Nb_3Sn cabling activities at EPFL-SPC

X. Sarasola

SWISS PLASMA CENTER

January 16th, 2026

Outline

- EDIPO2 prototype cable:
  - Prototype cable: MAG-T.04.01-T001-D001
  - Sub-scale coil : MAG-T.04.01-T002
- Short length TF conductor (RW5):
  - Cabling: MAG-T.01.01-T048-D004
  - Sample assembly: ~~MAG-T.01.01-T048-D001~~ (new task required)
  - Test in SULTAN: ~~MAG-T.01.01-T048-D002~~ (new task required)
- Insert coil conductor (RW6):
  - Strand: MAG-T.04.03-T001-D002
  - Cabling: MAG-T.01.01-T048-D004
  - Stabilizer: MAG-T.01.01-T018-D009
  - Heat treatment, industrial assembly and test: new tasks required
- Short length PF conductor (RW7):
  - Strand and stabilizer: MAG-T.01.01-T018-D009
  - Cabling: MAG-T.01.01-T048-D004
  - Assembly and test in SULTAN: new task required
- Double-jacket for CS conductor:
  - Industrial feasibility study: MAG-S.01.02-T003-D001
  - Demonstration on dummy conductor: ~~MAG-S.01.02-T007-D001~~ (new task required)

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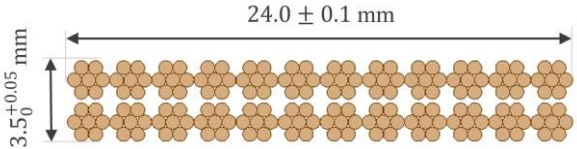
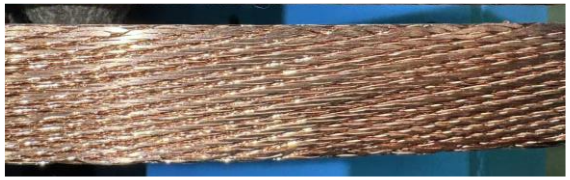
EDIPO2

- **EDIPO2 prototype cable (MAG-T.04.01-T001-D001):**
  - Contract awarded to **WST** in July 2024 to produce:
    - Copper dummy cable: 100 m (bare) + 500 m (insulated).
    - Insulated superdummy cable ~120 m, made of unstable KAT strand.
    - Insulated EDIPO2 prototype cable ~140 m, made of Bruker RRP strand.
  - **All cable lengths were delivered in October 2025** to be used in:
    - Industrial R&D activities for EDIPO2 at ASG (Swiss funding)
    - ~~EDIPO2 cable tests in SULTAN: MAG-T.04.01-T001-D001.~~
    - EDIPO2 sub-scale coil test in SULTAN: MAG-T.04.01-T002.

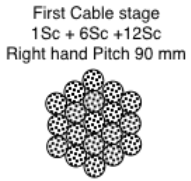


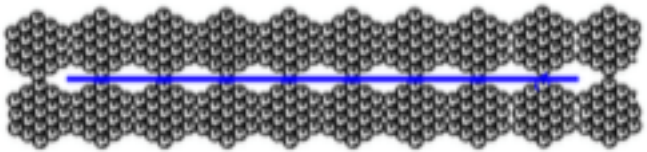


- **Final EDIPO2 strand (Swiss funding):**
  - Contract awarded to **Bruker** in May 2025.
  - Production expected to be completed Feb 2026.
- **Final EDIPO2 cable (Swiss funding):**
  - Adjudication of the call expected to be published in the coming days.
  - Production expected to be completed in 10 months after reception of the Nb_3Sn wires.

