DUMP DESIGN FOR TAILCLIPPER

R. Chamizo

N. Chritin, D. Grenier, L. Massidda, R. Rocca

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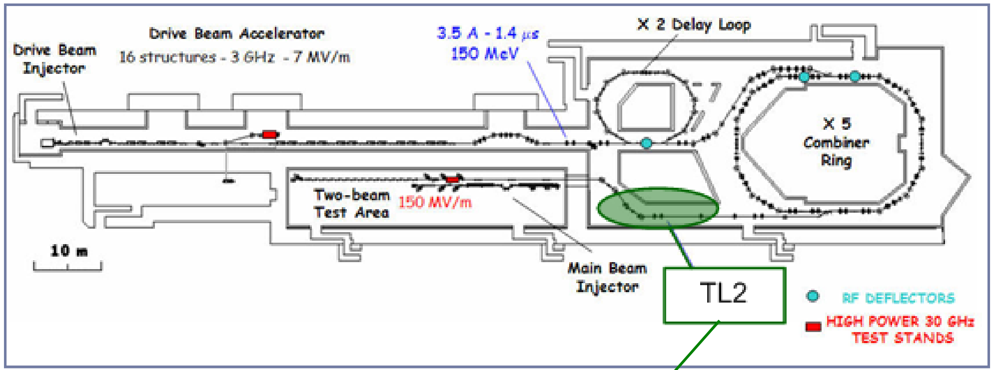
Outlook

- **Introduction – Tailclipper**
  - Description of the tailclipper
  - Design parameters - Beam parameters
  - Operation mode
- **Preliminary design - Status**
  - Vacuum chamber – Design status
  - Mechanical design
  - Integration
- **Conclusions**

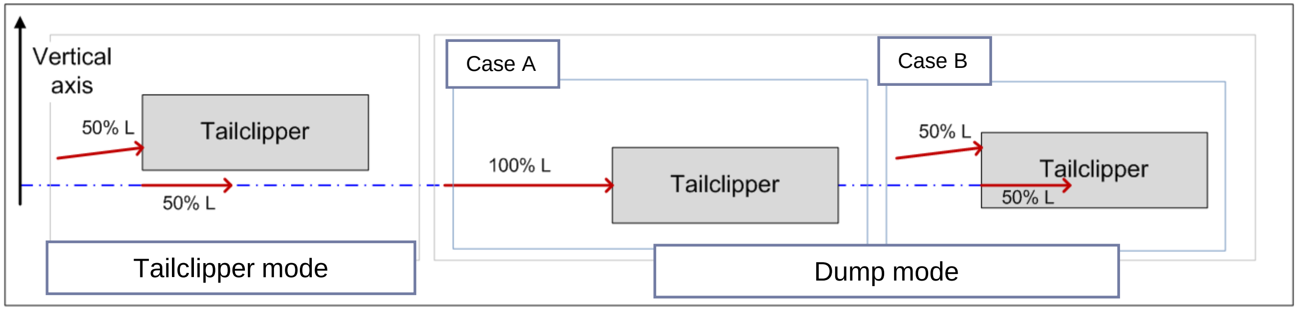
Description of the Tailclipper

- **The TL2 Tailclipper is a dump with two functions:**

1. **Adjust the bunch train length arriving from the combiner ring – *Tailclipper mode* :**
   - The tailclipper dumps the bunch deviated by the kicker in the vertical plane (~50% of the bunch train length). The rest of the bunch is not affected
2. **Act as an internal safety device – *Dump mode*:**
   - Dump of 100% of the bunch train length (in a continuous way)



At the exit of the combiner ring, a kicker displaces the beam in the vertical direction

