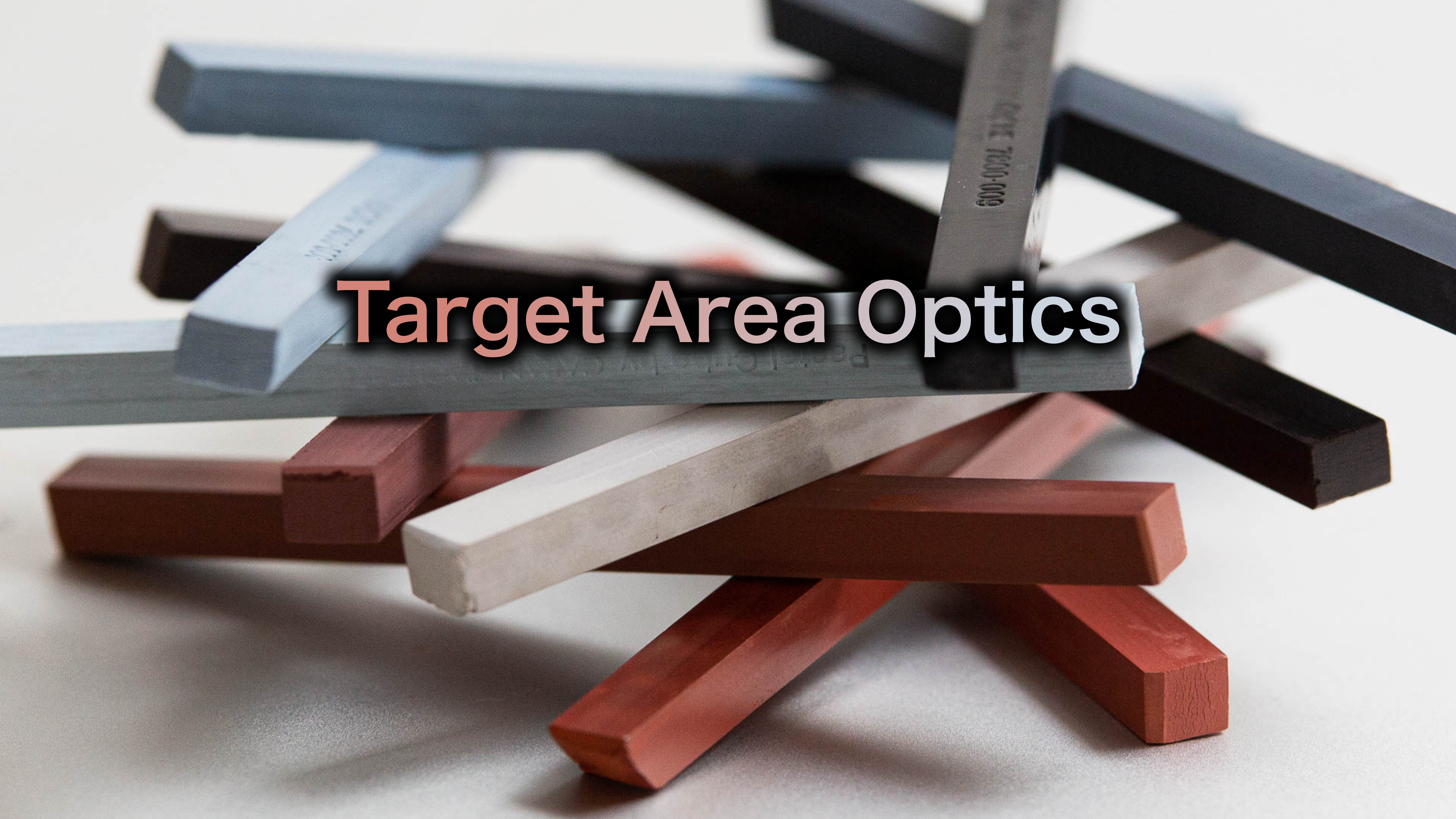
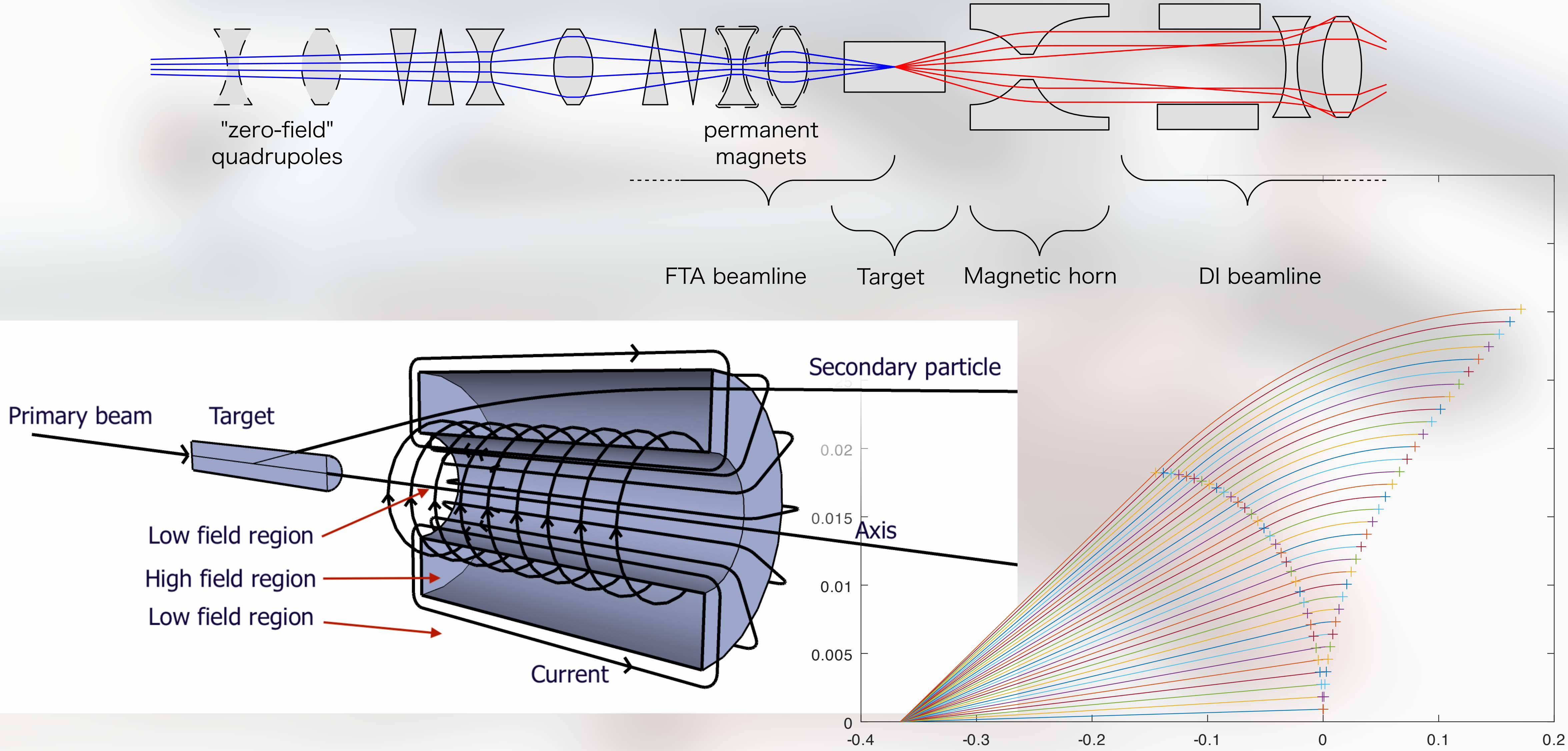
AD Target & Antiproton Intensities

