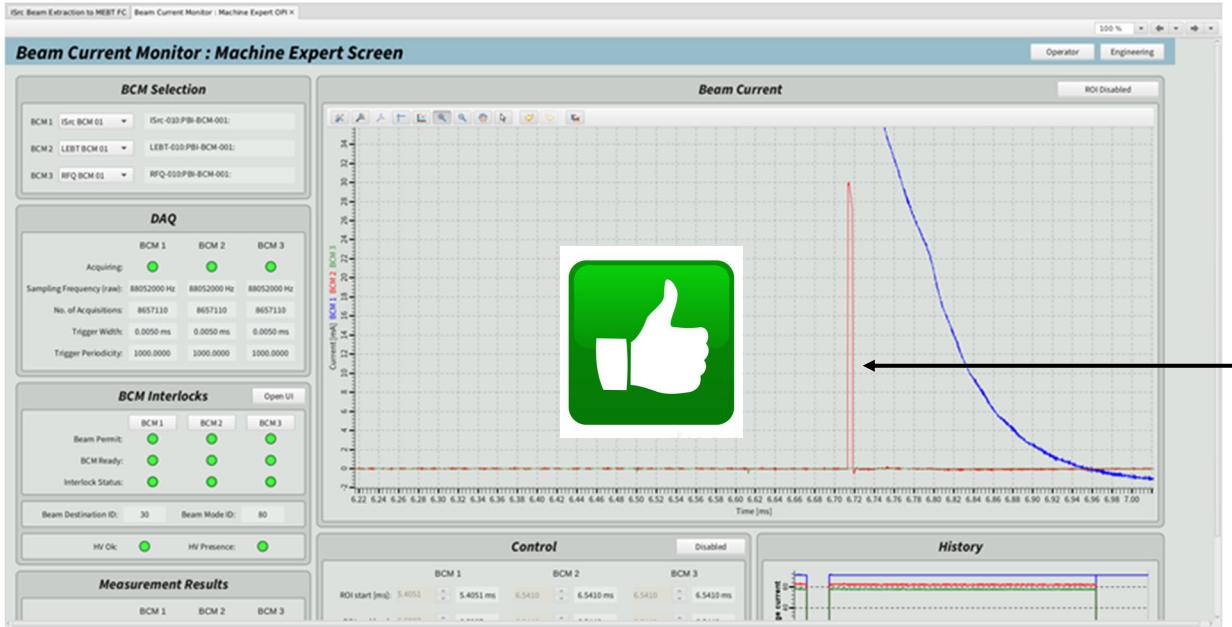


Beam pulse fall time: 519 ns



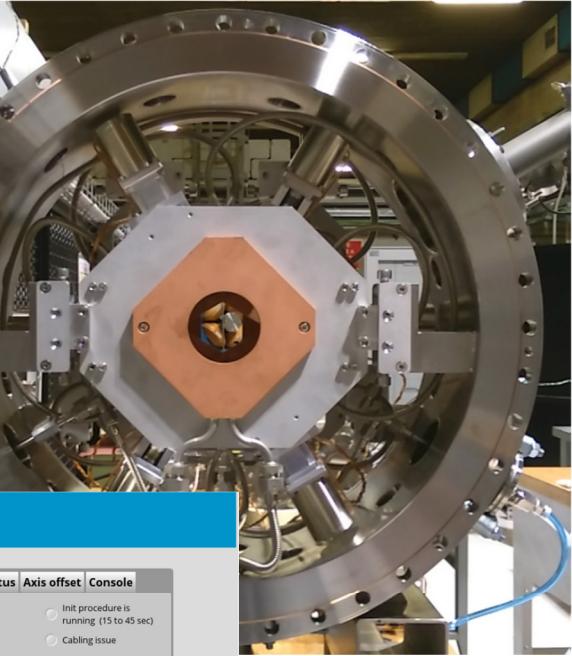
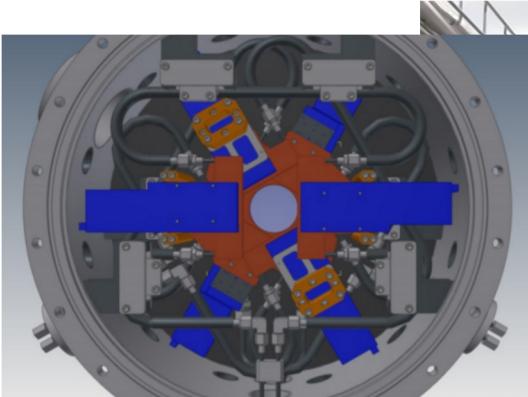
Beam pulse shape measured with the ACCT located at the end of the LEBT