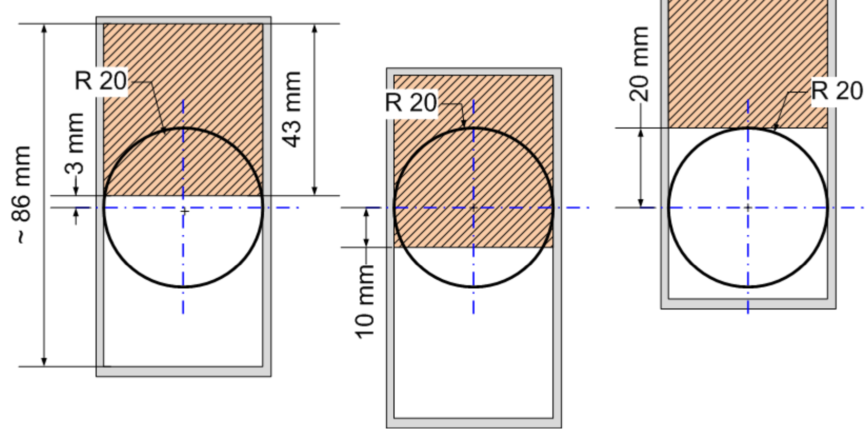


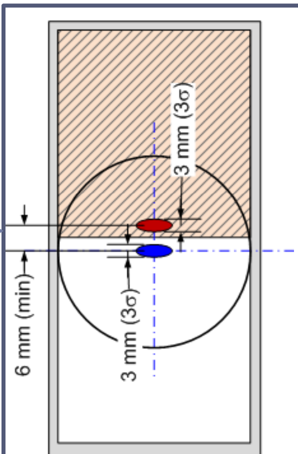
Design parameters

Particle type	**Electrons**
Beam energy	**100-300 MeV**
Repetition rate	**0.8-5.0 Hz**
Incoming pulse duration	**140 ns**
Maximum beam pulse current	**35 A**
Operation of the kicker	The beam is kicked upside, in the vertical plane
Beam size range (rms, 1σ)	**2-5 mm (horizontal plane); 1 mm (vertical plane)**
Displacement of beam on the tailclipper entry face due to kicker action	**> 6 mm**
Maximum average beam power	**3.7 kW**
Duty time	2000 h/year
Energy for maximum beam power	150 Mev
Length of the tailclipper (flange to flange)	1200 mm
Distance to the kicker (upstream to upstream)	3620.6 mm
Inner aperture of diameter of upstream and downstream beam pipe	40 mm
Flatness of the jaw	0.1mm
Positioning resolution in the movement of tailclipper	0.1 mm
Precision of tailclipper	0.3mm
Compatible with RF	No grooves; angles smaller than 20 deg.
Compatible with CTF3 dematerialized water line	Material of the cooling pipes: Cu, CuNi...
Compatible with CTF3 vacuum	~10^{-8} mbar
Compatible with radioprotection requirements	Radiation shielding if needed
Maximum time range to reach failsafe position	30 s

Operation: Tailclipper and Dump modes
Moving ranges

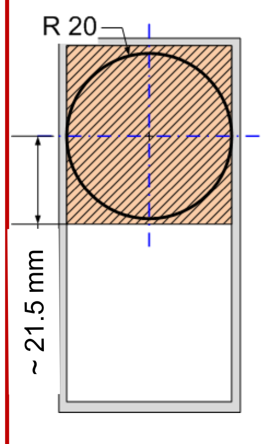
Tailclipper mode

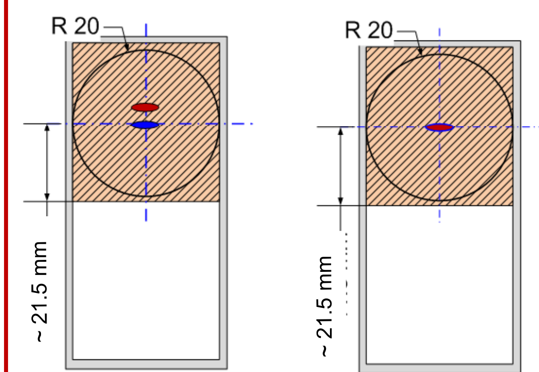




Tailclipper mode:
Minimun distance between kicked and passing beam: 6mm

Dump mode





Dump mode:
With kicked beam (50% + 50%)

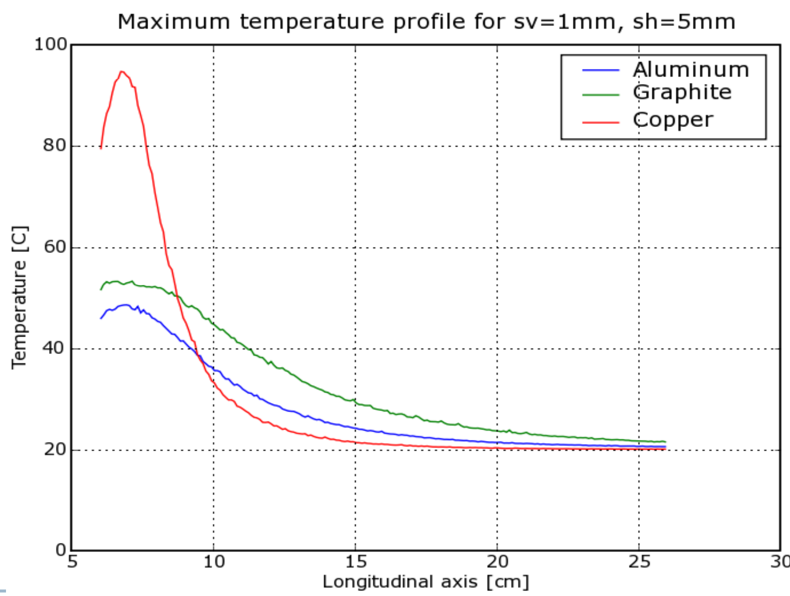
Dump mode:
With no kicked beam (100%)