Target Area Optics



Target area optical layout

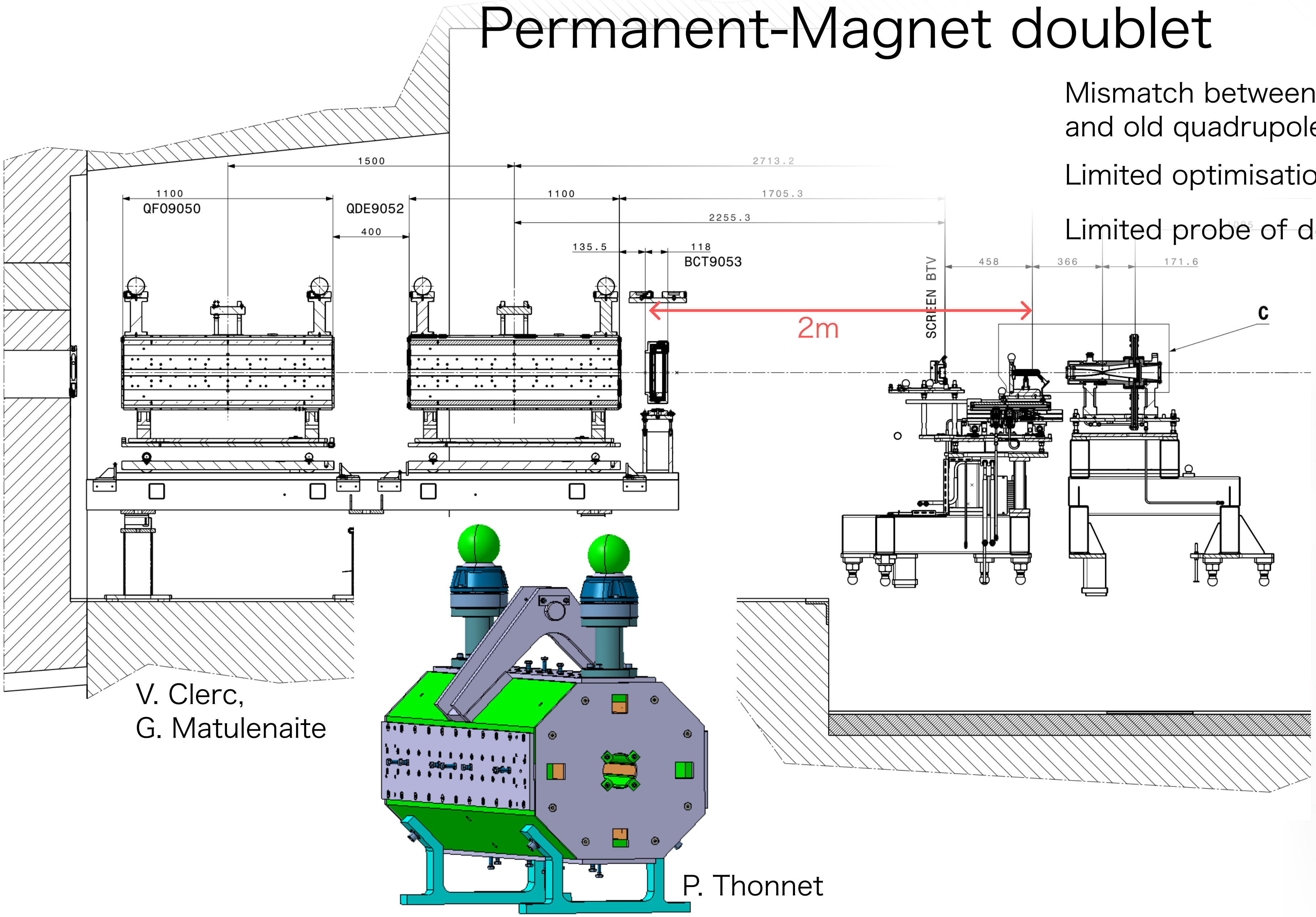


Permanent-Magnet doublet

Mismatch between new field (design value) and old quadrupoles

Limited optimisation of beam spot

Limited probe of downstream acceptance

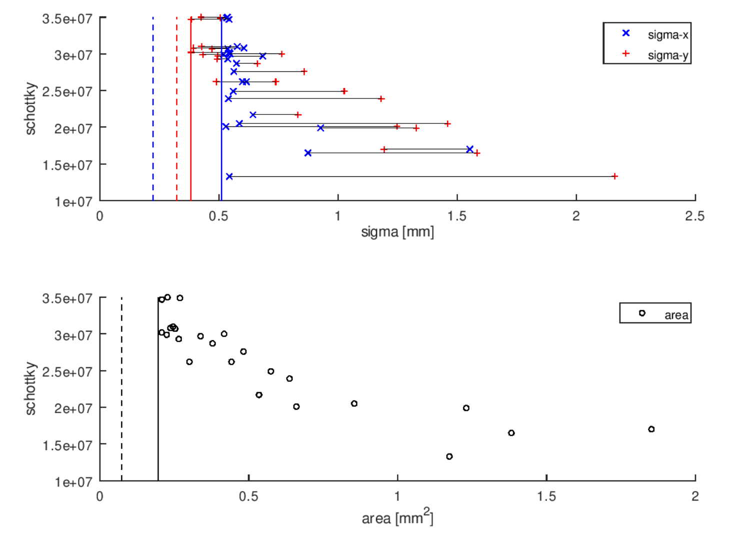


V. Clerc,
G. Matulenaite

