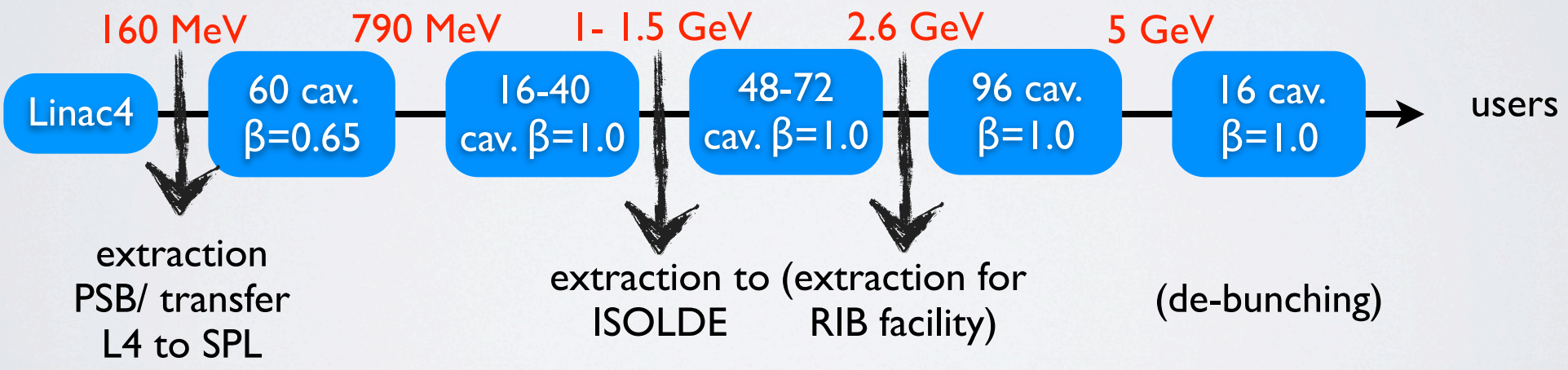
SPL ARCHITECTURE & PARAMETER SPACE

F Gerigk



OVERVIEW

- new mandate,
- conclusions from last meeting,
- parameter consolidation, definition of new "nominal" & "ultimate" scenarios for cryogenics,
- other progress,

NEW MANDATE FROM THE MANAGEMENT:

- write-up of LP-SPL study until end of 2011,
- focus on a HP proton driver for neutrino physics (& possibly RIB),
- R&D on SC cavities for such a machine: construct a 4-cavity "short" cryo-module,
- suspend work on civil engineering and integration.

presently focus on parameters for a neutrino driver!

SPL architecture & parameters, F. Gerigk, SPL/ESS collaboration meeting 30.6 - 2.07 2010, Lund

MILESTONE 1: SEPARATE CRYO-MODULES

after cryo-segmentation workshop (9-10 Nov. 2009) and 3d the collaboration meeting (11-13 Nov. 2009)