Vacuum chamber design: Jaw material I

- **FLUKA and ANSYS simulations for normal dump operation:**
  - Materials studied: Al, Cu, graphite
  - Nominal beam size (σv=1mm, σh=5mm); impact centered in the jaw

- **E= 150MeV; 5 bunches/s; P=3.7kW <=>735 J/pulse**
- **No cooling**

	Aluminum		Copper		Graphite	
	Simulation results	Tensile Yield Strength	Simulation results	Tensile Yield Strength	Simulation results	Tensile Yield Strength
Δt (140ns)	23 C	~ 55 MPa	70 C	~ 70 MPa	34 C	30 MPa
Δt (200ms)	5 C		10 C		6 C	
Max. Static Stress	37 MPa		136 MPa		1.2 MPa	



× **Copper is not an adequate material for this application**

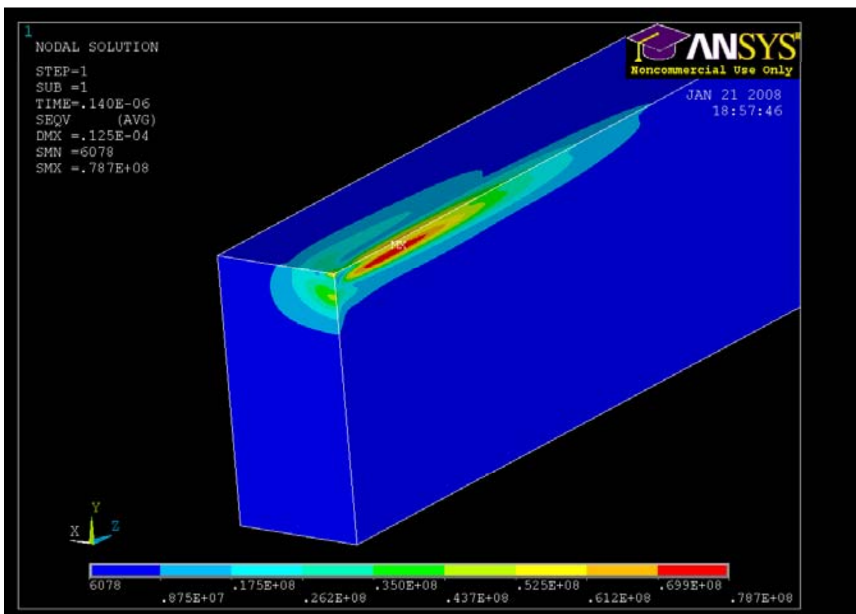
Vacuum chamber design: Jaw material II

FLUKA and ANSYS simulations for worst dump case:

- E= 150MeV; 5 bunches/s; P=3.7kW <=>735 J/pulse
- No cooling

1. Beam size: **(σv=1mm, σh=2mm)** (during setting-up)
2. Beam dumped at 1.3mm from the surface of the jaw (based on past calculations: *"Thermal and Mechanical Analysis of the LHC Injection Beam Stopper (TDI)"* , L. Massida and F. Mura)

	Aluminum		Graphite	
	Simulation results	Tensile Yield Strength	Simulation results	Tensile Yield Strength
Δt (140ns)	58 C	~ 55 MPa	78 C	30 MPa
Δt (200ms)	11 C		13 C	
Max. Static Stress	79 MPa		2 MPa	



× **Aluminum is not an adequate material for this application**

✓ **Graphite is the only material that withstands the operation conditions within the ones considered**

