A EUROPEAN ADVANCED TECHNOLOGY PROGRAMME FOR ADS ACCELERATOR DEVELOPMENT

IP-EUROTRANS · Integrated Project on European Transmutation

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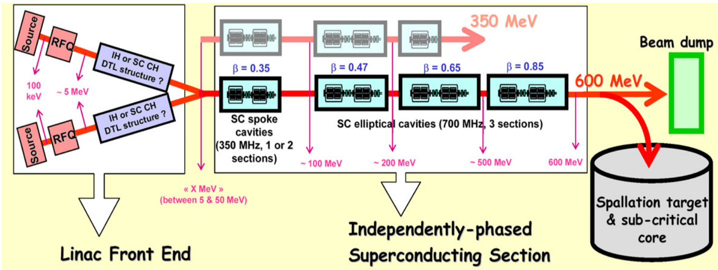
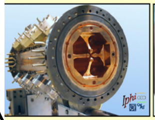
THE XADS REFERENCE ACCELERATOR

Proton beam parameters	Nominal values
Max. beam intensity	6 mA CW on target (10 mA rated)
Proton energy	600 MeV (including 800 MeV upgrade study)
Beam entry	Vertically from above
Number of Beam Trips	Less than 5 per year (exceeding 1 second)
Beam Stability	Energy: ± 1 %, Intensity: ± 2 %, Size: ± 10 %
Beam footprint on target	Gas-cooled XADS: circular ∅ 160 mm LBE-cooled XADS: rectangular 10×80 mm MYRRHA: circular, "donut" ∅ 72 mm
Intensity modulation	0.2 ms "interruptions" in CW beam for neutronics measurements, repetition frequency 0.01 - 1 Hz

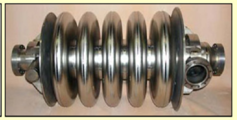




IPHI RFQ (CEA/CNRS)

CH-DTL prototype (IAP-FU)

β=0.35 spoke cavity (CNRS)



β=0.47 ellipt. cavity (INFN)

THE KEY ISSUE: RELIABILITY

GOAL: LESS THAN 5 BEAM TRIPS PER YEAR !

=> Reliability-oriented design based on:

1.OVER-DESIGN & REDUNDANCY:

=> components MTBF have to be optimized

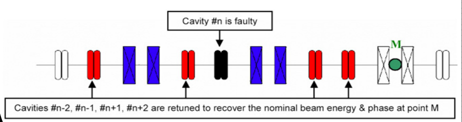
=> critical components must run below their maximal performance (de-rating principle)

=> redundant configurations must be used whenever possible, e.g. for the linac front end

2.FAULT-TOLERANCE

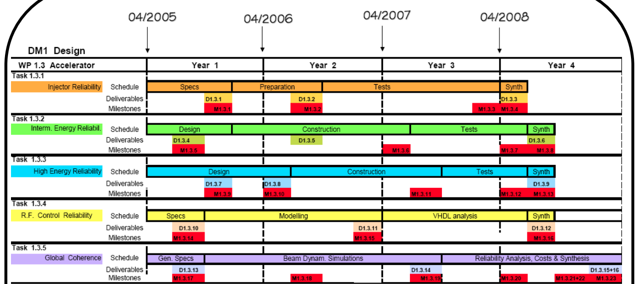
=> the system must have the ability to perform its duty even if some components are faulty; this is especially relevant for SC cavities' RF systems whose MTBF is poor

=> the "local compensation method" should allow to implement this fault-tolerance concept in the SC linac (see also Olry TuP38)