# Chopper beam pulse duration modulation



- Beam transition from 100% when it is off to 0% when it is on
- Transition speed of about 500 ns
- Beam pulse duration from 100% pulse length to a few 10  $\mu$ s pulse duration

# Beam intensity modulation with IRIS



LEBT - iris

Drive only flat blades with this software !

User inputs   Motors status   Axis offset   Console

Iris moving    Init procedure is running (15 to 45 sec)  
 Aperture in mm    Cabling issue  
50   Velocity  
Last aperture set   50 mm  
Center in mm   Emergency stop  
Axis X: 5   Y: -4  
Legend:  
No limits (hard and soft) hitten  
limit min or max hitten  
limit max hitten  
Switches not connected  
Absolute center  
New center  
Aperture limit

Back of the iris

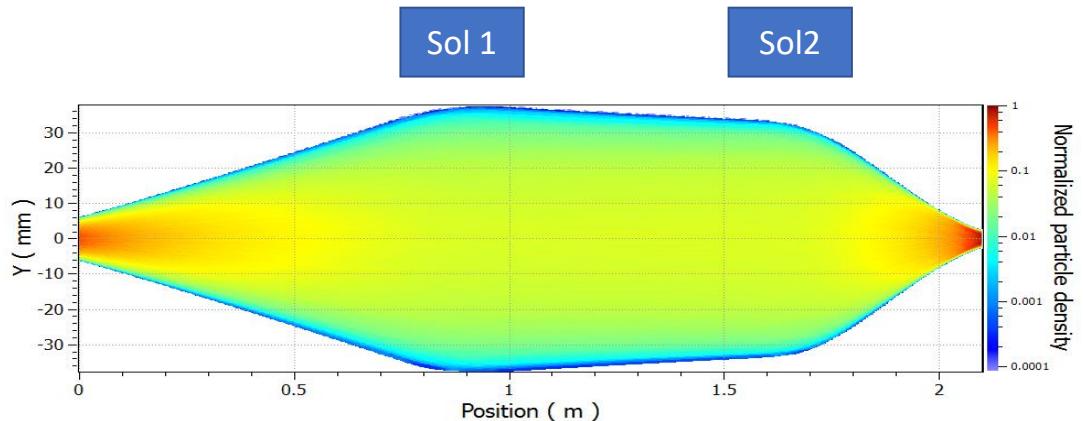
- Beam modulation from 100% when it is fully opened to 2% when it is at 6mm aperture diameter



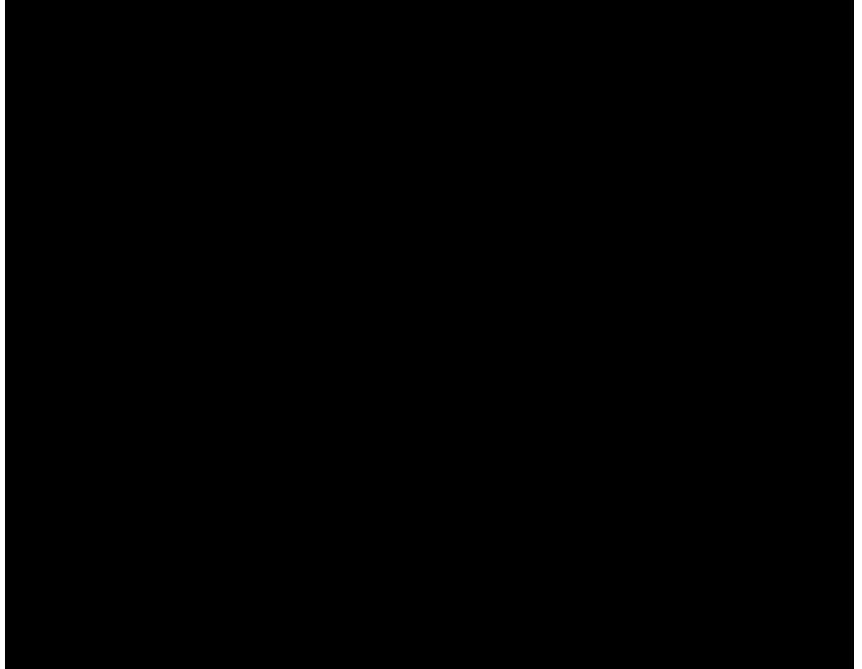
# Beam intensity modulation with first solenoid