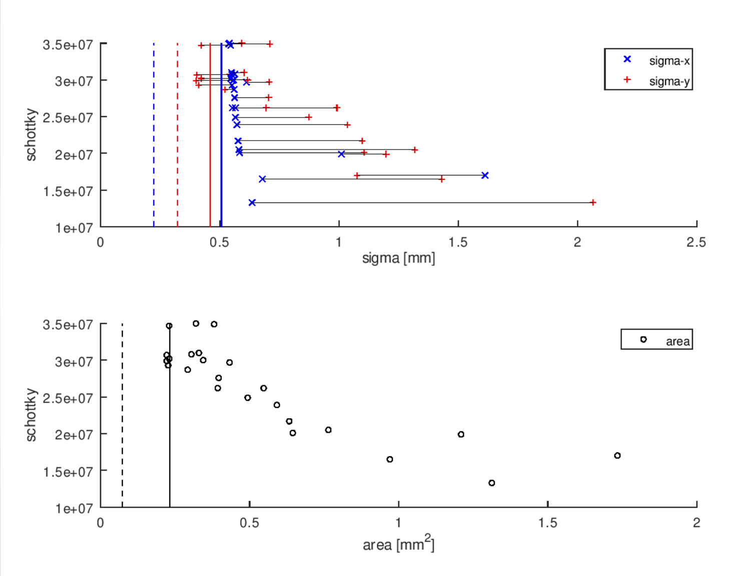
P. Thonnet

Downstream Acceptance : proton spot size

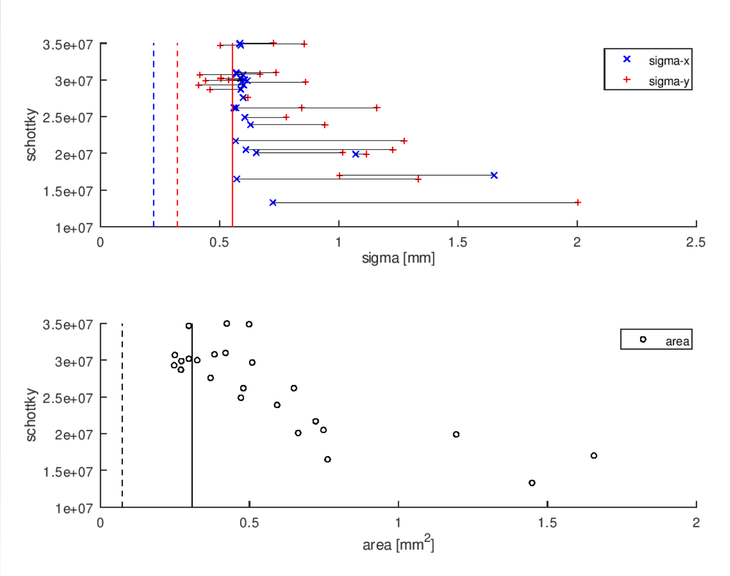
Pre-LS2 reports	x "size" = 1 mm	y "size" = 0.5 mm
Reference optics (MadX)	$\sigma_x = 0.55(5)$ mm	$\sigma_y = 0.4 - 1.0$ mm
Now (measured)	$\sigma_x = 1.27$ mm	$\sigma_y = 0.95$ mm



