AD Target & Antiproton Intensities
Target area optical layout

- "zero-field" quadrupoles
- permanent magnets
- FTA beamline
- Target
- Magnetic horn
- DI beamline

Diagram showing primary beam, target, low field region, high field region, and current. Graph showing secondary particle distribution with axis labels.
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

$z = \text{reference optics}$
$z = \text{reference optics} - 130$ mm
$z = \text{drawings}$
Primary beam

Secondary emittance vs z

50 % of maximum
maximum acceptance at focal point
50 % of maximum

\[ \Delta z = 50 \text{ mm for acceptance } \pm 1 \text{ mm, } \pm 80 \text{ mrad} \]

Measure acceptance from yield vs. proton $\sigma_x \sigma_y$

Target geometry directly related to downstream acceptance

NB Overall effect is product of X-acceptance with Y-acceptance
Target Tuning
Target & horn tuning

Front view with internal references 1:2

G. Matulenaite

Contour plot of antiproton yield

set-point August 2022 +15 %

set-point June 2022
Proton Intensity
Proton beam

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 $1.5 \times 10^{13}$
New available intensity at target $1.9 \times 10^{13}$ (+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

Pre-LS2 target

C. Torregrosa et al.

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

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

<table>
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<th>Material</th>
<th>Description</th>
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| 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