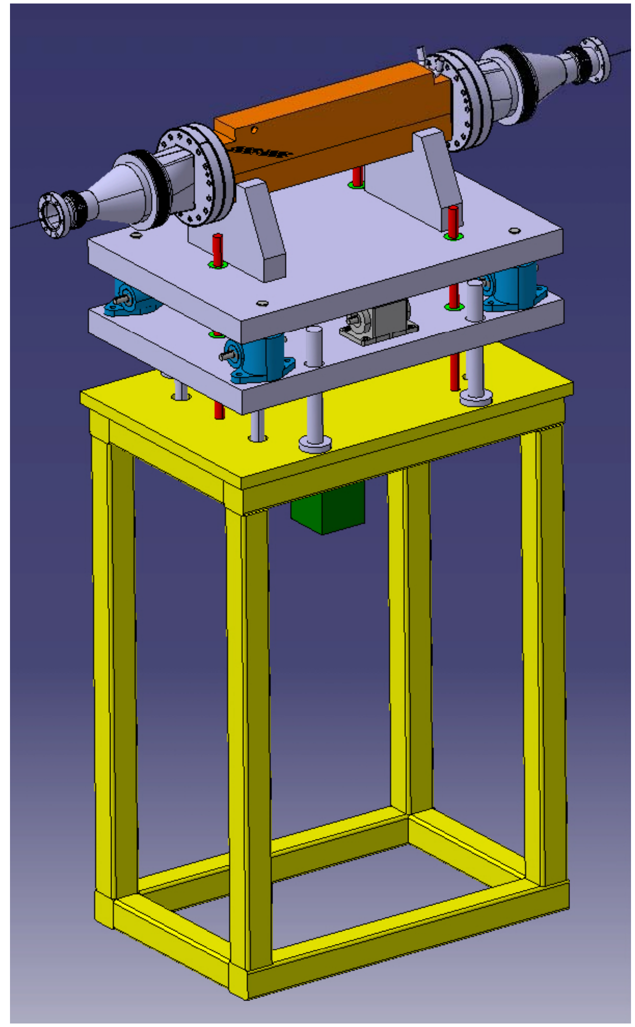
Preliminary mechanical design I

I. Movable vacuum chamber - Jaw

- The jaw is fixed to the vacuum chamber. The whole ensemble moves during the operation (tailclipper and dump)

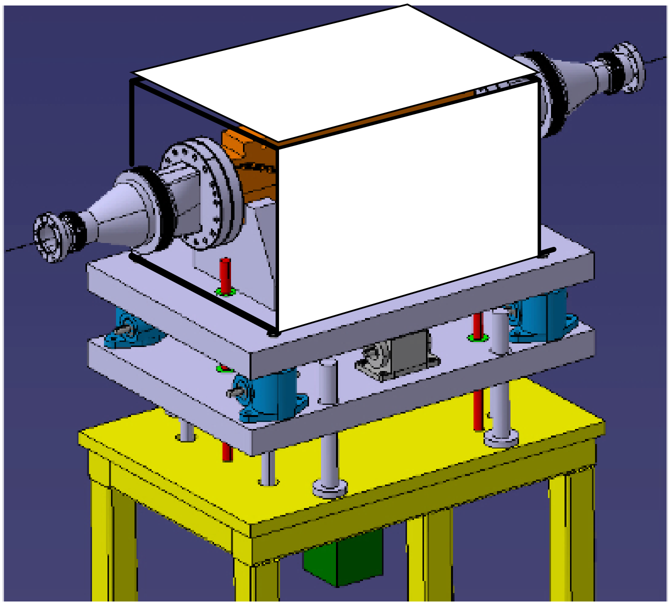
II. Support and mechanical tables

1. ***The upper table allows the movement ranges for the tailclipper operation with the required resolution and precision***
   - The movement range is procured by a stepper motor that commands 4 screw jacks
   - One potentiometer serves to monitor the displacement and detect a hypothetical motor failure.
   - The maximum and minimum range of movements are limited by end switches and mechanical stops
2. ***The lower table guarantees the positioning of the tailclipper for dump operation***
   - The pneumatic system guarantees that the dump position can always be reached (Tailclipper's own weight)
     - The rapidity of the system can be regulated. A safe movement is possible within 3s (safety requirements: within 30s)
   - The maximum and minimum range of movements are limited by end switches and mechanical stops



Preliminary mechanical design II

- **Shielding (under study)**
  - The design of the shielding is in progress (depends directly on the material and geometry of the jaw)
  - Present considerations:
    - **The shielding is placed on the upper table and covers the vacuum chamber over the jaw length**
    - **Advantage: All parts outside the vacuum chamber are shielded**