z = reference optics

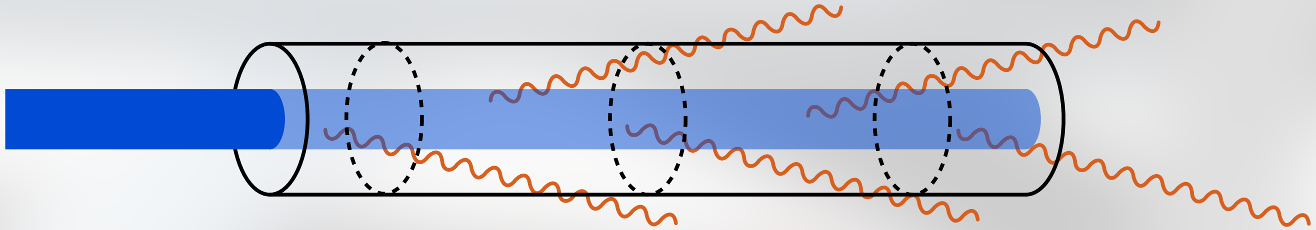


z = reference optics - 130 mm



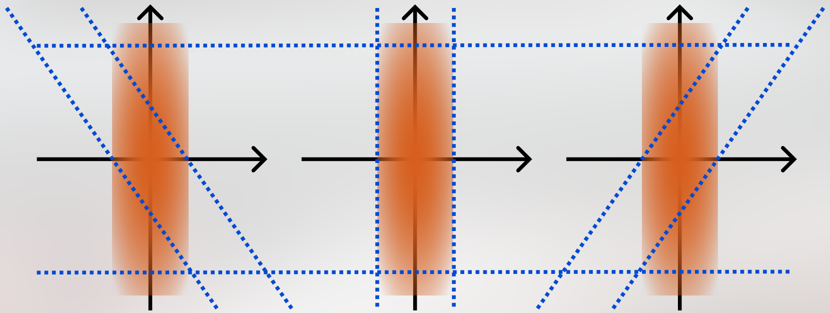
z = drawings

Downstream Acceptance



Primary beam

Measure acceptance from yield vs. proton σ_x σ_y



Secondary emittance vs z

50 % of maximum

maximum acceptance at focal point

50 % of maximum

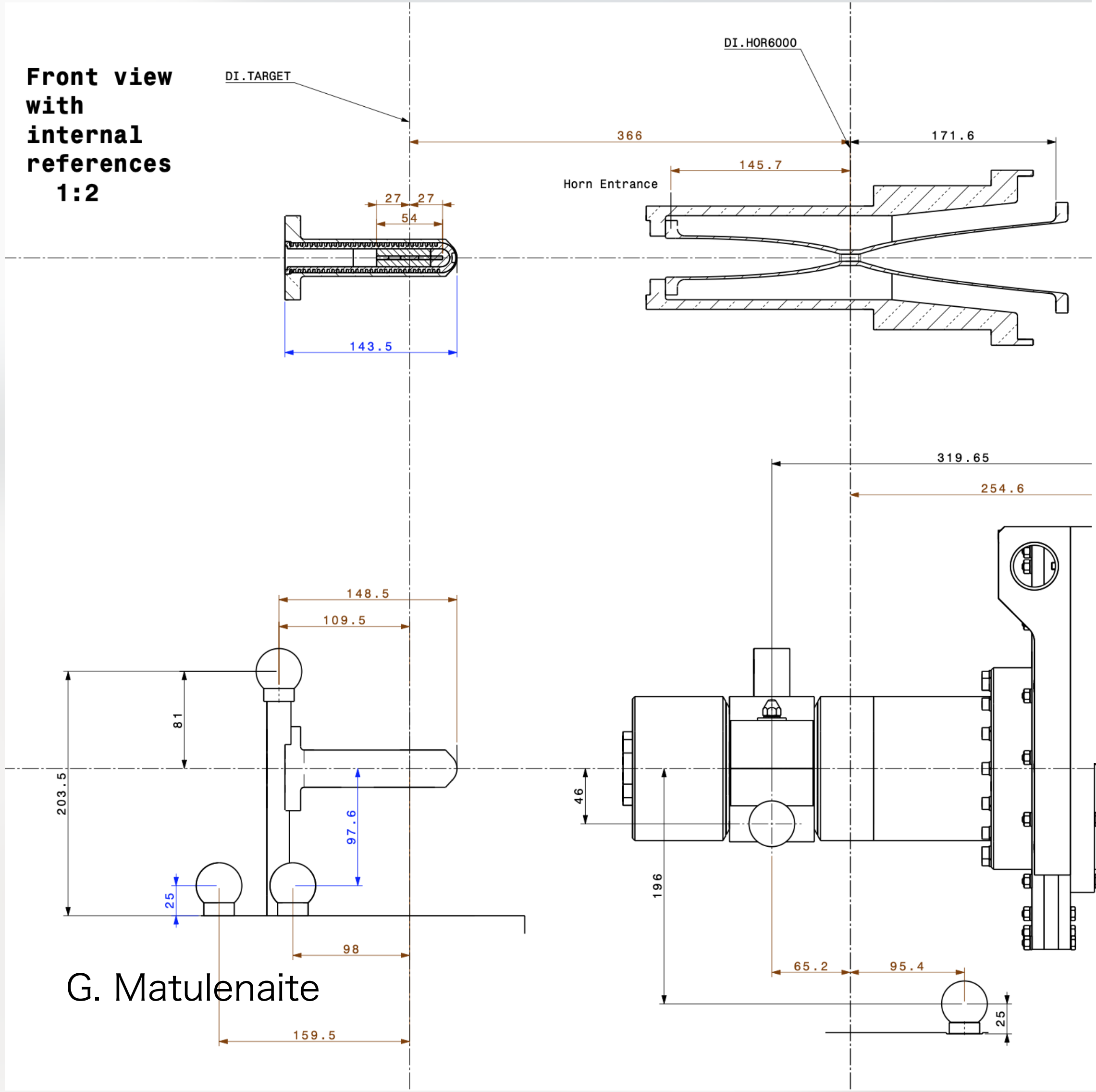
$\Delta z = 50$ mm
for acceptance
±1 mm , ±80 mrad