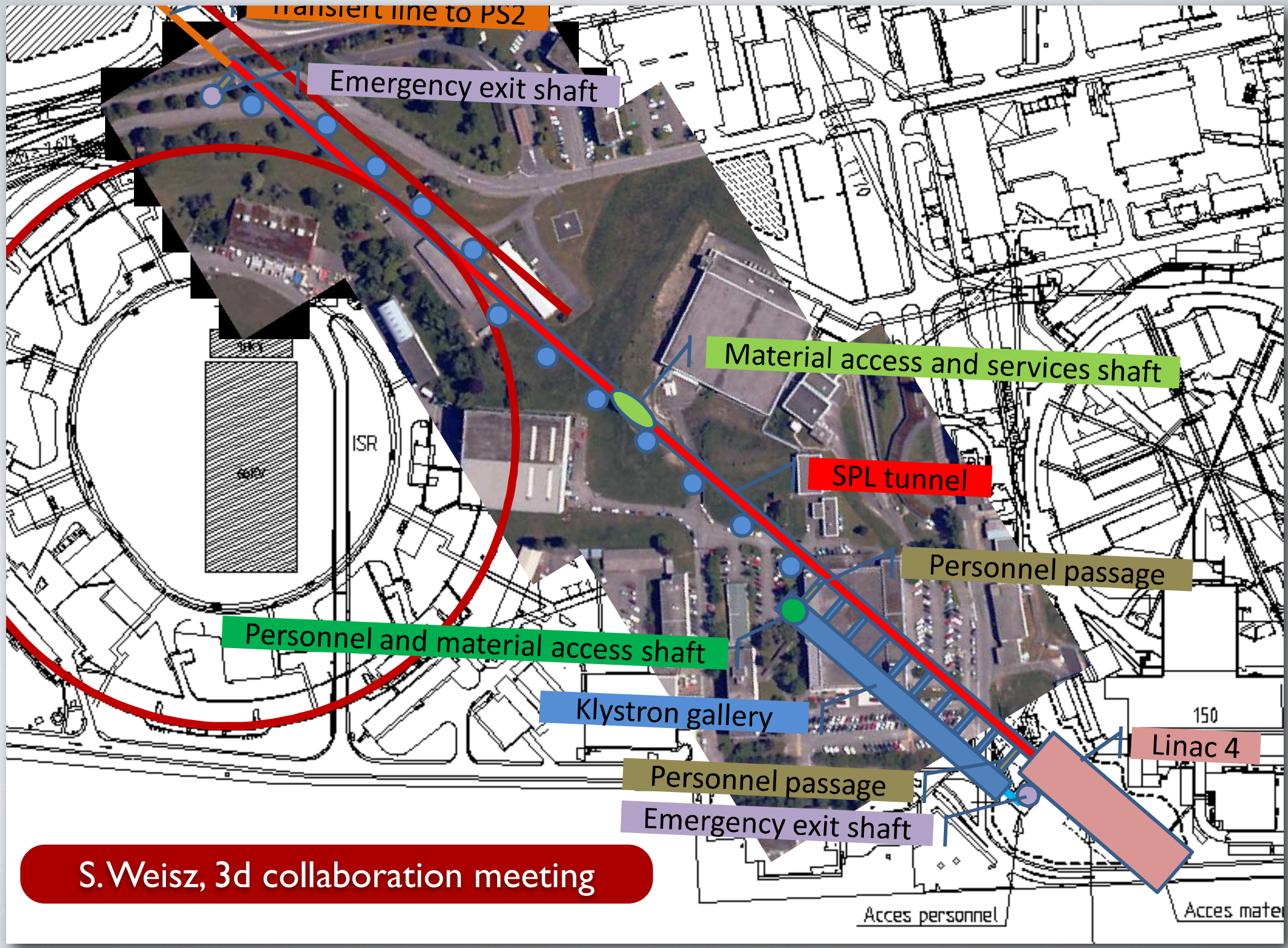
- quick exchange of single modules (promise of faster commissioning),
- slightly higher initial investment **but much reduced risk in case of a vacuum leak**,
- possibility of warm quads: i) easier alignment of quads, ii) simpler cryo-module design, iii) more flexible operation, iv) avoids safety issues with cold quads, v) higher power consumption,
- no margin (in terms of tunnel length) to have more cavities in order reach 5 GeV in case of lower than expected cavity performance, but since it easier to take modules out for reprocessing we will be less punished by under-performing cavities.
- use of FFDD lattice becomes mandatory.

confirmed!

MILESTONE 11: KLYSTRONS ON THE SURFACE

present baseline!

- potential cost saving and simplification of civil engineering (safety aspects, space restrictions, installation..),
- simplifies transition from a low-power SPL to a high-power SPL, solves problem of having "compact" HP-SPL modulators, safety aspects easier,
- first calculations indicate LLRF feasibility, similar installations are at work at FNAL (with working LLRF feedback),
- need to address cooling of wave-guides for high-power operation,
- need to find suitable wave-guide geometry (space vs low loss & group delay),
- needs further work on integration and civil engineering.



S. Weisz, 3d collaboration meeting

MILESTONE III: RF SPLITTING

- **LP-SPL:** most likely for we split from one klystron (1.5 MW) to 2 cavities in the high-beta part, and use one source (type of source to be defined) per cavity in the low-beta part,
- **HP-SPL**: use the same klystron and go to 1 klystron per cavity in high-beta part, upgrade low-beta part,
- study option of splitting to 2 cavities in more depth! but **abandon splitting to more than 2 cavities.**
- work needed on wave-guide type/routing, etc.

needs more work!

PARAMETER CONSOLIDATION:

FOCUS ON ONE HIGH-POWER USER: **NEUTRINOS**

design version	**2009**	**2010**
kinetic energy	5 GeV	5 GeV
beam power (@ 4 GeV)	3-8 MW	4 MW
repetition rate	50 Hz	50 Hz
beam pulse length	0.4-1.2 ms	0.4 or 0.8 ms
average pulse current	20/40 mA	40 or 20 mA
chopping ratio	62%	62%
protons p. pulse	$1\text{-}3\times10^{14}$	1×10^{14}
length (SC linac, nominal)	525 m	536 m