If beam out of the first solenoid do not enter in the acceptance of the latter solenoid part of the beam is lost in the LEBT walls

- Beam modulation from 100% when it is fully opened to 25% when it is switched off



# Several thousand of source magnetic configurations were tested during the commissioning at INFN-LNS



40192 configurations  
10 seconds each  
=  
4.7 days

In the graphical interface: **average**, **maximum** and **minimum** are evaluated, and the trend showed for the beam pulse between 2.9 ms and 5.9 ms .

## From plasma modelling :

Field @ 0 mm ==> 835:20:975 G  
Field @ 35 mm ==> 795:40:1395 G  
Field @ 84 mm ==> 675:40:1995 G  
H2 flow ==> 2:1:5 SCCM  
RF power ==> 600:200:1200 W

**40192 configurations**

## From evidence of stable configurations:

Field @ 0 mm ==> 795:20:1015 G  
Field @ 35 mm ==> 515:40:1075 G  
Field @ 84 mm ==> 235:40:1075 G  
H2 flow ==> 3.35:0.25:3.85 SCCM  
RF power ==> 550:50:650 W

**15480 configurations**

## With Doppler Shift Measurement:

H2 flow ==> 3.5 SCCM  
RF power ==> 175:75:325 W

**5160 configurations**

# MDIS magnetic configuration was precisely identified and HSMDIS was discovered

A high-current low-emittance dc ECR proton source

Terence Taylor and John S.C. Wills  
 Chalk River Laboratories, AECL Research, Chalk River, Ontario, K0J 1J0, Canada