NB Overall effect is product of X-acceptance with Y-acceptance

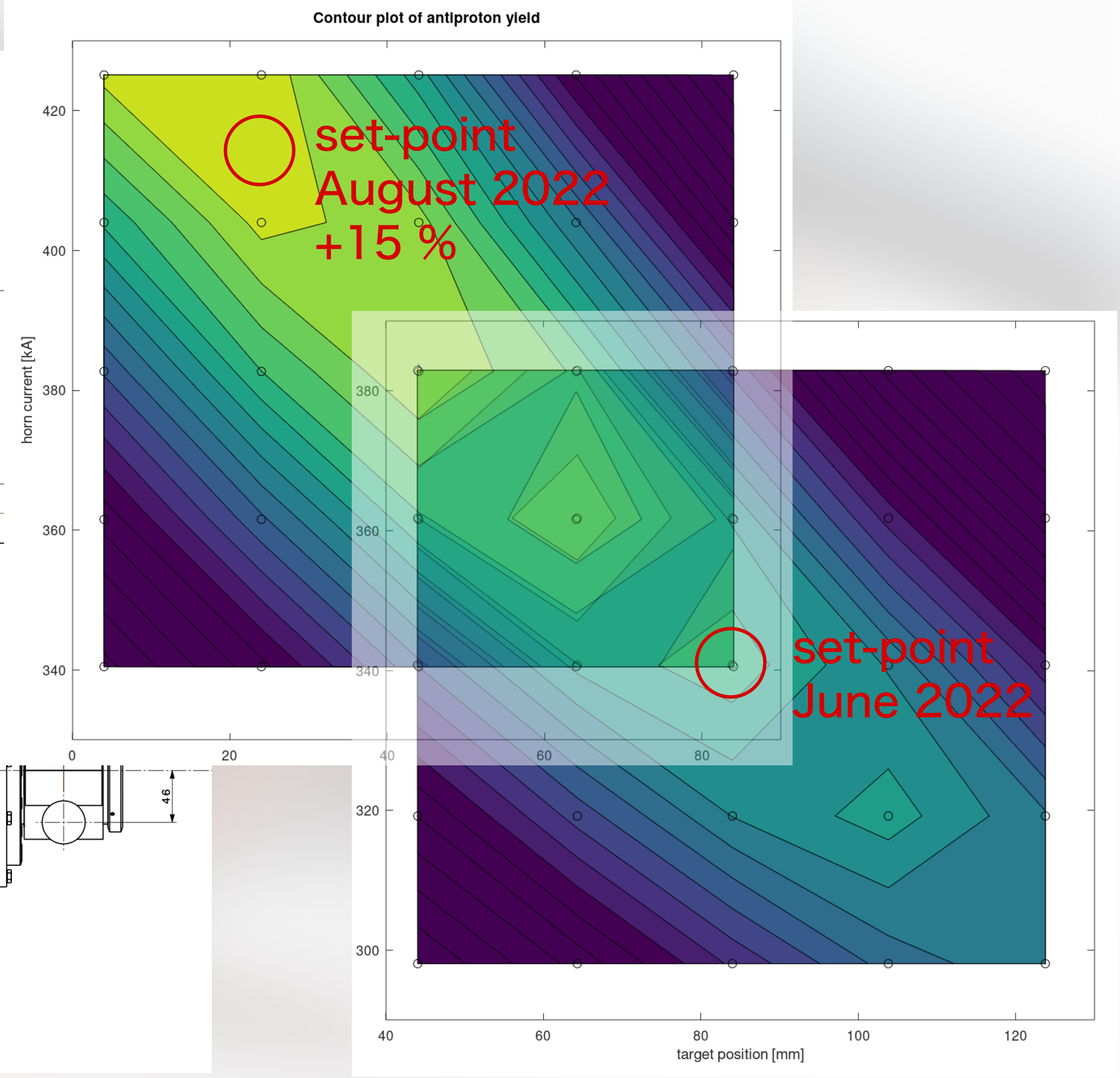
Target geometry directly related to downstream acceptance

Target Tuning

Target & horn tuning



G. Matulenaite

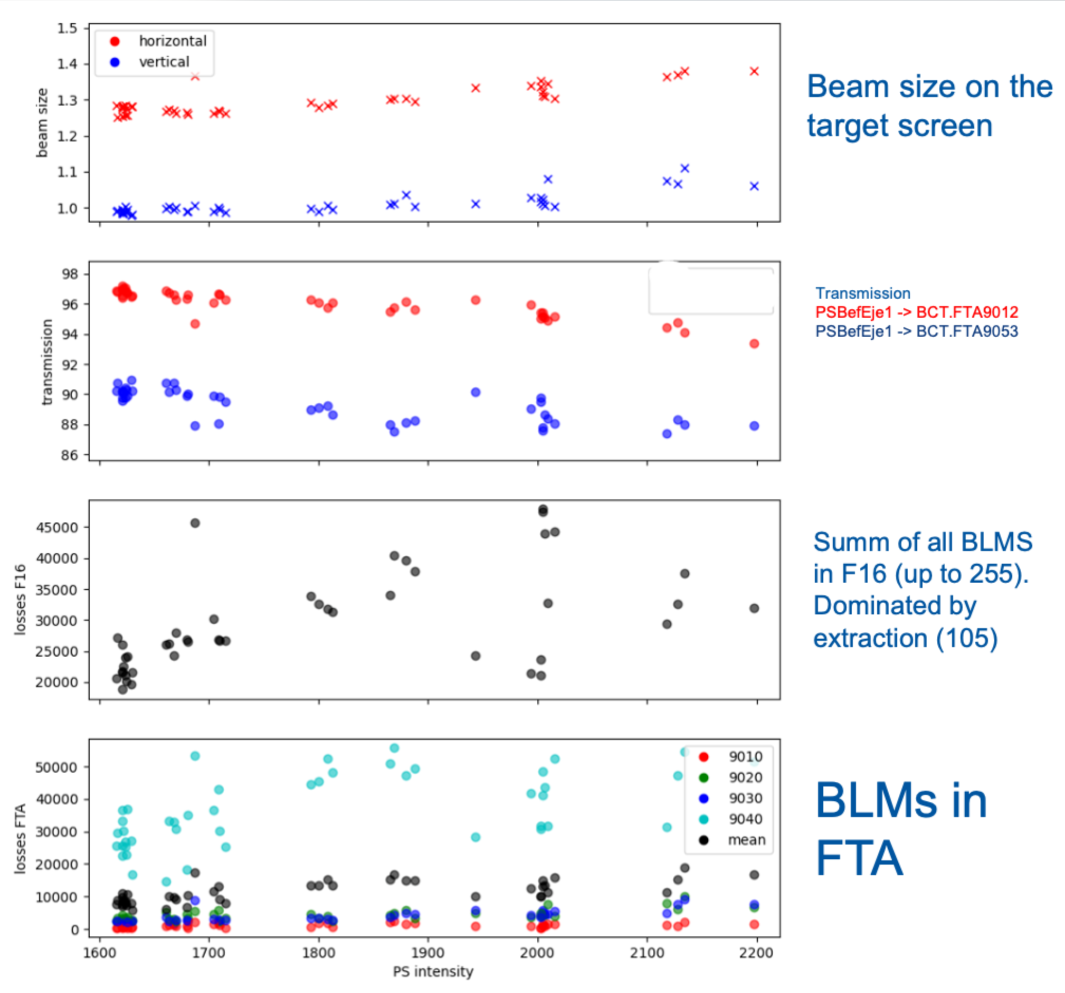


set-point
August 2022
+15 %

set-point
June 2022

Proton Intensity

Proton beam



Beam size on the target screen

Transmission
PSBefEje1 -> BCT.FTA9012
PSBefEje1 -> BCT.FTA9053

Summ of all BLMS in F16 (up to 255). Dominated by extraction (105)