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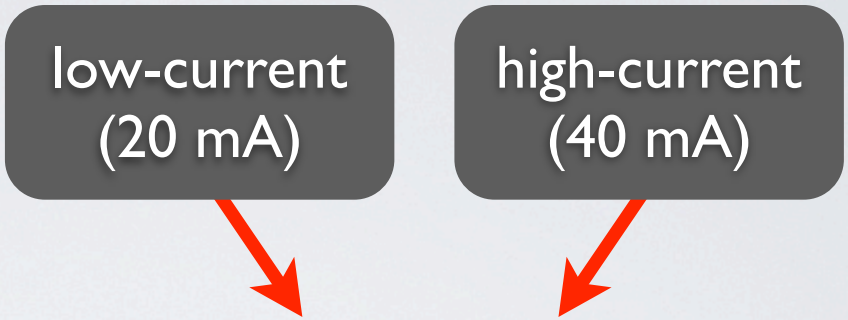
2 OPTIONS TO GET TO 4 MW:



filling time (total) β=0.65	0.75 ms	0.37 ms
filling time (total) β=1	0.76 ms	0.38 ms
beam pulse length	0.8 ms	0.4 ms
RF pulse length (fill+flat top) β=0.65	1.55 ms	0.78 ms
RF pulse length (fill+flat top) β=1	1.56 ms	0.78 ms
beam duty cycle	4%	2%
RF duty cycle	7.8%	3.9%
cryo duty cycle	8.2%	4.1%

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PROS & CONS FOR 20/40 MA

- 40 mA makes accumulation & compression easier,
- 40 mA requires twice the peak power from the klystrons (price difference probably within 20%),
- in both cases splitting the power to 2 cavities seems attractive but still needs to be verified experimentally, (peak power demands from klystrons seem feasible for both cases: ~3 MW/1.5 MW),
- at 20 mA lower peak field demand on modulator, coupler, but the same average power demand,
- 20 mA doubles the load on cryogenics.

CONSOLIDATION OF CAVITY PARAMETERS

design version	**2010**
frequency	704.4 MHz
design beta	0.65/1.0
cells per cavity	5/5
design gradient	19.3/25 MV/m
(R/Q) (linac Ohm)	**290/570**
Q_0	**$6/10 \times 10^9$**

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DEFINITION OF NOMINAL/ULTIMATE PARAMETERS FOR CRYOGENICS

"old" logic

- to go from the nominal to the "ultimate" load case Q0 was halved and the accelerating gradient increased by 10%.

"new" logic

- to go from the nominal to the "ultimate" load case Q0 is halved, the accelerating gradient is kept constant, but we use 20 instead of 40 mA (increased cryo-duty cycle),

DEFINITION OF NOMINAL/ULTIMATE PARAMETERS FOR CRYOGENICS

	b=0.65	b=1
	nominal/ultimate	
cavity bath temperature	2K	2K
beam loss	1W	1W
static loss along modules at 2 K	?	?
static loss at 5-280 K	?	?
accelerating field	**19.3 MV/m**	**25 MV/m**
quality factor	**6/3 x 10^9**	**10/5 x 10^9**
cryo duty cycle	4.09%/8.17%	4.11%/8.22%
power coupler loss at 2 K	**<0.2/<0.2 W**	**<0.2/<0.2 W**
HOM loss in cavity at 2 K	**<1/<3 W**	**<1/<3 W**
HOM coupler loss at 2 K (per coupl.)	**<0.2/<0.2 W**	**<0.2/<0.2 W**
HOM & power coupler 5-280 K	**0.05 g/s**	**0.05 g/s**
dynamic heat load p. cavity	4.2/13.4 W	5.1/16.2 W

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RF needs for SPL SC cavity tests