Received 18 June 1991

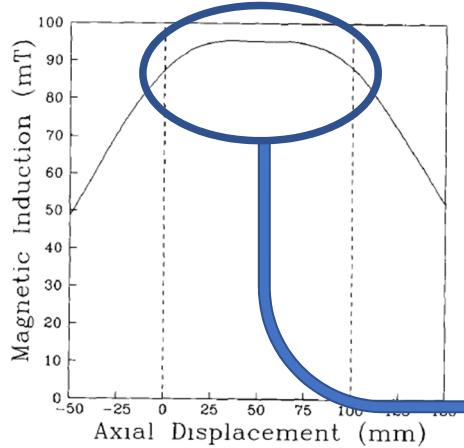
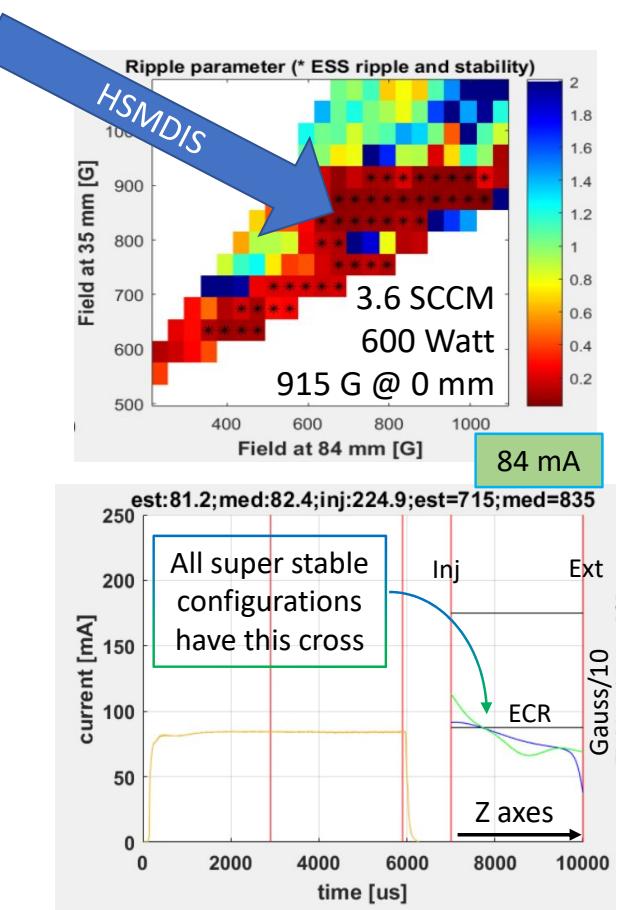