# faulty cavity	section	Final energy	Emittance growth (%)		Number of retuned cavities (before + after)	Max ΔEacc (%)	Max E_{pk} (SP) or B_{pk} (EL)	Max ΔPower (%)
			Transv.	Long.				
0	-	Nominal	+ 5 %	0 %	-	-	-	-
1	SP 0.15	Nominal	+ 7 %	+ 4 %	0 + 4	+ 67 %	19 MV/m	+ 67 %
2	SP 0.15	Nominal	+ 9 %	+ 12%	1 + 3	+ 90 %	19 MV/m	+ 68 %
3	SP 0.15	Nominal	+ 10%	+ 12%	2 + 3	+ 94 %	21 MV/m	+ 56 %
4	SP 0.15	Nominal	+ 9 %	+ 4 %	3 + 3	+ 46 %	15 MV/m	+ 35 %
19	SP 0.15	Nominal	+ 6 %	+ 6 %	2 + 3	+ 38 %	24 MV/m	+ 48 %
20	SP 0.15	Nominal	+ 9 %	+ 4 %	3 + 2	+ 37 %	26 MV/m	+ 58 %
35	SP 0.15	Nominal	+ 6 %	0 %	2 + 3	+ 20 %	32 MV/m	+ 27 %
36	SP 0.15	Nominal	+ 7 %	+ 4 %	3 + 3	+ 22 %	34 MV/m*	+ 32 %
37	SP 0.35	Nominal	+ 6 %	0 %	3 + 2	+ 22 %	35 MV/m*	+ 34 %
38	SP 0.35	Nominal	+ 7 %	+ 6 %	3 + 4	+ 29 %	31 MV/m	+ 26 %
39	SP 0.35	Nominal	+ 5 %	+ 5 %	4 + 2	+ 24 %	36 MV/m*	+ 35 %
61	SP 0.35	Nominal	+ 6 %	+ 2 %	2 + 3	+ 25 %	31 MV/m	+ 26 %
62	SP 0.35	Nominal	+ 6 %	0 %	2 + 2	+ 26 %	31 MV/m	+ 28 %
63	SP 0.35	Nominal	+ 5 %	+ 1 %	3 + 2	+ 25 %	31 MV/m	+ 27 %
94	SP 0.35	Nominal	+ 6 %	+ 2 %	3 + 3	+ 16 %	29 MV/m	+ 18 %
95	SP 0.35	Nominal	+ 7 %	- 1 %	3 + 3	+ 22 %	31 MV/m	+ 29 %
96	SP 0.35	Nominal	+ 5 %	+ 1 %	4 + 2	+ 21 %	30 MV/m	+ 25 %
97	EL 0.47	Nominal	+ 6 %	0 %	3 + 3	+18 %	59 mT	+27 %
98	EL 0.47	Nominal	+ 6 %	0 %	3 + 2	+ 23 %	62 mT	+ 31 %
109	EL 0.47	Nominal	+ 6 %	0 %	3 + 3	+ 20 %	60 mT	+ 28 %
110	EL 0.47	Nominal	+ 6 %	0 %	3 + 2	+ 20 %	60 mT	+ 29 %
123	EL 0.47	Nominal	+ 6 %	0 %	2 + 4	+ 20 %	60 mT	+ 26 %
124	EL 0.47	Nominal	+ 6 %	0 %	3 + 3	+ 19 %	60 mT	+ 28 %
125	EL 0.65	Nominal	+ 5 %	0 %	2 + 3	+ 18 %	59 mT	+ 27 %
126	EL 0.65	Nominal	+ 5 %	0 %	3 + 4	+ 21 %	61 mT	+ 20 %
127	EL 0.65	Nominal	+ 5 %	0 %	3 + 3	+ 21 %	61 mT	+ 25 %
146	EL 0.65	Nominal	+ 5 %	0 %	3 + 3	+ 18 %	59 mT	+ 22 %
147	EL 0.65	Nominal	+ 6 %	- 1 %	3 + 4	+ 19 %	60 mT	+ 22 %
148	EL 0.65	Nominal	+ 6 %	- 1 %	3 + 3	+ 20 %	60 mT	+ 22 %
173	EL 0.65	Nominal	+ 5 %	0 %	3 + 4	+ 17 %	59 mT	+ 19 %
174	EL 0.65	Nominal	+ 5 %	0 %	3 + 3	+ 18 %	59 mT	+ 22 %
175	EL 0.65	Nominal	+ 5 %	0 %	4 + 4	+ 17 %	59 mT	+ 18 %
176	EL 0.85	Nominal	+ 5 %	0 %	3 + 5	+ 18 %	59 mT	+ 22 %
177	EL 0.85	Nominal	+ 5 %	0 %	4 + 4	+ 18 %	59 mT	+ 20 %
178	EL 0.85	Nominal	+ 5 %	0 %	5 + 4	+ 18 %	59 mT	+ 19 %
179	EL 0.85	Nominal	+ 5 %	0 %	6 + 4	+ 17 %	59 mT	+ 16 %
184	EL 0.85	Nominal	+ 5 %	0 %	4 + 3	+ 17 %	59 mT	+ 29 %
185	EL 0.85	Nominal	+ 6 %	0 %	5 + 2	+ 19 %	60 mT	+ 30 %
186	EL 0.85	Nominal	+ 7 %	0 %	6 + 1	+ 21 %	61 mT	+ 33 %
187	EL 0.85	Nominal	+ 6 %	0 %	7 + 0	+ 25 %	63 mT	+ 37 %