BLMs in FTA

Y. Dutheil et al.

AD proton beam is 57 kJ per pulse (at 1.5e13 ppp)

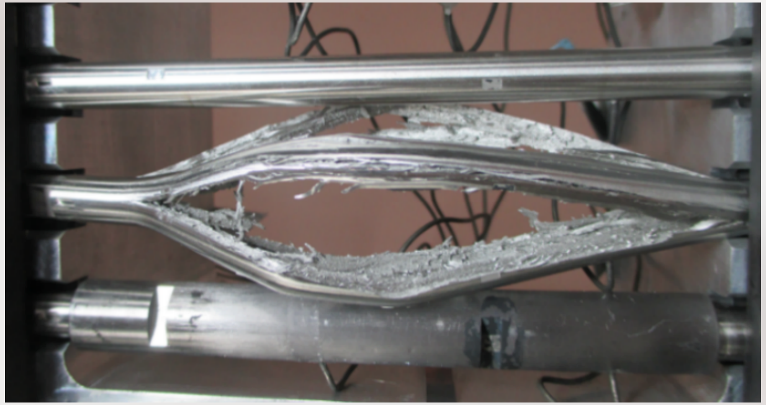
2.3% of beam energy is depositied in target core (Ir, 54mm)

Nominal intensity at target	1.5 x 10^{13}	
New available intensity at target	1.9 x 10^{13}	(+27%)
Beam spot size	+15%	

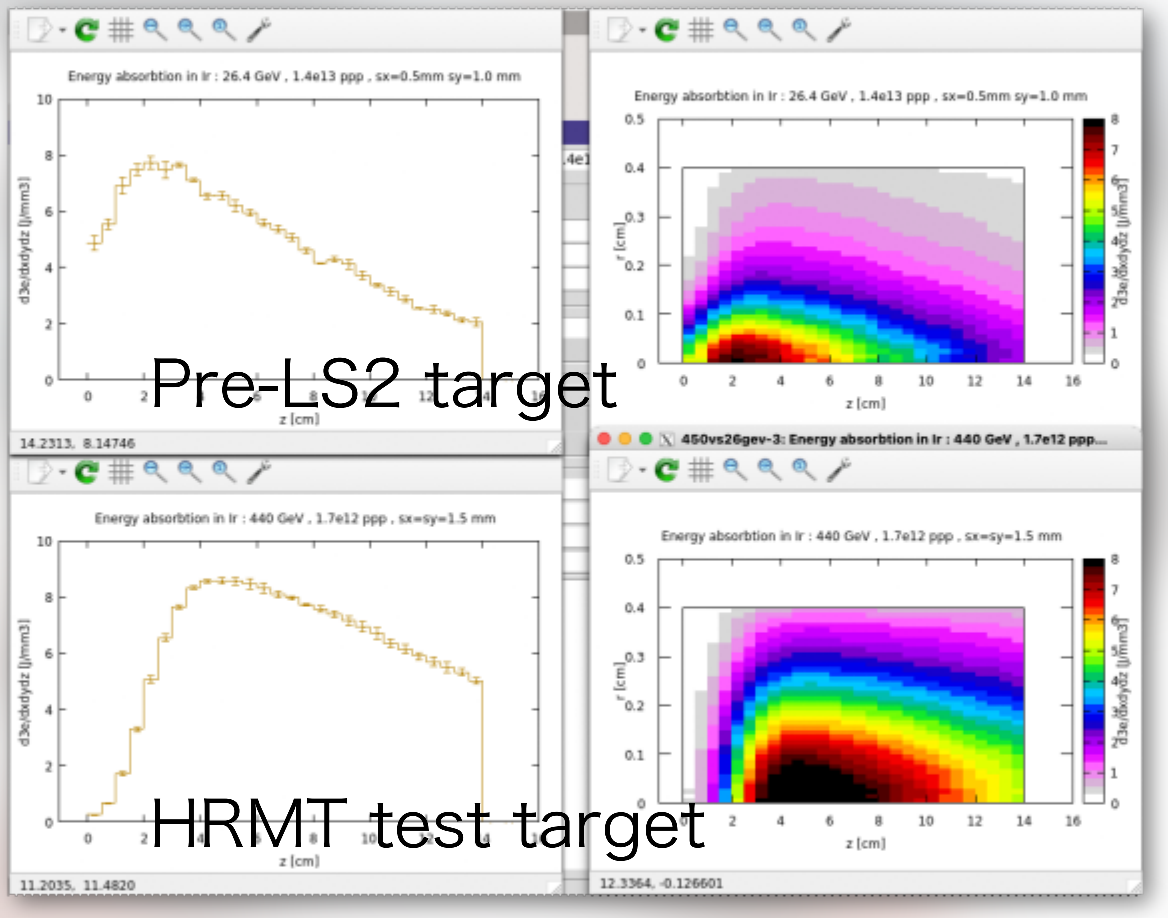
Iridium	Peak energy density 7.4 J/mm^3	
	Heat to MPT	>7.2 J/mm^3
Tungsten	Peak energy density 6.3 J/mm^3	
	Heat to MPT	12.4 J/mm^3