Short length prototypes: TF conductor (RW5)

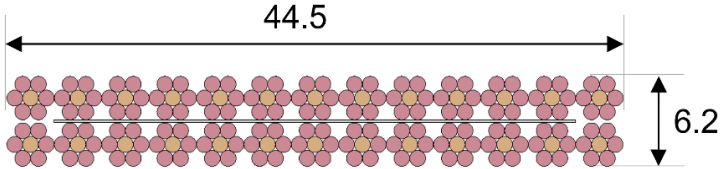
- The **high-grade TF conductor R&D** at SPC was based since 2018 on the **KAT** Nb_3Sn strands:
  - RW3 (66 kA) and RW4 (105 kA)
- The **unstable behavior of the strand** (identified in 2022) led to instability in both RW3 and RW4.
- To demonstrate the 100 kA conductor layout, the **production of RW5** was launched in 2022:
  - RW5 is identical to RW4, but made of **WST Nb_3Sn strands** (more stable).
  - The **strand** for RW5 was **procured from WST in 2023**: MAG-T.01.01-T018-D002.
  - The **cabling of RW5:**
    - **WST was qualified** in 2024 using a Cu-dummy (MAG-S.01.02-T005-D001).
    - **WST was awarded the Nb_3Sn cabling contract** in March 2025 (MAG-T.01.01-T048-D004).
    - **Production** of the Nb_3Sn cable is **expected in January 2026.**
  - The **stabilizer** for RW5 is already available from the RW4 procurement.
  - The **assembly and test of RW5 in SULTAN should follow in 2026**:
    - **New task required for 2026** (MAG-T.01.01-T048-D001 and D002 were withdrawn in late 2025).



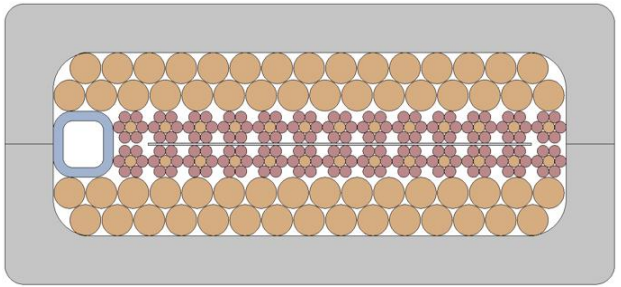


Insert coil conductor (RW6)

- The **final design** of the insert coil conductor is relevant for the **DEMO CS**:
  - **Nb_3Sn strand**: 1.2-mm-diam internal tin, j_c > 1100 A/mm^2 at 12T and 4.2 K, Cu:non-Cu =1.0
  - **Cable**: RW, fully transposed, I_{op} = 45.6 kA at 13 T

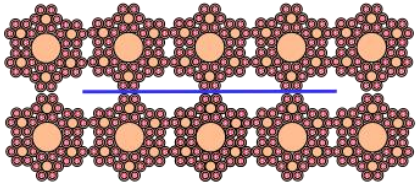


- The **Nb_3Sn strand** was produced at **WST in Oct 2025** (MAG-T.04.03-T001-D002)
- **Cabling is ongoing at WST** (MAG-T.01.01-T048-D004):
  - Satisfactory Cu and Nb_3Sn samples (Jan 2026).
  - Production of 100 m of Nb_3Sn cable in Q1 2026.
- **Stabilizer** cable order with WST (MAG-T.01.01-T018-D009), ~395 m, delivery Q2 2026. It will be used for the insert coil conductor and the PF prototype.
- **New tasks in 2026-2027** to complete this R&D:
  - Heat treatment of the Nb_3Sn cable
  - Industrial assembly and laser welding of the conductor
    - 100 m of copper dummy for trials would be desirable
  - Test in SULTAN
- Test in the Naka test facility as an insert coil?



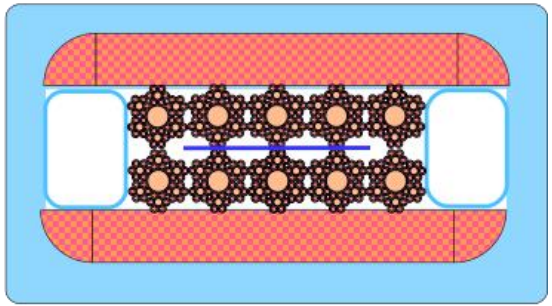
Short length prototypes: PF conductor (RW7)

- **Design** of the **high-current PF conductor** (MAG-S.01.01-T018-D004):
  - **Nb_3Sn strand**: 0.9-mm-diam bronze strand, low hysteresis loss (< 200 mJ/cm^3), j_c > 900 A/mm^2 at 12T & 4.2 K, Cu:non-Cu =1.5
  - **Cable**: RW, three-stage, fully transposed.
  - Cabled **stabilizer** with Cu/CuNi for low eddy loss.