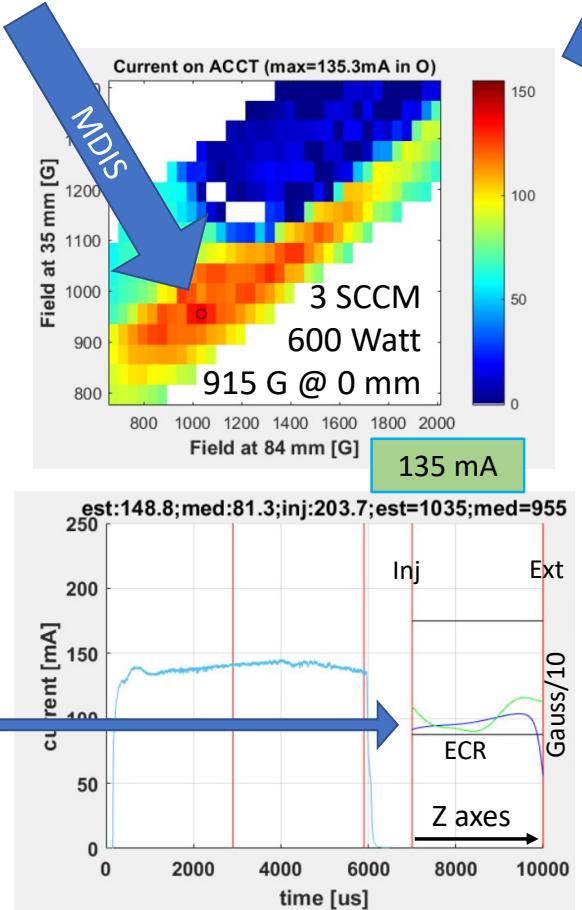
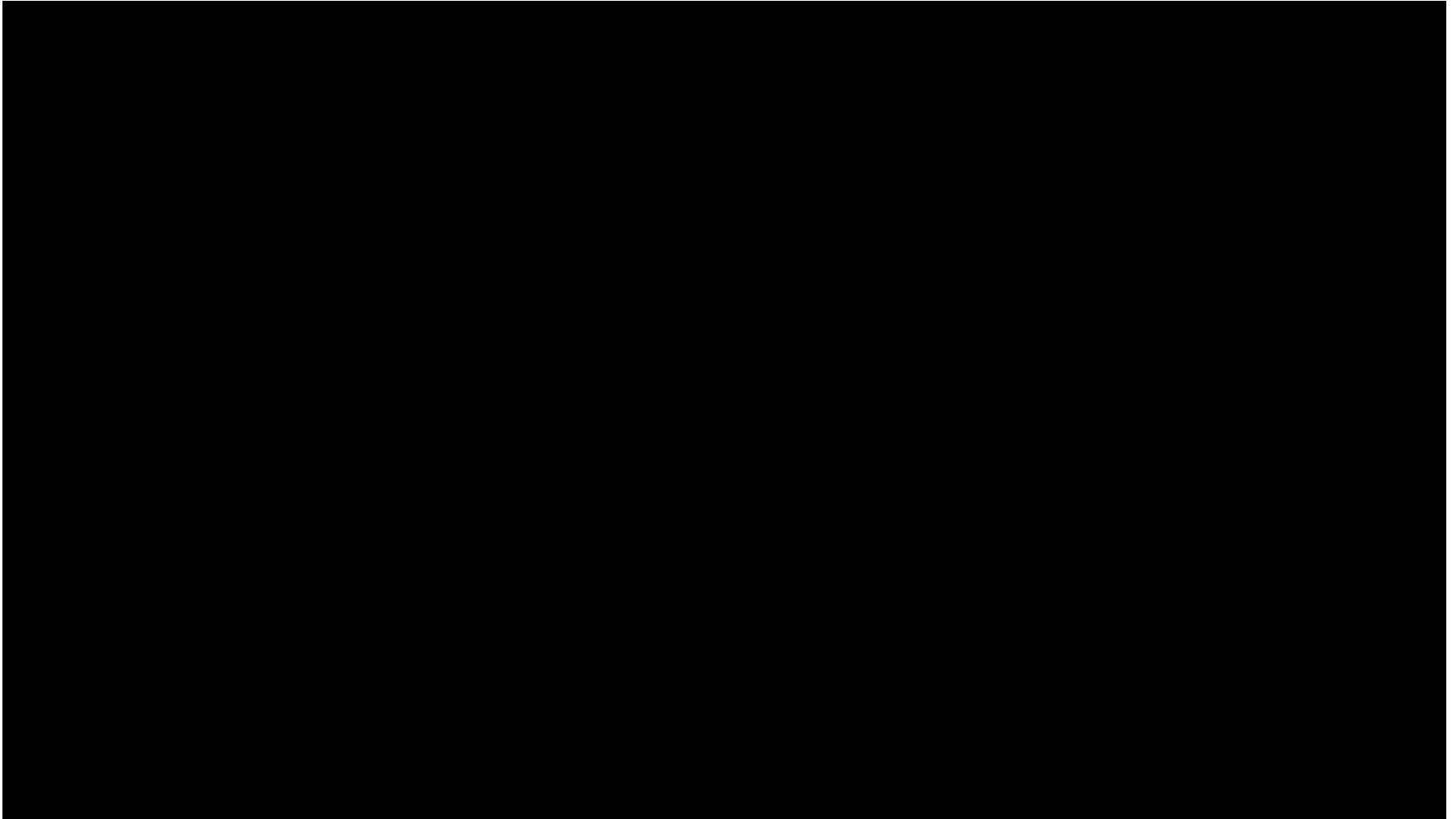