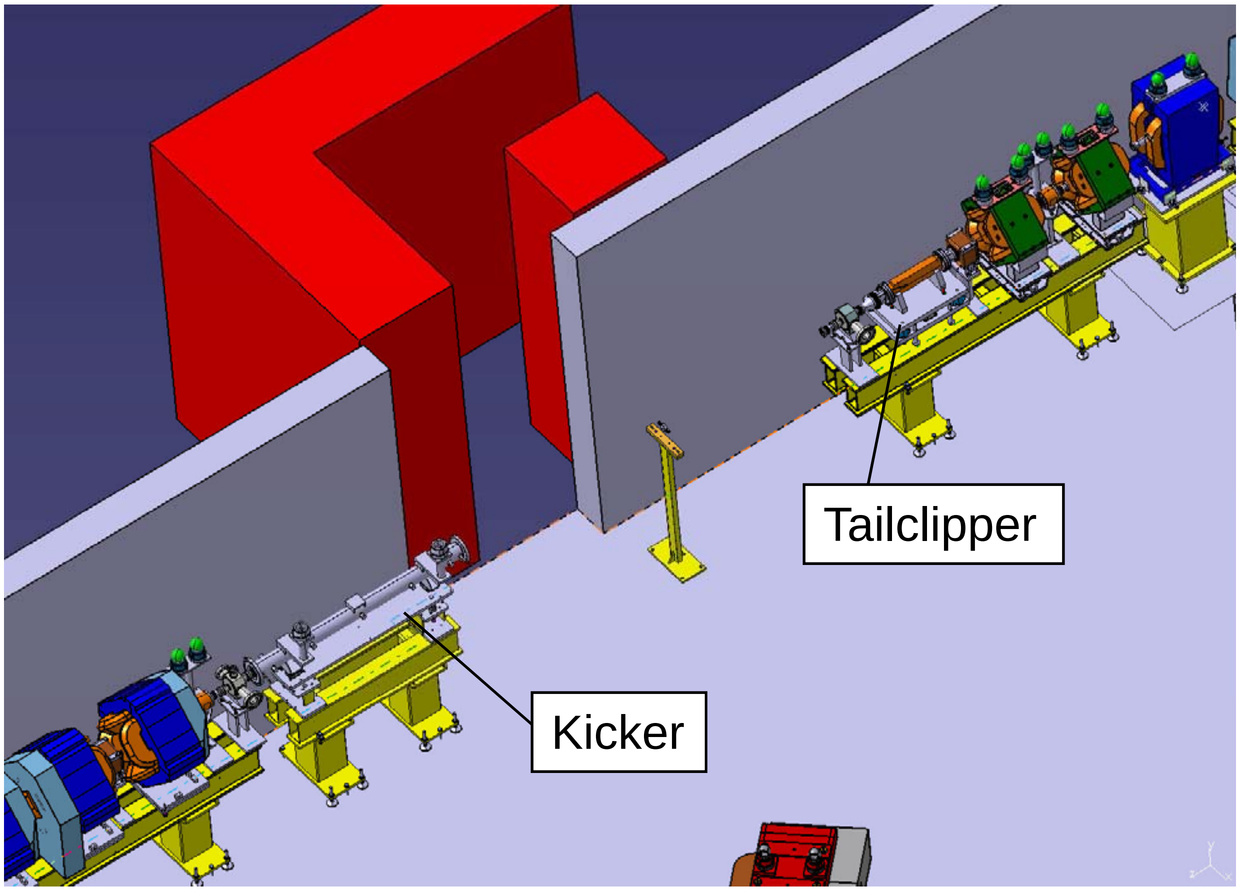


- **Accessibility (under study)**
  - Such a design of the shielding would allow:
    - **Intervention on the electronics and mechanics of the tailclipper without removing the shielding**
    - **Only in case of replacement of the tailclipper, the shielding should be removed**

R. Chamizo AB/ATB-TD
CTF3 Collaboration technical meeting

22/01/2008

Integration - TL2



- **Space in the line is already assigned**
  - Maximum length: 1200mm
- **From TL2 line, we need:**
  - De-mineralized water line (cooling)
  - Compressed air line (pneumatic system)
  - Power supply for electronics

Conclusions

- **The Tailclipper has to be installed in <u>September 2008</u>**
- **Design of the vacuum chamber/jaw - In progress:**
  - **The FLUKA and ANSYS simulations conclude that graphite is the only acceptable material ✓**
    - Tests (to be defined) will have to be performed in order to confirm **vacuum** compatibility (10^{-8} mbars in the line) of the graphite
    - Design of the **cooling system** - Materials, brazing…
    - Confirmation on **impedance** and **RF issues**
- **Mechanical design of the support and tables - Done**
  - **Robustness and simplicity of components (standard) ✓**
  - **Controllable and safe movable mechanism for both tailclipper and dump modes ✓**
  - **The pneumatic system guarantees the failsafe position in operation condition ✓**
- **Design of the shielding and integration/accessibility issues - In progress**
  - **Final design depends on the final design of the jaw**