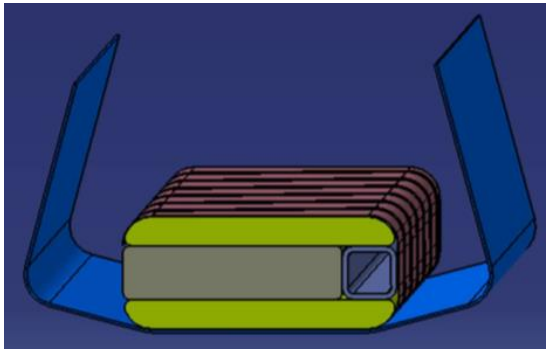
- The **Nb_3Sn strand** was produced at **WST in Oct 2025** (MAG-T.01.01-T018-D009)
- **Cabling is ongoing at WST** (MAG-T.01.01-T048-D004):
  - Cu sample received in Jan 2026.
  - Expected completion in Q2 2026.

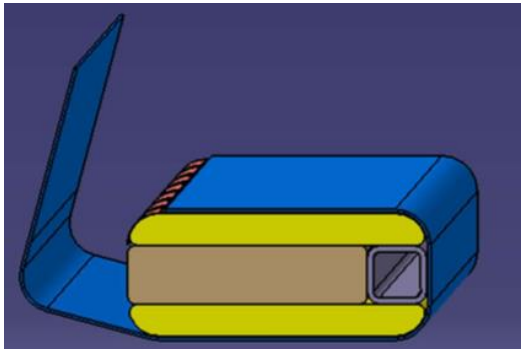
- **Stabilizer** cable order with WST (MAG-T.01.01-T018 -D009), ~395 m, delivery Q2 2026. It will be used for PF short prototype and the insert coil conductor.
- We need a **new task in 2026** to complete this R&D:
  - Assembly of the PF conductor
  - Test in SULTAN

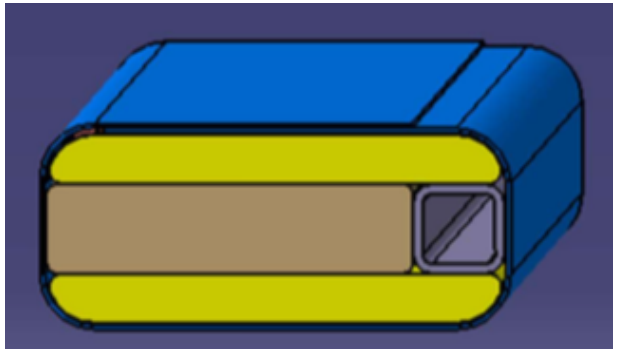


Double-jacket for CS conductor

- To **separate** the **structural** and **hydraulic functions** of the **CS jacket**, a thin, soft jacket is introduced between the thick steel jacket and the cable/stabilizer assembly.
- The **feasibility** of such design option was evaluated in the **industrial study with SEA ALP** (MAG-S.01.02-T003). The jacket is a 0.5 mm strip of **pure Titanium**, folded and laser welded along the cable in a dedicated reel-to-reel process.







- A **demonstration based on dummy conductor** was planned in 2025 (MAG-S.01.02-T007-D001):
  - **100 m of RW5 copper dummy conductor** have been produced at WST in 2025 (MAG-T.01.01-T048-D004)
  - **2×100 m of dummy stabilizer** will be likely available in Q2 2026 (MAG-T.01.01-T018-D009).
  - We launched a call for tender and identified an **industry willing to perform this work** for the existing budget.
- We need a **new task in 2026** to perform this **demonstration based on a dummy conductor.**