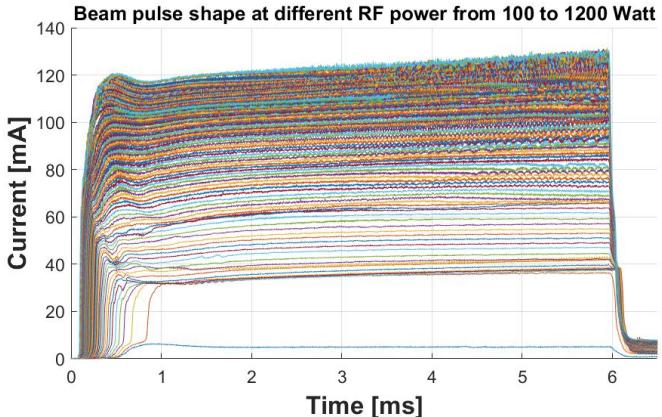
Fig. 3. Magnetic induction on the axis of the solenoids as a function of axial displacement from the microwave window. The dashed vertical lines define the axial extent of the plasma chamber.



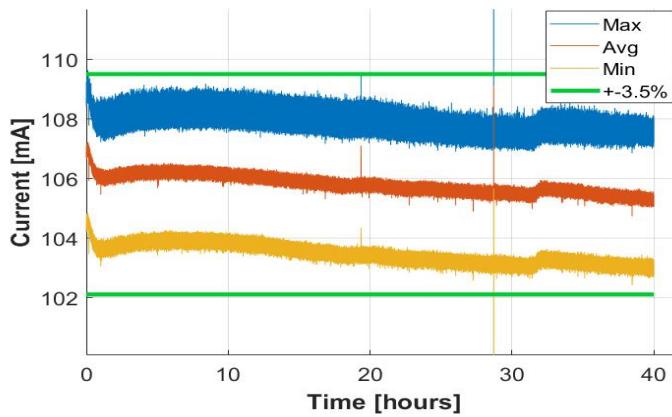


# Beam intensity modulation is an intrinsic property of HSMDIS magnetic configuration

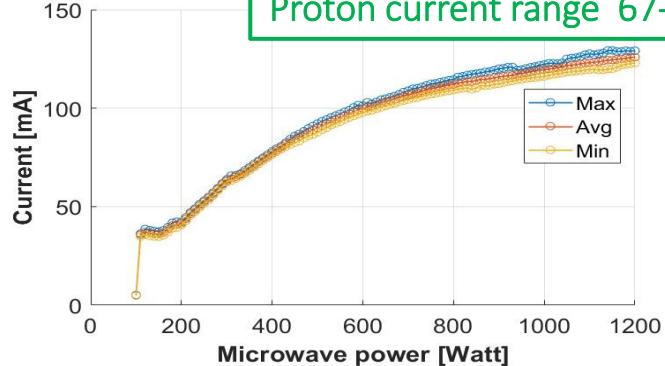
Intra-pulse stability <  $\pm 2\%$  SATISFIED



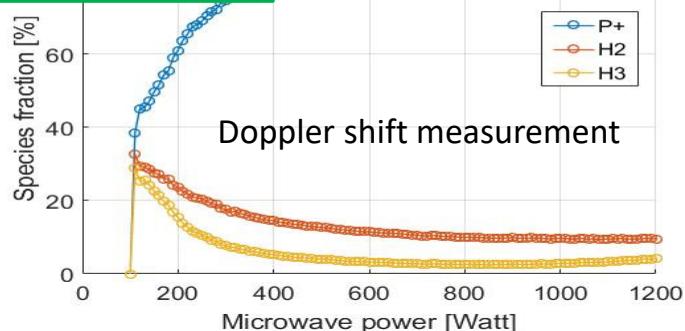
Pulse to pulse stability <  $\pm 3.5\%$  SATISFIED



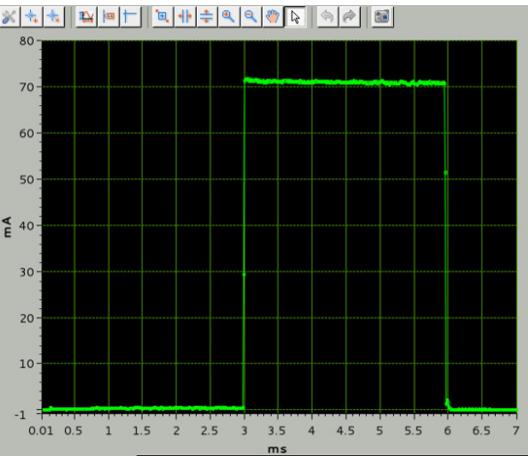
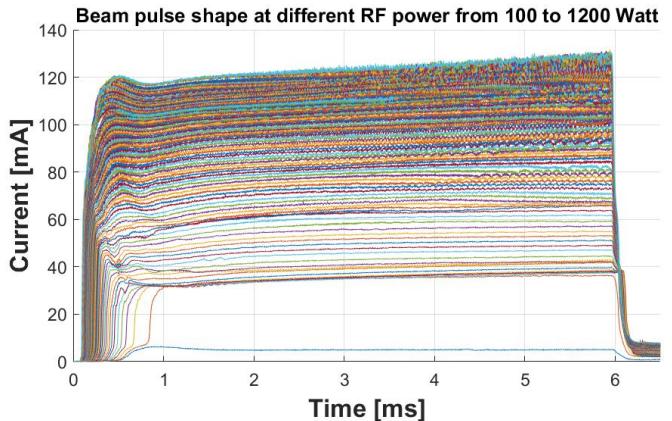
Proton current range 67-74 mA SATISFIED



Doppler shift measurement



# Conclusion



HSMDIS magnetic configuration

+

Chopper



all required beam modulation

**Additionally:** Iris can be removed from the LEBT → LEBT can be shorter and the residual beam space charge have less space to make bigger the LEBT emittance growth