Proton intensity limits

Framatom



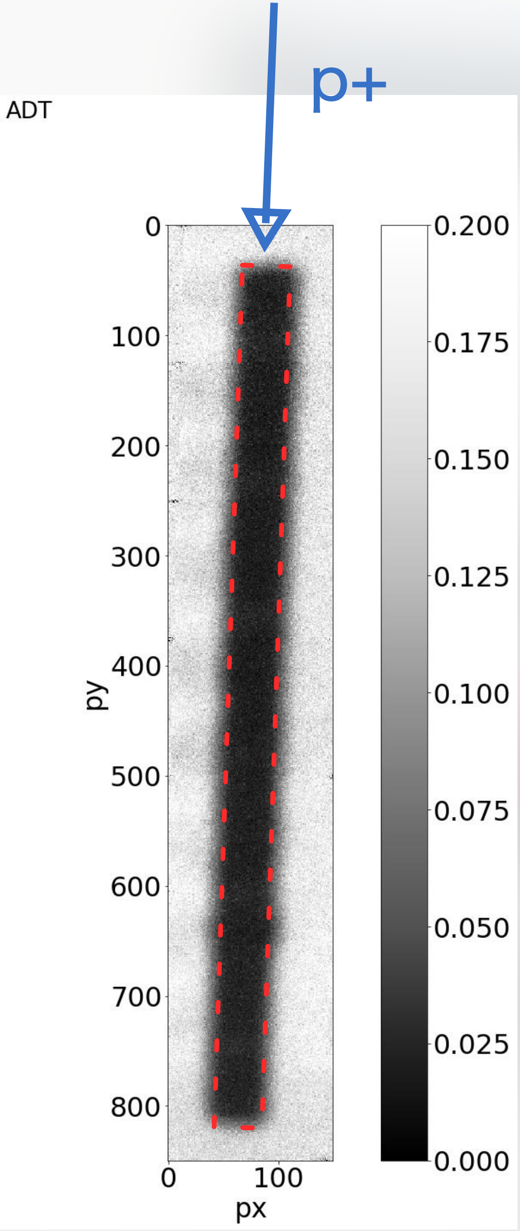
C. Torregrosa et al.



Pre-LS2 target

HRMT test target

Target examinations



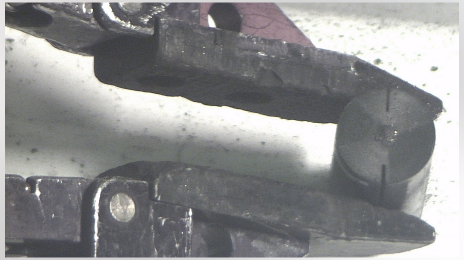
2021-2022 Target #1 irradiated 1.5e13 ppp

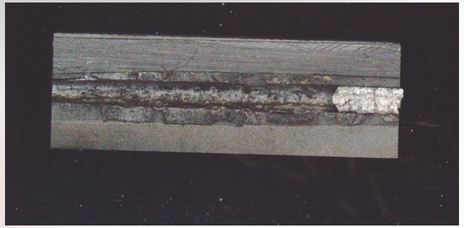
2022-2023 Target #2 irradiated >1.5e13 ppp

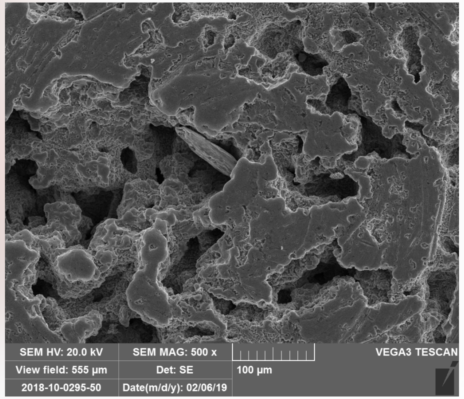
Hot-cell disassembly and microscopic examination

Comparison of target #1 & #2

Objective: determine cause of iridium fragmentation (resonant fatigue vs. prompt shock)







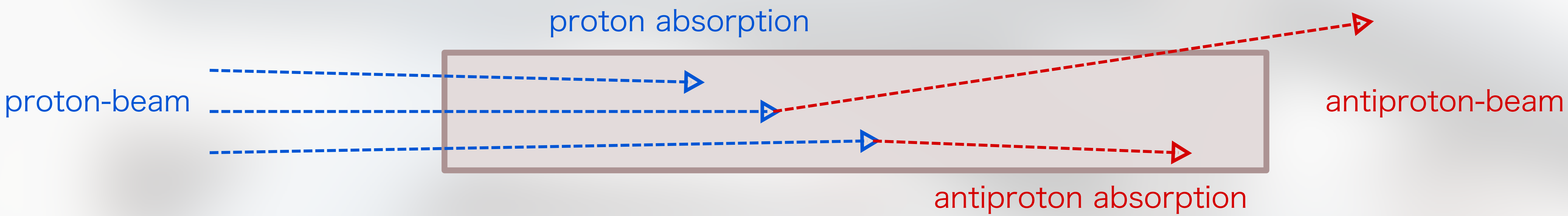
Neutron tomography at nToF

M. Bacak, A. Losko et al.

Framatom

Geometry and Materials

Antiproton production



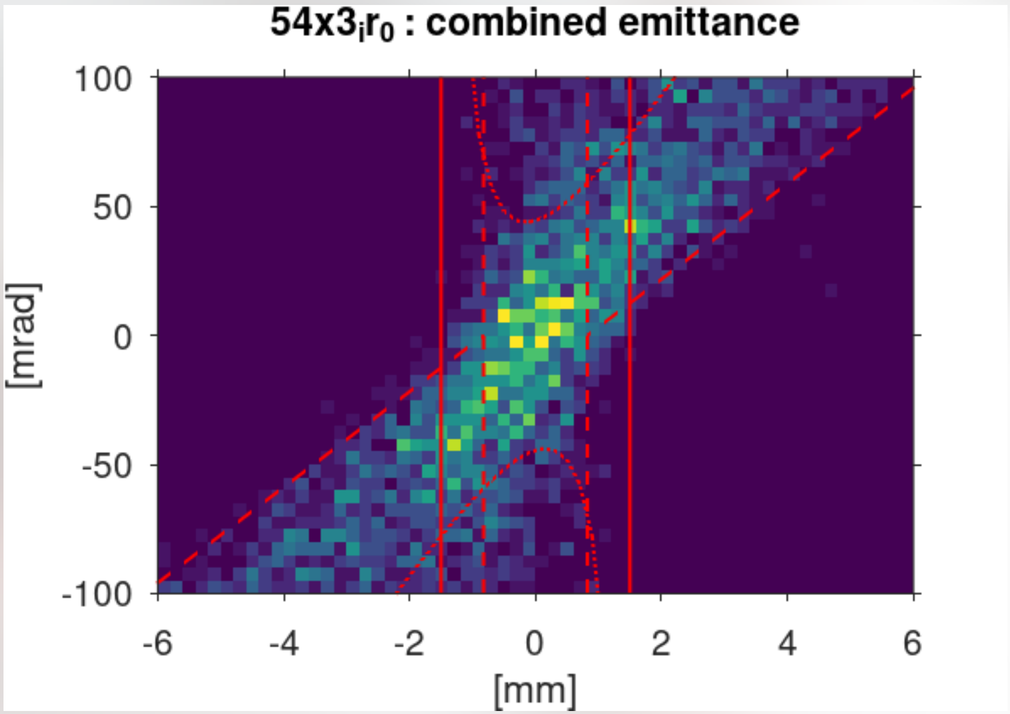
FLUKA + Custom Extension → Particle Trajectories