21 January 2010 *CERN*
Europe/Zurich timezone

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Thu 21/01

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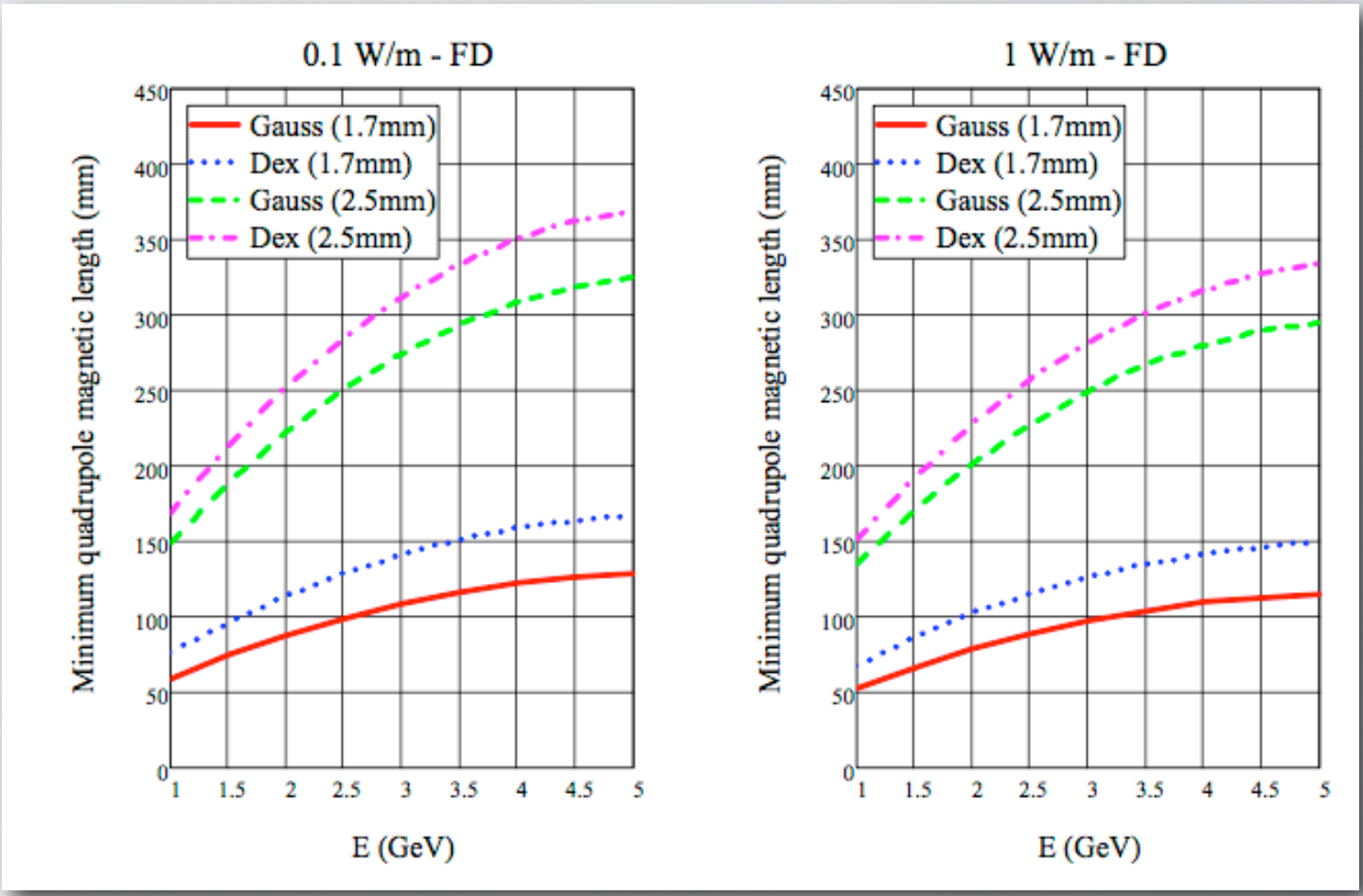
09:00	**Introduction**	*GAROBY, Roland*	
	864-1-D02 (auditorium), CERN	09:00 - 09:15	
	SPL needs for RF tests in SM18	*WEINGARTEN, Wolfgang*	
	864-1-D02 (auditorium), CERN	09:15 - 09:30	
	New plans for high-power RF test places at CERN	*BRUNNER, Olivier*	
	864-1-D02 (auditorium), CERN	09:30 - 09:45	
	Roadmap for SPL high-power modulator development	*NISBET, David*	
	864-1-D02 (auditorium), CERN	09:45 - 10:00	
10:00	**coffee break**		
	864-1-D02 (auditorium), CERN	10:00 - 10:20	
	Discussion on options and collaborations	*CIAPALA, Edmond*	
11:00	*864-1-D02 (auditorium), CERN*	10:20 - 11:20	

since then requirements have been coordinated with Linac4/HIE-Isolde/LHC

Magnetic stripping studies for SPL

P. A. Posocco [1], M. Eshraqi [1, 2]
[1] CERN, Geneva, Switzerland, [2] European Spallation Source, Lund, Sweden

400 mm magnetic length seems save!



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CHANGES TO MEETING SCHEDULE

- **Thursday 9:30**, Progress at TRIUMF is cancelled (subsequent talks & coffee break start 15 min earlier),
- **Thursday 12:15 - 12:30**: Pros and Cons of ESS cryo-module segmentation, A. Ponton,
- **Friday 8:30 (15 min earlier!):** Options for ESS linac lattice, M. Eshraqi,

please upload your talks or have your laptops ready!