THE R&D PROGRAMME



TASK 1: Experimental evaluation of the proton injector reliability *(CEA, CNRS)*

=> long-run test of IPHI, scheduled end of 2007

TASK 2: Assessment of the reliability performances of the intermediate energy accelerating components *(CNRS, IBA, IAP-FU, CEA)*

=> construction & test of prototypes (SC spoke, SC CH-DTL, NC IH-DTL) before 2009

=> determination of the energy transition up to where the injector has to be doubled for reliability

TASK 3: Qualification of the reliability performances of a high-energy cryomodule at full power and nominal temperature *(INFN, CNRS, CEA)*

=> design, construction and test of a full prototypical β=0.5 cryomodule before 2009

TASK 4: Conceptual design of an RF control system for fault-tolerant operation of the linear accelerator *(CEA, CNRS, IBA, INFN)*

=> modelling and VHDL analysis of a digital LLRF control system suited to fault-tolerant operation

TASK 5: Overall coherence of the accelerator design, final reliability analysis, cost estimation of XT-ADS and EFIT *(CNRS, CEA, INFN, ITN, IBA, UPM, IAP-FU, FANP-GmbH, ANS)*

=> beam dynamics simulations for fault-tolerance

=> integrated reliability analysis & cost analysis

=> freezing of the XT-ADS linac reference scheme in 2009

RELATED SRF ACTIVITIES @IPNO

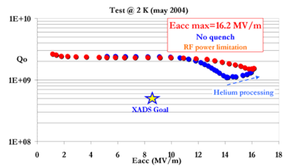
350 MHz SPOKE CAVITIES (see also Olry TuP38)

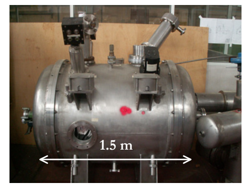
=> test of β=0.15 & β=0.35 2-gap 350 MHz prototypes

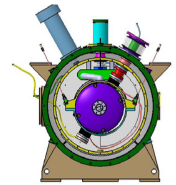
=> helium tank & cold tuning system development

=> power coupler design

2008 PESPECTIVE = test at nominal power in a horizontal cryostat CM0





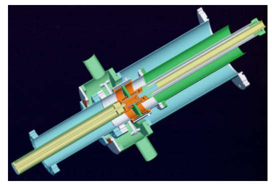


700 MHz ELLIPTICAL CAVITIES

=> test of a cold tuning system in CryHoLab (see also Saugnac ThP65)

=> development of a 150 kW CW coupler (see also Souli ThP53)

2008 PESPECTIVE = assembling and test of a full prototypical β=0.5 cryomodule, together with INFN Milano



LLRF DEVELOPMENTS & BEAM DYNAMICS SIMULATIONS

=> construction of a prototypical 350 MHz digital LLRF control system, together with CNRS/IN2P3/LPNHE

=> analysis of the SC linac fault-tolerance capability, and development of realistic fault recovery scenarios

2008 PESPECTIVE = assessment of the SC linac fault-tolerance capability