→ Data Cuts → Statistical Analysis

→ Phase-Space Plots

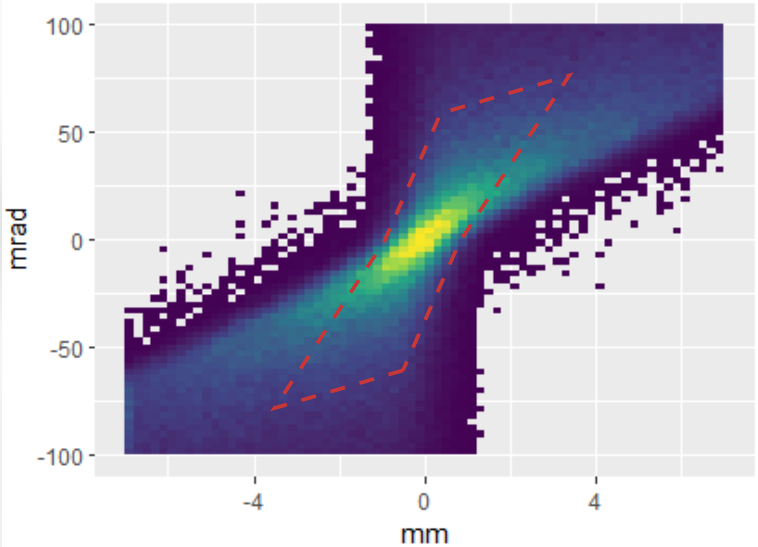
Objective : validate prototype targets prior to installation in ADT

Rare process : 3 p^- out for 10^6 p^+ in

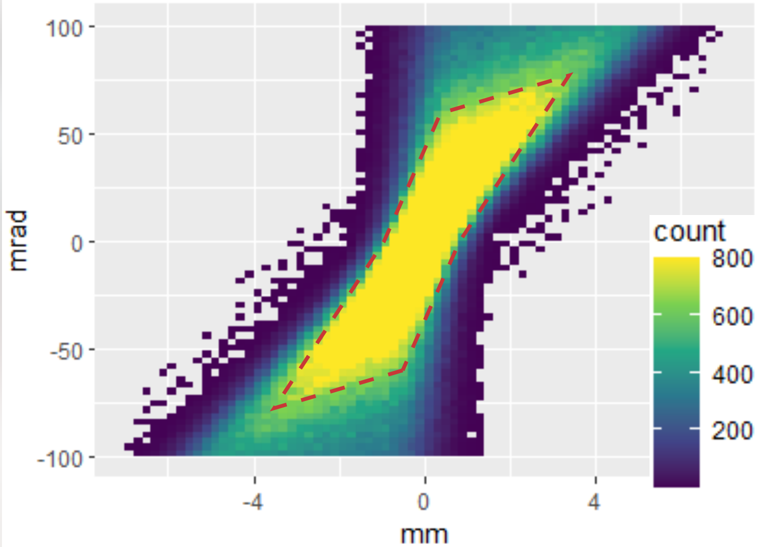


Antiproton emittance vs target geometry and material

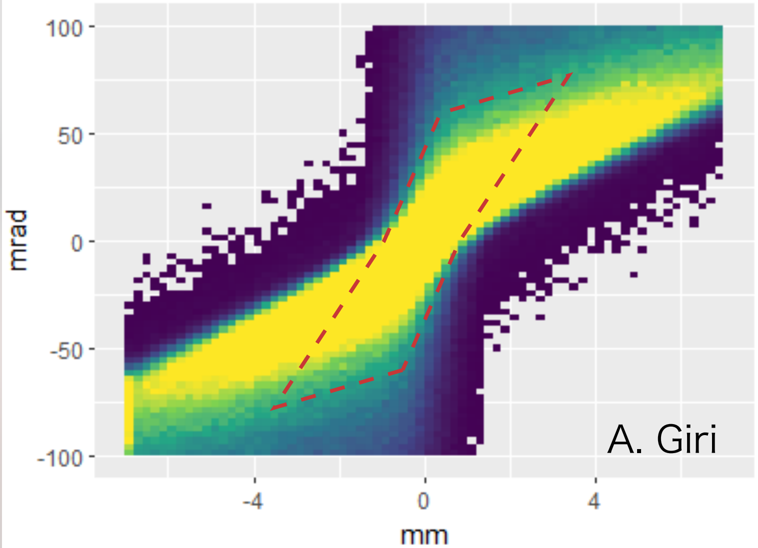
Long, half-density iridium target
108 mm x 3 mm



Standard iridium target
54 mm x 3 mm



Long, normal-density iridium target
108mm x 3mm



A. Giri

Promising Materials

Tungsten	Used in spallation targets with proton fluence 10x AD conditions Prone to corrosion in water High thermal head-room Special alloys under development
Tantalum	Ductile; resistant to fracture Prone to cavitation in pulsed beams
Iridium	Alternative cross-sections (diameter, shape)

Wrap-up

Antiproton Target Key Points

An understanding of the relevant optics is prerequisite

Permanent beamline magnets near a target area constrain tuning and machine development studies

Target and horn tuning is supported by STI

Renovation of the AD Target area has enabled a target development study, now underway

Target exchanges are relatively rapid and simple to carry out

The standard iridium target is near or at its material limits

Irradiated iridium will be studied to discover the mechanism for beam-induced damage

Other materials hold promise to withstand higher proton intensities

Other materials produce a less-ideal antiproton focus and beam capture needs to be accounted for

Prototype targets will be developed and tested at the AD during physics runs